CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
STATE OF OREGON
DOGAMI DIVISION 37
CONSOLIDATED PERMIT APPLICATION

NOVEMBER 2019

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November 2019

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ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
µg/m^3	micrograms per cubic meter
µm	micrometer
µS/cm	microSiemens per centimeter
3D	three-dimensional
AADT	average annual daily traffic
AASHTO	American Association of State Highway and Transportation Official
ABA	acid-base accounting
ACEC	Areas of Critical Environmental Concern
ACGIH	American Conference of Industrial Hygienists
ADR	absorption, desorption, and refining
ADT	average daily trips
amsl	above mean sea level
ANFO	Ammonium Nitrate and Fuel Oil
AP	Acidification Potential
ARD/ML	Acid Rock Drainage and Metal Leaching
Atlas	Atlas Precious Metals
ATV	all-terrain vehicle
BATFE	Bureau of Alcohol, Tobacco, Firearms and Explosives
bcy	bank cubic yards
bgs	below ground surface
Bison	Bison Engineering, Inc.
BLM	Bureau of Land Management
BMP	best management practices
BP	barometric pressure
C	Celsius
Calico	Calico Resources USA Corp.
CCC	Criterion Continuous Concentration
CES	Cascade Earth Sciences
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIL	carbon-in-leach
cm/s	centimeters per second
CMC	Criterion Maximum Concentration
CNWAD	weak acid dissociable cyanide
COG	cut-off grade
COOP	Cooperative Observer Network
CPE	corrugated polyethylene
CPT	Cone Penetration test

CRF	cemented rock fill
Cryla Agreement	Exploration and Option to Purchase Agreement Cryla Project
Cryla Project	28 Cryla, Lucky Lucy, and Winter unpatented mining claims
CSAMT	Audio-frequency Magnetotellurics
D&F	drift-and-fill
dB	decibel
De	equivalent dimension
DEM	digital elevation model
DHS	Department of Homeland Security
DO_2	dissolved oxygen
DOGAMI	Department of Geology and Mineral Industries
DPM	diesel particulate matter
drift	horizontal tunnel
dS/m	deciSiemens per meter
DSHA	deterministic seismic hazard analysis
DSL	Department of State Lands
E-Cell	Evaporation Cell
EFU	Exclusive Farm Use
EGL	effective grinding length
EM Strategies	EM Strategies, Inc.
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
Erionite SAP	Erionite Sampling and Analysis Plan
ERU	Exclusive Range Use
ESD	Education Service District
ESI	Environmental Simulations Incorporated
ESR	excavation support ratio
FOS	factors of safety
ft	feet
ft/d	feet per day
ft/hr	feet per hour
ft^2	square feet
ft^3	cubic feet
ft^3/min	cubic foot per minute
g	gram
GCL	geosynthetic clay liner
GIS	geographic information system
Golder Associates Inc.	Golder
gpm	gallons per minute
GPS	Global Positioning System
GV	Groundwater Vistas

H	horizontal
HCT	humidity cell test
HDPE	high-density polyethylene liner
HDR	HDR Engineering, Inc.
HG	high-grade
HHC	human health criteria
hp	horsepower
HSEC	Health, Safety, and Environmental Compliance
ICP	Inductive Couple Plasma
ILR	intensive-leach reactor
IMS	IMS, Inc.
In	inches
ISRM	International Society for Rock Mechanics
JCR	joint condition rating
kg	kilograms
kg/t	kilogram per ton
KOP	key observation points
kV	kilovolt
kW	kilowatts
kWh	kilowatt hour
Lb	length of the bolts
lb/ft^3	pound per cubic foot
lbs	pounds
LCRS	leakage collection and recovery systems
LG	low-grade
LHD	load-haul-dump vehicle
LOM	life of mine
Low PAG	Uncertain Potential/Lower Capacity
MBTA	Migratory Bird Treaty Act
MCC	Malheur County Code
MCE	Maximum Credible Earthquake
MCL	maximum contaminant levels
MDA	Mine Development Associates
MDL	minimum detection limit
MEK	Methyl Ethyl Ketone
mEq/L	milliequivalents per liter
MG	Medium-grade
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeters
mph	miles per hour

MRA	Malheur Resource Area
MSHA	Mine Safety and Health Administration
mtons	million tons
mV	millivolts
MW	megawatt
MWMP	meteoric water mobility procedure
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
NAG	net acid generating
Newmont	Newmont Exploration Ltd.
ng/L	nanogram/liter
NNP	Net Neutralization Potential
Non-PAG	Non-Acid Generating
NP	neutralization potential
NPDES	National Pollutant Discharge Elimination System
NPI	Net Profits Interest
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NSHM	National Seismic Hazard Model
NWC	Northwest Wildlife Consultants, Inc.
NWI	National Wetland Inventory
O_3	ozone
OAR	Oregon Administrative Rule
OBE	operational basis earthquake
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODT	Oregon Department of Transportation
OED	Oregon Employment Department
OGWQG	Oregon Groundwater Quality Guidelines
ONA	Outstanding Natural Area
ONHA	Oregon Natural Heritage Areas
OPDR	Oregon Partnership for Disaster Resilience
ORS	Oregon Revised Statutes
OSP	Oregon State Police
OWRD	Oregon Water Resources Department
oz Au/ton	ounce gold per ton
PAG	potentially acid generating
Paramount	Paramount Gold Nevada Corp.
PEA	Profitability Economic Assessment
PEL	permissible exposure limit

Permit Area	Permit Boundary (Mine and Process Area and Access Road Area)
PFD	Process Flow Diagram
PFS	Prefeasibility Study
PGA	peak ground accelerations
Plan	Plan of Operations
pls	pure live seed
PLT	Point load tests
PM_{10}	particulate matter less than ten microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
portal	surface entrance to underground excavated area to remove ore
ppb	parts per billion
ppm	parts per million
Project	Grassy Mountain Mine Project
PSHA	probabilistic seismic hazard analysis
PVC	polyvinyl chloride
Q	rock mass quality
QA/QC	quality assurance/quality control
RAWS	Remote Automated Weather Stations
RC	reverse circulation
RCE	reclamation cost estimate
RCRA	Resource Conservation and Recovery Act
RF	rock fill
RMR	rock mass rating
RNAs	Research Natural Areas
ROM	run-of-mine
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
RQD	rock quality designation
s.u.	significant unit
Seabridge	Seabridge Gold Corporation
SEM	Scanning Electron Microscopy
SEORMP	Southeastern Oregon Resource Management Plan and Record of Decision
SER	Significant Emission Rates
SHA	seismic hazard analysis
Sherry & Yates	Sherry & Yates Inc.
SHPO	State Historic Preservation Office
SLM	sound level meter
SMBS	sodium metabisulphite
SMCL	secondary maximum contaminant levels
SPF	SPF Water Engineering, LLC

SPLP	synthetic precipitation leaching procedure
SRK	SRK Consulting
st/hr	short tons per hour
st/d	short tons per day
TDS	total dissolved solids
TIC	total inorganic carbon
TLV	threshold limit values
Tombstone	Tombstone Exploration Company Ltd.
tons/hr	tons per hour
TRT	Technical Review Team
TSF	Tailings Storage Facility
U.S.	United States
U.S.C.	United States Code
UCS	uniaxial compressive strength
URMR	underground rock mass ratings
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
V	vertical
VHF	very high frequency
VOC	Volatile Organic Compound
VRM	Visual Resources Management
VWP	vibrating wire piezometers
WAD	weak acid dissociable
WB&M	Willamette Base & Meridian
WEG	Wind Erodibility Group
Wm^2	watts per square meter
WPCF	Water Pollution Control Facility
WRD	waste rock dump
XRD	X-Ray Diffraction Analysis
yd^3	cubic yard

1 INTRODUCTION AND GENERAL INFORMATION

Calico Resources USA Corp. (Calico) proposes to construct, operate, reclaim, and close an underground mining and precious metal milling operation known as the Grassy Mountain Mine Project (Project). The Project is proposed in Township 21 South, Range 44 East (T21S, R44E), and T22S, R44E, Malheur County, Oregon. A detailed description of the Project and location is below.

1.1 Applicant

Operator Name:	Calico Resources USA Corp.
Mailing Address:	665 Anderson Street Winnemucca, Nevada 89445
Phone Number:	(775) 625-3600
Taxpayer Identification Number:	45-2188867

1.2 Registered Agent

CT Corporation System
780 Commercial St SE, Ste 100
Salem, Oregon 97301-3465

1.3 Owners of Surface and Mineral Rights

Surface Rights:
US Bureau of Land Management
Vale District Office
100 Oregon Street
Vale, Oregon 97918
(541) 473-3144

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445
(775) 625-3600

Mineral Rights:
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665 Anderson Street
Winnemucca, Nevada 89445
(775) 625-3600

1.4 Legal Structure of Applicant in Oregon

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Registry Number: 78127694

Principal Place of Business:
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Winnemucca, Nevada 89445

Mailing Address:
665 Anderson Street
Winnemucca, Nevada 89445

President:
Glen van Treek
665 Anderson Street
Winnemucca, Nevada 89445

Secretary:
Glen van Treek
665 Anderson Street
Winnemucca, Nevada 89445

Registered Agent:
CT Corporation System
780 Commercial St. SE, Ste 100
Salem, Oregon 77301-3465

1.5 Authorized Field Representative

Calico personnel, or their agents, will be on site during all Project-related activities, and will be responsible for implementing and ensuring that all activities are completed in accordance with this Permit.

Point of Contact for this Permit Application:
Nancy Wolverson
665 Anderson Street
Winnemucca, Nevada 89445
Phone (775) 770-4615

Corporate Point of Contact:
Carlo Buffone
665 Anderson Street
Winnemucca, Nevada 89445
Phone (775) 625-3600

1.6 Project Location and Access

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 1 and Figure 2). The Permit Area shown in all figures and text shows and describes the boundary of the proposed Project. The Access Road extends north from the Mine and Process Area to the Malheur County Road named Twin Springs Road.

The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres (Figure 3). These patented and unpatented lode mining claims are part of a larger land position that includes 455 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM) Vale District Office (Figure 3). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, T22S, R44E, Willamette Base & Meridian (WB&M).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (WB&M). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or rerouting, and a powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 3), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be approximately 30 feet wide, which includes a 20-foot wide road travel width (ten feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres. All existing and planned roads are shown in Figures 1 and 2 below.

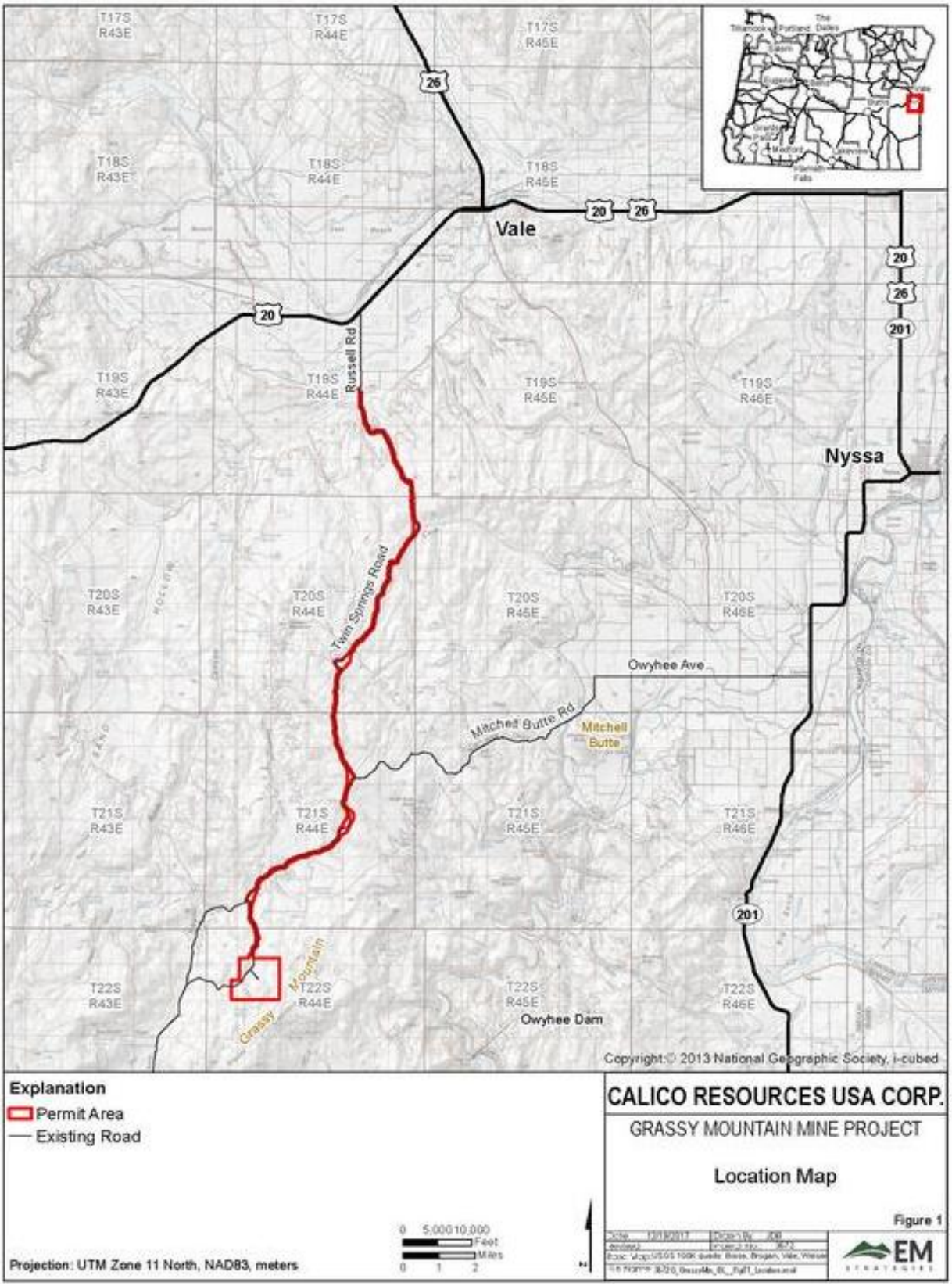


Figure 1. Location Map

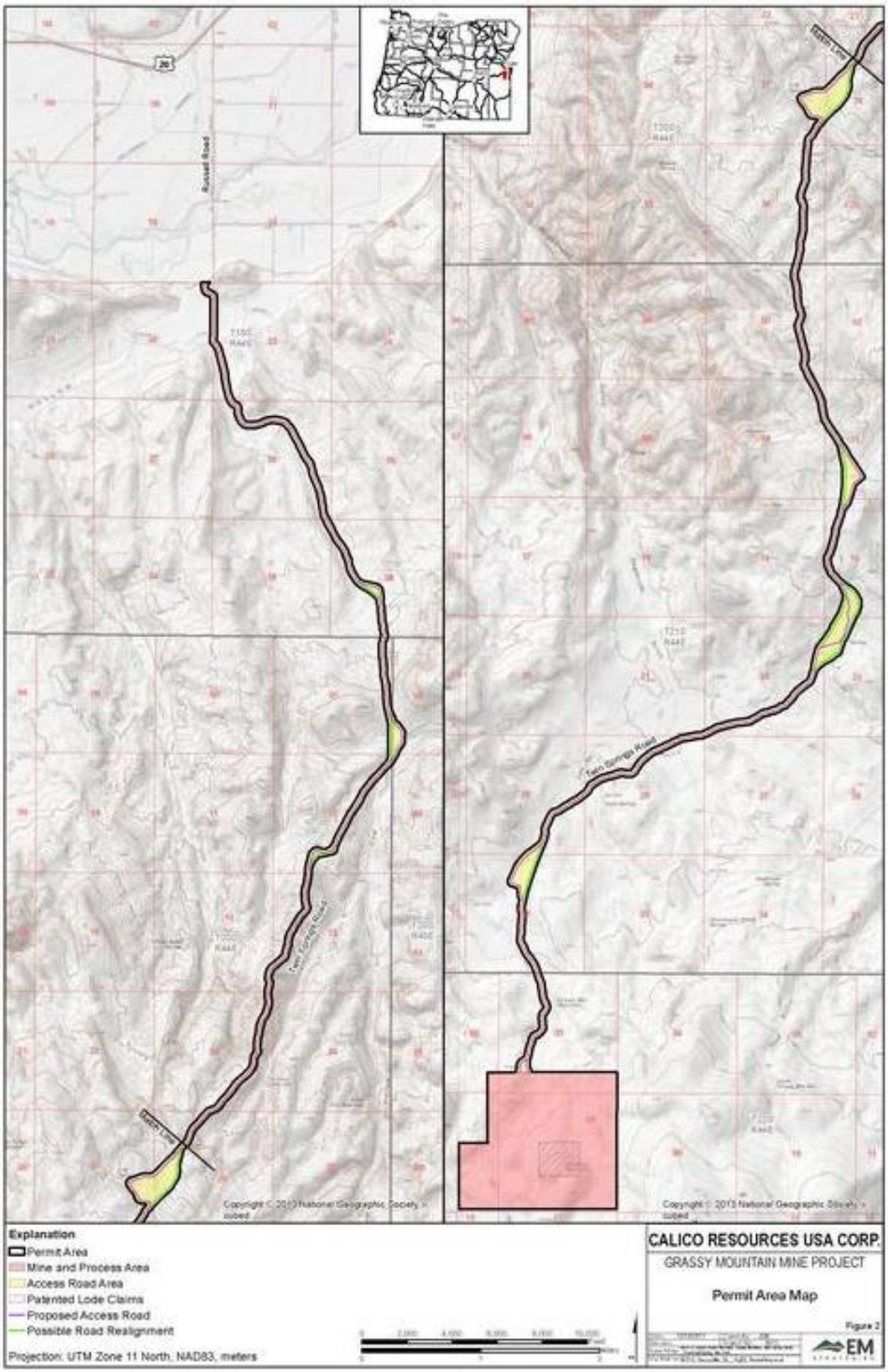


Figure 2. Permit Area Map

The study area is defined as the geographical area in which the potential direct and indirect socioeconomic effects of the Project are realized. The purpose of documenting the socioeconomic setting of the study area is to provide an understanding of the social and economic forces that have shaped the area and to provide a frame of reference necessary to estimate the social and economic effects of the Project.

Malheur County is Oregon's second largest county in the area but is largely undeveloped. The County is in the southeastern corner of the State of Oregon and is crossed by two major rivers, the Snake River and the Malheur River. Ninety-four percent of the County is undeveloped rangeland, most of which is federally owned and administered by the BLM. Developed areas along the Snake and Malheur Rivers support agricultural production areas and agriculture-focused communities.

1.7 Surface Ownership and Disturbance

1.7.1 Land Status

The Grassy Mountain property consists of 455 unpatented lode claims, nine unpatented mill site claims, six unpatented association placer claims, three patented claims, and two land leases covering all or portions of Sections 11 through 15 and 24 of T22S, R43E; portions of Sections 3 through 10 and 16 through 20, T22S, R44E; Sections 31 through 34, T21S, R44E; and Section 36, T21S, R43E, as shown in Figure 3 below. Patented claims were individually surveyed at the time of location. Unpatented claim and Fee land boundaries were established initially by Global Positioning System (GPS) handheld units and in 2011 by on-site survey work. Mining claim information is shown in Appendix X.

Calico, a wholly owned subsidiary of Paramount Gold Nevada Corp. (Paramount), owns and controls 100 percent of the mineral tenure of the unpatented mining claims, patented mining claims, fee lands, and mining leases that comprise the Grassy Mountain property. Calico acquired all right, title, and interest in the property, including all existing exploration and water rights pertaining to the Project, pursuant to the "Deed and Assignment of Mining Properties" between Seabridge Gold Inc., Seabridge Gold Corporation (Seabridge) and Calico dated February 5, 2013.

Ownership of unpatented mining claims is in the name of the holder (locator), subject to the paramount title of the United States (U.S.) of America, under the administration of the BLM. Under the Mining Law of 1872, which governs the location of unpatented mining claims on Federal lands, the locator has the right to explore, develop, and mine minerals on unpatented mining claims without payments of production royalties to the U.S. government, subject to the surface management regulation of the BLM.

Calico controls 100 percent of the surface rights to the patented and leased lands that comprise the Project, with the exception of the Bishop II leased lands. The surface rights controlled by

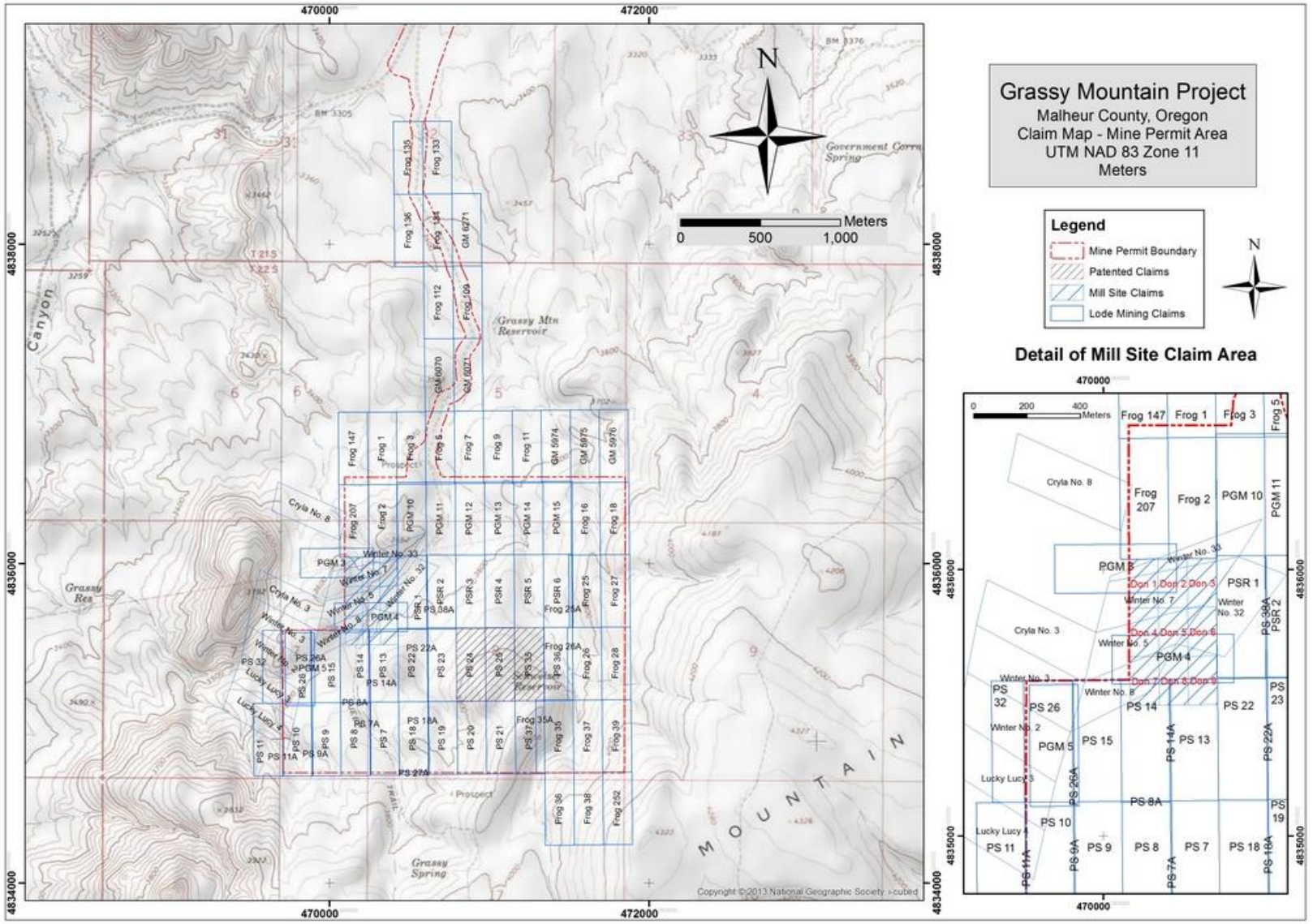


Figure 3. Grassy Mountain Land Status Map of the Mine and Process Portion of the Permit Area

Calico are subject to applicable Federal and State environmental regulations and the agreements outlined below.

1.7.1.1 Agreements and Encumbrances

Paramount's 100 percent ownership of the Project is subject to the underlying agreements and royalties summarized in the following subsections.

Seabridge Gold Corporation (Seabridge): Seabridge retains a ten percent Net Profits Interest (NPI) in the Project pursuant to the "Deed of Royalties" between Calico and Seabridge dated February 5, 2013. Pursuant to the "Deed of Royalties," within 30 days following the day that Calico has delivered to Seabridge a feasibility study on the Project, Seabridge may elect to cause Calico to purchase the ten percent NPI for ten million Canadian dollars.

Sherry & Yates Inc. (Sherry & Yates): On February 14, 2018, Calico exercised their option to purchase, whereby Sherry & Yates agreed to sell to Calico all right, title, and interest in the three patented and 37 unpatented mining claims. The 2004 lease and agreement with Sherry & Yates was terminated. The royalty attributed to Sherry & Yates has decreased from six percent to 1.5 percent.

Exploration and Option to Purchase Agreement Cryla Project (Cryla Agreement): Effective June 1, 2018, Calico executed the Cryla Agreement, whereby Cryla, LLC agreed to lease with an option to purchase the 28 Cryla, Lucky Lucy, and Winter unpatented mining claims (Cryla Project). The following terms are effective until May 31, 2043:

- Forty-thousand dollars due at signing; June 1, 2019, $40,000; June 1, 2020, and each succeeding year $60,000.
- Production royalty based on price of gold; two percent if less than or equal to $1,500 and four percent if greater than $1,500.
- Option to Purchase: Purchase price of $560,000 plus the amount determined by multiplying the number of troy ounces identified (prefeasibility or greater certainty) within the boundaries of the Cryla Project, multiplied by three dollars.

The Project covers a portion of the Calico land holdings. The Permit Area, which is the basis of this permit application is shown in Figure 2 (Section 1.6). The legal description of the Mine and Process Area includes all or portions of the following:

T22S, R44E
SW ¼ of Section 5
S ½ of SE ¼ of Section 5
NW ¼ of Section 5
SE ¼ of SE ¼ of Section 6
SE ¼ of Section 7
S ½ of NE ¼ of Section 7
NE ¼ of NE ¼ of Section 7

NW ¼ of Section 8
NE ¼ of Section 8
SW ¼ of Section 8
SE ¼ of Section 8

T21S, R44E
W ½ of SE ¼ of Section 32
E ½ of SW ¼ of Section 32
W ½ of NE ¼ of Section 32
E ½ of NW ¼ of Section 32
SW ¼ of SE ¼ of Section 29

1.7.2 Project History

The information in this section refers to the Calico holdings, which include the Project (Permit Area), which is the subject of the Consolidated Permit. The history summarized in this section of the report has been extracted and modified from Wilson et al. (2015), which was drawn from Hulse et al. (2012), with additional information derived from multiple sources, as cited. A concise, early history of the discovery of the Grassy Mountain deposit and other events to September 1988 were reported by Kelly (1988).

Portions of the present Grassy Mountain property were first staked in 1984 by two independent geologists, Dick Sherry and Skip Yates. Atlas Precious Metals (Atlas) acquired the Grassy Mountain property from Sherry and Yates in 1986. Between 1986 and 1991, Atlas conducted detailed mapping and sampling at the property and drilled a total of 227,397 feet in 400 drill holes. Of the 400 drill holes completed by Atlas at the Grassy Mountain property, 196 were reverse circulation (RC) holes drilled on 75- to 100-foot centers within what became the Grassy Mountain resource area. The remaining holes were drilled at prospects away from the main Grassy Mountain resource area. Shallow, apparently stratiform gold mineralization was delineated at the main Grassy Mountain deposit and 1.5 miles to the southwest at the Crabgrass prospect. Atlas identified exploration targets at the Project based on soil anomalies, conducted further soil and float sampling on several prospects, expanded the original claim block, and collected extensive geologic, mine engineering, civil engineering, and environmental baseline data. The baseline data were compiled to support a 1990 historical feasibility study for an envisioned open-pit heap-leach and milling operation. In addition to the Grassy Mountain deposit, Atlas delineated another gold prospect called Crabgrass, where they drilled 87 RC holes and defined three separate near-surface mineralized zones. Atlas then began to consider underground-mining scenarios, but declining gold prices and the perception of an unfavorable permitting environment discouraged Atlas from developing the project, and the property was optioned to Newmont Exploration Ltd. (Newmont) in 1992.

Newmont leased the Grassy Mountain property from Atlas in September 1992. Newmont geologists mapped the property and completed geochemical sampling. Several ground and airborne geophysical surveys were also conducted. In late 1994, Newmont drilled 15 holes and

completed an in-house mineral resource estimate that became the basis for an in-house economic and mining-method evaluation that was completed in 1995. In 1994, Newmont first drilled 11 inclined diamond-core holes designed to intersect and define the geometry of potential high-grade gold zones in the main Grassy Mountain deposit. These were followed with one wedge core hole off of their initial core hole, two holes pre-collared by RC and completed with core, and one additional core hole. Newmont's 15 holes were all angled and totaled 15,009.5 feet. This drilling defined what Newmont thought could be several gold zones in excess of 0.1-ounce gold per ton (oz Au/ton) within an area of the Grassy Mountain deposit measuring approximately 600 feet long by 350 feet wide by 250 feet thick. Mineralization was constrained to the northeast by a single hole which failed to encounter high-grade gold. Newmont considered the western extent of the main high-grade zone effectively closed off after encountering only low-grade gold (0.012 to 0.019 oz Au/ton) and local barren quartz-chalcedony veins. Based on the core drilling and mapping and sampling of surface exposures, Newmont geologists concluded that high gold grades at the Grassy Mountain deposit were controlled by narrow, steeply south-dipping quartz-chalcedony veins and clay matrix breccias that would need to be properly represented during grade modeling and resource estimation.

By 1996, Atlas and Newmont had identified and named several mineralized and potentially mineralized target areas peripheral to the main Grassy Mountain gold deposit based primarily on rock-chip, float, and soil-sample data. The exploration targets are: 1) Wheatgrass; 2) North Spur; 3) Crabgrass; 4) Bluegrass and North Bluegrass; 5) Snake Flats; 6) Wood; 7) Wally; 8) Ryegrass; 9) Clover; 10) Bunchgrass; and 11) Sweetgrass. They are predominately located to the north, west and southwest of the Grassy Mountain deposit. Newmont determined that the project did not meet corporate objectives and returned the property to Atlas in September 1996.

In January 1998, Atlas granted Tombstone Exploration Company Ltd. (Tombstone) the option to purchase 100 percent of the property. Tombstone executed the option agreement and conducted an exploration program which included six holes for a total of 8,071 feet. Lack of venture capital forced Tombstone to return the property to Atlas in May 1998.

In February 2000, Seabridge entered an option agreement with Atlas to acquire a 100 percent interest in the Grassy Mountain property. Seabridge completed its acquisition of the Grassy Mountain property in April 2003; however, did not carry out exploration at the Grassy Mountain property.

In April of 2011, Seabridge signed an option agreement granting Calico the sole and exclusive right and option to earn a 100 percent interest in the Project. The acquisition of the Grassy Mountain property by Calico was completed in 2012. In 2011 and 2012, Calico carried out geologic mapping and sampling, and drilled a total of 13,634 feet in 14 RC and three core holes. Thirteen of these holes were drilled in the Grassy Mountain deposit area and four were drilled in outlying targets. Calico also commissioned a geophysical survey to assist in their exploration efforts at the Grassy Mountain property.

In 2016, Paramount acquired Calico by issuing common shares to Calico shareholders, whereby Calico shareholders had the right to receive 0.07 of a share of common stock of Paramount for every common share of Calico.

Historical exploration conducted by previous operators includes exploration programs carried out by Atlas, Newmont, Tombstone, and Calico. A variety of historical resource and reserve estimates for the Grassy Mountain gold deposit were completed on behalf of previous owners and issuers from 1990 through 1997. These historical estimates are summarized in the 2011 technical report prepared by Resource Modeling Inc. (Lechner 2011) and are described in detail in various internal reports prepared by Atlas, Newmont, and their contractors. In addition, Wilson et al. (2015) provided a summary of historical estimated resources for the Crabgrass prospect. All of these estimates are relevant only for the historical context of exploration work done during this period and are not to be relied upon. Paramount is not treating these estimates as current mineral resources and they are superseded by the current mineral resources described in the 2018 Prefeasibility Study (PFS) completed by Paramount (Mine Development Associates [MDA] 2018).

1.7.3 Project Permits

The following are the permits associated with the Project:

- Chemical Process Mines Permit (Division 37)—Oregon Department of Geology and Mineral Industries
- Chemical Mining Permit (Division 43)—Oregon Department of Environmental Quality
- Air Quality Operating Permit—Oregon Department of Environmental Quality
- Permit to Appropriate Water—Oregon Water Resources Department
- General Discharge Permit (Storm Water)—Oregon Department of Environmental Quality
- Water Pollution Control Facility Permit—Oregon Department of Environmental Quality
- Dam Safety Permit—Oregon Water Resources Department
- Plan of Operations/Record of Decision—United States Department of the Interior, Bureau of Land Management
- Hazardous Waste Identification Number—United States Environmental Protection Agency
- Explosives Permit—United States Department of the Treasury, Bureau of Alcohol, Tobacco, Firearms, and Explosives

2 EXISTING ENVIRONMENT

The following are summaries of the Baseline Studies (Appendix B), which should be referenced for the methodologies used, study areas, and data collected for each of the respective resources. Also included in Appendix B is the Environmental Baseline Study Work Plans (EM Strategies, Inc. [EM Strategies] 2017).

2.1 Air Quality Resources

The Grassy Mountain Mine Project Air Quality Resources Baseline Report (Appendix B) was submitted to Department of Geology and Minerals Industries (DOGAMI) on January 18, 2018. The report was accepted by the Technical Review Team (TRT) on February 28, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. An air quality monitoring station was established by HDR Engineering, Inc. (HDR) in July 2014 west of the Mine and Process Area portion of the Permit Area to monitor particulates (i.e., particulate matter less than 2.5 microns in aerodynamic diameter [$PM_{2.5}$] and particulate matter less than ten microns in aerodynamic diameter [PM_{10}]). A meteorological station was installed in August 2014 to monitor wind speed, wind direction, standard deviation of wind direction, temperature at nine and two meters, delta temperature, relative humidity, barometric pressure, solar radiation, and precipitation. Data collection occurred between October 2014 and September 2015.

No monitoring has been performed within the Local Air Quality Study Area for ambient concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), or sulfur dioxide (SO_2), nor do regulatory agencies specify background concentrations for these pollutants. In the absence of major population centers, commercial activity, or highways near the proposed mine, the background concentrations of CO, NO_2, and SO_2 at the Permit Area boundary are expected to be very low. Taking into consideration the surrounding settings (terrain, land use, and proximity of sources), the ambient monitoring data collected at the St. Luke's Meridian station (16-001-0010) in Meridian, Idaho, were used to provide conservative background concentrations for the Project. This station is the closest monitoring station by proximity to the Local Air Quality Study Area. Due to its semi-urban location and proximity to the City of Boise, the data collected at this station were used as extremely conservative values as compared to the isolated and rural setting of the Local Air Quality Study Area. The background concentrations are shown in Table 1 and the meteorological station data are shown in Table 2.

Table 1. Ambient Pollutant Concentration Summary

Standard	Concentration	Source	Method
Carbon Monoxide 8-Hour	0.244 ppm	16-001-0010 Meridian, ID	2014-2016 (annual mean)
Carbon Monoxide 1-Hour	0.244 ppm	16-001-0010 Meridian, ID	2014-2016 (annual mean)
Lead 3-Month Average	1.99E-04	16-001-0010 Meridian, ID	2014-2016 (annual mean divided by 4)

Standard	Concentration	Source	Method
Nitrogen Dioxide 1-Hour	43.63 ppb	16-001-0010 Meridian, ID	2014-2016 (average 98th percentile)
Nitrogen Dioxide Annual	10.72 ppb	16-001-0010 Meridian, ID	2014-2016 (annual mean)
Ozone 8-Hour	.063 ppm	16-001-0010 Meridian, ID	2014-2016 (Annual Fourth High Average)
$PM_{2.5}$ 24-Hours	21 ug/m^3	Site Collected Data	Oct.2014-Sept.2015 Second High (less dates affected by wildfire smoke)
$PM_{2.5}$ Primary Annual	4.6 ug/m^3	Site Collected Data	Oct.2014-Sept.2015 Adjusted Annual Average (less dates affected by wildfire smoke)
PM_{10} 24-Hours	23 ug/m^3	Site Collected Data	Oct.2014-Sept.2015 Second High (less dates affected by wildfire smoke)
Sulfur Dioxide 1-Hour	4.17 ppb	16-001-0010 Meridian, ID	2014-2016 (average 99th percentile)
Sulfur Dioxide 3-Hours	.623 ppb	16-001-0010 Meridian, ID	2014-2016 (annual mean)

Source: U.S. Environmental Protection Agency (EPA) 2017; Bison Engineering, Inc. (Bison) 2015
ppb = parts per billion; ppm = parts per million; µg/m^3 = micrograms per cubic meter

Table 2. Quarterly and Annual Means for Meteorological Parameters

Quarter	Wind Speed (mph)	Wind Direction (Degrees)	Temp 9 meters (°F)	Temp 2 meters (° F)	Relative Humidity	BP (In Hg)	Solar Radiation (Wm^2)	Total Precipitation (In)
2014 3rd	7.0	340	68.1	68.0	38.2	26.48	224	0.85
2014 4th	7.3	284	41.7	41.2	68.9	26.56	91	3.22
2015 1st	6.6	300	39.4	39.0	74.2	26.65	116	2.18
2015 2nd	7.7	344	60.9	60.9	43.6	26.45	274	2.22
2015 3rd	7.2	295	71.9	71.8	33.9	26.48	254	1.64
Oct. 1, 2014 – Sept. 30, 2015	7.2	311	53.6	53.3	54.8	26.53	184	9.26

Source: Bison 2015
mph = miles per hour; °F = degrees Fahrenheit; BP = barometric pressure; In = inches; Hg = mercury; Wm^2 = watts per square meter

2.1 Aquatic Resources

The Grassy Mountain Mine Project Aquatic Resources Baseline Report (Appendix B) was originally submitted to DOGAMI on January 11, 2018, then again on August 24, 2018. The report was accepted by the TRT on December 14, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. A review of existing information from Oregon Department of Fish and Wildlife (ODFW) indicated that fish are unlikely to occur within the Aquatic Resources Study Area partially due to a fish barrier downstream at Rye Field Reservoir, and the ephemeral nature of the drainages in the Aquatic Resources Study Area. The information review yielded a list of five special status amphibian species that occur in southeastern Oregon: blotched tiger salamander (*Ambystoma tigrinum melanosticum*), a BLM special status species;

Columbia spotted frog (*Rana luteiventris*), a U.S. Fish and Wildlife Service (USFWS) Species of Concern and Sensitive-Critical ODFW species; northern leopard frog (*Rana pipiens*), a BLM sensitive species; western toad (*Anaxyrus boreas*), a BLM special status and ODFW sensitive species; and woodhouse toad (*Bufo woodhousii*), a BLM special status species.

Field surveys were conducted in May and October 2014 by HDR in the Aquatic Resources Study Area. Habitat suitable for fish was limited and the 18 sites visited showed no connection to perennial streams. Electrofishing in May 2014 was only feasible in limited reaches of Negro Rock Canyon; no fish were captured. Fish surveys were not conducted in October 2014 as there was no flowing water observed.

Only ten of the 18 sites included standing or flowing water during the May 2014 field surveys; therefore, only the ten sites were surveyed for amphibians. No special status amphibian species were observed; however, Pacific treefrog (*Pseudacris regilla*), a common species in Oregon, were observed at several sites in May 2014. The presence of treefrogs may be indicative of habitat suitability for other species with similar breeding requirements, which may have limited populations in the Aquatic Resources Study Area.

2.2 Areas of Critical Environmental Concern/Research Natural Areas

The Grassy Mountain Mine Project Areas of Critical Environmental Concern/Research Natural Areas Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Permit Area is in the Malheur Resource Area (MRA). There are 17 combined Areas of Critical Environmental Concern (ACECs)/Research Natural Areas (RNAs) and 11 ACECs in the MRA. There are no ACECs/RNAs or ACECs in the Permit Area. The closest ACEC or ACEC/RNA to the Permit Area is the Owyhee River Below The Dam ACEC.

2.3 Cultural Resources

In November 2017, a cultural resource inventory of 830 acres (Survey Area) was conducted for the proposed Project in Malheur County, Oregon. The Area of Potential Effect consists of a total of 1,762 acres, of which 932 acres were previously inventoried during previous iterations of the Project; the recent cultural Survey Area comprises the remaining 830 acres. The results of this inventory were discussed in a cultural resources inventory report submitted to the BLM on November 21, 2018. The BLM provided comments on the draft report on February 8, 2019. A revised draft was submitted on April 26, 2019; the BLM accepted the revised draft and submitted the draft to the State Historic Preservation Office (SHPO) on June 28, 2019. On August 9, 2019, the SHPO sent a letter to the BLM stating they finished their review of the built environment portion of the report, and subsequently provided preliminary comments on the archaeological portion of the report in a letter sent to the BLM on August 14, 2019.

A total of eight newly identified archaeological resources, five previously recorded archaeological resources, 14 built resources, and 20 isolated finds were identified during the inventory of the Survey Area. Of the eight newly identified archaeological resources, five are prehistoric simple flaked stone sites, two are prehistoric complex flaked stone sites, and one is a historic berm and ditch site associated with the historic Lowe Reservoir. The historic berm and ditch site is recommended as not eligible for listing in the National Register of Historic Places (NRHP) under any evaluation criteria, while one of the newly recorded prehistoric sites is recommended as eligible for listing in the NRHP under Criterion D. The remaining six newly recorded prehistoric sites are recommended to be considered unevaluated for listing in the NRHP until subsurface testing is completed. Of the 14 newly recorded built resources, 12 are historic road segments, one is a segment of a historic canal, and one is the historic Grassy Mountain Reservoir. All 14 built resources are recommended as not eligible for listing in the NRHP under any evaluation criteria. Of the six previously recorded archaeological sites, one is a prehistoric simple flaked stone sites, two are prehistoric basic habitation sites,, and one is a multicomponent site including prehistoric complex flaked stone and historic prospecting components. One of the previously recorded prehistoric sites is recommended as eligible for listing in the NRHP under Criterion D, while the historic component of the previously recorded multicomponent site is recommended as not eligible for the NRHP under any evaluation criteria. The prehistoric component of the multicomponent site and the remaining four previously recorded prehistoric sites are recommended to be considered unevaluated for the listing in the NRHP until further subsurface investigations are completed. Of the 20 isolated artifacts identified, seven are prehistoric, 12 are historic, and one is multicomponent, all of which are recommended as not eligible for listing in the NRHP under any evaluation criteria.

2.4 Environmental Justice

The Grassy Mountain Mine Project Environmental Justice Baseline Report (Appendix B) was submitted to DOGAMI on February 23, 2018. The report was accepted by the TRT on July 20, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Environmental Justice Study Area includes Malheur County and incorporates census tracts 9702, 9703, 9704, 9705, 9706, 9707, 9709, and 9400. Census tracts 9702, 9703, and 9704 include portions of the City of Ontario. Census Tract 9705 includes the City of Nyssa and community of Cairo. Census Tract 9706 includes the City of Vale and smaller communities of Willowcreek and Jamieson. The City of Adrian, and the communities of Kingman and Owyhee are included in Census Tract 9707. Census Tract 9709 encompasses the majority of the remainder of Malheur County, except for a small portion of the Fort McDermitt Indian Reservation (Census Tract 9400) at the southern border of the County that is shared with Nevada.

Table 3 summarizes information about race and ethnicity for the Environmental Justice Study Area from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison. Malheur County is a very large geographic area and its statistics do not necessarily provide good measures of income and poverty for the Environmental Justice Study Area.

Table 3. Race and Ethnicity for Oregon, Malheur County, and the Environmental Justice Study Area

Race or Ethnicity	Percent of Population								
	Oregon	Malheur County	9702	9703	9704	9705	9706	9707	9709
Race									
White Alone	85.1	85.7	80.9	89.8	78.9	89.1	91.5	90.5	82.6
Black or African American Alone	1.8	1.2	0.4	0.8	0.6	1.4	0.2	0	3.7
American Indian and Alaska Native Alone	1.2	0.8	0.7	0.6	0.2	0.2	0.7	1.5	1.8
Asian Alone	4.0	1.6	2.5	1.7	1.5	1.2	0.9	2.3	1.8
Native Hawaiian and Other Pacific Islander Alone	0.4	0	0.2	0	0	0	0	0	0
Some other race alone	3.4	6.6	9.2	3.7	14.2	5.6	5.6	3.1	4.0
Two or more races	4.1	4.0	6.0	3.4	4.7	2.6	1.3	2.6	6.0
Ethnicity									
Hispanic or Latino (of any race)	12.3	32.7	37.1	30.8	49.9	48.3	20.9	14.4	18.0
Not Hispanic or Latino	87.7	67.3	62.9	69.2	50.1	51.7	79.1	85.6	82.0

Source: U.S. Census Bureau 2016a

The American Community Survey (U.S. Census Bureau 2016a) data show that people living in all geographies are predominantly white alone. The U.S. Census Bureau collects information about Hispanic and Latino ethnicity separately from information about race. People of Hispanic or Latino origin might not feel like they belong in any of the race categories and thus identify with *some other race alone* or *two or more races*. Together these other categories comprise most of the racial minorities in the Study Area. All the communities in the Environmental Justice Study Area, except for Jordan Valley, have higher proportions of Hispanic or Latino residents when compared to the state as a whole. The cities of Vale and Adrian have lower proportions of Hispanic or Latino residents when compared to the entire County.

Census data and information available from the State of Oregon indicate that there are minority populations living in Census Tract 9709, the tract that contains the Project, as well as in adjacent census tracts. Census Tract 9709 contains the largest percentage of Black or African American persons; however, Census Tract 9709 is also the largest tract by size in the Environmental Justice Study Area, so the minority population could be spread throughout the Census Tract. The largest percentage of Asian persons live near the City of Ontario.

Table 4 summarizes the information about household income for the Environmental Justice Study Area from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison.

Table 4. Income Summary for Oregon, Malheur County, and the Environmental Justice Study Area

Income Type	Oregon	Malheur County	9702	9703	9704	9705	9706	9707	9709
Mean Income (dollars)	69,040	48,070	51,620	45,779	35,172	51,738	47,130	62,615	54,382
Median Income (dollars)	51,243	35,418	42,132	28,831	26,399	44,597	37,033	42,434	42,826
People with Earnings (percent of population)	75.6	71.6	67.4	61.7	70.7	78.3	72.9	73.6	81.7

Source: U.S. Census Bureau 2016b

Using the mean and median incomes for the Environmental Justice Study Area shown in Table 4, the U.S. Census Bureau income data suggest that the mean and median incomes for the Environmental Justice Study Area are above the U.S. Census Bureau poverty threshold for a five-person household and primarily above the U.S. Department of Health and Human Services poverty guidelines; however, the mean income in Census Tract 9704 is above the threshold for a six-person household, the median income in Census Tract 9703 is above the threshold for a six-person household, and the median income in Census Tract 9706 is above the threshold for a seven-person household.

Table 5 summarizes poverty information for the Environmental Justice Study Area from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison. The average family size is from the U.S. 2010 Census, as there are no current data available.

Table 5. Poverty Summary for Oregon, Malheur County, and the Environmental Justice Study Area

Income Type	Oregon	Malheur County	9702	9703	9704	9705	9706	9707	9709
Families									
Average Family Size (number of people)	3.0	3.24	3.13	3.03	3.60	3.52	3.17	3.09	2.93
Families Living in Poverty in the Last 12 Months (percent of population)	11.2	18.1	12.4	29.2	27.0	17.7	13.5	8.4	13.0
Individuals									
Average Household Size (number of people)	2.51	2.62	2.63	2.46	2.43	2.99	2.70	2.57	2.51
Individuals living in poverty in the last 12 months (percent of population)	16.5	25.5	25.2	31.9	36.2	24.4	21.4	11.8	15.4
People receiving Supplemental Security Income (SSI) (percent of population)	4.6	8.4	7.4	11.6	12.1	4.1	8.4	3.9	8.0
People Receiving Food Stamps in Last 12 Months (percent of population)	19.2	27.6	15.0	42.6	43.3	33.5	18.1	17.0	8.7

Source: U.S. Census Bureau 2010, 2016b, 2016c, 2016d

Table 6 summarizes employment information for the Environmental Justice Study Area for persons living in poverty from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison.

Table 6. Employment Summary for People Living in Poverty in Oregon, Malheur County, and the Environmental Justice Study Area

Employment Type	Oregon	Malheur County	9702	9703	9704	9705	9706	9707	9709
Individuals Living in Poverty in the Last 12 Months (percent of population for whom poverty is determined)	16.5	25.5	25.2	31.9	36.2	24.4	21.4	11.8	15.4
Individuals who worked full time in last 12 months (percent of population in poverty)	3.1	7.6	10.3	6.3	7.8	8.5	2.9	4.3	11.5
Individuals who did not work in last 12 months (percent of population in poverty)	22.5	30.6	31.8	36.2	41.8	27.1	26.5	16.5	21.0

Source: U.S. Census Bureau 2016c

In general, the Census data suggest that the Environmental Justice Study Area could support low-income populations. Mean and median incomes in the Environmental Justice Study Area are the lowest in Census Tract 9704, which mainly encompasses the urban center of the City of Ontario. The proportions of families and individuals living in poverty are higher in the Census Tracts surrounding the City of Ontario than the rest of the Environmental Justice Study Area. The rate of individuals that did not work in the last 12 months is also highest in the City of Ontario.

2.5 Geochemistry

The Grassy Mountain Mine Project Geochemistry Baseline Report (Appendix B) is being submitted with this Consolidated Permit. Previous versions of this report have been submitted to DOGAMI over the last few years. Additionally, there have been several requests for additional data. This report includes data previously submitted, along with additional data and interpretations, as requested by DOGAMI. The report is designed to conform to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Geochemistry Study Area was established to develop an environmental baseline for assessing potential impacts from Project facilities and to provide background data, which includes an area encompassing the Permit Area.

The purpose of the baseline geochemical characterization program is to define the potential geochemical reactivity and chemical stability of mine waste that will be produced by the proposed Project. The results of the geochemical characterization program will assist in determining the potential for acid rock drainage and metal leaching associated with the Project. Data produced during this study can be used in the Project design process and as an operational tool for identifying material types that require special handling during operations.

The characterization work undertaken for the Project meets the following regulatory requirements: Oregon DOGAMI Division 37 Chemical Process Mining; Oregon Administrative Rule (OAR) 632-037-0055 and OAR 632-037-0085 (Environmental Evaluation); and applicable Oregon Department of Environmental Quality (ODEQ) Division 43 Chemical Mining Rules, OAR 340-043, which address process mining.

In addition, the geochemical characterization program was designed to follow guidelines set forth in the Bureau of Land Management Instruction Memorandum NV-2013-046, Nevada Bureau of Land Management Rock Characterization Resources and Water Analysis Guidance for Mining Activities (BLM 2013). Provide baseline data of the quality and quantity of local groundwater resources.

The geologic setting, groundwater, surface water and mine plan were critical to the sample choices and types of testing that were chosen to characterize the geochemistry baseline setting. Please refer to those reports for background information on these topics (Appendix B). SRK Consulting (SRK) has developed a conceptual geochemical model based on the deposit geology combined with the proposed mining and processing methods. This conceptual model provides the basis for the scope and methodology of the geochemistry baseline study and defines the approach for sample selection, laboratory procedures and key criteria for decision-making throughout the process.

The design of the geochemical characterization program has been developed based on the geology of the site and the mine plan information and includes the following steps:

- Refinement of the current conceptual geochemical model for each mine facility including understanding of the geological materials involved and the conceptual management approach;
- Design of the sampling approach for each component;
- Selection of suitable test procedures to assess potential impacts; and
- Table 7 provides a list of the mine facilities that will require geochemical characterization, location and duration of the facility, and the types of geochemical data required. To date, the characterization program described herein is complete for six potential sources listed in Table 7 including: 1) waste rock dumps (WRDs); 2) ore stockpiles; 3) underground workings; 4) tailings impoundment; 5) borrow material; and 6) access and haul road cuts.

Table 7. Program Design

Source	Description	Location	Duration	Composition	Sample Types	Geochemical Data Needs				
						Static	Mineralogy	SPLP	MWMP	HCT
Waste rock dump	Waste rock dump	Mine area (surface)	Permanent	PAG and Non-PAG waste rock	Core	X	X	--	X	X
Ore stockpile	Ore stockpiled near mill	Plant site	LOM	Underground ore	Core	X	X	--	X	--
Underground workings	Exposed rock in workings	Mine area (underground)	Permanent	Waste rock and ore	Core	X	X	--	X	X
Tailings Impoundment	Tailings	Plant site	Permanent	Tailings with and without lime amendment	Metallurgical test work	X	X	X	X	X
Borrow material	Borrow materials for construction	Various	Permanent	Basalt	Core	X	X	--	X	--
Access and haul roads	Surface development (cut/fill)	Various	Permanent	Alluvium/ bedrock	Surface samples	X	X	--	X	--
Underground backfill	Rock Fill and Cemented Rock Fill	Mine area (underground)	Permanent	Basalt with or without cement	Core	X	X	--	X	--
Underground backfill[1]	Cemented Rock Fill	Mine area (underground)	Permanent	Waste rock with cement	Cemented core	X	--	--	X	--

[1] Characterization of this material source is not included in this study and will be provided under separate cover.
LOM = life of mine; PAG = potentially acid generating; Non-PAG = Non-Acid Generating; SPLP = synthetic precipitation leaching procedure; MWMP = meteoric water mobility procedure; HCT = humidity cell test

The term material type typically denotes a unique combination of lithology, alteration, and oxidation state. However, because silicic alteration is pervasive in the Grassy Mountain deposit and the deposit is mostly oxidized, material types were delineated solely on lithology. Based on this assumption, a total of eight material types have been identified and are summarized in Table 8 along with an estimated percentage of each material type that will be mined based on the geologic block model. The number and types of samples collected are based primarily on the type of test work that was planned.

Table 8. Grassy Mountain Material Types

Material Type	Approximate Proportion of Development Rock – Ore/Waste (%)
Siltstone	54
Sandstone	26
Sinter	11
Mud/clay	5
Breccia	<1
Mudstone	<1
Tuff	<1
Basalt	<1

Source: Calico (personal comm.)

Waste Rock and Ore: For evaluation of the waste rock and ore SRK collected a total of 105 samples for geochemical characterization testing, which included 68 samples collected from exploration drill core and 36 pulp samples representative of development rock (ore and waste rock).

To characterize the Acid Rock Drainage and Metal Leaching (ARD/ML) potential for the Project, a weighted approach was taken to assess the geochemical variability of geologic materials that will be encountered during mining. The approach included the collection of an appropriate number of samples based on the relative importance or mass of the lithological unit with respect to the total mass in the deposit. Professional judgment and sound geological knowledge of a deposit are significant factors in the number and types of samples selected, as opposed to a strictly numerical approach. Table 9 is the collection and testing matrix.

Table 9. Sample Collection and Testing Matrix

Material Type	Proportion of Development Rock - Ore/Waste (%)	Number of Samples Submitted for Testing				
		Core		Pulps		Total
		Waste	Ore	Waste	Ore	
Siltstone	54	13	9	10	1	33
Sandstone	26	19	5	14	2	40
Sinter	11	6	1	4	0	11

Material Type	Proportion of Development Rock - Ore/Waste (%)	Number of Samples Submitted for Testing				
		Core		Pulps		Total
		Waste	Ore	Waste	Ore	
Mud/clay	5	1	0	3	1	5
Breccia	<1	1	6	0	0	7
Mudstone	<1	6	1	0	1	8
Tuff	<1	0	0	0	0	0
Basalt	<1	0	0	0	0	0
TOTAL	100	46	22	31	5	104

Borrow and Road Cut Material: Calico resources drilled three diamond drill holes in the proposed basalt quarry location. Holes were logged by Calico geologists and a total of 20 representative samples were submitted for preparation and geochemical testing as summarized in Table 10.

Table 10. Summary of Borrow Material Test Work

Type	Lithology	Number of Samples	Lab Analyses				
			Mineralogy	Multi-Element Analysis	ABA	NAG	MWMP
Borrow Material	Andesitic Basalt	7	1	7	7	7	3
	Vesicular Basalt	4	3	4	4	4	3
	Basalt	2	1	2	2	2	--
	Clay	1	1	1	1	1	--
	Sand and Clay	1	--	1	1	1	1
	Sediments	5	2	5	5	5	2
Road Cut Material	Basalt	7	7	7	7	7	6
Total		27	15	27	27	27	15

ABA = acid-base accounting; NAG = net acid generating

Calico collected samples along the main access road from exposed outcrops in the area where major cuts will be required during road construction. This program resulted in seven samples of basalt. Samples were submitted for sample preparation and geochemical characterization testing using the same methods as the borrow material.

Tailings Samples: A total of four samples generated from metallurgical testing programs were collected, one sample in 2015 and three in 2018. The test work conducted on these four samples is summarized in Table 11.

Table 11. Summary of Tailings Sample Test Work

Year	Sample	Description	Lab Analyses						
			Decant Solution Analysis	Multi-Element Analysis	ABA/ TIC	NAG	Modified MWMP	Modified SPLP	HCT
2015	Calico Leach Res. After CN Destruct.	Mixed Lithology	--	x	x	x	x	--	x
2018	Arkose (1 of 2)	Arkose Sandstone	x	x	x	x	--	x	--
	Arkose (2 of 2)	Arkose Sandstone	x	--	--	--	--	--	--
	MLDWT (1 of 2)	Clay	x	x	x	x	--	x	--
	MLDWT (2 of 2)	Clay	x	--	--	--	--	--	--
	SLST (1 of 2)	Siltstone	x	x	x	x	--	x	--
	SLST (2 of 2)	Siltstone	x	--	--	--	--	--	--

TIC = total inorganic carbon

Following analysis of the original sample material, hydrated lime was added to the tailings samples to generate material representative of amended tailings. The results of the ABA tests from the original samples were used to determine the quantity of hydrated lime that needed to be added to the tailings samples to produce a sample of tailings that is net neutralizing based on the criteria specified in the OAR 340-043-0130 (2). A rigorous quality assurance/quality control (QA/QC) program was followed (See Appendix B).

The following test work methods are included in this report. Full details of the methods are in the Geochemistry Report in Appendix B.

Static Methods:

- Multi-element analysis using aqua regia digest and Inductive Couple Plasma (ICP) analysis to determine total metal and metalloid chemistry for 48 elements (ALS Chemex Method ME-MS41);
- ABA using the modified Sobek method (Sobek 1978) with sulfur speciation by hot water, hydrochloric acid (HCl), and nitric acid extraction;
- Total Sulfur determined from analysis of an untreated sample using a LECO furnace. The result is a measure of all sulfur forms in the sample;
- Non-Extractable Sulfur determined from digestion of a sample with nitric acid followed by filtration and then LECO analysis. Nitric acid removes sulfate and sulfide minerals and the only remaining minerals are insoluble sulfate minerals such as barite;

- Non-Sulfate Sulfur determined from digestion with hot water followed by filtration and then LECO analysis. The hot water extraction leaches sulfate minerals (e.g., gypsum) from the sample leaving behind sulfide sulfur and non-extractable sulfur forms;
- TIC Analysis by LECO;
- NAG test that reports the final NAG pH and final NAG value after a two-stage hydrogen peroxide digest.
- Nevada MWMP (MWMP – ASTM EE2242-13) and leachate analysis;
- Modified SPLP (EPA 1998) and analysis of leachate;
- X-Ray Diffraction Analysis (XRD), petrography and Scanning Electron Microscopy (SEM);
- HCT Procedure (ASTM D5744-13e1) and analysis of extracts; and
- Mineralogy according to the February 2015 Erionite Sampling and Analysis Plan (Erionite SAP).

Table 12 shows the analytes for the leach tests and Table 13 lists the waste and ore samples submitted for MWMP tests.

Table 12. List of Analytes for Leach Tests

Parameter	Laboratory Method	Detection Limit	Reporting Limit	Fraction[2]
Alkalinity	SM 2320B	2 mg/L	20 mg/L	dissolved
Bicarbonate	SM 2320	2 mg/L	20 mg/L	dissolved
Carbonate	SM 2320	2 mg/L	20 mg/L	dissolved
Aluminum	EPA 200.7	0.03 mg/L	0.15 mg/L	dissolved
Ammonia Direct as N	EPA 350.1	0.05 mg/L	0.5 mg/L	dissolved
Antimony	EPA 200.8	0.0004 mg/L	0.002 mg/L	dissolved
Arsenic	EPA 200.8	0.0002 mg/L	0.001 mg/L	dissolved
Barium	EPA 200.7	0.003 mg/L	0.015 mg/L	dissolved
Beryllium	EPA 200.8	0.00005 mg/L	0.00025 mg/L	dissolved
Bismuth	EPA 200.7	0.04 mg/L	0.2 mg/L	dissolved
Boron	EPA 200.8	0.0005 mg/L	0.001 mg/L	dissolved
Cadmium	EPA 200.8	0.001 mg/L	0.0005 mg/L	dissolved
Calcium	EPA 200.7	0.2 mg/L	1 mg/L	dissolved
Chloride	EPA 300.0	0.5 mg/L	2.5 mg/L	dissolved
Chromium	EPA 200.8	0.0005 mg/L	0.002 mg/L	dissolved
Cobalt	EPA 200.8	0.00005 mg/L	0.00025 mg/L	dissolved
Conductivity	SM 2510B	1 umhos/cm	10 umhos/cm	dissolved
Copper	EPA 200.8	0.0005 mg/L	0.0025 mg/L	dissolved
Cyanide[1], Total	EPA 335.4	0.003 mg/L	0.01 mg/L	dissolved
Cyanide, Weak Acid Digestion	SM 4500	0.003 mg/L	0.01 mg/L	dissolved
Fluoride	EPA 300.0	0.1 mg/L	0.5 mg/L	dissolved
Gallium	EPA 200.7	0.1 mg/L	0.5 mg/L	dissolved
Hardness	SM 2340B	calc	calc	dissolved
Iron	EPA 200.7	0.02 mg/L	0.05 mg/L	dissolved
Lead	EPA 200.8	0.0001 mg/L	0.0005 mg/L	dissolved
Lithium	EPA 200.7	0.02 mg/L	0.1 mg/L	dissolved
Magnesium	EPA 200.7	0.2 mg/L	1 mg/L	dissolved
Manganese	EPA 200.8	0.0005 mg/L	0.0025 mg/L	dissolved

Parameter	Laboratory Method	Detection Limit	Reporting Limit	Fraction[2]
Mercury[3]	EPA 200.8	0.0001 mg/L	0.0001 mg/L	dissolved
Molybdenum	EPA 200.8	0.0005 mg/L	0.0025 mg/L	dissolved
Nickel	EPA 200.8	0.0006 mg/L	0.003 mg/L	dissolved
Nitrate+Nitrite as N	EPA 353.2	0.02 mg/L	0.1 mg/L	dissolved
pH (s.u.)	SM 4500-H B	0.1 C	0.1 C	dissolved
Phosphorus	EPA 365.1	0.01 mg/L	0.05 mg/L	dissolved
Potassium	EPA 200.7	0.3 mg/L	1.5 mg/L	dissolved
Scandium	EPA 200.7	0.1 mg/L	0.5 mg/L	dissolved
Selenium	EPA 200.8	0.0001 mg/L	0.00025 mg/L	dissolved
Silver	EPA 200.8	0.00005 mg/L	0.00025 mg/L	dissolved
Sodium	EPA 200.7	0.3 mg/L	1.5 mg/L	dissolved
Strontium	EPA 200.7	0.01 mg/L	0.05 mg/L	dissolved
Sulfate	EPA 300.0	0.5 mg/L	2.5 mg/L	dissolved
Thallium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	dissolved
Tin	EPA 200.8	0.0004 mg/L	0.002 mg/L	dissolved
Titanium	EPA 200.7	0.005 mg/L	0.025 mg/L	dissolved
Total Dissolved Solids	SM 2540C	10 mg/L	20 mg/L	dissolved
Uranium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	dissolved
Vanadium	EPA 200.8	0.0002 mg/L	0.001 mg/L	dissolved
Zinc	EPA 200.7	0.01 mg/L	0.05 mg/L	dissolved

[1] Weak Acid Dissociable (WAD) cyanide and total cyanide will be analyzed for the tailings sample only.
[2] As part of the MWMP ASTM method, the column extract is filtered with a 0.45 micrometer (µm) filter. Extract analyses are therefore considered dissolved concentrations.
[3] HCT samples with mercury at concentrations below detection will be submitted every eight weeks for low level mercury using Method 1631E (low level) to obtain a detection limit of 0.2 nanogram/liter (ng/L) and 0.5 ng/L. MWMP extracts will be submitted for Method 1631E.
mg/L = milligrams per liter; umhos/cm = microhoms per centimeter

The objective of the static testing program described above was to allow rapid assessment of the acid generating and metal leaching characteristics of the main lithological units that will be exposed on site. However, these static tests do not consider the temporal variations that may occur in leachate chemistry as a result of long-term changes in oxidation, dissolution, and desorption reaction rates. The results of static tests need to be confirmed using kinetic methods, particularly for samples which demonstrate an uncertain potential for acid generation on the basis of ABA and NAG test work results. The Kinetic tests (e.g., HCT) evaluate temporal changes in leachate chemistry, through the sequential leaching of the rock weathered in a regular cycle of exposure to dry and wet air in a controlled laboratory environment. These cycles simulate and accelerate the chemical weathering rates observed under field conditions, using test conditions that are specifically designed to target oxidation of sulfide minerals. The goal of kinetic testing is to provide reaction rate data to support prediction of the leachate chemistry that would likely occur through contact of meteoric water with waste rock.

Table 13. Waste Rock and Ore Samples Submitted for MWMP Testing

Sample Type	Sample ID	From (ft)	To (ft)	Lithology	Paste pH	Sulfate Sulfur	Sulfide Sulfur	NNP	NPR	NAG pH	Total NAG	Sample Selection Rational
					s.u	wt%	wt%	-	-	s.u.	kg H_2SO4 eq/t	
Ore	GMC-006	593	613	Sandstone	7	0.06	0.045	-1.1	0.21	4.7	0	50th percentile sulfide S
	CAL-001	487	505.4	Sandstone	5.4	0.16	0.23	-6.8	0.07	3.1	13	95th percentile sulfide S
	CAL-002	235	255	Siltstone	6.7	0.099	0.11	-3	0.14	2.7	14	50th percentile sulfide S
	GMC-003	485	495	Siltstone	6.1	0.37	0.24	-7.1	0.04	2.5	15	95th percentile sulfide S
	CAL-002	430	438.2	Breccia	6.6	0.26	0.36	-11	0.03	2.7	16	95th percentile sulfide S
	CAL-002	480	496	Breccia	6.9	0.13	0.099	-2.8	0.1	3.3	11	50th percentile sulfide S
Waste	CAL-002	86	95	Sandstone	6.4	0.23	0.25	-7.4	0.04	2.4	12	95th percentile sulfide S
	CAL-004	860	875	Sandstone	7.7	0.16	0.083	-2.3	0.12	3.1	15	50th percentile sulfide S
	CAL-004	445	455	Sandstone	5.9	0.23	0.025	-0.5	0.38	5.6	0	75th percentile sulfate S, 25th percentile sulfide S
	GMC-012	780	800	Sandstone	6.5	0.35	0.18	-5.3	0.05	2.7	11	95th percentile sulfate S, 75th percentile sulfide S
	CAL-001	750	762	Siltstone	6.6	0.28	0.065	-1.7	0.15	3.7	15	50th percentile sulfide S
	GMC-014	176	184	Siltstone	3.3	0.62	0.49	-15	0.02	2.7	30	95th percentile sulfide S
	CAL-002	697	706	Siltstone	7.2	0.23	0.085	-2.4	0.11	3.5	12	75th percentile sulfate, 50th percentile sulfide S
	GMC-014	44	59	Siltstone	5.9	0.44	0.01	0	1.0	5.4	0	95th percentile sulfate, 25th percentile sulfide S
	CAL-001	380	400	Sinter	7.7	0.012	0.014	0.1	1.3	5.5	0	50th percentile sulfide S
	CAL-002	177	187	Sinter	6.9	0.041	0.044	-1.1	0.21	4	16	95th percentile sulfide S
	GMC-014	208	215	Sinter	6.3	0.16	0.022	-0.4	0.43	5.1	0	95th percentile sulfate, 70th percentile sulfide S
	GMC-012[1]	919	946	Mudstone	3	0.82	1.86	-57.8	0.01	2.24	64	95th percentile sulfide S
	CAL-004	295	315	Mud/clay	5.4	0.11	0.073	-2	0.13	3.2	9.2	75th percentile sulfide S (only available core sample – HCT)

ABA Criteria	PAG	NNP<-20 or NPR<1
	Low PAG	NP between -20 and +20 or NPR between 1 and 3
	Non-PAG	NNP>20 or NPR >3
NAG Criteria	PAG	NAG>20
	Low to Moderate PAG	NAG between 1 and 20
	Non-PAG	NAG<1

Source: Grassy Mountain Static Test Database Rev14

[1] This sample was chosen to replace the two mudstone samples identified in the work plan (CAL-003 675-685 and GMC-012 832-851) as those samples were consumed in HCT testing. PAG = potentially acid generating Low PAG = Uncertain Potential/Lower Capacity, Non-PAG = Non-Acid Generating

SRK selected a representative subset of nine waste rock samples from the static test database for kinetic testing. Details of these samples are provided in Table 14.

The steps taken to select samples for kinetic testing include:

- Identify the main material types that require characterization.
- Select two samples per material type including one that represents the median/mean sulfide sulfur content (50th percentile) and one that represents the 95th percentile sulfide content.
- Where more than one sample was available, the sample with the lowest neutralization potential (NP) was selected in order to characterize the effect of net acid generation.

The kinetic testing method selected for this project is the standard humidity cell test procedure designed to simulate water-rock interactions in order to evaluate the rate of sulfide mineral oxidation and thereby predict acid generation and metals mobility (ASTM D-5744-13e1). Under ASTM methodology, the test typically runs for a minimum of 20 weeks and follows a seven-day cycle, unless uncertain chemistry requires that it be run longer to achieve steady state conditions. The HCTs were executed until the majority of the mineral reactions that can be predicted from mineralogy or static testing have been observed. This endpoint was assessed by monitoring the release rates of key constituents such as pH, sulfate, acidity, alkalinity and iron as well as dissolved metals and metalloids. The Grassy Mountain HCTs were operated for 87 weeks and were terminated following approval from DOGAMI and BLM. Following termination of the leach portion of the HCTs, the material within the cells was blended and split for termination testing. Termination testing included multi-element analysis, ABA and NAG on the test residues to define the mineralogical processes that occurred as the materials were exposed to oxygen and water. Mineralogy on the HCT test residues is not considered necessary since the results of the HCT program are conclusive and indicate the majority of the waste rock and ore material will generate acid and leach metals.

Results for waste rock and ore are shown in the tables below: Table 15 is a summary of multi-element assay results (mg/kg); Table 16 is a summary of ABA; Table 17 is summary of NAG results; Table 18 is a summary of XRD results; Table 19 is a summary of MWMP results; Table 20 is a summary of HCT leachate concentration (mg/L) compared to Oregon Groundwater Quality Guidelines (OGWQG); and Table 21 comparison between static and HCT tests.

Table 14. Samples Submitted for Kinetic Testing

Sample ID	Lithology	Paste pH (s.u.)	Sulfide Sulfur (wt%)	NNP (kg $CaCO_3$ eq/t)	NPR	NAG pH (s.u.)	Total NAG (kg H_2SO_4 eq/t)	Sample Selection Rational
CAL-002 (86-95)	Sandstone	6.36	0.246	-7.7	0.04	2.37	11.7	95th percentile sulfide S
CAL-004 (860-875)	Sandstone	7.73	0.083	2.6	0.12	3.14	14.7	50th percentile sulfide S
CAL-003 (675-685)	Mudstone	3.76	1.36	-42.5	0.01	2.33	47.2	95th percentile sulfide S
GMC-012 (832-851)	Mudstone	3.78	0.526	-16.4	0.02	2.56	18	50th percentile sulfide S
CAL-004 (295-315)	Mud/clay	5.44	0.073	-2.3	0.13	3.2	9.2	75th percentile sulfide S (only available core sample)
CAL-001 (750-762)	Siltstone	6.57	0.065	-2.0	0.15	3.7	14.5	50th percentile sulfide S
GMC-014 (176-184)	Siltstone	3.29	0.488	-15.3	0.02	2.7	29.7	95th percentile sulfide S
CAL-001 (380-400)	Sinter	7.72	0.014	0.1	1.25	5.54	0	50th percentile sulfide S
CAL-002 (177-187)	Sinter	6.91	0.044	-1.4	0.21	3.96	15.6	95th percentile sulfide S
Calico Leach Res. After CN Destruct.	Tailings	6.80	0.089	-2.8	0.11	3.21	4.6	--

Criteria for AP Predictions:

ABA Criteria	PAG	NNP<-20 or NPR<1
	Low PAG	NP between -20 and +20 or NPR between 1 and 3
	Non-PAG	NNP>20 or NPR >3
NAG Criteria	PAG	NAG>20
	Low to Moderate PAG	NAG between 1 and 20
	Non-PAG	NAG<1

Source: Grassy Mountain HCT Database Rev02
PAG = Potentially Acid Generating, Low PAG = Uncertain Potential/Lower Capacity, Non-PAG = Non-Acid Generating

Table 15. Summary of Multi-Element Assay Results (mg/kg) Waste Rock and Ore

Material Type		Ag	Al	As	Au	B	Ba	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Li	Mg
	Average crustal abundance (Mason 1966)	*0.07*	*81,300*	*2*	*0.004*	*10*	*425*	*36,300*	*0.2*	*25*	*100*	*55*	*50,000*	*0.08*	*25,900*	*20*	*20,900*
Sandstone (n = 40)	Min	0.05	1000	14	<0.2	<10	30	100	<0.01	0.4	7	4	4400	0.14	700	0.4	<100
	P5	0.06	1400	39	<0.2	<10	30	100	0.01	0.5	9	5.6	5000	0.23	1000	0.6	100
	Average	2.2	2600	140	0.39	<10	57	1000	0.037	1.7	88	9.2	8900	1.7	1800	2.1	380
	P95	5.3	4700	290	1	<10	110	1600	0.11	4.5	150	17	13000	3.3	3600	2.4	600
	Max	6.3	8400	370	1.6	<10	120	22000	0.34	8	180	24	22000	12	3700	39	8600
Breccia (n = 7)	Min	0.78	1500	53	<0.2	<10	40	100	<0.01	0.5	92	7	4800	0.7	1300	0.4	<100
	P5	1.1	1500	58	<0.2	<10	43	130	0.01	0.5	96	7.2	5000	0.76	1300	0.43	100
	Average	5.7	1900	110	2.8	<10	69	290	0.016	1	130	11	7300	1.5	2000	0.64	100
	P95	11	2400	190	8.6	<10	100	400	0.034	1.7	160	17	10000	2.3	2900	0.87	100
	Max	12	2400	200	9.7	<10	110	400	0.04	1.8	160	17	10000	2.4	3200	0.9	100
Siltstone (n = 33)	Min	0.05	300	51	<0.2	<10	20	100	<0.01	0.4	8	5.5	5500	0.39	200	0.5	<100
	P5	0.08	660	63	<0.2	<10	30	100	0.01	0.56	8.6	6.3	5900	0.49	500	0.66	100
	Average	2.8	3000	150	0.45	<10	53	1700	0.056	2.5	110	11	11000	2.2	1700	2.5	370
	P95	8.6	12000	290	1.4	<10	84	4800	0.21	7.4	240	18	17000	5.5	3100	9.4	1000
	Max	15	14000	290	1.6	<10	90	33000	0.51	23	260	23	19000	7.3	3200	28	5600
Sinter (n = 11)	Min	0.12	300	14	<0.2	<10	20	100	<0.01	0.5	37	4.9	3700	0.37	200	0.6	<100
	P5	0.26	300	18	<0.2	<10	20	100	0.01	0.55	41	5	4100	0.38	200	0.6	100
	Average	2.1	730	59	1.4	<10	36	210	0.016	1.4	180	8.9	10000	1.3	550	1.1	120
	P95	5.3	1100	160	6.5	<10	60	450	0.045	3.7	270	15	22000	2.1	1300	1.8	200
	Max	7.7	1100	270	13	<10	60	500	0.07	5	290	18	22000	2.2	1300	2.2	300
Mud/clay (n = 5)	Min	0.09	1800	80	<0.2	<10	50	900	<0.05	0.9	16	7.3	11000	1.9	1100	0.8	400
	P5	0.12	2100	92	<0.2	<10	52	1100	<0.05	1.1	17	8	11000	2	1100	0.86	400
	Average	0.7	4300	180	0.42	<10	68	1800	0.12	2.8	58	20	15000	2.8	1600	2.2	660
	P95	1.7	5800	240	0.82	<10	80	2400	0.26	4.9	130	36	20000	3.9	2100	3.5	880
	Max	1.9	5900	250	0.9	<10	80	2500	0.3	5	150	38	21000	4	2100	3.6	900
Basal mudstone (n = 8)	Min	0.59	2800	15	<0.2	<10	10	700	<0.01	0.1	8	6	2000	0.12	1800	0.2	<100
	P5	0.7	2900	18	0.2	<10	14	770	<0.01	0.17	12	6.2	2500	0.15	1800	0.27	140
	Average	2.5	4000	140	0.28	<10	46	1200	0.079	4.5	47	15	12000	2.6	2300	0.79	300
	P95	5.8	6700	390	0.5	<10	110	2300	0.27	12	98	27	19000	5.3	3100	1.7	600
	Max	7.2	7100	500	0.5	<10	130	2500	0.28	13	100	30	21000	5.3	3300	2.1	700
Sandstone (n = 40)	Min	7	0.72	100	2.3	20	2.9	100	1.9	0.1	0.2	0.2	0.09	0.22	1	<0.05	2
	P5	15	1.2	100	2.7	30	3.6	100	4.6	0.2	0.4	0.2	0.13	0.29	3	0.07	4
	Average	48	17	220	9.1	140	13	2300	14	0.38	1.4	0.36	0.39	0.56	6.7	1.1	17
	P95	120	35	400	19	470	29	5100	25	0.61	4.8	0.51	0.95	0.98	15	3.3	46
	Max	290	150	900	27	550	130	10000	94	1.1	5.5	0.7	2	1.4	31	4.9	110
Breccia (n = 7)	Min	16	4.9	100	5.4	40	2.1	1300	4.4	0.2	0.6	0.3	0.05	0.26	3	<0.05	2
	P5	17	5.8	100	5.9	40	2.5	1300	4.5	0.2	0.63	0.3	0.068	0.29	3	0.053	2.6
	Average	22	14	130	9	64	4.8	2900	14	0.3	2.4	0.37	0.39	0.5	5	0.14	5.7
	P95	29	28	200	13	110	7.2	5700	32	0.58	5.3	0.47	0.9	0.7	8.4	0.33	8.7
	Max	30	33	200	13	120	7.4	6200	38	0.7	6	0.5	1.1	0.72	9	0.4	9
Siltstone (n = 33)	Min	11	1.3	100	3.3	10	1	100	5.5	0.1	0.3	0.2	0.11	0.09	2	<0.05	3
	P5	14	2.3	100	3.7	16	1.4	100	5.7	0.2	0.62	0.3	0.13	0.1	2	0.1	3.6
	Average	64	13	180	12	190	15	2800	16	0.59	1.9	0.45	0.53	0.67	7.1	1	19

Material Type		Ag	Al	As	Au	B	Ba	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Li	Mg
	Average crustal abundance (Mason 1966)	*0.07*	*81,300*	*2*	*0.004*	*10*	*425*	*36,300*	*0.2*	*25*	*100*	*55*	*50,000*	*0.08*	*25,900*	*20*	*20,900*
	P95	180	39	400	27	610	46	8000	37	1.9	5.5	0.78	1.6	1.3	14	2.6	56
	Max	520	72	1000	39	740	50	11000	55	2.2	6.1	0.9	2.4	2.8	16	8.7	110
Sinter (n = 11)	Min	14	4.5	100	2.7	10	0.5	100	3.9	0.1	0.7	0.2	0.11	<0.05	2	0.1	3
	P5	21	4.7	100	6.3	10	1.1	150	3.9	0.1	0.7	0.2	0.12	0.05	2	0.14	3
	Average	70	11	100	25	46	7.2	780	9.4	0.19	1.2	0.38	0.29	0.14	4.9	1	7.4
	P95	140	26	100	56	160	21	2400	24	0.35	2	0.55	0.72	0.34	11	2.7	18
	Max	140	29	100	65	200	25	3000	36	0.4	2.1	0.6	0.88	0.48	11	3.2	20
Mud/clay (n = 5)	Min	50	1.5	100	5.2	60	5.2	100	17	0.5	0.4	0.3	0.21	0.48	4	0.42	16
	P5	53	2	120	5.2	70	6.7	220	18	0.54	0.44	0.32	0.22	0.48	5.6	0.65	16
	Average	97	6.5	400	8.7	200	59	1700	31	1.1	1	0.76	0.66	0.71	17	4.6	120
	P95	170	11	1000	14	480	120	3400	51	1.6	2	1.6	1.4	1.1	24	12	330
	Max	190	11	1200	16	560	120	3700	56	1.7	2.3	1.8	1.6	1.2	25	15	390
Basal mudstone (n = 8)	Min	7	4.8	100	2.3	10	7.6	200	3.2	0.1	0.2	0.2	0.08	0.46	1	<0.05	2
	P5	8.4	5	100	2.5	42	9.5	310	3.8	0.14	0.38	0.24	0.084	0.5	1.4	0.089	2.4
	Average	24	14	110	9.2	160	23	8900	8.6	0.55	2.3	0.35	0.34	0.94	4.5	0.28	21
	P95	59	28	170	16	230	41	22000	18	1.2	5.2	0.47	0.68	1.4	11	0.55	58
	Max	78	32	200	18	240	43	25000	19	1.3	6.5	0.5	0.73	1.5	13	0.59	70

	Indicates less than three times average crustal abundance
	Indicates between three and six times average crustal abundance
	Indicates between six and 12 times average crustal abundance
	Indicates greater than 12 times average crustal abundance

Note: P5 = 5th Percentile, P95=95th percentile
Source: Grassy Mountain Static Test Database Rev14

Table 16. Summary of Acid Base Accounting Results Waste Rock and Ore

Material Type		pH	Total sulfur	Sulfate sulfur[1]	Sulfide sulfur[2]	AP[3]	NP	NNP[5]	NPR[6]
		s.u.	wt%	wt%	wt%	kg $CaCO_3$/t	kg $CaCO_3$/t	-	-
Sandstone (n = 40)	Min	5.3	<0.01	<0.01	<0.01	<0.3	<0.3	-30	0.03
	P5	5.4	0.01	0.01	0.01	0.3	0.3	-8	0.04
	Average	6.1	0.25	0.15	0.094	2.9	2.3	-0.7	0.77
	P95	8	0.56	0.3	0.25	7.9	3.2	2.8	10
	Max	8.4	1.2	0.35	0.88	27	57	57	190
Breccia (n = 7)	Min	5.4	0.14	0.082	<0.01	<0.3	<0.3	-10	0.03
	P5	5.6	0.14	0.086	0.015	0.45	0.3	-10	0.033
	Average	6.2	0.32	0.17	0.12	3.7	0.33	-3	0.088
	P95	7.3	0.6	0.28	0.33	10	0.44	-0.01	1.3
	Max	7.4	0.63	0.3	0.36	11	0.5	0.2	1.7
Siltstone (n = 33)	Min	3.3	<0.01	<0.01	<0.01	<0.3	<0.3	-30	0.01
	P5	5	0.011	0.011	0.01	0.3	0.3	-10	0.026
	Average	4.8	0.3	0.17	0.12	3.9	2.9	-0.9	0.76
	P95	7.4	0.83	0.4	0.38	12	3.7	3.4	9.7
	Max	7.8	1.1	0.62	0.83	26	73	65	15
Sinter (n = 11)	Min	6.3	<0.01	0.01	<0.01	<0.3	<0.3	-5	0.18
	P5	6.4	0.012	0.011	0.01	0.3	0.3	-3	0.2
	Average	6.8	0.083	0.054	0.032	0.99	2.5	1.5	2.6
	P95	7.8	0.25	0.15	0.11	3.5	7.9	7.5	20
	Max	8	0.32	0.16	0.18	5.5	8.6	8.2	22
Mud/clay (n = 5)	Min	5.4	0.014	0.014	<0.01	<0.3	<0.3	-3	0.13
	P5	5.5	0.026	0.022	0.012	0.38	0.34	-3	0.18
	Average	6.1	0.19	0.12	0.067	2.1	1.6	-0.5	0.76
	P95	8	0.38	0.2	0.15	4.5	3.7	1.7	2
	Max	8	0.41	0.21	0.16	5.1	4.1	2.1	2.1
Basal mudstone (n = 8)	Min	3	0.017	0.017	<0.01	<0.3	<0.3	-60	0.01
	P5	3.1	0.028	0.022	0.012	0.37	0.3	-50	0.01
	Average	3.7	0.95	0.29	0.64	20	0.39	-20	0.019
	P95	7	2.4	0.7	1.7	53	0.76	-0.07	0.86
	Max	7.1	2.7	0.82	1.9	58	1	0	1

Source: Grassy Mountain Static Test Database Rev14. Note: P5 = 5th Percentile, P95=95th percentile.

[1] Sulfate sulfur concentrations determined by hot water extraction.

[2] Sulfide sulfur concentrations calculated from non-sulfate sulfur values determined by hot water extraction.

[3] Acidification Potential (AP) calculated from sulfide sulfur.

[4] Neutralization Potential (NP) determined from titration according to the modified Sobek method.

[5] Net Neutralization Potential (NNP) = NP-AP.

[6] Neutralization Potential Ratio (NPR) = NP/AP

Table 17. Summary of Net Acid Generation Results Waste Rock and Ore

Material Type	NAG pH (s.u.)			Total NAG (kg H_2SO_4 eq/t)		
	Mean	Min.	Max	Mean	Min.	Max
Sandstone (n = 40)	4.47	2.37	6.78	5.71	0	24.6
Breccia (n = 7)	4.24	2.66	5.66	5.81	0	15.6
Siltstone (n = 33)	4.11	2.47	9.62	8.73	0	29.7
Sinter (n = 11)	4.90	2.84	5.54	2.38	0	15.6
Mud/clay (n = 5)	5.02	3.20	6.23	4.52	0	12.8
Mudstone (n = 8)	3.85	2.24	6.08	22.6	0	64.1

Source: Grassy Mountain Static Test Database Rev14

Table 18. X-Ray Diffraction Results Waste Rock and Ore

Mineral Phase	Sinter		Sandstone			Siltstone			Mudstone			Breccia
	CAL 001 (380 - 400)	CAL 002 (177 - 187)	CAL 001 (487 - 505)	CAL 002 (86 - 95)	CAL 004 (860 - 875)	CAL 001 (750 - 762)	GMC 003 (485 - 495)	GMC 014 (176 - 184)	CAL 003 (675 - 685)	CAL 004 (295 - 315)	GMC 012 (832 - 851)	CAL 002 (430 - 438)
Quartz	98	98	84	89	80	75	89	82	50	88	66	72
Orthoclase	1	2	8	11	12	14	7					9
Calcite	1											
Illite			8		8	11	4	7	42	6		
Albite										2		10
Muscovite											32	9
Kaolinite									6			
Pyrite								2	2			
Magnetite										2		
Goethite										2		
Anorthoclase											2	
Rectorite								9				

Note: Results presented as percentages of total mineral phases present.

Table 19. Summary of MWMP Results Waste Rock and Ore

Parameter	Oregon Groundwater Quality Guidelines	Sandstone						Breccia		Siltstone						Sinter			Mud/Clay	Mudstone
		Ore		Waste Rock				Ore		Ore		Waste Rock				Waste Rock			Waste Rock	Waste Rock
		GMC-006 (593-613)	CAL-001 (487-505.4)	CAL-004 (445-455)	GMC-012 (780-800)	CAL-002 (86-95)	CAL-004 (860-875)	CAL-002 (480-496)	CAL-002 (430-438.2)	CAL-002 (235-255)	GMC-003 (485-495)	GMC-014 (44-59)	CAL-001 (750-762)	CAL-002 (697-706)	GMC-014 (176-184)	CAL-001 (380-400)	GMC-014 (208-215)	CAL-002 (177-187)	CAL-004 (295-315)	GMC-012 (919-946)
pH	*6.5-8.5*	7.30	6.60	6.40	6.00	5.60	7.90	7.00	6.50	6.70	6.40	5.10	5.30	6.50	2.30	9.40	6.40	7.20	4.90	2.00
TDS	*500*	24	20	130	<10	242	42	34	24	20	28	1,440	<10	<10	8,680	150	24	52	556	9,100
SO4	*250*	2.4	<1	48.7	2.4	139	10.8	4.6	2.2	3.8	5	732	5.5	1.1	5,360	35.1	8.4	26.8	329	5,060
As	*0.05*	0.010	0.0012	0.0039	0.00040	0.041	0.028	0.021	0.0048	0.0066	0.0027	0.030	0.0011	0.0025	16.7	0.18	0.0015	0.0084	0.051	18.5
Ba	*1*	0.0070	0.016	<0.003	<0.003	0.064	0.10	0.0050	0.0050	0.0040	0.010	0.015	<0.003	<0.003	<0.02	0.026	<0.003	0.012	0.030	<0.02
Cd	*0.01*	<0.0001	<0.0001	<0.0001	<0.0001	0.00050	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00080	<0.0001	<0.0001	0.053	<0.0001	<0.0001	<0.0001	0.00030	0.14
Cl	*250*	0.60	0.70	4.50	0.70	5.20	1.00	0.90	0.80	0.80	<0.5	144	0.60	0.60	3.90	0.80	<0.5	1.40	15.4	2.10
Cr	*0.05*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.14	<0.01	<0.01	<0.01	<0.01	0.15
Cu	*1*	<0.01	<0.01	<0.01	<0.01	0.020	<0.01	<0.01	<0.01	<0.01	0.020	<0.01	<0.01	<0.01	6.73	<0.01	0.020	<0.01	0.050	3.07
F	*4*	0.080	<0.05	0.12	<0.05	0.21	0.48	0.20	<0.05	<0.05	<0.05	0.36	0.060	0.060	11.0	0.33	0.050	0.23	0.56	<5
Fe	*0.3*	<0.02	<0.02	<0.02	0.090	11.1	0.22	0.030	0.040	<0.02	0.44	<0.02	0.13	<0.02	479	<0.02	<0.02	<0.02	0.73	773
Pb	*0.05*	<0.0001	0.00030	<0.0001	0.00040	0.00040	0.00050	<0.0001	0.00010	<0.0001	0.00020	0.0024	<0.0001	<0.0001	0.0096	0.00010	0.00040	0.00020	0.00040	0.0098
Mn	*0.05*	0.0060	<0.005	0.032	<0.005	0.29	<0.005	<0.005	0.0090	<0.005	0.0090	0.50	<0.005	<0.005	6.43	<0.005	0.0060	0.0060	0.50	1.02
Hg	*0.002*	<0.0002	<0.0002	0.00030	<0.0002	<0.0002	0.00050	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
NO_3	*10*	0.08	0.14	0.13	0.02	0.06	0.14	0.04	0.02	<0.02	0.14	2.56	0.04	0.08	0.10	0.07	0.03	0.05	0.46	0.08
Se	*0.01*	0.00090	0.00010	0.016	<0.0001	0.0094	0.0037	0.0018	0.00060	0.00010	0.00070	0.0089	0.00030	0.00010	0.044	0.011	<0.0001	0.0091	0.036	0.034
Ag	*0.05*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.050
Zn	*5*	0.010	0.010	<0.01	0.020	0.040	<0.01	0.010	0.020	<0.01	0.060	0.19	0.010	<0.01	12.5	<0.01	0.020	0.010	0.070	24.5

Table 20. Summary of HCT Leachate Concentration (mg/L) Compared to Oregon Groundwater Quality Guidelines

Parameter	OGWQG	HC-1	HC-2	HC-3	HC-4	HC-5	HC-6	HC-7	HC-8	HC-9	HC-10
		Sandstone	Sandstone	Mudstone	Mudstone	Mud/Clay	Siltstone	Siltstone	Sinter	Sinter	Tailings
pH	*6.5-8.5*	X	X	X	X	X	X	X	O	X	X
As	*0.05*	X	O	X	O	O		X			
Ag	*0.05*										
Ba	*1*										
Cd	*0.01*			O	O			O			
Cu	*1*			O	O						O
Cl	*250*										
Cr	*0.05*	O	O	O	O			O			
F	*4*	O	O	X	O	O	O	O	O	O	O
Fe	*0.3*	X	X	X	X	X	X	X			X
Pb	*0.05*					O		O			
Hg	*0.002*		O								
Mn	*0.05*	O	O	X	O	X		X			X
NO_3	*10*										
Se	*0.01*		O	O	O	O	O	O			
SO4	*250*			X	O			O			
TDS	*500*			X	O			O			
Zn	*5*			O	O			O			

Source: Grassy Mountain HCT Database Rev02

Notes:

X indicates greater than 50% of measurements exceeded the Oregon Groundwater Quality Guidelines.

O indicates between 25% and 50% of measurements exceeded the Oregon Groundwater Quality Guidelines.

Blank cells Indicate measurements are all below the Oregon Groundwater Quality Guidelines.

All samples appeared to exceed as silver detection limit was higher than the standard.

Note: Due to differences in the liquid to solid ratio used in the test compared to typical site conditions HCT results only provide a qualitative estimate of elemental concentrations in the resulting leachates and are not considered conclusive or to represent actual predictions of water quality.

Table 21. Comparison of Humidity Cell Test and Static Tests Results

Cell	Sample ID	Lithology	Sulfide Sulfur (wt%)	NNP (kg $CaCO_3$ eq/t)	NPR	NAG pH (s.u.)	Total NAG (kg H_2SO_4 eq/t)	Final HCT pH	HCT Prediction
1	CAL-002 (86-95)	Sandstone	0.246	-7.7	0.04	2.37	11.7	3.37	Acidic
2	CAL-004 (860-875)	Sandstone	0.083	2.6	0.12	3.14	14.7	3.82	Acidic
3	CAL-003 (675-685)	Mudstone	1.36	-42.5	0.01	2.33	47.2	2.29	Acidic
4	GMC-012 (832-851)	Mudstone	0.526	-16.4	0.02	2.56	18	3.18	Acidic
5	CAL-004 (295-315)	Mud/clay	0.073	-2.3	0.13	3.2	9.2	3.41	Acidic
6	CAL-001 (750-762)	Siltstone	0.065	-2.0	0.15	3.7	14.5	3.71	Acidic
7	GMC-014 (176-184)	Siltstone	0.488	-15.3	0.02	2.7	29.7	2.59	Acidic
8	CAL-001 (380-400)	Sinter	0.014	0.1	1.25	5.54	0	6.88	Non-acidic
9	CAL-002 (177-187)	Sinter	0.044	-1.4	0.21	3.96	15.6	5.03	Non-acidic

Criteria for AP Predictions:

ABA Criteria	PAG	NNP<-20 or NPR<1
	Low PAG	NP between -20 and +20 or NPR between 1 and 3
	Non-PAG	NNP>20 or NPR >3
NAG Criteria	PAG	NAG>20
	Low to Moderate PAG	NAG between 1 and 20
	Non-PAG	NAG<1
HCT Criteria	Acidic	HCT pH < 5
	Non-acidic	HCT pH > 5

Source: Grassy Mountain HCT Database Rev02

PAG = Potentially Acid Generating, Low PAG = Uncertain Potential/Lower Capacity, Non-PAG = Non-Acid Generating

The results of the test work on the tailings samples are summarized in the following tables: Table 22 ABA results; Table 23 NAG results; Table 24 mineralogy results; Table 25 calculated lime amendment rates; Table 26 modified MWMP and SPLP results; and Table 27 supernatant results.

Table 22. Acid Base Accounting Results – Tailings

Sample	Paste pH	Total sulfur	Sulfate sulfur[1]	Sulfide sulfur[2]	AP[3]	NP[4]	NNP[5]	NPR[6]
	s.u.	wt%	wt%	wt%	kg $CaCO_3$/t	kg $CaCO_3$/t	kg $CaCO_3$/t	-
Calico Leach Res. After CN Destruct.	6.8	0.35	0.26	0.089	2.8	0.3	-3	0.11
Arkose (1 of 2)	8	0.36	0.26	0.09	2.8	4.2	1.4	1.5
MLDWT (1 of 2)	8.1	0.43	0.24	0.19	5.9	4.7	-1.2	0.8
SLST (1 of 2)	8.1	0.42	0.24	0.18	5.6	4.5	-1.1	0.8

Source: Grassy Mountain Static Test Database Rev14. Note: P5 = 5th Percentile, P95=95th percentile.
[1] Sulfate sulfur concentrations determined by hot water extraction.
[2] Sulfide sulfur concentrations calculated from non-sulfate sulfur values determined by hot water extraction.
[3] Acidification Potential (AP) calculated from sulfide sulfur.
[4] Neutralization Potential (NP) determined from titration according to the modified Sobek method.
[5] Net Neutralization Potential (NNP) = NP-AP.
[6] Neutralization Potential Ratio (NPR) = NP/AP.

Table 23. Net Acid Generation Results – Tailings

Sample	NAG pH	NAG
	s.u.	kg H_2SO_4/t
Calico Leach Res. After CN Destruct.	3.21	4.60
Arkose (1 of 2)	5.56	0
MLDWT (1 of 2)	5.76	0
SLST (1 of 2)	2.94	7
Source: Grassy Mountain Static Test Database Rev14		

Table 24. Mineralogy Results – Tailings

Phase Found	Percentage
Quartz	75
Orthoclase	14
Muscovite	11

Table 25. Calculated Lime Amendment Rates

Sample Name	ABA Results on Initial Sample					Lime Addition - NPR >3		Lime Addition - NNP >20	
	Sulfide Sulfur (wt%)	AGP (kg $CaCO_3$/t)	ANP (kg $CaCO_3$/t)	NNP (kg $CaCO_3$/t)	NPR	Net NP needed (kg $CaCO_3$/t)	$Ca(OH)_2$ Addition (g/kg)	Net NP needed (kg $CaCO_3$/t)	$Ca(OH)_2$ Addition (g/kg)
Arkose (1of 2)	0.09	2.81	4.2	1.4	1.5	4.2375	3.2	18.6	14.0
MLDWT (1of 2)	0.19	5.94	4.7	-1.2	0.8	13.1125	9.8	21.2	15.9
SLST (1of 2)	0.18	5.63	4.5	-1.1	0.8	12.375	9.3	21.1	15.8

Table 26. Summary of Modified MWMP and SPLP Results

Parameter	Oregon Groundwater Quality Guidelines	Modified MWMP	Modified SPLP		
		Calico Leach Res. After CN Destruct.	Arkose (1/2)	MLDWT (1/2)	SLST (1/2)
Arsenic	*0.05*	0.0046	0.0053	0.0076	0.0031
Barium	*1*	0.045	0.277	0.332	0.339
Cadmium	*0.01*	0.003	<0.0001	<0.0001	<0.0001
Chloride	*250*	1.6	14.8	44.8	20.6
Chromium	*0.05*	<0.01	0.05	0.07	0.04
Copper	*1*	15.1	0.04	0.03	0.02
Fluoride	*4*	0.9	<1	<1	<1
Iron	*0.3*	1.24	<0.02	0.02	<0.02
Lead	*0.05*	0.0028	0.0009	0.0009	0.0025
Manganese	*0.05*	5.6	<0.005	<0.005	<0.005
Mercury	*0.002*	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate/Nitrite as N	*10*	0.17	0.29	0.37	0.28
pH (s.u.)	*6.5-8.5*	4.5	12.1	12.2	12.2
Selenium	*0.01*	0.012	0.0244	0.033	0.0218
Silver	*0.05*	<0.01	<0.01	<0.01	<0.01
Sulfate	*250*	606	286	178	3.6
TDS	*500*	948	<0.005	<0.005	0.005
Zinc	*5*	0.55	<0.01	<0.01	<0.01

All units in mg/L except pH, which is in standard units (s.u.)
Pink shaded cells = Concentration exceeds Oregon Groundwater Quality Guidelines (OAR 340-40-020)
Source: Grassy Mountain Static Test Database Rev14

The kinetic test results on the tailings sample is as follows:

The tailings sample from the 2015 metallurgical test program that was not amended with lime was submitted for humidity cell testing. The tailings sample (HC-10) produced acidic leachates throughout the humidity cell test, with pH declining from 4.3 initially to pH~3 by week 40 and

increased slightly from week 40 onwards to ~3.6. The iron leaching rates (up to ten mg/kg/week) indicate that active sulfide oxidation occurred in this sample. Several constituents were mobile under these acidic conditions, with iron and manganese consistently elevated above OGWQG throughout the duration of the test and copper was elevated above the guideline between weeks zero and 24. The tailings cell also showed an initial flush (week zero) for a few additional constituents, including sulfate, aluminum, cadmium, fluoride, nickel, selenium, sulfate, and zinc, which likely reflects the removal of soluble oxidation products from the material surfaces. Of these, constituents that exceeded the OGWQG in week zero included selenium, sulfate, and total dissolved solids (TDS). All other constituents that were elevated in week zero either did not have an associated water quality guideline (i.e., aluminum) or were not elevated relative to guidelines. These were typically flushed during the first couple of leach cycles. In addition, WAD cyanide was detected in the first two weeks of testing at 0.011 mg/L and was measured at below the detection limit of 0.003 mg/L every other week.

Table 27. Summary of Supernatant Results

Parameter	Oregon Groundwater Quality Guidelines	Samples					
		Arkose (1/2)	Arkose (2/2)	MLDWT (1/2)	MLDWT (2/2)	SLST (1/2)	SLST (2/2)
Arsenic	*0.05*	0.244	0.213	0.455	0.314	0.69	0.643
Barium	*1*	0.052	0.057	0.065	0.059	0.054	0.055
Cadmium	*0.01*	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Chloride	*250*	12.8	11.9	16.1	7.5	11.9	13.6
Chromium	*0.05*	0.001	0.001	0.001	0.001	0.001	0.001
Copper	*1*	0.0085	0.007	0.0076	0.0065	0.048	0.0468
Fluoride	*4*	0.24	1	0.31	0.25	0.31	0.29
Iron	*0.3*	0.02	0.02	0.04	0.04	0.02	0.03
Lead	*0.05*	0.0007	0.001	0.0004	0.0005	0.0007	0.0002
Manganese	*0.05*	0.0398	0.0366	0.038	0.0258	0.0375	0.0369
Mercury	*0.002*	0.0066	0.0007	0.036	0.0009	0.028	0.0072
Nitrate/Nitrite as N	*10*	0.21	0.21	0.24	0.21	0.21	0.21
pH, stu	*6.5-8.5*	8.1	8.1	8.2	8.1	8.4	8.4
Selenium	*0.01*	0.0625	0.0573	0.0527	0.0423	0.0277	0.0277
Silver	*0.05*	0.0003	0.0001	0.0014	0.0001	0.0001	0.0001
Sulfate	*250*	1370	1400	1640	1590	1450	1330
Total Dissolved Solids	*500*	2110	2140	2510	2450	2310	2170
Zinc	*5*	0.01	0.01	0.06	0.02	0.01	0.01

All units in mg/L except pH, which is in standard units (s.u.)
Pink shaded cells = Concentration exceeds Oregon Groundwater Quality Guidelines (OAR 340-40-020)
Source: Grassy Mountain Static Test Database Rev14

The Geochemistry Report conclusions are as follows:

Waste Rock and Ore: The Grassy Mountain underground waste rock shows variable geochemical behavior and each material type has a wide range of sulfide content and predicted acid generation from the static test results. Overall, the waste rock has very limited acid neutralizing capacity due to the low inorganic carbon content and as such the predicted acid generating potential is strongly related to sulfide content. The characterization results for the ore grade material are comparable to the waste rock material.

Based on the ABA results, the majority of samples tested (93 percent) show an uncertain potential for acid generation based on the BLM criteria (BLM 2004). Only two percent of samples tested meet the BLM criteria and can be classified as NAG forming materials based on a net neutralizing potential greater than 20 kg CaCO3 eq/ton and greater than three-fold excess of neutralizing capacity. Five percent of samples tested are clearly acid forming materials based on NPR values less than one (i.e., no excess neutralizing capacity) and an NNP of less than -20 kg CaCO3 eq/ton. The Grassy Mountain waste rock and ore materials have very limited acid neutralizing capacity due to the low TIC content. In the absence of NP, the acid generating potential of the materials is directly related to the sulfide content. Samples with a sulfide content greater than 0.5 wt% are acid generating with NNP values less than -20 kg CaCO3 eq/ton. There is a near linear relationship between NPR and sulfide sulfur content and the potential for acid generation increases with increasing sulfide sulfur.

The presence of sulfide sulfur in higher concentrations increases the potential for the materials to produce acid where insufficient neutralizing potential is present. However, both the NPR and NNP criteria are less meaningful in instances where both NP and AP are low or near detection (i.e., inert from an ABA perspective) and the low NNP and NPR values may be misleading. In these cases, kinetic testing is important to better understand the actual acid generating potential of the materials.

The NAG results are consistent with the ABA data and show that samples with sulfide sulfur greater than 0.5 wt% are predicted to have a higher capacity for acid generation with NAG values greater than 20 kg H2SO4 eq/ton. Samples with sulfide sulfur content between 0.05 and 0.5 wt% show a low to moderate potential for acid generation with NAG values between one and 20 kg H2SO4 eq/ton.

Based on the MWMP test, the majority of the samples have neutral to alkaline paste pH values (pH 6 - 8) indicating minimal readily soluble acid sulfate salts from prior oxidation of the core material. The exceptions are a few samples of mudstone and siltstone with the highest sulfide sulfur content that generated acidic leachate. Constituents above OGWQG under the low pH conditions include sulfate, arsenic, cadmium, chromium, copper, fluoride, iron, manganese, selenium and zinc. For samples with neutral pH (i.e., pH >7) all constituents were below the OGWQG.

Eight of the nine HCTs generated acidic leachate throughout the test and indicate that samples with an uncertain potential for acid generation from the ABA will generate acid under long term weathering conditions. The only two samples that maintained neutral conditions during the HCT program consisted of sinter material. All other material types are considered to be acid generating including the sandstone, siltstone, and mudstone. A comparison of the HCT leachate chemistry to OGWQG indicates the mudstone (HC-3 and HC-4) had the greatest number of parameters that exceeded guidelines and the sinter cells (HC-8 and HC-9) had the least. Most cells that developed acidic conditions leached copper, iron, manganese, arsenic, and sulfate at concentrations greater than the guidelines, indicating these elements are mobile under acidic pH conditions. Other constituents that were leached above OGWQG during the first few weeks of the test include cadmium, chromium, copper, fluoride, lead, selenium, silver, and zinc.

In summary, the results of the Grassy Mountain geochemical characterization program indicate that the majority of the waste rock and unprocessed ore material will generate acid and leach metals under long term weathering conditions. The exceptions to this include the sinter material that shows a low potential for acid generation. This can be attributed to the lower sulfide sulfur content associated with this material type.

Road Cut and Borrow Material: The borrow material from the proposed basalt quarry has no potential for acid generation with total sulfur values below the detection limit of 0.01 percent for all samples. In addition, all samples were classified as near-neutral, low metal waters in the MWMP tests and all parameters were below the OGWQG.

The results for the road cut materials were similar to the borrow material and total sulfur values were below the detection limit of 0.01 percent indicating bedrock that could be encountered during the access road development has no potential for acid generation. All road cut samples were classified as near-neutral, low metal waters in the MWMP tests and all parameters were below the OGWQG.

Tailings Material: Geochemical testing included tailings material from the 2015 metallurgical test program (one sample) and the 2018 metallurgical test program (three samples). The results indicate that despite low sulfide sulfur, the tailings material has a potential to generate acid due to the low NP. The potential for tailings material to generate acid and leach metals was confirmed by the HCT results for the unamended tailings sample from the 2015 metallurgical test program. Under low pH conditions, iron, manganese, and copper were mobile at concentrations greater than the OGWQG. In addition, there was an initial flush of several other constituents, including sulfate, aluminum, cadmium, fluoride, nickel, selenium, sulfate, and zinc, which likely reflects the removal of soluble oxidation products from the tailings material surfaces. Supernatant samples had slightly alkaline pH and exceeded the OGWQG for arsenic, selenium, sulfate, and TDS.

ABA test results were used to determine the amount of lime required to neutralize the tailings to meet the regulatory requirement of an NPR > 3 and an NNP > 20 kg CaCO3/t. The ABA results for the tailings material demonstrate that there is some inherent variation in the sulfide sulfur and NP content of the tailings materials that is likely to occur during mining operations. In order

to take into account the slight variation in NP and sulfide sulfur in the tailings material, the amount of lime amendment needs to exceed the minimum amount required to ensure that the neutralization criteria specified in the OAR 340-043-0130 (2) is met. Based on the testing conducted to date, the lime amendment rate needs to include the amount of lime required to neutralize the tailings to meet the regulatory guideline.

Leach test results from tailings samples amended with lime indicate that selenium is leached under alkaline conditions at concentrations above the OGWQG. Sulfate and chromium were also slightly elevated above the OGWQG for one sample and all other parameters were below the OGWQG.

In summary, the tailings material associated with the Project requires lime amendment to achieve non-PAG characteristics. A tailings management plan will need to be developed to collect samples of tailings on a routine basis for geochemical testing in order to adjust the liming rate during operations.

Cemented Rock Fill: During operations, rock fill (RF) and cemented rock fill (CRF) will be placed as backfill in the underground workings to provide stability. Sources of aggregate include the borrow material (i.e., basalt) and waste rock. Due to the benign nature of the basalt, this material will be used as either RF or CRF aggregate. CRF will be used for waste rock and basalt where required, to produce a geochemically stable material.

Based on the waste rock characterization program described herein, the majority of the waste rock associated with the Project has a potential to generate acid and leach metals. Therefore, waste rock will only be used as aggregate for the CRF (i.e., not used as RF alone) and an estimated mix of five percent cement will be added to neutralize the waste rock material.

It is anticipated that a portion of the RF and CRF will be placed below the groundwater table. However, CRF containing waste rock will be placed above the saturated zone and will not become saturated once the groundwater recovers in the mine area, thereby minimizing the potential to impact groundwater.

2.6 Geology and Soils

The Grassy Mountain Mine Project Geology and Soils Baseline Report (Appendix B) was originally submitted to DOGAMI on October 18, 2018. The report was accepted by the TRT on December 17, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Geology Study Area includes the Mine and Process Area with a 4,000-meter buffer and the entire Access Road. The Soils Study Area includes the entire Permit Area (Mine and Process Area and Access Road Area).

Grassy Mountain is the largest of 12 recognized epithermal hot spring precious metal deposits of

the Lake Owyhee volcanic field. The Lake Owyhee volcanic field occurs at the intersection of three tectonic provinces: the buried cratonic margin; the northern basin and range; and the Snake River Plain. During the mid-Miocene, large volume, peralkaline, caldera volcanism occurred in response to large, silicic magma chambers emplaced in the shallow crust throughout the region. The volcanic field includes several caldera-sourced ash-flow sheets and rhyolite tuff cones that were deposited from 15.5 to 15 million years ago. Volcanism during the mid to late Miocene is evidenced by small volume, metaluminous, high-silica rhyolite domes and flows, and small volume basalt flows and mafic vent complexes in north- and northwest-trending basin and range-type fracture zones and ring structures related to resurgent calderas. Regional extension and subsidence facilitated the formation of through-going fluvial systems and extensive lacustrine basins. Large volumes of fluvial sediments, sourced from the exhumed Idaho Batholith to the southeast, were deposited in conjunction with volcanism and hot spring activity during the waning stages of volcanic field development. The resulting regional stratigraphic section is a thick sequence of mid-Miocene volcanic rocks and coeval-to-Pliocene age non-marine lacustrine, volcaniclastic, and fluvial sedimentary rocks.

Figure 6 is the stratigraphic column at Grassy Mountain and Figure 7 shows North-South and East-West cross sections showing the local geology and mineralization. Bedrock outcrops near the Mine and Process Area are typically composed of olivine-rich basalt and siltstones, sandstones, and conglomerates of the late Miocene Grassy Mountain Formation (Tgb, Tgsn, and Tgs). These rocks are locally covered with relatively thin, unconsolidated alluvial and colluvial deposits (Qal). Erosion-resistant basalts cap local topographic highs. Arkosic sandstones have been encountered at the surface and at depth but have not been correlated across the vicinity of the Mine and Process Area, in part due to lateral discontinuity associated with sedimentary facies changes and structural offset. Surface and drill-defined stratigraphy near the Mine and Process Area reveals complex facies that were produced during the waning stages of deposition of the Lake Owyhee volcanic field.

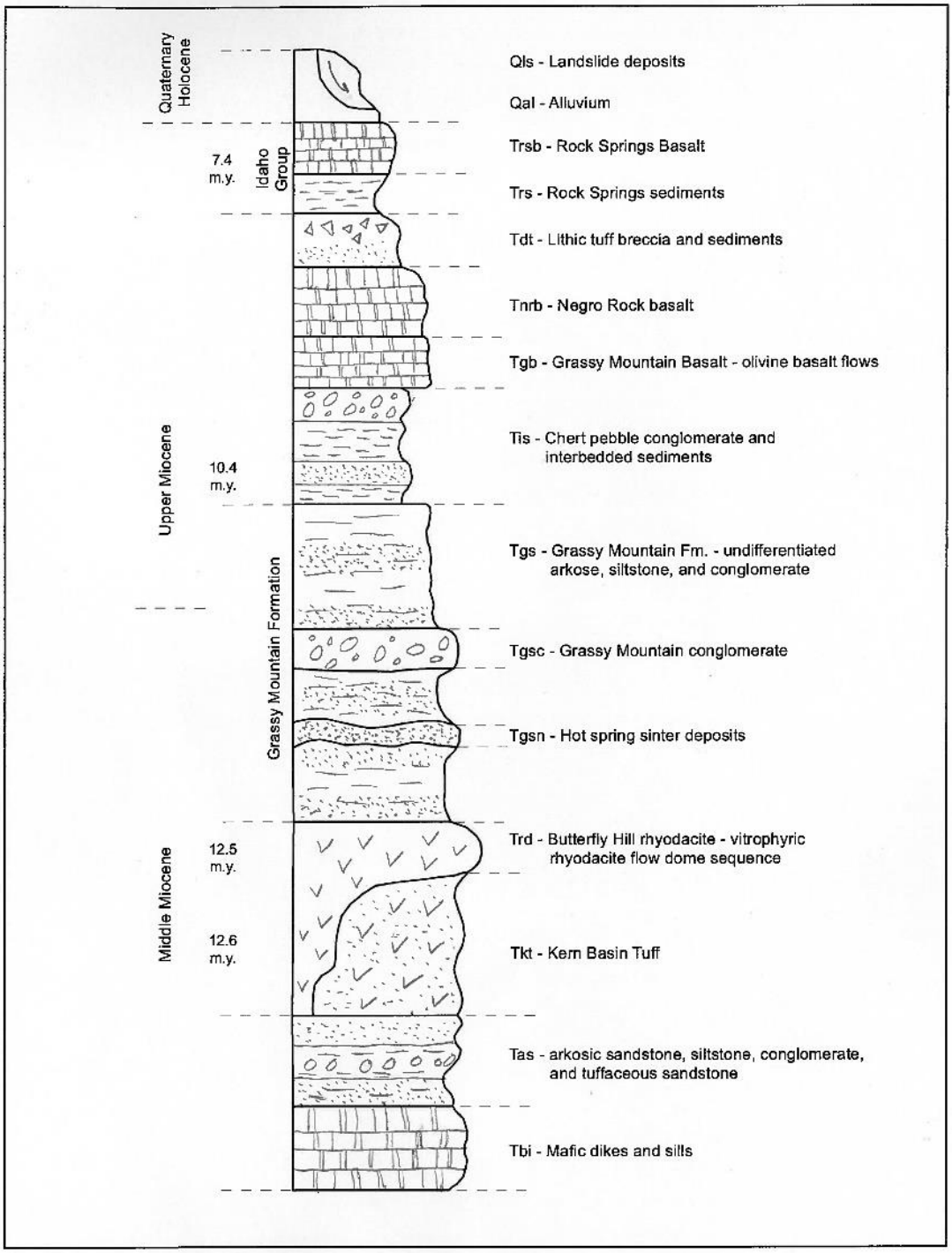


Figure 4. Stratigraphic Column at Grassy Mountain Permit Area

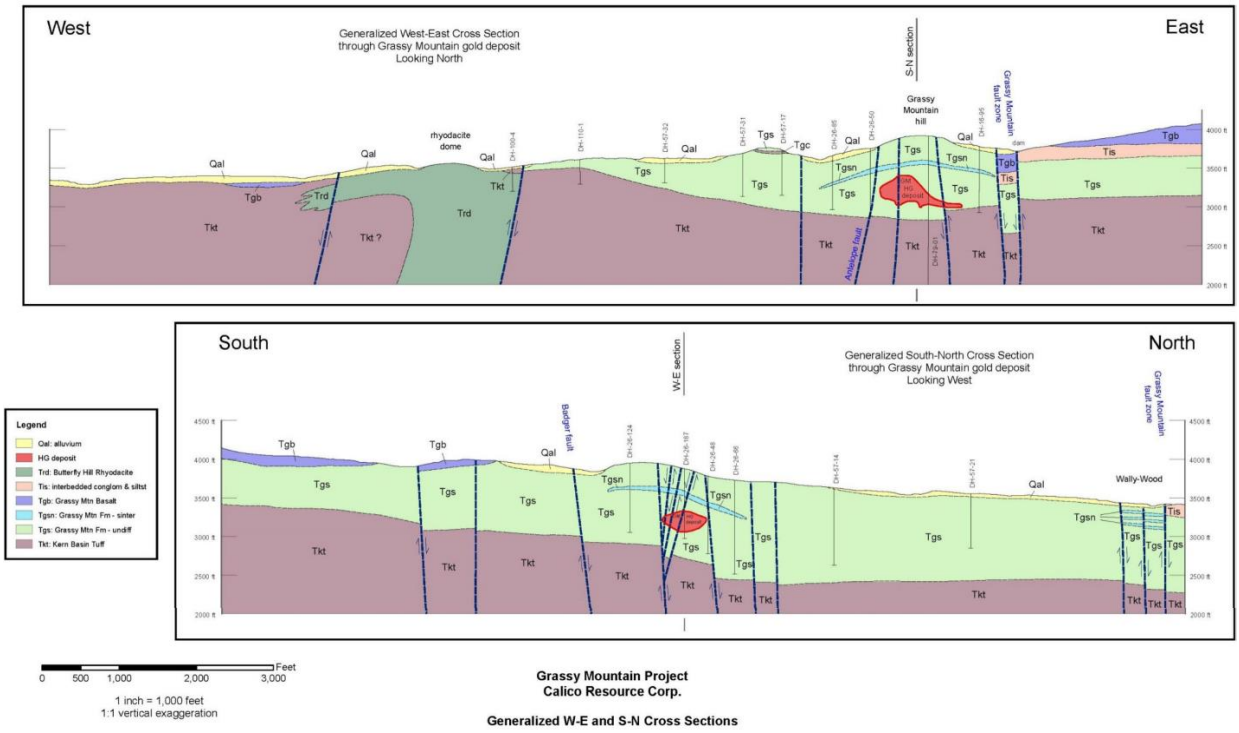


Figure 5. Geologic Cross Sections through the Grassy Mountain Geology Study Area Showing the Grassy Mountain Gold Deposit

The Grassy Mountain gold-silver deposit is located within an interpreted horst block that has been raised 50 to 200 feet in a region of complex block faulting and rotation. Faults at the Grassy Mountain deposit are mainly post-mineral 30 degrees west of north (N30°W) to ten degrees east of north (N10°E), striking normal faults developed during basin and range extension. On the northeast side of the deposit, these faults progressively downdrop mineralization beneath post-mineral cover. These offsets are suggested by interpreted offsets of a prominent white sinter bed in drill holes, as well as drill intersections with fault gouge. Silicification in the form of sinters and disseminated quartz is a prominent alteration type at Grassy Mountain and is largely controlled by hot-spring vents. Silicification occurs both pervasively as silica flooding, and as cross-cutting veins and stockworks. The silicified envelope has plan dimensions up to 3,000 feet (north-south) by 2,500 feet (east-west). Silicification is surrounded by widespread, barren, clay-rich (20- to 40-percent montmorillonite), tuffaceous siltstone and arkose with minor disseminated pyrite. Many of the sinters occur as sheets instead of mounds, which suggest that they are related to vents along faults rather than point sources. Potassic alteration occurs as adularia flooding with destruction of biotite. Orthoclase is unaffected by potassic alteration, and plagioclase is replaced by adularia.

Mineralization of the Grassy Mountain deposit includes: 1) low grade gold associated with hot springs silicification; 2) high grade gold associated with multi-stage quartz-adularia-gold-silver veins and stockworks; and 3) late remobilization within sub-vertical rubble zones defined by clay matrix breccias. The deposit is characterized by stacked sinter terraces capping acid-leached

sediments and multiple generations of quartz veins, which suggest repeated eruption, brecciation, breeching, and sealing of the hydrothermal system. Ore minerals include native gold (50 to 600 microns), electrum, and minor pyrite (up to 80 microns). Gangue minerals include quartz, calcite, chlorite, epidote, orthoclase, plagioclase, illite, sericite, chalcedony, montmorillonite, goethite, and jarosite.

At a local scale and within the immediate vicinity of the Grassy Mountain gold deposit, fault orientations can be grouped into two major sets: 20 degrees west of north to ten degrees east of north (N20°W to N10°E) striking faults, and 70 degrees east of north (N70°E) striking faults. Joint and fractures orientations fall into three major groups: 1) strikes of north to 20 degrees east of north (N to N20°E) dipping to the east-southeast; 2) strikes of a general south direction with dips to the west; and 3) strikes with a general west direction dipping to the north.

Geologic Hazards evaluated in this study include seismicity/earthquake hazards, slope failures/landslides, volcanic eruptions and unsuitable soil/soil erosion. The Geology Study Area is located in a region of low seismic risk. No active or potentially active faults are known in the Geology Study Area. The closest fault with historic surface rupture, the Lost River Fault, is located near Challis, Idaho, approximately 110 miles northeast of the Geology Study Area. The closest potential Holocene age faults are located over 20 miles north of the Geology Study Area. The probability of the occurrence of an earthquake with a magnitude greater than 5.0 over the next ten years is less than 0.03.

Within a 50-mile radius of the Geology Study Area, only a few earthquakes have been recorded since 1900 (United States Geological Survey [USGS] 2018). Only two earthquakes within a 50-mile radius of the Geology Study Area were associated with known fault systems: a magnitude 3.2 earthquake associated with the Squaw Creek Fault in April 1978 (approximately 47 miles away from the Permit Area); and a magnitude 3.2 earthquake associated with the Cottonwood Mountain fault in July 2009 (approximately 31 miles away from the Permit Area). Approximately 27 miles southeast of the Permit Area, there was a 2.9 magnitude earthquake in November 2012, and it's close to the Owyhee Mountains fault system. There were three other earthquakes that occurred within 50 miles of the Geology Study Area since 1900 that were not associated with any known faults or fault systems.

Using the USGS National Seismic Hazard Mapping Database, the peak ground acceleration at the facility resulting from a seismic event from one of the seismic sources was calculated. An earthquake that has a ten-percent probability of exceedance in 50 years (a nominal 500-year recurrence interval) is the maximum probable earthquake. An earthquake with a nominal 2,500-year recurrence interval (a two percent probability of exceedance in 50 years) is the maximum considered earthquake.

There are no known existing active landslides in the Geology Study Area.

Numerous volcanoes exist in the Cascade Range located approximately 200 to 250 miles west and northwest of the Geology Study Area. The recently active volcanoes are Mount Hood,

Mount Jefferson and Mount Mazama (Crater Lake). Mount Hood has erupted three times over the past 2,000 years and has been active as recently as 400 years ago. Within the Geology Study Area, the most recent volcanic activity is dated at 7.4 million years before present. The most likely volcanic hazard that could occur in the Geology Study Area would be from effects of a volcanic eruption from one of the Cascade volcanos. The Geology Study Area could possibly be covered by volcanic ash if the prevailing winds were directed toward the area.

Soil surveys were performed by IMS, Inc. (IMS) near the Mine and Process Area and southern portion of the Access Road Area in 1989 and 1991. Eleven map units, comprised of seven soil types and one undifferentiated soil group, were identified in the soil surveys performed by IMS (1989 and 1991). Soil surveys were performed in June 2018 by Cascade Earth Sciences (CES) in the remainder of the Permit Area/Soils Study Area. Six additional soil types were identified during the June 2018 surveys. All 17 map unit descriptions are presented in Table 28. Each map unit description provides basic information about the map unit such as predominant soil or soils of the unit, slope, and rock fragment content.

Table 28. Soil Survey Map Legend

Map Unit	Name - Description
1[1]	Farmell-Rock outcrop complex, eight to 30 percent slopes
2[1]	Farmell-Chardoton very cobbly soil, 15 to 30 percent slopes
3[1]	Farmell-Chardoton very cobbly soil, four to 15 percent slopes
4[1]	Farmell-Chardoton extremely stony soil, four to 15 percent
5[1]	Farmell-Chardoton soil, eight to 15 percent slopes
6[1]	Ruckles very stony loam, eight to 30 percent slopes
7[1]	Shano silt loam, two to six percent slopes
8[1]	Soil A extremely gravelly sandy loam, 15 to 30 percent slopes
9[1]	Virtue loam, two to eight percent slopes
10[1]	Xeric Torriorthents, eight to 30 percent slopes
11[1]	Soil B very gravelly sandy loam, eight to 30 percent slopes
12[2]	Nyssa silt loam, two to six percent slopes
13[2]	Drewsey very fine sandy loam, two to six percent slopes
14[2]	Ruclick cobbly loam, four to 15 percent slopes
15[2]	Drewsey-Quincy-Solarview complex, eight to 30 percent
16[2]	Owsel silt loam, two to six percent slopes
17[2]	Powder silt loam, zero to three percent slopes

Source: [1]IMS 1989, 1991; [2]CES 2018

Erionite is a fibrous zeolite-group mineral often occurring as microscopic acicular, prismatic crystals in altered volcanic tuffs of late Cenozoic age. Erionite can also occur as bedded zeolites within a lacustrine environment containing sediments high in calcium and magnesium. Less commonly erionite occurs in vesicles or cavities within volcanic rocks such as basalt, andesite or rhyolite. Numerous studies have been conducted concerning the occurrence of zeolites in Oregon. Not all zeolite minerals are considered hazardous. A December 2011 report, *Naturally Occurring Hazardous Materials,* Final Report SPR 686 (DOGAMI 2011), identifies numerous occurrences of zeolites and erionite in Oregon. The erionite localities closest to the Project are

Durkee in Baker County, and Rome in southern Malheur County. Durkee is approximately 65 miles north of the Project while Rome is approximately 60 miles to the south-southwest. The erionite study was carried out by SRK and is incorporated in the Geochemistry Baseline Report (Appendix B).

The Wind Erodibility Group (WEG) is an arbitrary grouping of soils based on texture, structure, and carbonate content. WEG values range from 1 to 8 with the lower values indicating greater susceptibility to wind erosion. The WEG is typically applied only to the surface layer of a soil. Classes are defined by the Natural Resources Conservation Service's (NRCS') *National Soil Survey Handbook*, Part 618, Subpart B (NRCS 2017). Table 29 shows the calculated K-factors and WEG values for each soil type.

Table 29. Erosion Factors of Surface Soils

Soil Series	WEG (Wind Erosion Group)	K-Factor (Soil Erodibility Factor)
Chardoton[1]	8	0.13
Farmell[1]	8	0.10
Ruckles[1]	8	0.10
Shano[1]	5	0.37
Soil A[1]	8	0.07
Soil B[1]	8	0.07
Virtue[1]	5	0.16
Nyssa[2]	5	0.61
Drewsey[2]	3	0.34
Ruclick[2]	8	0.37
Owsel[2]	5	0.46
Powder[2]	5	0.52

Source: [1]IMS 1989, 1991; [2]CES 2018

In all the areas where mining and processing will take place, suitable topsoil will be stripped and stockpiled for reclamation. A topsoil suitability rating table was developed by IMS (1991) for the three dominant soils within the Soils Study Area. The locations were selected to most accurately represent the pedon sampled and its landscape position. (Pedon is a three-dimensional body of soil with dimensions large enough to permit the study of individual soil horizons.) Topsoil suitability for the soil types identified during the June 2018 surveys were also tested. Laboratory analyses results for soil samples were compared to suitability criteria for topsoil developed at Colorado State University's soil testing laboratory (Soltanpour and Workman 1981). These criteria are presented in Table 30.

Table 30. Soil Suitability Ratings

Parameter	Testing Method	Good Suitability	Marginal Suitability	Unsuitable
pH	S-2-10	6.0 to 8.4	5.5 to 6.0, 8.4 to 8.8	<5.5, >8.8
EC (dS/m)	S-2.10	<4.0	4.0 to 12.0	>12.0
Texture	S-14.10 ASTM D6913	Loamy sand, sandy loam, loam, silt; soil with <35% clay	Sand, loamy coarse sand; soil with <45% clay	Soils with >45% clay
Saturation %	S-10.20	25 to 80	25 to 80	<25 and/or >80
$CaCO_3$ %	Fizz	0 to 15	15 to 30	>30
Rock fragments %	Field Estimated	<35	35 to 60	>60
Erosion factor K	Calculated	<0.37	>0.37	
Organic Matter	S-9.10			

Source: IMS 1989,1991; CES 2018

In general, the topsoil sampled in and near the Mine and Process Area during the IMS surveys (IMS 1989, 1991) has a higher clay content and is shallower in the soil profile. This soil generally meets the "Marginally Suitable" category. The topsoil throughout the June 2018 survey area appear generally suitable for reclamation. The primary limitation is surficial and subsurface coarse fragments, which were encountered on ridge sides and summits. The Ruclick soils and Drewsey-Quincy-Solarview Complex exhibited high surface and subsurface coarse fragments. Steep slopes also limit reclamation suitability. The Drewsey and Owsel soils, which generally occur on the valley floors, exhibited marginal limitations for reclamation due to pH level and/or soil erodibility. The Nyssa soil, also located on valley floors, have unsuitable subsurface soil horizons that are cemented and exhibit increased sodium and carbonate levels (CES 2018).

2.7 Grazing Management

The Grassy Mountain Mine Project Grazing Management Baseline Report (Appendix B) was submitted to DOGAMI on January 11, 2018. The report was accepted by the TRT on March 9, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. There are three grazing allotments in the Grazing Management Study Area: Nyssa (10403); Sourdough (10404); and Dry Creek (10411). The Nyssa Allotment includes four pastures and six enclosures or exclosures that occur partly or wholly within the Grazing Management Study Area. The Sourdough Allotment includes three pastures that occur partly or wholly within the Grazing Management Study Area. The Dry Creek Allotment includes three pastures and one exclosure that occur partly within the Grazing Management Study Area. These allotments and their pastures are shown in Table 31.

Table 31. Pasture Allotments in the Grazing Management Study Area

Allotment Number	Allotment Name	Pasture Number	Pasture Name	Grazing System	Management Strategy	Total Pasture Acres	Pasture Acres within Study Area
10403	Nyssa	4	Sagebrush	Deferred	Improve	11,877.2	544.5
10403	Nyssa	5	Ryefield Seeding	Deferred rotation	Improve	3,720.3	3,471.3
10403	Nyssa	6	Grassy Mountain Seeding	Deferred rotation	Improve	3,035.5	1,771.4
10403	Nyssa	7	Grassy Mountain	Deferred	Improve	29,764.2	8,099.1
10403	Nyssa	9	Ryefield Reservoir Exclosure	Riparian exclosure	Improve	19.7	19.7
10403	Nyssa	15	North Grassy Mountain Reservoir Exclosure	Reservoir enclosure	Improve	4.3	4.3
10403	Nyssa	30	Ryefield Seeding Test Plot	Management exclosure	Improve	2.4	2.4
10403	Nyssa	31	Owyhee Ridge Trough Exclosure	Reservoir enclosure	Improve	1.8	1.8
10403	Nyssa	32	Government corral	Reservoir enclosure	Improve	0.2	0.2
10403	Nyssa	34	Grassy Reservoir Exclosure	Reservoir enclosure	Improve	1.2	1.2
10404	Sourdough	4	Canyon	Deferred rotation	Maintain	21,121.1	624.9
10404	Sourdough	7	Freezeout Lake	Deferred rotation	Maintain	22,214.8	443.5
10404	Sourdough	10	Rye Field Fenced Federal Range	Custodial area	Maintain	1,439.7	372.4
10411	Dry Creek	1	Cow Hollow Seeding	Deferred rotation	Maintain	1,598.5	17.5
10411	Dry Creek	2	Double Mountain	Deferred rotation	Maintain	12,639.6	285.1
10411	Dry Creek	5	Russell Fenced Federal Range	Custodial area	Maintain	5,386.0	146.0
10411	Dry Creek	10	Little DM Spring Exclosure	Riparian exclosure	Maintain	3.1	1.3

2.8 Groundwater

The Grassy Mountain Groundwater Baseline Report (Groundwater Report) (Appendix B) is being submitted with this Consolidated Permit. This Groundwater Report includes data previously submitted, quarterly monitoring data, new recently collected data, and interpretations as requested by DOGAMI. The report is designed to conform to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Groundwater Resources Study Area was established to develop an environmental baseline for assessing potential impacts from Project facilities, potential impacts of surface runoff from Project facilities, and to provide background data. The Groundwater Resources Study Area includes an area encompassing the Mine and Process Area and two separate non-contiguous, areas on the Owyhee River/Lake. All baseline well and spring sites are located within the Groundwater Resources Study Area.

This Groundwater Report includes baseline data, groundwater characterization, and dewatering estimates. The report is written in three volumes: Volume I—Groundwater Baseline Data; Volume II—Groundwater Characterization; and Volume III—Groundwater Numerical Model and Dewatering. This summary will describe each volume separately for ease of reference to the full Groundwater Report in Appendix B.

VOLUME I

The purpose of the Groundwater Report is:

- Provide baseline data of the quality and quantity of local groundwater resources.
- Develop a monitoring well network for the purpose of monitoring groundwater levels and water quality within each aquifer potentially affected by mining operations.
- Collect data of known and acceptable quality in accordance with project-specific methods and procedures for use in this baseline report and for permitting. Data compilation is intended for future use in mine development and operations, exploration, closure, and long-term remediation.

The Project is in the Sourdough Basin/Negro Rock Canyon watershed, which drains to the north. Grassy Mountain, located southeast of the Project, serves as the hydrologic divide between the Sourdough Basin/Negro Rock Canyon watershed and the watersheds draining south to the Owyhee River.

Four quarterly water quality sampling events occurred during 2013: March (1st Quarter); June (2nd Quarter); August (3rd Quarter); and November (4th Quarter). Three more quarterly sampling events occurred in 2014: March (1st Quarter); June (2nd Quarter); and September (3rd Quarter). Apart from quarterly water quality sampling events, additional one-time sampling events occurred from well 59762 and from the recently constructed monitoring wells GMW17-32, and GMW17-33. These sampling events occurred in December of 2017 with additional development and sampling of GMW17-32 in July and December of 2018. During each of the water quality sampling events described above, spring flow rates and the well/piezometer water levels were

measured. With few exceptions, this flow and water level monitoring has continued on a voluntary, quarterly basis. This report includes all monitoring between 2013 and the 3rd Quarter of 2018. Quarterly reports will continue to be submitted to the TRT. In addition to the springs and wells used for water quality sampling purposes, flow rates from "background springs" and two flowing wells were measured on twice-yearly basis in 2013, 2014, and 2015. See Tables 32 and 33 below for details of the wells and springs.

At each of the monitoring wells the static water level was measured and recorded prior to purge pumping (if sampled) using a calibrated or non-stretch electric-line well sounder. Recording water level pressure transducers were installed in GW-1, GW-2, and GW-4 on March 26, 2013, during the 1st Quarter sampling event. This static water level measurement, along with the pressure transducer reading was used to establish an accurate height of water above the transducer. The continuous water level data were collected at one-hour intervals initially and then switched to 30 minutes for all remaining tests. Details of the installation and sampling of the wells and springs is available in the Groundwater Report (Appendix B).

Water-quality samples collected from wells and springs were analyzed for the list of approved water quality analytes. Table 34 lists the approved analytes, as well as the laboratory testing method, the laboratory minimum detection limit, and the reporting limit (five times the MDL). For metals, samples for both total and dissolved metals were collected. For the other parameters, only total samples were collected.

For the wells tested, field water quality parameters measured during purging of the wells allows for continuous measurement of field parameters (pH, temperature, electrical conductivity, and specific conductance) without significant aeration of the sample. These field parameters were monitored continuously during purging to ensure parameters were stable prior to sampling. Parameters are considered stable when consecutive measurements taken one casing volume apart meet the following conditions: temperature within one degree Celsius (C); pH within 0.3 standard pH units; and specific conductance measurements within ten percent of each other (ODEQ 2009). Dissolved oxygen was measured in a separate purge water container (clean plastic bucket). Water quality samples collected from monitoring wells were analyzed for the constituents shown in Table 34 (Water Quality Analytes). Sampling from the continuously flowing artesian well (Prod-1) was conducted in the same manner as spring water samples. Analytical methods meet ODEQ reporting and detection limits. Complete descriptions of the well sampling are included in the Groundwater Report.

Well and piezometer groundwater level monitoring throughout the monitoring well network are used in the following data analysis and interpretation. Groundwater level monitoring has focused predominantly on the shallow (typically above 500 feet depth) aquifer zone, where the majority of wells are completed. More recently, water levels in Well GMW17-32 were monitored in 2018. Groundwater levels within the deep zone were also monitored using Vibrating Wire Piezometer (VWP) sensors installed within the deposit. Detailed descriptions of

Table 32. Well Completion Details

Calico Well ID	OWRD Well Tag Number	OWRD Name	Alternate Name	Drill Method	Depth of First Water (ft)	Well Const. Depth (ft)	Screened Interval (ft)	Well Casing Diameter (in)	TOC Elevation[4]	Elevation Screened Interval (ft)	Water Level Elevation (9/26/2018)	Production (gpm)[2]	Screened Lithology[1]
59760	107462	MALH 2974	Middle Sweizer, TW-1	air rotary	160	203	163-203	6	3762.1	3599-3559	3673.43	+10	fractured basalt
59761	109400	MALH 2993	Lower Sweizer, MW-2	air rotary	100	118	97-117	4	3762.2	3665-3645	3673.48	+50	fractured basalt
59762	109371	MALH 2976, 2985	MW-3	air rotary	626	700	550-660	4	3724.8	3175-3065	3103.4	<1	siltstone
59763	109356	MALH 2994	TW-4	air rotary	277	323	293-323	6	3519.4	3226-3196	3239.03	+5	fractured volcanics
59764	107466	MALH 2986	MW-5	air rotary	270	300	279-299	4	3511.9	3233-3213	3238.24	+10	fractured sandstone
59765		MALH 2979	MW-6	air rotary	29	36	28-36	4	3446.5	3418-3410	dry	dry	shallow sandstone
59766	107468	MALH 2980	MWS-8	air rotary	only damp when drilled	45	25-45	4	3459.7	3435-3415	3426.68	+10	shallow sandstone
59767		MALH 2995	MWS-9	air rotary	dry	40	20-40	4	3495.3	3475-3455	dry	dry	shallow sandstone
59768		MALH 54197	MWS-10	air rotary	21	25	10-25	4	3480.6	3471-3456	3463.46	0.5	shallow sandstone
59770		MALH 2983	MW-11	air rotary	dry when drilled	424	374-424	4	3389.0	3015-2965	3241.71	+0.5	volcanic tuff
59772	109352	MALH 2984	Upper Sweizer, MWS-13	air rotary	125	207	165-205	4	3768.2	3603-3563	3673.5	+50	fractured basalt
26-092-915	109354	MALH 54071		unknown	unknown	915	228-268	2	3710.0	3482-3442	3633.55	unk	unk
57-1		MALH 54195		unknown	unknown	765	108-138	1.25	3770.6	3663-3633	3699.1	unk	unk
57-10		MALH 54196		unknown	unknown	500	126-156	1	3681.1	3555-3525	3635.67	unk	unk
89-2	109360	MALH 54072		unknown	200	425	386-406	2	3293.5	2907-2887	3235.54	unk	unk
Bishop	None	MALH 54046	Rye Field	cable	unknown	482	135-145	12	3391.5	3257-3247	3281	50	coarse gravel
BLM	109398	MALH 2277	Owyhee Ridge	cable	unknown	175	159-166	6	3579.6	3421-3414	3423.95	+12	white sand
GMW17-31	125168	MALH 54404		air rotary	dry when drilled	498	458-498	5	3722.0	3262-3222	3222.6	0	siltstone, sinter, clay
GMW17-32	125169	MALH 54405		air rotary	244	718	678-718	5	3702.1	3026-2986	3082.1	<1	Arkose, siltstone, Clay
GMW17-33	125170	MALH 54406		air rotary	243	338	238-338	5	3702.7	3465-3365	3452.16	<30	sinter, siltstone, tuff
GMW18-34	130031	MALH 54437		air rotary	dry	950	830-890	5	3953.3	3127-3067	dry	dry	Arkose, siltstone, Clay
GW-1	107469	MALH 2281	47-1	air rotary	140	155.5	135.5-155.5	4	3709.1	3573.5-3553.5	3654.18	60	gravel
GW-2	109357	MALH 2279	47-2	air rotary	dry when drilled	325	290-320	4	3827.5	3537-3507	3662.91	0	blue and grey clay
GW-3	107467	MALH 2278	47-3	air rotary	dry when drilled	350	320-350	4	3633.6	3314-3284	3401.68	<1	blue and grey clay
GW-3A		MALH 2579		air rotary	dry	420	380-420	2	3655	3275-3235	dry	dry	silt and clay
GW-3B		MALH 2576		air rotary	dry	340	80-100	2	3626	3546-3526	dry	dry	clay
GW-4	107460	MALH 54073		unknown	50	370	280-350	4	3342.7	3063-2993	3260.85	100	sandstone, congl, clay
GW-5		MALH 54194		air rotary	unknown	265	204-224	2	3413.0	3209-3189	3221.45	<1	tuff, clay
GW-6	109368	MALH 2578		air rotary	145	340	300-340	2	3377.3	3077-3037	3236.16	3-4	sandstone, congl, clay
Prod 1	107457	MALH 2275, 2511		air rotary	145	425	145-255, 325-355, 380-420	6	3436.4	3291-3181, 3111-3081, 3056-3016	3436.41	30-100[3]	sandstone, blue clay, and hard sandstone
PW-1	109353	MALH 2276		air rotary	320	520	320-340, 400-420	6	3709.1	3389-3369, 3309-3289	3654.66	25-35[3]	brown clay and sand; coarse sandstone
PW-4	109351	MALH 2206		air rotary	280	375	280-300, 340-360	6	3341.4	3061-3041, 3001-2981	3261.39	175-250[3]	sandstone and conglomerate

1 - as reported on the drillers log
2 - based on short-term testing by driller during or following construction
3 - based on long-term test pumping
4 - surveyed with the exception of GW-3A, GW-3, GMW-17-31, GMW17-32, GMW17-33, and GMW18-34

Table 33. List of all Wells and Springs with GPS Coordinates

Type	Site Name	Northing (ft, OR State Plane South)	Easting (ft, OR State Plane South)	MP Elevation (ft asl)
Monitoring Wells	59760	745645.981	5753551.517	3762.10
	59761	745772.825	5753658.537	3762.22
	59762	747093.548	5751854.980	3724.79
	59763	744833.301	5745691.957	3519.42
	59764	744814.369	5745502.507	3511.86
	59765	749408.542	5748338.635	3446.47
	59766	749128.353	5748254.792	3459.75
	59767	750823.434	5750882.309	3495.26
	59768	751987.933	5752488.768	3480.58
	59770	742710.937	5741955.406	3388.98
	59772	745572.389	5753583.613	3768.16
	26-092-915	746617.799	5752915.771	3710.00
	57-1	744890.820	5750760.310	3770.64
	57-10	747741.058	5753164.928	3681.14
	89-2	750181.789	5741874.789	3293.50
	Bishop	739450.422	5737602.762	3391.51
	BLM	747633.586	5749895.135	3579.64
	GW-1	746929.696	5753379.246	3709.10
	GW-2	741642.053	5750108.395	3827.46
	GW-3	746644.651	5750449.625	3633.59
	GW-3A	747154.659	5751260.753	3657.50
	GW-4	756961.961	5749996.486	3342.71
	GW-5	750443.408	5747915.292	3412.98
	GW-6	746405.775	5743134.903	3377.33
	Prod-1	753540.873	5751275.237	3436.41
	PW-1	746870.021	5753289.854	3709.10
	GMW17-31	747062.1437	5751890.41	3722.00
	GMW17-32	746507.8151	5751400.075	3702.00
	GMW17-33	746468.9358	5751387.606	3702.70
	GMW18-34	745311.4955	5752293.667	3953.26
	PW-4	757070.919	5749908.325	3341.40
Baseline Springs	Deposit Stock Tank	748376.460	5750879.694	3552.77
	Government Corral	756975.556	5757863.847	3456.01
	Grassy Spring	741738.614	5750275.765	3822.84
	Lowe Spring	761799.478	5753456.679	3278.96
	Poison Spring	759368.751	5740634.211	3213.85
	Sagebrush Spring	759029.757	5761380.835	3481.86
	Sourdough Lower	737582.250	5731598.434	3565.36
	Sourdough Upper	737587.997	5728058.732	3754.05
	Twin Springs North	726474.288	5737016.696	3240.02
	Twin Springs South	725277.033	5737632.836	3210.32
	Whiskey Spring	725895.946	5746824.847	3230.04
Background Springs and Wells (corrdinates from non-survey grade GPS, elevations estimated using Goole Earth)	Bull Spring Tank	731798.684	5730323.895	3727
	Central Grassy Mountain Spring	737920.331	5756588.347	3489
	Dark Rock Well	756210.058	5732296.357	3391
	East Grassy Mountain Spring	738055.897	5757538.706	3489
	Flowing Well	761550.474	5727332.014	3532
	Negro Rock Canyon Spring	767800.835	5735633.314	3117
	Negro Rock Spring Tank	754844.533	5737277.024	3319
	Oxbow Spring Tank	729591.481	5756563.613	3065
	Oxyoke Spring Tank	726801.090	5757094.644	3029
	Red Tank #3	756212.707	5753206.759	3389
	Spring in Sec13 T22S R44E	739203.805	5773378.134	3005
	Spring in Sec23 T21S R43E	769162.951	5732244.787	3297
	Spring North of Lowe Reservoir	764826.923	5752193.554	3247
	Spring South of Poison Spring	758410.107	5741317.082	3232
	Tank E of Negro Rock	752204.327	5742408.207	3273
	West Grassy Mountain Spring	738802.552	5755880.217	3619
	West Whiskey Spring	757611.371	5728513.411	3547
	Wildcat Spring	757839.970	5732821.848	3366

Table 34. List of Water Quality Analytes

Parameter	Laboratory Method of Analyses	Detection Limit	Reporting Limit	Sample Type
Aluminum, Al	EPA 200.7	0.03 mg/L	0.15 mg/L	total and dissolved
Total Arsenic	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Barium, Ba	EPA 200.7	0.003 mg/L	0.015 mg/L	total and dissolved
Cadmium Low	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Calcium, Ca	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Chromium Low	EPA 200.8	0.0005 mg/L	0.002 mg/L	total and dissolved
Copper Low	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Iron, Fe	EPA 200.7	0.02 mg/L	0.05 mg/L	total and dissolved
Lead Low	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Magnesium, Mg	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Manganese Low	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Mercury, Hg (Low Level)	1631E	0.2 ng/L	0.5 ng/L	total and dissolved
Nickel Low	EPA 200.8	0.0006 mg/L	0.003 mg/L	total and dissolved
Potassium, K	EPA 200.7	0.3 mg/L	1.5 mg/L	total and dissolved
Selenium Low	EPA 200.8	0.0001 mg/L	0.00025 mg/L	total and dissolved
Silver Low	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Sodium, Na	EPA 200.7	0.3 mg/L	1.5 mg/L	total and dissolved
Zinc, Zn	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Antimony	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Beryllium	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Bismuth	EPA 200.7	0.04 mg/L	0.2 mg/L	total and dissolved
Boron	EPA 200.8	0.0005 mg/L	0.001 mg/L	total and dissolved
Cobalt	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Gallium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Lithium	EPA 200.7	0.02 mg/L	0.1 mg/L	total and dissolved
Molybdenum	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Scandium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Strontium	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Thallium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Tin	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Titanium	EPA 200.7	0.005 mg/L	0.025 mg/L	total and dissolved
Vanadium	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Uranium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Nitrate+Nitrite (as N)	EPA 353.2	0.02 mg/L	0.1 mg/L	total
Ammonia Direct (as N)	EPA 350.1	0.05 mg/L	0.5 mg/L	total
Alkalinity	SM 2320B	2 mg/L	20 mg/L	total
Bicarbonate	SM 2320	2 mg/L	20 mg/L	total
Carbonate	SM 2320	2 mg/L	20 mg/L	total
Chloride, Cl	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Conductivity	SM 2510B	1 umhos/cm	10 umhos/cm	total
Cyanide, Total	EPA 335.4	0.003 mg/L	0.01 mg/L	total
Cyanide, Weak Acid Digestion	SM 4500	0.003 mg/L	0.01 mg/L	total
Fluoride, F	EPA 300.0	0.1 mg/L	0.5 mg/L	total
Hardness	SM 2340 B	calc	calc	total
pH	SM 4500-H B	0.1 C	0.1 C	total
Sulfate, SO4	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Total Dissolved Solids	SM 2540C	10 mg/L	20 mg/L	total
Total Suspended Solids	SM 2540D	5 mg/L	20 mg/L	total
Total Phosphorus	EPA 365.1	0.01 mg/L	0.05 mg/L	total

mg/L = milligrams per liter; ng/L = nanograms per liter; umhos/cm = microhoms per centimeter

the wells into the shallow and deep aquifers are in the Groundwater Report (Appendix B). Deep zone water levels have been monitored in Well 59762 since 2013. A total of 15 VWP sensors were installed in five boreholes during the 2017 mineral resource and reserve program (three sensors per borehole). Sensors were installed predominantly on the eastern side of the Proposed Project at shallow, intermediate, and deep intervals, intended to bracket the reserve ore body. The hydrographs and data for these are also in the Groundwater Report (Appendix B).

For the spring monitoring/sampling, springs with a minimum flow of ¼ liter per minute were sampled. Any flow less than that is considered unsuitable for collecting samples. For those springs that flow continuously, conditions were considered steady state and only one set of field parameters (pH, electrical conductivity, specific conductance, dissolved oxygen) were collected. The same meters were used as for groundwater sampling. Readings were recorded once the measurements had stabilized.

Water quality samples collected from springs were analyzed for the same constituents as for samples collected from monitoring wells (see Table 34, Water Quality Analytes). For non-filtered samples (non-metals), water quality samples were collected directly from each spring. For filtered samples (metals), a water sample was collected from the spring in a clean plastic container.

Groundwater quality of wells and springs was completed with the objective of providing a baseline characterization prior to the proposed mining activities. Well and spring water quality results are compared to both primary drinking water standards and secondary drinking water standards. The primary drinking water standards are legally enforceable standards due to potential human health concerns and are expressed as maximum contaminant levels (MCLs). The MCL is the highest level of an analyte allowed in drinking water. Secondary drinking water standards are non-enforceable recommended standards established to limit cosmetic or aesthetic effects (not health-related) in drinking water, expressed as secondary maximum contaminant levels (SMCLs). Spring water quality data is also compared to ODEQ water quality standards as described in OAR 340-041.

Tables 35 and 36 from Volume I show a summary of values above the MCL for springs and wells respectively.

The predominant hydrogeochemical facies noted for springs and wells within the Grassy Mountain Project vicinity are:

- Calcium bicarbonate (Ca-HCO3) for 59760, 59761, 59722, and GW-1.
- Sodium-potassium bicarbonate (Na/K-HCO3) for Bishop, GW-4, Prod-1, and PW- 1.
- Sodium-potassium sulfate (Na/K-SO4) for 59763, 59766, BLM, 59762, and GMW17-32.

Table 35. Grassy Mountain Baseline Spring Water Quality Results (Above Drinking Water MCLs)

MCL column has secondary MCL values indicated by an *		DEPOSIT STOCK TANK								GOVERNMENT CORRAL SPRING	LOWE SPRING		POISON SPRING							SOURDOUGH SPRING LOWER			
ANALYTE	MCL	3/17/13	6/20/13	8/13/13	11/22/13	3/16/14	3/16/14	6/24/14	9/17/14	11/22/13	3/13/13	6/26/13	6/26/13	8/13/13	11/21/13	3/16/14	6/24/14	9/16/14	3/26/13	3/17/14	8/14/13	6/27/13	11/23/13
Aluminum, dissolved	0.05*																						
Aluminum, total	0.05*									0.06													
Antimony, dissolved	0.006																						
Antimony, total	0.006																						
Arsenic, dissolved	0.010	0.0257	0.0287	0.033	0.0249	0.0301	0.0299	0.0262	0.0262				0.0364	0.0352	0.0356	0.0396	0.0348	0.034	0.036	0.0264	0.0232	0.0234	0.0238
Arsenic, total	0.010	0.0265	0.029	0.0307	0.0252	0.0257	0.0252	0.0278	0.027				0.0333	0.0335	0.0371	0.0337	0.035	0.0343	0.036	0.0229	0.0227	0.0227	0.0231
Chromium, total	0.1																						
Iron, dissolved	0.3*																						
Iron, total	0.3*																						
Lead, total	0.015																						
Manganese, dissolved	0.05*																						
Manganese, total	0.05*																						
Total Dissolved Solids (TDS)	500*										570	540											
Sulfate	250*																						

MCL column has secondary MCL values indicated by an *		SOURDOUGH SPRING UPPER						TWIN SPRINGS NORTH							TWIN SPRINGS SOUTH								
ANALYTE	MCL	6/27/13	3/17/13	11/23/13	3/17/14	6/23/14	9/16/14	3/13/13	6/20/13	8/14/13	11/22/13	3/16/14	6/23/14	9/16/14	3/13/13	3/13/13	6/20/13	8/14/13	11/22/13	3/16/14	6/23/14	6/23/14	9/16/14
Aluminum, dissolved	0.05*							0.11															
Aluminum, total	0.05*													0.3									
Antimony, dissolved	0.006																						
Antimony, total	0.006																						
Arsenic, dissolved	0.010	0.0283	0.0279	0.0311	0.0319	0.0276	0.0276	0.0607	0.0441	0.0463	0.045	0.0522	0.0401	0.0497	0.0433	0.0413	0.0434	0.043	0.0412	0.0489	0.038	0.0394	0.0418
Arsenic, total	0.010	0.0272	0.0276	0.0279	0.0278	0.0268	0.0278	0.061	0.0479	0.0442	0.0449	0.0444	0.0417	0.0466	0.0445	0.0436	0.044	0.0422	0.0435	0.0422	0.0409	0.0409	0.0396
Chromium, total	0.1																						
Iron, dissolved	0.3*																						
Iron, total	0.3*																						
Lead, total	0.015																						
Manganese, dissolved	0.05*								0.0809					0.1613									
Manganese, total	0.05*								0.101	0.053				0.216									
Total Dissolved Solids (TDS)	500*																						
Sulfate	250*																						

MCL column has secondary MCL values indicated by an *		WHISKEY SPRING							
ANALYTE	MCL	6/27/13	6/27/13	8/14/13	11/23/13	3/16/14	6/24/14	9/16/14	3/17/13
Aluminum, dissolved	0.05*								
Aluminum, total	0.05*								
Antimony, dissolved	0.006								
Antimony, total	0.006								
Arsenic, dissolved	0.010	0.0898	0.0889	0.0854	0.0922	0.1039	0.0853	0.0854	0.0861
Arsenic, total	0.010	0.0846	0.0821	0.0867	0.089	0.0867	0.0826	0.086	0.0874
Chromium, total	0.1								
Iron, dissolved	0.3*								
Iron, total	0.3*								
Lead, total	0.015								
Manganese, dissolved	0.05*								
Manganese, total	0.05*								
Total Dissolved Solids (TDS)	500*								
Sulfate	250*								

Table 36. Grassy Mountain Baseline Wells Water Quality Results (Above Drinking Water MCLs)

MCL column has secondary MCL values indicated by an *		59760								59761							59762	59763								59766						
ANALYTE	MCL	3/26/13	6/18/13	8/8/13	11/24/13	3/24/14	3/24/14	6/25/14	9/11/14	3/18/13	6/18/13	8/6/13	11/21/13	3/18/14	6/27/14	9/15/14	12/6/17	3/18/13	6/18/13	8/7/13	11/24/13	3/24/14	6/27/14	9/15/14	9/15/14	3/14/13	6/17/13	8/6/13	11/24/13	3/18/14	6/25/14	9/11/14
Aluminum, dissolved	0.05*																															
Aluminum, total	0.05*	0.12		0.15	0.37	0.59	0.37	0.22	0.74								3.37	2.07	0.1		0.14	0.12		0.09	0.12	25.6	8.36	1.84	3.7	2.9	4.36	7.26
Antimony, dissolved	0.006																0.298															
Antimony, total	0.006																0.21															
Arsenic, dissolved	0.010	0.0278	0.0263	0.0237	0.0285	0.0282	0.0221	0.0268	0.0271	0.0246	0.0234	0.0243	0.024	0.0227	0.0228	0.0223	0.018	0.0839	0.0609	0.0643	0.0713	0.0688	0.0578	0.0621	0.066	0.204	0.2094	0.1836	0.1958	0.1887	0.187	0.1644
Arsenic, total	0.010	0.0283	0.0268	0.0267	0.0275	0.0245	0.0251	0.0268	0.0258	0.0241	0.024	0.024	0.0244	0.0219	0.0228	0.0232	0.163	0.0787	0.0606	0.06	0.0658	0.0614	0.0624	0.0664	0.0669	0.276	0.259	0.206	0.202	0.191	0.1847	0.1927
Chromium, total	0.1																															
Iron, dissolved	0.3*																										0.97	0.9	1.06	0.89	0.86	0.71
Iron, total	0.3*								0.37								4.54	1.45								23	9.12	2.77	5.38	3.9	5.04	7.31
Lead, total	0.015																									0.019						
Manganese, dissolved	0.05*																0.535		0.1974	0.1098	0.096	0.0838	0.0856	0.0867	0.0857	0.263	0.475	0.422	0.442	0.432	0.407	0.389
Manganese, total	0.05*																0.589	0.23	0.205	0.1179	0.1235	0.1029	0.1007	0.0997	0.0992	0.73	0.688	0.452	0.506	0.49	0.486	0.519
Total Dissolved Solids (TDS)	500*																648	1090	1130	1220	1130	1170	1130	1160	1170	660	650	674	650	650	640	670
Sulfate	250*																333	575.7	568	626	569	580	612	582	377	308.57	311	307	302	305	320	300

MCL column has secondary MCL values indicated by an *		59772								BISHOP	BLM						BLM 12 VOLS	BLM 6 VOLS	GMW 17-32	GMW 17-33	GW-1								
ANALYTE	MCL	3/18/13	3/18/13	6/18/13	8/8/13	11/24/13	3/24/14	6/25/14	9/11/14	9/15/14	3/18/13	6/18/13	8/6/13	11/24/13	3/24/14	6/27/14	9/15/14	3/18/13	3/18/13	12/5/18	12/14/17	3/14/13	6/17/13	8/6/13	11/21/13	3/18/14	6/25/14	9/11/14	6/17/13
Aluminum, dissolved	0.05*																												
Aluminum, total	0.05*																			0.07									
Antimony, dissolved	0.006																			0.0371	0.0217								
Antimony, total	0.006																			0.0374	0.0244								
Arsenic, dissolved	0.010	0.041	0.0398	0.0376	0.0367	0.0394	0.0372	0.0366	0.0381		1.46	1.57	2.88	3.42	3.63	3.9	4.44	2.98	2.22	0.0789	0.106	0.0312	0.0304	0.0307	0.0317	0.0294	0.0309	0.0304	0.031
Arsenic, total	0.010	0.0366	0.0374	0.038	0.0368	0.038	0.0348	0.037	0.0352	0.0101	1.54	1.63	2.83	3.27	3.75	4.63	4.54	3.38	2.41	0.0799	0.107	0.0306	0.03	0.0296	0.0313	0.0283	0.0302	0.0268	0.0297
Chromium, total	0.1																												
Iron, dissolved	0.3*										55	54.6	113	146	163	189	200	131	92.2									
Iron, total	0.3*										47.4	47.6	111	139	156	186	201	129	88.9	0.52								
Lead, total	0.015																												
Manganese, dissolved	0.05*										0.57	0.532	1.05	1.28	1.31	1.53	1.67	1.29	0.93									
Manganese, total	0.05*										0.43	0.48	0.99	1.2	1.34	1.6	1.65	1.24	0.9									
Total Dissolved Solids (TDS)	500*										1130	1080	1570	1450	1640	1800	1850			830									
Sulfate	250*										578.3	541	941	1040	1070	1220	1200	830	1130	532									

MCL column has secondary MCL values indicated by an *		GW-4								PROD-1							PW-1							PW-4						
ANALYTE	MCL	3/14/13	6/17/13	8/6/13	11/21/13	3/18/14	6/27/14	9/11/14	11/21/13	3/17/13	6/20/13	8/13/13	11/22/13	3/16/14	6/24/14	9/16/14	3/26/13	6/17/13	8/6/13	11/21/13	3/18/14	6/25/14	9/11/14	3/14/13	6/17/13	8/6/13	11/21/13	3/18/14	6/25/14	9/11/14	6/25/14
Aluminum, dissolved	0.05*					0.06	0.07										0.08							0.08		0.07		0.11		0.08	0.08
Aluminum, total	0.05*	1.68	0.95	0.68	1.13	1.09	0.6	0.83	0.84								0.23		0.06	0.08				8.11	7.75	5.96	6.52	6.11	5.82	4.7	3.94
Antimony, dissolved	0.006																															
Antimony, total	0.006																															
Arsenic, dissolved	0.010	0.0119	0.0115	0.012	0.0118	0.0109	0.0109	0.0109	0.0119	0.0631	0.0604	0.0616	0.0629	0.071	0.0581	0.0624	0.0317	0.0309	0.0302	0.0315	0.0286	0.0313	0.0267	0.013	0.0126	0.0137	0.0133	0.0127	0.0131	0.0116	0.0129
Arsenic, total	0.010	0.0118	0.0118	0.0126	0.0116	0.0111	0.0114	0.0116	0.0113	0.061	0.0602	0.0598	0.0615	0.0589	0.0581	0.0579	0.0331	0.0307	0.0294	0.031	0.0282	0.0288	0.0304	0.0183	0.017	0.0168	0.0221	0.0148	0.016	0.0157	0.0148
Chromium, total	0.1																															
Iron, dissolved	0.3*																															
Iron, total	0.3*	0.59	0.36		0.42	0.41		0.36	0.33								1.04	0.68		0.32				7.99	7.3	5.82	23.5	6.06	5.96	4.85	3.98
Lead, total	0.015																															
Manganese, dissolved	0.05*													0.0513																		
Manganese, total	0.05*																							0.0971	0.0753	0.0689	0.1679	0.064	0.0602	0.0522	0.0509
Total Dissolved Solids (TDS)	500*																							570	590	550	540		510	510	
Sulfate	250*																															

The predominant water types appear to have a spatial distribution, attributed to local geologic conditions and areas of recharge/discharge. Predominantly Ca-HCO3 and Na/K-HCO3 water types are noted in areas hydraulically upgradient of the deposit and downgradient within the basin. Groundwater sampled from wells located hydraulically downgradient of the deposit appear to exhibit Na/K-SO4 and Ca-SO4 water types. The presence of calcium may be attributed to areas with basalt deposits, and sodium may be associated with volcanic tuff and sedimentary deposits. Sulfate may be associated with areas downgradient of the ore body and potentially attributed to longer residence times due to lower hydraulic conductivity and/or oxidation and leaching of the ore deposit.

The following conclusions are from Volume I of the Groundwater Report (Appendix B):

- Seven quarterly sampling events occurred from 2013 to 2014 in ten springs (when ample flow available) and twelve wells on a schedule in accordance with the Work Plan.
- After the development of 59762 and construction and development of GMW17-32 and GMW17-33, these wells were sampled during test pumping. Two additional development and sampling events occurred in GMW17-32 to obtain more representative results.
- Quarterly manual static water level or flow measurements were obtained from 24 monitoring wells and 11 background springs. The quarterly measurements were maintained from 2013 through 2018 for 19 wells and from the 3rd Quarter 2014 through 2018 for another five wells. Due to ownership changes, no monitoring occurred during the first and second quarters of 2016.
- Groundwater elevation trends appear relatively stable over time in wells throughout the Project Area, based on a monitoring period that spans several years. Some wells show influence of seasonal recharge, particularly during periods of above average precipitation. Other wells show fluctuations attributed to groundwater pumping or to drilling activities.
- Groundwater flow generally occurs from the southeast to the northwest in the vicinity of the Project, from higher elevations along the base of Grassy Mountain (~4,000 feet above mean sea level [amsl]) to lower elevations along Negro Rock Canyon (~3,200 feet amsl).
- Potentiometric surface maps based on shallow wells support a consistent flow direction without seasonally influenced variations. Groundwater flow appears to follow surface topography, generally to the northwest. The pattern of groundwater flow shows local variations attributed to the presence of faults, fractures, lithologic facies changes, vertical gradients, or some combination of these influences.
- Arsenic is present in groundwater within the Grassy Mountain vicinity. Concentrations exceeded the drinking water MCL at all of the 15 sampled well locations and at eight of the ten sampled spring locations.
- Other exceedances of the drinking water MCL included antimony (two samples), chromium (GMW17-32 prior to additional development), and lead (three samples, including one from GMW17-32 prior to additional development).
- Numerous samples from wells and springs exceeded the drinking water SMCLs for aluminum, iron, manganese, TDS, and sulfate. Most, but not all, exceedances for aluminum and iron appear to be associated with sediment in groundwater samples.

- Groundwater within the Grassy Mountain vicinity exhibits different water quality types (Ca-HCO3, Na/K-HCO3, or Na/K-SO4) based on spatial distribution, uted to subsurface lithology/facies characteristics.

VOLUME II

The geologic setting of the Project and surrounding area is an important factor in the groundwater flow. The aquifer system generally occurs within the Grassy Mountain Formation, described in Abrams (2018) as:

"Arkosic sandstones and channel-fill granite clast conglomerates. Mainly white to tan arkosic sandstones. Includes Tgsc, channel fill conglomerates with abundant granite and rhyolite clasts in the upper part of the unit. Uppermost conglomerates locally contain rounded obsidian clasts and rare black chert clasts. Unit Tgs generally becomes finer grained upward and includes white bentonitic clays near the top of the section which, where overlain by unit Tgb often generated large landslide masses. Hot spring activity contemporaneous with the deposition of the arkoses is indicated by sinter beds Tgsn, and sinter boulders containing silicified reeds and wood near the Grassy mountain gold deposit. Unit Tgs is the host for both the Grassy Mountain and Crabgrass gold deposits."

The monitoring well network describes the complex aquifer system:

- To the northeast of the Project at PW-1, the well log describes the water-bearing formation as brown clay and sand and coarse sandstone. The water-bearing zone is overlain by basalt and alluvium.
- To the south and west of the Project at GW-2 and GW-3, thick beds of clay were encountered to the completed depth of 400 feet. No water was encountered during drilling of the well, but water eventually entered the well.
- Farther to the southwest of the Project at 59763, the driller encountered tuff and rhyolite to a depth of 324 feet, with no water noted during drilling. The tuff and rhyolite were screened, and water eventually entered the well.
- To the west of the Project at GW-6, sand and clay with sandstone were encountered to 340 feet.
- To the northwest of the Project at GW-5, tuff was encountered to a depth of 260 feet.
- To the north of the Project at Prod-1, the water-bearing zone was sandstone with blue clay to a depth of 425 feet.
- Farther to the north at PW-4, layers of clay and sandstone were encountered to a depth of 375 feet, with sandstone being the water-bearing formation.

In and near the Project, most of the sedimentary units are silicified and strongly indurated (Abrams 2018). This silicification is noted in the exploratory drilling logs and the driller's logs for wells near the Project (59762, GMW17-31, GMW17-32, GMW17-33, and GMW18-34).

In 2012, a CSAMT survey was conducted by Zonge Geosciences Inc. While the intent of the CSAMT survey was for mineral exploration, the survey is also useful for locating areas of low permeability relative to groundwater flow. From the survey, values of high resistivity can be correlated to low porosity. In general, the silicification appears to have a negative effect on porosity and hydraulic conductivity as evidenced by wells and drill holes completed in the zone of silicification. Hydraulic conductivity increases moving away from the main Project.

The Project consists of highly silicified sediments of the Grassy Mountain Formation. The Project lithology is described by Abrams (2018):

"Silicification in the form of sinters and disseminated quartz is a prominent alteration type at Grassy Mountain and is largely controlled by hot-spring vents. Silicification occurs both pervasively as silica flooding, and as cross-cutting veins and stockworks. The silicified envelope has plan dimensions up to 3,000 feet (north-south) by 2,500 feet (east-west). Silicification is surrounded by widespread, barren, clay-rich (20- to 40-percent montmorillonite), tuffaceous siltstone and arkose with minor disseminated pyrite. Many of the sinters occur as sheets instead of mounds, which suggest that they are related to vents along faults rather than point sources."

The presence and quantity of groundwater within the Project can be described based on water reported during exploratory drilling, monitoring well construction and testing, and VWP water level data. The deeper wells screened below an elevation of about 3,200 feet are dry or poor producers. The monitoring well GMW18-34 drilled to a depth of 950 feet up-gradient of the Project did not encounter water during drilling in the spring of 2018. No water has been detected in the well since it was completed.

Groundwater elevations measured within the Project are often deeper than groundwater elevations measured immediately outside the Project. The deeper groundwater elevations, and associated large vertical gradients, are related to the geology of the Project. Specifically, decreased hydraulic conductivity associated with silicification, and the compartmentalization created by faulting, impedes groundwater flow into the Project from adjacent and upgradient portions of the Grassy Mountain Formation. Thus, the rate of groundwater flow into the Project is believed to be much less than the rate of flow through the permeable zones of Grassy Mountain Formation surrounding the Project.

The Project is located within an interpreted horst block, structurally affected by complex block faulting and rotation (Abrams 2018). From a two-dimensional perspective, faults surrounding the Project appear to act as lower permeable barriers to groundwater flow. There are typically higher flows south and east of the Badger and Schweizer faults and north of the Cherokee and Coyote faults. The geologic cross-sections in the Groundwater Report also provide insight into the effect of faulting on the presence of groundwater within the Project. These cross-sections help visualize the amount of compartmentalization caused by the significant amount of intersections between the faults and lower permeable sedimentary facies (clay, sinter, and siltstone). They also show the inconsistent nature of the encountered water during drilling.

Potentiometric surface maps are two-dimensional depictions of groundwater flow (See Groundwater Report, Volume II, Appendix B). In reality, groundwater flow occurs in three-dimensions. These maps, however, are useful for providing an indication of the overall, general groundwater flow direction and hydraulic gradient. Potentiometric surface maps of both shallow and deep surfaces are included in the Groundwater Report.

The horizontal hydraulic gradient is calculated from the change in groundwater elevation over distance between two locations. The shallow potentiometric surface generally shows a relatively high and somewhat uniform horizontal hydraulic gradient in the vicinity of the Project. The hydraulic gradient is a manifestation of flow resistance; higher gradients are an indication of higher resistance to groundwater flow. In the area of the Project, the high gradient most likely is a result of low hydraulic conductivity. The steep topography may also be a contributing factor. The gradient lessens where aquifer permeability increases in areas coinciding with flatter topography. The vertical hydraulic gradient is calculated from the change in groundwater elevation over difference in well completion depth.

Aquifer hydraulic properties in the vicinity of the Project can be estimated from aquifer pumping tests conducted during the late 1980s and early 1990s and more recently on 59762, GMW17-32 and GMW17-33 in 2017. The latter wells are located near the Project. Detail of the historic and recent pumping tests are included in the Groundwater Report (Appendix B). Overall, the historic and recent aquifer testing (i.e., PW-1, PW-4, Prod-1, GMW17-33) indicates that portions of the aquifer with higher transmissivity occur locally in proximity to the wells and that, as testing progresses over time, lower transmissivity regions are encountered based on negative boundary effects. These results suggest the conductive portions of the aquifer system are either compartmentalized or limited, with flow provided to wells initially via permeable zones (i.e., sand, sandstone, fractured basalt, etc.) that are limited in spatial extent.

Hydraulic conductivity in the vicinity of the Project increases to the north away from the Project, likely due to silicification in and near the Project. Testing of the most northern well, PW-4, suggests a hydraulic conductivity of approximately three feet per day (ft/d). Testing of PW-1, near the Project, suggests a hydraulic conductivity 100 times lower, approximately 0.03 ft/d. The deep wells 59762 and GMW17-32 exhibit low transmissivity and hydraulic conductivity assumed to representative of the silicified sediments at or near the Project, with hydraulic conductivities ranging from 0.0004 ft/d (GMW17-32) to 0.02 ft/d (59762). Estimates of hydraulic conductivity are sensitive to the assumed saturated aquifer thickness, with lower values obtained for thicker saturated aquifer extents. For the deep wells, the aquifer thickness is difficult to estimate as there is no information from drilling or lithology to develop an estimate. Based on previous investigations, aquifer thickness typically has been estimated on the order of 200 feet to 300 feet.

Drilling, test pumping, water level monitoring, and geophysical data all indicate that average hydraulic conductivities and corresponding aquifer transmissivities in the vicinity of the Project are very low. As a result, groundwater inflows to proposed mine workings should also be low.

A water balance is determined from the amount of groundwater recharge derived from infiltration during precipitation events and inflow from surface water and groundwater minus the amount of evapotranspiration and outflow from surface water and groundwater, accounting for any changes in storage (Fetter 1980). Available information to date on the water balance for the Grassy Mountain vicinity is largely based on previous investigations. Annual recharge to groundwater in the vicinity of Grassy Mountain has been estimated in the range of 0.25 to one inch based on climatic and topographic conditions (ABC 1992). Grassy Mountain serves as the groundwater divide between Negro Rock Canyon and the Owyhee River, supported by topography and geology. Ultimately Negro Rock Canyon discharges to the north to the Malheur River. While the Owyhee Reservoir and Owyhee River are the predominant regional drainage features near the Project, regional groundwater flow is to the north towards the Malheur River.

Geochemical characteristics of the groundwater (wells and springs) were evaluated using Trilinear diagrams and Stiff diagrams, with major ions expressed as mEq/L. These diagrams are useful for evaluating the geochemical signature of the water, to illustrate general differences in water chemistry using major ions, and to group waters with similar chemical signature into identifiable groups (or hydrochemical facies). Geochemistry results from all of the sampled springs and wells are presented in Volume I. The geochemical conclusions are presented above in the summary for Volume I.

The following are the geochemical interpretations based on the data presented in Volume I and Volume II of the Groundwater Report are:

- The aquifer to the east and northeast of the Project generally has a Ca-HCO3 signature, likely associated with volcanics.
- The aquifer immediately downgradient of the Project is predominantly a Na/K-SO4 water type. The presence of sulfate could be related to very low permeability near the Project and/or oxidation and leaching of the ore deposit (ABC 1992).
- Whiskey Spring exhibits geochemistry similar to the groundwater immediately downgradient of the Project. This spring appears to originate where the Kern Basin Tuff surfaces. Even though this spring is at a higher elevation than the presumed water surface within the Project and in a different hydrologic basin, the groundwater appears to be influenced by the same type of silicification associated with the Project.
- The groundwater located in the main regional flow system downgradient of the Project exhibits a Na/K-HCO3 chemistry. Sodium may be associated with volcanic tuff and sedimentary deposits.
- The data collected generally supports the idea of a single aquifer system, with chemistry influenced by lithology. Wells immediately downgradient of the Project exhibit the same geochemical signature and appear to be affected by the deposit characteristics, regardless of well depth.
- Groundwater farther from the Project also exhibits its own signature influenced by lithology, regardless of well depth.

- It is apparent that as the groundwater moves away from the volcanic formations it tends to decrease in calcium concentration.
- As groundwater moves away from areas with sulfate and the silicified areas of the Grassy Mountain Formation it tends to decrease in calcium concentration. The groundwater upgradient (or not in the downgradient path) of the groundwater flowing through silicified and mineralized sediments (Bishop, 59761, 59760, 59772, PW-1, and GW-1) has the least amount of sulfate. The groundwater downgradient of the silicified sediments (Prod-1, GQ-4, PW-4, GMW17-33) shows an increase in sulfate. Even though GMW17-33 is located near the Project, it is completed in the middle of what appears to be a section of unsilicified material. The wells located in silicified media appear to have the highest concentrations of sulfate and relatively the least desirable water quality from a drinking water standpoint. The trend of the cations presented on the trilinear diagrams indicates ground water movement throughout the aquifer system.

Summary of the conceptual model:
The aquifer system in the vicinity of the Project occurs within the Grassy Mountain Formation, generally consisting of arkosic sandstone, siltstone, and conglomerate. The unit includes interbedded fine-grained sediments. The Grassy Mountain Formation is the host unit for the Project. The unit is underlain by the Kern Basin Tuff, a fine-grained lithic tuff. Groundwater is typically found within the Grassy Mountain Formation in unconsolidated or weakly consolidated sandstone and conglomerate units and interbedded sediments. The water-bearing zones appear to be somewhat compartmentalized due to faults, sedimentary facies changes, and silicification in and around the Project.

Water levels in the area are typically stable, with some seasonal variations evident in shallow wells or wells otherwise subject to more direct recharge. There is some evidence of a general decline in the shallow aquifer zone in several wells in the vicinity of the Project, which may be due to inadequately sealed boreholes at or near the Project allowing shallow aquifer zones to drain to deeper zones. The observed decline is on the scale of a few feet over several years.

The Grassy Mountain Formation in and near the Project is silicified and strongly indurated. Geophysical data indicates that the zone of silicification increases with depth. Based on available information, a saturated zone occurs within the Project at an elevation ranging from 3,300 to 3,100 feet, which is above the expected maximum depth of the proposed mine (approximately 3,050 feet). However, this zone does not appear to be consistent throughout the Project. While portions of the Project are understood to be saturated, hydraulic conductivity and resultant groundwater flow appear to be severely restricted by silicification and/or faulting. Testing of GMW17-32 completed in silicified sediments near the Project suggests a very low hydraulic conductivity on the order of 10^{-6} to 10^{-7} centimeter per second (cm/s). A long recovery period after testing this well also is an indication of very low hydraulic conductivity.

Near the Project there are isolated pockets of less-silicified material with higher conductivity, and faults in these areas may act as conduits for groundwater flow. There is not an obvious relationship between groundwater occurrence and depth within the Project, suggesting a

complex heterogeneous system heavily influenced by silicification and faulting. Given the location of the Project relative to the groundwater divide, the available groundwater recharge to the area appears to be limited as well. The silicified nature and faulting of the sediments in and around the Project has a strong effect on hydraulic conductivity but may also result in a strong downward vertical gradient within the aquifer system.

In the general area of the Project, faults appear to act as barriers to groundwater flow on the south and east sides but the true impact of faulting on groundwater flow is hard to differentiate from the effects of deposit silicification. The silicification and faulting seems to decrease the hydraulic conductivity of the arkosic sandstone but potentially increase the hydraulic conductivity of the underlying tuff. It is possible with the combination of the silicification, steeply dipping interbedded clay, siltstone, and sinter, and the faulting near the Project allows some groundwater from the Project to flow into (or through) the tuff.

The Kern Basin Tuff, like the Grassy Mountain Formation, surfaces at higher elevations on the southern and eastern sides of Grassy Mountain and dip towards the north and northwest directions towards Negro Rock Canyon.

Downgradient of the Project, the strata are less silicified, and the horizontal and vertical gradients are not as pronounced. It is still likely that horizontal and vertical connectivity between aquifer zones is affected by low permeability, discontinuous, interbedded layers of clay and siltstone. Hydraulic conductivity is higher downgradient of the Project, but lithologic variations and faulting affect groundwater flow and occurrence. Hydraulic conductivity values downgradient of the Project derived from test pumping are on the order of 10^{-3} cm/s to 10^{-5} cm/s, representative of sandstone and conglomerate aquifers. Consistent piezometric head in wells completed at different elevations would suggest a single aquifer system.

The geochemistry of the groundwater appears to be strongly influenced by lithology. The main regional aquifer displays a Na/K-HCO3 geochemical identity, associated with volcanic tuff and sedimentary deposits. Groundwater originating from volcanics shows a Ca-HCO3 signature. Water chemistry changes are evident in the immediate vicinity of the Project.

While limited in spatial extent and hydraulic connectivity, the water-bearing zones within the Grassy Mountain Formation are proposed to constitute a single, heterogeneous and locally complex aquifer system. This conclusion is supported by lithology, piezometric surface, and geochemical signature. The aquifer system is defined by low hydraulic conductivity and high hydraulic gradient in and near the Project and higher hydraulic conductivity and lower hydraulic gradient away from the Project. Groundwater conditions appear to be mostly influenced by silicification and/or faulting near the Project and sedimentary facies changes and faulting downgradient of the Project.

The aquifer system is characterized by the following:

- Groundwater is found within permeable sediments and fractured rock within the Project Area. The Grassy Mountain Formation, consisting of arkosic sandstone, conglomerate, and tuffaceous siltstone is the primary water-bearing unit.
- Although there are different piezometric surfaces near and within the Project, available data suggest a single aquifer system with high vertical gradients in upland areas, including the vicinity of the Project.
- Groundwater elevations in most wells within the project area are relatively stable over time, based on a monitoring period that spans several years. Some wells show influence of seasonal recharge, particularly during periods of above average precipitation. Other wells show fluctuations attributed to groundwater pumping or to drilling activities.
- Groundwater flow is to the northwest, from areas of higher to lower ground surface elevation.
- Potentiometric surface maps based on wells and VWPs support a consistent flow direction without seasonally influenced variations. The pattern of groundwater flow shows local variations attributed to the presence of faults, fractures, lithologic facies changes, vertical gradients, or some combination of these influences.
- Aquifer hydraulic conductivity is low within the immediate vicinity of the Grassy Mountain ore body, attributed low permeability materials (i.e., clay and siltstone, competent bedrock, and silicified deposits). Faults appear to generally function as negative hydraulic boundaries. Spatially discontinuous aquifer zones with higher permeability are apparent, particularly to the north of the Project, based on borehole drilling and aquifer testing. However, the apparent higher permeability is also thought to reflect compartmentalized aquifer conditions, within an overall aquifer of lower, aggregate permeability.
- The low hydraulic conductivity in the vicinity of the Project is anticipated to significantly restrict groundwater flows into underground mine workings. Groundwater supply for mining purposes will need to be developed away from the silicified zones in the proximity of the ore body.

The water quality is characterized as follows:

- Arsenic is present in groundwater within the Grassy Mountain vicinity. Concentrations exceeded the drinking water MCL at all of the 15 sampled well locations and at eight of the 11 sampled spring locations. Higher arsenic concentrations hydraulically downgradient of the Project are likely due to mineralized areas associated with the ore body.
- Other exceedances of the drinking water MCL included antimony (two samples), chromium (one sample), and lead (two samples).
- Groundwater within the Grassy Mountain vicinity exhibits different water quality types (Ca-HCO3, Na/K-HCO3, or Na/K-SO4) based on spatial distribution, attributed to subsurface lithology/facies characteristics and proximity to the Project.

Volume III

Underground mine workings developed as part of the proposed Grassy Mountain gold mine will intercept the regional water table and require dewatering. Pumping from wells outside the mine area to supply mine water demands will result in water table drawdown outside of the mine. This report describes modeling efforts used to characterize pumping rates required for dewatering and impacts from groundwater pumping for mine water supply.

Theoretical groundwater inflow rates into the mine workings are on the order of 20 gallons per minute (gpm) to 100 gpm for sustained pumping, and up to 500 gpm for short-duration pumping and reflect the wide span of aquifer parameters and model assumptions utilized for predictive analyses. Actual inflow rates of several tens to a few hundred gpm should be anticipated based on median aquifer parameters and model assumptions. Based on drilling observations (within the resource) and aquifer testing performed (outside the resource) to date, the higher-end range of potential inflow rates (associated with higher hydraulic conductivity) are unlikely to be encountered during mining activities and, if encountered, the associated high dewatering rates would be anticipated for relatively short durations (i.e., likely on the order of days or weeks). Due to the proposed underground mining approach, the entire groundwater table will not be intercepted at once. Rather, the exposure to groundwater is anticipated to be restricted to subsurface workings that encounter groundwater; where groundwater is present, such inflow can be managed or mitigated as the conditions arise.

The lower range of inflow rates represents longer-term predicted dewatering as steady-state conditions are approached and reflects lower overall permeability of the aquifer system over a greater area (and likely within the resource). The higher inflow rates reflect shorter-duration flow rates resulting from dewatering of zones with higher permeability that appear to be laterally discontinuous throughout the area based on borehole drilling and aquifer testing. Based on borehole drilling and well (aquifer) testing performed to date in the vicinity of the ore body, higher permeability areas are thought to more likely be encountered away from the silicified ore body (i.e., to the north of the ore deposit and in basin areas characterized by greater amounts of sediment as compared to silicified and/or competent bedrock deposits). Direct long-term testing of aquifer properties within the ore body has not been performed to date as verification, but extensive anecdotal evidence from mineral exploration drilling and the drilling on GMW18-34 supports the concept of low permeability materials within the near vicinity of the ore body.

These estimates are within the range of previous estimates prepared by ABC (1992) for an open pit mining scenario, on the order of 30 gpm to 3,000 gpm (described in Section 2.1 of the Groundwater Report [Appendix B]). Variations in the estimates are attributed to aquifer property assignment, model assumptions and techniques, and time frames evaluated.

Potential water level impacts caused by groundwater pumping for mine water supply (estimated to be 320 gpm for ten years) are projected to range from approximately zero to 12 feet of drawdown at the closest named spring (Lowe Spring) to the main production wells. The high end of impact is possible given the estimated aquifer properties if Lowe Spring is directly connected to the Grassy Mountain Formation aquifer from which the water is being produced from, and there are no compartmentalization affects caused by faulting. Drawdown effects are observed

up to approximately 2 miles from the current highest producing well (PW-4), using a threshold of 0.5 feet of drawdown.

Calico seeks to characterize hydrogeology at the Grassy Mountain Project mine site to design dewatering and pumping systems. SPF Water Engineering, LLC (SPF), at Calico's request, has collected and compiled baseline hydrogeologic data (SPF 2019a) and developed a hydrogeologic conceptual model of the general mine area (SPF 2019b). This Groundwater Report describes the use of – and results from – analytical and numerical models to predict: 1) dewatering requirements of the active mine-site area; and 2) potential impacts of groundwater production on local groundwater levels.

Specific objectives of this modeling effort included the following:

- Identify and use appropriate analytical methods to predict dewatering pumping rate requirements and production well pumping groundwater-level impacts.
- Develop a numerical model to simulate groundwater flow in the vicinity of the Project.
- Simulate dewatering requirements and the effects of groundwater production on local springs using a range of hydraulic parameter values.
- Conduct sensitivity simulations to help evaluate uncertainty associated with hydraulic-parameter choices.

This modeling effort builds on a preceding conceptual model of groundwater flow (SPF 2019b) and supporting data sets. Other information used in developing the groundwater flow model includes the following:

- Monitoring Wells Completion Reports (SPF 2018a, SPF 2018b) – These documents present a summary of drilling, installation, and testing of three groundwater monitoring wells completed during 2017 and one additional upgradient monitoring well completed during 2018.
- Groundwater Resources Baseline Data Report (SPF 2019a) – This document presents a summary of groundwater baseline data collected since 2013, including groundwater levels, groundwater quality data from wells, spring discharge rates, and spring water quality data.
- Groundwater Characterization Report (SPF 2019b) – This document focuses on elements of the conceptual model. Specifically, the conceptual model report addresses the TRT Water Resources Subcommittee request for a conceptual model and specific questions raised about the conceptual model (Lynch 2014).
- Well Field Design Report (SPF 2019c) – This document provides a preliminary water supply evaluation, outlining projected water demands and proposed and existing water supply wells.

The numerical model simulating groundwater flow in the Grassy Mountain mine site area was built using existing hydrogeologic data. The existing hydrologic data are based on a limited number of measurements and observations. As such, the model and resulting projections has

inherent uncertainty. Nonetheless, the model forms a foundation for incorporating future data, which, in turn, should reduce model uncertainty and improve model projections.

Two two-dimensional analytical methods were used to evaluate steady-state and transient dewatering effects:

- The steady-state two-dimensional method (Marinelli and Niccoli 2000) incorporated both horizontal shallow flow and vertical, deeper flow contributions into the resource area. This method uses two steady-state analytical solutions useful for predicting the groundwater inflow to a mine pit excavated below the water table. Although the proposed mining method is drift-and-fill (D&F), calculating the inflow to the entire Project area provides a conservative dewatering estimate. The total inflow rate was the sum of the estimated flow rate from both the horizontal and vertical flow components.
- The transient method used the Theis equation (Theis 1935) to simulate the effects of pumping on drawdown over time with distance from a pumping well. Assumptions inherent to the use of the non-equilibrium Theis equation are that the aquifer is homogeneous and isotropic, uniform in thickness and areal extent, and receives no recharge; the pumping well penetrates the full aquifer thickness; water removed by discharge is removed instantaneously; the pumping well is 100 percent efficient; laminar flow exists throughout the aquifer; and the water table or potentiometric surface has no slope. Some of these assumptions are rarely completely satisfied under field conditions, but this method is commonly used for evaluating pumping (or dewatering) questions. In this case, some of the assumptions are clearly not met (e.g., the aquifer is not homogeneous and isotropic, uniform in thickness and areal extent) but nonetheless use of the method gives insight to possible dewatering rates.

Numerical groundwater flow modeling under steady state and transient conditions was performed using the MODFLOW code (Harbaugh, A.W. et al. 2000). Developed by the USGS, MODFLOW is a finite difference code capable of simulating three-dimensional groundwater flow. The code allows for representation of greater complexity than the analytical methods described above and is commonly used for simulating groundwater flow.

In general, dewatering was simulated in the MODFLOW model by assigning pumping wells along the perimeter and inside the Project, and the groundwater elevation during pumping was compared to the target dewatering elevation. Pumping wells were assigned in the analytical and numerical models to simulate the overall magnitude of aggregate dewatering rates. In reality, dewatering of the underground workings may be performed by booster pumps, sumps, or dewatering galleries, as needed. A limited sensitivity analysis was performed to evaluate the effects of hydraulic conductivity, storativity, and recharge on the results.

The conceptual model described above in Volume II is used as a basis for the modeling in Volume III of the Groundwater Report. The presence and quantity of groundwater within the Project can be described based on water reported during exploratory drilling, monitoring well construction and testing, and VWP water level data. The quantity of water is that air-lifted from the hole during drilling; there is not an indication of duration of flow in the driller notes. Within

the footprint of the Project, most of the drill holes did not encounter any water. Of the holes that did encounter water, flows were less than 25 gpm and often from a depth of more than 800 feet (below an elevation of 3,000 feet). When drill holes encountered water outside the Project, higher flows in excess of 50 gpm were occasionally noted, generally east of the Project. This area is typically less silicified, and it is also possible that the Badger and Schweizer faults act as barriers to groundwater flow on the east and south sides of the Project. Higher well yields are likely associated with less silicified materials. The deeper wells screened below an elevation of about 3,200 feet are dry or poor producers. GMW17-33 (screen interval 3,466-3,366 feet) is a moderately productive well; the well was test pumped at an average rate of 28 gpm for about two days before a negative boundary caused the pumping water level to reach the pump.

Two analytical approaches were used to evaluate potential dewatering needs; Inflows under steady-state conditions were projected using analytical equations by Marinelli and Niccoli (2000); inflows under transient conditions were evaluated using the Theis equation. Please refer to the Groundwater Report for the details, assumptions and calculations for each approach.

The steady-state analysis used potential groundwater inflow into the proposed mine workings, which were estimated from: 1) Shallow aquifer zones present at the same elevation as the mine workings; and 2) A deeper zone within the aquifer beneath the mine workings. Three general scenarios (i.e., 1, 2, and 3) were used to evaluate potential steady-state inflows. These scenarios are distinguished by low, intermediate, and high hydraulic conductivity values (ranging from 10-6 cm/s to 10-4 ft/d) for the shallow aquifer zone, and low hydraulic conductivity (10-6 cm/s, or 0.003 ft/d) for the deep zone (Table 37). These values reflect the typical measured range in transmissivity (and hydraulic conductivity) from historical and recent pumping tests.

The results suggest half an order of magnitude variation in the inflow rate between each of the three scenarios (i.e., approximately 25 gpm for Scenario 1; 80 gpm for Scenario 2; and 475 gpm for Scenario 3). Lowering the recharge rate did not significantly change the predicted inflow. Supporting equations for Zones 1 and 2 and calculations for each scenario are provided in the Groundwater Report (Volume III Appendices).

Transient analysis used the Theis analytical method (Theis 1935) yields a theoretical projection of potential drawdown effects associated with pumping to achieve mine dewatering over a period of time. In contrast, the steady state method described above does not account for variations in drawdown over time. Thus, the Theis method was used to evaluate the amount of time that may be necessary to dewater the mine workings to the target elevation of approximately 3,100 feet.

Table 37. Steady-State Estimated Groundwater Inflow Rates

Scenario	Description	Shallow Hydraulic Conductivity, K (Zone 1)	Deep Hydraulic Conductivity, K (Zone 2)	Recharge (in/yr)	Estimated Discharge (gpm)		
					Shallow (Zone 1)	Deep (Zone 2)	Combined Zones
1	Low K (shallow); High Rch	$1x10^{-6}$ cm/s (0.003 ft/d)	$1x10^{-6}$ cm/s (0.003 ft/d)	0.5	12	15	27
1a	Low K (shallow); Mid Rch			0.25	10	15	26
1b	Low K (shallow); Low Rch			0.07	8	15	23
2	Mid K (shallow); High Rch	$1x10^{-5}$ cm/s (0.03 ft/d)	$1x10^{-6}$ cm/s (0.003 ft/d)	0.5	70	15	85
2a	Mid K (shallow); Mid Rch			0.25	64	15	80
2b	Low K (shallow); Low Rch			0.07	53	15	68
3	High K (shallow); High Rch	$1x10^{-4}$ cm/s (0.3 ft/d)	$1x10^{-6}$ cm/s (0.003 ft/d)	0.5	501	15	516
3a	High K (shallow); Mid Rch			0.25	457	15	472
3b	High K (shallow); Low Rch			0.07	394	15	410

For this analysis, it was assumed that a single pumping well placed at the center of the mine workings could be used to evaluate the predicted drawdown at a distance from the pumping well that coincided with the perimeter of the mine workings. In reality, dewatering of the underground workings may utilize booster pumps or sumps placed as needed as opposed to a vertical well. Based on an approximate radius of 450 feet (roughly 0.1 mile), the pumping rate was adjusted to achieve the maximum projected drawdown of roughly 600 feet (i.e., 3,700 feet elevation minus 3,100 feet elevation) at 0.1 mile.

For scenario 2a, the most likely scenario (mid T, mid S), we assumed an aquifer transmissivity of 100 gallons per foot per day (gpd/ft), which is within the typical range based on aquifer testing (i.e., on the order of a few 10s to 250 gpd/ft, excluding PW-4 outlier), and storativity of 0.005 (upper range for confined conditions). Assuming a saturated aquifer thickness of 200 feet, the 100 gpd/ft transmissivity is equivalent to a hydraulic conductivity of 0.07 ft/day (2×10^{-5} cm/s) and is within the range of estimated values derived from pumping tests conducted within the vicinity of the resource area. The actual aquifer thickness varies across the resource area; however, this assumed value provides an upper end of expected drawdown. The storativity of 0.005 represents the upper range for confined aquifers (0.005 to 0.00005) based on literature reported values (Freeze and Cherry 1979).

Based on the Theis analysis, the predicted pumping rate needed to achieve the total drawdown in the pumping well was estimated to be roughly 250 gpm for one year. Actual drawdown effects will vary depending on actual aquifer conditions encountered within the resource area and the well efficiency. The predicted drawdown after one year of continuous pumping was approximately 600 feet at 0.1 mile from the pumping location in the center of the mine workings. Multiple scenarios were used to examine different hydraulic conductivity and storativity assumptions (aquifer thickness was assumed to remain the same). Results of the multiple scenarios are provided in Table 38 below.

Table 38. Theis Analytical Model Predicted Dewatering Flows

Scenario	Description	Transmissivity, T (gpd/ft)	Storativity, S (dimensionless)	Approximate Flow Required to Dewater 500 Feet at a Distance of 1 Mile After One Year (gpm)
1	Low T; Low S	4	0.00005	6
1a	Low T; Mid S	4	0.005	380
1b	Low T; High S	4	0.05	>1,000,000
2	Mid T; Low S	100	0.00005	80
2a	Mid T; Mid S	100	0.005	245
2b	Mid T; High S	100	0.05	1,450
3	High T; Low S	400	0.00005	260
3a	High T; Mid S	400	0.005	605
3b	High T; High S	400	0.05	1,600

The Theis method used for estimating dewatering rates was also used to project the aquifer impacts due to production well pumping over the life of the mine. The same limitations and assumptions described above for mine dewatering also apply to the estimation of aquifer impacts from production water pumping. The predicted drawdown from production well pumping calculated by the Theis analytical model is presented as Table 39 below.

Table 39. Theis Analytical Model Predicted Production Well Drawdown

Scenario	Description	Transmissivity, T	Storativity, S	Calculated Drawdown After Ten Years (feet)		
				One Mile	Four Miles	Seven Miles
1	Low T; Low S	1,500 gpd/ft	0.00005	172.92	105.31	78.33
1a	Low T; Mid S		0.0005	116.74	50.66	26.86
1b	Low T; High S		0.005	61.48	8.14	0.60
2	Mid T; Low S	4,000 gpd/ft	0.00005	73.84	48.44	38.23
2a	Mid T; Mid S		0.0005	52.74	20.45	17.83
2b	Mid T; High S		0.005	31.78	8.64	2.49
3	High T; Low S	10,000 gpd/ft	0.00005	32.89	22.73	18.63
3a	High T; Mid S		0.0005	24.45	14.32	10.31
3b	High T; High S		0.005	16.03	6.25	2.91

A numerical model was constructed to further evaluate potential dewatering requirements and groundwater production impact. The USGS code MODFLOW 2000 (Harbaugh, A.W. et al. 2000) was used for performing numerical groundwater flow modeling and dewatering projections. MODFLOW uses a modular finite-difference approach for simulating groundwater flow in three dimensions. MODFLOW is considered as the industry standard and is widely accepted within the hydrologic community for dewatering applications. Groundwater Vistas (GV) was used to construct and execute MODFLOW simulations. GV was developed by Environmental Simulations

Incorporated (ESI) as a graphical user interface for pre- and post- processing of MODFLOW files (ESI 2011). GV supports geographic information system (GIS) files for data visualization.

The model extent was approximately ten by ten miles, centered on the Project. The southern model boundary extended to portions of Owyhee Reservoir and the Owyhee River. The northern boundary extended north of Poison Creek. Eastern and western boundaries were set to comparable distances from the proposed resource and did not necessarily coincide with physical features. This domain was selected to minimize the potential effects of setting the boundary and assigned conditions too close to the proposed resource and thereby influencing the model's prediction of groundwater levels and drawdown from pumping in the resource area.

The model grid was comprised of 264 rows and 264 columns with uniform grid cell dimensions of 200 feet by 200 feet. The model was rotated 45 degrees counterclockwise to approximate the general, predominant direction of groundwater flow to the northwest in the vicinity of Grassy Mountain and the resource area. This rotation effectively allows groundwater flow to be simulated in three dimensions. The coordinate system for the model was North American Datum (NAD) 1983, State Plane Oregon, South, FIPS 3602 in feet with Lambert Conformal Conic projection.

The model consisted of three layers (layer 1, layer 2, and layer 3) defined to reflect topographic influences on groundwater flow:

- Layer 1 was typically 100 feet in thickness and formed the uppermost layer defined by the topographic surface. This layer represents surficial and shallow lithology and contains boundary conditions for select surface water features represented in the model (drain and river cells) described in the next section. Layer 1 was simulated as an unconfined layer (Type 3) condition, where transmissivity was allowed to vary.
    - The surface of the model was created from a digital elevation model (DEM) of topography with 30-meter resolution (USGS 2017). The USGS created the DEM from surface topography maps converted into digital format. Once the DEM was imported into the model, the top elevation of Layer 1 ranged from approximately 2,115 feet to 4,733 feet amsl.
- Layer 2 was the middle layer, intended to represent the shallow aquifer system and has a non-uniform thickness, ranging from less than 100 feet in lower- topography areas to nearly 1,000 feet at the center of the model. This layer contains most of the monitoring wells used as calibration targets for the model. This layer was assigned a uniform bottom elevation of 3,100 feet in the resource area as the target depth for dewatering. Pumping simulations were evaluated by comparing the predicted groundwater elevation to the 3,100-foot elevation level to assess magnitude of dewatering needs to achieve 100 percent dewatering in the resource area. Layer 2 was simulated as a confined (Type 0) condition.
- Layer 3 was the lowest layer in the model, with non-uniform thickness and an assigned uniform model base of 2,000 feet amsl. The bottom of this layer is implicitly a no-flow boundary. Layer 3 was simulated as a confined (Type 0) condition.

Numerical model simulations were performed under steady-state and transient conditions. The steady-state system reflects the groundwater flow regime once equilibrium has been established and does not account for changes in groundwater levels over time, which may occur on the order of decades or longer. Initial conditions were considered Layer 1. The boundary conditions considered are; constant head, river, drain, and no flow. The hydraulic properties assigned in the model are hydraulic conductivity, storativity and recharge. The model hydraulic conductivity is shown in Table 40. The storativity is shown in Table 41. The recharge is assigned to Layer 1 to simulate infiltration that reaches the groundwater table

Table 40. Model Hydraulic Conductivity (ft/d)

Zone	Description	Kx = Ky	Kz
1	Basin deposits (siltstone, sandstone, unconsolidated)	0.214	0.105
2	Alluvium (Qal, Qls)	5.57	2.18
3	Siltstone, sandstone (Tis)	0.676	0.347
4	Resistent topography and basalt	0.001	0.001
5	Altered zones (within and near deposit)	0.0031	0.0031
6	Rhyodacite dome	0.0007	0.0007
7	Deeper deposits and Kern Tuff (Tkt)	0.0025	0.0013
8	Higher topography region to south	0.0025	0.0025

Table 41. Model Storativity Values (Dimensionless)

Zone	Description	Specific Storage	Specific Yield	Porosity
1	Basin deposits (siltstone, sandstone, unconsolidated)	2.62E-04	0.30	0.20
2	Alluvium (Qal, Qls)	5.00E-03	0.13	0.30
3	Siltstone, sandstone (Tis)	5.00E-03	0.30	0.20
4	Resistent topography and basalt	5.00E-05	0.05	0.08
5	Altered zones (within and near deposit)	5.00E-05	0.11	0.10
6	Rhyodacite dome	7.14E-05	0.08	0.08
7	Deeper deposits and Kern Tuff (Tkt)	1.74E-03	0.30	0.06
8	Higher topography region to south	3.35E-03	0.05	0.06

Overall, the model simulates groundwater flow on a regional scale that generally follows topography. Groundwater flow from the resource area is predominantly to the northwest within the hydraulic basin north of Grassy Mountain. The model also represents the general direction of groundwater flow and horizontal hydraulic gradient within the resource area in the shallow zone, based on comparison of 2016 groundwater contours to model simulated heads within Layer 2. Model simulated contours are shown in blue, overlain on the 2016 contours in red. Layer 1 was predominantly dry in most areas of the model, attributed to the relatively thin layer, effects of boundary condition assignment in the model (particularly drains), and hydraulic conductivity values. For example, vertical hydraulic conductivity is not well represented in the model. Layer 3 does not contain head calibration targets; therefore, the overall degree to which model heads

represent actual conditions could not be evaluated. However, the model does not simulate the observed heads in the deep wells and VWP units. In general, the model typically simulated measured heads within +/- 45 feet, with some outliers with more or less associated error. The lowest error was less than one foot, and the highest error was 113 feet. The targets assigned to Layer 1 also contribute to the errors in the model.

A limited sensitivity analysis was performed by varying hydraulic conductivity and recharge from the base model case. The purpose of the sensitivity assessment was to bracket the model predictions within a reasonable range of model input values. This analysis was used prior to transient calibration and the base target statistics are slightly different than values presented above. This evaluation was intended to provide some additional context for the model predictions. Four, separate scenarios were evaluated:

- Sensitivity Run 1 – Hydraulic conductivity for all zones was increased by 2x. This run resulted in model simulated heads under-predicting measured heads at all locations.
- Sensitivity Run 2 – Hydraulic conductivity for all zones was decreased by 2x. This run resulted in model simulated heads over-predicting measured heads at nearly all locations.
- Sensitivity Run 3 – Recharge was increased by 2x. This run resulted in model simulated heads over-predicting measured heads at all locations.
- Sensitivity Run 4 – Recharge was decreased by 2x. This run resulted in model simulated heads under-predicting measured heads at all locations.

The overall direction of groundwater flow is similar for all cases; however, the magnitude of the model errors is considerably greater compared to the base case model (Table 42).

The data collected from monitoring wells, VWP, and other bores drilled in and near the Project demonstrate that the groundwater flow in this highly faulted and silicified aquifer section is highly restricted, and water levels are relatively deeper than in wells completed further from the mine. In some of the silicified sections, the aquifer is unable to produce any water. This numerical model, calibrated to the shallower and more consistent surrounding well water levels, is meant to show a maximum amount of dewatering possible. It is likely, where water is encountered in the deeper zones of the Project, that the lower flows (57.5 gpm) modeled to keep the water levels down after the first 70 days of pumping will be more than adequate for dewatering. Due to the compartmentalized nature of the aquifer surrounding the mine, it is possible larger flows of water may be initially encountered for short periods (days or weeks).

Table 42. Summary Of Sensitivity Analysis

Statistic	Base Model	Sensitivity Run 1 2x greater hydraulic conductivity	Sensitivity Run 2 2x lower hydraulic conductivity	Sensitivity Run 3 2x higher recharge	Sensitivity Run 4 2x lower recharge
Residual Mean	10.98	170.35	-249.03	-234.12	173.41
Absolute Residual Mean	45.83	176.96	278.72	260.13	180.01
Residual Std. Deviation	53.93	130.82	271.55	251.15	133.64
Sum of Squares	72,696	1,107,174	3,258,175	2,829,320	1,150,329
RMS Error	55.04	214.78	368.45	343.35	218.93
Min. Residual	-78.98	-74.42	-686.52	-648.67	-74.42
Max. Residual	113.94	406.12	113.94	113.94	412.36
Number of Observations	24	24	24	24	24
Range in Observations	498	498	498	498	498
Scaled Residual Std. Deviation	0.11	0.26	0.55	0.50	0.27
Scaled Absolute Residual Mean	0.09	0.36	0.56	0.52	0.36
Scaled RMS Error	0.11	0.43	0.74	0.69	0.44
Scaled Residual Mean	0.02	0.34	-0.50	-0.47	0.35

The data collected from monitoring wells, VWP, and other bores drilled in and near the Project demonstrate that the groundwater flow in this highly faulted and silicified aquifer section is highly restricted, and water levels are relatively deeper than in wells completed further from the mine. In some of the silicified sections, the aquifer is unable to produce any water. This numerical model, calibrated to the shallower and more consistent surrounding well water levels, is meant to show a maximum amount of dewatering possible. It is likely, where water is encountered in the deeper zones of the Project, that the lower flows (57.5 gpm) modeled to keep the water levels down after the first 70 days of pumping will be more than adequate for dewatering. Due to the compartmentalized nature of the aquifer surrounding the mine, it is possible larger flows of water may be initially encountered for short periods (days or weeks).

A transient model was used to predict aquifer drawdown and associated impact to springs. However, there are other factors to consider when attempting to predict impacts to springs, including source water characteristics (i.e. geochemistry), geology, and elevation differences.

Due to the geochemical signature of Lowe Spring being different from PW-4, and because the location of Lowe Spring is near the contact between the different geological units (SPF 2019b), it is anticipated there may be less hydraulic connection between the production wells and the source of Lowe Spring; therefore, the modeled drawdown is probably conservative. Using similar reasoning, Poison Spring is more likely to be affected by the production well pumping because Poison Spring has a similar geochemical signature as PW-4; thus, the model might under predict impacts to Poison Spring.

The following points summarize the results and conclusions from this investigation:

1. The conceptual model for groundwater flow at Grassy Mountain provides the basis for the dewatering estimates. The current model suggests a single aquifer system as a function of scale, supported by the relatively uniform, shallow and deep potentiometric surface (at a high-level view) and correlation with groundwater elevation and depth. On a local scale, heterogeneity effects are apparent, attributed to local variations in hydraulic properties, facies changes, and/or the occurrence of faults/fault zones.

2. Estimated analytical steady-state bulk dewatering rates on the order of 20 gpm, with the potential to intercept up to 500 gpm on a short-duration basis (i.e., days to weeks), are anticipated based on the analytical approach.

    a. The low-end estimate reflects lower permeability in the range of $1x10^{-6}$ cm/s (or 0.003 ft/d) anticipated directly within the resource area. Due to the expression of individual faults or fault zones, the actual permeability may be more or less. SPF is not aware of direct testing of hydraulic conductivity or transmissivity based on aquifer pumping tests within the resource area to date to confirm this estimate. However, the results of pumping tests performed around the perimeter of the resource extent support an aggregate lower hydraulic conductivity within this magnitude due to limited yields and negative boundary conditions.
    b. The high-end estimate reflects higher hydraulic conductivity that may be more representative of basin conditions (i.e., unconsolidated and consolidated sedimentary deposits) and short-duration inflows into the resource area (i.e., faults and fractures serving as conduits for flow) that could potentially be intercepted during the mining activities. The anticipated hydraulic conductivity may be on the order of $1x10^{-4}$ cm/s (0.3 ft/d). This condition may arise from contributions from local zones of higher permeability that are effectively dewatered in early time. As the cone of depression or radius of influence extends from the theoretical pumping well(s) with time, the overall aquifer properties are expected to produce less water due to overall lower permeability effects.

3. The dewatering evaluation also examined potential groundwater inflow rates using transient analytical methods.

    a. The transient analytical (Theis) method was used to estimate the predicted dewatering rate of approximately 250 gpm to 600 gpm, assuming a single pumping well scenario, placed at the center of the Project. The theoretical drawdown effects at the perimeter of the Project were evaluated after one year of continuous pumping to produce 600 feet of drawdown (assuming an initial groundwater elevation of 3,700 feet for upgradient conditions and an assumed dewatering elevation of 3,100 feet). The higher flow rate range is consistent with anticipated short-duration inflow amounts over the span of days to weeks.

4. A three-dimensional numerical groundwater flow model was constructed and executed using MODFLOW to evaluate potential dewatering rates under steady- state and transient conditions.

    a. The model was constructed at a ten by ten-mile resolution, centered on the Project, with three layers. Regional and local groundwater flow conditions were simulated based on a distribution of hydraulic conductivity and storativity (informed by geologic mapping and the results of aquifer pumping tests), recharge from surface infiltration predominantly in higher elevation regions, and assignment of boundary conditions to reflect physical boundaries to the extent possible (including Owyhee Reservoir, Owyhee River, and select spring features).
    b. The steady state model dewatering was simulated by placing wells along the Project perimeter and assigning uniform pumping rates to achieve dewatering to the 3,100-foot elevation. Four wells were simulated at five gpm each for 20 gpm total pumping requirements under steady-state conditions, resulting in a pumping level elevation of approximately 2,950 feet to 3,100 feet.
    c. The transient model dewatering was simulated by placing four wells around the perimeter and one well in the center of the Project and pumping a total 480 gpm for 70 days and 57.5 gpm for the remaining lifetime of the mine (approximately ten years). The higher rate pumping for 70 days was able to lower water level elevations to less than 3,050 feet and the lower rate pumping initially allowed minor recovery then lowered the water levels to a range of elevations from 2,700 to 2,870 feet.
    d. The three-dimensional numerical model was created as a regional model for a baseline analysis of dewatering needs. This model was calibrated using the regional water levels. The deeper water levels located near the proposed mine and other highly silicified and compartmentalized areas are not represented in the model. The conceptual model report (SPF 2019c) discusses these deeper water levels and potential causes. Currently, there are no wells or piezometers completed in the highly silicified region encompassing the proposed mine that have a static water level higher than 3,200 feet amsl. Drillers have indicated flows of up to ten gpm in only three of the exploratory bores drilled in the proposed mine at depths shallower than 3,200 feet amsl. Only two of the exploratory bores in the proposed mine had a reported static water level shallower than 3,200 feet amsl. Due to its silicified and compartmentalized nature, the amount of water that flows through the proposed mine area is significantly limited. The three-dimensional numerical dewatering model does not account for this limitation and should be used as a worst case estimate for the maximum flow that would be required to dewater the proposed mine in its entirety.
    e. The planned mining method is D&F. This method used in the compartmentalized aquifer located at the Project will decrease the total volume of material requiring dewatering.

5. The transient model was also used to evaluate the drawdown effects of the dewatering wells and the mine operation production wells on the aquifer and nearby springs. Lowe Spring is approximately one mile away from the nearest proposed pumping well (Well 5) and had a predicted maximum drawdown of approximately 12 feet. Approximately 1.75 miles away, Poison Spring has a maximum predicted drawdown less 0.5 feet. The water sampled from Poison Spring has a similar geochemical characteristic as PW-4, while Lowe Spring shows a more volcanic geochemical signature. The geochemical signatures indicated Poison Spring may be affected by the groundwater production more than modeled and Lowe Spring may be affected less than modeled.

6. The dewatering and drawdown estimates reflect inherent uncertainty, both in the available datasets and necessary simplifying assumptions for representing a complex system. Therefore, these results are considered appropriate for baseline-level planning.

7. The accuracy of representing predominant groundwater flow paths and estimates of potential groundwater inflow depends on the sufficiency and accuracy of supporting data and assumptions. This process is inherently uncertain with respect to the conceptual model, translation of the conceptual to analytical and numerical models, and interpretation of results. Simplifying assumptions are necessary throughout this process. The level of accuracy is considered appropriate for a baseline estimate. Overall, the magnitude of dewatering estimates generated during this investigation on the order of 20 to 100 gpm for long-duration pumping, and up to 500 gpm for shorter-duration pumping (days to weeks) are within the range of previous investigations that used different methods.

2.9 Land Use

The Grassy Mountain Mine Project Land Use Baseline Report (Appendix B) was submitted to DOGAMI on January 26, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. Seventy-one percent of the land in Malheur County is federal land that is administered by the BLM (Oregon Partnership for Disaster Resilience [OPDR] 2014). The 2002 Southeastern Oregon Resource Management Plan and Record of Decision (SEORMP) indicates that the Land Use Study Area does not include any BLM-administered land that the BLM has identified for disposal. The SEORMP shows that the Land Use Study Area supports the Oregon-Idaho Graben, which is an area that the USGS identifies as most likely to contain large gold deposits. A BLM-identified transportation and utility corridor passes along the southern limit of the Land Use Study Area. There is one recreation area near the Land Use Study Area, a primitive campground at Twin Springs. Dispersed recreation is allowed throughout the Land Use Study Area. The SEORMP indicates that the mining and processing proposed as part of the Project would be an allowable use of BLM-administered land.

The Land Use Study Area is zoned Exclusive Range Use (ERU) and Exclusive Farm Use (EFU) in the Malheur County Code (MCC). The County's land use zone maps reflect these designations (C-A1: EFU, and C-A2: ERU). The Oregon Revised Statutes 215.283 and 215.296 define the allowable uses on ERU-designated land; allowable uses are reiterated in the MCC. In some cases, the allowable uses are conditional and must receive a conditional use authorization from the County within which the ERU land is located. Land in and near the Land Use Study Area is currently used for grazing and dispersed recreation and supports an existing road network that provides local access. Grazing is a farm use and is allowed by right in the Land Use Study Area. The state and local statutes do not address dispersed recreation (the MCC addresses developed recreation facilities such as parks and playgrounds). Most of the land is administered by the BLM, so dispersed recreation is managed in accordance with BLM policies.

The BLM has not yet identified any potential issues with the SEORMP or other specific requirements for implementing the portions of the Project that are on BLM-administered land and subject to BLM authorization. Mining and accessory infrastructure proposed as part of the Project is an allowed use of BLM-administered land in and near the Land Use Study Area if the Project can be developed in a manner that protects other sensitive resources, per the SEORMP energy and mineral resource objectives. A review of the resource information and SEORMP indicates that the Land Use Study Area does not support any areas of critical environmental concern, wild and scenic rivers, wilderness study areas, sage grouse lek sites, or riparian conservation areas. Information in the SEORMP indicates that portions of the Land Use Study Area are in or near areas that are open to mining but subject to operational timing limitations. Factors that would affect the operational timing limitations include proximity to occurrences of special status plants and mule deer winter range. Surveys of the Permit Area and a two-mile radius did not locate any threatened or endangered species.

OAR 632 Division 37 requires the Project proponent to receive an operating permit from DOGAMI to establish the mine and related processing facilities. A baseline study is one of several studies that the proponent must complete as part of its application for an operating permit. As it reviews the proposed Project, DOGAMI will identify potential issues, and the proponent would work with DOGAMI and other state agencies to address such issues, such as ensuring the proposed uses are compatible with surrounding land uses and develop and implement mitigation for potential conflicts, if necessary.

DOGAMI can only issue a permit if the proposed Project also receives local approval. In the case of this Project, the local approval involves upgrades to county-maintained roads. By working closely with the state and Malheur County, the proponent will develop an operating and reclamation plan that avoids or minimizes land use conflicts at the time of mine operation and in the years following closure.

The most substantial potential for conflict with local land use policies and regulation is related to how the proposed Project would affect ongoing grazing use that is a by-right use of ERU-zoned land upon which the Project is located. All potential Project conflicts with ERU use would be addressed through the Project's permitting processes.

As it considers the proposed Project, the County will apply guidance in the Comprehensive Plan (relate Project findings to County policy and ordinances) and evaluate whether the proposed Project would not interfere with current ranching practices, and that it complies with the County code. The County approved the Conditional Use Permit on May 23, 2019 and issued the Land Use Compatibility Statement to Calico on July 30, 2019.

2.10 Noise

The Grassy Mountain Mine Project Noise Baseline Report (Appendix B) was originally submitted to DOGAMI on October 5, 2018, then again on December 6, 2018, and February 13, 2019. The report was accepted by the TRT on March 1, 2019, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The following four ambient noise monitoring sites were chosen to represent the ambient noise environment in the Noise Study Area: Site A – an undeveloped location on BLM land approximately 170 feet west of Twin Springs Road and approximately three miles south of the intersection of Twin Springs Road and Cow Hollow Road; Site B – Lake Owyhee State Park, approximately 250 feet west of Fisherman Road (the access road into Indian Creek Campground) and approximately 600 feet south of the gate entrance into Indian Creek Campground; Site C – a site within the Mine and Process Area, approximately 375 feet southwest of the entrance gate and 150 feet west of an unnamed access road; and Site D – a residence located at 2025 Bishop Road, approximately 250 feet east of Russell Road. Table 43 summarizes the ambient noise measurement results.

Table 43. Ambient Noise Summary (dBA)

Metric	L_{eq}	L_{max}	L_{min}	L_1	L_{10}	L_{50}
Site A: Undeveloped location along Twin Springs Road						
Daytime Minimum	27.2	49.4	17.4	35.8	26.6	19.2
Daytime Average	35.9	58.3	19.0	45.7	39.1	30.3
Daytime Maximum	49.0	73.8	24.8	59.8	53.2	40.0
Nighttime Minimum	20.6	40.2	17.1	27.7	19.7	17.8
Nighttime Average	29.1	51.4	19.0	38.2	31.0	24.8
Nighttime Maximum	39.8	65.4	22.3	50.1	43.5	37.5
Site B: Lake Owyhee State Park						
Daytime Minimum	22.4	37.9	17.3	29.4	25.0	20.3
Daytime Average	28.1	49.7	20.2	37.9	28.5	24.0
Daytime Maximum	41.6	71.9	26.3	54.7	37.3	35.2
Nighttime Minimum	19.3	32.1	17.2	23.4	20.3	18.1
Nighttime Average	29.9	45.4	23.6	34.9	32.1	28.3
Nighttime Maximum	38.1	55.8	31.4	48.6	43.7	37.0
Site C: Grassy Mountain Mine and Process Area						
Daytime Minimum	32.5	55.5	17.1	44.2	28.8	20.7
Daytime Average	40.4	67.3	20.6	51.7	40.7	31.2
Daytime Maximum	56.7	94.4	31.9	64.7	56.0	46.8
Nighttime Minimum	19.3	40.8	16.9	23.8	20.2	17.9
Nighttime Average	26.6	50.7	18.4	34.2	27.4	22.5

Metric	L_{eq}	L_{max}	L_{min}	L_1	L_{10}	L_{50}
Nighttime Maximum	48.8	81.3	21.9	53.4	41.7	30.2
Site D: 2025 Bishop Road, Vale, Oregon						
Daytime Minimum	30.8	52.1	20.2	40.5	32.0	26.2
Daytime Average	37.8	60.0	24.5	47.1	39.8	33.2
Daytime Maximum	50.7	77.7	36.4	58.9	54.2	48.2
Nighttime Minimum	28.6	48.6	23.3	33.1	30.1	27.3
Nighttime Average	40.8	58.9	30.3	48.4	41.8	37.4
Nighttime Maximum	69.8	92.5	36.0	86.2	50.6	45.1

dBA = A-weighted decibel; L_{eq} = hourly average levels; L_{max} = hourly maximum levels; L_{min} = hourly minimum levels; L_1 = noise levels exceeded for one percent of each hour; L_{10} = noise levels exceeded for ten percent of each hour; L_{50} = noise levels exceeded for 50 percent of each hour
Daytime = 7:00 A.M. to 10:00 P.M.
Nighttime = 10:00 P.M. to 7:00 A.M.

At Site A, the undeveloped location along Twin Springs Road, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, occasional vehicular traffic, and bird activity (song and movement).

At Site B, Lake Owyhee State Park, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, vehicular traffic, boating activity on the lake, occupied campground activity, and bird activity (song and movement). At night, an added contributor was insect activity around the lake and although audible, was not excessive in loudness nor duration and should not have an impact on the proposed ambient noise limits.

At Site C, within the Permit Area, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, and bird activity (song and movement). Although not necessarily quantifiable by the weather data obtained at ground level, some fluctuations in the measurement data can be explained by upper atmospheric wind gusts/turbulence. There were no anthropogenic noise sources in the vicinity of Site C when the measurements were taken.

At Site D, the residential site along Russell Road, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, vehicular traffic along Russell Road and some along Bishop Road, and agricultural activity including irrigation pumping equipment and field implements. On two separate occasions, an irrigation pump was in operation, at 6:00 A.M. on the second day and at 6:00 A.M. on the third day, both instances for less than a one-hour measurement interval. The noise contributions from the irrigation pump can be seen in the L_{10} data as a three decibel (dB) increase on the second day and a five dB increase on the third day, and in the L_{50} data as a one dB increase on the second day and a three dB increase on the third day. At 4:00 P.M. and 5:00 P.M. on the third day, a tractor worked in a field to the southwest of the irrigation pump. These noise contributions can be seen in the L_{10} data as a seven to 12 dB increase, and in the L_{50} data as an eight to ten dB increase. Over the course of 72 single hour duration measurements at Site D, the irrigation pump only impacted two

intervals, and the tractor activity also only impacted two intervals; therefore, noise from these two sources would only occur sporadically.

The results show that there is both diurnal variability and a reasonable amount of general variability from hour to hour within both the daytime and nighttime periods at all sites. L_{max} levels are typically higher during the daytime, indicating that the loudest noise sources are likely to be man-made sounds. Average daytime L_{eqs} are lowest at the Lake Owyhee State Park and highest in the proposed Mine and Process Area. Nighttime average L_{eqs} are lowest in the proposed Mine and Process Area and highest at the Bishop Road site. Average daytime and nighttime observed L_{50} levels at all sites range from approximately 22 dBA in the proposed Mine and Process Area to 37 dBA at the Bishop Road site.

Generally, noise levels in the Permit Area are low with L_{eq} levels at 57 dBA or below at all times, except for a nighttime spike at the residential site on Bishop Road, which occurred at 6:00 A.M. with the use of farming equipment near the road. The quietest site is at Lake Owyhee State Park, with the Mine and Process Area being the quietest during daytime hours, and the Bishop Road site being the loudest during nighttime hours. The calculated day-night noise levels (L_{dn}) at the residential site on Bishop Road was approximately 51 dBA for the first 48-hour period, with the calculated L_{dn} rising to 66 dBA on the third day due to the use of farming equipment.

A review of the lowest measured ambient noise levels indicates that only a few measured values approach the self-noise limits of the sound level meter (SLM). The SLM self-noise limit was measured at approximately 18 dBA. At three of the four monitoring locations (sites A, B, and C), the lowest nighttime L_{50} measured was between 17.8 dBA and 18.1 dBA. These values approach the self-noise limit of the SLM; therefore, actual ambient sound levels could have been quieter than the data indicate during those periods. However, at the two measurement locations that are near noise sensitive properties (Sites B and D), there were only three measured nighttime L_{50} values below 20 dBA (18.1, 19.0, and 19.2 dBA), all of which occurred at Site B. Only one of those hours approached the self-noise limit of the SLM, so the measurements are deemed to provide a valid representation of the existing ambient noise levels for the Project.

The representative ambient noise levels measured at the only two identified noise sensitive properties near the Noise Study Area are summarized in Table 44. The values in Table 33 were obtained using the statistical 5th percentile in each data category. The statistical 5th percentile was used rather than the L_{min} in each data category so that the representative levels would approach the lowest levels measured at each site without being biased by outlying quiet hours that occurred over the three-day measurement period. The proposed limits at the two sites (Table 45) are the representative ambient noise levels with the ten-dBA increase described in the ODEQ regulations.

Table 44. Representative Ambient Noise Levels Measured at Noise Sensitive Properties

Site	Daytime		Nighttime	
	L_{10}	L_{50}	L_{10}	L_{50}
Site B	25.6	22.4	21.3	19.1
Site D	34.0	26.7	30.2	28.1

Table 45. Proposed Ambient Noise Limits for the Project

Site	Daytime		Nighttime	
	L_{10}	L_{50}	L_{10}	L_{50}
Site B	35.6	32.4	31.3	29.1
Site D	44.0	36.7	40.2	38.1

2.11 Oregon Natural Heritage Areas

The Grassy Mountain Mine Project Oregon Natural Heritage Resources Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on August 15, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. There are no natural heritage resources in the Permit Area. The closest natural heritage resource to the Permit Area is the Succor Creek State Natural Area approximately 16 miles from the Permit Area. The next closest is the Crooked Creek State Natural Area approximately 61 miles from the Permit Area.

2.12 Outstanding Natural Areas

The Grassy Mountain Mine Project Outstanding Natural Areas Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on June 29, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The BLM list identifies only one Outstanding Natural Area (ONA) in Oregon: the Yaquina Head ONA, located along the coast in Newport, Oregon (BLM 2016). Additional internet searches also identified the Diamond Craters ONA (BLM 2018). The Diamond Craters ONA is located approximately 77 miles southwest of the Permit Area.

2.13 Recreation

The Grassy Mountain Mine Project Recreation Baseline Report (Appendix B) was submitted to DOGAMI on January 11, 2018. The report was accepted by the TRT on March 15, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Recreation Opportunity Spectrum (ROS) is a BLM-created conceptual framework for recreation managers to inventory, plan, and manage recreation resources on BLM land. The ROS provides a way to characterize either the capability of a resource to provide an experience, or the demand for an experience in terms of the activity

opportunity and setting opportunity provided or demanded. There are two ROS classes in the Recreation Study Area: Rural and Semi-primitive Motorized. These classes are described in Table 46.

Table 46. Recreation Opportunity Spectrum Classifications in the Recreation Study Area

Classification	Description
Rural	This is a substantially modified environment. Resource modifications and utilization practices are to enhance specific recreation activities. Facilities are designed for use by a larger number of people. Motorized use and parking opportunities are available. The probability of user interaction is moderate to high, as is the convenience of sites and opportunities. These factors are generally more important than the physical setting. Wildland challenges and testing of outdoor skills are generally important. Activities may include interpretive services, swimming, bicycling, recreation cabin use, and skiing.
Semi-primitive Motorized	This is a predominately natural or natural-appearing environment of moderate to large size. User interaction is low, but there is evidence of other users. Minimum on-site controls and restrictions may be present. Use of motorized vehicles is permitted. There is a moderate probability of experiencing isolation, closeness to nature, and self-reliance in outdoor skills. Activities may include boating, motor biking, specialized landcraft use, mountain climbing, driving for pleasure, camping, and picnicking.

Resource-dependent recreation use, including driving for pleasure, camping, picnicking, hiking, hunting, scenery viewing, nature studies, rockhounding, and all-terrain vehicle (ATV) use are all popular activities occurring within the Recreation Study Area. Twin Springs Campground is the only designated recreation site in the vicinity of the Study Area, and it is commonly used for dispersed recreation activities such as hunting, rockhounding, and ATV use; however, the campground is located outside the Recreation Study Area boundaries.

2.14 Socioeconomics

The Grassy Mountain Mine Project Socioeconomics Baseline Report (Appendix B) was submitted to DOGAMI on February 21, 2018. The report was accepted by the TRT on July 20, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Socioeconomics Study Area is Malheur County, which includes the cities of Vale, Nyssa, Ontario, Adrian, Jordan Valley, and other unincorporated communities. Malheur County is Oregon's second largest county in the area but is largely undeveloped. The County is in the southeastern corner of the State of Oregon and is crossed by two major rivers, the Snake River and the Malheur River. Ninety-four percent of the County is undeveloped rangeland, most of which is federally administered by the BLM. Developed areas along the Snake and Malheur Rivers support agricultural production areas and agriculture-focused communities.

The County's population centers consist mostly of its incorporated cities (Ontario, Vale, Nyssa, Adrian, and Jordan Valley). Several unincorporated communities are also located within the

County. Malheur County's population has grown slowly and includes periods of net population gain and loss.

Malheur County has a slightly higher percentage of people 18 years of age and younger than the State as a whole, but its proportion of residents age 65 and older is about the same as the State. Females make up a smaller proportion of the population than the State as a whole. The County is not very racially diverse; 86 percent of residents are white. Median household incomes are substantially lower in Malheur County than in the State as a whole, and median values of owner-occupied homes are lower in Malheur County than the State. Approximately 38 percent of residents have a high school diploma and approximately 34 percent have completed some college. The rates of residents having a high school diploma are higher than the State as a whole, but the rates of residents having completed some college are lower than the State as a whole. The rate of college graduates is lower than the State as a whole (U.S. Census Bureau 2016e).

Most residents speak English at home. Approximately 24 percent of the County's residents primarily speak a foreign language, with Spanish the most prevalent. Approximately 32 percent of County residents identify themselves as being of Hispanic or Latino ethnicity (regardless of race). This rate is higher than the State, which reports a Hispanic or Latino proportion as approximately 12 percent of the total population.

The County has 11,629 housing units, with 88.5 percent occupied and 11.5 percent vacant. These rates are similar to those for the State as a whole. Of the occupied households in the County, 59.7 percent are owner-occupied, and 40.3 percent are renter occupied. Owner-occupied homes have a slightly higher average household size than renter-occupied units. Approximately 40 percent of all housing units are in Ontario (U.S. Census Bureau 2016f). Single family housing units are the most common type of housing in the County, comprising approximately 65 percent of the total. Multifamily housing units make up approximately 17 percent and mobile homes comprise approximately 18 percent of the total units in the County.

The median age of Malheur County real estate is 41 years, which is only four years older than the national median age of 37 (Sperling's Best Places 2017). Over half of the householders in the County and statewide have been in the same home since the 2000 through 2009 period. When compared to the state, Malheur County has a higher proportion of long-time householders in the same home (since 1980 or earlier) (U.S. Census Bureau 2016f). The median home sale price peaked in February 2009 at $174,100 (Zillow 2017). Most owner-occupied homes in the County are valued between $50,000 and $99,999, with the median home value being $127,000. These values are significantly lower than the same metrics for the state as a whole. The statewide median value is over $100,000 more at $237,300 (U.S. Census Bureau 2016g).

The median rent for Malheur County ($604) is lower than the state median ($907). Most renters (approximately 63 percent) in the County pay between $500 and $999 per month. Statewide, most renters (about 51 percent) also pay between $500 and $999 per month. When compared to statewide renters, a larger proportion of Malheur County renters pay less than $500 per month

(approximately 32 percent for County renters compared to approximately nine percent of statewide renters) (U.S. Census Bureau 2016f).

For 2016, the U.S. Census Bureau estimated that the total civilian labor force (people aged 16 years and older and able to work) in Malheur County was approximately 11,936 people. Of these people, most of the unemployed individuals were age 16 to 19 years; approximately 28 percent of this population was estimated to be unemployed. People aged 20 to 24 years had the second highest unemployment rate, with approximately 18 percent of them being unemployed. For people living in poverty, the unemployment rate was approximately 31 percent in 2016. For disabled persons, approximately 21 percent were unemployed in 2016 (U.S. Census Bureau 2016h).

Malheur County October 2017 labor market information from the Oregon Employment Department (OED) shows that over-the-year employment increasing for manufacturing, professional/business services, retail trade, and mining/logging/construction services. The trends show reductions in private education/health services and local government (OED 2017a). In 2016, the average annual wage was $33,851, which is the lowest of the three southeastern Oregon counties (Grant, Harney, and Malheur) (OED 2017b).

The County does not provide water and sewer services. For unincorporated areas of the County, the Environmental Health Department issues on-site septic system permits, runs the Licensed Facility Program and Drinking Water Program, and oversees the County Solid Waste Program. The Cities of Ontario, Nyssa, and Vale provide specific services to their residents such as domestic water, wastewater, storm drain, and/or garbage collection services.
Fire protection in Malheur County is provided by the following districts, departments, and agencies: Ontario Fire & Rescue; Nyssa Fire Department; Vale Fire & Ambulance; Adrian Rural Fire Protection District; Jordan Valley Volunteer Fire Department; and BLM. The BLM has been integrated with the U.S. Forest Service since 1995 for fire and aviation management in the Pacific Northwest and is managed cooperatively between the two agencies and in close collaboration with the Pacific Northwest Wildfire Coordinating Group.

The Malheur County Sherriff's Office is the primary provider of law enforcement services to residents of Malheur County. The Ontario Police Department and Nyssa Police Department also provide law enforcement services to residents in those jurisdictions. The Oregon State Police (OSP) is a multi-disciplined organization that enforces traffic laws on state roadways, investigates and solves crime, conducts post-mortem examinations and forensic analysis, and provides background checks and law enforcement data. The OSP also regulates gaming, the handling of hazardous materials and fire codes, and educates the public on fire safety and enforce fish, wildlife, and natural resource laws (OSP 2016).

The Malheur Education Service District (ESD) provides a supporting infrastructure to the local school districts. The Malheur ESD supports ten local school districts containing 27 schools. These include eight high schools, three middle schools, nine elementary schools, and seven schools that service kindergarten through eighth grade (Malheur ESD 2017).

2.15 Surface Water

The revised Grassy Mountain Gold Project Surface Water Baseline Report (Appendix B) was submitted to DOGAMI on June 5, 2018, and again on August 14, 2018. The report was accepted by the TRT on January 14, 2019, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Surface Water Resources Study Area was established to develop an environmental baseline for assessing potential impacts from Project facilities, potential impacts of surface runoff from Project facilities, and to provide background data on the Owyhee River and Lake. The Surface Water Resources Study Area includes the Mine and Process Area and two separate and non-contiguous, areas on the Owyhee River/Lake. One location is on the Owyhee River, four miles downstream of Owyhee Dam, and the other location is upstream of the dam and Permit Area on the Owyhee River/Lake at Leslie Gulch.

No perennial surface water features are located within the immediate vicinity of the Surface Water Resources Study Area; therefore, the following five surface water sampling sites were selected and consisted of the closest perennial surface water bodies:

- Dry Creek Arm of Lake Owhyee;
- Owyhee River downstream of Owyhee Dam;
- Owyhee River/Lake upstream of Owyhee Dam at Leslie Gulch;
- Negro Rock Canyon Creek at the northern border of Study Area; and
- Twin Springs Creek upstream of Dry Creek.

Lake Owyhee and the Owyhee River are the predominant drainage features for the region, flowing south to north and ultimately discharging to the Snake River near the Oregon-Idaho border. Lake Owyhee, created in 1932 with construction of the Owyhee River Dam, is approximately six miles southeast of the Project. Tributary stream flow is typically ephemeral or intermittent (Orr, Orr, and Baldwin 1992; Baldwin 1959). Drainages in the Project Area do not flow directly into the Owyhee River or Lake Owyhee.

The main Surface Water Resources Study Area boundary includes a sampling site on Dry Creek Arm of Lake Owyhee, downstream from where Dry Creek and Twin Springs Creek enter the lake. The Surface Water Resources Study Area also includes the two separate and non-contiguous, areas on the Owyhee River/Lake: Owyhee River downstream of Owyhee Dam and Owyhee River upstream of Owyhee Dam at Leslie Gulch.

The Owyhee River/Lake sampling sites were selected to provide background surface water data in the vicinity of the Project. However, no impacts to Owyhee River/Lake are anticipated from the proposed Project because the Owyhee River drainage is in a different watershed than the Project site.

The Project is in the Sourdough Basin/Negro Rock Canyon watershed, which drains to the north. Grassy Mountain, located southeast of the Project, serves as the hydrologic divide between the

Sourdough Basin/Negro Rock Canyon watershed and the watersheds draining to the Owyhee River.

The five surface water sites located within the Surface Water Resources Study Area were visited bi-annually during the second and fourth quarters of 2013 and the second quarter of 2014. Water quality samples were collected from four of these five sites during the three sampling events. Samples were not collected at Twin Springs Creek upstream of Dry Creek because this site was dry during each visit.

Surface water conditions were considered steady state and only one set of field parameters (pH, electrical conductivity, specific conductance, dissolved oxygen) were collected. The sensors for the pH meter, conductivity meter, and dissolved oxygen meter were placed directly in the surface water for data collection. Readings were recorded once the measurements stabilized.

Water-quality samples collected from surface water were analyzed for the list of approved water quality analytes. Table 47 lists the approved analytes, as well as the laboratory testing method, the laboratory minimum detection limit (MDL), and the reporting limit (five times the MDL). For metals, samples for both total and dissolved metals were collected. For the other parameters, only total samples were collected.

Table 47. List of Water Quality Analytes

Parameter	Laboratory Method of Analyses	Detection Limit	Reporting Limit	Sample Type
Aluminum	EPA 200.7	0.03 mg/L	0.15 mg/L	total and dissolved
Arsenic	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Barium	EPA 200.7	0.003 mg/L	0.015 mg/L	total and dissolved
Cadmium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Calcium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Chromium	EPA 200.8	0.0005 mg/L	0.002 mg/L	total and dissolved
Copper	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Iron	EPA 200.7	0.02 mg/L	0.05 mg/L	total and dissolved
Lead	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Magnesium	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Manganese	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Mercury	1631E	0.2 ng/L	1.0 ng/L	total and dissolved
Nickel	EPA 200.8	0.0006 mg/L	0.003 mg/L	total and dissolved
Potassium	EPA 200.7	0.2 mg/L	1.0 mg/L	total and dissolved
Selenium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Silver	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Sodium	EPA 200.7	0.2 mg/L	1.0 mg/L	total and dissolved
Zinc	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Antimony	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Beryllium	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved

Parameter	Laboratory Method of Analyses	Detection Limit	Reporting Limit	Sample Type
Bismuth	EPA 200.7	0.04 mg/L	0.2 mg/L	total and dissolved
Boron	EPA 200.8	0.01 mg/L	0.05 mg/L	total and dissolved
Cobalt	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Gallium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Lithium	EPA 200.7	0.008 mg/L	0.04 mg/L	total and dissolved
Molybdenum	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Scandium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Strontium	EPA 200.7	0.005 mg/L	0.03 mg/L	total and dissolved
Thallium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Tin	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Titanium	EPA 200.7	0.005 mg/L	0.025 mg/L	total and dissolved
Vanadium	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Uranium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Nitrate+Nitrite (as N)	EPA 353.2	0.02 mg/L	0.1 mg/L	total
Ammonia Direct (as N)	EPA 350.1	0.05 mg/L	0.25 mg/L	total
Alkalinity	SM 2320B	2 mg/L	10 mg/L	total
Bicarbonate	SM 2320	2 mg/L	10 mg/L	total
Carbonate	SM 2320	2 mg/L	10 mg/L	total
Chloride	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Conductivity	SM 2510B	1 umhos/cm	5 umhos/cm	total
Cyanide, Total	EPA 335.4	0.003 mg/L	0.015 mg/L	total
Cyanide, WAD	SM 4500	0.003 mg/L	0.015 mg/L	total
Fluoride	EPA 300.0	0.05 mg/L	0.25 mg/L	total
Hardness	SM 2340B	0.8 mg/L	4.0 mg/L	total
pH	SM 4500-H B	0.1	0.5	total
Sulfate	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Total Dissolved Solids	SM 2540C	10 mg/L	50 mg/L	total
Total Suspended Solids	SM 2540D	5 mg/L	25 mg/L	total
Total Phosphorus	EPA 365.1	0.01 mg/L	0.05 mg/L	total

mg/L = milligrams per liter; ng/L = nanograms per liter; umhos/cm = microhoms per centimeter

Out of the five surface water sites that were visited bi-annually that serve as background water quality monitoring locations, flow was only directly measured at one of these sites during the sampling period, Negro Rock Canyon Creek. At the three Lake Owyhee/River sites, flow could not be directly measured. Instead, flow was estimated from available USGS gauging sites, and lake elevation was obtained for the Dry Creek Arm site above Owyhee Dam from the Bureau of Reclamation. Flow and lake elevation data are summarized in Table 48. Flow data for the Owyhee River downstream of Owyhee Dam was obtained from USGS gauge 13183000, located 0.8 mile downstream of the dam (located between the dam and the sampling site).

Table 48. Flow and Elevation Data from Surface Water Sites

Quarter (Q)	Parameter	Negro Rock Canyon Creek	Dry Creek Arm of Lake Owyhee	Owyhee River Downstream of Owyhee Dam	Owyhee River Upstream of Owyhee Dam at Leslie Gulch
Q2 2013	Date/Time	6/26/13 12:00	6/27/13 14:20	6/26/13 17:00	6/27/13 9:00
Q2 2013	Flow (cfs)	0.04	N/A	152	119
Q2 2013	Elevation (ft)	N/A	2,622.22	N/A	2,622.22
Q4 2013	Date/Time	11/21/13 14:55	11/23/13 15:50	11/20/13 15:10	11/20/13 11:00
Q4 2013	Flow (cfs)	0.01 – 0.02	N/A	21	141
Q4 2013	Elevation (ft)	N/A	2,597.13	N/A	N/A
Q2 2014	Date/Time	6/24/14 10:55	6/23/14 15:20	6/19/14 15:45	6/19/14 12:30
Q2 2014	Flow (cfs)	0.01 – 0.02	N/A	165	105
Q2 2014	Elevation (ft)	N/A	2,602.69	N/A	N/A

ft = feet; cfs = cubic feet per second; N/A = not applicable

Flow data for the Owyhee River upstream of Owyhee Dam at Leslie Gulch was obtained from USGS gauge 13181000, identified as Owyhee River near Rome, Oregon. This gauge is approximately 50 river miles upstream of the sampling location but is the closest gauge upstream of the dam. Flow data from this gauge, therefore, is not a reliable representation of flow at the sampling site. However, flow at this gauging location does provide a reference point to associate with the sampling event and may be used to identify relationships between flow and water quality data as additional flow and water quality are collected. The Owyhee Dam at Leslie Gulch sample site is within the pool of Lake Owyhee at high lake levels. At lower lake levels, the Owyhee River flows past the site. During the Q2 2013 event, the sample site was within the backwater of Lake Owyhee. During the Q4 2013 and Q2 2014 events, the Owyhee River was flowing at Leslie Gulch.

Field water quality data collected during surface water sampling are presented in Table 49 and represent the complete field water quality dataset, as only one set of field parameters were measured.

Table 49. Field Water Quality

Site Name	Sampling Period	pH	EC	SC	Temp	DO	DO Saturation
		S.U.	µS/cm	µS/cm at 25 °C	C	mg/L	%
Dry Creek Arm of Lake Owyhee	Q2 2013	8.74	230	243	22	8.5	113
	Q4 2013	7.92	217	328	7.3	11.0	100
	Q2 2014	8.57	263	275	22.8	8.7	112

Site Name	Sampling Period	pH	EC	SC	Temp	DO	DO Saturation
		S.U.	µS/cm	µS/cm at 25 °C	C	mg/L	%
Negro Rock Canyon Creek	Q2 2013	6.86	395	482	15.4	4.2	49
	Q4 2013	7.23	ND	592	9.9	5.71	50
	Q2 2014	7.35	393	490	14.6	6.6	78
Owyhee River Downstream of Owyhee Dam	Q2 2013	8.67	187	239	13.3	10.7	116
	Q4 2013	8.84	187	292	6.1	11.8	105
	Q2 2014	8.81	230	289	14.3	10.4	116
Owyhee River Upstream of Owyhee Dam at Leslie Gulch	Q2 2013	8.08	330	349	22.1	8.0	99
	Q4 2013	8.43	239	357	7.7	10.2	95
	Q2 2014	8.59	306	351	18.2	8.00	99

µS/cm = microSiemens per centimeter; S.U. = significant unit

The pH of the Owyhee River and Lake Owyhee sampling sites consistently ranged between 8.0 and 9.0. The pH of Negro Rock Canyon Creek was lower, ranging from 6.86 to 7.35.

The specific conductance of the Owyhee River and Lake Owyhee sites ranged between 239 and 357 µS/cm at 25 °C. Negro Rock Canyon Creek had consistently higher values, ranging from 482 to 592 µS/cm at 25 °C.

The dissolved oxygen concentration at the Dry Creek Arm and Owyhee River upstream of Owyhee Dam at Leslie Gulch ranged between eight and 11 mg/L, with values above ten during the 4th Quarter of 2013 (November). The Owyhee River downstream of Owyhee Dam had higher dissolved oxygen concentrations, ranging from 10.4 to 11.8 mg/L, with the higher value measured during the 4th Quarter of 2013. Dissolved oxygen is higher when water temperature is lower. The dissolved oxygen concentrations measured at Negro Rock Canyon Creek were lower than the Owyhee River sites, with values ranging from 4.2 to 6.6 mg/L. The percent oxygen saturation was consistently at or above 100 percent at the Owyhee River sites but ranged from 49 to 78 percent at Negro Rock Canyon Creek.

Surface water analytical results were compared to ODEQ water quality standards as described in OAR 340-041. Water quality in the Owyhee Basin is managed to protect the designated beneficial uses including public and private domestic water supply, fish and aquatic life, and fishing.

For the aquatic life criteria, the standards are presented as Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC) which indicate the maximum allowable average one-hour and 96-hour average contaminant concentrations, respectively. Sampling results were compared to both the CMC and CCC values.

Human health criteria (HHC) are presented as “organism only” for areas in which fishing is the designated use and as “water + organism” for areas in which water supply and fishing are

designated uses. In the Owyhee Basin, designated beneficial uses include water supply and fishing so the "water + organism" criteria apply.

The water quality results collected at each site for each parameter are included in Appendix E of the Surface Water Baseline Report (Appendix B). Table 50 displays the results that exceeded ODEQ's water quality standards.

Table 50. Water Quality Results

Sample Location	Arsenic, dissolved (mg/L) (CMC – 0.34, CCC – 0.15, HHC – 0.0021)			Arsenic, total (mg/L) (CCC – 0.34, CCC – 0.15, HHC – 0.0021)			Iron, total (mg/L) (CCC – 1.0)			Mercury, total (mg/L) (CMC – 2,400, CCC – 12.0)		
	Q2 2013	Q4 2013	Q2 2014	Q2 2013	Q4 2013	Q2 2014	Q2 2013	Q4 2013	Q2 2014	Q2 2013	Q4 2013	Q2 2014
Dry Creek Arm	0.0057	0.0072	0.0063	0.0057	0.0076	0.0064	--	1.16	1.45	--	--	--
Negro Rock Creek	0.0246	0.0231	0.0258	0.0243	0.0237	0.0268	--	--	--	--	--	--
Owyhee River DS	0.0059	0.0059	0.0063	0.0054	0.0059	0.0061	--	--	--	--	--	--
Leslie Gulch	0.0111	0.01	0.011	0.0114	0.0102	0.0108	1.15	--	1.22	23	13.2	19.9

Arsenic was the only water quality parameter where the HHC standard was exceeded at any of the surface water sampling sites. Arsenic was detected above the HHC limit of 0.0021 mg/L at all four of the surface water sampling sites during each of the three sampling events. Negro Rock Canyon Creek and Owyhee River upstream of the dam at Leslie Gulch consistently had the highest arsenic concentrations. At Negro Rock Canyon Creek, the total arsenic concentrations were consistent, ranging from 0.0237 to 0.0268 mg/L. At Leslie Gulch, the total arsenic concentrations were consistent but lower compared to Negro Rock Canyon Creek, ranging from 0.0102 to 0.0114 mg/L.

Total iron was detected above the aquatic life CCC standard of 1.0 mg/L on two occasions at both the Dry Creek Arm of Lake Owyhee and at the Owyhee River upstream of the Owyhee Dam at Leslie Gulch. At Dry Creek Arm, the first exceedance was 1.16 mg/L during the 4th Quarter of 2013 and the second exceedance was 1.45 mg/L during the 2nd Quarter of 2014. For the Leslie Gulch sampling location, the total iron concentration was 1.15 mg/L during the 2nd Quarter of 2013 and 1.22 mg/L during the 2nd Quarter of 2014.

Total mercury was detected above the aquatic life CCC standard of 12.0 mg/L at Leslie Gulch during all three of the surface water sampling events. Mercury was detected at 23 mg/L during the 2nd Quarter of 2013, 13.2 mg/L during the 4th Quarter of 2013, and 19.9 mg/L during the 2nd Quarter of 2014.

2.16 Terrestrial Vegetation

The Grassy Mountain Mine Project Terrestrial Vegetation Baseline Report (Appendix B) was originally submitted to DOGAMI on January 29, 2018, then again on October 2, 2018. The report was accepted by the TRT on October 23, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. Field surveys were conducted in a portion of the Terrestrial Vegetation Study Area by HDR in 2014 and 2015 (2014/2015 Survey Area). Additional field surveys were conducted in the remaining portion of the Terrestrial Vegetation Study Area by EM Strategies in 2017 (2017 Survey Area). Between the field surveys conducted in 2015 and 2017, there were six field-verified vegetation communities documented in the Terrestrial Vegetation Study Area: Agricultural; Bluebunch Wheatgrass/Cheatgrass/Annual; Burned Yellow Rabbitbrush/Bluebunch Wheatgrass; Crested Wheatgrass Seeding; Wyoming Big Sagebrush/Bluebunch Wheatgrass; and Wyoming Big Sagebrush/Crested Wheatgrass.

There were four transects established in the Wyoming Big Sagebrush/Crested Wheatgrass community during the 2014/2015 field surveys in the Terrestrial Vegetation Study Area, and three additional transects established during the 2017 field surveys, one each in the Bluebunch Wheatgrass/Cheatgrass/Annual community, the Crested Wheatgrass Seeding community, and the Wyoming Big Sagebrush/Crested Wheatgrass community. These transects were established to verify the mapped vegetation communities.

There were seven Daubenmire sampling locations established during the 2014/2015 field surveys in the Terrestrial Vegetation Study Area; six within the Wyoming Big Sagebrush/Bluebunch Wheatgrass community and one within the Crested Wheatgrass Seeding community. Seven additional Daubenmire sampling locations were established during the 2017 field surveys; two within the Bluebunch Wheatgrass/Cheatgrass/Annual community, one within the Crested Wheatgrass Seeding community, two within the Wyoming Big Sagebrush/Bluebunch Wheatgrass community, one within the Burned Yellow Rabbitbrush/Bluebunch Wheatgrass community, and one within the Wyoming Big Sagebrush/Crested Wheatgrass community. These sampling locations were established to determine the dominant plant species within each community.

The USFWS Information for Planning and Consultation species list reported that no federal threatened or endangered plant species are known to occur within the 2017 Survey Area. No federally threatened or endangered plant species were observed during the 2017 field surveys, or during the HDR 2014/2015 surveys.

A list of rare, threatened, and endangered plants was obtained from the Oregon Biodiversity Information Center in April 2017 for the 2017 Survey Area. Two plant species were reported to occur within two miles of the Terrestrial Vegetation Study Area: Cronquist's stickweed (*Hackelia cronquistii*), a State Threatened species and a federal Species of Concern; and Mulford's milk-vetch (*Astragalus mulfordiae*), a State Endangered species and a federal Species of Concern. No State-listed species were observed during the 2017 or 2014/2015 field surveys.

The Final Oregon/Washington State Director's Special Status Species List, July 13, 2015, which lists BLM sensitive plant species suspected or documented to occur with the Vale District was reviewed. No BLM sensitive plant species were observed during the 2017 or 2014/2015 surveys.

A list of noxious weeds for Malheur County, Oregon, was obtained from the Malheur County Weed Advisory Board. Malheur County has prioritized control and/or eradication of noxious weeds by A, B, and C classes, with Class A having the highest priority. Two noxious weed species were observed during the 2017 surveys: nodding thistle (*Carduus nutans*), a Class B species observed along the northern portion of the 2017 Terrestrial Vegetation Study Area in the Access Road Area; and cheatgrass (*Bromus tectorum*), the most dominant species observed throughout the Terrestrial Vegetation Study Area. The following species were observed during the 2014/2015 surveys: Austrian peaweed (*Sphaerophysa salusula*), a Class A species observed adjacent to the Access Road Area; Canada thistle (*Cirsium arvense*), a Class B species observed near the northern portion of the Mine and Process Area; and three class C species - cheatgrass, medusahead (*Taeniatherum caput-medusae*), and field bindweed (*Convoculus arvensis*). Class A species are subject to mandatory control/eradication where found. Class B species are required to be controlled within 50 feet of all property lines, easements, and rights-of-way. Class C species can be treated at the landowner's discretion.

2.17 Transportation

The Grassy Mountain Mine Project Transportation Baseline Report (Appendix B) was originally submitted to DOGAMI on January 18, 2018, then again on July 12, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Main Access Road used for the Transportation Study Area includes portions of U.S. Highways 20 and 26 (U.S. 20 and U.S. 26, respectively), County-maintained Russell Road, and BLM-maintained Cow Hollow Road and Twin Springs Road.

An emergency access route has been identified as a portion of Oregon State Route 201, and County-owned Mitchell Butte Road and Owyhee Avenue. Owyhee Avenue is part of the main access to Owyhee Reservoir, which is a popular destination for recreationists. The emergency access route would share approximately four miles of Owyhee Avenue with this type of recreation-focused traffic.

ODT traffic count data from 2015 show that the average annual daily traffic (AADT) for U.S. 20 and U.S. 26 through Vale ranges between 2,501 and 5,000 vehicles. The volume decreases east and west of Vale and ranges between 1,001 to 2,500 AADT. An ODT traffic counter located west of the point where the main access route intersects U.S. 20 shows an AADT of approximately 1,900 for 2015 (ODT 2017).

In coordination with the Malheur County surveyor, traffic counts (PicoCount 2500, Version 2.25) were taken at two locations in the Transportation Study Area in fall 2014 and again in spring 2015 to record existing two-way road and trail usage on Russell Road and Twin Springs Road. The traffic

counters do not reliably record lighter vehicles, like all-terrain vehicles and dirt bikes, so the data can only be said to reflect full-size vehicles. Table 51 summarizes the data collected.

Table 51. Traffic Count Data in the Transportation Study Area

Counter Number	Location	X Coordinate	Y Coordinate	Data Gathering Start Date	Data Gathering End Date	Total Recorded Vehicles
1	Russell Road (fall 2014)	475475	4862111	9/21/14	10/22/14	2,591
	Russell Road (spring 2015)			4/7/15	4/16/15	413
2	Twin Springs Road (fall 2014)	471910	4840599	9/21/14	10/22/14	564
	Twin Springs Road (spring 2015)			4/7/15	4/16/15	27

Note: coordinates are in NAD 83, UTM Zone 11 North, meters

2.18 Visual Resources

The Grassy Mountain Mine Project Visual Resources Baseline Report (Appendix B) was submitted to DOGAMI on December 22, 2017. The report was accepted by the TRT on February 28, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The BLM's Visual Resources Management (VRM) system provides a method to identify visual resource values, establishes objectives for managing these values, and provides information to evaluate the visual effects of the proposed projects on public lands. The inventory of visual values combines evaluations of scenic quality, sensitivity levels, and distance zones to establish visual resource inventory classes, which are "informational in nature and provide the basis for considering visual values in the land use planning process. They do not establish management direction and should not be used as a basis for constraining or limiting surface disturbing activities" (BLM 1986).

VRM classes are typically assigned to public land units through the use of the visual resource inventory classes in the BLM's land use planning process. Two out of four VRM classes occur in the Visual Resources Study Area. Table 52 displays the two classes and the objectives of each class.

Table 52. BLM Visual Resources Management Classes in the Visual Resources Study Area

VRM Class	Description
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the character should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
IV	The objective of this class is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. Management activities may dominate the view and be the major focus of viewer attention. However, every attempt

VRM Class	Description
	should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Four key observation points (KOPs) were chosen to describe the existing visual elements within the Visual Resources Study Area in the context of form, line, color, and texture associated with the characteristic landscape, and to capture views that represent the existing landscape where Project activities are being proposed. Brief descriptions of the views at each KOP are provided in Table 53. Detailed descriptions of the form, line, color, and texture and photographs at each KOP are included in the Visual Resources Baseline Report (Appendix B).

Table 53. Key Observation Points

KOP	Location Description	VRM Class	View Description
1	End of Access Road facing south in Mine and Process Area	IV	Gently rolling hills with rock outcroppings in middleground and background. Sagebrush/bunchgrass vegetation has fine to medium texture. Linear elements include access road tire tracks.
2	Western portion of Mine and Process Area facing northeast	IV	Gently rolling hills. Sagebrush/bunchgrass vegetation creates a mottled, fine to medium texture across the landscape. Linear elements include access road tire tracks.
3	Intersection of Access Road Area and Twin Springs Road facing south toward Mine and Process Area	IV	Relatively flat valley bottom. Gently rolling hills are visible in the middleground and background near the Mine and Process Area. Vegetation is relatively homogeneous. The color and texture of the access road contrasts sharply with the adjacent, undisturbed landscape.
4	Along Twin Springs Road facing south toward Mine and Process Area	IV	Terrain slopes gently toward the south toward the Mine and Process Area. Slightly undulating landforms are visible in the middleground and background. Landscape is mottled with fine textured grass species. The color and texture of Twin Springs Road contrasts sharply with the adjacent, undisturbed landscape.

2.19 Wetlands

The Grassy Mountain Mine Project Draft Wetland Delineation Report (Appendix B) was submitted to the Oregon Department of State Lands (DSL) on March 1, 2018, and DSL concurrence was received May 3, 2018. On July 24, 2018, the TRT accepted the DSL concurrence

as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. An additional letter from DOGAMI was received February 11, 2019, which repeated the acceptance by the TRT. Existing literature was reviewed to evaluate the physical features of the Wetland Study Area, including USGS maps, aerial imagery, National Wetland Inventory (NWI) maps, and the National Hydrography Dataset. The data review facilitated the identification of potential wetland areas and prioritization of field survey areas.

NWI mapping indicated the presence of two emergent wetlands and three ponds within or partially within the Wetland Study Area. The NWI describes the wetlands as PEM1Ch (palustrine, emergent, persistent, seasonally flooded, diked/impounded) and PEM1B (palustrine, emergent, persistent, saturated). The ponds are described as PUBH (palustrine, unconsolidated bottom, permanently flooded), PUSCx (palustrine, unconsolidated shore, excavated), and PUSCh (palustrine, unconsolidated shore, seasonally flooded, diked/impounded). The third pond, designated PUSCh, corresponds to Schweizer Reservoir on USGS maps. Two palustrine emergent wetlands, two springs, and one impounded area (Schweizer Reservoir) were identified during the 2015 and 2017 field investigations.

HDR surveyed a portion of the Wetland Study Area in 2012 (identified as Tax Lot 101), and an additional area in 2015. EM Strategies surveyed another portion in 2017. There were no surface waters observed during the 2012 surveys in Tax Lot 101. Between the 2015 and 2017 surveys, a total of two wetlands, two springs, one pond, one artificial waterway, and ten tributary drainages were observed in the Wetland Study Area. Three tributary drainages and one pond (Schweizer Reservoir) were observed within the area surveyed in 2015. Two wetlands, two springs, one artificial waterway (J-H Canal), and ten tributary drainages were observed within the area surveyed in 2017. The three tributary drainages surveyed in 2015 were contiguous with three of the ten drainages surveyed in 2017.

The Oregon DSL concurred with the findings on May 3, 2018. The purpose of the concurrence was to evaluate the features for the state Removal-Fill Law, which determined that the two wetlands and artificial waterway (J-H Canal) are subject to the permit requirements of the Removal-Fill Law. A separate determination by the Army Corps of Engineers may be conducted for purposes of complying with the Clean Water Act.

2.20 Wild, Scenic or Recreational Rivers

The Grassy Mountain Mine Project Wild, Scenic, or Recreational Rivers Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. There are no designated wild, scenic, or recreational rivers in the Permit Area. The closest nationally designated wild, scenic, or recreational river is the Owyhee River, located approximately 31 miles to the south of the southernmost tip of the Permit Area. There are two portions of the Owyhee River included in the Oregon Scenic Waterway system: a portion of the main stem of the river,

from Crooked Creek to Birch Creek, and a portion of the South Fork, from the Idaho border to the Three Forks area. These two segments total approximately 26 miles.

2.21 Wildlife Resources

The Grassy Mountain Mine Project Wildlife Resources Baseline Report (Appendix B) was originally submitted to DOGAMI on April 18, 2018, October 16, 2018, and January 30, 2019. Field surveys were conducted in a portion of the Wildlife Study Area by Northwest Wildlife Consultants, Inc. (NWC) between June 24, 2013, and May 30, 2014. Additional field surveys were conducted in the remaining portion of the Wildlife Study Area by EM Strategies between April 18, 2017, and February 6, 2018. Surveys were conducted in a 0.5-Mile Buffer Study Area or a Two-Mile Buffer Study Area, dependent on the species. In the 0.5-Mile Buffer Study Area, the following species were surveyed: pygmy rabbits and white-tailed jackrabbit (leoprids); bats; burrowing owl; landbirds; and general wildlife encounters were documented. In the Two-Mile Buffer Study Area, a greater sage-grouse habitat assessment and lek surveys, golden eagle nest surveys, nesting raptor surveys, and general observations of specials status species and non-listed species occurred.

Seventeen avian species were detected during large-plot avian surveys conducted by NWC at five plots between June 2013 and May 2014. Three of these species, horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), and common raven (*Corvus corax*), were found during all seasons and accounted for 137 of the 171 individuals detected. Golden eagles were detected during all seasons. Ferruginous hawks, a BLM Sensitive species, were detected during summer and spring (and found nesting during the 2014 raptor nest survey). The burrowing owl, also a BLM Sensitive species, was detected in the summer and fall of 2013 but was not found during any subsequent surveys. Other raptors detected outside of the large-plot surveys were northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*Buteo lagopus*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and prairie falcon (*Falco mexicanus*). The prairie falcon was confirmed nesting within the Two-Mile Buffer Study Area; northern harrier was believed to be nesting within the Two-Mile Buffer Study Area in 2014, and long-eared owl was estimated to have bred successfully in 2013.

Forty-seven avian species were detected during small-plot avian surveys conducted by NWC at eight plots between June 2013 and May 2014. Of these, 25 were found only at plot 6, which was more than a mile from the Permit Area and contained habitats not found in the Permit Area. Together, the pond, marsh, and riparian trees at plot 6 constituted an oasis that attracted not only waterfowl, marsh birds, and riparian obligates (some of which nested there) but also migrants (including passerines) that used this taller, denser vegetation for cover and foraging during stopovers. Twenty-two species were detected at the other seven plots in habitat that is found within the Permit Area. Horned lark and western meadowlark were each found at six of the seven small plots, the only species found during all four survey seasons, and the most commonly detected species. Rock wren (*Salpinctes obsoletus*) was detected during spring, summer, and fall seasons (at the three plots containing a small amount of exposed rock). Six species were detected multiple times during spring and summer seasons; these were Brewer's

sparrow (*Spizella breweri*), lark sparrow (*Chondestes grammacus*), loggerhead shrike (*Lanius ludovicianus*), Say's phoebe (*Sayornis saya*), sagebrush sparrow (*Artemisiospiza nevadensis*), and sage thrasher (*Oreoscoptes montanus*). All these birds are presumed to breed in or near the Permit Area, and active nests of horned lark, lark sparrow, and common nighthawk (*Chordeiles minor*) were found incidentally during other surveys. Mountain bluebirds (*Sialia currucoides*) were detected at two plots, but these detections occurred on a single fall survey day. Twelve other species were detected on a single occasion and at a single plot: ferruginous hawk (*Buteo regalis*), California quail (*Callipepla californica*), mourning dove (*Zenaida macroura*), common raven, barn swallow (*Hirundo rustica*), canyon wren (*Catherpes mexicanus*), black-throated sparrow (*Amphispiza bilineata*), white-crowned sparrow (*Zonotrichia leucophrys*), dark-eyed junco (*Junco hyemalis*), Brewer's blackbird (*Euphagus cyanocephalus*), and house finch (*Haemorhous mexicanus*).

Three raptor nests were active in 2013. One of these, a common raven nest, was active again in 2014. A burrowing owl (*Athene cunicularia hypugaea*) nest was identified by the presence of an adult owl and an abundance at the burrow entrance of pellets and excrement of this species. Only a single individual was ever seen at any one time, however, so whether a breeding attempt occurred remains uncertain. (Surveys did not begin in 2013 until after breeding would be expected to be complete.) The burrowing owl is a BLM Sensitive species. A successful breeding attempt by long-eared owls was documented by the presence at the pond of three young of this species and a stick nest in a tree with pellets and excrement in and beneath it. This nest was likely originally built by black-billed magpies (*Pica hudsonia*).

One active ferruginous hawk nest was observed within the Two-Mile Buffer Study Area during the April 27, 2014, aerial raptor nesting survey performed by NWC (NWC 2014). Within ten meters of the active ferruginous hawk nest, there was an inactive alternate nest. There were also two older inactive nests built by ferruginous hawks approximately two and three kilometers to the northeast and east-northeast of the active nest. These nests likely represented a separate ferruginous hawk breeding territory from the past. The ferruginous hawk is a BLM Sensitive species. Three active common raven nests were also located during the aerial survey. These nests could be used in future years by raptors, especially by great horned owl (*Bubo virginianus*) or prairie falcon, both of which will use stick nests constructed by other species. There were two other inactive stick nests (besides those of ferruginous hawk) identified during the aerial survey.

Raptor nest surveys were flown within the Two-Mile Buffer Study Area on April 21 and 28, 2017, in conjunction with the greater sage-grouse lek surveys. Potential nesting sites for raptors were surveyed from 100 feet to 350 feet from the aircraft. Nest site transect routes were flown along likely habitat on rock outcroppings, cliff faces, trees, and powerline structures. No occupied raptor nests were recorded during the aerial survey. A single red-tailed hawk was observed on two occasions during the surveys south of Grassy Mountain along the rimrock. Although there were many perch sites, no nests were found in the area. It is suspected the hawk may be resident of the Owyhee Canyon cliff faces immediately south of Grassy Mountain, as both times the hawk departed the area in the direction of the canyon to the south. A red-tailed hawk was also observed perched on a power transmission pole southeast of the Permit Area.

Seven raptor nests were recorded during the June 21 through 23, 2017, ground surveys. Two stick raptor nests were recorded on a southeast oriented rock outcrop in Sagebrush Gulch: a large raptor nest was approximately 25 feet from the ground on an approximately 35-foot high outcrop; and a small raptor nest is situated east of the larger nest at approximately the same height. No raptors were observed at or near the nests during visits on June 21 and 22, 2017. No evidence of occupancy such as recent whitewash and/or feathers was observed at the larger nest. However, one old pellet, possibly from a red-tailed hawk, as well as a few old bleached rabbit bones were found below the nest. The small raptor nest had abundant whitewash on the rock face below the nest and a few dark downy feathers were visible in sticks above the nest bowl. It is possible a common raven used the nest at one time; however, no raven pellets or feathers were found below the nest. A pair of red-tailed hawks was observed perched and flying near the golden eagle nest OR GE 1327. The birds were observed in courtship behavior during the May 27, 2017, survey. Numerous perch sites were found on several rocks and sagebrush on the ridge line approximately 750 feet southeast of the nest location with abundant whitewash, molted feathers, and prey remains of rabbits. No further breeding activity at this nest was observed during the June and July 2017 surveys. A female Cooper's hawk (*Accipiter cooperii*) was recorded on June 23, 2017, in the cottonwood trees that surround the pond below Sagebrush Spring. At least three small stick nests were observed in the trees. The hawk gave an alarm call but remained in the cover of the trees while the biologist surveyed the site for sage-grouse broods from approximately 100 meters away. No Cooper's hawks were observed during site visits on July 4 and 5, 2017, and it is unlikely any of the nests were used by Cooper's hawks. On June 22, 2017, an inactive large raptor nest was recorded in a cottonwood tree at No Name Springs. Two adult red-tailed hawks were observed soaring approximately 0.25 mile south of the nest tree. No raptors were observed perched in or near the tree during a one-hour observation period. No sign (e.g., whitewash, scat, feathers, prey remains, pellets) was found below or near the nest. On June 23, 2017, an inactive prairie falcon nest was recorded on a rock outcrop at the south end of Double Mountain. No falcons were observed during a 1.5-hour monitoring session. Molted feathers, old eggshells, and pellets were present beneath the nest ledge. No downy feathers, recent prey remains, or scat, which could suggest use in 2017, were found. Two pairs of rock doves (*Columbia livia*) were nesting in a horizontal ledge in the outcrop. A hive of bees occupied a pothole in the outcrop. Two closed-leghold trap sets were also located along the base of the outcrop.

No burrowing owls (*Athene cunicularia hypugaea*) or burrowing owl nests were found during the three broadcast surveys conducted in 2017. No evidence of burrowing owl presence within the 0.5-Mile Buffer Study Area, such as pellets, feathers, tracks, and scat, were found during surveys conducted for other wildlife species. Potentially suitable breeding habitat is present along the access road in locations dominated by grass and low shrubs. Numerous burrows dug by ground squirrels (*Urocitellus* spp.), badgers (*Taxidea taxus*), and coyotes (*Canis latrans*), which could provide potential nest sites, are found throughout the 0.5-Mile Buffer Study Area.

Observations of raptors and raptor nests were recorded January 25 and February 6, 2018, while flying aerial winter greater sage-grouse (*Centrocercus urophasianus*) surveys in the Two-Mile Buffer Study Area. A red-tailed hawk was observed perched at a large raptor nest in a cottonwood

tree along the Malheur River. A second red-tailed hawk was observed perched at a large raptor nest in a cottonwood tree next to a farmhouse. A pair of ferruginous hawks was recorded at a platform nest in the foothills south of the J H Canal. One bird was perched on the platform and the other bird flushed from the ground near the platform. A ferruginous hawk nest was recorded upslope of Cow Hollow on a low relief rock outcrop approximately ten feet above the ground. A pair of prairie falcons was recorded at the nest identified in 2017 on a rock outcrop at the south end of Double Mountain.

The golden eagle (*Aquila chrysaetos*) nests located and monitored by NWC in the 2014 aerial survey are outside of the Two-Mile Buffer Study Area, and therefore, are not discussed in the baseline wildlife report. An aerial survey was conducted of the Two-Mile Buffer Study Area on April 21 and 28, 2017, in conjunction with the greater sage-grouse lek survey. No occupied golden eagle nests were observed. Golden eagle nest OR GE 1327, which is within the Two-Mile Buffer Study Area, was observed from the ground for a four-hour period on May 27, 2017. A pair of red-tailed hawks was engaged in courtship behavior near the nest, however no golden eagles were observed.

Observations of golden eagles were recorded during the aerial survey for winter use by greater sage-grouse in the Two-Mile Buffer Study Area. Golden eagle nest OR GE 1327 was observed from the air on both January 24 and February 6, 2018; no golden eagles were observed near the nest nor were recent greens present in the nest. Two golden eagle nests were recorded on a pinnacle rock outcrop approximately 0.75-mile upslope of Sagebrush Gulch. An adult golden eagle flushed from the rock outcrop. One nest is approximately 30 feet above the ground while the other nest is approximately 40 feet above the ground on a 60-foot rock outcrop. Both nests are located on ledges. One eagle was observed perched on the outcrop on January 24, 2018, while a pair of eagles was observed at the outcrop during the February 6, 2018, survey. The eagles were variously seen flying together or perched on the outcrop with nests. In addition, observations of four adults and one immature golden eagle were recorded during both the January 24 and February 6, 2018, flights at locations that were not associated with nest sites.

Greater sage-grouse brood-rearing surveys were conducted on June 25, 2013, and July 25, 2013. No sign of use of the Two-Mile Buffer Study Area by greater sage-grouse was detected. No birds were encountered, nor were any feathers, tracks, or scat found. No greater sage-grouse or their sign were encountered during any other field surveys. Scat of this species can persist for many months and even years; therefore, the lack of such sign is indicative of little or no use of the Two-Mile Buffer Study Area by this species in recent years. Winter use surveys were conducted on December 20, 2013, and January 14 and 15, 2014; the latter were done under ideal conditions, clear days with a covering of snow on the ground. No sign of use of the survey area by greater sage-grouse was detected. No birds were encountered, nor were any feathers, tracks, or scat found. No known greater sage-grouse leks are known to exist within the Two-Mile Buffer Study Area (Milburn 2014). No sign of this species was found during any surveys prior to the April 2014 lekking season; therefore, there were no areas of potential concentration to be checked for leks. Listening for drumming males during the hour before and after sunset (on April 10 and April 28, 2014) yielded no detections of greater sage-grouse or their leks.

No sage-grouse hens and chicks or evidence of sage-grouse presence (e.g., scat, tracks, feathers) were found in any of the surveyed spring locations during the June and July 2017 surveys. No greater sage-grouse were detected during the two aerial winter-use surveys in January and February 2018. No leks were found during ten hours of aerial transect surveys in April 2017.

No potentially suitable pygmy rabbit (*Brachylagus idahoensis*) habitat was identified within the 0.5-Mile Buffer Study Area. The most nearly suitable areas were surveyed on November 26, 2013, and May 30, 2014. No pygmy rabbits or their sign (scat or burrows) were detected. No pygmy rabbits or their sign were detected during any of the other surveys conducted within the Two-Mile Buffer Study Area. No potentially suitable white-tailed jackrabbit (*Lepus townsendii*) habitat was identified within the 0.5-Mile Buffer Study Area. The most nearly suitable areas were surveyed on November 26, 2013, and May 30, 2014. No white-tailed jackrabbits were encountered, and all jackrabbit pellets found were in habitat more characteristic of the widespread congeneric black-tailed jackrabbit. No white-tailed jackrabbits were detected during any of the surveys conducted within Two-Mile Buffer Study Area.

No pygmy rabbits or their sign (e.g., burrows, scat, tracks) were found in the 0.5-Mile Buffer Study Area along the access road during the May and July 2017 surveys. Potentially suitable habitat is present in the extensive patch of sagebrush that extends from DM Spring south approximately 2.5 miles. Within this area, surveys focused on patches of sagebrush that were uneven in height and density and in drainages. The sagebrush habitat in the other mapped patches lacks the shrub density and canopy cover characteristic of occupied pygmy rabbit habitat as described by Ulmschneider et al. (2004). Small scats produced by juvenile cottontail (*Sylvilagus nuttallii*) rabbits in summer can be similar in size to those of pygmy rabbits. To confirm species attribution of these scats, three samples were collected and submitted for species identification via DNA analysis to the University of Idaho Laboratory for Ecological, Evolutionary and Conservation Genetics. The scats were from mountain cottontails, not pygmy rabbits. During the 2017 surveys, no white-tailed jackrabbits were observed in any of the survey areas. The large lagomorph scats found were typical of black-tailed jackrabbit (*Lepus americanus*) not the larger scats produced by white-tailed jackrabbits. This species can also be readily observed during aerial surveys, but none were detected during the low-elevation 2018 winter aerial surveys conducted for sage-grouse. Potential habitat is present in the sagebrush steppe habitat in the southern portion of the 0.5-Mile Buffer Study Area along the access road.

No caves or mine adits were found during the 2013-2014 field surveys, and no areas with potential to concentrate bat roosting or maternal colonies were identified within the Permit Area. Bat detectors were operational from before sunset to after sunrise at each of the five locations during a total of 21 nights between June 24 and October 25, 2013, and between April 8 and May 30, 2014. Ten species of bats were detected over the course of the study. Small-footed myotis (*Myotis ciliolabrum*) appears to be present near the Permit Area from at least April through September. Canyon bat (*Parastrellus merican*) and California myotis (*Myotis californicus*) are also likely present in the Permit Area through a majority of the survey season, with the latter having a slightly more protracted period of presence. Silver-haired bat (*Lasiomycteris noctivagans*) appears to move through the area during spring and late summer migration with

some regularity. The other species detected are uncommon or rare, with the possible exception of pallid bat (*Antrozous pallidus*), for which there were detections at three locations and on several nights in July and August 2013.

Three bat species were detected during the 2017 acoustic surveys: California myotis; small-footed myotis; and silver-haired bat. Three of the six survey locations did not have any recordings. All equipment was working. Fewer species were detected in 2017 as compared to 2014 likely due to only five survey nights. In addition, the 0.5-Mile Buffer Study Area along the access road provides little structural diversity that can provide day-roosting habitat for bats. No adits, shafts, or caves were found. Potential day-roosting habitat consists of a few rock outcrops and the deciduous trees at DM Spring. The three sites with recordings had water that probably attracted bats for foraging and drinking.

Wildlife species and habitats occurring within and adjacent to the 0.5-Mile Buffer Study Area are consistent with desert areas of the Great Basin and consist of desert-rangeland type habitat where sagebrush and grasses are the dominant species. Mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*) are present in the 0.5-Mile Buffer Study Area year-round, but in low densities. ODFW-designated mule deer winter range is bisected by approximately five miles of the north end of the Permit Area. There is no other big game winter range that intersects the Permit Area (ODFW 2015). During the NWC surveys in 2014, the largest herds of mule deer and pronghorn antelope were observed at the northern end of the Permit Area along the access road where they presumably feed in the alfalfa fields. During the 2017 EMS surveys, mule deer and pronghorn antelope were observed primarily in the vicinity of springs. Elk (*Cervus canadensis*) scat was noted in a few locations near springs and one bull elk was observed near an unnamed spring east of Sagebrush Gulch. During the 2018 aerial winter sage-grouse surveys, groups of mule deer were recorded throughout the Two-Mile Buffer Study Area while a herd of 30 pronghorn antelope was observed in Cow Hollow. No elk were observed.

Use of the 0.5-Mile Buffer Study Area is low by water-dependent species, such as the migratory waterfowl and shorebirds that travel within the Pacific Flyway. Lake Owyhee, located six miles to the southeast of the site, attracts several species of migrating waterfowl, shorebirds, and passerines. Many of these birds cross the 0.5-Mile Buffer Study Area in transit. Sagebrush-dependent species, like sage sparrow, occur in the 0.5-Mile Buffer Study Area, but in low numbers due to the high degree of disturbance to the existing habitat and the dominance of cheatgrass. Raptor use is common.

During the NWC surveys, the Pacific chorus frog (*Pseudacris regilla*) was detected numerous times at the single pond within the Permit Area and at DM Spring. The sagebrush lizard (*Sceloporus graciosus*) and western fence lizard (*Sceloporus occidentalis*) were generally associated with small rock outcrops, like those at Small Avian Plots 1 through 3. The long-nosed leopard lizard (*Gambelia wislizenii*), Great Basin collared lizard (*Crotaphytus bicinctores*), western whiptail (*Cnemidophorus tigris*), desert horned lizard (*Phrynosoma platyrhinos*), and pygmy short-horned lizard (*Phrynosoma douglasi*) were encountered primarily in sagebrush shrub steppe and in sandy soil types.

Ground squirrels, especially Merriam's (*Urocitellus canus*), were extremely abundant in the 0.5-Mile Buffer Study Area. They provide an important source of prey for the raptor species that breed in the area. Both badger and coyote were present; these species prey on the abundant ground squirrels, create their own burrows and expand those of their prey, and provide potential burrows for burrowing owls and other wildlife. A bobcat (*Lynx rufus*) was encountered on one occasion during the NWC survey, and tracks were found during winter surveys. Porcupines (*Erethizon dorsatum*) were observed in several locations within the 0.5-Mile Buffer Study Area.

3 OPERATING PLANS

3.1 Proposed Operations

Calico proposes to construct, operate, reclaim, and close an underground mining and precious metal milling operation known as the Grassy Mountain Mine (Project).

In general, the proposed mining and precious metal processing operations will consist of an underground mine and ore processing facilities, including a conventional mill and tailings storage facility (TSF), and a waste rock storage area, as well as other support facilities. The Project will include the following major components (Figure 6):

- One underground mine;
- One waste rock storage area;
- One carbon-in-leach (CIL) processing plant;
- One borrow pit area;
- One TSF;
- Run-of-mine (ROM) ore stockpile;
- One reclaim pond;
- A water supply well field and pipeline, associated water delivery pipelines, and power;
- A power substation and distribution system;
- One ventilation shaft;
- Access and haul roads;
- Ancillary facilities that include the following: haul, secondary, and exploration roads; truck workshop; warehouse; stormwater diversions; sediment control basins; reagent and fuel storage; storage and laydown yards; explosive magazines; fresh water storage; monitoring wells; meteorological station, an administration/security building; borrow area; growth media stockpiles; and solid and hazardous waste management facilities to manage wastes; and
- Reclamation and closure, including the use of the reclaim pond as an Evaporation Cell (E-Cell) during the TSF closure.

Calico proposes to mine approximately three million tons (mtons) of mill-grade ore and 0.2 mtons of waste rock (total of 3.2 mtons). The material (both ore and waste) will be extracted from the underground mine using conventional underground mining techniques of drilling, blasting, mucking, loading, and hauling. Calico will use hydraulic loaders to load the ore and waste into the haul trucks. The haul trucks will transport the waste rock to the waste rock disposal areas near the TSF and transport the ore to the ROM stockpile adjacent to the crushing and milling facilities. The ore will be leached in a CIL processing plant to recover the precious metals into a “pregnant” leach solution. The pregnant solution will then be processed for metal recovery and further off-site refining. Exploration activities, expected to disturb up to ten acres, will occur within the Project Area.

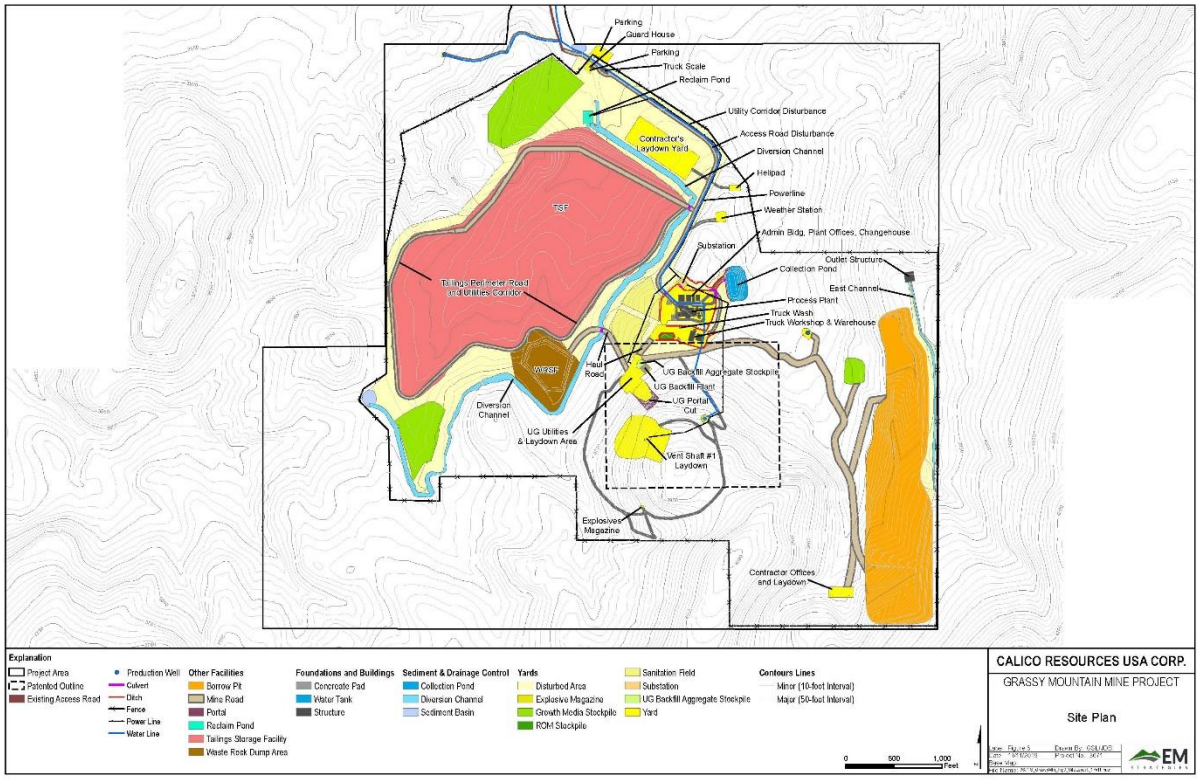


Figure 6. Grassy Mountain Site Arrangement

3.1.1 Estimated Disturbance Acreage

The Project would result in approximately 320 acres of proposed surface disturbance for the planned underground mine, process plant, waste rock storage, tailings storage, ore stockpile, water-well sites and distribution system, electrical power substation and distribution system, ancillary facilities, reclamation, and closure. Table 54 describes the proposed surface disturbance, by disturbance component, for the Project.

Table 54. Proposed Surface Disturbance for the Grassy Mountain Mine

Component	Public Acres	Private Acres	Total Acres
Portal Area	0.0	0.5	0.5
Waste Rock Storage Area	8.4	0.0	8.4
Tailings Storage Facility (TSF)	99.2	0.0	99.2
Process/Administration Area[1]	6.5	0.7	7.2
Laydown/Yard Areas	65.5	8.2	73.7
Roads	21.6	3.3	24.9
Water Tank	0.0	0.1	0.1
Water Wells and Water Pipeline[2]	6.5	0.6	7.1
Fence[3]	15.5	0.0	15.5

Component	Public Acres	Private Acres	Total Acres
Borrow Area[4]	42.9	0.0	42.9
Diversion Ditches and Sediment Basins	11.9	0.0	11.9
Growth Media Stockpiles	18.2	0.0	18.2
Exploration[5]	5.0	5.0	10.0
Total	**301.2**	**18.4**	**319.6**

[1]This includes the mill, refining plant, administrative building, parking lot, security building, mining contractor yard, reagent storage, assay laboratory, and substation.
[2]Includes the water supply pipeline at 16,164 feet with a 15-foot construction disturbance width and well locations each at 0.25 acre.
[3]Includes the perimeter fence at 22,358 feet with a 30-foot construction disturbance width.
[4]The aggregate quarry application (Appendix V of the Consolidated Permit Application) has an acreage value of 50 acres, which includes diversion structures, yards, and a growth media stockpile. These features, excluding the Borrow Area, are accounted in other categories in this table.
[5]The actual location of the exploration activities within the Project Area is currently unknown and is assumed to be equally on public and private lands.

3.1.2 Operational Timeframes

The proposed Project will be active for approximately 14 years, which includes two years of pre-production and nine years of mining and processing. Three years of closure and reclamation are estimated with several years beyond anticipated for groundwater monitoring. This schedule may be modified based on the rate of mining and future commodities prices. Table 55 and Figure 7, respectively, show detailed schedules.

Table 55. Development Schedule

Development Type	Units	Pre-Prod -2	Pre-Prod -1	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Total
Main Decline	K Feet	1.3	4.4	1.5	-	-	-	-	-	-	-	-	7.3
Vent Drift	K Feet	0.1	1.1	1.5	-	-	-	-	-	-	-	-	2.6
Level Access	K Feet	-	-	0.5	0.4	0.2	0.4	0.4	0.4	0.5	0.5	-	3.2
Level Development Waste	K Feet	-	-	2.1	1.5	1.0	1.4	2.1	3.0	2.1	0.3	-	13.4
Level Development Ore	K Feet	-	0.1	11.9	0.3	-	-	-	-	-	-	-	12.2
Vent Shaft	K Feet	-	1.0	0.5	-	-	-	-	-	-	-	-	1.5
Total Development	K Feet	1.4	6.6	18.0	2.2	1.1	1.7	2.4	3.3	2.7	0.8	-	40.2

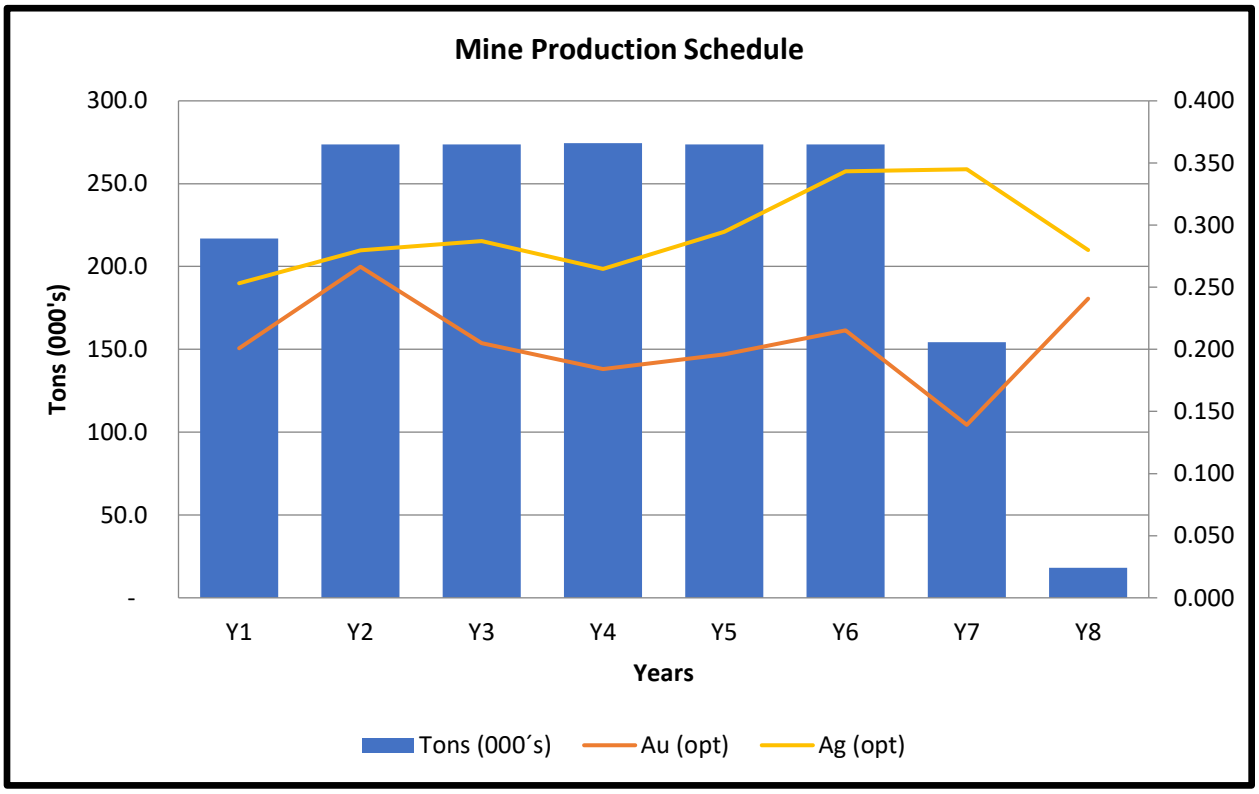


Figure 7. Mine Production Schedule

3.1.3 Work Force

Personnel requirements for the LOM are shown in Figure 8, which includes the mine, process facility, administration, security, and Health, Safety, and Environmental Compliance (HSEC). The administrative personnel shift system is planned to be five days on and two days off, at ten hours per day. Production-related mining personnel (operators, fitters, electricians, and assistants) will work a shift system of four days on and three days off in two teams. Each team will work 12 hours per day so the mine can operate 24 hours per day, four days per week. Processing will work 24 hours per day, seven days a week. Some personnel may work additional overtime through weekends for care-and-maintenance requirements, as needed. The operating calendar is based on 360 operating days per year.

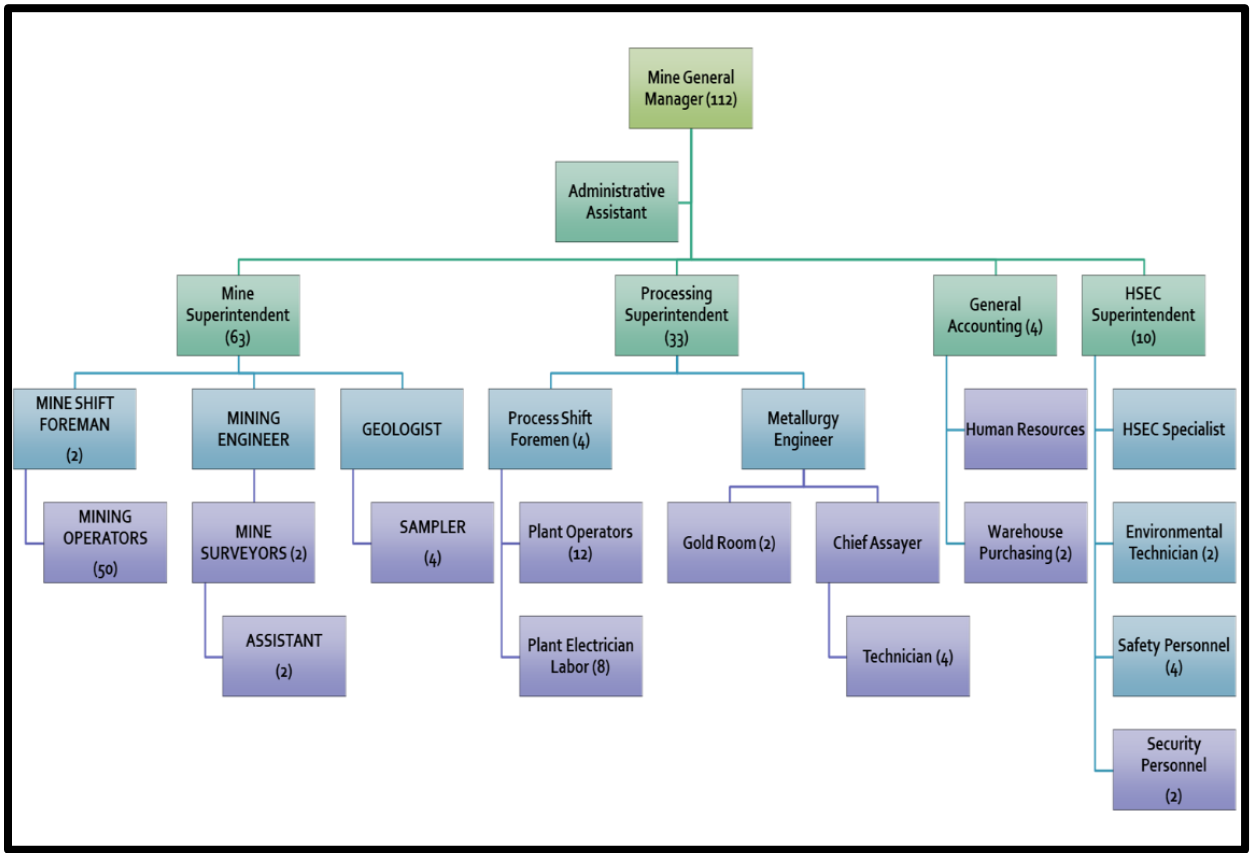


Figure 8. Mine Organization Chart

3.1.4 Local Hire Policy

Calico plans to implement a proactive community involvement and consultation process including: 1) local-hire preference; 2) local contracting and purchasing where practicable; and 3) mine-worker job training to provide an experienced workforce.

Mining and milling jobs are expected to be sourced to local communities where possible, with limited relocation to supply the expertise reinforcing the local experience level. Calico also has plans to further partnerships with local community colleges and vocational schools whereby "mining expertise" can be developed through "partnership curriculums." These partnerships are likely to include Treasure Valley Community College in Ontario, Eastern Oregon University in LaGrande, and the College of Western Idaho in Boise. The Project will employ approximately 100 people.

The Project will create many jobs within Malheur County. This would enable economic development during the one-year construction period and the estimated ten-year mine life. Currently, Malheur County is the poorest County in Oregon with an unemployment rate of 10.7 percent and a recent job growth rate of -2.10 percent. The economy of the County would increase with the new high-paying jobs provided by Calico. Workers will commute daily to the

Project from surrounding towns. Calico will also provide a daily bus shuttle service from Vale designed to limit the number of personal vehicles traveling to the work site.

3.2 Project Access Road

To provide for employee and public safety, Calico plans to control access at both the mine area and the processing plant, as well as the Permit Area in general. This would be accomplished by fencing, gating, and upgrading the existing public access from the existing Twin Springs Road.

The main access road to Grassy Mountain will utilize an existing BLM road to the site and a County right-of-way (ROW) across private land. This road is approximately 17 miles long and will need to be upgraded to include some straightening and widening in portions and have a gravel roadbed. The location and land status of the road is shown in Figure 2 in Section 1.6 and Figure 9 below.

The Road Design Report (Appendix AC) includes improvements, realignments where necessary, culvert size and location, and cross sections along the alignment. A drainage analysis was also performed to assess drainage patterns and to determine the adequacy of culverts and propose upgrades where necessary. Access road specifications are included in Section 3.2.1. This Project access road will be maintained by Calico during the mine operations and roadbed water, as needed, and grading as necessary to maintain the designed condition of the roadbed.

3.2.1 Road Design

HDR, an engineering firm in Boise, Idaho completed the design for the road alignment and provided general road profiles (Appendix AC). The road design conforms to BLM Gold Book standards and the American Association of State Highway and Transportation Official's (AASHTO) manual Geometric Design of Very Low-Volume Local Roads (average daily trips [ADT]<=400). The area type is rural, the total roadway width is 24 feet (includes travel lanes and shoulders) and the speed limit will be 35 mph. All design details are included in the Road Design Report in Appendix AC.

Lidar survey data was processed to create an existing ground model, which was then evaluated, and field reviewed to assure width, slope, ditches and culvert locations/sizes were adequate. Wherever the design model deviated from the existing roadbed, changes were proposed in design (Appendix AC).

An aggregate source located on private property has been identified, although other public sources may also be available.

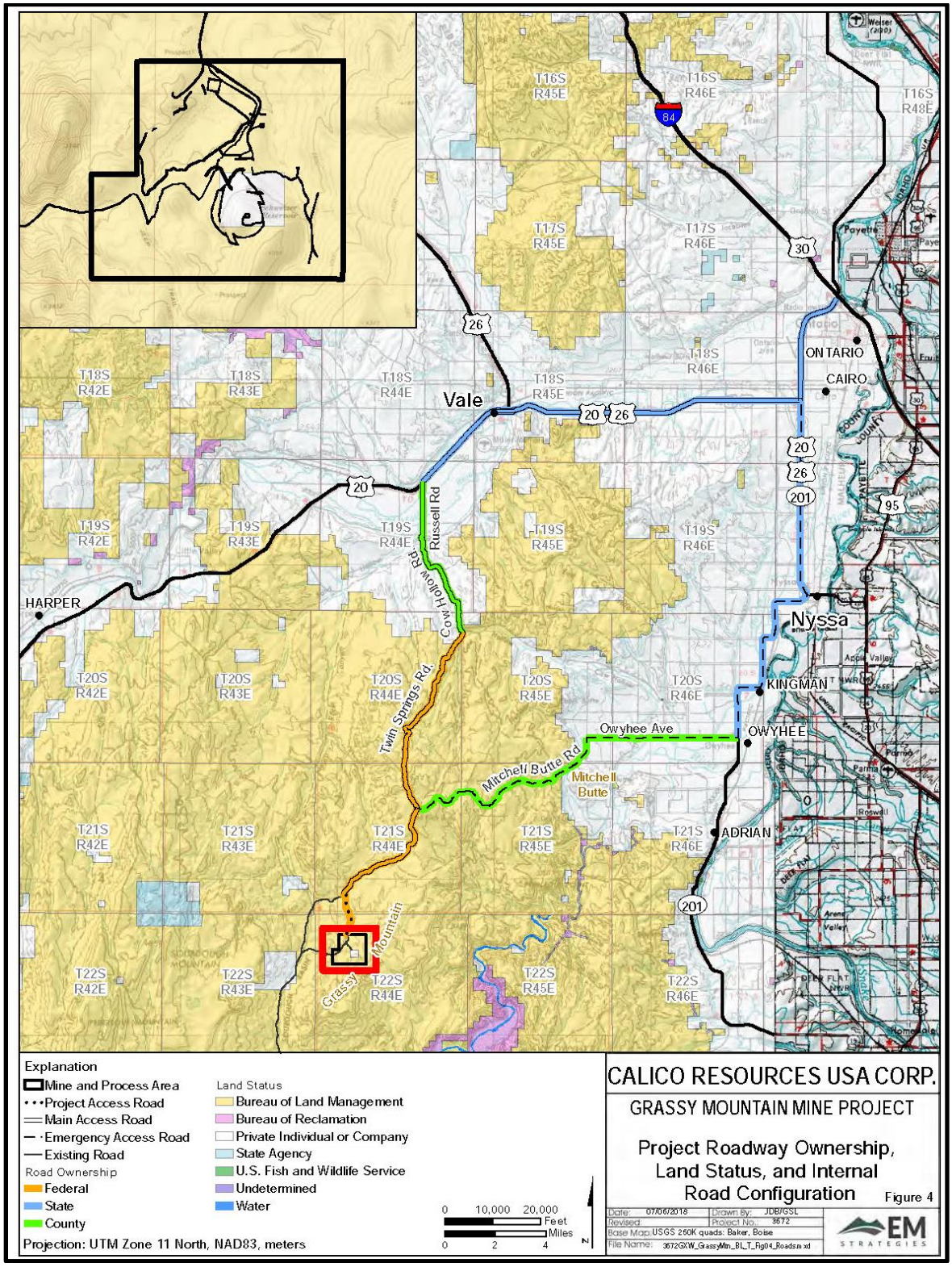


Figure 9. Grassy Road Land Status

Table 56. Selected Access Road Specifications

Item	Criteria
Design Speed	35 mph
Travelway	20 ft
Shoulder Width	2 ft each side
Ditches	2:1 Cut Slope
ADT	<100
Design Vehicle	WB-67
Design Load	HS-20
Maximum Curve Radius	460 ft
Maximum Grade	8% (except pitch grades not exceeding 300 ft in length and 10% in grade
Stopping Sight Distance	170 ft

3.2.2 Operation and Maintenance

It is expected that seasonal road maintenance will be sufficient to provide access to the site for all personnel and any deliveries related to the mine site. Mining and exploration activities can be conducted year-round.

This Project access road will be maintained by Calico during the mine operations and water will be used on the roadbed, as needed for dust suppression. The road will be graded, as necessary, to maintain the designed condition of the roadbed.

3.3 Mining Operation

Extraction of the Grassy Mountain estimated mineral reserves is planned via a proposed underground mine that will be accessed via one decline and a system of internal ramps as shown in Figure 10. One shaft is planned for exhaust ventilation and secondary egress. The planned mining method is D&F using diesel-powered mining equipment. CRF and uncemented RF will be used for backfill of the production drifts and level access to prevent any subsidence.

The mine design is based on a production rate of 1,300 to 1,400 tons per day over four days per week, with two shifts per day. This is intended to provide sufficient material to feed the mill at a rate of 750 tons per day on a seven day per week basis. The underground production schedule is discussed in Section 3.3.11.

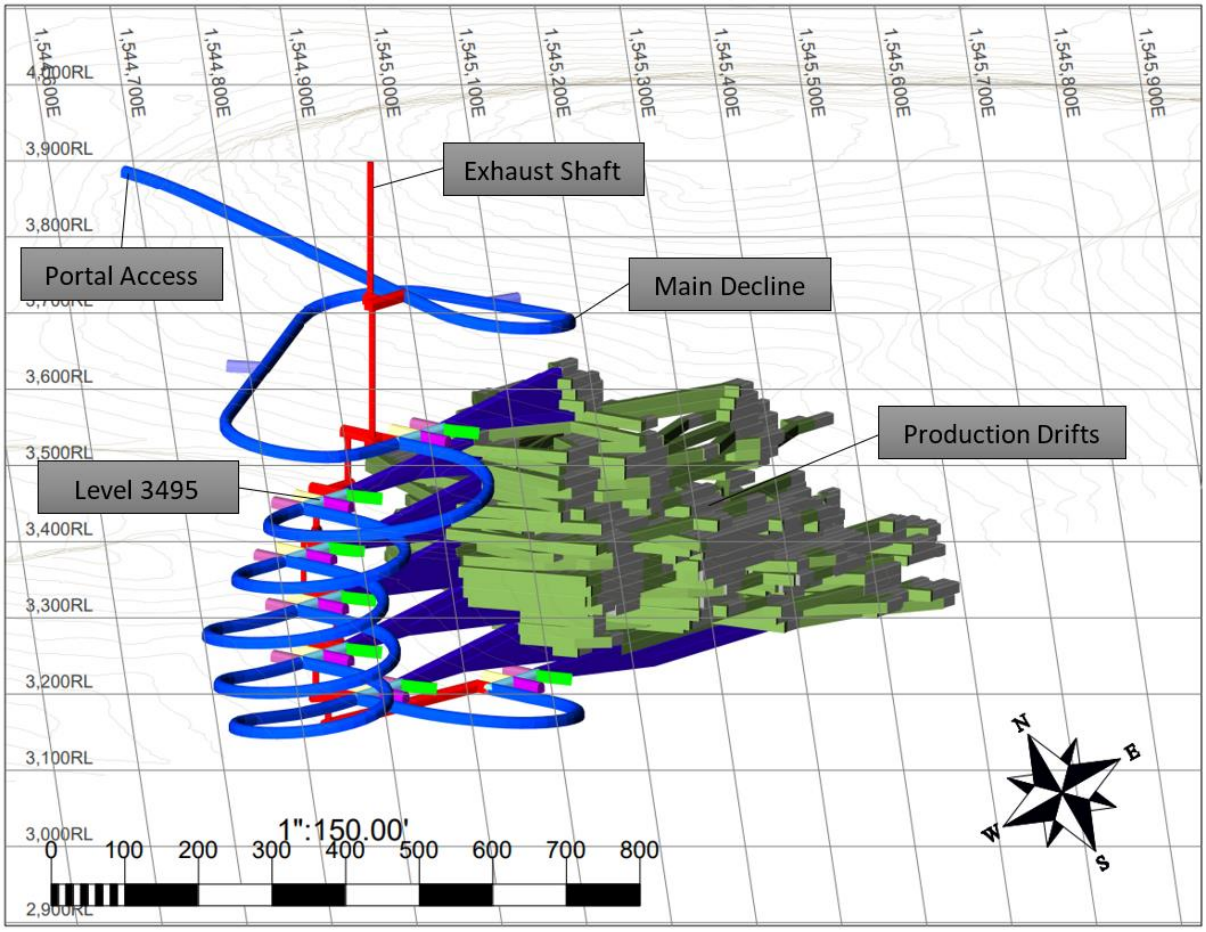


Figure 10. Isometric View of Grassy Mountain Mine

Nominal development sizes of 15 feet wide by 15 feet high are planned for the main decline. All production drifts will be 15 feet high and will have three different width sizes that include 15 feet, 20 feet, and 30 feet wide. Production drifts will vary in width depending on ground conditions and ground support. These production drift sizes will allow the miners and associated mining equipment access and flexibility to maximize production from the mine, as well as minimize waste haulage from the development headings.

According to the analysis conducted by Ausenco, the majority of the ground conditions within the Grassy Mountain deposit are classified as being of fair to poor rock quality, and the rock mass rating (RMR) is typically less than 49. Ground support was designed to maintain a safe operation for these ground conditions.

The mining cycle involves drilling, blasting, and mucking for the development and production drifts. This will be followed by reinforcement and ground support for safe operation, and finally backfill of the production drifts.

Mining Equipment to be used for the Grassy Mountain underground mine is specified in Section 3.3.3.

3.3.1 Geotechnical Considerations

Miss Allison M. Pyrch, PE, GE Associate Geotechnical Engineer at Hart Crowser Inc, and an Oregon-Certified Engineer, has conducted a high-level overview of the preliminary geotechnical data analysis and underground support recommendations. Miss Pyrch confirms the adequacy of the prefeasibility / preliminary level of design development methodologies and ground support recommendations based on the current information. Additional engineering analyses, supported by a continuing program of geological / geotechnical and hydrogeological exploration, is expected to continue through future design stages and facility operation. As stated by Ms. Pyrch, "*Further, final support and design parameters must be evaluated and re-assessed continuously during mine operation to ensure that the designed and implemented ground support is matched to the encountered ground conditions to ensure stability and more importantly a safe working condition for all personnel entering the mine.*"

3.3.1.1 Geotechnical Characterization

The details of the mining design require the application of empirical methods and geotechnical criteria to classify the rock mass. These details allow for evaluation of the geotechnical variations throughout the deposit, thus defining different geotechnical zones within the deposit. This facilitates the design of all underground excavations.
It is necessary to classify the quality of the rock mass on the basis of its geotechnical attributes in order to obtain uniform zones or units, as follows:

- Identify the parameters that influence the behavior of the rock mass
- To divide the information of the rock mass in groups or classes of similar behavior.
- Provide characteristics and quantitative data for each rock class

There are many different classification systems of rock, the Q (Barton et al. 1974) and the RMR (Bieniawski 1976, 1989) systems are widely used for the construction of tunnels and civil works.

The rock quality designation (RQD) is defined as the percentage of whole pieces greater than or equal to 100 millimeters (mm) in length, Figure 11 shows the procedure for measurement and calculation of RQD and Table 57 shows the rock mass quality based on RQD.

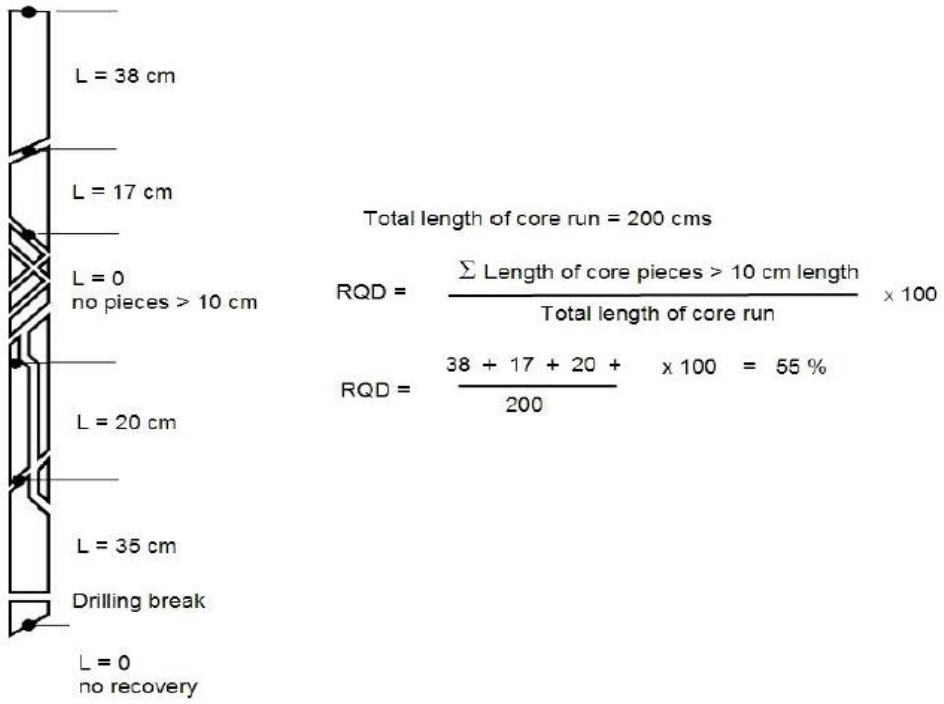


Figure 11. Procedure for Measurement and Calculation of RQD (after Deere 1989)

Table 57. Rock Mass Quality According to RQD

Rock Quality Designation (RQD)	Rock Mass Quality
<25	Very Poor
25 - 50%	Poor
50 - 75<%	Regular
75 – 90%	Good
90 – 100%	Very Good

Source: Practical Rock Engineering 2006.

The RMR was proposed by Z.T. Wieniawski in 1976 and is used to evaluate the rock mass according to its quality, hardness, orientation, spacing, groundwater conditions and orientation of discontinuities.

The application of the RMR system aims to identify the most significant parameters influencing the behavior of a rock mass, divide a particular rock mass formation into a number of rock mass classes of varying quality, provide a basis for understanding engineering design and to derive quantitative factors for engineering design.

The RMR classification includes information on the strength of the intact rock material, the spacing, number and surface properties of the structural discontinuities as well as allowances for the influence of subsurface groundwater, in situ stresses and the orientation and inclination of dominant discontinuities.

The following six (6) parameters are used to classify a rock mass using the RMR system:

- Uniaxial compressive strength of rock material
- RQD
- Spacing of discontinuities
- Condition of discontinuities
- Groundwater conditions
- Orientation of discontinuities

In applying this classification system, the rock mass is divided into a number of structural regions and each region is classified separately. The boundaries of the structural regions usually coincide with a major structural feature such as a fault or with a change in rock type. In some cases, significant changes in discontinuity spacing or characteristics, within the same rock type, may necessitate the division of the rock mass into a number of small structural regions.

The RMR system is presented in Table 58, giving the ratings for each of the six parameters listed above. These ratings are summed to give a value of RMR. The following example illustrates the use of these tables to arrive at an RMR value.

Table 58. Rock Mass Classes Determined from Total Ratings

Rock Mass Classes Determined From Total Ratings					
Rating	100 < 81	80 < 61	60 < 41	40 < 21	< 21
Class Number	I	II	III	IV	V
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock

Source: Practical Rock Engineering.

3.3.1.1.1 Golder Geotechnical Appraisal

A geotechnical appraisal of the proposed underground mine area was carried out by Golder Associates Inc. (Golder) during 2016-2017 (Golder 2018). Geotechnical data are available from three different drilling campaigns that were completed prior to the 2016-2017 drill campaign. Calico, Newmont, and Atlas carried out RQD measurements. Additional geotechnical data from the Newmont and Calico drilling were reviewed, but not used directly in Golder´s 2016-2017 evaluation, due to uncertain reliability and consistency in the data. Table 59 shows the drill holes used in the Golder appraisal.

Table 59. Geotechnical Drill Hole Investigation

Company	Year	Number of Geotechnical Drill Holes	Information Considered	Other Geotechnical Information
Calico	2011	2	RQD	None
Newmont	1992	13	RQD, core photographs in splits	Recovery, fracture, frequency, joint condition rating (JCR), hardness, rock strength, underground rock mass ratings (URMR)
Atlas	1986-1992	6	RQD	Recovery, weathering, breakage, hardness, bedding, joints
Paramount	2016-2017	27	RMR	RQD, fractures, International Society for Rock Mechanics (ISRM) strength rating, weathering index, JCR

The 2016-2017 drilling campaign included 27 core holes of HQ3-diameter (2 3/8-inch diameter) drilled using a triple-tube core barrel to maximize core recovery. Two holes were logged in detail for geotechnical characterization by Golder personnel at the drill rig. The other 2016-2017 holes were logged by Calico personnel according to Golder's instructions and procedures. Drill Holes Collar Locations (2016-2017) (Figure 12) shows the locations of the two Paramount geotechnical hole collars within an approximate 0.075 oz Au/ton cut-off boundary.

Golder utilized the Paramount and Golder geotechnical log data to characterize the orebody and surrounding rock mass based on a calculation of RMR from the logged data. Figure 13 (The Golder Rock Mass Rating, all 2016-2017 Core) is the RMR histogram for all core that was geotechnically logged from the 2016-2017 drill campaign. The historical data was not evaluated with the 2016-2017 campaign because the historical logging of RQD data is not comparable with the RMR logging during the 2016-2017 campaign.

The Golder review of the 2016-2017 drill core indicated the presence of a significant number of zones of broken rock fragments within what Golder termed "a matrix of soil" and referred to as "Soil Matrix Breccia." These zones are more correctly referred to as "clay matrix breccia" as described in detail in the "Preliminary Feasibility Study and Technical Report for The Grassy Mountain Gold and Silver Project" (MDA 2018). The clay matrix breccia is readily observed in core in split tubes immediately after drilling, but it is also clearly identifiable after the core has been boxed and somewhat disturbed.

The geological and geotechnical data did not identify any trends or patterns that would allow the delineation of rock quality domains for mine design, with the exception of very poor-quality rock encountered in and around the interpreted subvertical structures. However, very poor-quality rock is not limited to the vicinity of the structures, it is also frequently observed between

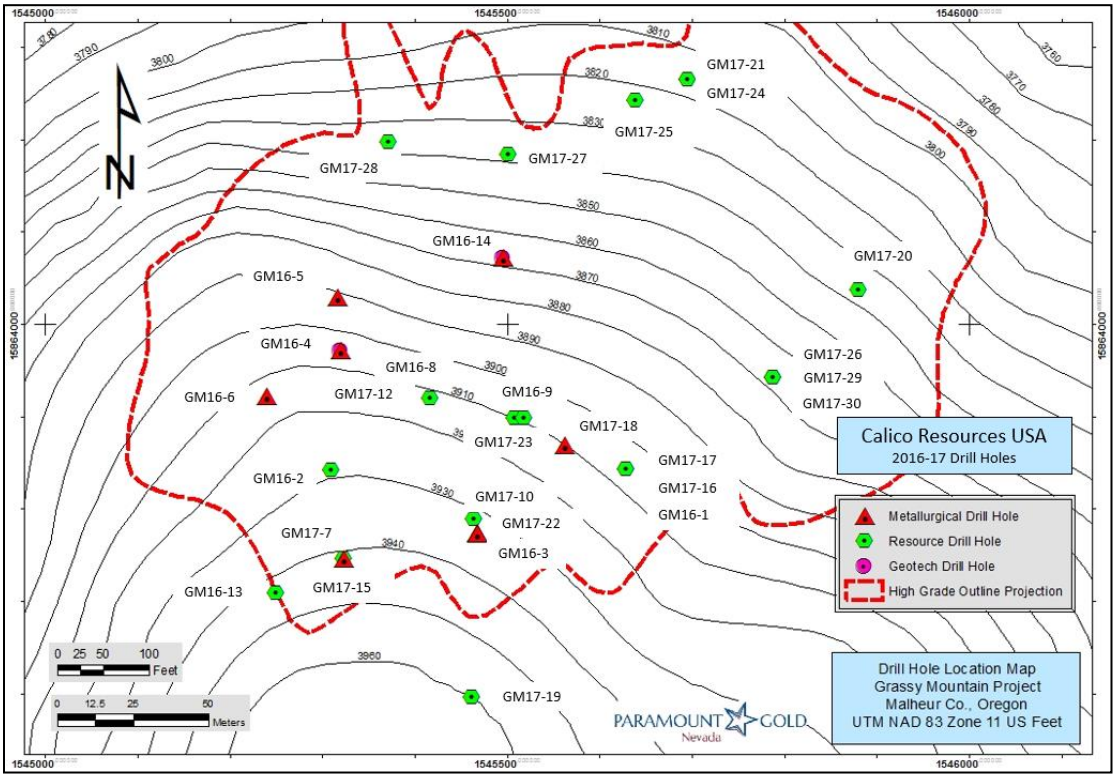
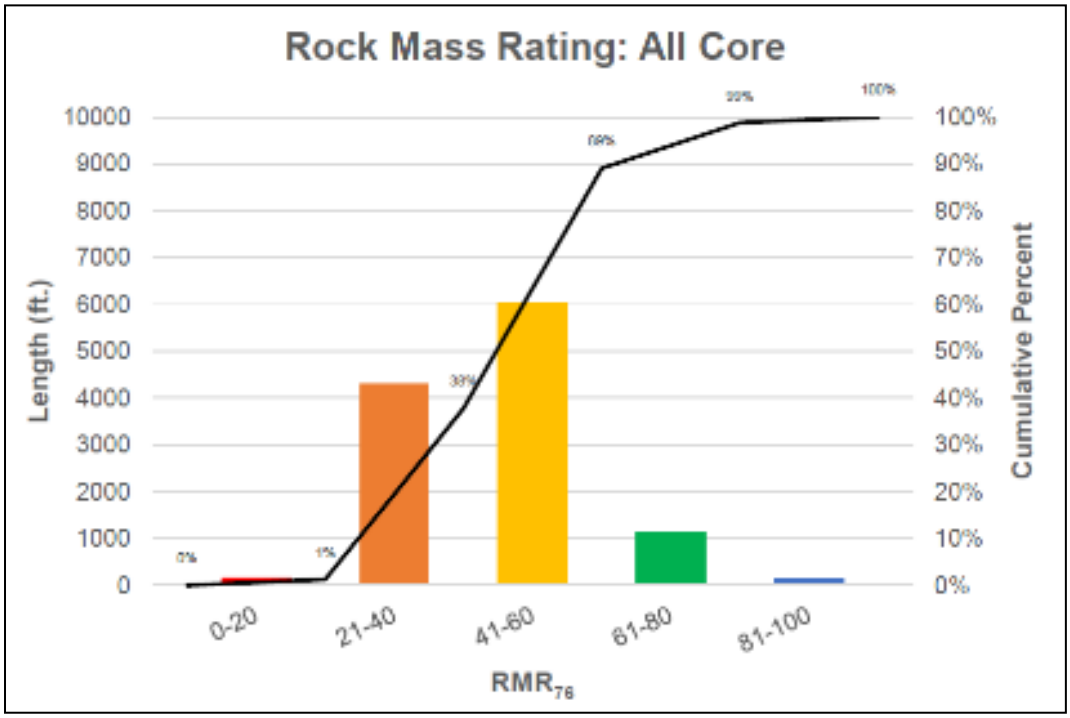


Figure 12. **Drill Holes Collar Locations (2016 - 2017)**



Source: Golder 2018

Figure 13. Golder Rock Mass Rating, All 2016-2017 Core

structures. Therefore, this degree of variability will require a selective mining method that can quickly respond to changing ground conditions.

Golder concluded that, in the absence of spatial patterns in rock quality, three categories of rock quality should be used for PFS-level design and cost estimating purposes. Table 60 (The Rock Quality Categories, modified after Golder 2017) shows the three rock quality categories applied to the design of the Grassy Mountain underground mine workings.

Table 60. Rock Quality Categories, Modified from Golder 2017

Rock Quality Category	Description	Approximate Expected Percent of Excavations(a)
Type I	Moderately fractured rock	20%
Type II	Poor quality, highly fractured rock	40%
Type III	Clay matrix breccia and other very poor-quality rock (clay, broken rock and rubble in core boxes)	40% (15% clay matrix breccia, 25% other poor-quality rock)

Note: based on percent encountered within 2016-2017 drill holes.

3.3.1.1.2 Ausenco 2017 Geotechnical Work

In 2017, Ausenco's geotechnical group, conducted a review of all the available geotechnical information provided by Paramount, including core logs, core photographs, and the work completed by Golder that is summarized above. Ausenco's objectives were to select a mining method and develop support recommendations for underground openings.

Ausenco's geotechnical group reviewed all core photographs from the 2016 - 2017 core drilling campaign and estimated additional geotechnical parameters that were incorporated into the geotechnical review.

In order to characterize the rock mass ore body a statistical analysis was performed on the geotechnical data derived from the core logging by Paramount and Golder staff. This analysis was performed on each hole as well as the 27 drill holes in aggregate. The RMR results are shown in Figure 14 (RMR Histogram from 27 Drill Holes).

Based on the RMR statistics and Ausenco's interpretation and correlation of the RMR data with the geological database, the Grassy Mountain deposit was assigned to three classes of rocks according to geotechnical quality:

- Class 1: Rocks of Poor geotechnical quality according to RMR; approximately 40 percent of the deposit.

- Class 2: Rocks of Regular geotechnical quality according to RMR; approximately 50 percent of the deposit.
- Class 3: Rocks of Good geotechnical quality according to RMR; approximately ten percent of the deposit.

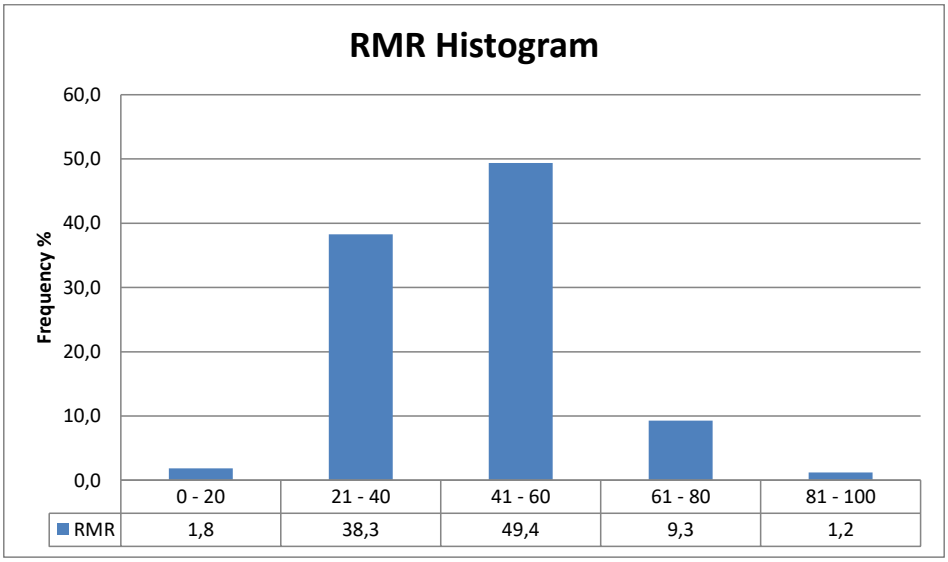


Figure 14. RMR Histogram from 27 Drill Holes

The Ausenco Rock Quality Categories (Table 61) shows the cumulative frequency values based on the RMR Histogram from 27 Drill Holes (Figure 14) with the classes of rocks assigned by Ausenco.

Table 61. Ausenco Rock Quality Categories

Rock Quality (RMR)		Frequency (%)	Rock Class	Deposit (%)
0 - 20	Very Poor	1.8	-	-
20 - 40	Poor	38.3	Class 1	40
40 - 60	Fair	49.4	Class 2	50
60 - 80	Good	9.3	Class 3	10
80 - 100	Very Good	1.2	-	-

The Very Poor and Very Good rock qualities, according to the RMR classification, are not representative of the deposit due to the low frequencies measured, so they were omitted from

the three classes of rock assigned. However, they do exist and should be considered when mining, in particular the very poor quality, as if encounter it may require additional support revision. Examples of the three classes are shown in Figure 15.

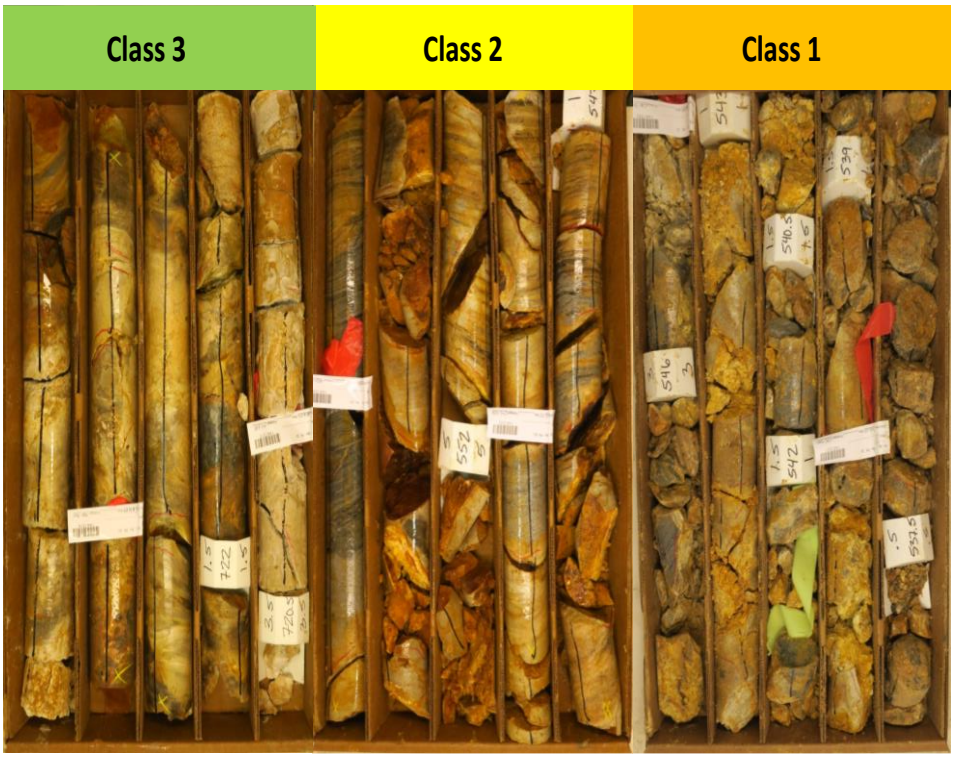


Figure 15. Examples of Three Geotechnical Rock Classes

3.3.1.2 Intact Rock Strength

Physical testing of suitable rock core specimens allows the determination of the mechanical properties of intact rock required for mine design using rock mass classification or numerical analysis methods. The intact rock strength is commonly measured in uniaxial compression, point load, indirect tensile, and triaxial compression tests (Brady and Brown 2004). Usually, a limited (but representative) number of cylindrical specimens of each rock type should be tested for uniaxial compressive strength (UCS) in a suitable laboratory equipped with a stiff testing machine. A larger number of point load tests can be carried out during the core logging process for orebody delineation. A comprehensive set of suggested testing methods has been published by the International Society for Rock Mechanics (ISRM) (Brown 1981; Ulusay and Hudson 2007).

The 2016–2017 drill campaign where Golder´s characterized the rock mass using the RMR system also selected core samples for laboratory testing from six boreholes.
Point load tests (PLT) were carried out by Paramount geologists in the core shed, after geotechnical logging, according to the ASTM Standard D 5731-07: Determination of the Point Load Strength Index of Rocks, and Application to Rock Strength Classifications. PLTs were

performed at approximately ten-foot intervals down hole on the six (6) boreholes, see Table 62 below.

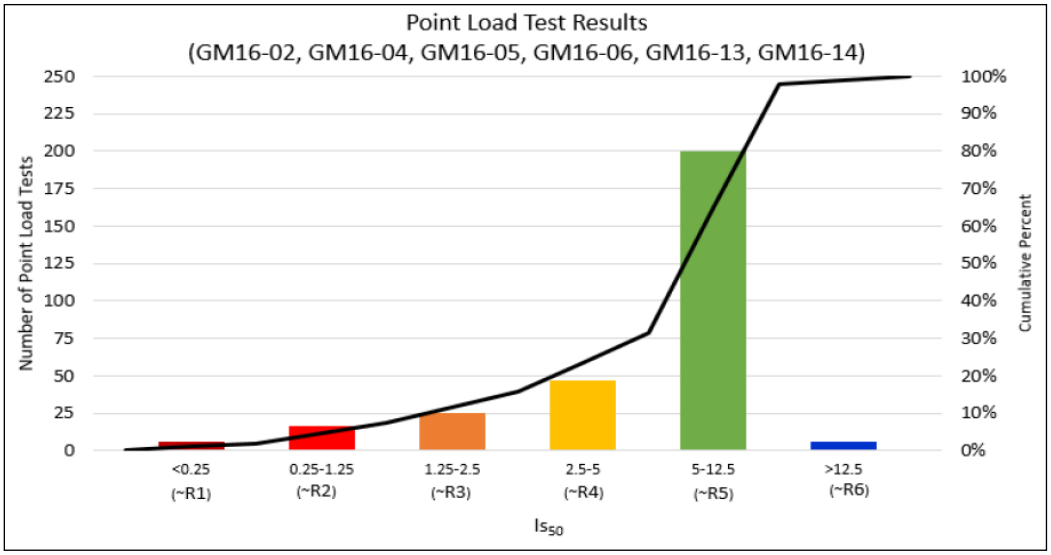
Table 62. Summary of Point Load Testing, Modified from Golder 2017

Hole ID	Number of Point Load Tests
GM16-02	33
GM16-03	41
GM16-04	76
GM16-05	28
GM16-13	46
GM16-14	76

A histogram of Is50 (Is50 is the point load strength with the size of samples corrected; according with ASTM standard D 5731-01 named before) calculated from the point load test results, and the approximate equivalent ISRM field strength is presented in Figure 16. The ISRM field strength grouping are based on the following correlation between UCS and Is50, assumed based on typical correlation value.

$$UCS = 20\ x\ Is50$$

An all point load test was performed at the Vale core shed and are presented together.



Source: Golder, 2018.

Figure 16. Histogram of Point Load Test Results

Rock core samples were collected by Golder personnel from holes GM16-04 and GM16-14 for UCS testing after the core was logged and photographed. Samples were shipped to Golder´s laboratory in Burnaby, British Columbia for UCS testing. UCS tests were only performed on samples from GM16-04 and GM16-14 (Golder, 2018), see Table 63 below.

Table 63. UCS Results Summary, Modified from Golder

N°	Borehole #	Sample #	Depth (ft)	Stress SigmaU (Mpa)	Rock Type	Failure Mode	
						Type	(deg)
1	GM16-04	1	8,0 - 8,8	50,7	Sandstone / Arkose	6	-
2	GM16-04	2	79,5 - 80	64,7	Sandstone / Arkose	1	-
3	GM16-04	3	151,7 - 152,5	119	Sandstone / Arkose	2	-
4	GM16-04	4	212,8 - 213,4	109,2	Siltstone	2	-
5	GM16-04	6	296,2 - 297,0	96,6	Siltstone	2	-
6	GM16-04	7	370,6 - 371,3	139,4	Siltstone	7*	-
7	GM16-04	8	410,0 - 410,8	138	Sandstone / Arkose	2/6	-
8	GM16-04	9	441,0 - 442,0	152,8	Sandstone / Arkose	7*	-
9	GM16-04	11a	563,1 - 564,3	24,4	Sandstone / Arkose	6/7*	-
10	GM16-04	11b	563,1 - 564,3	124,7	Breccia	6*	-
11	GM16-04	12	597,1 - 597,9	40,9	Sandstone / Arkose	6*	-
12	GM16-04	13	652,7 - 653,8	113	Sandstone / Arkose	7*	-
13	GM16-04	16	742,0 - 742,6	2,8	Sandstone / Arkose	1	-
14	GM16-14	1	30,3 - 31,0	16,5	Sandstone / Arkose	5	19
15	GM16-14	3	115,9 - 116,7	123,4	Siltstone	5	25
16	GM16-14	4	167,0 - 167,8	81,5	Siltstone	6	-
17	GM16-14	5	245,5 - 246,1	99,3	Siltstone	6*	-
18	GM16-14	6	306,0 - 306,5	92,7	Siltstone	6*	-
19	GM16-14	7	375,2 - 375,9	118,9	Siltstone	6*	-
20	GM16-14	9	482,8 - 483,4	90,1	Sandstone / Arkose	6	-
21	GM16-14	10	560,6 - 561,3	78,2	Siltstone	6*	-
22	GM16-14	11	597,9 - 598,5	133,8	Sandstone / Arkose	5*	28
23	GM16-14	12	630,7 - 631,3	44,6	Sandstone / Arkose	5	27

Note: Codes for failure mode as follows:
1.- diagonal shear plane(s); 2.- vertical fracture(s); 3.- vertical splitting; 4.- shear along discontinuity; 5.- conical; 6.- spalling; 7.- other.

The following observations have been made with respect to the UCS results:

- Field strength estimates for the intervals that were sampled UCS results for eight out of 23 samples. Where different, the laboratory UCS was generally higher than the field estimate. This is commonly the case for relatively strong rock since it can be difficult to distinguish between an R4 and R5 rock in the field.
- Spalling was the most common mode of failure, with several tests showing signs of high energy spalling prior to failure.

3.3.1.3 Field Estimates of Rock Strength

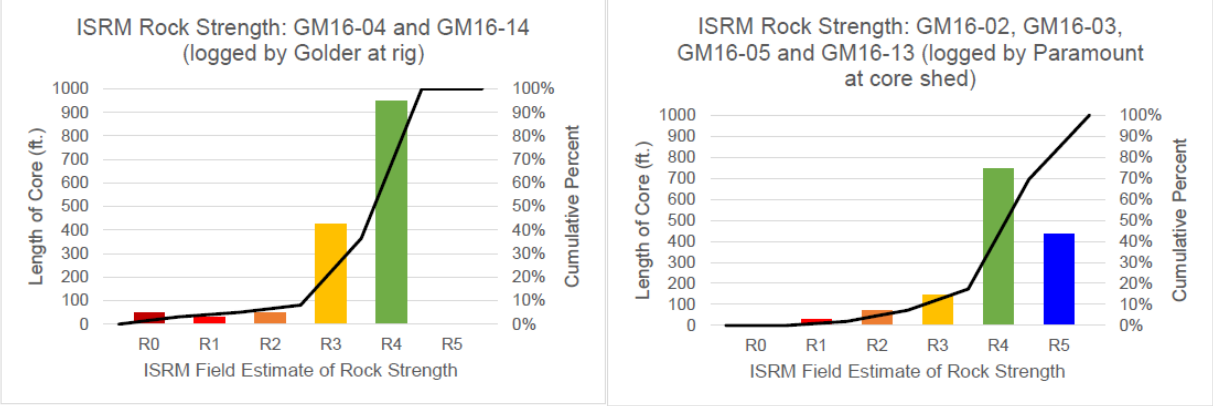
Field estimates of intact rock strength were carried out by Golder and Paramount personnel during core logging. No field strength estimates were assigned to zones of "lost core" or no recovery. The field estimates of intact rock strength are based in the ISRM method (ISRM 1981) summarized in Table 64.

Table 64. Field Estimate of Strength

Grade*	Term	Uniaxial Comp. Strength (MPa)	Point Load Index (MPa)	Field estimate of strength	Examples
R6	Extremely Strong	> 250	>10	Specimen can only be chipped with a geological hammer	Fresh basalt, chert, diabase, gneiss, granite, quartzite
R5	Very strong	100 - 250	4 - 10	Specimen requires many blows of a geological hammer to fracture it	Amphibolite, sandstone, basalt, gabbro, gneiss, granodiorite, limestone, marble, rhyolite, tuff
R4	Strong	50 - 100	2 - 4	Specimen requires more than one blow of a geological hammer to fracture it	Limestone, marble, phyllite, sandstone, schist, shale
R3	Medium strong	25 - 50	1 - 2	Cannot be scraped or peeled with a pocketknife, specimen can be fractured with a single blow from a geological hammer	Claystone, coal, concrete, schist, shale, siltstone
R2	Weak	5 - 25	**	Can be peeled with a pocketknife with difficulty, shallow indentation made by firm blow with point of a geological hammer	Chalk, rocksalt, potash
R1	Very weak	1 - 5	**	Crumbles under firm blows with point of a geological hammer, can be peeled by a pocketknife	Highly weathered or altered rock
R0	Extremely weak	0.25 - 1	**	Indented by thumbnail	Stiff fault gouge

*Grade according to Brown. **Point load test on rocks with a uniaxial compressive strength below 25 MPa are likely to yield ambiguous results. Source: ISRM suggested methods, 1981.

Histograms of the ISRM field estimates of intact rock strength are presented in Figure 17 below. The data for GM16-04 and GM16-14 (detailed logging by Golder personnel at the rig) are plotted separately from the four oles logged by Paramount personnel at the core shed for comparison.



Source: Golder 2018.

Figure 17. Rock Strength – Detailed Core Logging

The distribution of strength from point load test is broadly similar to the field estimated strengths. The absolute magnitude of the UCS based on the Is50 is uncertain since no site-specific correlation exists.

3.3.1.4 Structural Analysis

The purpose of the structural model is to describe the orientation and spatial distribution of the structural defects that are likely to influence the stability of the mine. A structural model for mine design is typically developed at two levels, major structure and structural fabric. This differentiation relates largely to continuity of the features and the resultant impact with respect to the mine design elements. Major faults are likely to be continuous, both along strike and down dip, although they may be relatively widely spaced. Hence, they could be expected to influence the design at the mine scale. On the other hand, the structural fabric typically has limited continuity but close spacing, and therefore becomes a major consideration in stope design scale and development.

3.3.1.4.1 Major Structure and 3D Model

The gold-silver deposit is situated within a zone of complex extensional block faulting and rotation (Figure 18). Faults at Grassy Mountain are dominated by N30°W to N10°E striking normal faults developed during Basin and Range extension and are inferred to have post-mineral displacement. On the east side of the deposit, these faults are inferred to have down-to-the east movement based on interpreted offsets of a prominent white sinter bed in drill holes, as well as drilled intersections of fault gouge. A set of orthogonal, N70°E-striking high-angle faults of minor displacement are inferred to link the graben faults. One of these, the Grassy fault, has vertical

offset of only ten to 40 feet or less, but it coincides with the axis of the high-grade core of the deposit.

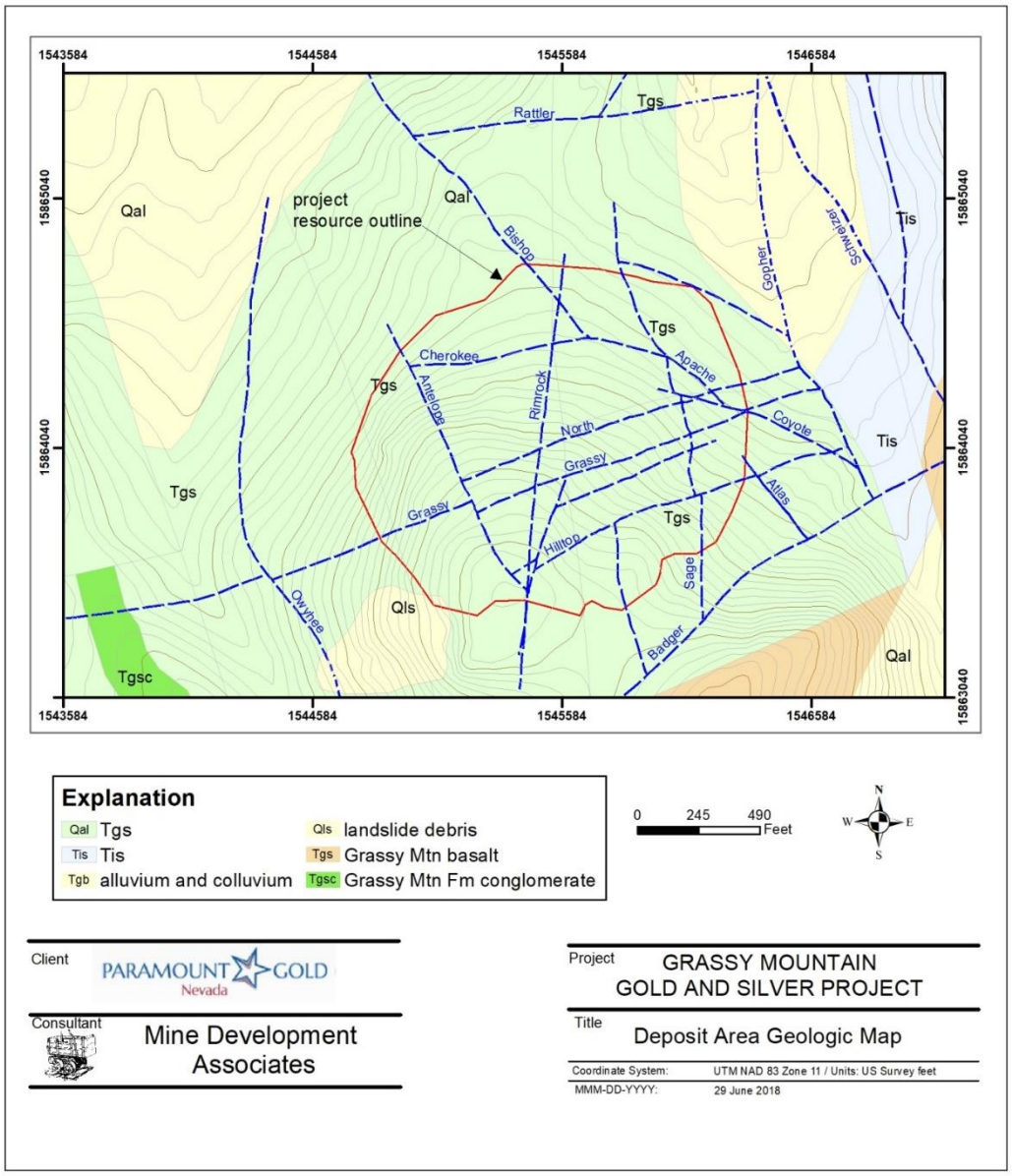


Figure 18. Major Faults in the Deposit Area

3.3.1.4.2 Structural Fabric

The geotechnical holes drilled in the 2016–2017 campaign were drilled with "Triple Tube" techniques to increase core integrity and preservation for best geotechnical logging and measurements. Observations of the core suggest that there is little systematic structure, except for the very steep features often sub-parallel to core axis that are likely oriented similarly to the interpreted northwest-southeast striking structural set that is associated with mineralization. The

remaining structure is typically very small scale, irregular, and generally related to micro-defects within the rock mass.

3.3.1.5 Summary of Geotechnical Analysis and Evaluation for Underground Mining

Ausenco believes the available geotechnical data are adequate for designing the mine openings associated with the estimation of the Grassy Mountain mineral reserves at current stage. Risks associated with the current level of geotechnical analysis are discussed in the PFS (MDA 2018).

While the rock quality is variable, and the deposit is mineable based on the chosen mining method, care will need to be taken during the execution of the mining plan. The selected mining method and underground support recommendations are specified in the PFS (MDA 2018).

3.3.2 Underground Mining Method

Initial surface access to the estimated reserves, which lie at depths between 500 and 700 feet below the surface, will be via a portal and decline. This portal is further described in Section 3.3.8 Mine Access. The decline will be developed from the portal proceeding on an approximately 12 to 14 percent slope down to the lowest mineralized zones. D&F techniques, also known as cut-and-fill, will be used to mine the orebody.

A total of 32 levels, each of 15 feet in height, are in the current mine plan.

The decline will provide the connection to all services. The design intent is to have the decline located as close as possible to the mineralization in order to reduce transportation costs, but sufficiently removed from mining activities to ensure that the decline is geotechnically stable for the planned life of mine. A summary of the mine design dimensions is shown in Table 65.

Table 65. Underground Mine Design Dimensions

Activty Type	Width (ft)	Height (ft)	Diameter (ft)	Length (ft)	Maximum Gradient (%)
Decline	15	15		varies	12 to 14
Level Access	15	15		varies	0 to 14
Ventilation Access	15	15		varies	0
Sump	15	15		50	-12
Stockpile	15	15		50	0
Power Station	15	15		50	0
Loading Bay	15	15		50	0
Production Drifts	15, 20, & 30	15		varies	0
Decline Turning Radius				100	
Ventilation Raise			9		Vertical

Excavated waste rock from the decline construction will be stored on the surface in the WRD area (Section 3.3.4). Other excavations for ventilation would also connect the underground with the surface.

A surface explosive magazine for storage of blasting materials will be constructed according to the Mine Safety and Health Administration (MSHA) and U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives (BATFE) regulations. Blasting agents will include ammonium nitrate and fuel oil (ANFO) and emulsions. An explosives truck will be loaded with blasting agents at the surface explosives magazine. Caps and boosters will be hauled in separate dry boxes.

The D&F mining method was selected using the methodology proposed by Nicholas (1981), taking into account the geometry and the geotechnical conditions of the Grassy Mountain gold deposit. The D&F method is highly flexible and can achieve high recovery rates in deposits with complex and flat-dipping geometries, as is the case at Grassy Mountain. The D&F design proposed for levels 3315, 3300, and 3285 is shown in Figures 19, 20, 21 and 22. Each level plan shows the proposed mine operational layout.

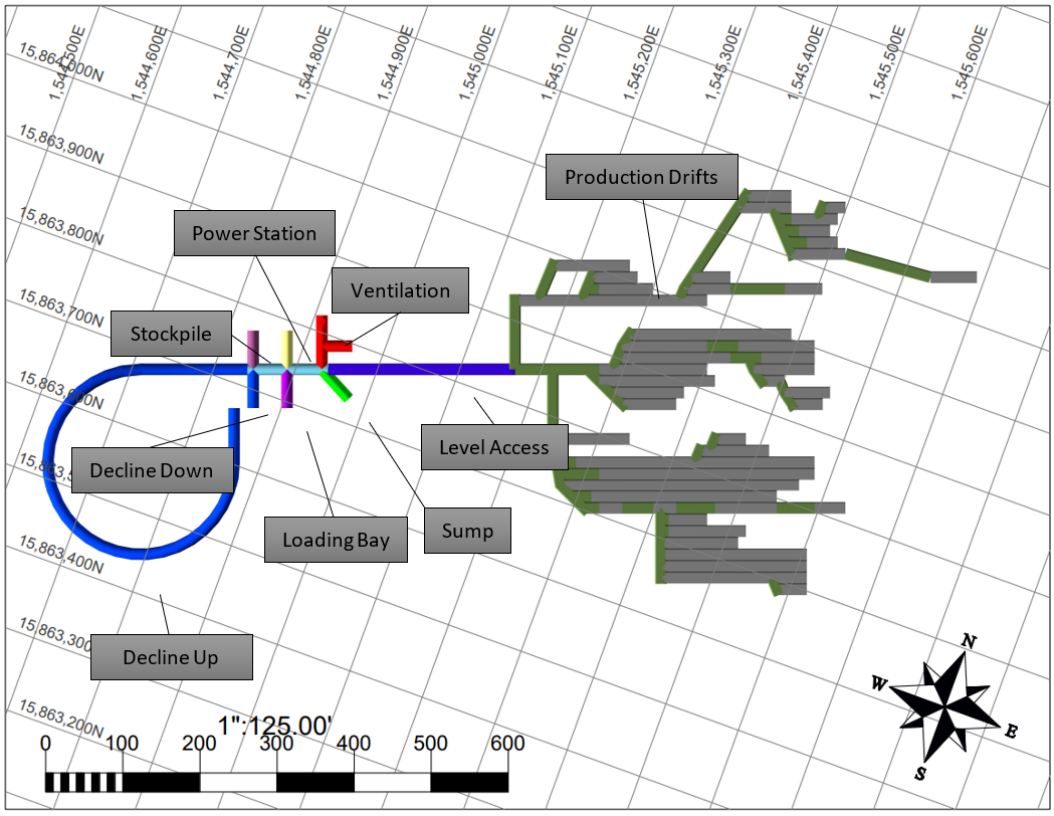


Figure 19. Proposed Drift and Fill Design for the 3315 Level

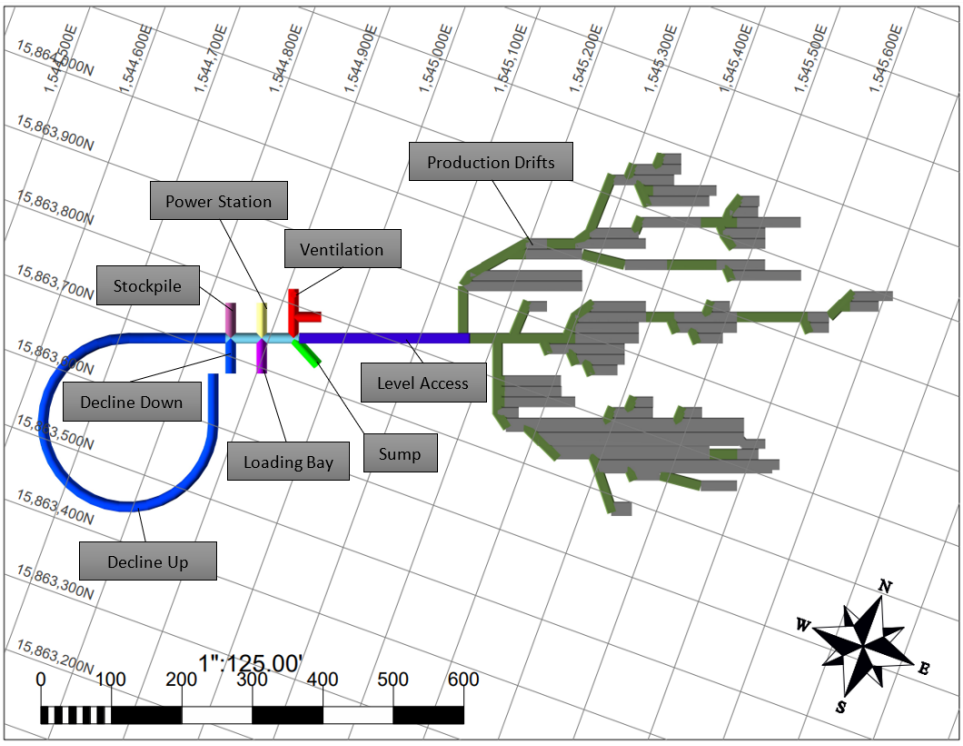


Figure 20. Proposed Drift and Fill Design for the 3300 Level

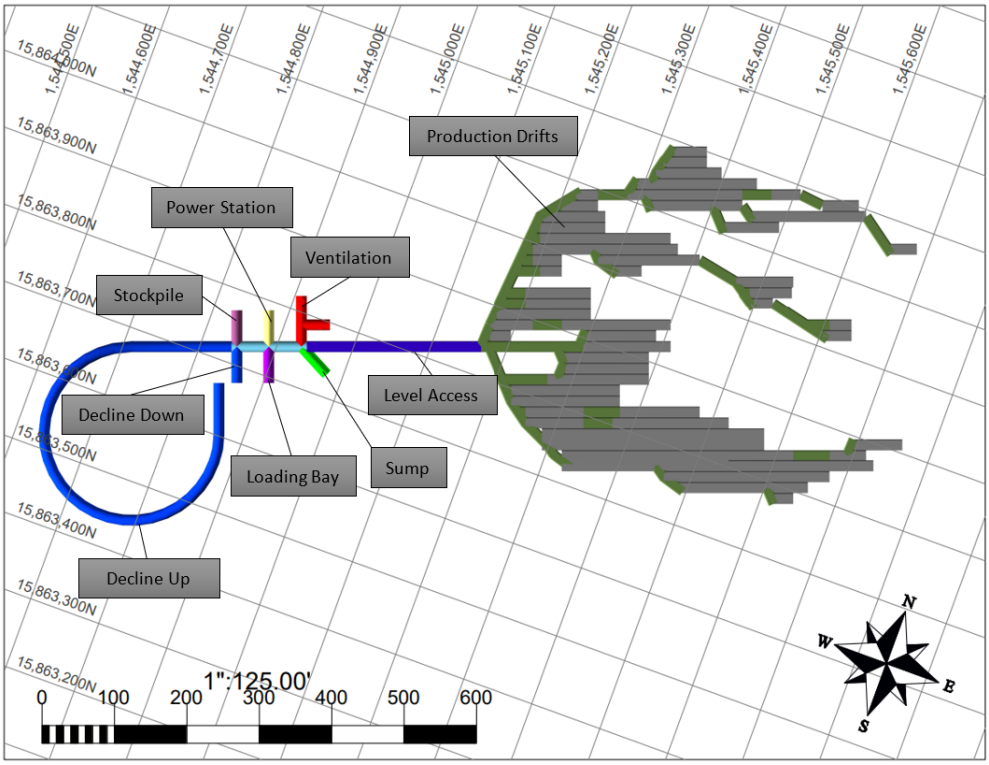


Figure 21. Proposed Drift and Fill Design for the 3285 Level

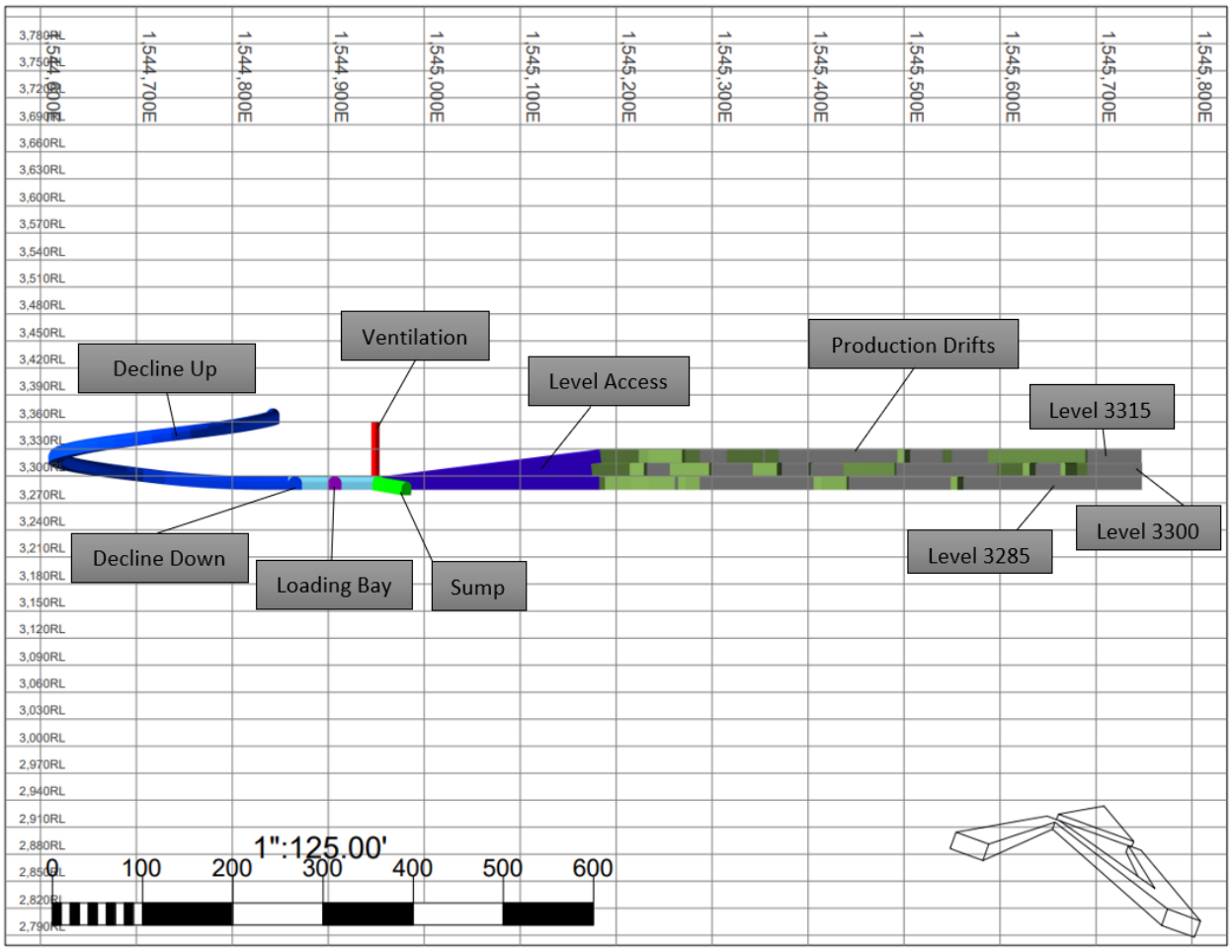


Figure 22. Section View of Drift and Fill Designs for the Levels 3315, 3300, and 3285

Each development level will have a sump, power station, ventilation raise, a stockpile, a truck loading bay, and access to the decline. Each development level will have access to three to five production levels depending on the geometry of the mineralized reserves. Each production level will have a few main hauling routes developed in ore, as much as possible, to minimize waste extraction. From these routes, interconnected drifts will be used to mine the ore.

The production will utilize a combination of top-down and bottom-up mining directions depending on mineralization geometry and economic factors. The areas using a bottom-up direction will be sequenced in the following order:

Bottom-Up Sequence

1. Mine primary production drifts;
2. Fill primary production drifts using CRF;
3. Mine secondary production drifts;
4. Fill secondary production drifts using RF; and
5. Procced to next level up.

The areas using a top-down direction will be sequenced in the following order:

Top-Down Sequence

1. Mine a production drift;
2. Fill the production drift with CRF;
3. Repeat steps 1 & 2 until the level is filled with CRF; and
4. Procced to the next level down.

All production and development levels will be backfilled with CRF or RF after production is complete (see Section 3.3.5.). Backfill material will be mine waste which had been previously stored on the surface and basalt from the Borrow Pit proposed on the far east side of the Permit Area. The material to be used for CRF will have sufficient cement added to neutralize any acid generation potential. If waste is not suitable, it will be permanently stored in the waste rock storage facility, which is to be a fully lined facility adjacent to the TSF. The mining operation will generate less than 200,000 tons of mine waste and therefore the majority of the backfill material will be composed of basalt that will be mined from the project Borrow Pit. The basalt has been tested and does not have acid generating potential (Appendix B).

The maximum D&F dimensions (Table 65 and Figure 23) were defined to ensure underground stability, based on the geotechnical conditions. These dimensions were estimated using the methodology proposed by Mathews (1981), which considers the hydraulic ratio of the drift and the geology and geotechnical conditions of the deposit.

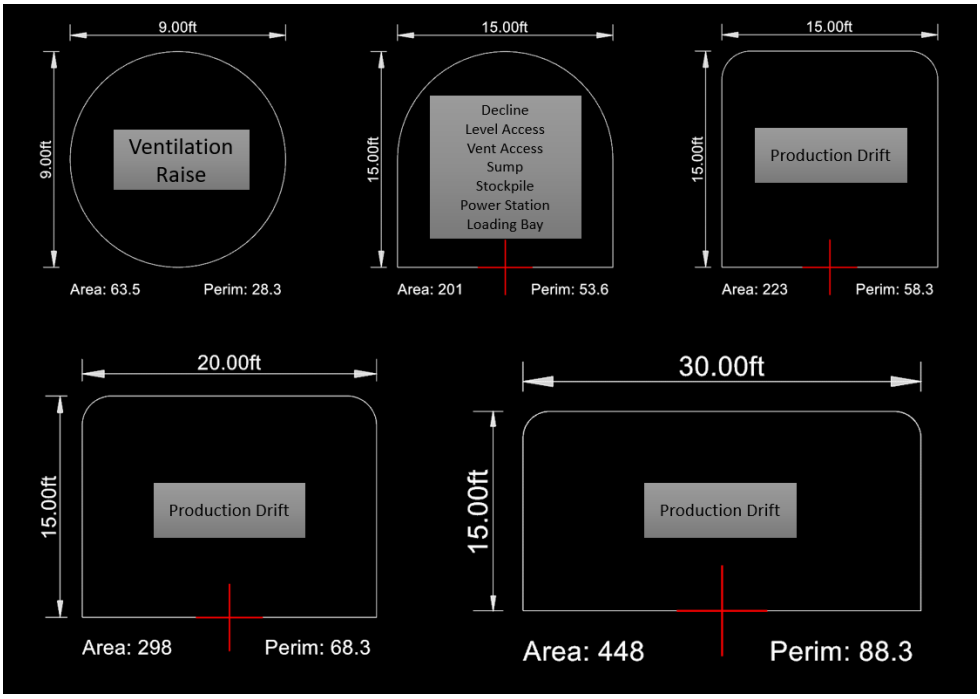


Figure 23. Underground Drift Profile Sections

3.3.2.1 Surface Stability Assessment

Surface stability is critical to ensure safe underground extraction. The dimensions and stability of the area between surface and the mine are a function of several parameters. The most important parameters are the width of the orebody, the stress regime, the blasting practices, the rock mass strength, the extraction sequence (top-down or bottom-up), and whether backfill will be introduced into the system.

The ground conditions in the Grassy Mountain deposit are estimated to be without problematic stress conditions. The mining method selected, the support designed, and the backfill together will ensure the mine to be stable, allowing safe underground extraction without surface subsidence. The operating mine plan has incorporated a geotechnical instrumentation plan for the entire mine with topographic instrumentation on surface to monitor stability.

3.3.2.2 Drilling and Bolting

Production and development drilling will be done using electric-hydraulic development-drill jumbos. Twin-boom jumbos are planned for large-dimension development rounds. Bolting machines will provide for ground support installation.

3.3.2.3 Blasting

Local contractors will perform blasting services. Emulsion will be used for most production blasting and development rounds. Boosters, primers, detonators, detonation cord, and other ancillary blasting supplies will also be required. Bulk explosives will be stored in a secure powder magazine on surface in accordance with current applicable explosives regulations.

Blasting will occur at designated times using a centralized blasting system. Where ventilation allows, on-shift-blasting of isolated high-priority development headings is anticipated.

Once the jumbo drill has completed the drilling cycle, the emulsion blasting agent will be loaded into the holes with the respective NONEL® blasting cap and booster. The timing of the round with the NONEL® caps is extremely important as it is critical to pulling the maximum amount of distance per round.

For decline development with a 15-foot by 15-foot profile, an estimated 591 pounds (268 kg) of emulsion is required for each round. The powder factor will be 3.90 lbs/ton (1.95 kilogram per ton [kg/t]) assuming 164 tons of material movement per round. For level access development, an estimated 507 pounds (230 kg) of emulsion will be required for each round. A powder factor of 3.86 lbs/ton (1.93 kg/t) is estimated for level-access development assuming 129 tons of material will be moved per round.

3.3.2.4 Ground Support

Ground support will be installed with specifications based on the geotechnical analysis discussed in the Prefeasibility Study report (Mine Development Associates, 2018). The support analysis was carried out using empirical techniques based on recommendations from Barton et al. (1974) and Barton (2002). The empirical design used the support abacus approach, which relates the rock mass quality (Q) to an equivalent dimension (De). The Q value was obtained from a range of values that define each rock class, derived from Gonzalez de Vallejo (2004) as follows:

$$RMR = 9 * Ln\,(Q) + 44$$

These values use the RMR and Q values summarized in Table 66 that are based on the three rock classes shown in Figure 24.

Table 66. Interpreted Relationship between RMR and Q

Rock Class	$RMR_{B'89}$		Q Barton ´74	
	Min	Max	Min	Max
Class 1	21	40	0.08	0.64
Class 2	41	60	0.72	5.92
Class 3	61	80	6.61	54.60

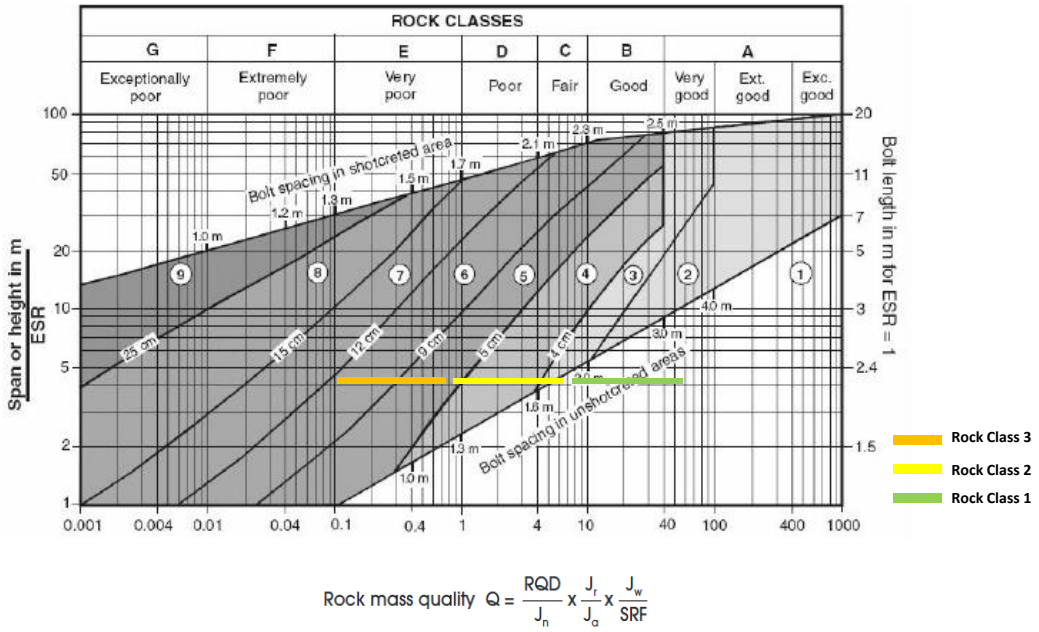


Figure 24. Rock Mass Quality and Rock Support

The De value is obtained by dividing the size of the excavation by the excavation support ratio (ESR), which is relative to the intended use of the excavation and the required factors of safety (FOS), and based on the following empirical relationship:

$$De = \frac{Excavation\ Span, diameter\ or\ height\ (ft)}{Excavation\ Support\ Ratio\ ESR}$$

An ESR equal to 1.0 was selected as a conservative parameter for the De calculation.

Dimensions for the decline, level access, and drifts were calculated using the following equation:

$$De = \frac{15\ (ft)}{1.0} = 15$$

- Decline: 15 by 15 feet;
- Level Access: 15 by 15 feet; and
- Drifts: 20 by 13 feet.

The decline ramp 15-foot by 15-foot dimension was used as maximum excavation span, which is considered for permanent infrastructure. The other infrastructure is considered to be temporary. The recommended support is shown in Table 67.

Table 67. Support Recommended (based on Barton 2002)

Rock Class	Q	Value	Support Pattern (ft)			Shotcrete (ft)
Class 1	0.08	Min	4.3	x	4.3	0.2 – 0.3
	0.64	Max	5.2	x	5.2	
Class 2	0.72	Min	5.6	x	5.6	0.16 – 0.2
	5.92	Max	6.9	x	6.9	
Class 3	6,61	Min	5.9	x	5.9	Occasional
	54,60	Max	10.8	x	10.8	

The support pattern and shotcrete thickness for the decline ramp should be assigned according to the rock class indicated in Table 34.The geotechnical stability analysis also indicates that the support pattern and shotcrete thickness for the level access and drifts will be associated to rock class 2 and rock class 1, respectively.

The length of the bolts (Lb) as proposed by Barton (1980) was estimated using the following empirical relationship:

$$Lb = 2 + 0.15 * \frac{D}{ESR}$$

Where the D is the maximum span dimension for each access and ESR is equal to 1.0.

Table 68 shows the rock bolt length calculated for the decline ramp, level access, and drift sections.

Table 68. Estimated Rock Bolt Lengths

Infrastructure	Section (ft)	Bolts Length (ft)
Decline Ramp	15 x 15	8.8
Level Access	15 x 15	8.8
Drift	20 x 13	8.5

The installation of the advance support as a function of the distance to the excavation front has been evaluated using the empirical relationship as follows:

$$Max\ Span\ Unsupported = 2 * ESR * Q\text{^}0.4$$

Table 69 shows the maximum distance to the excavation front by rock class.

Table 69. Maximum Unsupported Span

Rock Class	Q	Range	Maximum Span (Unsupported) (ft)
Class 1	0.08	Min	2.3
	0.64	Max	5.6
Class 2	0.72	Min	5.9
	5.92	Max	13.5
Class 3s	6.61	Min	14.0
	54.60	Max	32.5

An example of ground support design for the main decline in Grassy Mountain is shown in a cross section view in Figure 25.

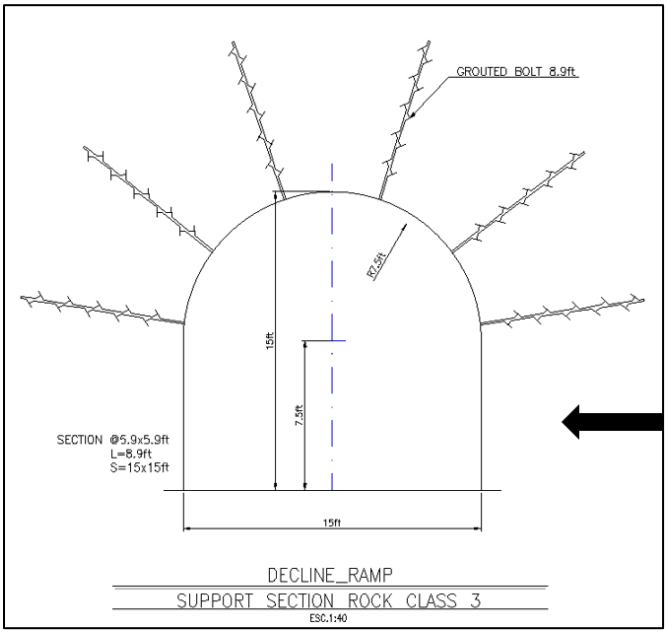


Figure 25. Cross Section of Support for Decline (Rock Class 3)

3.3.2.5 Mucking

Load-haul-dump vehicles (LHDs) with a nominal 5.2 cubic yard (yd^3) bucket capacity will be used for decline development and excavation of level accesses, drifts, and footwall drives. Backfill placement will also be done using the 5.2 yd^3 LHDs.

The LHDs will be used to load the underground mining trucks using the same main access for each level. Material will then be hauled by the trucks up the decline to the surface and dumped at the ore stockpile or waste dump as appropriate. A front-end loader will feed the ore from the stockpile into the primary crusher. On every development level 15 feet by 50 feet truck loading bay will be excavated off the decline back to make sufficient room for loading operations.

3.3.2.6 Haulage

The planned haulage will use conventional low-profile underground-mining trucks of 20 ton equipped with ejector beds. For all mining levels, trucks loaded underground will transport the ore and waste directly to surface. Once unloaded on the surface, the truck capacities will be used to transport backfill materials on their return trips into the mine.

Ore that is hauled to surface as part of mine scheduling will be placed in the crusher stockpile. Waste rock hauled to surface will be deposited at a WRD facility that will be located about 1,640 feet from the mine portal. The waste will be fully utilized over the mine life as CRF material, reducing the total amount of basalt borrow material required over the mine life.

3.3.3 Mining Equipment

Mine operations at Grassy Mountain will utilize mobile mining equipment suitable for underground mines as specified in Table 70. The estimate of the fleet size was based on equipment running-time requirements to achieve the mine production plan.

Table 70. Mine Equipment Requirements

Underground Mining Equipment	Quantity
Drilling Development Jumbo (Sandvik DD210)	2
Bolter (Sandvik DS311)	1
LHD 5.2 yd3 (CAT R1600)	4
Front-end Loader (JCB 456ZX)	1
Truck with Ejector Bed (CAT AD22)	3
Emulsion Loader (CAT 440)	1
Telehandler (JCB 540-170)	2
Bulldozer (Cat D6T)	1
Motor Grader (Paus PG5HA)	1
Service Truck (Chevrolet Colorado)	1
Diamond Drilling (Hydracore Gopher)	1

During the first year of usage, the utilization is restricted to the range between 50 percent and 60 percent for all the equipment due to the limited production faces. The productivities of development drill and long hole drill are 222 feet per hour (ft/hr) and 114 tons per hour (ton/hr), respectively. The truck productivity varies from 15 to 153 tons/hr depending the haul distance. The shortest haul distance is only 1,640 ft and the longest is more than 12,000 ft.

The maximum permanent underground mine equipment required for the LOM are summarized in Table 71.

Table 71. Mine Equipment Requirements

Underground Mining Equipment	Quantity
Drilling Development Jumbo (Jumbo DD21-40)	2
Bolter (Sandvik DS311)	1
LHD 5.2 yd^3 (LH410)	4
Front-end Loader (JCB 456ZX)	1
Low Profile Truck (AD30)	3

Underground Mining Equipment	Quantity
Emulsion Loader	1
Telehandler (JCB 540-170)	2
Bulldozer (Cat D6T)	1
Motor Grader (Paus PG5HA)	1
Fuel Truck	1
Service Truck	1
Diamond Drilling (Hydracore Gopher)	1

During very limited peak times, the maximum requirement of low-profile trucks will be five, however, only three trucks are considered as permanent fleet and additional trucks will be provided by a local contractor sporadically.

3.3.4 Waste Rock Storage

A single waste rock storage area will be constructed over the life of the Project to temporarily store the approximately 0.2 million tons of material. A haul road will connect the portal with the waste rock storage area. The design of the WRD facility is included in Appendix C.

The WRD is designed to employ the same containment system design and underdrain collection piping system as the TSF described in Section 3.3.13 below. The design criteria presented below are based on OAR, requirements of the Project as defined by Calico, and Golder's experience designing and constructing lined WRDs in similar environments. The following OAR Divisions have been used to develop minimum acceptable design levels:

- DOGAMI, Chemical Process Mine Regulations, OAR 632, Division 37
- ODFW, Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420
- ODEQ, Chemical Mining, OAR Chapter 340, Division 43

The WRD design criteria in Table 72 presents the minimum design criteria proposed for the Project WRD and the corresponding OAR Regulation or Guideline.

Table 72. WRD Design Criteria Table

Parameter	Value	Reference or Regulation
Capacity	200,000 tons	Ausenco/MDA
WRD Containment System (top to bottom)	Continuous 80-mil high-density polyethylene liner (HDPE) geomembrane, geosynthetic clay liner (GCL), prepared subgrade	Golder
WRD Underflow Collection System	Perforated and solid CPE and HDPE gravity draining piping network	OAR 690-020-0038
WRD Leak Detection System	Perforated 2-inch diameter Schedule 80 PolyVinyl Chloride (PVC) pipe network and monitoring ports	OAR 340-043-0000
WRD Underflow Collection System	Perforated and solid CPE and HDPE gravity piping network in 18-inch-thick drainage layer 6-inch-thick filter layer Gravity flow to reclaim pond	Golder and OAR 340-043-0050
WRD Design Earthquake, Operational	475-year return period	Golder
Peak Ground Acceleration, PGA	0.08g	Golder
Horizontal PGA Factor, k, for pseudo-static stability analyses	½ of the PGA	Haynes-Griffin, Franklin (1984) and Seed (1982)
Static Stability, Factor of Safety	1.5 (minimum)	Golder
Seismic Stability (pseudo-static), Factor of Safety	1.1 (minimum)	Golder

Water Management: An underdrain collection system will also be installed above the geomembrane liner for the WRD. The system will capture and convey any storm water that contacts the stockpiled material above the geomembrane liner. Similar to the TSF described in Section 3.3.13, the collection system will consist of a series of perforated corrugated polyethylene (CPE) and HDPE pipes installed within the drainage layer above the geomembrane liner.

Prior to exiting the WRD, the perforated HDPE collection pipe will transition to solid-wall HDPE dual containment WRD underdrain pipe. The WRD underdrain delivery pipe consist of a six-inch diameter DR17 HDPE carrier pipe and an outer ten-inch diameter DR17 HDPE containment pipe. The WRD containment system design is presented on the Design Drawings in Appendix C.

The underdrain outlet pipe will travel overland to the Stage 1 TSF impoundment where the outer ten-inch diameter HDPE containment pipe will terminate above the geomembrane lining system.

The six-inch diameter DR17 HDPE solid wall carrier pipe will continue to the TSF reclaim pond described in Section 3.3.13. Prior to discharging into the reclaim pond, the WRD underdrain

outlet pipe will enter an open channel monitoring flume for sampling and flow rate measurement.

WRD Stability: The WRD is designed to remain in place during operation only. Due to the temporary nature of the WRD, geotechnical stability of the WRD was performed for static and pseudo-static conditions using an operational basis earthquake (OBE) with a return period of 475 years. The site-specific hazard assessment for the Project is presented in Appendix C. The following table presents the geotechnical stability analysis results for the WRD.

Table 73. Summary of Critical WRD Stability Analysis Results

Analysis Method	Static FOS (Target design minimum is 1.5)		Pseudo-static FOS (k = 0.04 g) (Target design minimum is 1.1)	
Effective Stress	Failure through Foundation	Waste Rock Slide over the Liner	Failure through Foundation	Waste Rock Slide over the Liner
	1.8	1.6	1.6	1.4

Detailed discussions on analyses and construction-level design of the WRD containment system are presented in Appendix C.

3.3.5 Backfill

The backfill method has been selected according to the geological and geotechnical conditions of the deposit, as well as the selected D&F mining method. The main objectives of the backfill are to provide stability to the drifts and to control dilution associated with the ore extraction. CRF and RF will be used in the primary and secondary drifts, respectively. To the extent possible, the waste rock from underground operations will be used for CRF and rock from the borrow pit will be used for RF.

3.3.5.1 Cemented Rock Fill

A plant to produce the CRF will be built as part of the Project infrastructure. The backfill plant will be located near the underground mine portal and will produce the CRF. No test work has been done for CRF at this time, so a standard mix with seven percent cement will be used pending further study. The CRF from the backfill plant will be transported down the decline using the haul trucks. Haul trucks will place the CRF in the production drifts using ejector beds. LHDs will have push plate attachments to jam the CRF as tight as possible to the back.

Control of the CRF slump properties will be an important factor to its successful use. The CRF will need to be thin enough for trucks to handle in the transporting and dumping of the material, but stiff enough to allow the LHDs to pack the material into position. The slump properties will be adjusted based on locations and experience. It is assumed that the curing time for the CRF will

be approximately 28 days. Following curing, the adjacent secondary drift can be filled with RF using LHDs. A utility crew will be required to move connections so that backfill is delivered to the appropriate stope. This will allow backfilling to proceed on a 24-hour basis.

CRF will be used to backfill primary drifts allowing for reasonable recovery of secondary drifts. The CRF will have the following properties:

- Cement: 7.0%;
- Water / Cement (ratio): 0.70 to 0.85;
- Waste Rock: 85% – 90% (rock with good geotechnical rating); and
- Nominal Size: -6 inches.

It is assumed that the cement will properly encapsulate any potentially acid-generating material. Thus, the mine waste will be used as available. This will reduce the mine waste storage to zero over the LOM. When mine waste is not available, rock from the borrow pit on the east side of the Project will be utilized for CRF.

3.3.5.2 Rock Fill

The RF will be used in the secondary drifts according to the design and mine plan. It will act as an unconfined filling adjacent to the primary drifts which will have been previously filled with CRF. Basalt material from the borrow pit on the east side of the Project will be used. This basaltic rock is not acid generating (Appendix B).

RF material will be hauled at the ROM size. The transport and disposal of RF into the drifts will use mine trucks that will place the material at unloading points inside the mine, where it will subsequently be loaded and transported to the drifts using LHDs. The LHDs will push the material into place as tight as possible using the push plate attachment.

3.3.6 Mine Drainage

Any mine drainage will be collected and used in the drilling and mining process or pumped to the surface for use in the milling process or will be hauled to the Collection Pond near the Processing Facilities. This water quality will be tested regularly to ensure that the quality meets the intended use. If significant volumes are encountered, the mine drainage will be collected in a water truck and hauled to the processing plant for use/reuse or infiltrated. Dewatering operations are described in Section 3.3.9.1 in this document.

3.3.7 Ventilation

The ventilation network was designed to comply with U.S. ventilation standards for underground mines [Code of Federal Regulations (CFR)/Title 30. Underground metal and non-metal mines. Washington, DC: U.S. Government Printing Office, Office of the Federal Register]. Regulatory concentrations for gases are specified by the 1973 American Conference of Industrial Hygienists

(ACGIH) threshold limit values (TLVs) [71 Fed. Reg. 3 28924 (2006)]. For diesel particulate matter (DPM), a permissible exposure limit (PEL) of 160 µg/m3 total carbon is specified in the U.S. diesel rule for metal/non-metal mines [71 Fed. Reg. 28924 (2006)].

MSHA sets an airflow requirement for the dilution of gas emissions, and an additional airflow requirement for dilution of DPM. These values are published with the list of approved engines on MSHA's internet website. Airflow of 200,000 cubic foot per minute (ft^3/min) was selected as a minimum reference for the ventilation design in order to meet the MSHA ventilation standards.

Required airflows were determined at multiple stages during the mine life, using equipment numbers and utilization rates, specific engine types and exhaust output, and the number of personnel expected to be working underground. The designed ventilation system includes the following parameters:

- Required air flow of 200,000 ft^3/min;
- Two 70HP Fans in parallel with 3.4 in w.g.;
- Air density of 0.072 pound per cubic feet (lb/ft^3); and
- Only four production levels operating at a single time.

The planned ventilation will use an exhaust system and will require two exhaust fans in parallel on the surface. An exhaust vent raise of nine feet in diameter will connect all the levels in the mine to the surface exhaust fans. Figure 26 shows the main components of the proposed ventilation network with air-flow directions. The ventilation is limited to only four production levels operating at a single time.

The development of the ventilation raises will utilize a raise bore machine. A raise bore machine is an electro-hydraulic mechanical method of excavating vertical or near-vertical raises from one level to another level. A pilot hole of nine to 14-inches in diameter is drilled from the upper level to the lower level. Then the reamer is attached and reams from the lower level to the upper level, with smooth circular walls. This will create a raise with a diameter of nine feet.

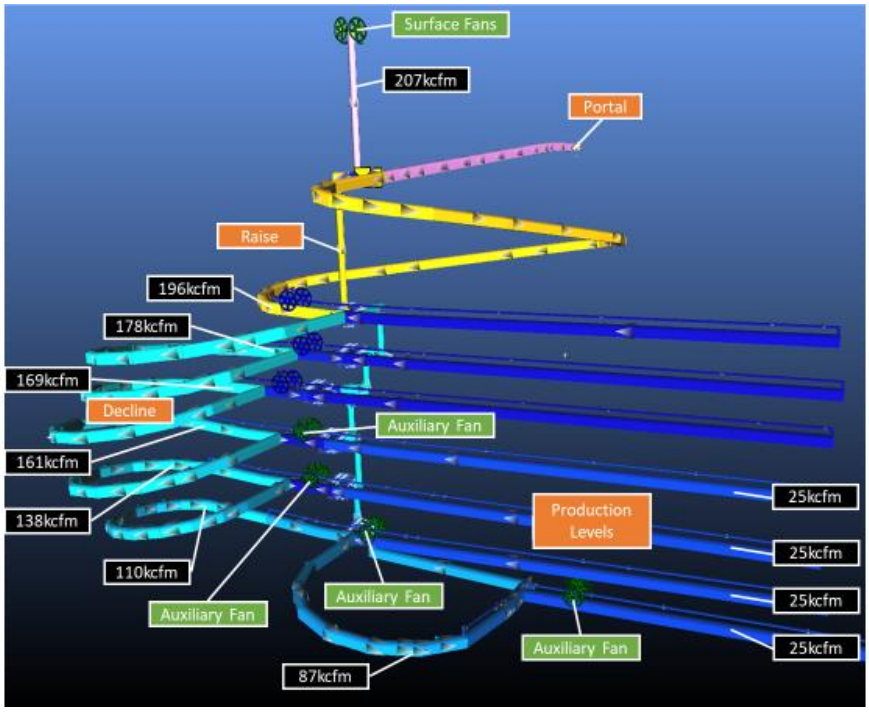


Figure 26. Ventilation Network

3.3.8 Mine Access

The main access portal will be located close to the process plant infrastructure. Figure 27 shows the location and configuration of the portal. Figure 28 shows the cross sectional view of the planned design for the portal.

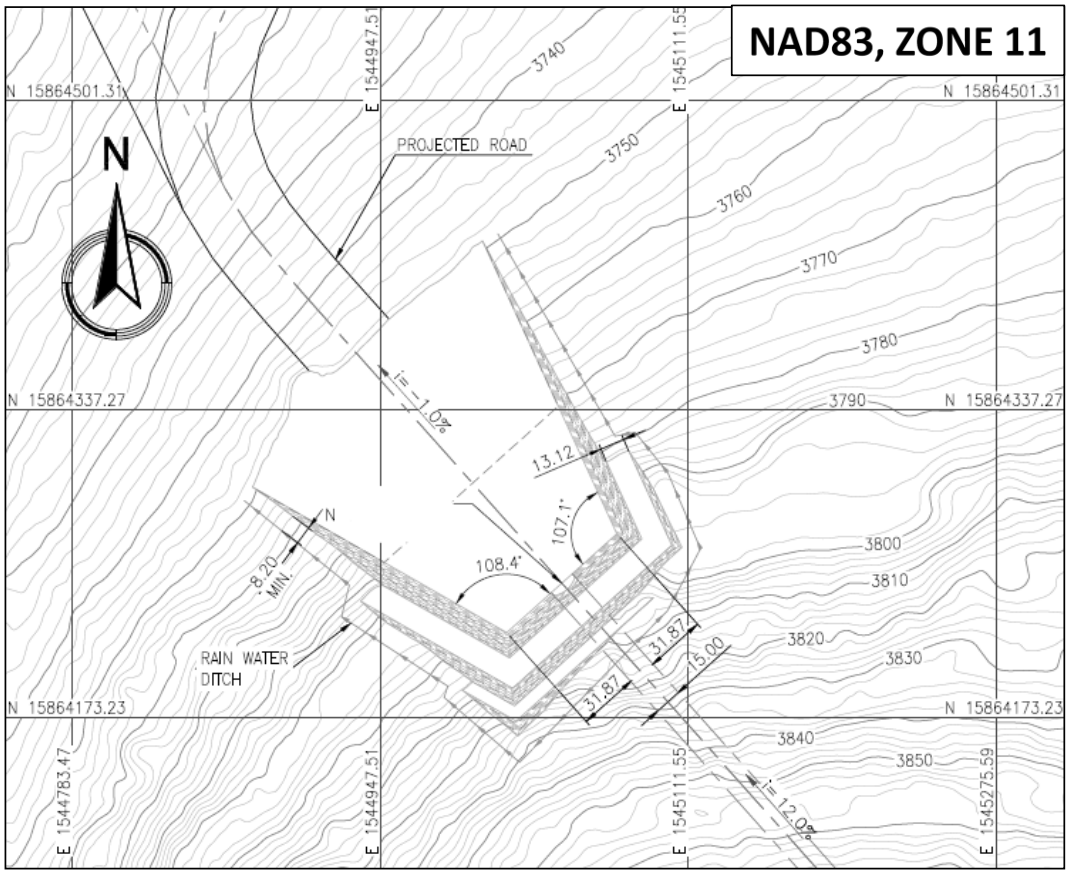


Figure 27. Location of Main Portal Access

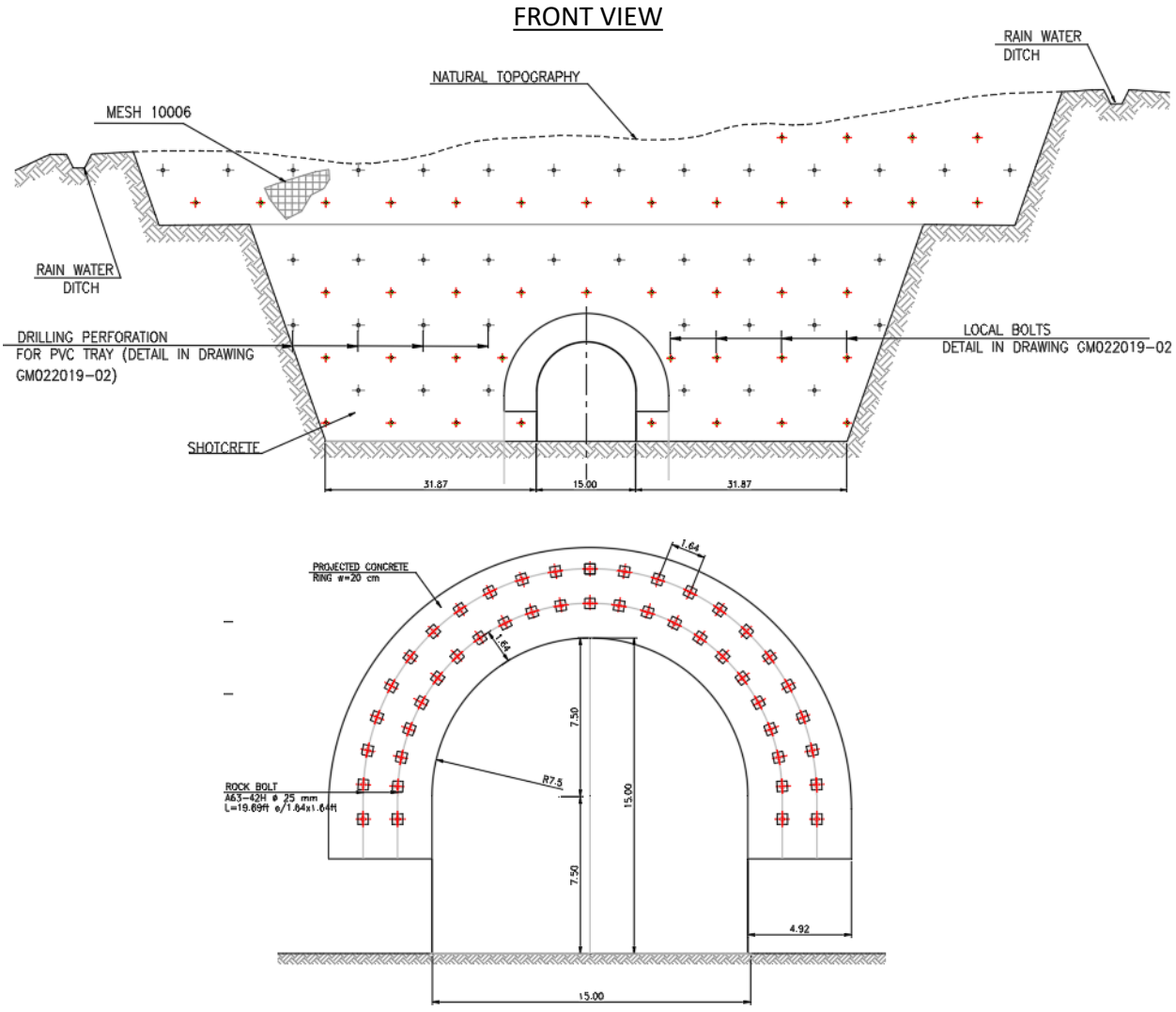


Figure 28. Main Portal Design

3.3.9 Hydrogeology Analysis

This section is from the Groundwater Baseline Data Report (Appendix B) by SPF of Boise, Idaho. This summary is the Conceptual Model from Vol. II of the Groundwater Baseline Data Report.

The aquifer system in the vicinity of the Project occurs within the Grassy Mountain Formation, generally consisting of arkosic sandstone, siltstone, and conglomerate. The unit includes interbedded fine-grained sediments. The Grassy Mountain Formation is the host unit for the Project. The unit is underlain by the Kern Basin Tuff, a fine-grained lithic tuff.

Groundwater is typically found within the Grassy Mountain Formation in unconsolidated or weakly consolidated sandstone and conglomerate units and interbedded sediments. The water-bearing zones appear to be somewhat compartmentalized due to faults, sedimentary facies

changes, and silicification in and around the Project. Cross- sections developed from available subsurface lithology demonstrate the variability in water-bearing strata throughout the Project area. However, a relatively consistent and uniform piezometric surface throughout the area indicates some degree of hydraulic connectivity between the various water-bearing zones.

Water levels in the area are typically stable, with some seasonal variations evident in shallow wells or wells otherwise subject to more direct recharge. There is some evidence of a general decline in the shallow aquifer zone in several wells in the vicinity of the Project, possibly due to inadequately sealed boreholes at or near the Project allowing shallow aquifer zones to drain to deeper zones. The observed decline is on the scale of a few feet over several years.

The Grassy Mountain Formation in and near the Project is silicified and strongly indurated. Geophysical data indicates that the zone of silicification increases with depth. Based on available information, a saturated zone occurs within the Project at an elevation ranging from 3,300 to 3,100 feet, which is above the expected maximum depth of the proposed mine (approximately 3,050 feet). However, this zone does not appear to be consistent throughout the Project. While portions of the Project are understood to be saturated, hydraulic conductivity and resultant groundwater flow appear to be severely restricted by silicification and/or faulting. Testing of GMW17-32 completed in silicified sediments near the Project suggests a very low hydraulic conductivity on the order of 10^{-6} to 10^{-7} cm/s. A long recovery period after testing this well also is an indication of very low hydraulic conductivity.

Near the Project there are isolated pockets of less-silicified material with higher conductivity, and faults in these areas may act as conduits for groundwater flow. There is not an obvious relationship between groundwater occurrence and depth within the Project, suggesting a complex heterogeneous system heavily influenced by silicification and faulting. Given the location of the Project relative to the groundwater divide, the available groundwater recharge to the area appears to be limited as well.

The silicified nature and faulting of the sediments in and around the Project has a strong effect on hydraulic conductivity but may also result in a strong downward vertical gradient within the aquifer system. Groundwater elevation is strongly correlated with well depth in this area. This vertical gradient is theorized to result in the deeper potentiometric surface observed in deeper wells. The horizontal gradient in this area is also relatively high, consistent with flow impeded by low hydraulic conductivity, with silicification apparently being a major factor.

In the general area of the Project, faults appear to act as barriers to groundwater flow on the south and east sides but the true impact of faulting on groundwater flow is hard to differentiate from the effects of deposit silicification. The silicification and faulting seems to decrease the hydraulic conductivity of the arkosic sandstone but potentially increase the hydraulic conductivity of the underlying tuff. It is possible with the combination of the silicification, steeply dipping interbedded clay, siltstone, and sinter, and the faulting near the Project allows some groundwater from the Project to flow into (or through) the tuff.

The Kern Basin Tuff, like the Grassy Mountain Formation, surfaces at higher elevations on the southern and eastern sides of Grassy Mountain and dip towards the north and northwest directions towards Negro Rock Canyon.

Groundwater flow in the Project area is generally from the southeast to the northwest, from higher elevations along the base of Grassy Mountain to lower elevations along Negro Rock Canyon. This flow direction is evident in both the shallow and deep potentiometric surfaces, a result that also supports a single aquifer system.

Downgradient of the Project, the strata are less silicified, and the horizontal and vertical gradients are not as pronounced. It is still likely that horizontal and vertical connectivity between aquifer zones is affected by low permeability, discontinuous, interbedded layers of clay and siltstone. Hydraulic conductivity is higher downgradient of the Project, but lithologic variations and faulting affect groundwater flow and occurrence. Hydraulic conductivity values downgradient of the Project derived from test pumping are on the order of 10^{-3} cm/s to 10^{-5} cm/s, representative of sandstone and conglomerate aquifers. Consistent piezometric head in wells completed at different elevations would suggest a single aquifer system.

The geochemistry of the groundwater appears to be strongly influenced by lithology. The main regional aquifer displays a Na/K-HCO3 geochemical identity, associated with volcanic tuff and sedimentary deposits. Groundwater originating from volcanics shows a Ca-HCO3 signature. Water chemistry changes are evident in the immediate vicinity of the Project.

The Grassy Mountain fault zone extending north of the Project acts like a barrier to groundwater flow based on testing of nearby wells; the most productive wells in the area are presumably located on the east side of the Grassy Mountain fault zone.

Discharge of the regional aquifer is assumed to be local springs and ultimately the Malheur River. The low total aggregate spring discharge in the hydrologic basin suggests a low groundwater recharge.

While limited in spatial extent and hydraulic connectivity, the water-bearing zones within the Grassy Mountain Formation are proposed to constitute a single, heterogeneous and locally complex aquifer system. This conclusion is supported by lithology, piezometric surface, and geochemical signature. The aquifer system is defined by low hydraulic conductivity and high hydraulic gradient in and near the Project and higher hydraulic conductivity and lower hydraulic gradient away from the Project. Groundwater conditions appear to be mostly influenced by silicification and/or faulting near the Project and sedimentary facies changes and faulting downgradient of the Project.

3.3.9.1 Dewatering

The following discussion on dewatering is from Vol. III of the Groundwater Baseline Data Report (Appendix B).

The Inflows under steady-state conditions were projected using analytical equations by Marinelli and Niccoli (2000); inflows under transient conditions were evaluated using the Theis equation.

- For the steady-state analysis, potential groundwater inflow into the proposed mine workings were estimated from: (1) shallow aquifer zones present at the same elevation as mine workings; and (2) a deeper zone within the aquifer beneath the mine workings. The rate obtained from the steady-state approach reflects equilibrium, long-duration dewatering conditions and does not necessarily reflect dewatering estimates under a short-duration. Initially, higher pumping rates are anticipated due to higher groundwater inflow during the early stages of dewatering. Dewatering requirements are expected to lessen over time as dewatering takes place in the surrounding aquifer until steady-state conditions are ultimately reached.
- The transient analysis involved performing Theis drawdown calculations (Theis 1935) to evaluate potential short-duration pumping requirements. This method calculates drawdown effects with distance from the pumping location over time. The assumed pumping center is in the middle of the resource area, and theoretical drawdown is calculated at a distance that coincides with the edge of the resource area (i.e., approximately 0.1 mile from the center of the Project).

The analytical methods used to project dewatering requirements and possible impacts from pumping (see Section 4) are simplified solutions for analyzing a complex problem. A numerical model was constructed to further evaluate potential dewatering requirements and groundwater-production impact. A numerical model is also a simplified representation of a complex system but allows more simulation flexibility (such as including a sloping aquifer and multiple pumping wells). This section describes model construction, parameter values, calibration results, sensitivity analysis, and the results from an additional dewatering scenario. The USGS code MODFLOW 2000 (Harbaugh, A.W. et al. 2000) was used for performing numerical groundwater flow modeling and dewatering projections.

The following points summarize the results and conclusions from the steady-state, Theis and numerical modeling on dewatering and drawdown effects:

1. The conceptual model for groundwater flow at Grassy Mountain provides the basis for the dewatering estimates. The current model suggests a single aquifer system as a function of scale, supported by the relatively uniform, shallow and deep potentiometric surface (at a high-level view) and correlation with groundwater elevation and depth. On a local scale, heterogeneity effects are apparent, attributed to local variations in hydraulic properties, facies changes, and/or the occurrence of faults/fault zones.
2. Estimated analytical steady-state bulk dewatering rates on the order of 20 gpm, with the potential to intercept up to 500 gpm on a short-duration basis (i.e., days to weeks), are anticipated based on the analytical approach.
    a. The low-end estimate reflects lower permeability in the range of 1x10-6 cm/s (or 0.003 ft/d) anticipated directly within the resource area. Due to the expression of individual faults or fault zones, the actual permeability may be more or less. SPF is not aware of direct testing of hydraulic conductivity or transmissivity based on

aquifer pumping tests within the resource area to date to confirm this estimate. However, the results of pumping tests performed around the perimeter of the resource extent support an aggregate lower hydraulic conductivity within this magnitude due to limited yields and negative boundary conditions.

b. The high-end estimate reflects higher hydraulic conductivity that may be more representative of basin conditions (i.e., unconsolidated and consolidated sedimentary deposits) and short-duration inflows into the resource area (i.e., faults and fractures serving as conduits for flow) that could potentially be intercepted during the mining activities. The anticipated hydraulic conductivity may be on the order of 1x10-4 cm/s (0.3 ft/d). This condition may arise from contributions from local zones of higher permeability that are effectively dewatered in early time. As the cone of depression or radius of influence extends from the theoretical pumping well(s) with time, the overall aquifer properties are expected to produce less water due to overall lower permeability effects.

3. The dewatering evaluation also examined potential groundwater inflow rates using transient analytical methods.
    a. The transient analytical (Theis) method was used to estimate the predicted dewatering rate of approximately 250 gpm to 600 gpm, assuming a single pumping well scenario, placed at the center of the Project. The theoretical drawdown effects at the perimeter of the Project were evaluated after one year of continuous pumping to produce 600 feet of drawdown (assuming an initial groundwater elevation of 3,700 feet for upgradient conditions and an assumed dewatering elevation of 3,100 feet). The higher flow rate range is consistent with anticipated short-duration inflow amounts over the span of days to weeks.

4. A three-dimensional numerical groundwater flow model was constructed and executed using MODFLOW to evaluate potential dewatering rates under steady-state and transient conditions.
    a. The model was constructed at a ten by ten-mile resolution, centered on the Project, with three layers. Regional and local groundwater flow conditions were simulated based on a distribution of hydraulic conductivity and storativity (informed by geologic mapping and the results of aquifer pumping tests), recharge from surface infiltration predominantly in higher elevation regions, and assignment of boundary conditions to reflect physical boundaries to the extent possible (including Owyhee Reservoir, Owyhee River, and select spring features).
    b. The steady state model dewatering was simulated by placing wells along the Project perimeter and assigning uniform pumping rates to achieve dewatering to the 3,100-foot elevation. Four wells were simulated at 5 gpm each for 20 gpm total pumping requirements under steady-state conditions, resulting in a pumping level elevation of approximately 2,950 feet to 3,100 feet.
    c. The transient model dewatering was simulated by placing four wells around the perimeter and one well in the center of the Project and pumping a total 480 gpm for 70 days and 57.5 gpm for the remaining lifetime of the mine (approximately

ten years). The higher rate pumping for 70 days was able to lower water level elevations to less than 3,050 feet and the lower rate pumping initially allowed minor recovery then lowered the water levels to a range of elevations from 2,700 to 2,870 feet.

d. The three-dimensional numerical model was created as a regional model for a baseline analysis of dewatering needs. This model was calibrated using the regional water levels. The deeper water levels located near the proposed mine and other highly silicified and compartmentalized areas are not represented in the model. The conceptual model report (SPF 2019c) discusses these deeper water levels and potential causes. Currently, there are no wells or piezometers completed in the highly silicified region encompassing the proposed mine that have a static water level higher than 3,200 feet amsl. Drillers have indicated flows of up to ten gpm in only three of the exploratory bores drilled in the proposed mine at depths shallower than 3,200 feet amsl. Only two of the exploratory bores in the proposed mine had a reported static water level shallower than 3,200 feet amsl. Due to its silicified and compartmentalized nature, the amount of water that flows through the proposed mine area is significantly limited. The three-dimensional numerical dewatering model does not account for this limitation and should be used as a worst case estimate for the maximum flow that would be required to dewater the proposed mine in its entirety.
e. The planned mining method is drift-and-fill. This method used in the compartmentalized aquifer located at the Project will decrease the total volume of material requiring dewatering.

5. The transient model was also used to evaluate the drawdown effects of the dewatering wells and the mine operation production wells on the aquifer and nearby springs. Lowe Spring is approximately 1 mile away from the nearest proposed pumping well (Well 5) and had a predicted maximum drawdown of approximately 12 feet. Approximately 1.75 miles away, Poison Spring has a maximum predicted drawdown less 0.5 feet. The water sampled from Poison Spring has a similar geochemical characteristic as PW-4, while Lowe Spring shows a more volcanic geochemical signature. The geochemical signatures indicated Poison Spring may be affected by the groundwater production more than modeled and Lowe Spring may be affected less than modeled.
6. The dewatering and drawdown estimates reflect inherent uncertainty, both in the available datasets and necessary simplifying assumptions for representing a complex system. Therefore, these results are considered appropriate for baseline-level planning.

7. The accuracy of representing predominant groundwater flow paths and estimates of potential groundwater inflow depends on the sufficiency and accuracy of supporting data and assumptions. This process is inherently uncertain with respect to the conceptual model, translation of the conceptual to analytical and numerical models, and interpretation of results. Simplifying assumptions are necessary throughout this process. The level of accuracy is considered appropriate for a baseline estimate. Overall, the magnitude of dewatering estimates generated during this investigation on the order of

20 to 100 gpm for long-duration pumping, and up to 500 gpm for shorter duration pumping (days to weeks) are within the range of previous investigations that used different methods.

3.3.10 Electrical, Communications, Refuge, Maintenance

3.3.10.1 Electrical Distribution

An underground 480V transformer will be placed near the entrance to the portal at the start of mining. This will supply power to electrical equipment used to develop the decline and to portable fans. A main powerline will be installed along the rib of the decline to carry 1.4 kilovolt (kV) when development has advanced far enough that carrying power at 480Vs becomes too inefficient. This line will be connected to a transformer that will be moved underground. Line power will also be extended to the location of the exhaust to supply power to the ventilation fans.

Upon completion of the decline to the first production level, and commencement of mine production activities, a second underground transformer will be purchased for use in the lower areas of the mine.

3.3.10.2 Mine Communications

Inside the mine, a leaky-feeder very high frequency (VHF) radio system will be used as the primary means of communication. The system will allow for communications between the underground mine and surface operations.

3.3.10.3 Refuge Station

Two emergency refuge stations are necessary in case of emergencies. The refuges are mobile, each can accommodate up to 20 people, and they will be arranged so that they are always no more than 1,000 feet from the areas where the mine operation personnel are located. Figure 29 shows an example of a refuge station.

Figure 29. Typical Mobile Refuge Station

3.3.11 Mining Rate

The following discussion of the Mining Rate is taken from the 2018 PFS commissioned by Paramount (MDA 2018). They used the Proven and Probable mineral reserves defined by Ausenco to create a mine production schedule using MineSched™ (version 9.1), which allows for the scheduling of both underground development and production. The primary inputs used to develop the schedule include:

- The resource block model with defined material types;
- Development centerlines drawn in the direction of mining;
- Solids representing the stopes or production areas to be mined;
- Locations defining stockpiles, processing plant, and waste dumps;
- Material movement definition;
- Mining sequence among developments and production areas;
- Development and production rates by location; and
- Definition of the periods to be used.

The naming convention for material types considered either ore or waste. Ore was assigned to four categories based on grade: high-grade (HG), medium-grade (MG), low-grade (LG), and sub-grade. Sub-grade is material that is below the mining economic cut-off grade (COG), but above the resource COG. The basic assumption is that a production drift that is economic to be mined will be processed in its entirety.

Waste development in each sublevel was estimated using the ratio of waste development footage per ore ton, calculated from the main level. Material movement allowed for all of the waste to be sent directly to the waste dump, which includes development tonnages mined. Material mined from the drifts will be routed to the stockpile and then re-handled into the plant.

An advance rate of 15 feet per day was assumed, which would yield 290 tons per day in a single cut. It was anticipated that two stopes could be mined during the day on some levels where

sufficient stoping areas would be available. Based on the number of headings, a maximum production of 290 tons per day would be possible with a single heading, or 580 tons per day for two headings on a level.

The PFS contemplates mining of primary and secondary stopes. This will require completion of the primary stope to allow placement and curing of the CRF before the secondary stope can be mined. Ausenco specified that there should be a 28-day delay between primary and secondary stopes to allow for curing time. Detailing the sequence between primary and secondary stopes will be completed as part of short-term mine planning. MDA reviewed each main level to determine a production rate based on the sequence of primary and secondary stopes. This was done by assigning a sequence number for each stope block and then reviewing the difference in the sequence number between the primary and secondary stopes. The difference between the primary and secondary stopes, together with the production rate, defined a maximum productivity that could be accomplished for secondary stoping based on the delay for the primary stopes to be backfilled. MDA determined the maximum tons per day for each main level (Table 74) and these values were also used for the sublevels below and above the main levels.

The final PFS production schedule was calculated in MineSched™ and then summarized in Excel. Ore loss and dilution were applied using Excel spreadsheets. Waste development rates were smoothed out in Excel by Ausenco. Table 75 , Table 76, Table 77 and Figure 30 are below.

Table 74. Maximum Productivity Estimate

	Level	Max Number of Headings	Maximum Tons per Day		
			Secondary	Headings	Used
Lower Levels	3068	1	200	290	200
	3081	1	200	290	200
	3094	1	275	290	275
	3107	2	400	580	400
	3120	2	500	580	500
	3133	2	690	580	580
	3146	2	850	580	580
	3159	2	900	580	580
	3172	2	900	580	580
	3185	2	900	580	580
	3198	2	900	580	580
	3211	2	1000	580	580
Upper Levels	3224	2	1100	580	580
	3237	2	1200	580	580
	3250	2	1300	580	580
	3263	2	1500	580	580
	3276	2	1500	580	580
	3289	2	1500	580	580
	3302	2	1200	580	580
	3315	2	1000	580	580
	3328	2	900	580	580
	3341	2	800	580	580
	3354	2	700	580	580
	3367	2	500	580	500
	3380	2	400	580	400
	3393	2	275	580	275
	3406	2	275	580	275
	3419	2	200	580	200
	3432	2	200	580	200
	3445	2	200	580	200
	3458	1	200	290	200
	3471	1	200	290	200
	3484	1	200	290	200
	3497	1	200	290	200
	3510	1	200	290	200
	3523	1	200	290	200

Table 75. Mine Production Summary

	Units	Pre-Prod	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Total
Mined Ore Above Economic	K Tons	-	135	182	189	178	163	169	63	11	-	1,089
COG	oz Au/ton	-	0.296	0.385	0.278	0.259	0.298	0.322	0.254	0.395	-	0.304
	K ozs Au	-	40	70	53	46	48	54	16	4	-	332
	oz Ag/ton	-	0.298	0.328	0.331	0.312	0.359	0.422	0.506	0.335	-	0.352
	K ozs Ag	-	40	60	63	55	58	71	32	4	-	383
Subgrade Ore	K Tons	-	76	90	83	95	110	102	45	7	-	609
	oz Au/ton	-	0.062	0.064	0.067	0.065	0.066	0.068	0.070	0.049	-	0.066
	K ozs Au	-	5	6	6	6	7	7	3	0	-	40
	oz Ag/ton	-	0.193	0.213	0.218	0.198	0.236	0.252	0.265	0.227	-	0.224
	K ozs Ag	-	15	19	18	19	26	26	12	2	-	136
Internal Waste	K Tons	-	1	1	2	1	1	1	1	0	-	8
Level Access Mined as Ore	K Tons	0	1	-	-	-	-	-	-	-	-	1
	oz Au/ton	0.149	0.115	-	-	-	-	-	-	-	-	0.125
	K ozs Au	0	0	-	-	-	-	-	-	-	-	0
	oz Ag/ton	0.141	0.221	-	-	-	-	-	-	-	-	0.199
	K ozs Ag	0	0	-	-	-	-	-	-	-	-	0
Total Mined to Stockpile	K Tons	0	214	274	274	275	274	271	109	18	-	1,708
	oz Au/ton	0.149	0.210	0.277	0.213	0.190	0.203	0.226	0.175	0.256	-	0.218
	K ozs Au	0	45	76	58	52	56	61	19	5	-	372
	oz Ag/ton	0.141	0.259	0.288	0.295	0.271	0.308	0.357	0.401	0.290	-	0.304
	K ozs Ag	0	55	79	81	74	84	97	44	5	-	519
Backfill Dilution	K Tons	0	4	5	5	5	5	5	2	0	-	31
Total w/ Ore Loss & Dilution	Tons	0	220	282	282	283	282	279	113	18	-	1,759
	oz Au/ton	0.142	0.199	0.261	0.201	0.181	0.192	0.213	0.166	0.241	-	0.206
	ozs Au	0	44	74	57	51	54	59	19	4	-	362
	oz Ag/ton	0.143	0.252	0.279	0.285	0.263	0.297	0.343	0.383	0.281	-	0.294
	ozs Ag	0	55	79	80	74	84	96	43	5	-	517

Table 76. Material Sent to the Mill

	Units	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Total
Internal Waste	K Tons	1	1	1	1	1	1	1	0	-	8
Sub-Grade Material	K Tons	74	83	76	88	103	98	87	7	-	616
	oz Au/ton	0.063	0.065	0.068	0.066	0.067	0.067	0.070	0.051	-	0.066
	K ozs Au	5	5	5	6	7	7	6	0	-	41
	oz Ag/ton	0.196	0.209	0.219	0.200	0.223	0.248	0.257	0.226	-	0.223
	K ozs Ag	14	17	17	18	23	24	22	2	-	137
Low-Grade Material	K Tons	94	114	130	130	111	121	45	5	-	750
	oz Au/ton	0.154	0.153	0.159	0.156	0.156	0.152	0.146	0.147	-	0.154
	K ozs Au	14	17	21	20	17	18	7	1	-	116
	oz Ag/ton	0.251	0.256	0.290	0.272	0.305	0.335	0.425	0.358	-	0.295
	K ozs Ag	24	29	38	35	34	41	19	2	-	221
Medium-Grade Material	K Tons	25	37	40	30	32	25	13	2	-	203
	oz Au/ton	0.315	0.318	0.310	0.301	0.297	0.304	0.319	0.321	-	0.309
	K ozs Au	8	12	12	9	10	7	4	1	-	63
	oz Ag/ton	0.294	0.327	0.341	0.334	0.294	0.395	0.683	0.372	-	0.352
	K ozs Ag	7	12	13	10	9	10	9	1	-	71
High-Grade Material	K Tons	19	34	22	20	21	25	6	3	-	150
	oz Au/ton	0.857	1.136	0.822	0.762	0.948	1.070	0.833	0.789	-	0.947
	K ozs Au	17	38	18	15	20	26	5	3	-	142
	oz Ag/ton	0.490	0.532	0.497	0.480	0.675	0.783	0.558	0.249	-	0.571
	K ozs Ag	10	18	11	10	14	19	3	1	-	86
Backfill Dilution	K Tons	4	5	5	5	5	5	3	0	-	31
Total to Plant	K Tons	217	274	274	275	274	274	154	18	-	1,759
	oz Au/ton	0.201	0.266	0.205	0.184	0.196	0.215	0.139	0.241	-	0.206
	K ozs Au	44	73	56	51	54	59	21	4	-	362
	oz Ag/ton	0.253	0.280	0.287	0.265	0.295	0.343	0.345	0.280	-	0.293
	K ozs Ag	55	77	79	73	81	94	53	5	-	516
Plant Throughput	TPD	594	750	750	750	750	750	423	50	-	

Table 77. Stockpile Balance

	Units	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Added	K Tons	220	282	282	283	282	279	113	18	-
	oz Au/ton	-	-	-	-	-	-	-	-	-
	K ozs Au	44	74	57	51	54	59	19	4	-
	oz Ag/ton	-	-	-	-	-	-	-	-	-
	K ozs Ag	55	79	80	74	84	96	43	5	-
Removed	K Tons	217	274	274	275	274	274	154	18	-
	oz Au/ton	-	-	-	-	-	-	-	-	-
	K ozs Au	44	73	56	51	54	59	21	4	-
	oz Ag/ton	-	-	-	-	-	-	-	-	-
	K ozs Ag	55	77	79	73	81	94	53	5	-
Balance	K Tons	3	12	20	28	36	42	-	-	-
	oz Au/ton	0.067	0.071	0.073	0.072	0.071	0.075	-	-	-
	K ozs Au	0	1	1	2	3	3	-	-	-
	oz Ag/ton	2.752	3.382	3.184	3.120	3.693	3.546	-	-	-
	K ozs Ag	1	3	5	6	10	11	-	-	-

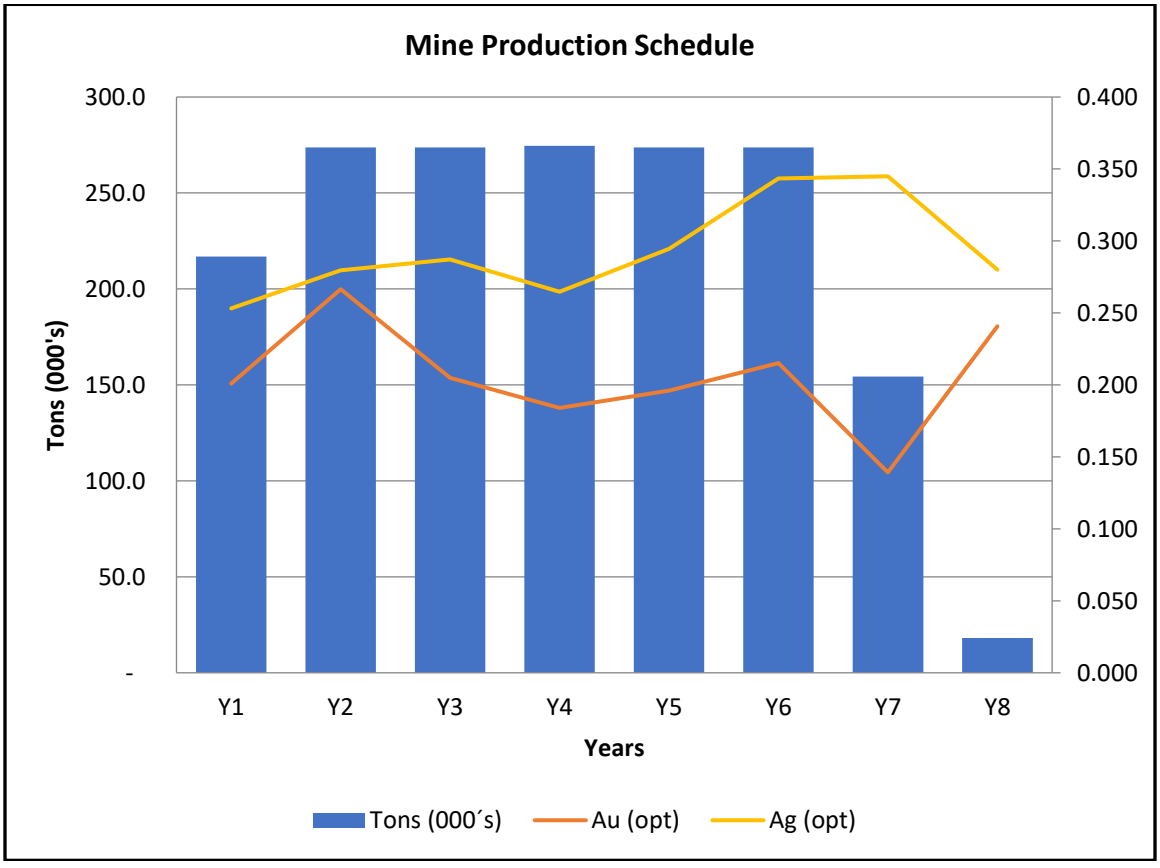


Figure 30. Mine Production Schedule

3.3.12 Milling and Refining

The following is a summary of the Mill Design Report, which is included with all drawings in Appendix D.

The intent of this section is to summarize the processes proposed for Grassy Mountain. It will address the following items from Chapter 340, Division 43 - Chemical Mining, by the Oregon Department of Environmental Quality:

- Description of the facilities to be constructed, including tanks, pipes, and other storage and conveyance means for processing chemicals, solutions, and wastewaters;
- Description of all chemical process and facilities for mixing, distribution, and application of chemicals associated with on-site mining operations, ore preparation, and beneficiation facilities;
- Description of all chemical conveyances (ditches, troughs, pipes, etc.) and the requisite equipment with secondary containment and leak detection means for preventing and detecting release of chemicals to surface water, groundwater, and soils.

The crushing and process plant consists of:

- Crushing and screening plant
- Ball mill grinding circuit
- Gravity and intensive cyanidation circuit
- Pre-aeration & CIL circuit
- Elution circuit
- Gold room
- Carbon regeneration
- Cyanide detoxification
- Reagent and air services
- Water services (raw water, process water, potable water)

The crushing plant consists of primary and secondary crushing producing a crushed ore product, which is then conveyed to feed the process plant. The CIL circuit cyanide is used to recover gold from the ore and activated carbon is used to adsorb the extracted gold from solution. Following the CIL circuit, the carbon is collected and treated in the elution circuit which separates the gold from the carbon. The carbon is regenerated and reused in the CIL circuit while the gold is removed from solution in the integrated electrowinning plant. The stripped gold is then smelted in a gold room to produce gold doré bars. Leached tails are detoxified in an INCO™ Air/SO_2 cyanide destruction circuit. Detoxified tails are pumped to a TSF for final deposition and recovery of decant water.

Figure 31 shows the key processing facility components.

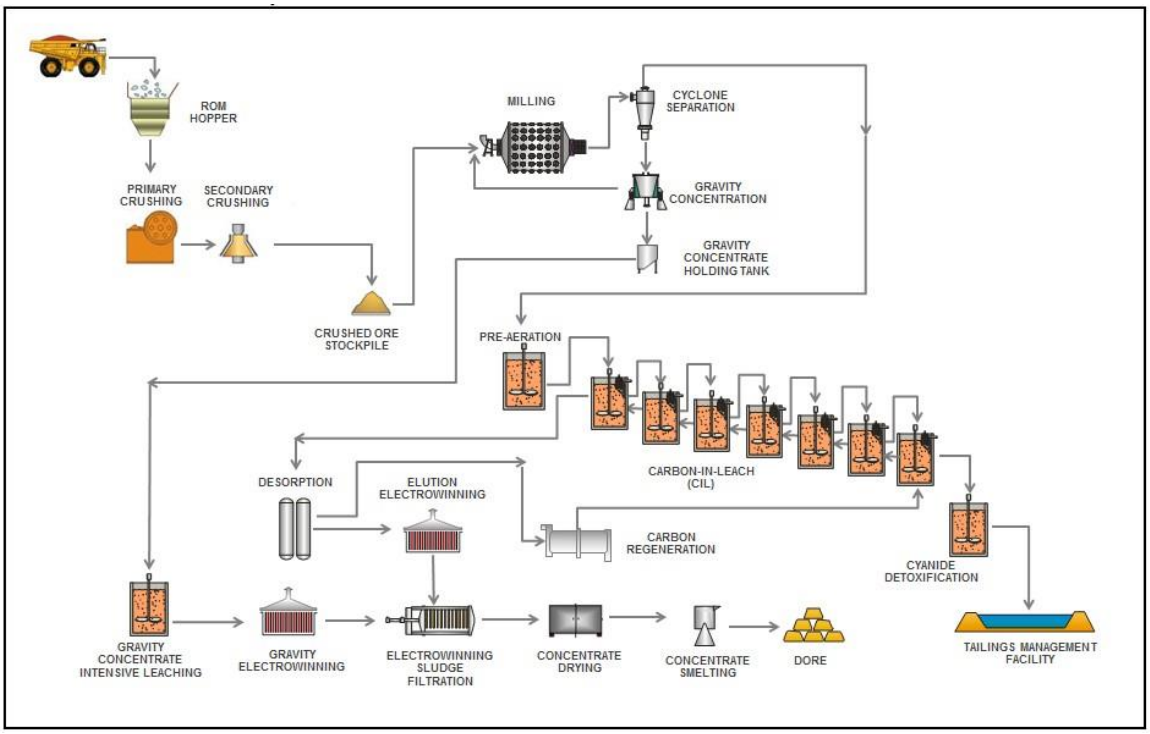


Figure 31. Grassy Mountain Process Flowsheet

3.3.12.1 Key Design Criteria

The key criteria selected for the plant design are:

- Average plant treatment rate of 700 short tons per day (st/d) on a solids basis
- Design crushing plant operating time of 70 percent (crushing/screening/conveying)
- Design process plant operating time of 91.3 percent (milling/leaching & adsorption/detoxification/elution/refining).

Drawing 101768-0000-F-001 in Appendix A of Appendix D shows the basic process design circuits and the selection of major equipment for the process plant.

The major process design criteria developed for the Project are outlined in Table 78.

Table 78. Grassy Mountain Process Design Criteria

Description	Units	Value
Ore Throughput	st/y	255,500
Design Grade - Au	oz/st	0.22
Design Grade - Ag	oz/st	0.35
Operating Schedule		
Crusher Availability	%	70

Description	Units	Value
Plant Availability	%	91.3
Throughput, Daily - average	st/d	700
Plant capacity, Hourly	st/h	32
Crushing (Two Stage)		
Primary Crusher	type	Single Toggle Jaw Crusher
Secondary Crusher	type	Cone Crusher
Fine Ore Stockpile Residence Time - Live	d	1
Grinding		
Circuit Type		Ball mill
Bond Ball Mill Work Index	Hp/st	25.8
Ball Mill, Dimensions	ft x ft	11 x 14
Ball Mill Power	hp	1072
Feed Particle Size, F80	in	0.394
Product Particle Size, P80	U.S. mesh	100
Gravity Concentration		
Overall Gravity Gold Recovery	%	10
Carbon-in-Leach		
Total Leach Time	h	24
Number of Tanks	#	1 pre-aeration + 7 leach / adsorption
Cyanide Addition	lb/st	0.82
Lime Addition	lb/st	2
Carbon Concentration	lb/ft^3	1.56
Carbon Loading (Au + Ag)	oz/st	175
Desorption		
Carbon batch size	st	3.3
Elution CIL strips per week	#	7
Gravity strips per week	#	7
Cyanide Destruction		
Method	-	Air / SO_2
Residence time	h	2
CNWAD not-to-exceed value	ppm	30

The descriptions in the following sections include references to Process Flow Diagrams (PFDs) which are included in Appendix B of Appendix D.

3.3.12.2 Crushing

ROM ore is transported by haul truck from the underground mining operation to the crushing plant area and fed either directly to the ROM hopper or to the coarse ore stockpile. Ore is received by the ROM hopper at the crushing plant before being discharged onto the vibrating grizzly feeder and fed to the primary crusher for the first crushing stage. The crushed ore is then collected onto the coarse ore conveyor which conveys the reduced ore to the coarse ore screen. The undersize from the screen is suitable for ball mill feed while the oversize is fed to the secondary crusher included in the crushing plant. The secondary crusher product is received by the coarse ore conveyor and is returned to the coarse ore screen along with new crushed product from the primary crusher, initiating the closed-circuit loop within the crushing plant. This process repeats itself to ensure that the ore has enough time to be reduced before moving on for further downstream processing. Reference PFDs: 101768-0000-F-002

3.3.12.2.1 Crushing Plant

The crushing plant operates seven days per week for the entire year with an availability of 70 percent. The nominal throughput is 42 short tons per hour (st/hr). The crushing plant consists of one of each of the following: ROM hopper, vibrating grizzly feeder, primary crusher, coarse ore screen, and secondary crusher. The ROM ore is received at a ROM hopper having a capacity 353 cubic feet (ft^3), filled either directly by the dump truck or by using a front-end loader that draws from the ROM ore stockpile. The ROM hopper is equipped with a static grizzly, and particles larger than the grizzly can be removed for individual breakage. The ore passes over a vibrating grizzly feeder leaving the ROM hopper before is fed to the primary crusher. The vibrating grizzly feeder allows for smaller material to pass directly though the feeder and onto the coarse ore conveyor, allowing for more efficient crushing in the primary crusher. The ore passing over the vibrating feeder is then reduced by a primary crusher and discharged onto the coarse ore conveyor as well.

The coarse ore conveyor transports the crushed ore to the coarse ore screen, where the undersize is collected and conveyed for mill feed, while the oversize is sent to the secondary crusher to be reduced further. The secondary crusher discharge is recirculated to the coarse ore screen to repeat the size classification step. A metal detector is included in the crushing plant to recognize any metal debris that could potentially cause damage to the crushing equipment.

The product from the crushing plant is conveyed to the crushed ore stockpile to be sent to the grinding circuit in the process plant. The stockpile conveyor is fitted with a weightometer to monitor crushing plant throughput and assist with operational and metallurgical accounting. The fine ore stockpile has a live capacity of one day, the equivalent of 750 short ton (st) of live material. This material is collected with a front-end loader which deposits the fine ore into the fine ore reclaim hopper.

3.3.12.3 Grinding

The grinding circuit receives the fine ore product at the ball mill feed conveyor which then deposits the material at the mill feed chute. The ore is ground to a desired product size with the addition of process water and steel ball grinding media. The ground ore slurry is discharged to the cyclone feed pumpbox and pumped to the cyclone cluster pack to be classified into cyclone overflow stream, dominated by fine particles, and cyclone underflow stream, dominated by coarse particles. The overflow stream is sent to leaching process while the underflow is split into two streams, which one reports back to the ball mill and the other one reports to the gravity concentration and intensive leaching circuit. Reference PFDs: 101768-0000-F-002; 101768-0000-F-003

3.3.12.3.1 Ball Mill

The fine ore stockpile allows for over 24 hours of continuous milling operation at the nominal feed rate of 31.9 st/hr. A front-end loader is used to transport the fine ore from the stockpile to the fine ore reclaim hopper, which has sufficient capacity to provide the grinding circuit with one hour of feed. The fine ore is fed to a 11 feet by 14 feet (d x EGL) overflow ball mill, which is operated at 75 percent of the critical speed and with a normal operating ball mill charge of 35 percent on a volumetric basis. Ore addition to the ball mill is supplemented with process water to achieve a milling density of 72 percent solids (by weight). The ball mill also receives a nominal circulating load of 350 percent from the underflow portion of the cyclone cluster. To avoid damage to the cyclone feed pumps and cyclone cluster, the ball mill discharge is screened through a trommel to scalp off oversized particles and broken grinding media. The scalped off materials are then stored in the scats bunker. The aperture size of the ball mill trommel is the same as the product size leaving the crushing plant. The oversize material will be manually removed periodically.

The trommel screen undersize slurry from the ball mill is discharged to the cyclone feed pumpbox, diluted to 61 percent solids with process water, and pumped to two classification cyclones (one duty and one standby).

3.3.12.3.2 Cyclone Classification

The cyclone cluster operates in a closed-circuit with the ball mill and is configured to achieve a target cyclone overflow product size. The cyclone cluster has one operating and one standby unit with pneumatically actuated valves that allow automated feed pressure control, as well as manually actuated isolation valves.

The slurry from the cyclone cluster underflow launder flows to the manual splitter box which splits approximately 33 percent of the cyclone underflow to the gravity concentrator via a scalping screen to remove particles larger than ten mesh (0.08”). The remaining portion is recirculated back to the ball mill for further grinding.

The cyclone overflow slurry from the cyclone clusters gravity flows to a trash screen distributor where the slurry is distributed over the trash screen to remove any plastic, steel, wood, and organic refuse coming from the mine. The overflow slurry density is nominally 42 percent solids.

A sump pump is installed in the grinding area to facilitate clean-up. The pump discharges into the cyclone pumpbox. Maintenance activities in the grinding and classification area are serviced by the mill area crane (33 st) and the grinding area hoist (3.3 st) which will be used for ball mill charging duties and minor lifts.

3.3.12.4 Gravity Circuit and Intensive Cyanidation

The gravity circuit included in the process plant receives a portion of the cyclone cluster underflow slurry that is passed through the gravity scalping screen. The slurry is treated by the gravity concentrator to recover free gold from the slurry into gravity concentrate. The concentrate is transported to the intensive leach reactor system by fluidization water. During this stage, the gravity concentrate is exposed to cyanide leaching resulting in high gold extraction. The pregnant solution is pumped to the electrowinning area while the tailings are recirculated back to the ball mill for further grinding. Reference PFDs: 101768-0000-F-003; 101768-0000-F-004

3.3.12.4.1 Process Background

The gravity concentration and intensive leaching reactor circuit offers several advantages by:

- Reducing the exposure and accumulation of gold in grinding equipment
- Reducing the quantity of loaded carbon to be eluted
- Reduces the chances of losing gold to tailings from the CIL circuit either from:
  - Incomplete leaching of gold, or
  - operational fluctuations causing inefficiencies in carbon adsorption.

The concentrating portion of the process allows for free gold to be separated from the gangue material through the principal of a centrifuge, where the heavier gold particles are collected in the bowl of the concentrator while the lighter gangue material overflows and are removed back to the ball mill. This allows the free gold to be recovered with minimal processing, reducing the risk of losing gold to tailings and grinding circuit. Once the gold concentrate has reached its specified loading, fresh water is used to move the concentrate to the intensive leaching area without exposing it to any contaminants in the process water. The size and number of gravity concentrators required depends on the throughput and rate at which free gold is collected.

The intensive leaching reactor circuit is typically a packaged system designed to receive a concentrated coarse gold bearing ore product from the gravity concentrator. These systems, as well as all other gold leaching circuits, rely on the fundamental leaching reaction seen below, known as the Elsner Equation.

$$4Au(s) + 8NaCN(aq) + O_2(g) + 2H_2O(l) \rightarrow 4NaAu(CN)_2(aq) + 4NaOH(aq)$$

From this equation it can be observed that the reaction relies heavily on sodium cyanide and oxygen to complete the gold leaching reaction. Dissolved oxygen oxidizes the gold resulting in the formation of the soluble gold complexes. Sodium hydroxide is added to provide a basic pH environment required to prevent cyanide ions from reacting with hydrogen cations to form hydrogen cyanide. As such the reagents and dosages supplied to the intensive leaching reactor must be able to satisfy these requirements. Oxygen is supplied through a hydrogen peroxide tote and dosing pump located in the intensive-leach reactor (ILR) area. Adequate concentration of oxygen is essential for the cyanidation reaction, and its absence will prevent the reaction from occurring. Additional reagents can also be included depending on the specific process or a specific operational objective.

After the addition of the initial levels of reagents along with the required water and gravity concentrate, the agitator is started, and the leaching reaction begins. Dosing rates of reagents are calibrated to optimize the process, depending on the ore in question. The leaching reaction lasts several hours before the gold is leached into the pregnant leaching solution and transferred to the electrowinning area for gold plating. Tailings from the reactor typically are collected and recirculated to the grinding area. Gold recoveries using this process are typically above 95 percent.

3.3.12.4.2 Scalping Screen and Gravity Concentrator

A portion of the cyclone underflow slurry is directed to one gravity circuit scalping screen where oversized material is subsequently sent back to ball mill, while the undersize is supplied to a single gravity concentrator. Nominally 90 percent of the slurry received by the screen passes and is received by the gravity concentrator, while the remaining 10 percent is oversized and recirculated back to the ball mill. Process water is added to the screen feed stream to reduce the percent solids from 76 percent to 55 percent, allowing for improved screening efficiency.

The centrifugal gravity concentrator is an automated batch process. Feed is received from the cyclone underflow for a specified time. When one concentration cycle is finished, the feed stream is paused and the bowl stops spinning to allow the concentrate that has been built up in the bowl to be flushed to the concentrate holding tank. After the flushing, a new concentration cycle starts again. Gravity concentrator tails flow back to the ball mill during the feeding portion of the cycle. Cycle times are 45 minutes each and about 46lb of concentrate is expected from each cycle of the selected unit. Cycle time is manually adjusted based on the head grade and circuit performance.

Flushing water rinses the gravity concentrate to a gravity concentrate holding tank located beneath the concentrator. Water is continually decanted as the gravity recoverable gold concentrate accumulates in the hopper. Access to the gravity concentrator holding tank is restricted, and only authorized personnel are allowed access.

Once per day the concentrate accumulated in the gravity concentrate holding tank is pumped to the intensive leach reactor where it is dosed with sodium hydroxide and high levels of sodium cyanide.

3.3.12.4.3 Intensive Leach Reactor

Following gravity concentration, the concentrate is held by the gravity concentrate holding tank before being supplied to one intensive leach reactor. The agitated reactor is dosed with sodium hydroxide, sodium cyanide, hydrogen peroxide and flocculant/leach aid to facilitate the high-cyanide gold extraction reaction. A complete cycle for the concentrate to be fully leached will take 24 hours and is operated daily. The gold bearing pregnant solution is then pumped to the gravity electrolyte tank for the electrowinning process. Tailings from the reactor are collected and pumped back to the ball mill feed chute.

Given the nature of the process, cyanide specific design considerations are implemented for both personnel safety, equipment integrity and operational performance. Control valves and alarm interlocks are utilized to ensure the operation is performed within an acceptable pH range and will also monitor the presence of hydrogen cyanide; a toxic gas evolved from cyanide bearing solution when pH values are lowered out of the operating range. The area will be equipped with hydrogen cyanide monitors, and operators will wear hydrogen cyanide badges to alert them of any potential evolution of cyanide gas in the area. The sodium cyanide solution is monitored by operator titration, ensuring that the dosing concentration is suitable for the intensive leaching reaction. Piping providing cyanide solution is socket welded stainless-steel connection, with double block and bleed isolation valving. The area is also designed to account for complete containment of all process vessels. Standard operating procedures are developed to accurately describe the methods and equipment required to achieve these tasks safely.

3.3.12.5 Carbon-in-Leach

The overflow slurry from the cyclone cluster is initially screened by the trash screen to prevent any debris that could impact the gold extraction or recovery to reach the CIL circuit. After passing through the screen the slurry reports to the pre-aeration tank where the slurry is pre-treated with air to ensure optimal gold extraction and minimize cyanide consumption. Following pre-treatment, the slurry flows through the leaching tanks. During this stage the slurry and activated carbon flow counter-currently throughout the CIL tanks. Carbon is added to the last tank and sequentially pumped to the first tank, while slurry is added to the first tank and flows to the last. Most of the metal extraction from ore to solution occurs at the front end of the circuit, while adsorption from solution to the carbon primarily occurs towards the end of the circuit. The slurry exits the final tank and is sent to the carbon safety screen before being treated for tailings storage. The loaded carbon exiting the first CIL tank is pumped to the loaded carbon screen in the elution circuit to be prepared for acid washing and elution. Reference PFDs: 101768-0000-F-005

3.3.12.5.1 Process Background

The CIL circuit is responsible for the gold leaching and carbon adsorption of the main slurry stream coming from the grinding circuit. It utilizes a counter-current flow of activated carbon in reference to the slurry flow to optimize the gold extraction and recovery. After the grinding circuit the ore particle size should be sufficiently reduced so that the gold in the ore is exposed allowing for the leaching reaction to occur.

In the presence of sulphide species native to the ore, the leach rate of gold into solution can be influenced by the amount of dissolved sulphur and the oxygen concentration in solution. A pre-aeration tank is used to oxidize and precipitate soluble species such as sulphides to prevent them from consuming oxygen during the process. A pre-aeration tank can also prevent a passivation layer from forming over the ore that hinders the leaching process. This passivation layer is often caused due to sulphide species forming sulphur monolayers on the surface of the exposed gold in the ore.

In this circuit the leaching reaction follows the same reaction shown in the intensive leaching reaction.

$$4Au(s) + 8NaCN(aq) + O_2(g) + 2H_2O(l) \leftrightarrow 4NaAu(CN)_2(aq) + 4NaOH(aq)$$

Sodium cyanide is dosed into the front end of the circuit along with air additions to facilitate the dissolution of gold into solution. The rate of the gold extraction is highest in the first tank where the reaction begins and rapidly decreases as the gold in the ore becomes scarcer. The extraction eventually reaches a plateau point where all the recoverable gold has been leached into solution in the form of a soluble and stable cyanide-gold species. With the gold in solution, the adsorption process will then recover the dissolved gold onto activated carbon to be recovered in the elution circuit.

The availability of free cyanide in solution is dependent on the pH of the solution. At a lower pH less cyanide ions are retained in solution while more are evolved as hydrogen cyanide molecules. From this relationship we can determine that the desired result is to have the free cyanide ions stay in solution at high pH. This is true for both safety and operation, as hydrogen cyanide gas is toxic to operators and cyanide must be in solution to perform the leaching reaction. For this reason, the CIL circuit is operated in a basic environment maintained through the addition of hydrated lime.

In solution the sodium-gold-cyanide complex dissociates into a negative gold-cyanide anion and a positive sodium cation. The negative gold-cyanide ion in solution preferentially pairs with a positive ion found in solution based on reduced activation energy. The addition of lime in the CIL circuit ensures sufficient calcium is available to produce an ionic pair between the gold-cyanide anion and the calcium cation resulting in a stable pair with neutral charge. The importance of this lies in the fact that the surface of activated carbon has a neutral charge and for species to adsorb to it they also require a neutral charge.

$$2Au(CN^{-})^{-} + Ca^{2+} \leftrightarrow_{2} Ca\ (Au(CN2))2\ (ion\ pair)$$

As both the ion-pair and the surface of the carbon are neutral, no reaction occurs between the two items and the adsorption process is dependent on process parameters. Key parameters include mixing efficiency, slurry density, particle size of carbon, cyanide concentration, slurry pH and gold concentration among others used to design the adsorption process of a specific operation.

With the activated carbon being introduced in the last tank and moving towards the first tank the greatest gold recovery occurs in the last tank of the CIL circuit and progressively diminishes as the carbon advances through the tanks with increasing gold loading. After the fully loaded carbon is reaches the first tank of the circuit, the final transfer pump transports the loaded carbon to the next stage for the acid wash and elution stages.

Test work determined that the gold is leached to completion with a residence time of 24 hours. Carbon management modelling determined that seven leach stages were required, the optimum carbon concentration is 1.56 lb/ft^3 and advance rate to minimize solution losses is three tonnes per day.

3.3.12.5.2 Pre-Aeration and Carbon-in-Leach Tanks

The leach feed slurry from the cyclone cluster overflow reports to the pre-aeration and CIL circuit. The slurry will first reach one pre-aeration tank where low-pressure air addition is added prior to the introduction of cyanide. Lime is added to adjust the solution to a pH of 10-10.5. Following the pre- aeration step the slurry will then flow to a series of seven open top CIL tanks.

In the CIL tank train, the gold bearing slurry is brought into contact with cyanide and dissolves the gold from the ore into solution by forming stable gold-cyanide complexes in the presence of sparging air. The pH of slurry in the tanks is monitored and lime is added as necessary at several points in the CIL circuit to maintain target (10-10.5 pH typical). Low pressure compressed air is blown into slurry in the tank through blowers and dispersed using dispersion cones located at the bottom of the agitator.

Slurry exiting each tank flows by gravity to the next through an up-comer inside the tank to an overflow launder. Each tank is connected to the next two tanks via overflow launders with knife gate valves for tank isolation on each discharge point. This arrangement will allow the slurry to bypass the next tank in the series if one of the downstream tanks must be taken out of service for maintenance. Once the slurry discharges at the final tank, the slurry gravity flows to the carbon safety screen.

The purpose of the activated carbon is to recover gold from leached slurry. The gold is recovered by bringing the leached slurry, containing gold in solution, in contact with the carbon so that the dissolved gold can be loaded onto it through the process of adsorption. Each CIL tank is equipped

with an agitator, an inter-stage screen to retain the carbon and a carbon advance transfer pump. Slurry in the first tank flows through the inter-stage screen to the next tank via an overflow launder while the screen holds back the carbon from moving to the next tank. Each subsequent tank in the series sends slurry to the next tank until the slurry reaches the last tank which then gravity flows out to the cyanide destruction circuit by the carbon safety screen. Carbon flows through the circuit in the opposite direction, through carbon advance pumps in a batch process. The carbon is transferred once per day and is retained in the tanks by the inter-stage screens. Once the carbon has been transferred through all CIL tanks to the first tank in the train, the loaded carbon recovery pump will transfer the loaded carbon to the loaded carbon screen before being treated in the elution circuit.

As the nature of the process is similar to that of intensive leaching, similar safety considerations are implemented. Cyanide monitors will be installed at the top of the tanks and at ground level. Control valves, and alarm interlocks are utilized to ensure the operation is performed within an acceptable pH range and will monitor the presence of hydrogen cyanide. Operators are also equipped with hydrogen cyanide badges to alert them of any potential generation of cyanide gas. The sodium cyanide solution will be monitored by operator titration, ensuring that the dosing concentration is suitable for the leaching and adsorption reactions. Standard operating procedures are developed to accurately describe the methods and equipment required to achieve these tasks safely.

3.3.12.6 Acid Wash and Elution

Carbon containing slurry from the CIL circuit is transferred by the loaded carbon recovery pump to the loaded carbon screen in preparation for the acid wash and elution steps. The undersize slurry from the screen is sent back to the pre-aeration tank while the carbon retained in the oversize fraction reports to the acid wash column. During the acid wash stage, acid soluble contaminants that were adsorbed onto the surface of the loaded carbon are removed using a dilute HCl stream followed by a rinse water cycle to clean the acid washed carbon before moving onto the elution step. The acid rinsed carbon is then transferred from the acid wash column to the elution column. During this step a strip solution of sodium hydroxide and cyanide is heated and is passed through the carbon in the elution column. This process reverses the kinetics of the gold loading onto the carbon and brings the gold into solution. The gold bearing solution also known as the pregnant solution then flows to the gold room where the gold will be recovered in the electrowinning process. Once the loaded carbon has been stripped of gold it is considered barren carbon and is transferred to the carbon regeneration area. Reference PFDs: 101768-0000-F-006

3.3.12.6.1 Process Background – Elution

Loaded carbon will undergo the desorption process where the loaded carbon is acid washed and eluted. The underlying principle during these stages is that the stable gold complexes loaded on the carbon must be changed so that they separate from the carbon.

The loaded carbon is initially received from the adsorption stage to a loaded carbon screen, where the carbon and slurry are separated. The carbon is then fed to one acid wash tank where a dilute HCl solution is passed through. This process removes undesirable contaminants such as calcium carbonate from the surface of the carbon that would otherwise move forward to the elution column. The acid wash cycle is done at ambient conditions. Rinse water is passed through to remove residual acid and protect downstream equipment from low pH conditions.

Once the loaded carbon is acid washed it is transferred from the acid wash column to one elution column. In the elution stage a solution of sodium hydroxide and sodium cyanide, called the strip solution, is heated under pressure and flows up through the elution column. During elution the adsorption kinetics that initially bonded the gold complexes to the carbon are reversed and the gold is brought back into solution. This solution flows from the elution column to the electrowinning cells.

After the stripping of the pregnant solution by the electrowinning cell, the solution has trace amounts of gold remaining that will not be recoverable in electrowinning. Due to need for new reagent additions and water top ups, a certain portion of the barren solution will be bled to the CIL circuit, where the gold has the potential to be re-adsorbed.

3.3.12.6.2 Loaded Carbon Screening

Once the carbon in the first CIL tank is completely loaded, carbon slurry is pumped to the loaded carbon screen where the loaded carbon is screened and separated from the slurry under water spray. Water sprays on the vibrating screen decks wash off process slurry from the loaded carbon. The loaded carbon gravity flows to the acid wash column ahead of the elution cycle, and the slurry returns to the pre-aeration tank.

3.3.12.6.3 Acid Wash

The loaded carbon from CIL tanks recovered on the loaded carbon screen is directed to an acid wash column. Acid soluble foulants which have loaded onto the carbon are dissolved during the acid washing stage. Hydrochloric acid (HCl) is diluted with fresh water to provide the required acid wash solution concentration of 3 percent HCl and injected into the acid wash column. The solution will soak in the acidic solution for 30 minutes.

Following acid solution contact, the carbon is rinsed with fresh water to remove residual acid of the liquor in the carbon column at a rate of two bed volumes (BVs) per hour. The neutralized acid solution is drained back to the acid solution circulation tank. Washed carbon is then hydraulically

transferred to the elution column using pressurized transport water supplied by a transport water pump.

3.3.12.6.4 Elution

The elution system comprises an elution column, strip solution tank, strip solution pump and an elution heater package. Strip solution (eluate) is made up in the strip solution tank using raw water dosed with two percent sodium hydroxide and 0.2 percent cyanide to form an electrolyte for the electrowinning process. The eluate flows upwards through a stationary bed of loaded carbon at a flow rate of about two BVs per hour at 275°F. The elution system is pressurized to keep the solution from flashing to steam in the heater or elution column. At this temperature gold that was previously adsorbed on the carbon is desorbed from the carbon by a reversal of the adsorption kinetics.

The direct electric strip solution heater is designed to increase the temperature of the strip solution up to 275°F (135°C) for the stripping cycle. Additionally, an elution recovery heat exchanger ensures that the nominal temperature of the pregnant solution directed to the electrowinning cells is below boiling to prevent flashing.

Following the elution process, gold is recovered from the pregnant strip solution with a single electrowinning cell located inside the gold room (the gravity circuit has its own electrowinning cell). The pregnant and barren solution streams will be pumped between the elution plant and electrowinning cell in a dual contained pipe with flow meters positioned at both ends for leak detection.

The gold depleted solution from electrowinning is then re-heated and recycled to the elution column for additional stripping.

Given the use of sodium cyanide during the elution of the loaded carbon, additional steps are included to ensure safe and efficient operation. The pH of the solution will be properly buffered using sodium hydroxide, utilizing control valve interlocks to ensure the process is operating at the designed operating parameters.

3.3.12.7 Carbon Regeneration and Management

After the completion of the elution stage, the barren carbon is transported to the carbon regeneration area to treat the used carbon to be recycled for the adsorption process. The carbon is first screened through the kiln dewatering screen, where the oversize will report to the horizontal kiln while the undersize carbon and water are collected in the carbon fines clarifier. The carbon in the kiln is exposed to elevated temperatures to remove any remaining foulants that could impact the adsorption process. The carbon is then received by the quench tank for cooling before being sent to the carbon sizing screen in the CIL circuit. The fine carbon reporting to the clarifier is collected with the use of a filter press for further off-site processing, while the process

water from the clarifier overflow is received by the transfer water tank for application in the elution circuit. Reference PFDs: 101768-0000-F-007

3.3.12.7.1 Carbon Regeneration

After completion of the elution process, barren carbon is hydraulically transferred from the elution column to a kiln dewatering screen. The screened carbon is fed into the kiln feed hopper then metered into a carbon regeneration kiln. The carbon regeneration kiln is a horizontal, rotary, electrically heated unit and reaches a temperature of at least 1400°F (750°C) to regenerate the stripped carbon.

Regenerated carbon discharges by gravity from the kiln to a quench tank to cool down and is then transferred via recessed impeller transfer pump to the carbon sizing screen. The barren carbon is then screened and reports to the last tank in the CIL adsorption train.

Fine carbon is received by the carbon fines clarifier, which then settles to the bottom of the tank while water overflows out of the top. The underflow of the clarifier is batch fed to the carbon fines filter, which removes additional water allowing the fines to be bagged and may be sold for further gold recovery at an offsite location.

3.3.12.7.2 Carbon Pre-attrition

Bags of new carbon are processed in a pre-attrition tank before being sent to the leach circuit. This process breaks off the corners of the angular coconut shell-based carbon particles, and the fine particles are collected. The fine particles are too small to be retained by the leach tank inter-stage screens and would therefore pass through to leach tails. Without this step the sharp corners of the loaded carbon particles would be broken off in the leach circuit and these carbon fines would flow to tails carrying the gold they had adsorbed causing gold losses.

The new carbon is charged to the pre-attrition tank via a bag breaker where water is added to produce an effective solids density of about 50 percent carbon. A high intensity agitator stirs the carbon slurry vigorously to break off the sharp corners, reducing the angular particles to a more rounded shape. Once complete, the new carbon is pumped to the regeneration kiln quench hopper where it is stored before being added to the leach circuit. Fresh and regenerated carbon passes over a barren carbon sizing screen, which also separates and removes fines.

3.3.12.7.3 Carbon Transport Water

All carbon movements in the elution and regeneration circuits are accomplished using carbon transport water. A transport water tank and pump are provided to supply transport water to carbon movement demands as needed.

As an example; when moving carbon from the acid wash column to the elution column, the carbon is drained into a venturi with transport water passing through it in sufficient quantity and velocity to carry it to the next destination at an effective solids density of about 20 percent. As the carbon arrives at the elution column, strainers in the column discharge ports allow the transport water to exit the column while retaining the carbon.

Transport water picks up fines when moving carbon from one place to another as a result of both the previous process and the attrition associated with the carbon movement itself. Once the movement is complete, strained or decanted transport water reports to a carbon fines clarifier where flocculant settles the fines and the overflow water recharges the transport water tank. Process water is added as necessary to maintain the level in this tank. The carbon fines are removed from the clarifier underflow periodically and shipped to the refinery to recover contained precious metal values.

3.3.12.8 Electrowinning and Gold Room

The elution circuit and the intensive leach reactor circuit both produce a gold bearing solution that will flow through electrowinning cells to remove the gold from solution and onto cathodes. The flow of pregnant solution and the electrical current is controlled for operation under optimal gold plating parameters. The plated gold is removed from the cathodes with the use of a high-pressure cleaner and the gold sludge is collected in the electrowinning sludge filter feed tank. The sludge is pumped through a filter and then moved by hand to the drying oven. The smelting of the dried sludge is then completed by hand and ultimately produces the final doré bars. Reference PFDs: 101768-0000-F-008

The gold room houses the electrowinning cells, smelting furnace, and associated support equipment within a security envelope which limits access to authorized gold room personnel only. Access and egress are controlled by security personnel at both a man door and a vehicle access roll up door for the armored car. The armored car door is enclosed by a fence with an automated gate controlled by security personnel. The exception to this is an emergency exit door which sets off alarms when opened from the inside.

3.3.12.8.1 Electrowinning

Two electrowinning sludging cells are located on the upper floor within the gold room. One electrowinning cell is dedicated to the intensive cyanidation circuit and the other to the elution circuit. The rectifiers associated with the electrowinning cells back onto the gold room wall, allowing easy access for operations and maintenance outside the secure area of the gold room.

The electrowinning cell dedicated to the intensive cyanidation circuit is fed eluate via a fixed speed centrifugal pump from the gravity eluate storage tank. Eluate is pumped to the electrowinning cell and then gravitates back into the gravity eluate storage tank in a closed loop until suitable gold recovery is achieved. The electrowinning cell dedicated to the elution circuit operates in a closed loop with the elution column and associated equipment. Eluate flows directly from the top of the elution column to the electrowinning cell after cooling through heat exchangers. The eluate flows through the electrowinning cell and then gravitates back to the strip solution tank and is pumped to the elution column in a continuous closed loop. Both cells extract gold by passing a current through the liquid solution, resulting in metal extraction through electroplating onto the cathodes within the cell.

Periodically, high pressure spray dislodges sludge from the cathodes and cell floor to a sludge hopper. A positive displacement pump feeds a plate and frame filter from the sludge hopper where the moisture content of the sludge is reduced. The pressed filter cake (gold sludge) is loaded from the plate and frame filter into trays on the electrowinning sludge trolley. The trays slide into the gold room drying oven, which heats the sludge to remove the entrained moisture.

3.3.12.8.2 Smelting

The dried and cooled sludge is combined with fluxes (silica, nitre, borax and sodium carbonate) in the flux mixer. The fluxes are manually added to the flux mixer after they are weighed. The sludge- flux mix is direct smelted in an electric furnace. The fluxes react with base metal oxides to form a low viscosity, free flowing slag, whilst the gold and silver remains as a molten metal.

The gold doré is poured into a cascade pouring table of doré moulds. The slag (non-precious metal compounds) is separated from the precious metal and collected in slag trays at the bottom of the cascade tables. The doré bars solidify and are quenched in water, cleaned to remove slag, weighed, stamped for identification, sampled for analysis and stored in a safe while awaiting dispatch.

3.3.12.9 Cyanide Detoxification

Tailings from the CIL circuit that no longer contains economically recoverable gold will flow to the carbon safety screen prior to reaching the cyanide detoxification stage. The slurry contains cyanide species that are not suitable for release from the process plant, and therefore a detoxification process is completed. In this circuit reagents are added to facilitate the breakdown of cyanide species to acceptable levels before reporting to the tailings pumpbox and sent to the TSF. Reference PFDs: 101768-0000-F-009

3.3.12.9.1 Process Background

The cyanide detoxification stage of a gold processing operation is the location where the process slurry reports prior to tailings storage to reduce the level of WAD cyanide and in turn the total cyanide released from the plant.

WAD cyanides are described as weak metal complexes that form during the leaching stage of the operation. Typical metals seen in these complexes include copper, zinc and nickel. The concern with these complexes is that they dissociate in solution to produce an environmentally significant concentration of free cyanide that could pose a risk to the environment and wildlife or persist on a longer-term basis due to a resistance to natural degradation.

The detoxification circuit receives all of the slurry from the upstream processes with the addition of acid rinse solution from the elution circuit and sump slurry on an intermittent basis from several areas within the plant. During the detoxification process the reaction will convert the free cyanide in solution to the less toxic cyanate ion. This is achieved through the SO2/Air reaction utilizing a copper catalyst, and the reaction is shown below.

$$CN^{-} + SO_2 + O_2 + H_2O \rightarrow OCN^{-} + H_2SO_4$$

The free cyanide and WAD cyanide are oxidized during the reaction to form cyanate and sulphuric acid. The reaction typically operates in the pH range of 8 to 9 therefore requires the addition of lime to counteract the acid production.

Sodium metabisulphite (Na2S2O5), also known as SMBS, is the source for SO_2 in the Air/SO_2 process. The reaction also requires a soluble copper catalyst to achieve the cyanide reduction. The copper is typically administered in the form of a soluble copper sulphate pentahydrate solution.

Iron cyanide removal is initiated by the reduction of iron from the ferric to the ferrous state. Following this step, the reaction will then react with a soluble metal cation to produce a precipitate. The same will be the case for trace metals that will be precipitated as their hydroxides. The remaining thiocyanate and cyanate are reduced by means of oxidation and hydrolysis respectively.

Through this process the key cyanide species of interest are converted into chemical species acceptable for discharge to the tailing's storage facility.

Once in the tailing's management facility processes such as photodegradation by UV light and biodegradation will also contribute to the minimization of cyanide species in a lined TSF where precautions are implemented to minimize the impact to wildlife.

3.3.12.9.2 Carbon Safety Screen

Tailings from the CIL circuit flows by gravity to a carbon safety screen. The safety screen retains any carbon that has reported with the slurry due to a leak in inter-stage screen mesh or seals in the CIL circuit. Water sprays are used on the vibrating screen deck to wash off process slurry from the carbon particles before reporting to a tote box. Screen underflow flows to the cyanide detoxification tanks.

3.3.12.9.3 Cyanide Detoxification Tanks

The cyanide detoxification circuit provides sufficient residence time for the detoxification reaction. In addition to leach tails, the tanks receive acid wash effluent from the acid wash column and the area sump pump discharge on an intermittent basis.

The cyanide detoxification circuit reduces weak acid dissociable cyanide (CNWAD) to a target value. Air supply for the detoxification reaction is supplied to each cyanide destruction tank via a dispersion cone mounted to the bottom of each tank to maintain a high redox potential, maximizing oxidation of cyanide. The tanks utilize dual-impeller high shear agitators to enhance air dispersion and dissolution in the slurry to meet the oxygen demand of the cyanide destruction process. A SMBS solution (the source of SO_2) is added to the slurry in the tanks. Copper sulphate solution, when needed, is dosed as catalyst for the cyanide detoxification process while lime slurry is added from a ring main into each tank to maintain a desired pH between 7.0 and 9.0. pH monitoring and HCN gas monitors will be interlocked with control valves to prevent detect the evolution of HCN gas. Operators will also wear personal HCN badges or monitors. The slurry will be reduced from a CNWAD concentration of 100 ppm from the CIL circuit to below the not-to-exceed limit of 30 ppm. The final CN concentration will be monitored by operator titration to ensure compliance with the target discharge limit and the not-to-exceed regulatory limit of 30 ppm.

3.3.12.9.4 Tailings Discharge

Detoxified slurry overflows the second detoxification tank to the final tailings pump box, where it is then pumped to the TSF by two final tailings pumps (1 duty / 1 standby). The tailing slurry flows through a tailings discharge pipeline and will have dual containment initially provided through a buried pipe-in-pipe configuration, before daylighting to an HDPE lined containment trench. At the TSF the tailings are deposited using spigotting manifolds positioned along the rim of the impoundment to create low angle deposition beaches.

The position of the spigotting manifolds are moved periodically to produce an even beach head and push decant water towards the decant water pool. A pontoon mounted decant return water pump is provided to pump decant water back to the process water tank plant for re-use in the plant.

3.3.12.10 Reagents and Services

Given the properties of the reagents and their interactions with each other, design of the reagent preparation area will largely focus on the isolation of the cyanide. The cyanide preparation area is located away from incompatible reagents and in a low traffic area of the process plant. The cyanide preparation area will also be separated from the acidic reagents preparation area by the alkaline reagents. In this configuration the basic chemicals act as a buffer to prevent the exposure of acidic reagents and sodium cyanide, which would lead to the generation of cyanide gas.

Reference PFDs:101768-0000-F-010; 101768-0000-F-011; 101768-0000-F-012; 101768-0000-F-013

3.3.12.10.1 Hydrated Lime

Preparation of the hydrated lime will require:

- A bulk storage silo
- A mixing tank
- Dosing pumps feeding a ring main
- Automatically controlled dosing points from the ring main.

Hydrated lime is used in leaching and detoxification for pH control. The hydrated lime is delivered to site by bulk tanker and blown into a bulk storage silo.

When the mixing tank level is low, hydrated lime is added to the tank via a rotary valve and screw feeder. Process water is added at the same time to maintain the mixture strength of 20 percent forming a milk-of-lime suspension.

Milk-of-lime is distributed to the various dosing points using a ring main that provides constant flow to various destinations. Dosing is accomplished with drop lines off the ring main with automated on- off valves that open when pH is low and close when the operator specified target is reached.

3.3.12.10.2 Sodium Hydroxide

Preparation of Sodium hydroxide will require:

- Dosing pumps.

Sodium hydroxide (NaOH), also known as caustic soda, is used as a pH modifier in the intensive cyanidation and in the elution circuit to prepare the stripping solution used to recover the gold from the loaded carbon. The reagent will be delivered in a 1,000 L tote received by truck and unloaded near sodium hydroxide area. The solution is supplied at a concentration of 50 percent by weight basis. Three positive displacement pumps will then each provide the required dosages of sodium hydroxide to their dedicated area. These areas include the intensive leach area, the elution circuit and the sodium cyanide preparation area.

3.3.12.10.3 Sodium Cyanide

Preparation of sodium cyanide will require:

- A bulk handling system
- Mixing and holding tanks
- Dosing pumps

Sodium cyanide is used in leaching as a lixiviant and in elution as a carbon stripping aid. Cyanide is delivered to site in one-ton bulk bags contained within wooden boxes and is stored in a separate area of the plant from the other chemicals.

When the storage tank level is low, a cyanide mix batch is started by removing a cyanide bulk bag from its box and dropping it onto a bag breaker, which discharges cyanide into the mix tank. The mix tank has been previously filled with sufficient raw water and buffered with sodium hydroxide to pH 12 to produce a cyanide mixture strength of 28 percent. Once mixing is complete and there is sufficient room in the holding tank, the mixed cyanide solution is pumped to the holding tank by a sodium cyanide transfer pump.

Sodium cyanide is dosed from the storage tank to dosing points via dedicated positive displacement metering pumps. The discharge piping is arranged such that the infrequently utilized pumps can be used as back-up spares for the leach dosing pump. For additional information on the equipment and procedures for the handling of cyanide, reference the Cyanide Management Plan in Appendix F of the Consolidated Permit Application.

3.3.12.10.4 Sodium Metabisulphite

Preparation of SMBS will require:

- A bulk handling system
- Mixing and holding tanks
- Dosing pumps.

SMBS is the source for SO_2 in the Air/SO_2 process and will be supplied in 2000-pound bulk bags with a minimum quality of 67 percent SO_2. It will be shipped by road to site, offloaded by forklift, and stored in the reagents storage area.

When the storage tank level is low a SMBS mix is started by dropping a bulk bag of SMBS onto a bag breaker which discharges SMBS into the mix tank. The mix tank has been previously filled with sufficient process water to produce a mixture strength of 20 percent. Once mixing is complete, and there is sufficient room in the holding tank, the mixed SMBS solution is pumped to the holding tank by a SMBS transfer pump.

SMBS is dosed from the storage tank to the detoxification circuit via dedicated positive displacement metering pumps for each stage. A third pump is provided as an installed spare for the detoxification dosing pumps.

3.3.12.10.5 Copper Sulphate (Pentahydrate)

Preparation of Copper Sulphate will require:

- A bulk handling system
- A combined mixing/storage tank

- Dosing pumps

Copper sulphate (pentahydrate) ($CuSO_2.5H_2O$) is supplied in 2000-pound bulk bags at a purity of 98 percent on a weight basis. It will be shipped by road to site, offloaded by forklift and stored in the reagents storage area adjacent to the reagents mixing facility. Copper sulphate is mixed and stored in a combined mixing/storage tank laid out such that the mixing tank is directly above the storage tank and mixed solution drops by gravity into the storage tank.

When the storage tank level is low copper sulphate is added to the mixing tank by dropping a bulk bag of onto a bag breaker which discharges copper sulphate into the mix tank. The mix tank has been previously filled with sufficient process water to produce a mixture strength of 15 percent. Once mixing is complete, and there is sufficient room in the holding tank, the mixed copper sulphate solution is transferred by gravity to the holding tank.

Copper sulphate is dosed from the storage tank to the detoxification circuit via duty / standby positive displacement metering pumps.

3.3.12.10.6 Hydrochloric Acid

HCI is used in the elution circuit and is supplied in 275-gallon totes in liquid form at 32 percent concentration on a weight basis. The acid will be dosed directly to the acid wash column through the use of a metering pump.

3.3.12.10.7 Flocculant

Flocculant will be used in the carbon fines clarifier and intensive leach reactor to assist in solids settling. The flocculant will be supplied in 1,000L totes and dosed directly through two metering pumps.

3.3.12.10.8 Blower Air

The blowers will supply low pressure process air to the CIL tanks and the cyanide detoxification circuits. Both the CIL and cyanide detoxification trains will have a dedicated blower fan, with one common standby fan, able to supply process air to any of the four usage points.

3.3.12.10.9 Plant & Instrument Air

An air compressor will provide high pressure compressed air operating in lead-lag mode, to meet the demand for plant and instrument air requirements.

Plant air will be stored in the plant air receivers to account for variations in demand prior to being distributed throughout the plant. Instrument air will be dried in an instrument air dryer before being stored in the instrument air receivers and distributed throughout the plant.

3.3.12.10.10 Assay and Metallurgical Laboratory and Quality Control

The plant is equipped with automatic samplers to collect shift and routine samples for aqua regia digestion, atomic absorption, and fire assays. Those samples include plant feed, intermediate products, tailings, and final products. The data obtained will be used for product quality control and routine process optimization.

The metallurgical laboratory will perform metallurgical tests for quality control and process flowsheet optimization. The laboratory will include equipment such as laboratory crushers, ball mill, sieve screens, laboratory flotation cells, balances, and pH meters.

3.3.12.11 Water Services

The overall process has a negative water balance and requires raw water makeup from site wells. The raw water is used for gland water, makeup water, and treated to produce potable water. Raw water that has entered the process becomes part of the process water circuit and may be eventually discharged to the TSF. Decanted water from the TSF is recycled back to the process plant for reuse in the process water circuit. Reference PFDs: 101768-0000-F-014; 101768-0000-F-015

3.3.12.11.1 Tailings Storage Facility

The TSF receives the treated tails from the process plant and allows for material to settle while water is decanted and recovered at the process water tank for re-use in the process plant. Two centrifugal pumps (one duty and one standby) located on a barge at the TSF return water through a decant water pipeline, which runs in the same containment trench used for the tailings discharge pipeline.

The TSF also allows for the natural degradation of remaining trace cyanide. Degradation is achieved through exposure to ultraviolet light received from the sun and metabolic processes from micro- organisms native to the environment in the water of the supernatant pool.

The TSF is described in detail in Section 3.3.13 and Appendix C.

3.3.12.11.2 Raw Water

Raw water will be pumped from site wells to the raw water tank for distribution throughout the operation. Raw water in the tank is used to supply the following services:

- Reagent preparation water
- Slurry pumps gland seal water
- Intensive cyanidation
- Make-up water for the process water system
- Fire Water

- Potable water treatment plant, potable water is then sent to the potable water tank for safety showers and eyewash stations.

3.3.12.11.3 Gland Water

Water for the gland water system is supplied by fresh water from the raw water tank and distributed to each slurry pump by the gland seal water pumps in a duty/standby configuration.

3.3.12.11.4 Process Water

Process water is comprised of decant water from the TSF and raw water additions. Process water is stored in the process water storage tank and distributed by the Process Water Pumps, in a duty/standby configuration, to the circuits throughout the process plant, select reagent preparation areas and the truck washing station.

3.3.12.12 Process Solution Containment

The containment strategy associated with the process plant can be divided between the containment of process flows and reagents, and the collection and containment of surface contact water.

3.3.12.12.1 Process Flows and Reagents

There are eight primary areas which require containment at the plant site. Each area is located on a cast in-situ concrete slab, which will have curbs providing the required containment volume. The required volume is determined by the equipment located in the area, and in each case, this has been determined to be 110 percent of the volume of the largest vessel plus allowance for adequate freeboard for precipitation. Adequate precipitation freeboard is defined as the height required to provide a volume capable to contain a 25-year 24-hour storm event. The containment areas drawings are included in Appendix D of Appendix D.

The concrete bund for the air services area is mainly for housekeeping purposes, and the required volume is only related to the 25-year 24-hour storm event for the catchment area.

3.3.12.12.2 Surface Contact Water

For a detailed description of contact water management and the design of water management structures, reference Appendix Y of the Consolidated Permit Application.

Diversion ditches will be constructed above plant infrastructure where required to prevent runoff from entering the process plant areas. Precipitation that falls directly on the pad will be collected in a system of ditches and culverts and directed by gravity towards the collection pond.

The contact collection pond is sized to contain the runoff from a 100-year 24-hour storm event and includes other allowances such as sediment deposition and freeboard. The pond will be double lined with a fluid evacuation zone between the liners.

3.3.12.13 Dust Suppression and Collection

Considerations for the design of the dust suppression and collection facilities is intended to comply with applicable federal and state regulations for air quality, including the Cleaner Air Oregon objectives.

Detailed information pertaining to the regulations, identification and control of air emissions can be found in Appendix M.

3.3.12.13.1 Dust Generating Sources and Controls

The key dust generating sources and identified control methods for the plant site are identified as follows:

Table 79. Selected Air Quality Controls

Dust Source	Control Method
Unpaved Roads	Dust suppression chemicals and water application
Stockpiles (ROM and Crushed Ore)	Inherent moisture content of the ore
Primary and Secondary Crushing Unit	Inherent moisture content of the ore
Ball Mill Feed Conveyor	Inherent moisture content of the ore
Carbon Kiln	Wet dust scrubber
Barring Furnace	Baghouse
Lime Silo	Bin ventilation baghouse

3.3.12.14 General Foundation Recommendations for Mine Process Facilities:

Mine process and support facilities are situated directly north of the proposed mine portal as shown on the Design Drawings. These facilities will include office buildings, truck maintenance facilities, crushers, mill, and additional structures. Based on the subsurface exploration, the subsurface beneath the proposed location for the mine facilities can generally be separated into two areas as summarized below:

- East portion: Approximately five to 20 feet of Quaternary deposits comprising lean to fat clay soils and clayey sands overlying lacustrine clays.
- West portion: About three to ten feet of Quaternary deposits comprising lean to fat clays and poorly graded gravel to silty sand overlying sandstone bedrock encountered at depths ranging from 3.5 to ten feet below ground surface (bgs).

In general, planned structures may be founded on conventional shallow foundations. Foundations may be supported by undisturbed medium dense to very dense granular, native

alluvium/colluvium or weathered sandstone, or properly placed engineered fill. Lacustrine and overburden clay soils are not suitable to support foundations.

Topsoil, soil supporting plant growth, or loose soils are not considered suitable for the support of floor slabs, footings, or mat foundations, and should be removed from the site prior to grading.

Due to the presence of clay with a high potential for swelling, a minimum of four feet of separation between the bottom of foundations and the clay soils is recommended. If clay soils are located within four feet of the base of foundations and slabs-on-grade, the clays are to be over-excavated and replaced with granular engineered fill.

The extent of over-excavation will depend on final grades established for the area. Maintaining positive site drainage away from foundations will be imperative to reduce the potential for swelling of the clays that may affect performance of the foundations. This is particularly important for the truck wash and other areas where water is likely to be present with an increased risk of ponding.

3.3.13 Tailings Disposal

The proposed TSF will be located in the broad valley immediately west of the Grassy Mountain mine portal and process facilities. The TSF will fill the native valley and require staged embankment constructions on the north and west sides. The embankments will be constructed in stages using downstream construction techniques. At an average deposition rate of 680 dry st/d and total available tailings capacity of 3.67 mtons, the facility will have an approximate design life of 14 years. The overall disturbance area approximately 108 acres at completion of operation. Total disturbance will include the following:

- Embankments constructed of benign run-of-quarry basalt or other quarried materials;
- Geomembrane-lined tailings impoundment area;
- Process water and tailings delivery pipelines;
- Process water collection systems;
- Light vehicle access roads;
- Stormwater diversion channels;
- Closure and reclamation components.

The fundamental objectives of the TSF design are as follows:

- Zero-discharge facility design;
- Designed for closure;
- Permanent and secure storage of all tailings;
- Protection of the Project Area’s groundwater and surface water;
- Diversion of surface water flows around the facility to the maximum extent practicable during operation;
- Routing of surface water over the TSF closure cover;

- Achievement of a stable, drained inert tailings mass that will be suitable for reclamation soon after operations cease, and will not pose a long-term threat to downstream water quality;
- Tailings disposal will be consistent with OAR 340-043-0130.

The TSF will be a 100 percent geomembrane-lined facility with continuous primary and secondary containment and leak detection systems where process solutions are expected to be localized. Process solution will be managed with two independent return water systems that return collected water from the TSF back to the mill for reuse in the process circuit.

Freeboard water at the tailings surface will be collected and managed at the supernatant pool. A tailings seepage selection system above the geomembrane liner will convey underdrain flows via gravity to the reclaim pond at the northern downstream toe of the facility where the water is pumped back to the mill for use in the process circuit. The anticipated maximum flow rates for each system is estimated using a monthly time-step deterministic water balance. The supernatant pool will be maintained away from the embankments on the eastern side of the facility as shown on the Design Drawing in Appendix C.

The TSF has been designed as a zero-discharge facility capable of storing the 500-year, 24-hour storm and an allowance for wave action above the anticipated normal operation pool. Permanent and temporary storm water diversion channels will collect and divert a majority of the storm water runoff around the facility to a natural drainage north of the TSF.

Adjacent to the TSF, a geomembrane lined storage area has been designed to provide temporary containment of waste rock produced during ongoing mining operations. Design concepts for containment leak detection, and underdrain collection systems for the WRD are the same as those for the TSF. The underdrain collection piping system will be hydraulically separate from the TSF and collected underdrain flows will be routed to the TSF reclaim pond through a solid wall pipe for independent monitoring and sampling.

3.3.13.1 Design Criteria

The design criteria presented below are based on OAR, requirements of the Project as defined by Calico, and Golder's experience designing and constructing TSFs in similar environments. The following OAR Divisions have been used to develop minimum acceptable design levels:

- Oregon Water Resources Department (OWRD), Dam Safety Regulations, OAR 690, Division 20.
- DOGAMI, Chemical Process Mine Regulations, OAR 632, Division 37
- ODFW, Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420
- ODEQ, Chemical Mining, OAR Chapter 340, Division 43

The following TSF Design Criteria Tables present the minimum design criteria proposed for the Project TSF and the corresponding OAR Regulation or Guideline.

Table 80. General TSF Design Criteria Table

Parameter	Value	Reference or Regulation
Capacity	3.67 million dry st	Calico
Life of Mine	~14 years	Calico
Average Tailings Deposition Rate	248,346 tons/year (680 tons per day)	Ausenco
Tailings Slurry Concentration	46% solids (by weight)	Ausenco
Settled Tailings Density	-80 lb/ft^3	Golder
Slope of Tailings Surface	1.0%	Golder
Dam Construction Method	Staged Downstream Construction	Golder
Dam Construction Material	Heterogeneous RF and/or soil fill	Golder
Tailings Deposition System	Subaerial discharge spigots	Golder
Reclaim Water System	Decant pumping and gravity underflow reclaim pond	Golder
Supernatant Pool Location	East side hill, not in contact with dam	Golder

Table 81. Division 20- Dam Safety Minimum Design Criteria Table

Parameter	Value	Reference or Regulation
Embankment Geometry		
Upstream Slope Angle	Overall 3 horizontal to 1 vertical (3H:1V), or flatter local slopes 2.5H:1V	OAR 690-020-0038
Downstream Slope Angle	2.5H:1V	OAR 690-020-0038
Geotechnical Criteria		
Hazard Classification	Low	OAR 690-020-0100, Golder recommended
Design Earthquake, Operational	Median MCE	Exceeds OAR 690-020-0038 for Low Hazard Dams
Peak Ground Acceleration, PGA	0.15g	Golder
Horizontal PGA Factor, k, for pseudo-static stability analyses	½ of the PGA	Haynes-Griffin, Franklin (1984) and Seed (1982)
Static Stability, Factor of Safety	1.5 (minimum)	Golder[1]
Closure Seismic Stability (pseudo-static), Factor of Safety Hazard Classification	1 (minimum) Low	Golder[1] OAR 690-020-0100
Impoundment Storage Requirement[2]		
Watershed and Hydrologic Inflows	Precipitation on TSF, small area of run-on into impoundment	Golder
Minimum Freeboard Above Supernatant Pool	3 feet above maximum operating water surface elevation for peak design storm event and wave action	Golder and Partial OAR 690-020-0042
Minimum Freeboard Above Tailings Beach	2 feet against dam embankment	Golder

Parameter	Value	Reference or Regulation
Water Conveyance		
Tailings Underflow Collection System	Perforated and solid CPE and HDPE piping network	OAR 690-020-0038

Table 82. Chemical Mining Minimum Containment Design Criteria Table

Parameter	Value	Reference or Regulation
Containment and Leak Detection		
Facility Discharge	Zero discharge facility	Calico, Golder, and OAR 340-043-0000
TSF Basin Containment System (top to bottom)	Continuous 80-mil HDPE geomembrane, GCL, prepared subgrade	Golder and OAR 340-043-0130
TSF Reclaim Pond Containment System (top to bottom)	Continuous 80-mil HDPE geomembrane, geonet leak collection and recovery system (LCRS), 60-mil HDPE geomembrane	Golder
Overall TSF and WRD Leak Detection System	Up gradient and down gradient groundwater monitoring wells	OAR 340-043-0050
Underdrain Channel Leak Detection System	Geomembrane lined channel will provide secondary containment, leak detection will be visual	Golder
Reclaim Pond Leak Detection System	LCRS between two geomembranes, and evacuation port	Golder
Process Water Management		
Tailings Underflow Collection System	Perforated and solid CPE and HDPE gravity piping network in 18-inch-thick drainage layer 6-inch-thick filter layer Gravity flow to reclaim pond	Golder and OAR 340-043-0050
Supernatant Water	Decant pumping system	Golder
Surface Water Management		
Perimeter Diversion Channels	100-year, 24-hour storm event plus nine-inches freeboard or 500-year, 24-hour storm event to channel crest	OAR 340-043-0090
Temporary Diversions Channels	25-year, 24-hour storm event plus 9-inches of freeboard, or 100-year, 24-hour storm event to channel crest	

3.3.13.2 TSF Design Summary

Site Layout: The proposed TSF is located in the broad valley immediately east of the Grassy Mountain mine portal and process facilities. Native slopes within the valley range between approximately four and 20 percent. Embankments will be constructed on the north and west sides to impound the tailings. The north embankment will span the width of the valley (generally east to west) while the smaller west embankments will be used to bridge saddles along the western ridge. The TSF will cover an approximate area of 108 acres and has been designed to

accommodate 3.67 M dry st of tailings. An overall layout of the site is presented on the Design Drawings in Appendix C.

Hazard Classification: The Project TSF is designed to meet or exceed the minimum OAR design requirements for a hazard rating of "Low" in accordance with OAR 690-020-0022 (22). This classification is based on OWRD's definition of a low hazard classification as:

"*if the dam were to fail, loss of life would be unlikely and damage to property would not be extensive*".

Although a dam breach analysis is not required for a low hazard dam, one was performed and is presented in Appendix C.

Embankments: As shown on the Design Drawings in Appendix C, embankments will be constructed to impound the tailings along the north and west sides. The main embankment will cross the natural drainage to the north, and small secondary embankments will be constructed across saddles along the western ridge. The embankments with have a maximum overall upstream slope of 3H:1V with a downstream slope of 2.5H:1V. The north and west embankments will have a maximum height of 82 feet and 30 feet, respectively. The crest width of the north embankment will be 50 feet, with 30-feet wide crests for the smaller west embankments. The upstream slope of the embankments will be geomembrane-lined to maintain the continuous lining within the facility. A discussion on the embankment lining system is presented in Appendix C.

The TSF will be constructed in a maximum three stages utilizing downstream construction techniques. Embankment construction materials will be soil or RF sourced from the on-site basalt borrow area and during impoundment grading operations. A detailed discussion on construction materials and construction quality assurance and control (QA/QC) is presented in Appendix C.

Staged construction will provide incremental increases to the facility's storage capacity. The staged storage capacity has been calculated based on a measured settled dry density of 80 lb/ft^3. The following table presents a summary of the storage capacity relationship of the TSF.

Table 49. Stage Capacity Relationship Summary Table

Stage	Main Embankment Crest Elevation (ft)	Maximum Tailings Surface Elevation (ft)	Maximum Tailings Surface Area (acres)	Stage Storage Capacity (million tons)	Cumulative Storage Capacity (million tons)
1	Varies (Min. 3595)	3593	37.0	1.00	1.00
2	Varies (Min. 3609)	3607	59.5	1.07	2.07
3	Varies (Min. 3622)	3620	83.0	1.60	3.67

Lining System: The TSF impoundment area and upstream slopes of each embankment will be continuously lined with both primary and secondary lining systems to provide continuous

containment of process solution. The overall lining system will vary depending on the location within the facility. The proposed lined areas are presented on the Design Drawings in Appendix C.

Golder performed an evaluation to compare an alternative lining system to the one prescribed in OAR 340-043-0130 (3). The OAR guidelines for secondary containment are:

"*an engineered, stable, soil/clay bottom liner (maximum coefficient of permeability of 10^{-7} cm/sec) have a minimum thickness of 36 inches*".

The evaluation compared the OAR guideline with both a standard GCL and an enhanced GCL. Both GCL's consist of a sodium bentonite layer between two geotextiles needle-punched together. The enhanced GCL contains an additional laminated thin flexible membrane barrier to offer an increased level of hydraulic performance (decreased hydraulic conductivity). To perform the comparison, the potential fluid travel time through each of the lining systems was evaluated for the following scenarios:

- Comparison of secondary containment alternatives alone (Soil/clay liner versus GCL)
- Comparison of a 60-mil primary containment geomembrane liner with the secondary containment
- Comparison of an 80-mil primary containment geomembrane liner with the secondary containment

Using the comparison of fluid travel times, the standard GCL did not meet the same performance standard as the soil/clay secondary layer (OAR requirement), however the enhanced GCL exceeded the performance based on fluid travel time for all three scenarios. The enhanced GCL in place of the soil/clay secondary liner is proposed. The detailed evaluation is presented in Appendix C.

Within the impoundment, the lining system will consist of (from bottom to top) a 6- to 12-inch thick native prepared subgrade, a 300-mil thick enhanced GCL, 80-mil HDPE geomembrane liner, an 18-inch thick drainage layer, and a six-inch thick filter layer. Perforated piping will be located within the drainage layer to promote drainage of the tailings and to reduce hydraulic head on the lining system.

On the upstream embankment slopes, the lining system will be the same, but without the overlying piping, drainage layer, and filter layer. Placement of a drainage layer above the geomembrane on the upstream embankment slopes is impractical due to the relatively steep side slopes and erosion potential of a cover from tailings deposition. Additionally, the TSF underdrain channel, WRD underdrain channel, and tailings delivery channel from the process area will utilize the same lining system as the TSF embankment slopes.

3.3.13.3 Water Management

Process Fluid Circuit: Water is used in the process circuit for both the metallurgical process and transportation of the tailings to the TSF. Tailings are thickened in the mill after metals extraction. Prior to transport, water is added back into the tailings slurry to decrease the solids concentration. Based on rheological requirements for transport, the tailings will be deposited into the TSF at an average solids concentration of 46 percent solids by weight (w/w).

Tailings are then transported to the TSF and discharged sub-aerially into the lined impoundment through evenly spaced discharge pipes (spigots). As tailings are deposited into the impoundment, the solids separate from the slurry. A portion of the separated water flows to a low point within the impoundment to form the supernatant pool. The remaining water within the tailings mass will drain down to the underdrain collection and lining system.

All piping and pumping systems comprised of HDPE pipes that are either dual containment pipelines or are located above geomembrane-lined channels. Leak detection is performed by visually monitoring flows within the secondary containment systems.

Tailings Distribution System: Tailings will be delivered to the TSF from the mill via a dual containment HDPE tailings delivery pipe. The tailings delivery pipe consists of a 4-inch diameter DR17 HDPE carrier pipe and an outer 8-inch diameter DR17 HDPE containment pipe. The tailings delivery pipe will be parallel the proposed reclaim water pipe located along the access road from the mill to the TSF as shown on the Design Drawings in Appendix C.

The tailings delivery pipe will tie into a 4-inch diameter DR17 HDPE tailings distribution pipe that will route along the TSF perimeter access road where tailings will be deposited via evenly spaced spigots. Spigots are 1-inch diameter HDPE drop pipes with manual control valves to allow for tailings deposition as needed to maintain the appropriate supernatant pool configuration and location.

The tailings distribution pipe and spigots are located above the TSF basin containment system, providing dual containment at all times. Detailed design of the tailings delivery pipe and discharge spigots is being performed by other parties and is not included in the TSF design presented in Appendix C.

Supernatant Pool: Water collecting in the supernatant pool is comprised of free water produced during tailings deposition and precipitation falling on the impoundment surface. Water in the supernatant pool is pumped back to the mill for reuse in the process circuit. The supernatant pool will be maintained on the eastern side of the facility away from the facility embankments as shown on the Design Drawings in Appendix C. As outlined in Section 3.3.12.9, the tailings discharged to the TSF will be detoxified to minimize cyanide concentration of the water in the supernatant pool. An Ecological Risk Assessment (ERA) of the constituents in the supernatant

pool was completed and is incorporated in the application as Appendix T. The ERA shows the supernatant pool would not be detrimental to wildlife.

Water from the supernatant pool will be extracted via pumping and delivered back to the mill for reuse through a return water pipe. The supernatant pool is designed to fluctuate seasonally depending on climatological conditions. The supernatant pool will have an average operating depth of five feet that is controlled by the pumping system and is adequately deep enough to prevent drawing tailings solids from the pool bottom.

The return water pipe will combine the flows from the supernatant pool and the reclaim pond. The combined flows will be pumped in a single return water pipe consisting of a four-inch diameter DR17 HDPE carrier pipe and an outer 8-inch diameter DR17 HDPE containment pipe that will parallel the tailings delivery pipe located along the access road from the mill to the TSF as shown on the Design Drawings in Appendix C.

Underdrain Collection System: As deposition continues, the tailings will consolidate due to increased vertical pressure as the tailings surface elevation increases. In addition to water bleeding upward into the tailings surface, water will also be released from the tailings downward. To capture the water released downward, an underdrain collection piping system will be installed above the geomembrane liner within the drainage layer in the TSF basin as shown on Design Drawings in Appendix C. The intent of the underdrain collection system is to reduce the hydraulic head on the geomembrane liner and promote drainage of the tailings for long-term closure.

This network of perforated pipes will capture and convey underflow via gravity to the reclaim pond located downstream of the main embankment as shown on the Design Drawing in Appendix C. The underdrain collection system will consist of variable diameter and pipe types depending on their location and vertical pressure. In general, primary and secondary collection pipes will be perforated 6-inch diameter double-wall CPE and tertiary collections pipes will be 4-inch diameter double-wall CPE. Tertiary collection pipes will be installed with greater density adjacent to the north embankment and beneath the supernatant pool.

The primary collection pipes will transition to solid wall HDPE outlet pipes and then penetrate through the geomembrane liner at the upstream toe of the north embankment and pass under the dam via solid wall HDPE gravity conveyance pipelines to the reclaim pond. For redundancy, the primary collection pipes will interconnect within the TSF basin and flow to the reclaim pond.

Where the underdrain outlet pipes pass beneath the embankment, the pipes will be encased in reinforced concrete to protect against deformation and maintain the integrity of the pipes. The pipes and reinforced concrete will be located above a geomembrane-lined channel below the embankment to provide further protection and containment of the system. Beyond the Stage 3 downstream toe, the reinforced concrete encasement will terminate, and the outlet pipes and geomembrane-lined channel will continue to the reclaim pond.

Prior to discharging into the reclaim pond, each underdrain pipe will enter a monitoring flume. Valves will be located upstream of the monitoring flumes to restrict flows or be closed in the event that flows to the pond need to be limited for short periods of time for maintenance or emergencies.

Reclaim Pond: The reclaim pond will be a double-lined pond north of the main embankment and will contain the TSF underdrain flows as shown on the Design Drawings in Appendix C. The lining system for the reclaim pond will consist of (from bottom to top): a native prepared subgrade, 60-mil HDPE secondary geomembrane liner, HDPE geonet, and 80-mil HDPE geomembrane primary liner. The geonet located between the two geomembranes will serve as the LCRS.

The reclaim pond was sized to contain, at a minimum, the total volume of water generated during the following:

- 500-year, 24-hour design storm event falling on the surface of the pond,
- Gravity underdrain flow from the TSF for the duration of a 48-hour power outage,
- Volume of water within the entire length of the reclaim water pipe between the reclaim pond and the mill.

The reclaim pond has a storage capacity of 146,000 gallons to the underdrain channel invert elevation which is 3.6 ft below the pond crest. The total storage capacity of the reclaim pond is 215,000 while maintaining two feet of freeboard beneath the pond crest. In this scenario, water in the pond would also back up into the portion of the lined underdrain channel for additional emergency storage above the minimum required. Pond sizing calculations are presented in Appendix C.

Water from the reclaim pond will be pumped back to the mill for reuse in the process circuit. The reclaim water pipe consists of a 4-inch diameter DR17 HDPE carrier pipe and an outer 8-inch diameter DR17 HDPE containment pipe. The reclaim water pipe will be installed along the access road downstream of the TSF and along the eastern TSF perimeter access road as shown on the Design Drawings in Appendix C. The reclaim water pipe will connect with the supernatant return water pipe where the combined flows will be pumped in a single dual containment pipe installed parallel with the tailings delivery pipe located along the access road from the mill to the TSF.

At all times, process fluid pipelines will be located above secondary containment that consists of either geomembrane liners or concrete containment structures.

Development of Climate Data: Climate data for the Grassy Mountain project site was developed using nearby weather station data and regression analysis based on elevation of the proposed Project TSF dam. For this project, climate data and station metadata of the closest Remote Automated Weather Stations (RAWS) and Cooperative Observer Network (COOP) stations to the Project site were identified and compared, along with the PRISM Climate Group (PRISM) spatial data, using statistical and regression analyses.

Details of the climate model are presented in Appendix C.

Water Balance: A deterministic spreadsheet-based monthly time step water balance was developed for each stage of the TSF based on a tailings deposition rate of 680 st/d and a slurry concentration of 46 percent solid, by weight.

Inflows to the system include precipitation above lined areas, surface water run-on from up-gradient catchment areas below the permanent and temporary storm water diversions, and water being deposited within the tailings slurry at a rate of 133 gpm.

Outflows/losses include evaporation from the tailings beach area, evaporation from the supernatant pool area, interstitial water permanently stored within the tailings mass, and estimated reclaim flow rates to the mill. Results from this water balance estimate reclaim water flow rates from the TSF to the mill in order to effectively manage water in the supernatant pool.

The average reclaim rate from the supernatant pool is 44 gpm for Stages 1 through 3 and varies between zero during summer months (July and August) to 106 gpm during winter months (December and January). Make-up water required was defined as the rate of evaporation from the tailings beach and supernatant pool (outflow) plus interstitial water loss (outflow) minus precipitation (inflow). The make-up water rate is less than or equal to the rate that water is reporting to the TSF in the tailings slurry. The average make-up water rate is 68 gpm for Stages 1 through 3 and varies between 133 gpm during summer months (July and August) to 1 gpm during winter months (December and January).

The detailed water balance and supporting discussions are presented in Appendix C.

TSF Freeboard: For TSFs (non-water impounding structures), freeboard is generally defined separately for the area with free water in the supernatant pool and dry tailings beach areas. The OAR guidelines do not define these separately. The minimum freeboard definition presented in OAR 690-020-0042 is generally intended for water storage reservoirs where water is in contact with the embankments. However, for tailings storage facilities in arid climates, tailings deposition and reclaim water can be managed to prevent free water from contacting the embankment, similar to the proposed TSF, as shown on the Design Drawings in Appendix C.

The proposed TSF is designed to provide a minimum freeboard depth of 3 feet above the maximum supernatant pool water surface where it is impounded against the geomembrane-lined southern hillside. This freeboard will provide suitable dam storage height above the maximum water surface elevation to contain wave action above the 500-year, 24-hour storm event falling on the TSF impoundment and the upgradient catchment areas below the permanent and temporary diversion channels. Wave run-up calculations were developed assuming the TSF had experiences of a 500-year, 24-hour storm with waves generated from sustained wind loading using the average wind speed and the longest reach length of the supernatant pool in the prevailing wind direction. Wave run-up calculations have been included in Appendix C.

Tailings beach areas are defined as areas where the impoundment surface is free of pooled water and only comprised of drying or dry tailings. The TSF is designed so that only tailings will impound against the embankments. In the tailings beach areas, a minimum freeboard of 2 feet will be provided from the highest beach elevation to the lowest dam crest elevation.

In addition to the above freeboard dimensions, the TSF is designed such that the lowest tailings surface and pool elevation is away from the facility embankments. This results in the overall tailings surface sloping away from the perimeter embankments southeast toward the Supernatant Pool. With the fluid management for the TSF as presented in Appendix C, overtopping or freeboard encroachment is not expected.

A closure spillway has been sized to accommodate surface water flows from the TSF closure cover while the permanent diversion channels (discussed below) remain in place. This spillway can be constructed and implement at any point during operation or closure.

Storm Water Control: Permanent and temporary storm water diversion channels have been included in the design to convey surface water run-off from up gradient catchment areas around the TSF to decrease the amount of run-on water that needs to be managed within the TSF. The permanent storm water diversion channels are sized to contain the peak discharge from the 500-year, 24-hour storm event of 2.91 inches, and will be lined with riprap in areas where erosion protection is required.

To prevent overtopping, all channels have been designed with a minimum freeboard of 9 inches above the maximum anticipated flow depth resulting from the 100-year, 24-hour storm event. The total depth of each channel is designed to fully contain, with little to no freeboard, the 500-year, 24-hour storm event. A detailed summary of the hydrologic and channel hydraulic calculations is presented in Appendix C.

3.3.13.4 Geotechnical Considerations

The following sections present the general subsurface soil and groundwater conditions at the site along a summary of the stability and settlement analyses performed for the TSF embankment. Slope stability analyses were conducted to evaluate performance of the north TSF embankment for long-term, post-closure conditions based on design criteria of the facility.

Settlement analyses were conducted to evaluate potential impacts of settlement within native and engineered materials on performance of the underdrain collection piping beneath the embankment. Brief summaries on stability and settlement analyses are presented in the following section, and presented in detail in Appendix C.

Geotechnical Investigations: Subsurface geotechnical investigations were performed throughout the design of the TSF and WRD, which included:

- December 2017 – 15 geotechnical boreholes, 44 test pits and six in-situ field falling head permeability tests on native subgrade materials;
- March 2019 – Six geotechnical boreholes;
- July 2019 – 11 cone penetrations test soundings.

Geotechnical laboratory testing was performed on selected soil samples deemed representative of the materials encountered during the investigation. The laboratory testing program focused on providing information for the more critical aspects of the design. These included the north TSF embankment and potential borrow areas, with a majority of the laboratory tests performed on the lacustrine clay deposits within the footprint of the north embankment. Laboratory testing completed on the lacustrine foundation clays included moisture content, grain size analyses, Atterberg Limits, consolidated-undrained triaxial, and one-dimensional consolidation tests.

To further support the selection of materials strength parameters used in the stability analyses, a Cone Penetration Test (CPT) program was completed within the foundation of the TSF embankments and basin. This program further refined the material properties of the lacustrine clay deposits below the embankments including pre-consolidation, saturation level, stiffness, grain size distribution, and pore-pressure dissipation potential.

General Subsurface Soil and Groundwater Conditions: Subsurface soil and water conditions are described in detail in Appendix C.

In general, topsoil was generally observed to be about ½ feet thick across the majority of the TSF site. The topsoil is underlain by near surficial alluvial and colluvial deposits across the site with depths ranging from about ½ feet to 25 feet below the existing ground surface (bgs). These deposits were generally unconsolidated Generally, the upper portion of the deposit was classified as fine-grained soils classified as lean and fat clay with varying amounts of sand and gravel and were underlain by coarse-grained soils classified as clayey- to silty-sand, clayey- to silty-gravel, and poorly- to well-graded sand and gravel.

Lacustrine deposits were encountered across a majority of the TSF site and primarily classified as lean to high plasticity clay with varying sand content. Abundant evaporites were often found in the upper three (3) feet of the deposit and continued in limited amounts throughout. Based on similar units in the region, these units are estimated to be Miocene-age deposits. This horizon was encountered up to depths of 120 feet bgs (maximum depth of exploration) within the footprint of the TSF and may extend deeper.

Relatively shallow (less than 15 feet) weathered arkosic sandstone was observed within the north-central portion of the TSF and west portion of the mine process facilities. The sandstone is similar to a silty- to poorly graded sand. In general, the west portion of the mine process facilities consisted of Quaternary deposits underlain by weathered arkosic sandstone, and the east portion of the mine process facilities area consisted of Quaternary deposits overlying lacustrine fat clay deposits.

No subsurface water was encountered during the field exploration with boreholes extending to a maximum depth of approximately 120 feet bgs. In the *Groundwater Resources Baseline Data Report* prepared by SPF it was reported that the groundwater depth beneath the southern portion of the TSF basin ranged between 155 feet at the BLM well located within the TSF footprint and 232 feet at the GW-3 well located just southwest of the TSF (SPF 2019a). Inferred groundwater contours presented in the same report indicate groundwater beneath the reclaim pond area may be as shallow as 55-feet, however, no groundwater was encountered in any of the boreholes.

Groundwater depths in this area will be refined after the installation of proposed groundwater monitoring wells as presented in SPF's report. In addition, no springs were observed in the TSF or mine facility areas during the field investigation. However, fluctuations in precipitation may occur that could affect subsurface water conditions at the sites.

Seismic Hazard Analysis: Golder completed a seismic hazard analysis (SHA) for the Project site and is presented in Appendix C. The purpose of the SHA was to identify faults that have the potential for surface rupture and to estimate earthquake ground motions for the operational and closure design earthquakes at the site for input into stability modelling. The Grassy Mountain site is located in the Columbia Plateau, a region of relatively low historical earthquake activity.

A probabilistic seismic hazard analysis (PSHA) using the USGS 2014 National Seismic Hazard Model indicates that the earthquakes for the 475-year return period has a mean peak ground accelerations (PGAs) of 0.08 gram. The complete SHA has been included in Appendix C.

A deterministic seismic hazard analysis (DSHA) indicates that the Cottonwood Mountain fault is the controlling Maximum Credible Earthquake (MCE) for the Project TSF. The Cottonwood Mountain fault has a surface trace mapped about 18 miles (28 km) from the TSF at its closest approach and generates an MCE M7.2 earthquake. Using the geometric mean of four equally weighted ground motion models, the median PGA value for the MCE is 0.15 g. The median deterministic PGA has return periods estimated from the 2014 USGS National Seismic Hazard Model (NSHM) at about 1,500 years.

By comparing the PSHA and DSHA, Golder selected the PGA resulting from the median MCE as determined by the DSHA as the design seismic event for the Project TSF for operation and closure. The event results in a PGA of 0.15g.

A seismic coefficient (k) of 0.075 g (one half the peak acceleration) was utilized for the pseudo-static slope stability analysis to model the earthquake loading of the embankment. This reduction in PGA is in line with the commonly accepted state-of-practice by Hynes-Griffin and Franklin (1984).

Embankment Slope Stability: Slope stability of the north and west TSF embankments were analyzed along cross sections that were considered to be the critical embankment section based

on anticipated geotechnical conditions in the embankment foundation and the current design configuration (e.g., embankment height, slope angles, and existing topography).

For the north embankment, downstream critical failure surfaces were analyzed at the ultimate Stage 3 height of the 3.67 mtons capacity TSF through the natural drainage. The analysis considered both drained effective stress and undrained strength considering both circular and block-type failures. Circular failures included both global failures through the embankment and foundation soils and shallow 'sloughing' failures of the downstream slope. Block-type failures were assumed to occur at the interface between the embankment fill and the underlying foundation material. Based on the stability analyses, the controlling scenario for geotechnical stability is a deep foundation circular failure using drained effective stress parameters for the clay foundation. Therefore, block-type failures are not presented.

All calculated FOS values were found to be above the minimum criterion (FOS≥1.5 for static, FOS≥1.1 for pseudo-static) as summarized in the table below. Based on the stability analyses, the controlling scenario for geotechnical stability is a deep foundation circular failure using drained effective stress parameters for the clay foundation.

Table 83. Summary of Critical TSF Stability Analysis Results

Analysis Method	TSF Stage	Static FOS (Target design minimum = 1.5)		Pseudo-static FOS (k = 0.075 g) (Target design minimum = 1.1)	
		North Embankment	West Embankment	North Embankment	West Embankment
		Section A	Section D	Section A	Section D
Effective Stress	1	1.5	1.9	1.2	1.4
	2	1.5	1.7	1.2	1.3
	3	1.5	1.5	1.2	1.2
Total Stress	1	2.1	-	1.7	-
	2	1.8	-	1.3	-
	3	1.5	-	1.1	-

Settlement: Settlement analysis was performed to evaluate impacts to the integrity and performance of the underdrain collection piping due to settlement of engineered fills and native foundation materials below the facility. Material properties for settlement calculations were estimated from Golder's geotechnical field and laboratory testing programs presented in Appendix C. Subsurface soils generally consist of alluvium and colluvium Quaternary deposits of varying thickness (approximately two feet to 25 feet) overlying over-consolidated, lean to fat

clays with varying sand content. Clays below the embankment were generally stiff to hard and settlement in both the engineered fills and native materials was evaluated using elastic theory.

Post-settlement grades along the underdrain collection piping must remain adequately steep for positive solution flow. To maintain this flow, underdrain collection pipes are designed to be installed at steeper grades and expected to flatten as the dam is constructed and tailings deposition progresses.

In order to achieve a minimum post-settlement of one percent, the underdrain outlet pipes will be installed at grades between one and 2.5 percent. Results of the settlement analysis indicate that beneath the upstream and main portions of the north embankment, the underdrain outlet pipes will have a post settlement grade of one percent and beneath the downstream portion of the main embankment, the underdrain outlet pipes will have a post settlement grade between 1.4 and 2.5 percent. Appendix C presents detailed foundation settlement calculations of the TSF embankment and minimum underdrain collection pipe design grades below the North Embankment.

Borrow Material: Borrow material will be needed for construction of the TSF embankments and potential fill below planned structures. Several areas were explored during the design to determine potential borrow source areas within the project boundary. The borrow area on the east side of the Permit Area will supply aggregate for the Project. Embankment fill material will generally consist of native granular soils such as sand, gravel, clayey to silty sand, and clayey to silty gravel and run-of-quarry fill materials. Embankment fill will be generated from the proposed borrow area east of the process facility as shown in Appendix C.

Basalt material encountered on the hillsides east of the project area is suitable for use as embankment fill. Development of this area as a borrow source will likely require ripping and/or blasting. Weathered arkosic sandstone is considered unsuitable for embankment material as it is generally brittle and erosive. If material meeting the requirements for embankment fill is used as fill beneath planned structures, screening may be required to remove over-sized material.

3.3.13.5 Tailings Testing

Golder completed geotechnical laboratory testing, consolidation modeling, and thin lift modeling on two pilot mill tailings sample delivered to Golder's Denver, Colorado, geotechnical laboratory. Detailed discussions on the laboratory classification, consolidation properties, and results are included in Appendix C.

The tailings sample tested in the laboratory had about 46 percent solids (by weight) and a specific gravity of 2.62. Consolidation modelling was completed using a tailings deposition rate of 680 tons per day and consolidation properties developed during the laboratory testing were used for the consolidation modelling to estimate the settled dry density of the deposited tailings with time.

Consolidation modeling did not show a significant change in settled dry density with time or staging. Estimated settled dry densities range between 79 and 82 pcf. For design of the TSF, an overall settled dry density of 80 pcf was selected.

3.4 Chemical Storage and Use

The volume and shipment frequency of fuels and reagents used in process is shown in the Fuels and Reagents Volumes and Shipments table below. Acid solutions, caustic soda, and concentrated cyanide solutions will be delivered to the site in liquid form. Containment of process solutions is based on 110 percent of the largest containment volume for each reagent.

Acid will be stored in the absorption, desorption, and refining (ADR) building and limited to individual totes or barrels that are used in the acid area and will not exceed 1,300 gallons. The volume of acid stored in the building will be less than the largest acid tank, which will be the acid wash vessel having a volume of 2,320 gallons.

Caustic soda solution will be received in a 10,000-gallon tank, diluted, and then distributed to the plant. Liquid caustic soda will be delivered to the mine site at 50 percent concentration and diluted to 20 percent concentration for use on site. Transfer of caustic soda solution will occur on the same concrete slab used for cyanide solution.

Hydrocarbon products, including lubricants, oils, antifreeze, and used oil will be stored at the truck workshop (Figure 6). Reagents will be transported, stored, and used in accordance with federal, state, and local regulations. Diesel fuel and hydrocarbon products will be stored in primary (tanks, tote bins, barrels) and secondary containment to prevent release to the environment. Used oil and used containers will be disposed or recycled according to federal, state, and local regulations.

Table 84. Fuels and Reagents Volumes and Shipments

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Mill Ore Processing				
Sodium Cyanide - Mixed to 25% NaCN	10,000 gallons	10,000 gallons		1
Lime - Dry pebble at 90% CaO	25-ton truckload	100-ton silo	30 tons/day	3 - 4
Anti-Scalant (liquid surfactant)	240 lb carboy	2 carboys	30 lb/day	
Carbon Acid Wash & Neutralization				
Hydrochloric Acid (HCl) - Liquid 30%	HDPE totes	3,000 gallons	10 lbs/day	7
Acid Wash Vessel	2,320 working gallons			
Acid Mix Tank	282 working gallons			

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Caustic Soda - Sodium Hydroxide (NaOH) - Liquid	4,887 working gallons	5,000 gallons	5 lbs/day	7
Fluxes				
Borax (pentahydrats) - Dry	50 lb sacks	20 sacks	20 lb/day	*
Silica (SiO_2) - Dry	50 lb sacks	10 sacks	10 lb/day	
Niter ($NaNO_3$) - Dry	50 lb sacks	5 sacks		
Feldspar - Dry	50 lb sacks	5 sacks		
Mercury Control				
Sulfide-impregnated Carbon - Dry	50 lb sacks	40 sacks	25 lbs/day	*
Mercury Recovered				
Mercury	80 lb flask		5 lbs/day	*
Electrolytes				
Sodium Hydroxide (NaOH) - Dry	20 lb sacks	10 sacks	15 lbs/day	*
Assay and Met Lab				
Sulfuric Acid (H_2SO_4) Reagent Grade	1 gallon	6 gallons		
Nitric Acid (HNO_3) Reagent Grade	1 gallon	10 gallons	1lb/day	
Hydrofluoric Acid (HFI) Reagent Grade	1 gallon	2 gallons		
Hydrochloric Acid (HCl) Reagent Grade	1 gallon	4 gallons		
Sodium Cyanide (NaCN) Reagent Grade – Dry	5 lb box	10 boxes	1 lb/ day	*
Buffer Solution Reagent Grade - Dry	5 lb box	10 boxes		
Lead Nitrate ($PbNO_3$)- Dry	20 lb bag	1 bag		
Acetylene	Size 45 industrial Acetylene Cylinder	3 in lab/15 in shop	2 cylinders per week	
Fluxes				
Borax Penta - Use Plant Source			18 lbs/day	*
Silica - Use Plant Source				
Lead Oxide - Reagent Grade	80 lb pail	1 pail	2 lbs/day	*
Methyl Ethyl Ketone (MEK)	5-gallon pail	1 pail		
Silver lnquart	10 lb package	1 pkg		
Fuel/Lube/Oil				
Diesel- Truck Shop	30,000 gallons	Up to 30,000 gal	6,000 gal/day	1
Ammonium Nitrate/Fuel Oil (ANFO)	60-ton silo	Up to 60 tons	8 tons/day	
Gasoline	10,000 gallons	Up to 10,000 gal	250 gal/day	
30WT Motor Oil	4,000 gallons	Up to 4,000 gal	15-20 gal/day	
Used Motor Oil	4,000 gallons	Up to 4,000 gal	15-20 gal/day	

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Antifreeze	2,000 gallons	Up to 2,000 gal	1-l5 gal/day	
Hydraulic Fluid	2,000 gallons	Up to 2,000 gal	10-15 gal/day	
90WT Gear Lube	2,000 gallons	Up to 2,000 gal	10-15 gal/day	
Waste Antifreeze	2,000 gallons	Up to 2,000 gal	10-15 gal/day	
Grease bins	4 x 120-gallon totes, 4 x 30-gallon drums	Up to 4 totes, up to 4 drums	5-10 gal /day	

3.4.1 Petroleum Contaminated Soil Management

A Petroleum Contaminated Soil Management Plan is included in Appendix Z.

3.4.2 Waste Disposal Management

Used lubricants and solvents will be characterized according to the Resource Conservation and Recovery Act (RCRA) requirements and will be stored appropriately. Calico may obtain a Hazardous Waste Identification Number from the ODEQ. The mine is expected to be in the "conditionally exempt small quantity generator" category as defined by the EPA. Used solvents are the only identified potentially hazardous wastes at this time. Calico will institute a waste management plan that will identify the wastes generated at the site and their means of disposal.

Used oil and coolant will also be stored at the truck workshop in secondary containment. These will be either recycled or disposed of in accordance with state and federal regulations. Used containers will be disposed of or recycled according to federal, state, and local regulations.

Solid wastes and industrial solid wastes generated by the mine and process departments will be collected in dumpsters near the point of generation. A training program will be implemented to inform employees of their responsibilities in proper waste disposal procedures.

Calico will have a trained response team at the site 24 hours per day to manage potential spills of regulated materials at the site. Response for transportation-related releases of regulated materials bound for the site will be the responsibility of the local and regional agencies. However, where appropriate, Calico may assist with response to off-site incidents, including providing resources, based on agency requests.

3.4.3 Explosive Storage and Use

Explosive agents will be purchased, transported, stored, and used in accordance with the BATFE, Department of Homeland Security (DHS) provisions, and MSHA regulations. The primary explosive used will be ANFO. Explosive agents, boosters, and blasting caps will be stored within a secured area. Boosters and detonators will be stored in separate storage magazines.

Explosives-storage facilities will be constructed at the southwest side of the Project (Figure 6). This location uses the hill as a natural barrier between the explosives-storage facility and other infrastructure. The storage facilities will consist of leased powder magazines as per vendor quotation. Dirt berms will be places around the magazines for additional security.

Explosives will be delivered to site by vendors using the main access and will be delivered to the working face using stainless-steel totes on flatbed trucks.

3.4.4 Cyanide Management

Cyanide transporters are expected to comply with the International Cyanide Management Code for the implementation of appropriate emergency response plans and capabilities in the event of a release or spill, and with the Federal Motor Carrier Safety Administration's regulations for transportation of hazardous materials on public highways (49 CFR Part 397). Cyanide will be delivered to the Project in dry form by truck from Winnemucca, Nevada, and will be supplied as one-ton bulk bags packed in wooden crates. The crates will be stored on site in a cyanide mixing and storage area, which will be completely fenced and secured, and placed on an impervious concrete slab with walls providing a 110 percent containment. The dry cyanide is dissolved in water in an agitated mix tank. After the cyanide is mixed, the solution gravitates towards a 10,000-gallon storage tank. The cyanide solution will then be metered to various points throughout the plant. Additional information on cyanide management is in the Cyanide Management Plan (Appendix F).

3.5 Mine Site Infrastructure

3.5.1 Haul and Access Roads

The roads used to access the Mine and Process Area are described in detail in the Road Design Report (Appendix AC) and summarized in Section 3.2. The Road Design Report describes the design specifications and where the existing road will be upgraded, widened, and realigned. See Table 56 in Section 3.2.1 for select access road specifications.

The roads within the Mine Permit Area are shown on the Site Arrangement map (Figure 6). These roads will be upgraded in accordance with MSHA regulations, and best management practices (BMPs) will be used where necessary to control erosion.

3.5.2 Power Supply

Electrical power will be supplied to the mine via a powerline owned and maintained by Idaho Power. Idaho Power will apply for authorization to construct from the BLM under a ROW. The power demand will be approximately five megawatts (MWs) throughout the life of the mine. The Idaho Power powerline will connect to the Project substation, located near the processing facility. The powerline will be within the Access Road portion of the Permit Area.

During construction of the powerline, one emergency diesel generator capable of producing 2,000 kilowatts (kW) will be located at the process facility. It will be used for slightly more than one year during construction and initial mining of the decline. After the powerline is complete, this generator will provide sufficient emergency power to operate critical components at the facility in the event of a power outage.

3.5.2.1 On-Site Power Generation

Quotations for portable power generation, including the leasing of generation equipment, were obtained from vendors. Once construction of the primary powerlines has been completed, the generators would remain on site for backup in case of power outages. Power generation is estimated based on monthly rates and fuel, as the rate per kilowatt hour (kWh) will vary depending on power consumption.

3.5.2.2 Line Power

HDR, an engineering company with offices in Boise, Idaho, coordinated with Idaho Power to design the line power to deliver approximately 5.3 MW of power to site, including a 23-mile distribution circuit, a new 69/34.5 kV to 14 millivolts (mV) transformer, and a new 34.5-kV 167-amp regulator. The powerline would be constructed from the Hope Substation near Vale, Oregon, to the mine site along the main access road, within the Access Road portion of the Permit Area. Figures 32 through 34 show the planned line pole configurations.

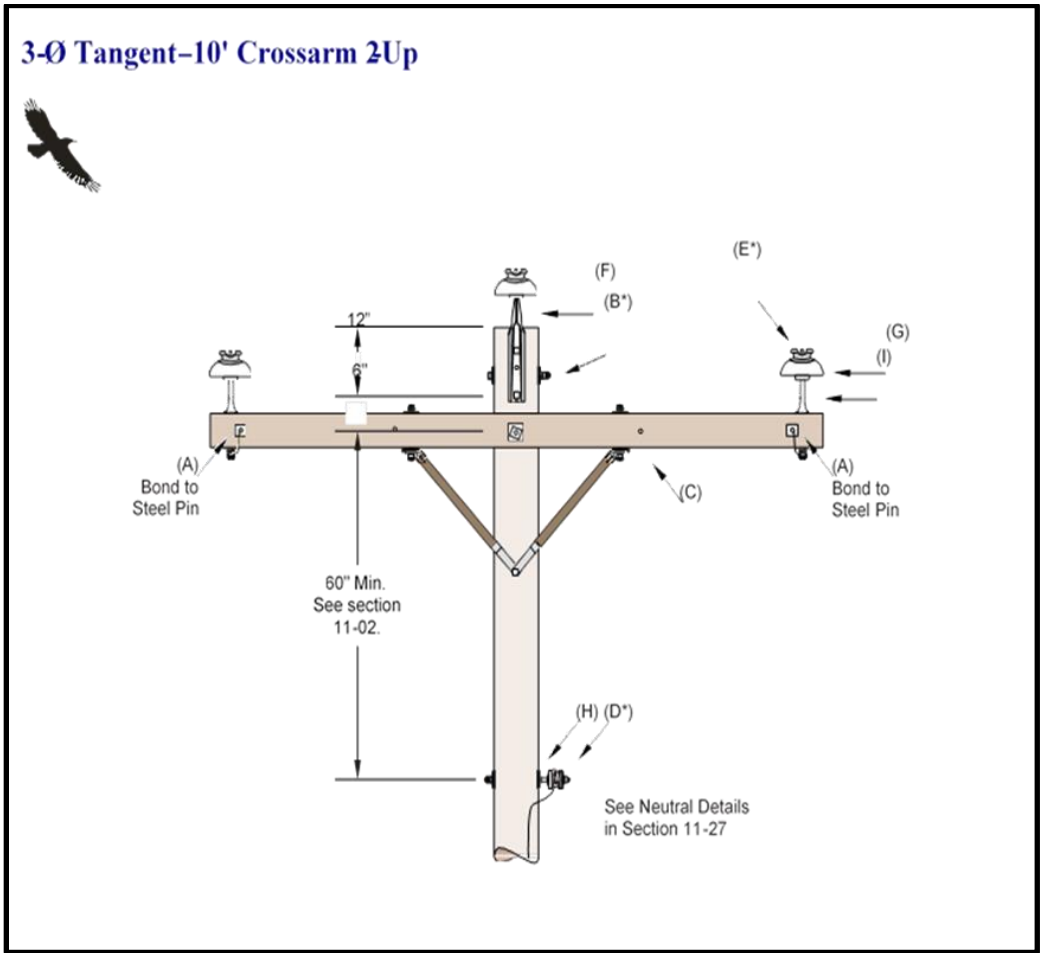


Figure 32. Planned Line Pole Configurations

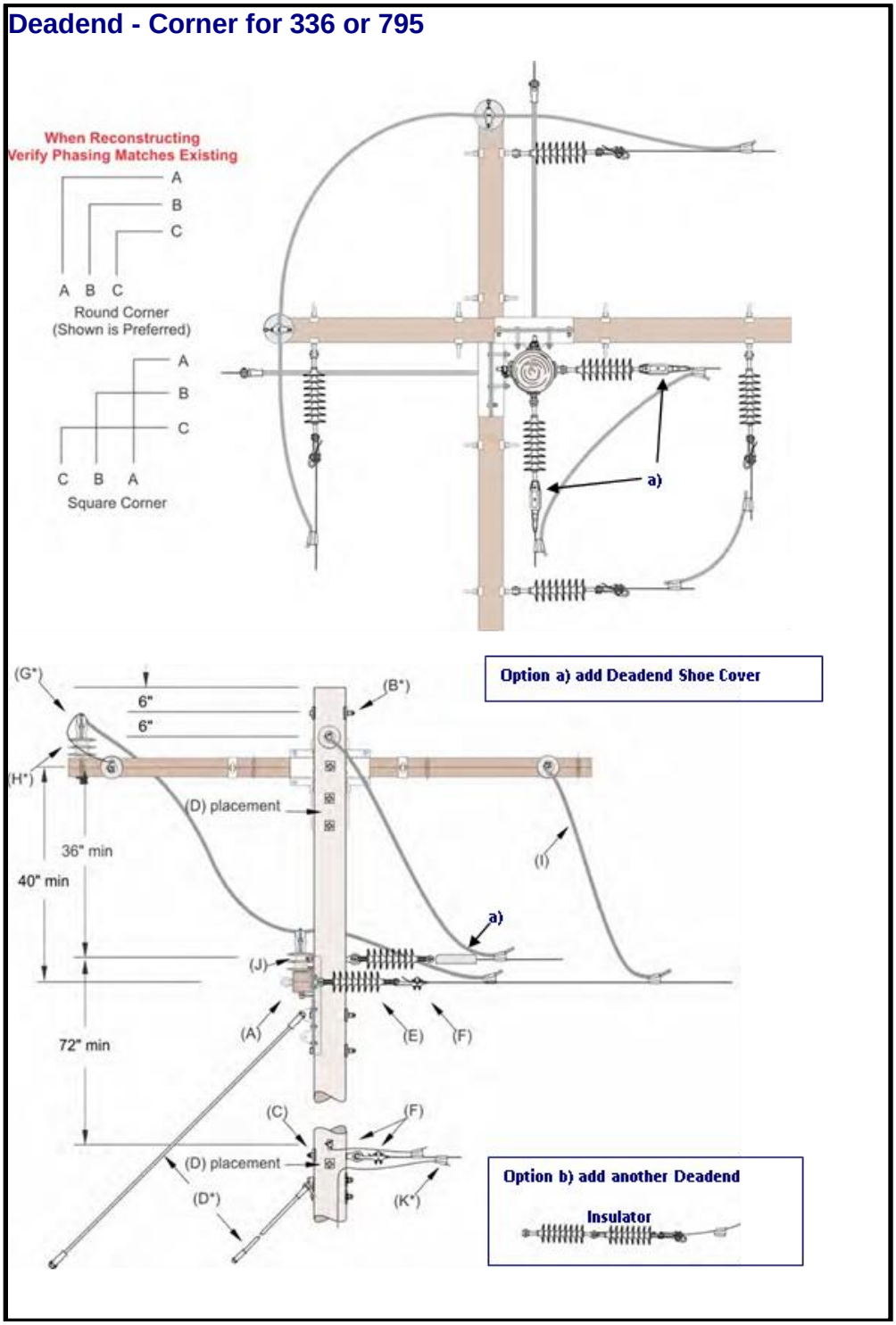


Figure 33. Planned Line Pole Configurations

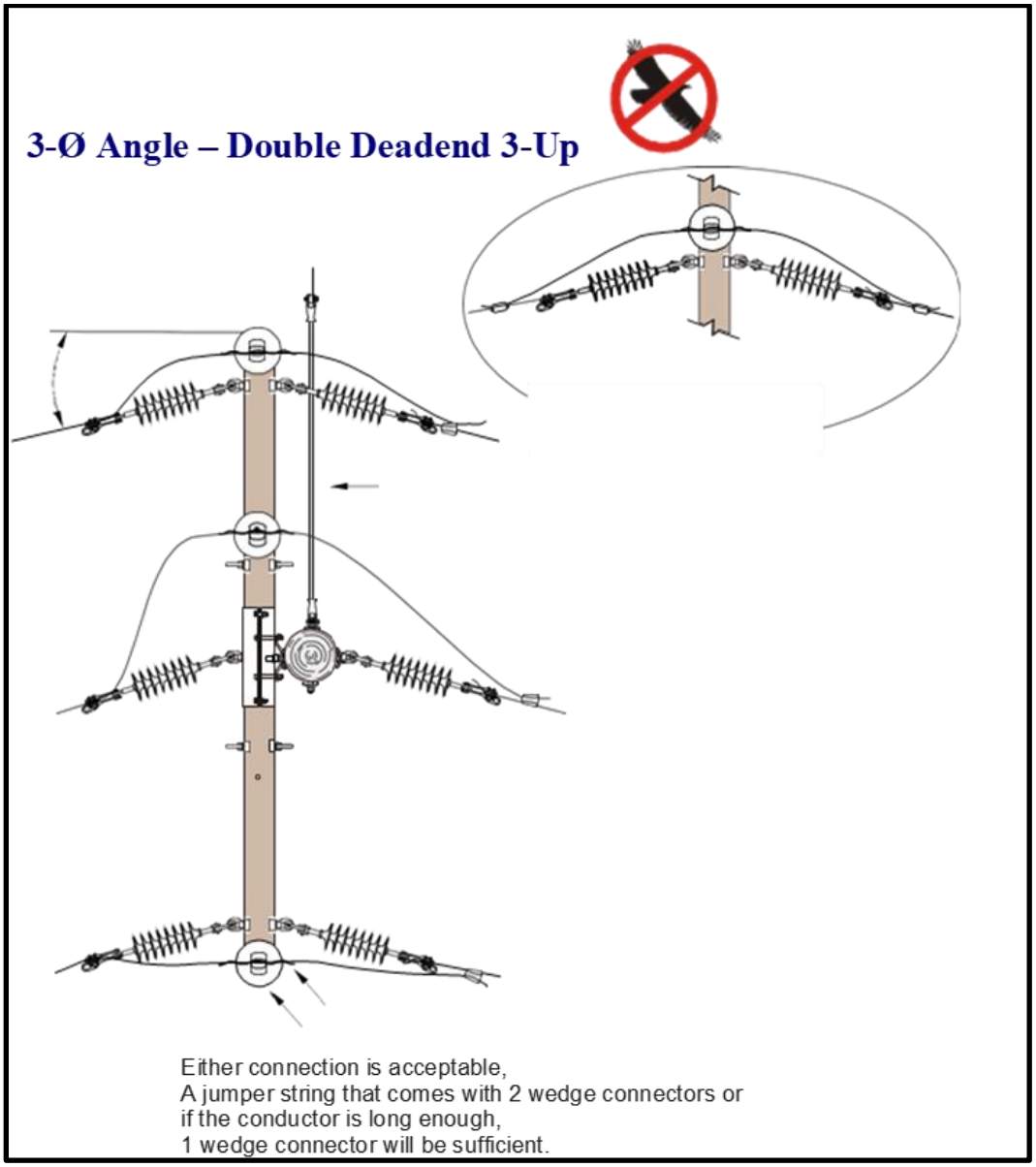


Figure 34. Planned Line Pole Configurations

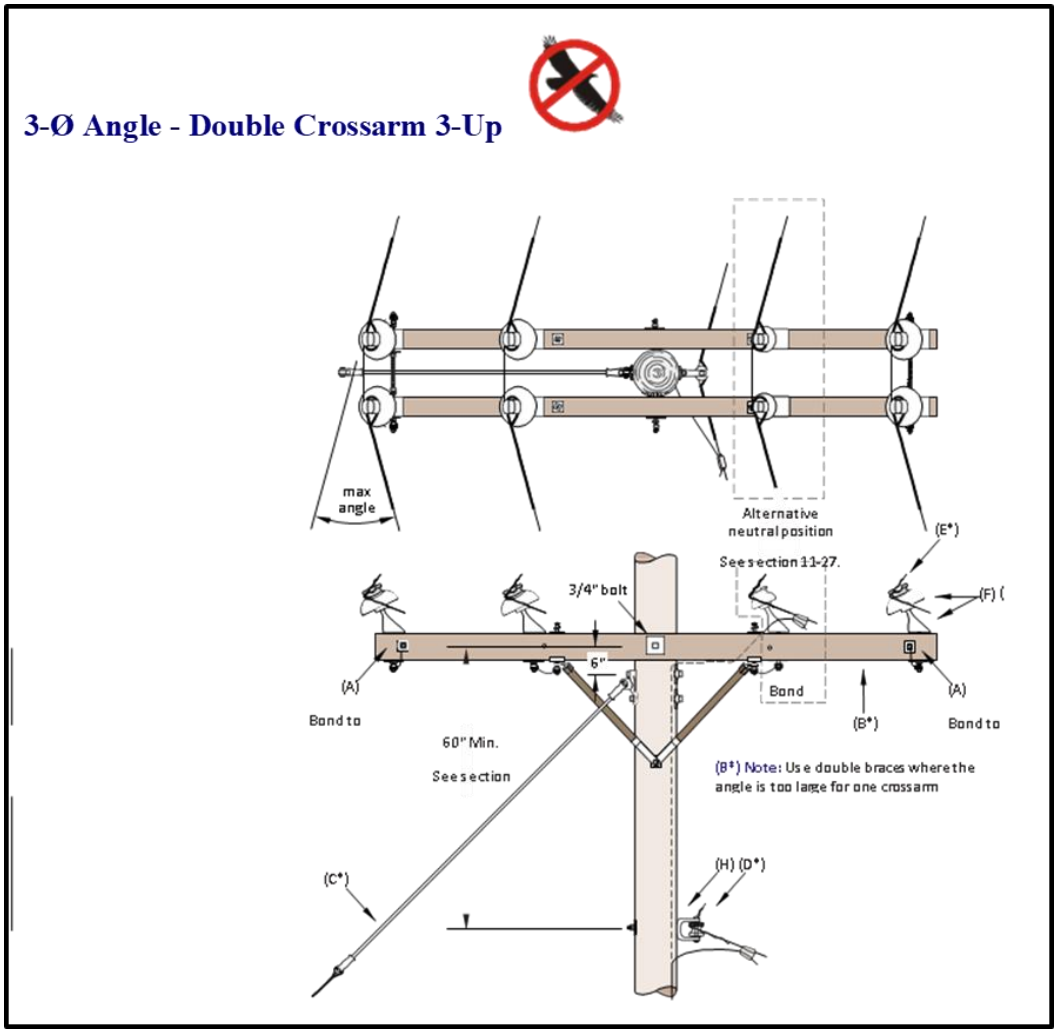


Figure 35. Planned Line Pole Configurations

3.5.2.3 Site Power Distribution

The plant power distribution from the powerhouse will be via overhead powerlines. The distribution voltage to the local electrical rooms will be 4.16 kV. There will be a combination control-room and motor-control-center room, which will be prefabricated and loaded with electrical equipment prior to delivery to site. The power distribution from the electrical rooms will be 480 volts.

The total connected load for the process plant is expected to be 4.9 MW, with an average power draw of 3.3 MW.

3.5.2.4 Underground Mine Power Distribution

At the start of mining an underground 480-volt transformer will be placed near the entrance to the portal. This will supply power to electrical equipment used to develop the main decline and portable fans. Once development has advanced far enough that carrying power at 480-volt becomes too inefficient, a main powerline will be installed along the rib of the decline to carry 4.16 kV and connected to the transformer, which will be moved underground.

Upon completion of the decline to the 3,224 level, and the initiation of production-mining activities, a second underground transformer will be purchased for use in the lower areas of the mine.

Line power will also be carried up the hill to the location of the ventilation shaft to supply power to the ventilation fans.

3.5.3 Ancillary Facilities

Planned ancillary facilities will include access roads and other facilities, laydown areas, maintenance facilities, a meteorological station, and other support facilities on similar flat terrain where the future disturbance will be reclaimed in a similar manner. Figure 6 presents the planned site layout.

3.5.3.1 Support Facilities

Support facilities will consist of the mine maintenance shop, warehouse, and administration buildings. The maintenance shop will have a concrete floor with rails to support the heavy equipment. The buildings will typically be insulated, prefabricated office trailers without concrete foundations. Heat will be provided by electric forced air furnaces in the office and personnel buildings and propane gas radiant heat in the maintenance bays. Gas will be provided from a propane tank located near the ADR plant building. Air conditioning will be provided by electrical cooling units.

Mobile equipment maintenance will be performed at the maintenance shop. The maintenance area will consist of an enclosure and concrete pad of appropriate size and an oil/water separator. Reclamation of support facilities are addressed in Section 4.7.

A fuel storage depot will be located near the Processing Facilities. It will include separate diesel above-ground tanks for fueling of light/intermediate and heavy vehicles. Gasoline will also be stored in an above tank in the fuel storage depot. Spill containment will be designed for 110 percent of the largest tank or tanker within the containment. Fuel will be delivered via highway-legal trucks directly to the depot. Drivers off-loading fuel will be certified and trained. Camlock fittings or other appropriate fittings will be located within the containment to collect spilled fuels. A sump will be located at one end of the containment so that spilled fuels can be pumped for appropriate disposal from the containment using a portable pump. Refer to

Appendix E for the Emergency Response Plan and Appendix Z for the Petroleum-Contaminated Soils Management Plan.

Lubricants, antifreeze, and used oil and coolant will be managed and stored in the area in a manner complying with MSHA requirements and other state and federal regulations.

A centralized oil-water separator will be installed adjacent to the truck workshop to treat water from drains located at each maintenance bay and from the wash rack. The floor drains in the truck workshop will be intended for collection of rainwater and snow melt from vehicles and equipment. Gray water from the oil/water separator will be collected in a tank within containment or a lined impoundment. The gray water will be recycled back to the wash system; excess water will be used for dust control. The separated oil will be stored either in a double-lined tank or a single-wall tank in a concrete containment and collected by a licensed waste collection contractor.

Administration and security offices will be located northwest of the process building as shown on Figure 6. These offices will house the reception area, offices for administrative staff, a first aid clinic, and a meeting/training room.

A septic field with the capacity to treat waste for up to 100 persons will be installed to the west of the administration and warehouse buildings (Figure 6).

3.5.3.2 Water Supply and Management

Process water will be provided from the Project well field and recycled process water. The current and proposed water supply areas are described in Appendix AD, Well Field Design Report. Water from the well field will be piped through a combination of underground and above ground steel and HDPE piping to a freshwater tank, located south of the processing facility. From the freshwater tank, the fresh water will be distributed around the mine area. The full Water and Wastewater Design is described in Appendix AE. The nominal capacity of the freshwater delivery system will be approximately 750 gpm (Figure 6).

Potable water will be supplied from the freshwater tank. Water quality is expected to meet drinking water standards. Water will gravity flow from the freshwater tank to the potable water tank. Calico will secure appropriate permits for the potable water system.

Calico has water rights from the OWRD in the amount of two cfs (see Appendix P - Water Rights Amendment). This equates to approximately 900 gpm, which is more than the planned water demand for the Project.

3.5.3.3 Growth Media and Stockpiles

As shown in Table 85, Table 86, and Figure 36, there are seventeen soil map units. Each map unit description provides basic information about the map unit such as predominant soil or soils of the unit, slope, and rock fragment content.

Table 85. Soil Survey Map Unit Descriptions

Map Unit [1]	Name - Description
1	Farmell- Rock outcrop complex,eight to 30 percent slopes
2	Farmel-Chardoton very cobbly soil, 15 to 30 percent slopes
3	Farmell-Chardoton very cobbly soil,four to 15 percent slopes
4	Farmell-Chardoton extremely stony soil,four to 15 percent slopes
5	Farmell-Chardoton soil, 8 to 15 percent slopes
6	Ruckles very stony loam,eight to 30 percent slopes
7	Shano silt loam, two to six percent slopes
8	Soil A extremely gravelly sandy loam, 15 to 30 percent slope
9	Virtue loam, two to eight perfect slopes
10	Xeric Torriorthents, eight to 30 percent slopes
11	Soil B very gravelly sandy loam, eight to 30 percent slopes
12	Nyssa silt loam, two to six percent slopes
13	Drewsey very fine sandy loam, two to six percent slopes
14	Ruclick cobbly loam, four to 15 percent slopes
15	Drewsey-Quincy-Solarview Complex, eight to 30 percent slopes
16	Owsel silt loam, two to six percent slopes
17	Powder silt loam, zero to three percent slopes
1 Map units 1-11 were obtained from IMS report (IMS, Inc. 1989, 1991)	

Table 86. Taxonomic Classification of Soil Series

Series	Family
Chardoton [1]	Fine, montmorillontic, mesic Xerollic Paleargids
Farmell [1]	Fine, montmorillontic, mesic Xerollic Haplargids
Ruckles [1]	Clayey-skeletal, montmorillonitic, mesic lithic Argixerolls
Shano [1]	Coarse-silty, mixed, mesic Xerollic Camborthids
Soil A [1]	fine-loamy, mixed mesic Xerollic Haplargids
Soil B [1]	Clayey-skeletal, montmorillonitic, mesic Xerollic Durargids
Virtue [1]	Fine-silty, mixed, Xerollic Duragids
	Xeric Torriorthents[1]
Nyssa	Coarse-silty, mixed, mesic Xeric Haplodurids
Drewsey	Coarse-loamy, mixed, mesic Xeric Haplocambids
Ruclick	Clayey-skeletal, smectitic, mesic Aridic Argixerolls
Owsel	Fine-silty, mixed, mesic Durinodic Xeric Haplargids
Powder	Coarse-silty, mixed, mesic Cumulic Haploxerolls
Source: IMS, Inc. 1989, 1991	
[1]Soil Series data obtained from IMS report (IMS Inc, 1989, 1991)	

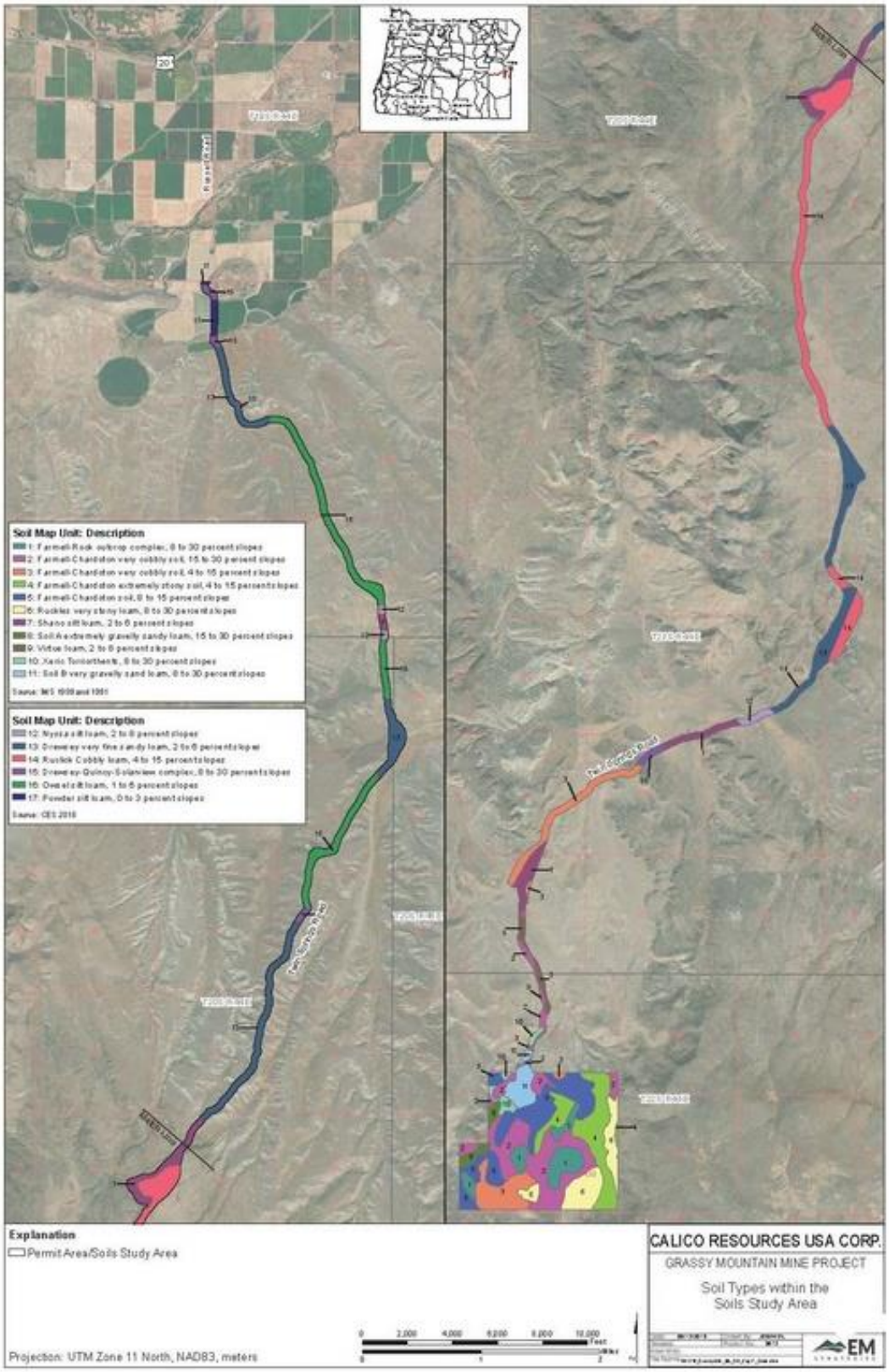


Figure 36. Soil Types Within the Soils Study Area

The following description of the soils is from the Geology and Soils Baseline Report in Appendix B. Soil found on the ridges is typically less than 30 inches deep and is high in rock fragments throughout the profile. Farmell and Chardoton soil, with high amounts of clay in the sub-soil and varying amounts of surficial rock fragments, is found throughout the Mine and Process Area. The moderately fine textured Virtue soil has a hard silica and carbonate hard pan layer at about 20 to 30 inches below the surface. Deep, coarse-textured Shano soil is found along drainage channels. Ruckles soil is typically found over areas where the underlying bedrock is basalt. Soils A and B have high percentages of surficial rock fragments. Soil A is found on slopes of 15 to 30 percent. Soil B is found in areas with slopes of approximately eight percent.

The soils located in the valleys consist predominately of alluvium, loess (wind-blown silt) and eolian (wind-blown) sand. These soils belong to the Drewsey, Shano, Power, and Owsel series. The Drewsey series is a deep, coarse-textured soil with a weakly-developed subsoil. The Owsel series is a deep, finer soil with a well-developed subsoil. The Shano series is similar to the Owsel series but lacks a well-developed subsoil. Nyssa soil, encountered sporadically, are generally silty throughout the profile and exhibit a cemented silica and carbonate layer between 25 to 30 inches. Soils located on and along ridges were formed from the underlying bedrock which generally consisted of conglomerate sandstone and basalt. The soils underlain by basalt were predominantly the Ruclick series, a moderately deep, fine-textured soil. These soils exhibited many surficial and subsurface coarse fragments. The soils underlain by conglomerate sandstone were the Drewsey and the Drewsey-Quincy-Solarview complex. These soils were generally deeper to rock and coarser-textured. Soils further south along Twin Springs Road generally consist of the Shano series and Farnell-Chardoton complex. The Farnell-Chardoton complex exhibited high amounts of clay and rock throughout the profile. The map unit characteristics of these soils are listed in Table 30. Suitability for reclamation is also included in the table.

Salvageable growth media from the Project surface disturbance will be stockpiled at centralized locations, as shown on Figure 6. Growth media will be salvaged for reclamation. Soils on slope that are less than ten percent will be salvaged to a depth of three feet. Soil on slope at 15 percent or less will be salvaged to a depth of two feet. Soils on slopes greater than 15 percent will be salvage to a depth of one foot. Section 4.1 presents further discussion on growth media salvage. Growth media will consist of soils and alluvium stripped prior to surface disturbance activities. Any growth media remaining in the stockpiles for one or more planting seasons will be seeded with an interim seed mix to stabilize the material to reduce erosion and minimize the establishment of undesirable weeds.

Approximately 551,759 bank cubic yards (bcy) of growth media will be salvaged from the footprint of the facilities. Facilities that will not have growth media salvaged are the water pipeline, fence, growth media stockpiles, and exploration areas. These bcy convert to approximately 690,000 cubic yards based on a 25 percent swell factor. Figure 36 shows the distribution of the growth media (soils) within the area of Project surface disturbance. This volume could change based on actual field conditions encountered. On sloped terrain, some soil may be salvaged by pushing available natural growth media cover downhill with a dozer to construct toe berms to prevent rocks from scattering on the hillside below the stockpile toes.

3.5.3.4 Storm Water and Sediment Control Structures

Surface water diversion channels and ditches will be constructed as necessary around surface facilities and waste rock storage areas to control storm water run-on to these sites (Figure 3). Surface water control ditches and sediment retention ponds will be constructed in accordance with BMPs as outlined in the Best Management Practices for Reclaiming Surface Mines in Washington and Oregon (DOGAMI 1997) and in the Tailings Facility and Ancillary Facilities Design Report (Appendix C). Sediment retention ponds and diversion ditches are sized to contain a 100-year, 24-hour precipitation event. Run-on diversion channels and ditches will remain as permanent features after final reclamation and mine closure.

Run- off control structures include silt traps and fences constructed of certified weed-free straw bales, or geotextile fabric, and sediment retention ponds. Sediment control measures are implemented as necessary to reduce soil movement within the site and to minimize off-site effects. These structures will be maintained throughout the life of the Project. Soil collected in these structures will be periodically removed and placed in soil stockpiles or used for reclamation. These features will be removed once vegetation is established and sediment runoff has stabilized.

3.5.3.5 Borrow Areas

One borrow area is located on the east edge of the Project Area. The DOGAMI Aggregate Application is in Appendix V. Borrow material will be required for areas that need prepared subgrade materials, drainage materials, pipe bedding materials, road surfacing materials, retarding layer materials, closure cover materials, growth media, underground mine backfill, and riprap.

The surface mining operation will cover approximately 43 acres, with a maximum depth of 125 feet, with the lowest elevation at 3,790 feet amsl. Quarry benches will be approximately 40 feet vertical faces separated by 60-foot horizontal benches, resulting in an interim sloping configuration of 1.5H:1V. The Permit Boundary setback is 50 feet from all operations. Activities associated with the borrow surface mining will require drilling and blasting, shovel/loader/scraper for moving the material, crushing, stockpiling and screening. Water will be used for dust control. Detailed drawings are included in Appendix V.

Surface water diversion channels and surface water run-on diversion berms are included in the design. These features will be removed during final reclamation grading. Precipitation that falls into the quarry footprint will be managed within the quarry using internal sloping, retention berms and a stormwater management sump. Additional BMPs will be implemented to minimize erosion and sedimentation. All stormwater will be managed under the Stormwater Management Plan (Appendix Y). The process material will be stockpiled at the borrow areas until it is needed.

3.5.3.6 Fencing

A perimeter fence, approximately 22,358 feet in length, will be constructed around the Project facilities to prevent access by livestock, wildlife, and the public (Figure 6). In general, three-strand barbed wire fences will be constructed in accordance with BLM fencing standards per BLM Handbook 1741-1. The area within the perimeter fence is approximately 540 acres. Within the perimeter fence in areas where a higher level of security is needed, chain-link fences will be erected. Gates or cattle guards will be installed along roadways within the Project Area, as appropriate. The perimeter fence will be monitored on a regular basis and repairs made as needed.

3.5.4 Safety and Fire Protection

3.5.4.1 Safety

The Project will operate in conformance with all MSHA safety regulations (30 CFR 1 199). Site access will be restricted to employees and authorized visitors.

3.5.4.2 Fire Protection

Water for fire protection will be distributed from the fire water tank located on Grassy Mountain near the mine facilities via a network of piping and will be maintained under a constant pressure with a jockey pump. The piping will be looped and sectionalized to minimize loss of fire protection during maintenance. Where located outside buildings, fire water piping will be buried below the ground surface to eliminate the potential of pipes freezing.

Yard hydrants will be limited to the fuel storage tank area. Wall hydrants will be used in lieu of yard hydrants, and these will be located on the outside walls of the buildings in cabinets that will be heated during winter months.

Fire protection within buildings will include standpipe systems, sprinkler systems, and portable fire extinguishers. Standpipe systems will be provided in all structures that exceed 46 feet in height, as well as where required by building code, local authorities, or the insurance underwriter.

Sprinklers will be provided at the following locations or to protect the following items:

- Truck workshop;
- Assay laboratory;
- Over hydraulic or lube packs that contain more than 120 gallons of fluid;
- Lube-storage rooms;
- Any conveyor belts that are within tunnels or other enclosed spaces which would be hazardous to fight fires manually;
- Transformers; and

- Warehouse.

3.5.5 Additional Infrastructure

3.5.5.1 Fuel Supply, Storage, and Distribution

A single double-walled steel tank will be used for diesel storage. There will be one 8,200-gallon tank for mobile mining equipment. The fuel will be used by both underground and surface mobile equipment. The surface equipment will primarily be fuelled at a fuel island near the storage tanks. The underground-mining equipment includes a fuel truck that will be used to fuel underground equipment as required. This fuel truck may be used to fuel surface equipment as needed.

A small portable tank will be maintained for unleaded gasoline as required for light vehicles and other small equipment (e.g., portable pumps). This tank will be stored in a location away from fire hazards and will be placed within a lined berm area as required by local regulations. Light vehicles that return off-site overnight will be fuelled in other locations, thereby reducing the storage requirements for gasoline on site.

3.5.5.2 Compressed Air Supply

High-pressure compressed air will be provided by two duty screw compressors, one standby screw compressor, and a duty-plant air receiver. There will be two high-pressure air uses: instrument air and plant air. The instrument air will be dried and then stored in a dedicated air receiver. The plant air will be fed straight from the plant air receiver without a drying step.

Low-pressure air for pre-aeration tank air requirements will be provided by two duty and one standby centrifugal blowers.

3.5.5.3 Communications

On-site communications will comprise inter-connected mobile and fixed systems, including a land-line telephone network, portable two-way radios, and internet. Access for internet and corporate network connection will be made via satellite connections or a cable line.

Underground communication with the surface will be via a leaky-feeder system as described in Section 3.3.10.2.

3.5.5.4 Transportation

Main transportation of personnel and supplies will be via the main access road. No provisions have been made at this time for the transport of employees, as they will be required to drive out or carpool at their own expense.

3.5.5.5 Buildings

A total of nine buildings are planned to be constructed at the site to support mining, processing, and administrative activities. The locations of these buildings are shown in Figure 6.

Administration Building: The administration building will be a double-width Atco trailer of approximately 3,600 square feet (ft^2). It will contain the mine general manager's office, as well as accounting and human resources offices.

Plant Office and Changehouse: The plant office building and changehouse will constructed as a single-level modular wood-frame building of approximately 2,900 ft^2. It will contain the plant offices and change rooms for the process plant staff and labor force. These facilities will be complete with showers, basins, toilets, lockers, and overhead laundry baskets.

Plant Maintenance and Warehouse: The process-plant maintenance and warehouse building will be a pre-engineered steel-frame and metal-clad building of approximately 1,075 ft^2. This building will be used to perform maintenance for process equipment, as well as for the storage of equipment spare parts.

Mine Office: The mine office and changehouse will be constructed as a single-level modular wood-frame building of approximately 4,300 ft^2. This building will include Engineering and Geology offices as well as mine-operations offices. The building will also have showers, basins, toilets, lockers, and overhead laundry baskets. The building will also include first-aid facilities, along with safety-training areas to be used for site-wide training.

Truck Workshop and Warehouse: The truck workshop and warehouse building will be a pre-engineered steel-frame and metal-clad building with an area of 7,100 ft^2 and will be positioned adjacent to the mine-office building. This area will be divided into two sections, one for warehousing spare parts and tool storage and the other for a maintenance workshop. An overhead crane will be included in this building, above the maintenance workshop.

Vehicle Wash-Bay Facility: The vehicle wash-bay facility will be an open-air, 50- by 50-foot concrete slab with a fluid-collection sump and will be located adjacent to the truck workshop and warehouse. Wash water will be collected in the sump where settling will occur prior to the water being recirculated back to the wash system. An oil-water separation system will be included in the facility to recover hydrocarbons prior to re-use of the wash water. The recovered hydrocarbons will be collected and shipped offsite for disposal in accordance with applicable environmental regulations.

Laboratory: The laboratory will be constructed as a single-level modular wood-frame building of approximately 1,850 ft^2 situated adjacent to the process building. The laboratory building will house all laboratory equipment for assaying, metallurgical, and environmental requirements. Dust-collection equipment will be located external to the laboratory building.

3.6 Operational Environmental Protection Measures

3.6.1 Air Emissions

Appropriate air quality permits will be obtained from the ODEQ for the Project facilities and land disturbance (Appendix M). As per ODEQ regulations, the Project air quality operating permit will be authorized by the ODEQ prior to Project commissioning. Committed air quality practices will include dust control for mine unit operations as described by the ODEQ-required Fugitive Dust Control Plan. In general, the Fugitive Dust Control Plan will provide for water application of haul roads and other disturbed areas, chemical dust suppressant application (such as magnesium chloride) where appropriate, and other dust control measures as per accepted and reasonable industry practice. Also, disturbed areas will be seeded with an interim seed mix to minimize fugitive dust emissions from surfaces without vegetation, where appropriate.

Appropriate emission control equipment will be installed and operated in accordance with the construction and operating air permits. Where required, pollution control devices installed by equipment manufacturers will control combustion emissions. Pollution control equipment will be installed, operated, and maintained in good working order to minimize emissions.

3.6.2 Cultural Resources

A Class III cultural resources survey is being performed for the Project Area. The Cultural Baseline Report is described in Section 2.3 of this report. Avoidance is the Oregon SHPO and BLM-preferred treatment for preventing effects to historic properties (a historic property is any prehistoric or historic site eligible to the NRHP) or unevaluated cultural resources.

If avoidance is not possible or is not adequate to prevent adverse effects, Calico will undertake data recovery at the affected historic properties in accordance with the Programmatic Agreement between the BLM, Oregon SHPO, and the Advisory Council on Historic Preservation. Development of a treatment plan, data recovery, archaeological documentation, and report preparation will be based on the "Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation," 48 CFR 44716 (September 29, 1983), as amended or replaced. If an unevaluated site cannot be avoided, additional information will be gathered, and the site will be evaluated. If the site does not meet eligibility criteria as defined by the Oregon SHPO, no further cultural work will be performed. If the site meets eligibility criteria, a data recovery plan or appropriate mitigation will be completed under the Programmatic Agreement (Appendix U). Once data recovery has been completed at a historic property, the BLM will issue a Notice to Proceed for work at that location.

3.6.3 Erosion and Sediment Control

Calico will obtain coverage under the Mining General Stormwater National Pollutant Discharge Elimination System (NPDES) permit for the operations within the Mine and Process Area. The application is included under Appendix O and the Stormwater Management Plan is included

under Appendix Y. The Stormwater Management Plan addresses the necessary BMPs, as well as the monitoring requirements under the permit.

BMPs will be used to limit erosion and reduce sediment in precipitation runoff from Project facilities and disturbed areas during construction, operations, and initial stages of reclamation. BMPs may include, but are not limited to, diversion and routing of storm water using accepted engineering practices, such as diversion ditches, and the placement of erosion control devices, such as sediment traps, and rock and gravel cover. Sediment removed from the sediment control structures will be placed on the waste rock storage areas during operations and will be disposed of in an approved disposal site after closure.

Re-vegetation of disturbed areas will reduce the potential for wind and water erosion. Following construction activities, areas such as cut-and-fill embankments and growth media stockpiles will be seeded as soon as practical and safe. Concurrent reclamation will be maximized to the extent practicable to accelerate revegetation of disturbed areas. All sediment and erosion control measures will be inspected periodically, and repairs performed as needed.

3.6.4 Waters of the State

Process components will be designed, constructed and operated in accordance with DOGAMI and ODEQ regulations. Proposed process facilities will be zero discharge and the TSF will have a composite liner system in accordance with ODEQ design criteria. Waste rock has been determined to have the potential to generate acid and/or mobilize deleterious constituents and therefore will be managed on containment (Appendix C).

If any ponds will be over ten feet in height or impound over approximately nine acre-feet of water, a dam permit will be obtained from OWRD.

3.6.5 Hazardous Materials Management

Hazardous materials will be transported, stored, and used in accordance with federal, state, and local regulations. Employees will be trained in the proper transportation, use, and disposal of hazardous materials. Spill contingency and emergency preparedness measures are laid out in the Emergency Response Plan, included as Appendix E.

3.6.6 Solid Waste

Employee training plans will cover appropriate disposal practices, which will include which wastes may be placed in a dumpster or in the WRD, management of used filters, oily rags, fluorescent light bulbs, aerosol cans, and other regulated substances. Solid waste will be stored onsite in dumpsters and transported to an off-site landfill periodically. All other wastes will be disposed of off site. Used solvent, liquids drained from aerosol cans, accumulations of mercury fluorescent lights, and used antifreeze may be regulated by RCRA. Calico anticipates that the mine will fall in the “small generator” category.

3.6.7 Monitoring

A plan for monitoring the proposed Project that was developed for the Project Chemical Mining application is included in Appendix G.

3.6.8 Growth Media and Cover Salvage and Storage

Suitable growth media will be salvaged and stockpiled during the development of the facilities, during construction of the waste rock storage areas and the TSF, and construction of other Project facilities. See Section 4.1 for details on growth media management.

Following stripping, growth media will be stockpiled within the proposed disturbance areas. Growth media stockpiles will be located such that they will not be disturbed by mining operations. The surfaces of the stockpiles will be contoured with slopes no steeper than 2.5H:1V to reduce erosion. To further minimize wind and water erosion, growth media stockpiles will be seeded after contouring with an interim seed mix developed in conjunction with the BLM. Diversion channels and/or berms will be constructed around the stockpiles as needed to prevent erosion from overland runoff. BMPs such as silt fences or staked weed-free straw bales will be used as necessary to contain sediment in runoff.

3.6.9 Wildlife and Migratory Birds

Calico will implement a Wildlife Mitigation Plan for the Project (Appendix I). This plan addresses the avoidance, minimization, and mitigation of potential impacts to wildlife. Operators will be trained to monitor mining and process areas for the presence of larger wildlife such as deer. Mortality information will be recorded. Calico will establish wildlife protection policies that will prohibit the feeding or harassment of wildlife.

If possible, land clearing and surface disturbance will be timed to prevent destruction of active bird nests or young of birds during the avian breeding season (annually in accordance with the BLM policies) to comply with the Migratory Bird Treaty Act (MBTA). If surface disturbing activities are unavoidable during the avian breeding and nesting season, Calico will have a qualified biologist survey the areas proposed for disturbance to determine the presence of active nests immediately prior to the disturbance. If active nests are located, or if other evidence of nesting is observed (mating pairs, territorial defense, carrying nesting material, transporting of food) the area will be avoided to prevent destruction or disturbance of nests until birds are no longer present.

3.6.10 Protection of Surface Monuments

To the extent practicable, Calico will protect all survey monuments, witness corners, reference monuments, bearing trees, and line trees against unnecessary or undue destruction, obliteration, or damage. If in the course of operations any monuments, corners, or accessories are destroyed, Calico will immediately report the matter to the appropriate authority. Prior to obliteration,

destruction, or damage during surface disturbing activities, Calico will contact the BLM to develop a plan for any necessary restoration or reestablishment activity of the affected monument. Calico will bear the cost for the restoration or re-establishment activities including the fees for an Oregon Professional Land Surveyor.

3.6.11 Noxious Weeds and Invasive Nonnative Species

Calico recognizes the economic and environmental impact that can result from the establishment of noxious weeds and has committed to a proactive approach to weed control. A noxious weed monitoring and control plan will be implemented during construction and continuing through operations. The plan, provided as Appendix H, contains a risk assessment, management strategies, provisions for annual monitoring and treatment evaluation, and provisions for treatment. The results from annual monitoring will be the basis for updating the plan and developing annual treatment programs.

3.6.12 Inadvertent Cultural Discoveries

All Inadvertent Cultural Discoveries will follow the BLM and Oregon SHPO regulations. Calico has created an Inadvertent Discovery Plan for Cultural Resources-Grassy Mountain, which will be used throughout all aspects of the exploration, mining and reclamation activities at Grassy.

Pursuant to 43 CFR 10.4(c) and (d), Calico will immediately stop all activities in the vicinity of the inadvertent cultural discovery and not commence again for 30 days after certification is received from the BLM-authorized officer, or a binding agreement is executed between the federal agency and the affiliated Indian tribes. According to 43 CFR 10.4d(2): “The activity that resulted in the inadvertent discovery may resume thirty (30) days after certification by the notified Federal agency of receipt of the written confirmation of notification of inadvertent discovery if the resumption of the activity is otherwise lawful. The activity may also resume, if otherwise lawful, at any time that a written, binding agreement is executed between the federal agency and the affiliated Indian tribes or Native Hawaiian organizations that adopt a recovery plan for the excavation or removal of the human remains, funerary objects, sacred objects, or objects of cultural patrimony following 10.3(b)(1) of these regulations. The disposition of all human remains, funerary objects, sacred objects, or objects of cultural patrimony must be carried out following 10.6.”

3.6.13 Fire Protection Measures

All applicable state and federal fire laws and regulations will be complied with and all reasonable measures will be taken to prevent and suppress fires in the Project Area.

All equipment will be properly muffled and equipped with suitable and necessary fire suppression equipment, such as fire extinguishers and hand tools. All Project-related traffic will observe prudent speed limits to enhance public safety, protect wildlife and livestock, and minimize dust

emissions. All activities will be conducted in conformance with applicable federal and state health and safety requirements.

3.6.14 Public Safety Measures

Public safety will be maintained throughout the life of the Project. All equipment and other facilities will be maintained in a safe and orderly manner.

In the event that any existing roads in the Project Area are severely damaged as a result of Project activities, Calico will return them as close as possible to their original condition.

3.6.15 Quality Assurance Plan

A plan for ensuring quality assurance developed for the proposed Project is included in Appendix AA.

4 RECLAMATION AND CLOSURE

Reclamation of disturbed areas resulting from activities outlined in this Reclamation Plan will be completed in accordance with the BLM, DOGAMI, and ODEQ regulations. The purpose of Subpart 43 CFR 3809 - Surface Management is to prevent unnecessary or undue degradation of public lands by operations authorized by the mining laws. Anyone intending to develop mineral resources on public lands must prevent unnecessary or undue degradation of the land and reclaim disturbed areas. This subpart establishes procedures and standards to ensure that operators and mining claimants meet this responsibility and provide for the maximum possible coordination with appropriate state agencies to avoid duplication and to ensure that operators prevent unnecessary or undue degradation of public lands by operations authorized by the mining laws. The State of Oregon requires that a reclamation plan be developed for any new mining project and for expansions of existing operations (OAR 632-037-0070).

The Project disturbance areas are summarized in Table 54. The areas proposed for disturbance can be divided into the following: underground mine opening (portal); waste rock storage areas; milling and processing facility; a TSF; borrow area; growth media stockpiles; haul roads; buildings and yard areas around mine; process plant; administration; laboratory; and ancillary facilities. Calico anticipates that the surface mine components will be reclaimed and revegetated.

Costs to support financial surety associated with this Plan will be developed and submitted for approval prior to Plan approval. In this manner, the reclamation plan cost estimate will be as accurate as possible.

Surface management regulations 43 CFR 3809.420 establish the performance standards that apply to this Plan. The State of Oregon has established mining, reclamation, water quality, and air quality regulations. The following measures designed to prevent unnecessary or undue degradation will be implemented during the design, construction, operation, and closure of the Project:

- All regulated components of the facility will be designed and constructed to meet or exceed BLM/DOGAMI/ODEQ/OWRD design criteria;
- Mineral exploration and development drill holes, monitoring and observation wells, and production wells subject to State of Oregon regulations will be properly abandoned to prevent potential contamination of water resources;
- Roads will be constructed to the minimum necessary width;
- Regulated wastes will be managed according to applicable regulations;
- Surface disturbance will be minimized while optimizing the recovery of mineral resources;
- Fugitive dust and other air emissions from disturbed and exposed surfaces will be controlled in accordance with ODEQ regulations and permits;
- Calico will comply with applicable federal and state water quality standards, including the Federal Water Pollution Control Act, as amended (30 United States Code [U.S.C.] 1151 et seq.);

- Through successful revegetation utilizing the seed mix provided by the BLM and recontouring of the topography to mimic the surrounding environment, wildlife habitat will be rehabilitated (43 CFR 3809.401(b)(3)(v) and 43 CFR 3809.420(b)(3)(iii)(E);
- Surface water drainage control will be accomplished by diverting storm water, isolating facility runoff, and minimizing erosion;
- Where suitable as a growth media, surface soils and alluvium will be managed as a growth media resource and removed, stockpiled, and replaced during reclamation; and
- A reclamation plan will be implemented that addresses earthwork and re-contouring, re-vegetation and stabilization, detoxification and disposal, and monitoring operations necessary to satisfactorily reclaim the proposed disturbance including roads, ponds, tailings facilities, stockpiles, buildings, and equipment.

4.1 Growth Media Balance

As outlined in the soils survey for the Project area (Section 2 and Appendix B), have limited depth and variable suitability for reclamation uses. Generally, soils salvage is on the order of 0.5 foot, though some soils are salvageable to a depth of 2.5 feet. Therefore, the depth of growth media salvage will vary based on soil type. A preliminary growth media balance for the Project, shown below in Table 87, indicates approximately 533,261 cubic yards of material will be required to establish growth media on the Project facilities to a depth of six to 24 inches, depending on the facility component.

Table 87. Growth Media Balance Needed

Facility	Area (acres)[1]	Growth Media Depth (feet)[2]	Volume (cubic yards)
Mine Portal	0.5	0.5	403
Waste Rock Storage Area	8.4	0.5	7,476
Tailings Storage Facility	99.2	2.0	320,085
Process/Administration Area	7.2	1.0	11,616
Laydown/Yard Area	73.7	1.0	118,903
Roads	24.9	1.0	40,172
Water Tank	0.1	0	0
Water Wells and Water Pipelines	7.1	0	0
Fence	15.5	0	0
Borrow Pit	42.9	0.5	34,606
Diversion Ditches and Sediment Basins	11.9	0	0
Growth Media Stockpiles	18.2	0	0
Exploration	10	0	0
Total	**319.6**	**-**	**533,261**

[1]The acres are the same as those presented in Table 54.

[2]The growth media depth on the fence, water tank, water wells and pipeline, growth media stockpiles, and the exploration is set at zero since the construction of these facilities will incorporate the soils into the construction and reclamation and there will be no growth media applied. The diversion ditches and sediment basins and the barrow pit will be permanent features and no growth media will be applied. Any remaining waste rock in the waste rock storage area would be moved to the TSF as part of reclamation and the site reclaimed at the original grade.

Based on the soil survey completed in the Project area, the following amounts of growth media, as outlined in Table 88, are available and will be salvaged from each of the mine components prior to component construction. This amount exceeds the amount planned for growth media application.

Table 88. Growth Media Salvaged

Facility	Area (acres)[1]	Growth Media Depth (feet)[2]	Volume (cubic yards)
Mine Portal	0.5	0	0
Waste Rock Storage Area	8.4	2.5	33,880
Tailings Storage Facility	99.2	2.5	400,107
Process/Administration Area	7.2	1.0	11,616
Laydown/Yard Area	73.7	1.0	118,903
Roads	24.9	1.0	40,172
Water Tank	0.1	0	0
Water Wells and Water Pipelines	7.1	0	0
Fence	15.5	0	0
Borrow Pit	42.9	1.0	69,212
Diversion Ditches and Sediment Basins	11.9	0	0
Growth Media Stockpiles	18.2	0	0
Exploration	10	0	0
Total	**319.6**	**-**	**673,890**

[1] The acres are the same as those presented in Table 2.1 of the Plan, except the waste rock storage areas and the TSF, which are based on the area of the constructed slopes.

[2] The growth media depth on the fence, water tank, water wells and pipeline, growth media stockpiles, and the exploration is set at zero since the construction of these facilities will incorporate the soils into the construction and reclamation and there will be no growth media applied. The diversion ditches and sediment basins and the barrow pit will be permanent features and no growth media will be applied. Any remaining waste rock in the waste rock storage area would be moved to the TSF as part of reclamation and the site reclaimed at the original grade.

Growth media will be loaded from the growth media stockpiles using front-end loaders into end-dump trucks and then hauled to the needed locations. Once there the growth media will be dumped and then spread using a rubber-tired dozer.

4.2 Revegetation, Seeding, and Planting

Reclaimed surfaces will be re-vegetated to control runoff, reduce erosion, provide forage for wildlife and livestock, and reduce visual impacts. Seed will be applied with either a rangeland drill or with a mechanical broadcaster and harrow, depending upon accessibility. Seedbed preparation and seeding will take place in the fall after grading and growth media application to the reclaimed areas.

Reclamation seed mixtures and application rates, which are based on BLM requirements, as shown below in the Seed Mix for the Project Area table (Table 89), will be used in the reclamation cost estimate (RCE). This mixture will provide forage and cover species similar to the pre-disturbance conditions, facilitating the post-mining land uses of livestock grazing and wildlife

habitat. In addition, the seed mix has been determined, according to the species' effectiveness in providing erosion protection, the ability to grow within the constraints of the low annual precipitation experienced in the region, suitability for site aspect, and the elevation and soil type.

Table 89. Seed Mix for the Project Area

Species Common Name (Species Scientific Name)[1]	Pounds/Acre (PLS[2])
Shrubs	
Wyoming big sagebrush	0.10
Grasses	
Bluebunch wheatgrass	8.00
Bottlebrush squirreltail	2.00

[1] Early contemporaneous re-vegetation will be monitored, and final seed mixtures will be evaluated and modified depending on monitoring results.
[2] Pure live seed

The proposed seed mixture and application rates are subject to modification by the BLM. The actual seed mixture and application rates will be determined prior to reseeding based on the results of reclamation in other areas of the mine, concurrent reclamation, or changes by the BLM in its seed mix requirements.

4.3 Proposed Reclamation Schedule

The proposed Project will be active for approximately 14 years, which includes one year of construction, ten years of mining and processing, and three years of closure and reclamation. Several years beyond that date, as determined by ODEQ, may be anticipated for groundwater monitoring, which is currently estimated at five years. This schedule may be modified based on the rate of mining and future commodities prices. The projected reclamation schedule for the Project is shown in on Figure 37.

Concurrent reclamation will be ongoing over the life of the Project in areas that have reached their final configurations. Reclamation of TSF dam face will be started in Year 8 when final build-out is expected to be completed. At final build-out, the TSF dam face will be recontoured to an overall slope of 2.5H:1V or less. Upon completion of mining, the TSF recontouring, cover and growth media placement, and seeding will be completed pursuant to the Final Plan for Permanent Closure and reclamation schedule submitted for the Project.

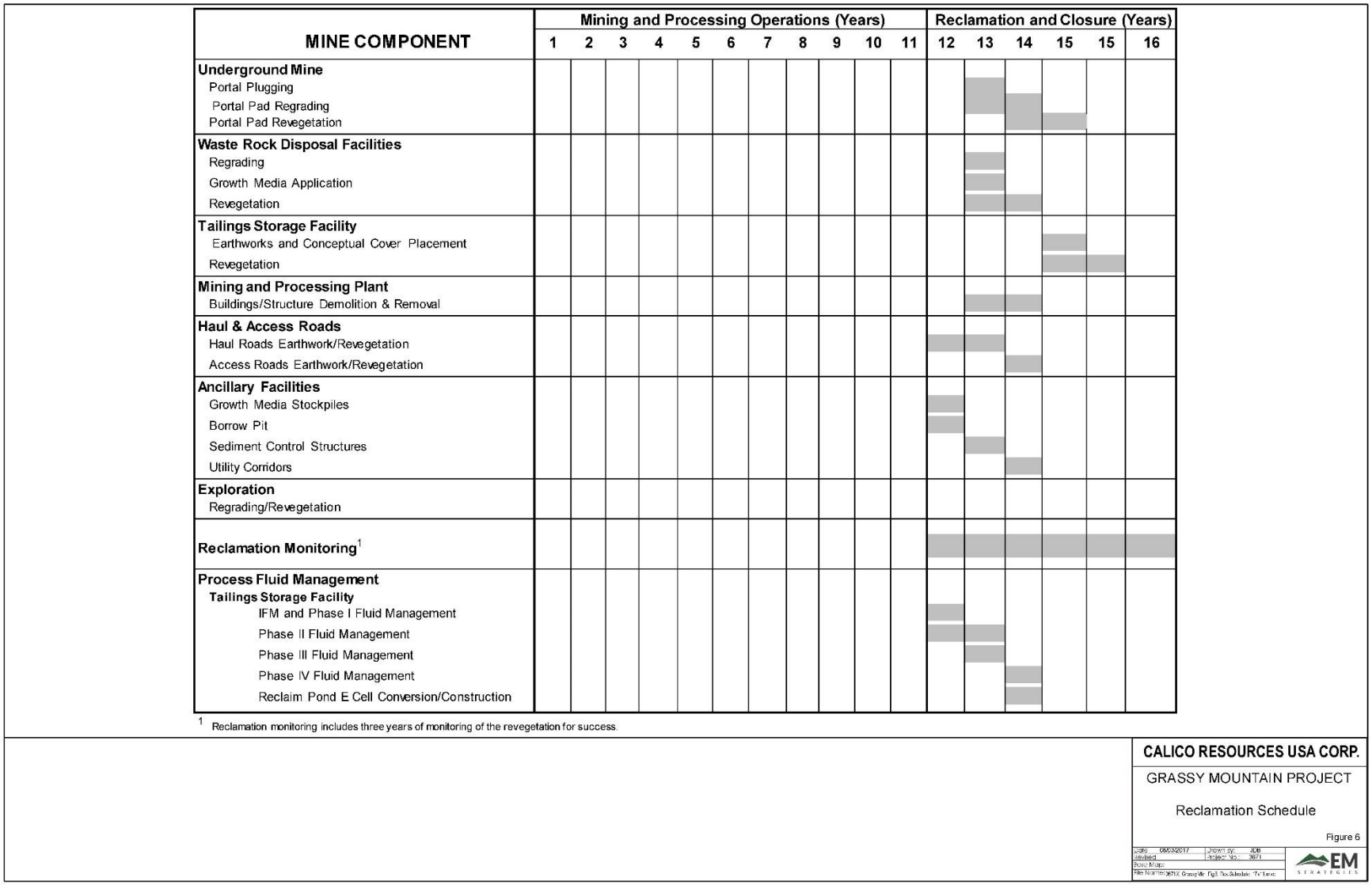


Figure 37. Reclamation Schedule

Closure of the TSF will commence in Year 11. Reclamation of this facility is expected to be concurrent with drain down operations. Closure and reclamation of the process facilities and ancillary facilities will begin after the completion of mining and ore processing.

4.4 Post-Mining Land Use and Reclamation Goals

The same land uses of mineral exploration and development, livestock grazing, wildlife habitat, and dispersed recreation will remain following closure with an emphasis on the last three uses. Calico will work with the agencies and local governments to evaluate alternative land uses that could provide long-term socioeconomic benefits from the mine infrastructure. Post-closure land uses are in conformance with the BLM Vale District Management Plan and Malheur County Land Use Plans.

The objectives of the reclamation program are as follows:

- Provide a stable post-mining landscape that supports defined land uses;
- Maintain existing access to private land;
- Minimize erosion damage and protect water resources through control of water runoff and stabilization of components;
- Establish post-reclamation surface soil conditions conducive to the regeneration of a stable plant community through stripping, stockpiling and reapplication of growth media;
- Revegetate disturbed areas with appropriate plant species in order to establish long-term productive plant communities compatible with existing land uses; and
- Maintain public safety by stabilizing or limiting access to landforms that could constitute a public hazard.

4.5 Post-Mining Contours and Topography

The final grading plan for the Project is designed in part to minimize the visual impacts of the disturbance proposed by Calico. Slopes will be recontoured with standard mine mobile equipment (i.e., dozers, trucks, loaders, scrapers) to blend with surrounding topography, interrupt straight-line features and facilitate revegetation, where practicable. Where feasible, large constructed topographic features, such as the TSF dam, may have rounded crests and variable slope angles to resemble natural landforms. The post-mining topography is shown on the Post Reclamation Topography Map located in Appendix A.

4.6 Final Grade and Slope Stability Criteria

4.6.1 Mine Portal

The decline will be plugged with rock approximately 100 feet inside the portal entrance. Then the portal entrance will be filled with the material that was used to construct the portal pad. The slopes in the vicinity of the portal area will be returned to near original grade. Once this is completed the surface will be covered with growth media and revegetated.

4.6.2 Waste Rock Storage Facility

All 0.2 million tons of waste rock will be removed from the waste rock storage area and placed on the TSF, along with a lime amendment, to aid in the development of the final surface slope of the TSF. As a result, the final grade of the waste rock storage area will be returned to near original contour.

4.6.3 Tailings Storage Facility

Slope stability analyses on the TSF were performed using industry practices and experience from similar projects (Appendix C).

4.6.4 Erosional Stability

Soils salvaged during construction of mine components as well as some of the near-surface alluvial material mined from the open pits will be used as growth media cover during reclamation. The soils survey completed in the Project Area by the NRCS provides an inventory of available growth media (Table 88). This inventory has been utilized to estimate the likely mix of growth media available for each component and to allow a detailed evaluation of the site-specific stability of the proposed major reclamation components.

Analyses and recent similar experience at Nevada mines indicate that the use of erosion control BMPs during reclamation activities will greatly reduce the sediment migration from the facilities until vegetation can be established. Calico will maintain BMPs (sediment control structures) at the base of reclaimed slopes to prevent or limit excessive erosion until vegetation has established.

4.7 Facility Reclamation

4.7.1 Tailings Storage Facility and WRD Closure

Reclamation methods for the TSF will recognize ore and solution characteristics, site conditions, and climatic conditions. Pursuant to the requirements of ODEQ, a summary of the principal closure steps follows.

Upon completion of mining operations, active deposition into the TSF will cease. During this time, water collected in the TSF reclaim pond will be recirculated to the supernatant pool for active water management. Over time, the supernatant pool will evaporate and the underdrain flows reporting from the TSF will reduce as the tailings consolidate and drain. This is considered the active management period of closure.

Once the tailings surface no longer has a free water surface and the tailings continue to desiccate and densify, a closure cover can be constructed over the tailings surface and TSF embankments. The closure cover should be installed at a point in time where the majority of tailings

consolidation has occurred and is not expected to negatively impact drainage of the closure cover.

The closure cover proposed for the TSF tailings surface and embankments is presented on the Design Drawings in Appendix C and will be constructed with the following (bottom to top):

- Operational layer of waste rock (if available) or other materials to provide vehicle access
- Four to 12 inches of Liner bedding (if required)
- Geomembrane liner
- Twelve to 18 inches of non-acid generating drainage layer
- Twelve to 24 inches of growth medium

Once tailings draindown flow rates reduce to levels considered appropriate for passive water management, the reclaim pond will be retrofitted to a geomembrane-lined evaporation pond. With installation of the closure cover and gravity drainage from the underdrain collection system, it is expected that draindown from the TSF will cease.

Upon completion of closure cover construction, stormwater falling on the TSF and upgradient catchment areas will be routed over the covered impoundment surface to a closure drop chute channel located at the eastern abutment of the North embankment. To provide long-term redundancy, the closure drop chute and impoundment surface swale are designed to safely convey all stormwater flows resulting from the 500-year, 24-hour storm. The upgradient catchment area assumed for closure does not include permanent stormwater diversion channels around the TSF.

Although the permanent diversion channels will remain in place during long-term closure, in the event that the channels overtop and discharge on to the TSF closure clover during the 500-year, 24-hour storm event, the proposed closure cover and drop chute channel are designed to accommodate these additional inflows and are expected to operate as intended.

Upon cessation of mining operations, the remaining waste rock (if any) stockpiled on the WRD will be removed and placed as an operation layer above the tailings surface when it is safe to do so. The WRD lining system will either be removed or buried in-place and precipitation collected on the closed area will be routed to the TSF during the active management period. Once the TSF closure cover is constructed, run-off from the closed WRD area will be routed onto the TSF closure cover and conveyed to the drop chute channel. Conceptual closure designs for the TSF, WRD, and drop chute channel are presented on the Design Drawings in Appendix C.

All growth media originally stockpiled from clearing the area will be used in constructing the tailings cap to promote final reclamation and revegetation. The conceptual closure design of the TSF is intended to meet the OAR requirements. In accordance with the OAR 340-043-0140 (5) requirement, the tailings surface will be covered with a composite cover designed to prevent water and air infiltration. The closure cover will consist of (from bottom to top) the regraded tailings surface, operation layer of mine waste or on-site borrow (as needed for equipment

access), a geomembrane liner, 18 to 24 inches of growth medium, and seed mix to revegetate the growth medium with native species. Contact precipitation (snowmelt and rain) from the capped revegetated TSF will be routed to the two sediment retention ponds. From the sediment retention pond and rocked spillway, flows will then be routed to open natural areas and constructed dispersion terraces to slow the velocity of the flow to enhance infiltration and evaporation. The sediment retention pond will be designed for the 100-year, 24-hour storm event. The typical closure cover system is detailed in Appendix C.

The following design components have been considered during the TSF design and will help facilitate closure once mining has ceased:

- During the staged construction of the TSF, the growth medium beneath the embankments and within the TSF basin will be removed prior to embankment construction and stockpiled for use during closure.
- At the end of milling, water will be evaporated from the supernatant pool. The surface of the TSF will then be allowed to dry for one to two years.
- Once the surficial tailings have sufficiently dried out, the TSF surface will be graded to maintain positive surface flow to the northeast to prevent ponding water. Surface water run-off developing on the surface of the impoundment will be directed off the impoundment through an open channel that will tie into the permanent diversion channel on the east side of the TSF as shown on Drawing C10.
- There are no back-dams that will permanently impound the natural tributary drainages upstream of the TSF below the permanent diversion channels. During the reclamation period, the perimeter access road and any temporary storm water diversion channels can be backfilled and reclaimed to facilitate surface flows and prevent ponding.
- The downstream embankments have been designed with 2.5H:1V downstream slopes that exceed the OAR 632-037-0130 (9) requirement for closure.
- The underdrain collection system installed above the geomembrane liner will help speed consolidation, settlement and drain down of the tailings during the closure period.
- Monitoring and management of TSF drain down will be required for a period of time after the completion of mining. During this time, monitoring and measurement of drain down flow rates and quality will be performed to assist with refinement of long-term closure plans.
- Drain down water may be managed with spray evaporators, if needed but not anticipated, until flow rates decrease to the point that the reclaim pond can be retrofitted into an evaporation cell.

4.7.1.1 Tailings Storage Facility Cover

Calico will implement a tailings cover system that is intended to isolate and control the deposited tailings and waste rock. Calico will use various types of earthmoving and other equipment to construct the cover system. The specifics on the number and type of equipment are included with the RCE in Appendix J. Growth media will be hauled to the TSF surfaces from growth media stockpiles and the borrow area located on the east side of the Permit Area, as shown on Figure

6. The closure cover will consist of (from bottom to top) the regraded tailings surface, operation layer of mine waste rock and on-site borrow, a geomembrane liner, 18 to 24 inches of growth medium, and seed mix to revegetate the growth media with native species. The cover for the TSF is generally designed to accomplish the following:

- Limit infiltration of meteoric water;
- Isolate process materials from storm water runoff;
- Limit erosion; and
- Support successful revegetation.

4.7.1.2 Tailings Storage Facility Recontouring, Resoiling, and Revegetation

The TSF will be recontoured to an average final slope configuration not steeper than 2.5H:1V on the dam face to provide for long-term mass stability. As discussed above, the surface of the impounded tailings will be covered, and the cover will slope to a drainage system to shed water off the relatively flat surface. A figure of the closed facility is included in Appendix C. The toe of the recontoured slopes will end inside and at the edge of the lined facility such that the subsequently placed cover material will direct surface runoff off the lined area of the TSF. The dam face will also include slope breaks horizontally along contour approximately every 100 vertical feet. Slope breaks will be small flat benches up to 20 feet wide and blended into the slopes. The toe and crest of the facility will also be rounded to blend into the adjacent slopes. Minimizing the total continuous slope length with benches and rounding the toe and crests will help to limit erosion until vegetation is established.

4.7.1.3 Solution Management

At the time of the TSF closure, drain down will be managed by a regime of passive evaporation within the supernatant pool, the reclaim pond (E-cell), and recirculation back to the TSF. As the solution is removed from inventory through evaporation, portions of the TSF surface will be reclaimed and covered with the above described cover system. Once drain down flows are low enough to be managed through evaporation at the reclaim pond below the TSF, the remainder of the TSF will be reclaimed as described above.

Four phases of solution management or process fluid stabilization could be required throughout the closure process, with blending of strategies from one phase to another. However, given the limited anticipated volumes in the supernatant pool and the underdrain flow, Phase I is not planned for with this TSF closure and only passive evaporation under Phase II:

- Phase I - active evaporation at the supernatant pool and reclaim pond and recirculation;
- Phase II - active evaporation at the reclaim pond only, and passive evaporation at the supernatant pool. Latter stages of Phase II are characterized by intermittent active evaporation within the pond footprints. Pond inventories are eliminated at maximum in-pond active evaporation rates, and then evaporation is halted, and inventories allowed to accumulate to maximum operating volumes prior to the next active evaporation event;

- Phase III - passive evaporation only at the reclaim pond and conversion of the pond to an E-Cell; and
- Phase IV – long-term passive evaporation using the reclaim pond as an E-cell until the tailings facility is fully drained.

This approach acknowledges the initially higher drainage rates and the need to prevent release from the system, while effectively eliminating inventory at maximum drainage rates from the TSF. Also, since recirculation and evaporation at the supernatant pool will result in additional infiltration into the TSF, the supernatant pool evaporation system will be eliminated first in preference for downstream active evaporation within the reclaim pond. Finally, active management will be phased out by improving the TSF cover and eliminating residual drain down to a level that can be handled by passive systems. The passive systems may then be partially reduced in size over time as flows reach steady state and decrease to zero.

Long-term effluent discharge will be managed pursuant to the requirements of ODEQ (OAR 340-043-130). This will include the construction of an E-Cell or another ODEQ-approved method. The amount of the annual long-term discharge will be used to establish the number of acres of the reclaim pond that will be needed to provide evaporation of drain down fluids during Phase IV of PFS. The costs for converting the existing reclaim pond into an E-Cell and constructing the new E-Cell will be established in the RCE (Appendix J). Assumptions and bond costs will be included in the RCE.

4.7.1.4 Recontouring, Seeding, and Planting

The TSF will be recontoured to an average final slope configuration not steeper than 2.5H:1V on the dam face to provide for long-term mass stability. As discussed above, the surface of the impounded tailings will be covered, and the cover will slope to a drainage system to shed water off the relatively flat surface. The toe of the recontoured slopes will end inside and at the edge of the lined facility such that the subsequently placed cover material will direct surface runoff off the lined area of the TSF. The dam face will also include slope breaks horizontally along contour approximately every 100 vertical feet. Slope breaks will be small flat benches up to 20 feet wide and blended into the slopes. The toe and crest of the facility will also be rounded to blend into the adjacent slopes. Minimizing the total continuous slope length with benches and rounding the toe and crests will help to limit erosion until vegetation is established.

4.7.1.5 Reclaim Pond Closure

When no longer needed for solution management, the Reclaim Pond will be converted into an E-Cell until the tailings facility is fully drained. Under the RCE, assumptions have been made to convert the Reclaim Pond into an E-Cell since the cell is a double-lined facility with LCRS. As part of the design, the converted E-Cell will be covered with six inches of growth media and seeded. Once the underdrain flows cease, the sediments and precipitates in the cell will be sampled and tested. Depending on the results, the sediments and precipitates will either be buried in place or transported to an appropriate off-site disposal facility.

4.7.2 Milling and Refining Facility

The general concept for reclaiming the Project site is to remove all buildings and facilities that can be dismantled. Non-movable physical aspects such as the plant site itself will be contoured to match the original site topography and revegetated.

Removal of facilities and remediation of the site, including revegetation, will take approximately two years. Monitoring of site conditions will be undertaken on a quarterly and annual basis for the first five years with maintenance and remedial action taken on an as-required basis to ensure that the results of reclamation are sustainable.

The buildings and structures erected during the mining operation will be decommissioned and removed as part of the reclamation process. Buildings at the plant site will be dismantled during the first year of reclamation and sold or re-used elsewhere. These buildings will include:

- Administration building
- Laboratory
- Plant Workshop/Warehouse
- Mine Offices
- Truck Workshop/Warehouse
- Mill Building and Structures

The administration, laboratory, and mine office buildings will be modular structures that will break down into their component parts and can be hauled away and reused. The Plant and Truck Workshop/Warehouses are steel frame, fabric covered structures that can be similarly dismantled and reused elsewhere. The process facility is a steel frame non-enclosed structure containing process equipment, which will be removed before the frame is dismantled and removed.

The reclamation of the collection pond will be in accordance with the Water Pollution Control Facility (WPCF) permit as required by the ODEQ (Appendix L). Reclamation of lined ditches and other water management structures will be in accordance with the WPCF (Appendix L) and Stormwater Management Plan (Appendix Y).

Other structures to be remediated and removed include:

- Truck Wash Pad
- Crushing Area

The Truck Wash Pad is a concrete slab that will be broken up, have the rebar removed, and disposed of off site. The crushing area consists of a series of portable units mounted on chassis that can be towed away for use elsewhere.
Pipelines will be removed and disposed of off site:

- Tailings distribution pipeline
- Tailings reclaim water pipeline

All foundations remaining from decommissioned structures, made from inert materials such as concrete, will be broken up and covered with two feet of fill and growth media, which includes concrete slabs. Before burial all exposed rebar that has a potential to protrude through the completed backfill will be cut level with the remaining concrete.

Concrete that may be contaminated through exposure to process reagents will be excavated and disposed of in the TSF.

Soils under and adjacent to the fuel storage areas would be tested for contamination. The results will be submitted to the ODEQ as part of a Final Closure Activities Report, which will summarize closure activities and status.

Chemicals will be disposed of at an approved solid waste management facility. All chemical reagents (including NaCN), petroleum products, solvents, and other hazardous or toxic materials in the mill, not salvaged, will be removed from the site and either reused or disposed of according to federal and state regulations. All salvageable equipment, instrumentation, and unused petroleum products and solid wastes from the mill operation will be used or recycled. Non-hazardous solid wastes will be disposed of at an off-site landfill designed to handle the waste material.

4.7.3 Underground Mine

At the permanent cessation of all mining activities, any adit openings to the surface will be permanently sealed by the placement of concrete and rock plugs, or steel bulkheads. The vent raise will be sealed by the placement of a concrete plug, covered with at least one foot of fill and growth medium, and revegetated.

Removal of underground facilities and equipment will consist of the following steps:

- Underground piping, pumps, tanks and pumping equipment will be removed and salvaged, or disposed of in an approved solid waste disposal facility.
- Piping that cannot be salvaged for reuse will be dismantled as required for backfill placement and left underground.
- Fans, motors, pumps, compressors, power supply, electrical distribution equipment, ventilation curtains and ducts, and other equipment will be removed, as practicable, and salvaged for use at another facility or disposed of in an approved solid waste disposal facility.
- Non-reactive equipment (e.g., HDPE pipe) may be left underground.
- Remaining fuel, lubricants and explosives will be removed from the underground workings and transported to other sites or disposed of according to federal and state standards and regulations.

All salvageable equipment, instrumentation, and unused petroleum products and chemicals and solid wastes from the underground mine will be used or recycled. Examples include piping,

pumps, diesel, lubricating fluids, etc. Used and waste petroleum products and chemicals will be disposed of at a Class I landfill. Non-hazardous solid wastes would be disposed of at an off-site landfill. Water pipelines from the underground workings will be removed and hauled off site.

4.7.4 Road and Yard Features

All Project roads and yard features, including parking areas, will be gravel base and not be paved with asphalt. Roads without a defined post-mining use will be reclaimed concurrently as they are no longer needed for access. Where the original topography exceeds 3H:1V, the road cut will be filled with the road bed material to blend with existing topography and to ensure no steeper than 3H:1V slopes except where cut banks are located generally in bedrock.

Roads and safety berms will be recontoured or regraded to approximate the original contour. Where the road is located on fill, the side slopes will be rounded and regraded to 2.5H:1V. Finished slopes will be relatively similar to the surrounding topography. Compacted road surfaces will be ripped, covered with growth media from the safety berms or road fill, and re-vegetated.

Some access roads will be needed to access monitoring points. As monitoring is completed and the facility is considered to be closed, the access road will be reclaimed, as determined by the BLM and DOGAMI. However, access to the private land portion of the Project Area will remain after reclamation.

4.7.5 Measures to Minimize Sediment Loading to Surface Waters

Runoff from the TSF area and other slopes will occur following precipitation events; however, regraded slope angles, revegetation (including growth media placement) and BMPs will be used to limit erosion and reduce sediment in runoff. Silt fences, sediment traps, or other BMPs will be used to prevent migration of eroded material until reclaimed slopes and exposed surfaces have demonstrated erosional stability.

Long-term drainage structures installed for the main access will include properly installed ditches, water-bars, cross drains, and design flow culverts, as needed.

Details on the management of stormwater are in accordance with the Stormwater Management Plan (Appendix Y).

4.7.6 Disposition of Buildings and Ancillary Facilities

During final mine closure, buildings and structures will likely be dismantled and materials will be salvaged or removed to an authorized landfill. Concrete foundations and slabs will be broken using a track-hoe mounted hydraulic hammer or similar methods and buried in place under approximately three feet of material in such a manner to prevent ponding and to allow vegetation growth. After demolition and salvage operations are complete, the disturbed areas will be covered with approximately 12 inches of growth media and revegetated.

All reagents and explosives will be removed or appropriately disposed of. Any surface pipelines will be removed and salvaged or disposed. Underground pipeline ends will be capped and left in place. Unneeded utility poles will be cut off at ground level and removed.

All mining equipment, trailers, supplies, the cement silo, and other mine site infrastructure will also be removed from the site.

4.8 Facilities Not Subject to Reclamation

As determined by the BLM, roads on public lands suitable for public access or which continue to provide public access consistent with pre-mining conditions will not be reclaimed at mine closure. Narrow access roads may remain on large haul roads after they have been re-contoured and seeded.

4.9 Post Reclamation Monitoring and Maintenance

Post reclamation monitoring and maintenance will include the following:

- Following mine closure, berm and sign maintenance, site inspections, and any other necessary monitoring for the period of reclamation responsibility will be conducted. Monitoring of revegetation success will be conducted annually until the revegetation standards have been met and will include noxious weed monitoring and abatement as necessary.
- Calico will monitor the TSF drainage flow and chemistry. Mitigation will be developed if necessary.
- Post-mining groundwater quality will be monitored according to the requirements established by the ODEQ upon approval of the Chemical Mining Permit the goal of demonstrating the site poses no potential to degrade waters of the state through the successful implementation of the detailed Final Plan for Permanent Closure. The Reclamation Cost Estimate will contain costs for five years of groundwater monitoring.
- Revegetation monitoring will be conducted for a minimum of five years following implementation of revegetation activities or until revegetation success has been achieved. Revegetation monitoring will occur based on seasonal growth patterns, precipitation, and weather conditions.
- Noxious weed monitoring and control, as described in Appendix H, will be implemented for a five-year period following closure.

Surface erosion would be visually monitored on a weekly basis by Calico during storm events, or periods of high runoff; the frequency may be more often depending on weather conditions. Erosion control BMPs would be implemented as needed. Examples include diversion ditches to prevent run-on to the mine site and culverts to carry water across access roadways.

Security measures implemented at the mine site during operations would be installed during reclamation, including gating and warning signs. At closure, additional safety measures would be employed by Calico as necessary to secure the abandoned mining operations.

Revegetation monitoring of the reclaimed facilities would be conducted at both the mine and mill sites for at least three years following final reclamation. The monitoring would involve photo-documentation and be conducted during the "peak green" spring season. This program would be coordinated with the BLM and DOGAMI. Reclaimed areas not meeting regulatory standards would be evaluated, and corrective actions implemented. These measures could include, if necessary, additional soil amendments, reseeding, and installation of erosion control measures. This obligation would cease when the reclamation goals and requirements have been achieved, and upon release of all related reclamation bond(s).

Once all the final reclamation is completed, yearly post-reclamation maintenance would involve remedial dirt work and reseeding, if required. Yearly visits to the site would be conducted to monitor the success of revegetation for a three-year period, or until attainment of revegetation standards.

4.10 Drill Hole Plugging and Water Well Abandonment

Mineral exploration and development drill holes, monitoring, and production wells subject to OWRD regulations will be abandoned in accordance with applicable rules and regulations (OAR 690-220-0005 through 690-220-0140). Drill holes will be sealed to prevent cross contamination between aquifers and the required shallow seal will be placed to prevent contamination by surface access.

Monitoring wells around the TSF will be maintained until Calico is released of this requirement by the ODEQ. These wells will then be plugged and abandoned according to the requirements of the State Engineer.

As outlined under OAR 690-220-0005, any water well to be temporarily removed from service, temporarily abandoned due to a recess in construction, or temporarily abandoned before commencing service, shall be capped with a watertight seal, watertight welded steel cap, or threaded cap. If temporary abandonment is to be 90 days or less in duration, the temporary steel cap may be welded to the well casing with a minimum of four separate welds, evenly spaced, each at least 3/16 of an inch in length. Access ports and airlines, as described in OAR 690-210-0280, shall be maintained during the temporary abandonment. During the temporary abandonment, the well must be maintained to the standards prescribed in OAR 690-215.

Any water supply well that is to be permanently abandoned shall be completely filled in such a manner that vertical movement of water within the well bore, including vertical movement of water within the annular space surrounding the well casing, is effectively and permanently prevented, per OAR 690-220-0030. If a dry or non-producing water supply well is to be permanently abandoned, it shall be abandoned in accordance with these standards. All

permanent water supply well abandonments shall be performed by a licensed Water Supply Well Constructor.

The abandonment procedure shall be recorded on a form provided by or previously approved in writing by the Department. The form shall include, as a minimum, all the requirements as listed in OAR 690-205-0210, plus a description of the method of abandonment; well identification information, including owner information; and confirmation that the well identification tag shall be destroyed and will not be reused.

4.11 Reclamation Cost Estimate

The Consolidated Permit describes the maximum development that is likely to occur at the site based on current knowledge of geologic and other site conditions. The ultimate development will occur over a five-year period.

The proposed disturbance acreage for the Project is provided in Table 54. Acreage for ancillary facilities allows for bonding of a complete infill footprint with a resulting overstatement in RCE because sections within the footprint will likely remain undisturbed throughout the life of the Project. Disturbance has been provided for excess ancillary facilities, process facilities, waste rock storage areas, piping, and open pit. The RCE will be submitted at a later date for the purposes of review and approval of the reclamation permit.

Calico plans to use a phased bonding approach and will work out suitable milestone events with respect to Project development with the BLM and the ODEQ. Calico will provide a reclamation surety in accordance with regulations at 43 CFR 3809.522, 3809.553, and at Oregon Revised Statutes (ORS) 517.810. Calico will update the surety to reflect the actual disturbance and whatever additional disturbance is planned for the subsequent period. Any changes to equipment, consumable, and manpower costs will also be incorporated during the updates.

5 ALTERNATIVES ANALYSIS

5.1 Proposed Mining Operation Impact Analysis

Table 90 summarizes potential impacts to all listed resources from the proposed Project, as well as a comparison to the impacts associated with the action alternatives.

Table 90. Proposed Project and Alternatives Impact Analyses

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Air Quality Resources	An emissions inventory conducted for the proposed Project indicated that the following criteria pollutants had potential annual emissions below the Significant Emission Rates (SERs) as defined in OAR 340-200-0020: $PM_{2.5}$; CO; NO_x; SO_2; Volatile Organic Compound (VOC); and lead. The potential annual emissions for PM_{10} were above the SER; therefore, the PM_{10} emissions were modeled. The total concentration of the modeled emissions for PM_{10} 24-hour were 43.6 µg/m^3, compared to the National Ambient Air Quality Standards (NAAQS) of 150 µg/m^3.	Under this alternative, criteria pollutant emissions would significantly increase from the construction of the open pit, blasting activities in an open pit area, increased hauling and dumping, and increased equipment travel and operations.	Under this alternative, there would be more ore left in the tailings, so the daily processing needs would be much greater than the proposed Project. Therefore, the criteria pollutant emissions and specifically fugitive dust emissions would be greater than the proposed Project.
Aquatic Resources	There were no sites observed during field surveys that contained aquatic resources. There is no site with aquatic resources habitat within the Permit Area; therefore, impacts to aquatic resources are not anticipated from the proposed Project.	Impacts under this alternative would be the same as the proposed Project.	Impacts under this alternative would be the same as the proposed Project.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Areas of Critical Environmental Concern (ACECs)/Research Natural Areas (RNAs)	There are no ACECs or ACECs/RNAs in the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.
Cultural Resources	The proposed Project would potentially impact two cultural sites recommended as eligible for listing on the NRHP and one unevaluated site that requires further testing within the Mine and Process Area, and five unevaluated sites in the Access Road Area that require further testing in areas proposed to be widened or realigned.	Depending on the location of the open pit under this alternative, one additional unevaluated cultural site that requires further testing may be impacted,	Depending on the location of the heap leach facility under this alternative, one additional unevaluated cultural site that requires further testing may be impacted,
Environmental Justice	There are minority, low-income, and tribal populations in and near the Permit Area. Impacts from the proposed Project are currently unknown, but outreach would continue to be conducted throughout the permitting process. Dewatering needs for the underground mine may result in concerns from Tribal nations in the area.	Dewatering needs associated with this alternative would be greater than the proposed Project. Potential Tribal concerns may be increased from the increased dewatering needs.	Impacts under this alternative are anticipated to be the same as the proposed Project.
Geochemistry	The results of the Grassy Mountain geochemical characterization program indicate that the majority of the waste rock and unprocessed ore material will generate acid and leach metals under long-term weathering conditions. The exceptions to this include the sinter material that shows a low potential for acid generation. This can be attributed to	Impacts under this alternative are anticipated to be proportionally greater than the impacts associated with the proposed Project. This is due to the greater tonnage of materials mined under the open pit mining method.	Impacts under this alternative are anticipated to be the same as the proposed Project.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
	the lower sulfide sulfur content associated with this material type.		
Geology and Soils	There are 17 soil types identified in the Permit Area. Activities in the Mine and Process Area would impact up to 265 total acres of soils, consisting of the following nine soil types: Farmell-Rock outcrop complex, 8 to 30 percent slopes; Farmell-Chardoton very cobbly soil, 15 to 30 percent slopes; Farmell-Chardoton very cobbly soil, 4 to 15 percent slopes; Farmell-Chardoton extremely stony soil, 4 to 15 percent slopes; Farmell-Chardoton soil, 8 to 15 percent slopes; Ruckles very stony loam, 8 to 30 percent slopes; Soil A extremely gravelly sandy loam, 15 to 30 percent slopes; Xeric Torriorthents, 8 to 30 percent slopes; and Soil B very gravelly sandy loam, 8 to 30 percent slopes. Surface disturbance would increase the potential for wind and water erosion; however, the high rock fragment content in the soils reduces the potential for sheet erosion by water. Geologic hazards (i.e., seismicity/earthquake hazards, slope failures/landslide areas, volcanic eruptions) have low probability in the area. The proposed Project would extract approximately three mtons of ore and 0.2 mtons of waste rock.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would primarily impact up to 471 acres more of the nine soil types in the Mine and Process Area. Under this alternative, approximately 30 mtons of ore and 49 mtons of waste rock would be extracted.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the nine soil types in the Mine and Process Area.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Grazing Management	The proposed Project would impact approximately 265 acres of the following grazing allotments: Dry Creek (10411) and Nyssa (10403).	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would impact up to 471 acres more of the Nyssa Grazing Allotment.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the Nyssa Grazing Allotment.
Groundwater	Production well pumping was modeled simultaneously with the transient model dewatering pumping to predict drawdown effects on the aquifer system for a ten-year period. After ten years of pumping, the model predicts a little over two feet of drawdown at Lowe Spring and zero drawdown at Poison Spring. After ten years of pumping, when the wells cease pumping, the area of impact would continue to migrate outward due to the slow equilibration of the cone of depression. After approximately 27 years of recovery, the model predicts a residual drawdown of over 20 feet near the production wells, approximately ten feet of drawdown at Lowe Spring, and less than 0.5 feet of drawdown at Poison Spring. The maximum drawdown in the production wells is 212 feet after ten years.	This alternative would have a greater level of groundwater impacts as compared to the proposed Project, since more mine dewatering would be required to dewater the open pit, as well as longer production water needs to process the additional tons of ore. In addition, once mining ceases, a pit lake would likely develop in the bottom of the open pit.	This alternative would have approximately the same level of groundwater impacts as the proposed Project.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Land Use	Part of the Access Road Area is designated Exclusive Farm Use; the remainder of the Access Road Area and Mine and Process Area are designated Exclusive Range Use (ERU). Mining operations are permitted conditional uses of ERU-designated lands under Oregon Revised Statutes 215.283 and 215.296. The Malheur County Planning Commission approved the Conditional Use Permit and issued a Land Use Compatibility Statement on May 23, 2019. The existing land uses in the Permit Area are primarily wildlife habitat and mineral exploration. The areas proposed for disturbance would be recontoured and reseeded, returning the land to pre-Project conditions.	Impacts under this alternative would be the same as the proposed Project.	Impacts under this alternative would be the same as the proposed Project.
Noise	Noise generating sources associated with the proposed Project include blasting of the underground mine, the crushing and screening plant, the processing plant, and equipment and vehicles.	Under this alternative, noise levels and the duration of noise from blasting the open pit would be increased. There would also be more noise associated with the larger numbers of haul trucks needed to haul the larger amounts of ore mined from the open pit.	Noise generated under this alternative would be less than the proposed Project, as there would be no mill and tailings facility associated with this alternative.
Oregon Natural Heritage Areas (ONHAs)	There are no ONHAs in the Permit Area; the closest ONHA is approximately 16 miles from the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Outstanding Natural Areas (ONAs)	There are no ONAs in the Permit Area; the closest ONA is approximately 77 miles southwest of the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.
Recreation	The proposed Project would temporarily reduce opportunities for dispersed recreationists, in the Recreation Opportunity Spectrum (ROS) classification of "Semi-primitive Motorized," of pleasure driving, hiking, scenery viewing, rockhounding, and ATV use. The Access Road would be widened in some areas, providing better access for larger vehicles accessing the Twin Springs Campground to the southwest of the Mine and Process Area.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would impact up to 471 acres more of the "Semi-primitive Motorized" ROS classification and reduce opportunities for dispersed recreationists.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to dispersed recreation opportunities and the "Semi-primitive Motorized" ROS classification.
Socioeconomics	The proposed Project would employ approximately 100 people. Calico would implement a local hire preference policy thereby resulting in beneficial impacts to the surrounding communities.	Under this alternative, a larger workforce would be required to handle the increased amount of ore needing to be processed. In addition, more construction workers, equipment operators, and miners would be needed. Although there could be increased beneficial economic impacts to the local communities, there could also be increased impacts to traffic, noise, air quality, wildlife, visual resources, and dispersed recreation.	Under this alternative, a larger workforce would be required to handle the increased amount of ore needing to be processed through a heap leach. In addition, more construction workers, equipment operators, and miners would be needed. Although there could be increased beneficial economic impacts to the local communities, there could also be increased impacts to traffic, noise, air quality, wildlife, visual resources, and dispersed recreation.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Surface Water	Surface water features in the Permit Area consist of ephemeral or intermittent drainages. Storm water would be managed through diversion channels and ditches constructed around the surface facilities and waste rock storage areas, which would change the surface drainage patterns.	Impacts to surface drainage patterns would be similar under this alternative; however, due to the large surface size of the open pit, several additional diversion channels would need to be constructed.	Impacts to surface drainage patterns would be similar under this alternative.
Terrestrial Vegetation	The proposed Project would impact up to 265 acres of the following vegetation communities: Wyoming Big Sagebrush/Crested Wheatgrass; Crested Wheatgrass Seeding; Bluebunch Wheatgrass/Cheatgrass/Annual; Wyoming Big Sagebrush/Bluebunch Wheatgrass; and Burned Yellow Rabbitbrush/Bluebunch Wheatgrass.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would primarily impact up to 471 additional acres of the Wyoming Big Sagebrush/Bluebunch Wheatgrass vegetation community.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the Wyoming Big Sagebrush/Bluebunch Wheatgrass vegetation community.
Transportation	The proposed Project would result in increased vehicle travel on the Main Access Road from mining equipment and support vehicles. In addition, approximately 100 workers would be employed at the mine, resulting in increased personal vehicle travel along the Main Access Road; however, a daily bus shuttle service from Vale to the mine site is anticipated to be provided, reducing the number of personal vehicles traveling on the road.	Under this alternative, approximately ten times more ore would be mined from the open pit than from the underground mine. This would result in the need for additional mining equipment and employees, resulting in more equipment and vehicles using the Main Access Road. However, this alternative would also operate a daily bus service from Vale.	Under this alternative, a larger workforce would be required to handle the increased amount of ore needing to be processed through a heap leach. In addition, more construction workers, equipment operators, and miners would be needed. This would result in the need for additional mining equipment and employees, resulting in more equipment and vehicles using the Main Access Road. However, this alternative would also operate a daily bus service from Vale.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Visual Resources	The proposed Project would create visual resource impacts to the existing visual environment with the addition of mine buildings, associated mining facilities, and equipment. There are existing man-made features in the area consisting of roads, fences, and a powerline, which disturb the rural feel of the surrounding undeveloped landscape. The mining features may be visible from several KOPs, and would alter the forms, lines, colors, and textures of the existing landscape. Most of the mining-related equipment would be underground, so would not be visible from the KOPs.	This alternative would create a very large open pit, which would result in a large alteration of the existing landscape in comparison to an underground portal. All the mining equipment would be on the surface or in the open pit, and potentially visible from the KOPs.	This alternative would create a heap leach pad with adjacent precious metal recovery plant. This would alter the characteristics of the existing visual environment by changing the forms, lines, colors, and textures of the existing landscape. The heap leach pad and plant could potentially be visible from the KOPs.
Wetlands	There were two wetlands identified in the Permit Area during field surveys. The proposed road design would avoid the wetland; therefore, no impacts to the wetlands are anticipated from the proposed Project.	Impacts under this alternative would be the same as the proposed Project.	Impacts under this alternative would be the same as the proposed Project.
Wild, Scenic or Recreational Rivers	There are no wild, scenic or recreational rivers in the Permit Area; the closest is located approximately 31 miles to the south of the southernmost tip of the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Wildlife Resources	The proposed Project would potentially impact the following wildlife habitat types: Exotic Annual Grassland; Perennial Grassland; and Sagebrush Shrub-steppe. The Mine and Process Area is primarily within the Sagebrush Shrub-steppe habitat, with small portions of developed roads. The proposed Project could also potentially impact the habitat of several avian species including greater sage-grouse, and bats.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would primarily impact up to 471 additional acres of the Sagebrush Shrub-steppe habitat type and increase the loss of foraging habitat for several wildlife species. The open pit mine would also potentially create nesting habitat for specific avian species such as golden eagles.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the Sagebrush Shrub-steppe habitat type.

5.2 Alternatives Analyzed

There are no alternatives that will avoid or minimize environmental impacts. The proposed mine design and operations include design features that result in the smallest disturbance footprint for the proposed activities.

5.2.1 Open Pit Mine

Under this alternative, the Project would be developed as outlined in the Proposed Action, except the mineral resource would be mined by a surface mining method, rather than by an underground method. The open pit resource would total approximately 30 million tons of ore and 49 million tons of waste rock. The open pit alternative is anticipated to be up to approximately 75 acres in size. The waste rock storage area would need to be placed near the open pit and would be anticipated to cover up to approximately 200 acres, depending on the location and design. The tailings facility that would contain the 30 million tons of processed ore would be anticipated to be up to approximately 300 acres, depending on the location and the height of the tailings dam.

5.2.2 Heap Leach Ore Processing

Under this alternative, the Project would be developed as outlined in the Proposed Action, except the ore would be processed by a heap leach method rather than a milling method. Under this alternative the mill and tailings facility would not be built. Instead, a heap leach pad would contain and process the ore. In addition, a precious metal recovery plant would be built adjacent to the leach pad. The leach pad and plant would be anticipated to cover up to approximately 40 acres, depending on the pad design.

5.3 Alternatives Eliminated from Detailed Consideration

5.3.1 Mining in Another Location

The location of the proposed underground mine is strictly dictated by the location of the identified ore deposit; therefore, no location alternatives for the underground mine would be possible.

5.3.2 Alternate Tailing Storage Location

Under this alternative, the Project would be developed as outlined in the Proposed Action, except an alternate tailings location would be used for the disposal of the process ore. As part of the design development for the Project, Golder, the engineering firm that designed the proposed tailings facility, assessed several alternate sites (Appendix C). Based on that assessment, the proposed site was determined to be the most technically viable location. There might be other locations more distant from the mining and processing operation; however, any other such location would result in a larger project footprint over a larger permit area.

Six alternative TSF storage options were evaluated as part of the TSF design process. These included:

- Option 1 – TSF located east of the proposed underground portal (included in the 2015 Profitability Economic Assessment [PEA])
- Option 2 – TSF located northwest of the underground portal
- Option 3 – TSF located southwest of the underground portal (Included in the 2015 PEA)
- Option 4 – TSF located south and further west of the underground portal in a separate ephemeral drainage than the other options (included in the 2015 PEA)
- Option 5 – TSF located on Bishop's property about 3 miles southwest of the underground portal
- Option 6 – Filtered or paste tailings storage options

Each of these options were evaluated at a conceptual level by Golder and included in a trade-off study letter presented as Appendices C and W.

To adequately compare each option, technical and environmental/social criteria were used. Based on this review, Option 2 was identified as the most preferable TSF option. Option 2 was then advanced through pre-feasibility and the construction-level design presented in Appendix C.

5.3.3 Alternative Tailing Disposal

Under this alternative, the Project would be developed as outlined in the Proposed Action, except an alternate tailings disposal method would be used for the disposal of the process ore. The Proposed Action would pump the tailings into a pipeline for the subaerial deposition of the tailings. The alternatives to this method would be to pump the tailings into a pipeline for subaqueous deposition, or to mechanically dewater the tailings and then haul the tailings to the disposal site. Subaqueous deposition requires that the impoundment area behind the tailings dam be filled with solution. This would result in a higher water consumption during operation and a longer closure period as the tailings are dewatered through consolidation. The mechanical dewatering of the tailings would require a significant capital investment that would make the project uneconomical.

5.3.4 Alternative Water Supply

Under this alternative, water for the Project would be obtained through a municipal water supply system from the City of Vale. This alternative would not be physically feasible, as the pipeline system would need to be approximately 22 miles long. In addition, the adequacy of the City of Vale water supply to meet the Project's needs has not been determined.

5.3.5 Alternative Power Supply

Under this alternative, the Project would be developed as outlined in the Proposed Action, except there would be on-site power generation using generators instead of power obtained from a powerline. This alternative would result in the need for three 60 hertz (Hz) diesel-powered generators and one backup 60 Hz diesel-powered generator to supply power to the processing plant, and one 60 Hz diesel-powered generator and one 60 Hz backup diesel-powered generator to supply power to the underground mine. To accommodate the power demand generated by the underground mine and processing plant, the generators would operate at a maximum of 24 hours per day, or 8,640 hours per year, with the backup generators running approximately 500 hours per year. These generators would accommodate the power demands of the Project, but would result in substantial additional air quality emissions, specifically from nitrogen oxide and carbon monoxide, as well as additional traffic associated with the fuel deliveries (Appendix W).

6 REFERENCES

Abrams, Mark J., 2018. Calico Resources USA Corp, Grassy Mountain Mine Project, Malheur County, Oregon, Geology and Soils Baseline Report; October 2018.

Adrian Brown Consultants, Inc. (ABC). 1992. *Water Resources Technical Memorandum for Atlas Precious Metals Inc. Grassy Mountain Project Environmental Impact Statement*. Prepared for: USDI Bureau of Land Management. Prepared by ABC, Denver, Colorado. June 29, 1992.

Baldwin, E.M. 1959. Geology of Oregon. Edwards Brothers, Ann Arbor, MI. 135 p.

Barton, N., R. Lien, and J. Lunde. 1974. *Engineering classification of rock masses for the design of tunnel support, Rock Mechanics*: Vol. 6, N° 4.

Barton, N. 1980. Estimation of in situ joint properties, Nåsliden mine. Int. Conf. on Application of Rock Mechanics to Cut-and-Fill Mining, Luleå, Sweden, Institution of Mining and Metallurgy, London.

_____. 1980. Discussion - Shear Strength of Rock Joints, Quarried Rocks and Gravels - Point of Contact. Euromech. 133, Oxford 1980.

_____. 2002. *Some new Q-value correlations to assist in site characterization and tunnel design*: Int. J Rock Mech and Min Sci, (39), p. 185-21.

Bieniawski, Z.T. 1976. Rock mass classifications in rock engineering. Z.T. Bieniawski (Ed.), Proceedings of the symposium on exploration for rock engineering, vol. 1, A.A. Balkema, Johannesburg, South Africa (1976), pp. 97-106

_____. 1989. Engineering rock mass classifications. John Wiley & Sons, New York (1989), pp. 1-125

Bison Engineering, Inc. (Bison). 2015. *Grassy Mountain Exploration Project, Vale, Oregon, Ambient Air Monitoring Program, Final Summary Report July 31, 2014 – September 30, 2015*. Billings, Montana.

Bureau of Land Management (BLM). 1986. *Manual H-8410-1 – Visual Resource Inventory*. https://www.blm.gov/sites/blm.gov/files/uploads/Media_Library_BLM_Policy_H-8410.pdf.

_____. 2008 (updated 2013), Instruction Memorandum No. NV-2013-046, Nevada Bureau of Land Management Rock Characterization Resources and Water Analysis Guidance for Mining Activities. Updated September 19, 2013.

_____. 2016. *National Conservation Lands; About NCL; Maps, Data, and Resources*. https://www.blm.gov/programs/national-conservation-lands/about/maps-data-and-resources. Accessed May 7, 2018.

_____. 2018. *Diamond Craters Outstanding Natural Area*. https://www.blm.gov/visit/diamond-craters-outstanding-natural-area. Accessed May 17, 2018.

Brady, B.H.G. and E.T. Brown. 2004. Rock Mechanics for Underground Mining. 3rd Edition. Kluwer Academic Publishers. pp626.

Brown, E. (Ed.). 1981. Rock Characterization, Testing & Monitoring: ISRM suggested methods, Pergamon Press, Oxford, 211 p.

Cascade Earth Sciences (CES). 2018. *Grassy Mountain Mine Soil Survey, Malheur County, Oregon*. August 2018.

Department of Geology and Minerals Industries (DOGAMI). 1997. *Best Management Practices for Reclaiming Surface Mines in Washington and Oregon.* Open-File Report O-96-02. Revised Edition December 1997.

_____. 2011. *Naturally Occurring Hazardous Materials*. Final Report SPR 686. Prepared for Oregon Department of Transportation Research Section. http://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR686_Final2.pdf. Accessed February 8, 2018.

EM Strategies, Inc. (EMS). 2017. Environmental Baseline Study Work Plans. Prepared for Calico Resources. Prepared by EM Strategies, Inc.

Fetter, C.W. 1980. Applied Hydrogeology. Charles E. Merrill Publishing Co. 488 p.

Freeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice Hall, New Jersey. 604 p.

Golder Associates Inc. (Golder). 2018. *Paramount Gold Nevada – Grassy Mountain Project, Geotechnical Data Collection Factual Report*: prepared for Paramount Gold Nevada Corp. by Golder Associates Inc., 281 p. March 2018.

Gonzalez de Vallejo. 2004. *Ingeniería Geológica*: Pearson Educación, Madrid.

Hulse, D.E., J.J. Brown, and D. Malhotra. 2012. *NI 43-101 Technical report on resources Grassy Mountain gold project Malheur County, Oregon*: prepared by Gustavson Associates for Calico Resources Corp., 96 p. March 2012.

Hynes-Griffin, M.E. and A.G. Franklin. 1984. *Rationalizing the Seismic Coefficient Method*. July 1984.

IMS, Inc. (IMS). 1989. *Final Report: Soil, Vegetation and Wildlife Resources of the Grassy Mountain Project Area*. December 1989.

_____. 1991. *Soils Resources of the Grassy Mountain Area*. April 1991.

International Society for Rock Mechanics (ISRM). 1981. Rock Characterization Testing and Monitoring. Brown, E., Ed., Pergamon Press, Oxford, 211 p.

Kelly, J.M. 1988. *Discovery history of the Grassy Mountain deposit*: unpublished inter-office correspondence of Atlas Precious Metals Inc., 4 p. September 1988.

Lechner, M.J. 2011. *Grassy Mountain NI 43-101 Technical Report Malheur County, Oregon*: NI 43-10 l Technical Report prepared for Seabridge Gold Inc. by Resource Modeling Inc., 361 p. April 2011.

Lynch, G. 2014. Letter Re. "State Agency Water Resources Review" to Vance Thornsberry, Calico Resources. Oregon Department of Geology & Mineral Industries. December 10, 2014.

Malheur Education Service District (Malheur ESD). 2017. Malheur Education Service District website. http://www.malesd.k12.or.us/home. Accessed December 5, 2017.

Marinelli, F. and W.L. Niccoli. 2000. Simple Analytical Equations for Estimating Groundwater Inflow to a Mine Pit. Ground Water. Vol. 38, No. 2. pg. 311-314.

Mason, B. 1966. Principals of Geochemistry, 3rd Edition.

Mathews, K. 1981. *Stability Graph Method*: SME Mining Engineering Handbook, Third Edition, p. 362-363.

Mine Development Associates (MDA). 2018. Preliminary Feasibility Study and Technical Report for the Grassy Mountain Gold and Silver Project, Malheur County, Oregon, USA; prepared for Paramount Gold Nevada Corp, July 9, 2018.

Nicholas, D.E. 1981. *Method Selection – A Numerical Approach. Design and Operation of Caving and Sublevel Stoping Mines*: SME-AIME, New York.

Natural Resources Conservation Service (NRCS). 2017. *National Soil Survey Handbook*. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054242. Accessed February 6, 2018.

Northwest Wildlife Consultants, Inc. (NWC). 2014. Wildlife Resources Baseline Study. Grassy Mountain Exploration Project, Calico Resources USA Corporation. Prepared for HDR Engineering, Inc. and Calico Resources USA Corporation.

Oregon Department of Environmental Quality (ODEQ). 2009. Water Monitoring and Assessment Mode of Operations Manual, March 2009.

Oregon Department of Transportation (ODT). 2017. *ODOT TransGIS*. http://gis.odot.state.or.us/transgis/

Oregon Employment Department (OED). 2017a. *Labor Market Information: Southeast Oregon Economic Indicators*. October 2017. https://www.qualityinfo.org/documents/10182/96541/Southeast+Oregon+Indicators?version=1.35. Accessed November 20, 2017.

_____. 2017b. *Employment and Wages by Industry: Industry Summary Report*. https://www.qualityinfo.org/edewind/?at=1&t1=0~4104000045~00~0~0000~00~00000~2016~00. Accessed November 20, 2017.

Oregon Partnership for Disaster Resilience (OPDR). 2014. *Malheur County Multi-Jurisdictional Natural Hazards Mitigation Plan*. Prepared for Malheur County, Nyssa, Ontario, and Vale. May 2014.

Orr, E.L., W.N. Orr, and E.M. Baldwin. 1992. Oregon Geology. Geology of Oregon Fourth Edition. Kendall/Hunt Publishing Company. Dubuque, Iowa. 254 p.

Oregon State Police (OSP). 2016. *5-Year Strategic Roadmap 2016-2021*. http://www.oregon.gov/osp/docs/5-Year%20strategic%20roadmap.pdf. Accessed December 5, 2017.

Sobek, A.A, W.A. Schuller, J.R. Freeman, J.R., and R.M. Smith. 1978. Field and laboratory methods applicable to overburden and minesoils: EPA 600/2-78-054, 203 pp.

Soltanpour, P.N. and S.M. Workman. 1981. Soil testing methods used at Colorado State University Soil Testing Laboratory for evaluation of fertility, salinity, and trace element toxicity. CSU Experimental Station Technical Bulletin 142, Fort Collins, Colorado.

Sperling's Best Places. 2017. *Oregon State*. https://www.bestplaces.net/housing/state/oregon. Accessed November 14, 2017.

SPF Water Engineering (SPF), 2018a. Monitoring Well GMW17-32 Completion Report. Prepared for Calico Resources. Prepared by SPF, Boise, Idaho. August 20, 2018.

_____. 2018b. GMW17-31, GMW17-33, and GMW17-34 Wells Completion Report. Prepared for Calico Resources. Prepared by SPF, Boise, Idaho. September 12, 2018.

_____. 2019a. Grassy Mountain Gold Project Groundwater. Vol. I, Groundwater Baseline Data Report. Prepared by SPF, Boise, Idaho. August 13, 2019

_____. 2019b. Grassy Mountain Gold Project Groundwater. Vol. II, Groundwater Characterization Report. Prepared by SPF, Boise, Idaho. August 13, 2019

_____. 2019c. Well Field Design Report Grassy Mountain Project. Prepared by SPF, Boise, Idaho. July 9, 2019

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of a well using ground-water storage. Transactions, American Geophysical Union, 16: 519-524.

Ulmschneider, Helen, Dave Hays, Hadley Roberts, Janet Rachlow, Todd Forbes, John Himes, Eveline Sequin, Marcy Haworth, Todd Katzner, Adam Kozlowski, Ryan Rauscher, and Pat Lauridson. 2004. Surveying for pygmy rabbits (Brachylagus idahoensis). Boise District, Idaho BLM. June 2004.

Ulusay R. and J.A. Hudson. 2007. The complete ISRM suggested methods for rock characterization, testing and monitoring: 1974–2006. In: Ulusay R, Hudson JA (eds) Commission on testing methods. International Society of Rock Mechanics. Compilation arranged by the ISRM Turkish National Group, Ankara, Turkey, 628 p

U.S. Census Bureau. 2010. *Households and Families: 2010*. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_QTP11&prodType=table. Accessed January 4, 2018.

_____. 2016a. *Poverty Thresholds for 2016 by Size of Family and Number of Related Children Under 18 Years*. https://www.census.gov/data/tables/time-series/demo/incomepoverty/historical-poverty-thresholds.html. Accessed November 27, 2017.

_____. 2016b. *2011-2015 American Community Survey 5-Year Estimates: ACS Demographic and Housing Estimates*. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_DP05&prodType=table. Accessed November 28, 2017.

_____. 2016c. *2011-2015 American Community Survey 5-Year Estimates: Selected Economic Characteristics.* https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_DP03&prodType=table. Accessed November 28, 2017.

_____. 2016d. *2011-2015 American Community Survey 5-Year Estimates: Poverty Status in the Past 12 Months.* https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_S1701&prodType=table. Accessed November 29, 2017.

_____. 2016e. *2011-2015 American Community Survey 5-Year Estimates: Average Household Size of Occupied Housing Units by Tenure.* https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_B25010&prodType=table. Accessed November 29, 2017.

_____. 2016f. *2011-2015 American Community Survey 5-Year Estimates: Selected Economic Characteristics.* https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_DP03&prodType=table. Accessed November 13, 2017.

_____. 2016g. *2011-2015 American Community Survey 5-Year Estimates: Selected Housing Characteristics.* https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_DP04&prodType=table. Accessed November 14, 2017.

_____. 2016h. *2015 Poverty and Median Household Income Estimates – Counties, States, and National*. Small Area Income and Poverty Estimates (SAIPE) Program. Release date December 2016.

_____. 2017. *AirData Air Quality Monitors*. https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=5f239fd3e72f424f98ef3d5def547eb5&extent=-146.2334,13.1913,-46.3896,56.5319. Accessed December 1, 2017.

U.S. Environmental Protection Agency (EPA). 1998. Method 1312: Synthetic Precipitation Leaching Procedure, Revision 0. September 1994

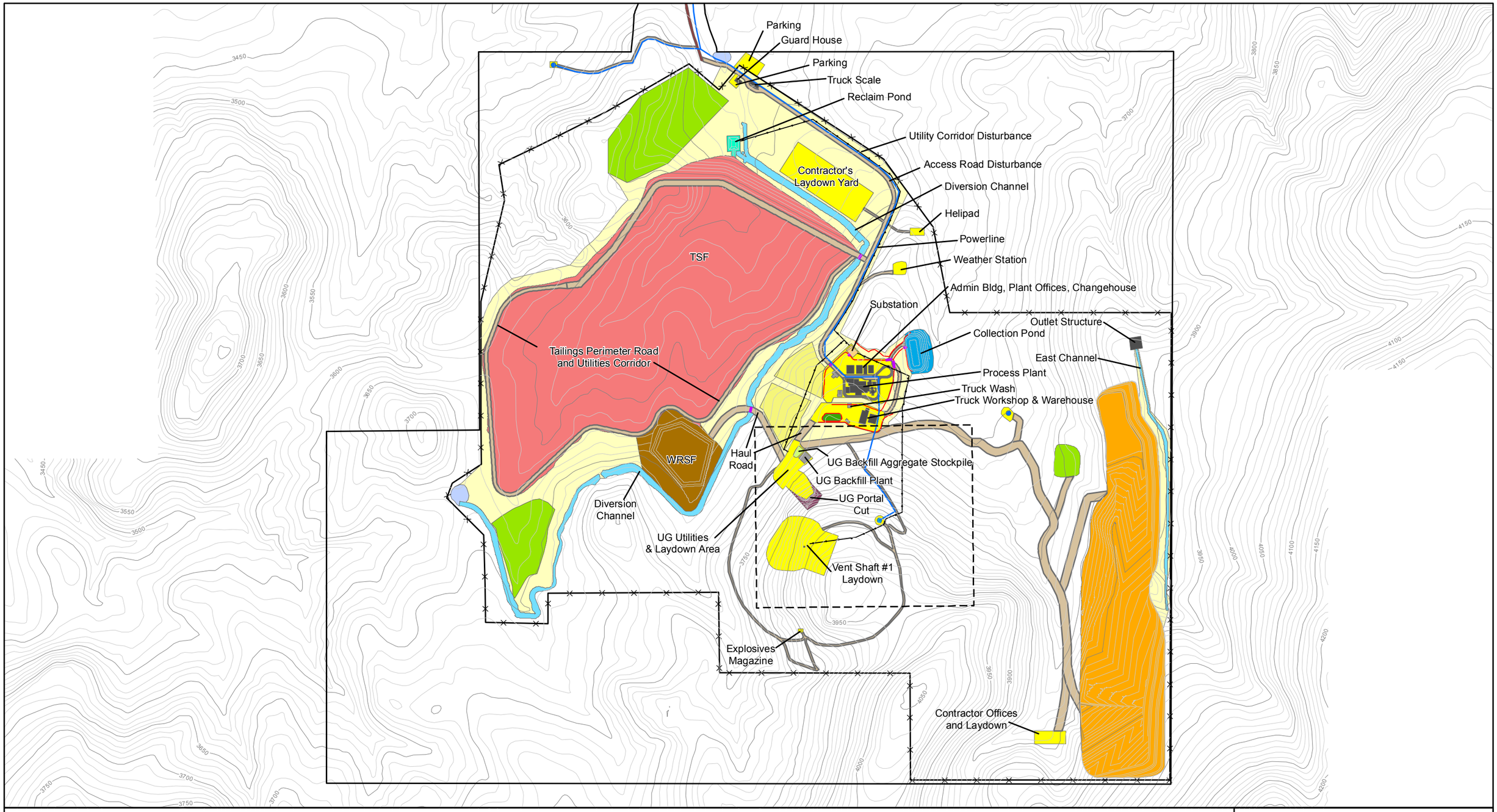
United States Geological Survey (USGS). 2018. *Earthquake Hazards Program: Earthquakes*. https://earthquake.usgs.gov/earthquakes/search/. Accessed February 12, 2018.

_____. 2017. The DEM was downloaded from the website: https://earthexplorer.usgs.gov/. The data source for the DEM is the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model.

Wilson, S.E., R. Hufford, W.J. Pennstrom, and Z.J. Black, Z.J. 2015. *Preliminary economic assessment Calico Resources Corp. Grassy Mountain project Malheur County, Oregon, USA*: NI 43-101 technical report prepared for Calico Resources Corp., 165 p. February 2015.

Zillow. 2017. *Median Sale Price*. http://files.zillowstatic.com/research/public/County/Sale_Prices_County.csv. Accessed December 22, 2017.

Appendix A: Oversize Figures



Explanation

- Project Area
- Patented Outline
- Existing Access Road
- Production Well
- Culvert
- Ditch
- Fence
- Power Line
- Water Line

Other Facilities
- Borrow Pit
- Mine Road
- Portal
- Reclaim Pond
- Tailings Storage Facility
- Waste Rock Dump Area

Foundations and Buildings
- Concreate Pad
- Water Tank
- Structure

Sediment & Drainage Control
- Collection Pond
- Diversion Channel
- Sediment Basin

Yards
- Disturbed Area
- Explosive Magazine
- Growth Media Stockpile
- ROM Stockpile
- Sanitation Field
- Substation
- UG Backfill Aggregate Stockpile
- Yard

Contours Lines
- Minor (10-foot Interval)
- Major (50-foot Interval)

0 500 1,000 Feet

N

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT

Site Plan

Label: Figure 3	Drawn By: GSL/JDB
Date: 11/11/2019	Project No.: 3671
Base Map:	
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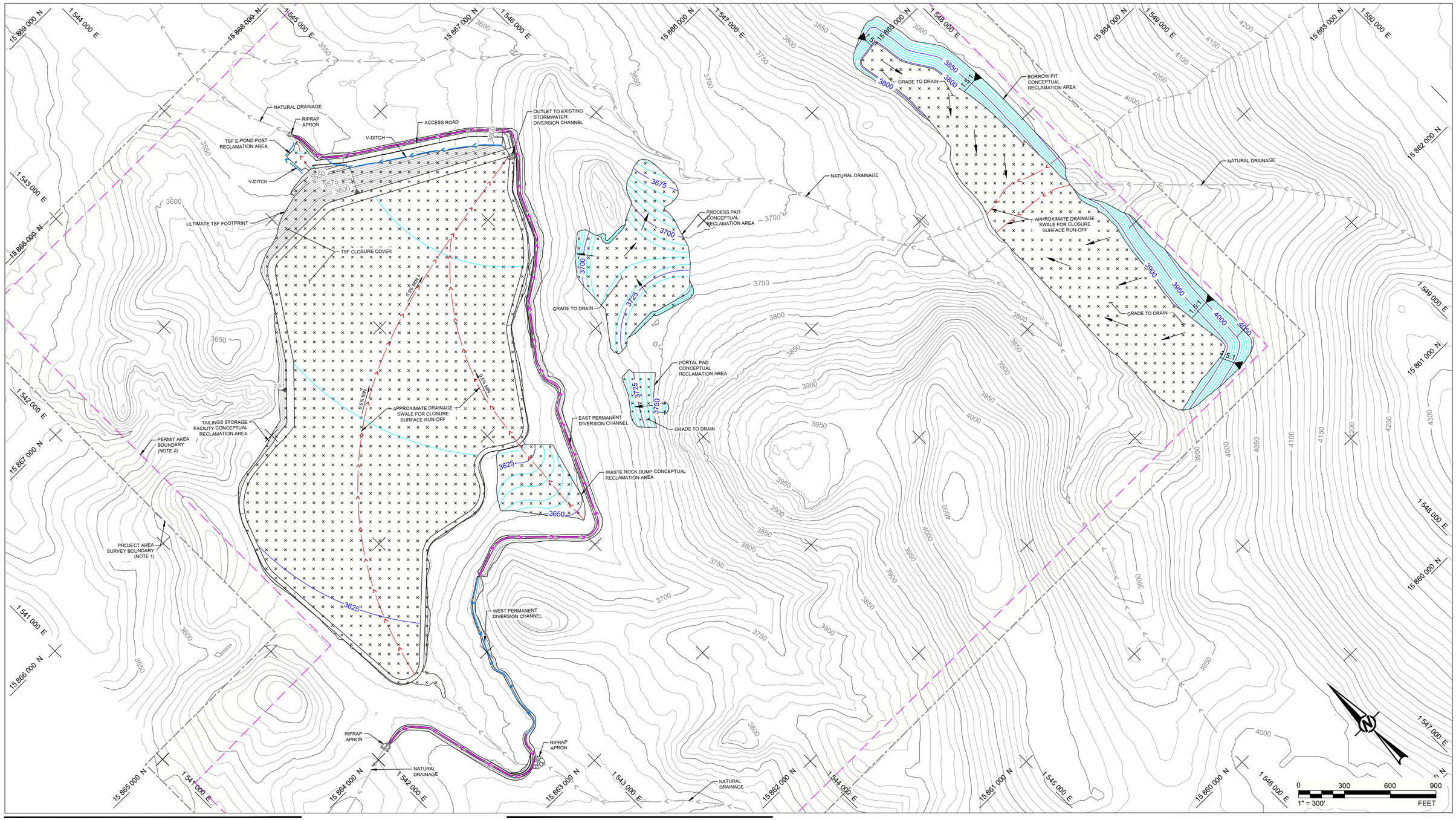

LEGEND

- 3600 — EXISTING GROUND CONTOURS (5 FT) (NOTES 1 AND 3)
- PERMIT AREA BOUNDARY (NOTE 2)
- PERMANENT TRAPEZOIDAL STORMWATER DIVERSION CHANNEL
- PERMANENT V-DITCH STORMWATER DIVERSION CHANNEL
- 3600 PROPOSED RECLAMATION TOPOGRAPHY
- NATURAL DRAINAGE
- CLOSURE DRAINAGE SWALE
- PROJECT AREA SURVEY BOUNDARY (NOTE 1)
- REVEGETATION AREA

NOTES

1. EXISTING GROUND TOPOGRAPHY WITHIN THE PROJECT AREA SURVEY BOUNDARY WAS PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf". TOPOGRAPHY OUTSIDE THE PROJECT AREA SURVEY BOUNDARY WAS AVAILABLE FROM WEBGIS DIGITAL ELEVATION MODELS WITH 30 m RESOLUTION.
2. PERMIT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".
3. EXISTING GROUND AS SHOWN COMPRISED OF 2017 TOPOGRAPHY (REFER TO NOTE 1) AND THE STAGE 3 TSF LAYOUT.

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

YYYY-MM-DD	2019-11-08
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
CONSOLIDATED PERMIT APPLICATION

TITLE
POST-RECLAMATION TOPOGRAPHY MAP

PROJECT NO. 1663241
REV. 0

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Appendix B: Baseline Studies and Work Plans (uploaded to sharesite)

Appendix C: Tailings Design Report

REPORT

Detailed Design
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon

Submitted to:

Calico Resources USA Corp.
665 Anderson St.
Winnemucca, Nevada 89445

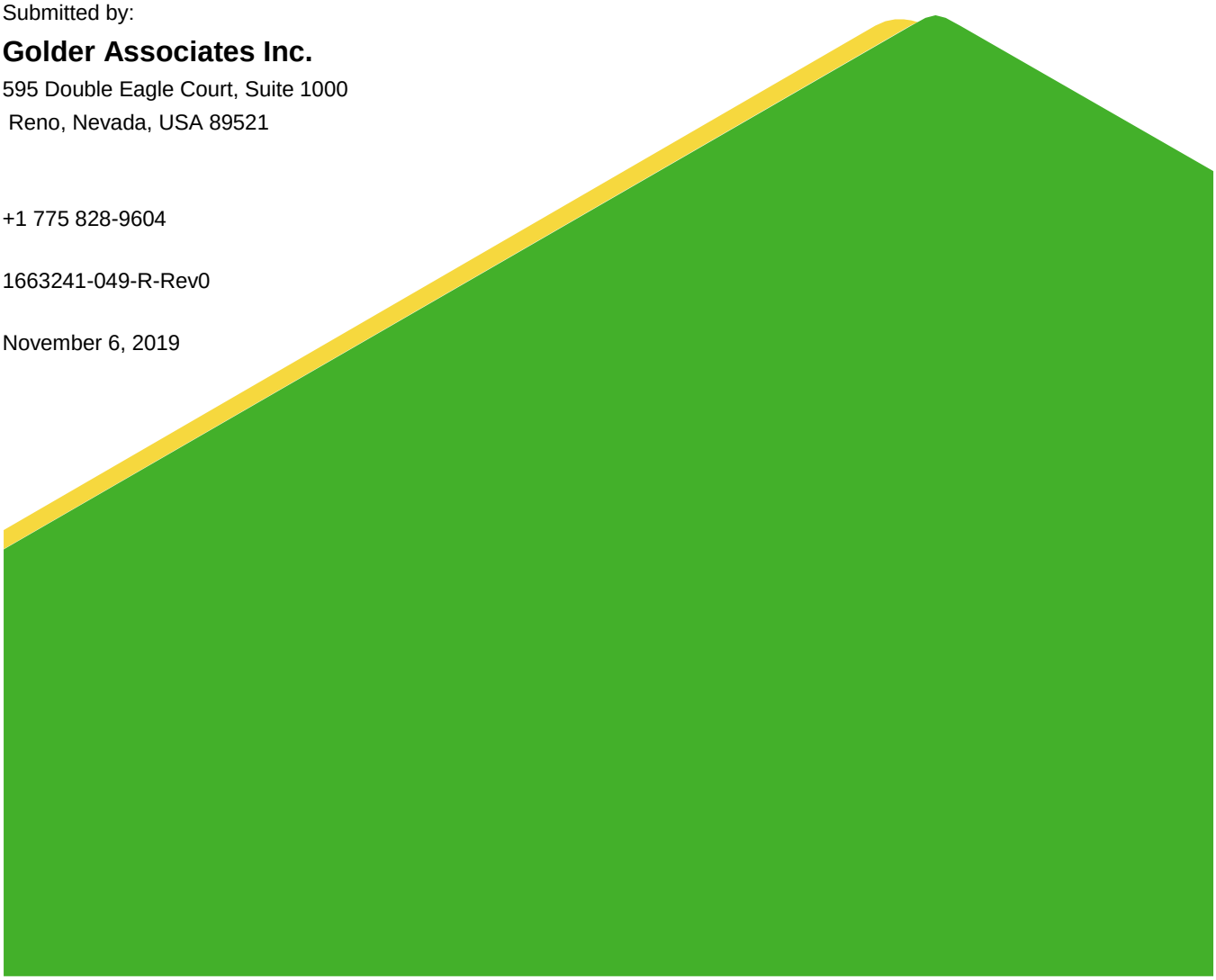
Submitted by:

Golder Associates Inc.
595 Double Eagle Court, Suite 1000
Reno, Nevada, USA 89521

+1 775 828-9604

1663241-049-R-Rev0

November 6, 2019



Detailed Design
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon

The following Design Report has been prepared by the staff of Golder Associates Inc. under the professional supervision of the engineers whose signatures appear herein.

The findings, design, and recommendations presented in this Design Report are within the scope of services requested by Calico Resources USA Corp. and have been prepared in accordance with generally accepted profession engineering principles and practices.

11/6/19

EXPIRES: 12/31/2020

Christopher J. MacMahon, PE
Associate, Project Manager

Russell A. Browne, PE (NV)
Principal, Senior Tailings Practice Leader

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Lead Civil Design Engineer

Executive Summary

This report presents the geotechnical field investigations, laboratory testing, detailed calculations, technical analyses, design drawings, technical specifications, construction quality assurance plan, geotechnical monitoring plan, and dam breach assessment to support design of the Grassy Mountain Tailings Storage Facility (TSF) and Waste Rock Dump (WRD) at the Grassy Mountain Mine.

The TSF has been designed using downstream construction concepts to allow for the installation of a continuous lining system within the TSF. The TSF has a maximum embankment height of 84 feet at the deepest point along the North embankment and provides approximately 3.67 million tons of tailings storage.

The design incorporates the following design components:

- Phased construction of the TSF embankments and basin in a total of three stages
- Dual containment geosynthetic lining, leak detection, leakage collection recovery systems within the TSF basin, on the TSF embankments, TSF underdrain channel, TSF reclaim pond, WRD pad, and process water piping systems
- Gravity underdrain collection piping systems within the TSF impoundment and WRD pad
- Process fluid management systems
- Permanent and temporary stormwater diversion structures
- Geotechnical monitoring instrumentation

To support the complex geotechnical analyses required for the design, Golder conducted three comprehensive field investigations which included borings, test pits, and cone penetrometer testing within the TSF, WRD, and below the TSF embankments. Field measurements and laboratory tests results on samples obtained during the investigations were used to determine material properties and behavior of the materials when subject to seismic loading.

The seismic hazard evaluation provides earthquake ground motions using the latest ground motion prediction equations and latest probabilistic seismic hazard model and takes advantage of improved site-to-source distance estimates from accurate fault maps provided by the United States Geological Survey.

Static and pseudo-static stability analyses evaluate the geotechnical stability of the embankment under both static and simulated earthquake conditions. Settlement analyses assess post-settlement grades of the gravity underdrain system and dam crest elevation.

The design presented herein provides a safe and stable dam in accordance with the guidelines set forth by the Oregon Administrative Rules Division 20 as regulated by the State of Oregon Water Resources Department and Division 43 as regulated by the State of Oregon Department of Environmental Quality.

This report and accompanying design drawings present the detailed design and technical analyses needed to permit, construct, and operate the Grassy Mountain Tailings Storage Facility in accordance with OAR guidelines.

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1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this report to present the construction-level detailed design of the tailings storage facility (TSF) and waste rock dump (WRD) for Calico Resources USA Corp.'s (Calico's) Grassy Mountain Project (Project) located in Malheur County in southeastern Oregon.

Calico plans to construct a lined impoundment to contain approximately 3.67 million short dry tons (M tons) of processes tailings to be generated by milling operations. The TSF is designed to be constructed in a total of three stages.

This report presents the design work of Stages 1 through 3 for the TSF conducted by Golder for Calico. Specifically, this report describes the results of Golder's site explorations, dam design methodology, and presents design calculations, construction drawings, technical specifications, dam breach analysis, and geotechnical monitoring plan which are appended to this design report.

- The TSF is designed as a "zero discharge" facility in accordance with the Oregon Administrative Rules (OAR) Division 43 – Chemical Mining as administered by the Department of Environmental Quality (ODEQ) and OAR Division 20 – Dam Safety as administered by the Department of Water Resources (OWRD).

1.1 Project Description

The Grassy Mountain Mine is a proposed gold mining and milling operation located approximately 20 miles south of Vale, Oregon in Malheur County as shown on the Design Drawings. Ore processing will incorporate gravity gold recovery, and leaching. The ore grind is anticipated to be 80 percent passing (P_{80}) the 110 microns. Milling operations will produce and estimated 1.8M tons of tailings with a nominal mill throughput rate of 680 dry short tons per day (tpd) Although the current life of mine estimate is for 1.8M tons, the TSF has been designed in three stages to accommodate up to 3.67M tons of tailings storage at an estimated settled dry density of 80 pounds per cubic foot (pcf).

1.2 Scope of Services

Golder has performed the following work related to the design of the TSF and WRD:

- Subsurface geotechnical investigations of the TSF foundation:
  - December 2017 – 15 geotechnical boreholes, 44 test pits and six field falling head permeability tests were conducted in boreholes
  - March 2019 – Six geotechnical boreholes
  - July 2019 – 11 cone penetration test soundings
- Geotechnical laboratory testing performed on soil samples collected from the subsurface investigations for soil classification. Laboratory testing included grain size analyses, Atterberg Limits, moisture content and density, triaxial strength testing, and consolidation testing.
- Geotechnical laboratory testing performed on pilot tailings samples to estimate post deposition characteristics of the tailings mass for settled dry density, surface slope parameters, water recover, seepage rates, soil-water characteristics, and long-term consolidation.
- Volumetric sizing of Stages 1 through 3.

- Geotechnical analyses were performed in support of the TSF and WRD design. Analyses included slope stability and settlement calculations using the final dam geometries and estimated/measures material properties.
- Hydrologic analysis of the TSF and hydraulic design of stormwater control structures.
- Hydraulic design of the TSF and WRD underdrain collection and drainage layer systems.
- Water balance of the TSF and WRD including design of the reclaim pond and return water pumping requirements.
- Dual containment system designs for the TSF basin, embankments, underdrain channel, reclaim pond, WRD pad, and pipelines to and from the mill.
- Leak detection and leakage collection recovery systems to monitor and manage potential leakage in areas where concentrated flows are expected.
- Civil engineering design including layout of the impoundment, reclaim water systems, and stormwater control structures.
- Design drawings and technical specification.
- Geotechnical monitoring plan of the TSF and WRD.
- Dam breach analysis to estimate inundation area and depths based on a “worst case” scenario failure mechanism.

This final design report was prepared to present the design and document Golder’s design calculations and support work for construction-level design of the TSF and WRD. This report is in a format that can be utilized by Calico for permitting, construction, and operations.

1.3 Battery Limits

This design report has been prepared by Golder to include construction-level design of the TSF and WRD only. Excluded from this design report are detailed designs for the following:

- Mill containment facilities
- Underground mining operations and surface containment facilities
- Tailings delivery and distribution pumping and piping systems
- Supernatant pool returns water pumping and piping systems
- Reclaim water pumping and piping systems
- Mechanical, structural, and electrical designs

The battery limits for the TSF and WRD containment systems start at the western edge of the process facility site as shown on the Design Drawings. The TSF and WRD containment systems are interconnected and continuous to provide secondary containment in all areas of the TSF and WRD.

2.0 DESIGN CRITERIA

The design criteria presented below are based on Oregon Administrative Rules (OAR), requirements of the Project as defined by Calico, and Golder's experience designing and constructing TSFs and waste rock dumps (WRDs) in similar environments. The following OAR Divisions have been used to develop minimum acceptable design levels:

- Water Resources Department, Dam Safety Regulations, OAR 690, Division 20
- Department of Geology and Minerals Industries (DOGAMI), Chemical Process Mine Regulations, OAR 632, Division 37
- Department of Fish and Wildlife (ODFW), Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420
- Department of Environmental Quality (DEQ), Chemical Mining, OAR Chapter 340, Division 43

2.1 Hazard Classification

The TSF has been designed based on the assumption that a hazard rating of "Low" will be assigned by the OWRD. Based on Golder's understanding of OAR 690-020-0022 (22), the guidelines support the use of a Low Hazard designation by stating:

> *If the dam were to fail, loss of life would be unlikely and damage to property would not be extensive*.

The use of a Low Hazard designation is based on the knowledge that there are no structures or dwellings downgradient of the TSF that would be at risk of inundation or damage in the unlikely event of dam failure. The stability analyses completed for the project and discussed in Section 8.0 indicate that for the design criteria listed in Section 2.2, the TSF design meets or exceeds the design factor-of-safety requirements for stability.

Although not required for a Low Hazard classification dam, Golder performed a dam breach analysis on the ultimate TSF configuration and is discussed in further detail in Section 11.0.

2.2 Design Criteria for the Tailings Storage Facility

The following tables present the minimum design criteria for the TSF.

Table 1: General TSF Design Criteria

Parameter	Value	Reference or Regulation
Capacity	3.67 million dry tons	Calico
Life of Mine	~15 years	Calico
Average Tailings Deposition Rate	248,200 tons/year (680 tons/day)	Ausenco (others)
Tailings Slurry Concentration	46% solids (by weight)	Ausenco (others)
Settled Tailings Density	80 lb/ft^3	Golder
Slope of Tailings Surface estimated	1.0%	Golder
Dam Construction Method	Staged Downstream Construction	Golder
Dam Construction Material	Heterogeneous rock fill and/or soil fill	Golder
Tailings Deposition System	Subaerial discharge spigots	Golder
Reclaim Water System	Decant pumping and gravity underflow reclaim pond	Golder
Supernatant Pool Location	East side hill, not in contact with dam	Golder

Table 2: Division 20 - Dam Safety Minimum Design Criteria

Parameter	Value	Reference or Regulation
Embankment Geometry		
Upstream Slope Angle	Overall 3 horizontal to 1 vertical (3H:1V) or flatter Local slopes 2.5H:1V	OAR 690-020-0038
Downstream Slope Angle	2.5H:1V	OAR 690-020-0038
Geotechnical Criteria		
Hazard Classification	Low	OAR 690-020-0100 Golder recommended

Parameter		Value	Reference or Regulation
Design Earthquake During Closure	Event	Median Maximum Credible Earthquake (MCE)	Exceeds OAR 690-020-0038 for Low Hazard Dams
	PGA	0.15g	Golder
Horizontal PGA Factor, k, for pseudo-static stability analyses		½ of the PGA	Haynes and Franklin (1984) and Seed (1982)
Static Stability, Factor of Safety		1.5 (minimum)	Golder[1]
Closure Seismic Stability (pseudo-static), Factor of Safety		1.1 (minimum)	Golder[1]
Impoundment Storage Requirement			
Watershed and Hydrologic Inflows		Precipitation on TSF, small area of run-on into impoundment	Golder
Minimum Freeboard Above Supernatant Pool[2]		3 feet above supernatant pool operating depth for peak design storm event and wave action	Golder and Partial OAR 690-020-0042
Minimum Freeboard Above Tailings Beach		2 feet against dam embankment	Golder
Peak Design Storm Event		500-year, 24-hour plus wave run-up above supernatant pool operating depth	Exceeds OAR 690-020-0037 and OAR 340-043-0090
Process Water Conveyance			
Tailings Underflow Collection System		Perforated and solid CPE and HDPE gravity draining piping network	OAR 690-020-0038

1) Minimum factors of safety are not presented in OAR Division 20. Therefore, Golder has selected factors of safety that meet or exceed industry standard of care for similar seismic activity and hazard classification.
2) Although a minimum freeboard for free water against the embankment is provided, the TSF is designed to so that after initial deposition, no free water during normal operation is against the embankment.

Table 3: Division 43 - Chemical Mining Minimum Containment Design Criteria

Parameter	Value	Reference or Regulation
Containment and Leak Detection		
Facility Discharge	Zero discharge facility	Calico, Golder, and OAR 340-043-0000
TSF Basin and WRD Pad Containment System (top to bottom)	Continuous 80-mil HDPE geomembrane, geosynthetic clay liner (GCL), prepared subgrade	Golder and OAR 340-043-0130
TSF Reclaim Pond Containment System (top to bottom)	Continuous 80-mil HDPE geomembrane, geonet leak collection and recovery system (LCRS), 60-mil HDPE geomembrane	Golder
Overall TSF and WRD Leak Detection System	Perforated 2-inch diameter Schedule 80 PVC pipe network and monitoring/evacuation ports	OAR 340-043-0000
Underdrain Channel Leak Detection System	Geomembrane lined channel will provide secondary containment, leak detection will be visual	Golder
Reclaim Pond Leak Detection System	LCRS between two geomembranes, and evacuation port	Golder and OAR 340-043-0000
Process Water Management		
Tailings Underflow Collection System	– Perforated and solid CPE and HDPE gravity piping network in 18-inch thick drainage layer – 6-inch thick filter layer – Gravity flow to reclaim pond	Golder and OAR 340-043-0050
Tailings Delivery and Distribution System	– 4-inch diameter HDPE DR17 carrier pipe inside 8-inch diameter HDPE DR17 containment pipe – Pumping system, if any (designed by others)	Ausenco (others)/Golder
Supernatant Water System	– Decant pumping system (designed by others) – 4-inch diameter HDPE DR17 carrier pipe inside 8-inch diameter HDPE DR17 containment pipe	Ausenco (others)/Golder
Reclaim Water System	– Pumping system (designed by others) – 4-inch diameter HDPE DR17 carrier pipe inside 8-inch diameter HDPE DR17 containment pipe	Ausenco (others)/Golder
Surface Water Management		

Parameter	Value	Reference or Regulation
Perimeter Diversion Channels	100-year, 24-hour storm event plus 9-inches freeboard or 500-year, 24-hour storm event to channel crest	OAR 340-043-0090
Temporary Diversion Channels	25-year, 24-hour storm event plus 9-inches of freeboard, or 100-year, 24-hour storm event to channel crest	Golder

2.3 Design Criteria for the Waste Rock Dump

Table 4 presents the minimum design criteria for the Waste Rock Dump (WRD) facility.

Table 4: WRD Design Criteria

Parameter	Value	Reference or Regulation
Capacity	200,000 tons	Ausenco/MDA others)
WRD Containment System (top to bottom)	Continuous 80-mil HDPE geomembrane, geosynthetic clay liner (GCL), prepared subgrade	Golder
WRD Underflow Collection System	Perforated and solid CPE and HDPE gravity draining piping network	OAR 690-020-0038
WRD Leak Detection System	Perforated 2-inch diameter Schedule 80 PVC pipe network and monitoring ports	OAR 340-043-0000
WRD Underflow Collection System	– Perforated and solid CPE and HDPE gravity piping network in 18-inch-thick drainage layer – 6-inch-thick filter layer Gravity flow to reclaim pond	Golder and OAR 340-043-0050
WRD Design Earthquake, Operational	475-year return period	Golder
Peak Ground Acceleration, PGA	0.08g	Golder
Horizontal PGA Factor, k, for pseudo-static stability analyses	½ of the PGA	Haynes and Franklin (1984) and Seed (1982)

Parameter	Value	Reference or Regulation
Static Stability, Factor of Safety	1.5 (minimum)	Golder[1]
Seismic Stability (pseudo-static), Factor of Safety	1.1 (minimum)	Golder[1]

1) Golder has assigned these minimum factor of safety values for geotechnical stability of the WRD. Minimum factors of safety are not presented in the OAR. Therefore, Golder has selected minimum FOS values that meet or exceed industry standard of care for similar seismic activity.

3.0 SITE CONDITIONS

3.1 Physical setting

In general, the mine site and surrounding area has rolling topography with bedrock exposed at or near the ground surface in upland and hill areas, including Grassy Mountain proper. Within the TSF area, as topographic elevation drops, the surrounding hills transition into broad valleys with shallow alluvial soils overlying deeper lacustrine clays.

The TSF generally slopes from south to north at about two percent along the valley floor. Valley wall slopes to the east and west ranging from about 10 percent to 15 percent, and about 5 percent in the south along the higher valley slopes in the southern portion of the TSF basin.

Vegetation across the site generally consisted of moderately dense native shrubs and grasses. No surface water, perennial streams, or springs were observed within the TSF footprint or WRD areas at the time of the geotechnical field investigations.

3.2 Climate

3.2.1 Development of Climate Data

There is no weather station located at the project site. Climate data for the site was developed using nearby weather station data, regression analyses, and elevation of the TSF. Daily recorded data from two Remote Automated Weather Stations (RAWS), one Cooperative Observer Network (COOP) station, and PRISM Climate spatial data were used as the base climate data sets. The overlapping data set between all stations was January 1, 1987 through December 31, 2017.

Golder used statistical regression analyses to develop a factor based on measured annual average precipitation and station elevation for each of the three data sets in relation to the project site. That factor was used to predict the average monthly precipitation for the project site used for hydrologic analyses. Based on available data and unknown properties of the future supernatant pool, evapotranspiration data was used to predict average monthly evaporation used for the TSF water balance. Supporting calculations and discussions about the predicted climate data are presented in Appendix F.

Based on the results of Golder's analysis, a regression function estimated from the average annual precipitation and elevations of the Owhyee Ridge RAWS, Kelsay Butte RAWS, and Owhyee Dam COOP, the Owhyee Ridge RAWS has the best monthly average precipitation correlation to the project site. Therefore, the Owyhee Ridge

RAWS station's average monthly precipitation values were multiplied by 1.01 to obtain the predicted average monthly precipitation values for the site.

Monthly climate data from the Owhyee Ridge RAWS was used to calculate evaporation rates using the Penman-Monteith equation for the available data set between April 1998 and May 2019.

Table 5: Factor-predicted Average Monthly Climate Data

Month	Precipitation (in)	Evaporation (in)
January	0.93	0.85
February	0.62	1.31
March	0.97	2.69
April	1.14	3.81
May	1.49	5.28
June	0.89	6.37
July	0.51	8.16
August	0.31	7.04
September	0.46	4.39
October	0.83	2.95
November	0.73	1.31
December	0.89	0.79
Annual	**9.77**	**44.97**

In addition to developing site specific average monthly precipitation and evaporation climate data, extreme wet and dry climate data sets were developed. Extreme climate data sets were calculated using the factor predicted monthly average precipitation and evaporation rates presented in Table 5.

The Log Pearson III method, determined to be the best-fit for the data set, was used to calculate the average monthly precipitation and evaporation rates for both extreme wet and dry climate scenarios for the 100-year return period. These extreme climate data sets were used in preparation of the TSF to estimate season and extreme fluctuations in the supernatant pool as discussed in Section 6.8 and presented in detail in Appendix F.

3.3 Regional Geology

The project site is located within in the Columbia Plateau, a physiographic province of the United States that comprises thick sequences of basalt flows (Columbia River Basalt) from about 17.5 to 6 million years ago (Ma). The Columbia River Basalts are part of long-lived volcanic activity related to the mantle "hot spot" that is now

located below Yellowstone National Park. The relatively unaltered basalt flows in the Payette section range in elevation from about 3,800 feet to about 4,500 feet above sea level (asl).

The project site is located about 15 mi (24.5 km) southwest of the Snake River plain near Adrian, Oregon. At this location, some dissection of the basalt flow-dominated landscape has occurred, exposing the underlying sedimentary units of the Grassy Mountain Formation. The site is located within a north-flowing drainage at an elevation of about 3,700 feet asl northwest of Schweizer Reservoir as presented in Appendix B.

3.4 Site Geology

The geology of the region surrounding the project site is a sequence of sedimentary and volcanic deposits within the Oregon-Idaho Graben. Contemporaneous deposition of sandstone and conglomerate (Tgs), olivine basalt emplacement (Tbi), and repeated episodes of calc-alkaline lava eruption and flow (Tgb) occurred during middle to upper Miocene time. The volcanoes of west-central to southeastern Oregon range in age from 15 to 2 Ma. The Payette section of the Columbia Plateau, where the site is located, is a relatively uniform area of basalt flows that overlie and cap the underlying older sedimentary deposits.

Grassy Mountain itself is mapped by Ferns et al. (1993) as underlain by calc-alkaline rich volcanic flow deposits (Tgb) and associated olivine basalt that crops out farther northeast. Ferns et al. (1993) geologic map presented in Appendix A indicates that the TSF and WRD site is located on a thick sequence of arkosic sandstones containing interbeds of conglomerate separated by the tuff of Kern Basin. Geologically, the site is within the upper arkosic (mid- to upper Miocene) and the lower (mid-Miocene) arkosic units. Erosion over about the last 11 Ma has removed some of the volcanic deposits that overlie and cap the sedimentary units to expose the upper arkosic unit at the site.

Bedrock outcrops within the site expose siltstone, sandstone, and conglomerate of the late Miocene Grassy Mountain Formation. These units are also exposed in the northeast–southwest trending drainage that the TSF will partially fill. Olivine-rich basalts are present immediately to the east and south. Igneous intrusions (Tbi) are mapped as isolated bodies surrounded by the sedimentary units (Tgs). The intrusive bodies are in places aligned along the mapped pre-Quaternary faults that may have controlled the locations and extent of these shallow intrusions.

Golder's subsurface investigation discussed in Section 4.0 identified unconsolidated alluvium and colluvium overlying previously unmapped Miocene-aged lacustrine clays underlying most of the TSF and WRD sites. The lacustrine deposits are generally characterized as fat clay (with variable quantities of fine- to medium-grained sand, dark tan to brown with some blue-gray deposits) with lesser amounts of lean clay and poorly graded sand lenses. Similar deposits were mapped by Ferns et al. (1993) approximately 2 miles (3 km) northeast of the TSF site. Gray et al. (1989) considers that the clay was deposited during the Upper Miocene within alkaline lakes subjected to regular volcanic ash fall and/or hydrothermal alteration.

The Grassy Mountain mine is located on a 150-foot high, highly resistant, silicified and iron-stained knoll. Bedding within the sandstone unit appears unaltered at the hilltop, dips at 10° to 25° toward the north-northeast on the northern and eastern flanks of the hill and steepens to 30° to 40° on the west side of the hill due to drag folding in the footwall along a fault striking about N20°W (Paramount 2017). Normal faulting of the Miocene-age units is common, with most faults striking either northwest–southeast or northeast–southwest (most common).

Also, a number of mapped older faults strike approximately north–south, but these faults are generally located west of the TSF site and are not considered seismogenic under the current tectonic environment.

3.5 Seismic Hazard Assessment

Golder completed a preliminary seismic hazard analysis (SHA) for the project in 2017 (Golder 2017). Subsequent to additional geotechnical field investigations in 2019, the preliminary SHA was updated to support this detailed design of the TSF. The updated SHA is presented in detail in Appendix B.

The purpose of the SHA was to identify faults that have the potential for surface rupture and to estimate earthquake ground motions for the operational and closure design earthquakes at the site for input into stability modelling. The site is located in the Columbia Plateau, a region of relatively low historical earthquake activity.

This SHA updates the earthquake ground motions presented in Golder (2017) with a deterministic seismic hazard analysis (DSHA) and probabilistic seismic hazard analysis (PSHA) for the TSF site. This SHA provides earthquake ground motion values for two assumed shear wave velocity values equivalent to the mid-point of a soil Site Class D as defined in ASCE/SEI 7-16. These lower values are considered appropriate for design of the TSF structure given the known subsurface conditions.

A probabilistic analysis using the USGS 2014 National Seismic Hazard Model indicates mean PGAs for Site Soil Class D for return periods of 475-, 2,475-, and 4,975 years. The following table presents PGA and spectral accelerations for the referenced return periods:

Table 6: Peak Ground Acceleration, 0.2- and 1.0-second Spectral Accelerations (Sa) for Selected Return Periods at the Grassy Mountain Tailings Storage Facility Site, Malheur County, Oregon

Probability of Exceedance (return period in years)[1]	Mean PGA (g)	0.2 second Sa (g)	1.0 second Sa (g)
10% in 50 years (475)	0.08	0.20	0.10
2% in 50 years (2,475)	0.20	0.50	0.23
1% in 50 years (4,975)	0.27	0.69	0.31

1. Values from the 2014 USGS national probabilistic model (Dynamic; Conterminous v.4.1.1) for a site location of 43.6728°N, 117.36437°W

A deterministic analysis was used to estimate the maximum credible earthquake (MCE) that could be experienced at the site. The MCE is the largest possible earthquake that may reasonably occur along a recognized fault or within a geographically defined tectonic province, under the presently known or presumed tectonic framework. Little regard is given to the earthquake recurrence interval, which may vary from less than a hundred years to more than ten thousand years, depending on the geologic and tectonic environment under consideration.

Median (50th percentile) values of PGA are sometimes used for analysis and design of low failure consequence structures, while 84th percentile values are often used for high consequence failure structures.

Median (50th percentile) PGA values were calculated because the earthquakes originate on faults with average slip rates less than 0.3 mm/yr as recommended in Idriss et al. (2018). Soil Site Class D values range from 0.03 to 0.15 g. The largest median PGA values result from an **M**7.2 earthquake occurring along the Cottonwood Mountain fault north of the TSF site. The median MCE PGAs of 0.15 g indicates a relatively low level for the deterministic hazard at the TSF site.

4.0 GEOTECHNICAL FIELD INVESTIGATION

The following sections present the general subsurface soil and groundwater conditions encountered at the TSF and WRD sites based on geotechnical field investigations and laboratory testing programs performed to support design of the TSF embankments and WRD facility. Detailed descriptions of conditions and materials encountered are presented in Appendix A.

Subsurface soil and water conditions described herein are based on the field exploration and laboratory testing performed for the project to-date. The following subsurface geotechnical field investigation and laboratory testing programs were conducted at the TSF and WRD site:

- December 2017 – 15 geotechnical boreholes, 44 test pits and six field falling head permeability tests were conducted in boreholes and laboratory testing
- March 2019 – Six geotechnical boreholes and laboratory testing
- July 2019 – 11 cone penetration test soundings

During the December 2017, Golder identified clay materials (lacustrine deposits) below the foundation of the TSF embankments that were visually observed to have high plasticity. These were classified as Lacustrine Deposits and discussed in Section 4.2

As the design progressed, further characterization and evaluation of the Lacustrine Deposits resulted in the completion of the March and July 2019 field investigations.

Findings from the geotechnical field investigations are discussed in detail in Appendix A.

4.1 Geotechnical Laboratory Testing Program

Geotechnical laboratory testing was performed on selected soil samples deemed representative of the materials encountered during the investigation. The geotechnical laboratory testing program, summarized in Table 1, was developed to focus on classifying and characterizing the engineering properties of the foundation soils and potential construction materials.

Geotechnical laboratory testing was completed at Golder's Lakewood, Colorado geotechnical testing laboratory. Selected samples were also subjected to x-ray diffraction (XRD) mineral composition testing. These tests were performed by Miles Industrial Mineral Research of Denver, Colorado, subcontracted to Calico. All geotechnical laboratory testing results are presented in Appendix A.

Table 7: Summary of Laboratory Testing Program

Laboratory Test	Test Method	Quantity
Grain Size Analysis	ASTM D 421/D 422	81
Moisture Content	ASTM D 2216	72
Atterberg Limits	ASTM D 4318	81
Flexible Wall Permeability	ASTM D 5084	5
Moisture-Density Relationship (Modified Proctor)	ASTM D 1557	1
Consolidated-Undrained Triaxial Shear Strength	ASTM D 4767	6
1-Dimensional Consolidation	ASTM D 2435	6
X-ray Diffraction	N/A	15

Index tests (grain size, moisture, and Atterberg Limits tests) were performed on selected subsurface soils encountered during the investigations to assist in classifying the soils in accordance with ASTM D 2487 and the Unified Soil Classification System (USCS) for verification of soil descriptions logged in the field.

Hydraulic conductivity (permeability) tests were run on both relatively undisturbed samples and a remolded sample using a flexible wall permeameter. The remolded sample was tested to assess the permeability of the lacustrine deposits if the material were to be excavated and used during construction. The relatively undisturbed samples were tested to provide the permeability of in-situ lacustrine soils beneath the TSF. The modified Proctor (moisture-density relationship test) was utilized to obtain parameters for remolding the permeability sample.

Consolidated-undrained triaxial shear strength tests (CUTX) were performed on relatively undisturbed samples extruded from the MC and Shelby tubes to assess the in-situ strength of the lacustrine deposits. A majority of the MC and some of the Shelby tube samples delivered to the laboratory were too disturbed or too fractured to be utilized for CUTX testing. This was most likely due to disturbance while driving the samplers into stiff to hard clays.

One-dimensional consolidation tests were conducted on relatively undisturbed lacustrine clay samples to determine the estimated pre-consolidation pressure and soil parameters for use in assessing settlement of the soils under loading conditions.

In addition, XRD mineral composition testing was performed on 15 samples to determine montmorillonite and accessory mineral concentrations.

4.2 Subsurface Conditions

In general, site soils consisted of surficial alluvial and colluvial deposits across the site with thicknesses ranging from about 0 to 25 feet below the existing ground surface (bgs). These deposits were generally comprised of a mixture of stiff to hard silt and clay and dense to very dense sand and gravel. The surficial soils were generally

underlain by relatively weak lacustrine deposits classified as very stiff to hard, lean to fat clay with varying fine to medium sand content. Laboratory testing of the lacustrine clays indicate a range of plasticity index (PI) from 25 to 198, with several samples having plasticity index values over 100.

Within the clay lacustrine deposits, zones of relatively clean sand varying in thickness from less than one foot to 20 feet were encountered below the TSF. These sand zones were generally comprised of medium dense to dense poorly graded and silty or clayey sands, with the sand content mainly consisting of fine to medium sand. These lacustrine deposits with sand zones were encountered up to depths of 120 feet bgs (maximum depth of exploration) within the footprint of the TSF and may extend deeper. Site soils were generally observed to be moist. No groundwater was encountered in the borings.

Relatively shallow (less than 15 feet) weathered arkosic sandstone was observed within the north-central portion of the TSF and west portion of the mine process facilities. The sandstone is similar to a silty- to poorly-graded sand. In general, the west portion of the mine process facilities consisted of Quaternary deposits underlain by weathered arkosic sandstone, and the east portion of the mine process facilities area consisted of Quaternary deposits overlying fat clay lacustrine deposits.

The subsurface profile at the site generally consisted of alluvial and colluvial deposits underlain by lacustrine deposits, sandstone, and basalt as presented on the geologic sections shown on Figures 2B and 2C. Subsurface stratigraphy at the site is described as follows:

- **TOPSOIL:** Topsoil was estimated to have an average thickness of about ½ foot across a majority of the site. Dense rootlets were observed in the topsoil with scattered roots observed up to ¼-inch thick in the upper 2 to 3 feet of the subsurface profile. Topsoil was generally comprised of dark brown, silty- to clayey-sands with non-plastic to low plastic fines, and observed to contain few to little gravel, cobbles, and boulders in the south and northeast portions of the TSF and potential borrow areas.
- **QUATERNARY DEPOSITS:** These deposits include unconsolidated sediments deposited by water (alluvium) and accumulated material on exposed slopes (colluvium). Based on the previously-referenced mapped geology, these units are estimated to be Quaternary-age deposits. These materials were encountered across the site consisting of variable sands, gravels, clays, and silts with thicknesses ranging from ground surface to 25 feet bgs. Generally, the upper portion of the deposit was described as fine-grained soils classified as lean and fat clay with varying amounts of sand and gravel, which were underlain by more coarse-grained soils classified as clayey- to silty-sand, clayey- to silty-gravel, and poorly- to well-graded sand and gravel.
- **OLDER DEPOSITS:** These deposits include Miocene-age lacustrine, alluvial, beach, and sandstone deposits described as:
  - **LACUSTRINE DEPOSITS:** Underlying the Quaternary Deposits, Lacustrine deposits were encountered across a majority of the site and primarily classified as lean- to high-plasticity clay with varying sand content. Abundant evaporites were often found in the upper three (3) feet of the deposit and were occasionally observed throughout the formation. As previously discussed, these deposits were not identified on the referenced surface geologic map; however, based on similar units in the region, these units are estimated to be Miocene-age deposits.
  - **ALLUVIUM AND BEACH SAND DEPOSITS:** Discontinuous alluvium and beach sand deposits were observed within the lacustrine clay deposits generally consisting of poorly-graded sand and silty sand.

Due to the location of these deposits within the lacustrine clays, these deposits were estimated to be Miocene-age deposits.

- **ARKOSIC SANDSTONE:** Part of the Grassy Mountain Formation was encountered generally along the higher elevations with the valley the TSF is situated and was identified in Borehole BH-10 at a depth of 10 feet bgs and in Test Pits TP-13, 14, 16, 20, 26, 27, 30, and 40 at depths ranging between 2.5 feet 12 feet bgs. Arkosic sandstone generally consisted of silty sand to fine- to coarse-grained sands and mapped as mid-Miocene in age (Ferns et al, 1993).
- **BASALT:** Upper Miocene olivine basalt flows were observed in the geotechnical coreholes advanced for the proposed Basalt Borrow Quarry (Golder 2019a) and is generally encountered in the hills east of the project area (Ferns et al, 1993).

4.2.1 Subsurface Water Conditions

No subsurface water was encountered during the field explorations to the maximum depth of the boreholes of approximately 120 feet bgs. In the *Groundwater Characterization Data Report*, prepared by SPF Water Engineering, LLC (SPF), it was reported that the ground water depth beneath the southern portion of the TSF basin ranged between 155 feet at the BLM well located within the TSF footprint and 232 feet at the GW-3 well located just southwest of the TSF (SPF 2019).

Inferred ground water contours presented in the same report indicate ground water beneath the reclaim pond area may be as shallow as 55-feet; however, no ground water was encountered in Golder's borehole BH-05 which were drilled to maximum depth of 100 feet bgs.

Ground water depths in the TSF area will be refined after the installation of proposed ground water monitoring wells as presented in SPF's report. In addition, no springs were observed in the TSF or mine facility areas during the field investigation.

5.0 TAILINGS TESTING AND CONSOLIDATION MODELING

To support detailed design of the TSF, Golder conducted a geotechnical laboratory testing program on representative tailings samples. Using the test results, Golder performed consolidation and thin lift modeling to estimate water seepage rates from the tailings mass and ultimate settled dry density and beach slope angles relationships of the TSF. Detailed discussion of the laboratory testing program and analyses are presented in Appendix D.

Estimated water seepage rates from the thin lift and consolidation modeling were used in preparation of the TSF water balance discussed in Section 6.8. Settled dry density and beach slope angles estimated in the consolidation modeling were used in estimating the stage-storage capacity relationship and stage expansion design discussed in Section 6.0.

5.1 Sample Preparation

Metallurgical testing to support the project was performed by SGS Canada Inc. (SGS) in 2018 (SGS 2018). Test specimens were prepared from residual head samples to represent a mixture of the main lithologies that comprise the bulk of the ore domains that are expected to be disposed of in the TSF.

During sample preparation, SRK Consulting (US), Inc. (SRK) conducted geochemical testing on the test specimens to determine the minimum required lime additional and blending required to produce tailings that are

net neutralizing based on the criteria specified in the OAR 340-043-0130 (2) guideline. Based on this evaluation, lime rates required to produce a net neutralizing potential (NNP) greater than 20 kg $CaCO_3$/t were determined for the dominate ore domain Mixed Lithology (ML), (SRK 2019).

Prior to Golder receiving tailings samples from SGS in Vancouver, British Columbia, Canada, SGS blended two Mixed Lithology tailings samples (GMTC-1 and GMTC-2) with 15.9 g/kg of hydrated lime.

Representative, lime treated, tailings samples were then shipped to Golder's Denver, Colorado geotechnical laboratory for testing. Detailed discussions on the laboratory classification, consolidation properties and results of the consolidation and thin lift modelling are included in Appendix D.

As specified by Ausenco Engineering Canada Inc. (Ausenco), the estimated solids concentration of the tailings slurry during transport and deposition will be 46 percent solids, by weight (w/w), (Ausenco 2018). The samples received by Golder contained slightly higher water contents, therefore, prior to any testing, Golder adjusted the slurry concentrations to 46 percent solids (w/w).

5.2 Tailings Testing

Laboratory testing performed on GMTC-1 and GMTC-2 samples was conducted in two phases. The Phase 1 testing program was conducted to determine classification properties, settled density, compressibility and permeability characteristics and to evaluate the potential for tailings to segregate. The Phase 1 testing included:

- Particle size distribution (PSD) – ASTM D 422 (historic)
- Atterberg limits – ASTM D4318
- Specific gravity – ASTM D854
- Settling column testing – Golder procedure
- Slurry consolidation testing – Golder procedure

The Phase 2 testing was conducted to determine parameters required for the thin-lift deposition modeling, and to determine beach angles and the segregation potential during the deposition process. The Phase 1 test results indicated that the GMTC-1 and GMTC-2 specimens have very similar geotechnical properties. Therefore, the GMTC-1 and GMTC-2 samples were composited into a single specimen (GMTC Composite). The Phase 2 testing included:

- Soil water characteristic curves (SWCC) determination – ASTM D 6836
- Shrinkage curve – Golder procedure
- Flume test – Golder procedure

Detailed descriptions of the testing program and results are presented in Appendix D.

5.3 Consolidation and Thin Lift Model

5.3.1 Consolidation Model

Consolidation modeling was performed by Golder using CONDES (Yao and Znidarcic 1997) and FSConsol (GWP 2014) model codes. CONDES is used to estimate time-dependent void ratio distribution and later thickness. FSConsol is used to estimate pore pressure distribution and void ration profiles as a function of time. A

detailed discussion of the consolidation model, inputs, and assumptions is presented in Appendix D. The following table present the estimated settled dry density per stage of operation:

Table 8: Average Dry Density Estimates

Stage	Top of Tailings Elevation (ft)	Model Column Height (ft)	Average Dry Density (pcf)	
			FSConsol	CONDES
1	3,592	46	80.62	81.0 – 82.2
2	3,605	60	81.98	79.4 – 80.4
3	3,617	>63	>82.26	79.8 – 80.8

Based on the dry density estimates above, Golder selected an average settled dry density of 80 pcf for use in estimating the stage-storage relationship for the TSF.

Additionally, the consolidation model estimated the amount of seepage water reporting to both the supernatant pool and underdrain collection system during active deposition and consolidation. Approximately 50 percent or more of the consolidation water (interstitial) is expected to be intercepted by the underdrain system at the beginning of impoundment filling. As the tailings cover the TSF basin drainage layer, the amount of water conveyed by the underdrain collection system is expected to decrease to approximately 30 to 40 percent of the total consolidation water (interstitial) with the potential for further reduction as the tailings height in the impoundment increases.

5.3.2 Thin Lift Model

Due to the arid environment, tailings surface area, and relatively low tailings deposition rate into the TSF, Golder performed a thin-lift evaluation to determine if additional water loss can be expected beyond those estimated in the consolidation models.

Thin-lift deposition assumes that the tailings are deposited in a controlled manner allowing for the fresh tailings to desiccate in a climate characterized by relatively high net evaporation losses. As the tailings' densities increase, a large amount of water from the porous matrix is lost to the atmosphere. Consequently, water inflows to the supernatant pool are significantly reduced as compared to conventional deposition practices or in areas where net evaporation losses are lower.

To evaluate impacts of the seasonal effects on tailings deposition, the thin-lift model needs to account for the continuous deposition (tailings accretion) and the tailings interaction with the atmosphere. The thin-lift accretion model used in this study allows for the interaction of the deposited tailings with the atmosphere. The accretion model geometry is updated in daily increments and is accompanied with adjustments of the SWCC determined from laboratory testing discussed in Section 5.2. The outputs from the accretion model include evaporation and drainage losses reported in daily increments. The simplified and the accretion models were developed for two case scenarios:

- Case 1 – assume that all tailings water entering the TSF is initially contained within the soil matrix.
- Case 2 – assume that a portion of the tailings discharge water is lost during the sedimentation process and reports directly to the tailings pool. Consequently, the initial amount of porous water, at the onset of the thin-

lift modeling process, is reduced by the estimated initial bleed. The initial bleed estimates used for the thin-lift analyses were selected based on the settling column test results.

To estimate the minimum TSF area required for thin-lift deposition, a simplified model based on net evaporation requirements was utilized. Based on the assumption that all water (in excess of the amount contained in the pores of a fully saturated tailings deposit) is expelled by evaporation until reaching tailings' shrinkage limit, the minimum required TSF area is estimated using the average annual net evaporation rate presented in Section 3.2. The simplified thin-lift deposition model results are summarized in the following Table:

Table 9: Minimum TSF Area for Thin-Lift Management

Scenario	Production Rate (t/day)	Solids Volume Rate (yd^3/day)	Evaporation Demand (yd^3/day)	Minimum TSF Management Area (acre)	Dry Density[1] (pcf)
Case 1	680	307	635	49	81.2
Case 2	680	307	322	25	81.2

The simplified thin-lift model predictions for underdrain drainage rates presented in Table 10 are based on the design annual tailings deposition rate and the average annual net evaporation. These rates are annual average flow rates that can be expected from the TSF underdrain collection system reporting the TSF reclaim pond. Immediate or season fluctuations can vary between 2 gallons per minute (gpm) to 99 gpm with an overall average rate of 21 gpm over the modeled deposition period (~15 years).

Table 10: Underdrain Drainage Rates

Year	Case 2 – Drainage Rate (gpm)		
	Minimum	Maximum	Average
1	2.3	99.3	13.5
2	3.3	30.3	12.5
3	5.1	72.1	20.7
4	4.3	52.4	16.6
5	4.9	73.5	19.5
6	5.7	46.3	18.3
7	6.5	57.8	24.6
8	7.9	47.0	20.3
9	8.0	91.4	25.0
10	8.6	58.4	21.7
11	9.1	65.7	26.4
12	10.9	58.8	25.3
13	12.6	64.7	27.0
14	13.7	63.1	28.8
Average	16	21	26

6.0 TSF DESIGN

The TSF will be a continuous geomembrane-lined facility with continuous primary and secondary containment as discussed in Section 6.3. Process solution will be managed with two independent underdrain and supernatant pool decant return water systems as discussed in Section 6.4. Anticipated maximum flow rates for each system have been estimated using a monthly time-step water balance discussed in Section 6.8. The supernatant pool will be maintained away from the embankment on the eastern side of the facility as shown on the Design Drawings.

The TSF has been designed as a zero-discharge facility capable of storing the 500-year, 24-hour storm and an allowance for wave action and to meet the minimum requirements for a Low Hazard Dam as discussed in Section 2.1. Permanent and temporary stormwater diversions will collect and divert a majority of the stormwater runoff around the facility to a natural drainage on the north side of the TSF.

6.1 Site Layout

The TSF will be located in the broad valley immediately east of the Grassy Mountain mine portal and process facilities. Native slopes within the valley range between approximately one and 20 percent. Embankments will be required on the north and west sides to impound tailings. The main North embankment will span the width of the valley while the smaller West embankment will be used to bridge saddles along the western ridge. The TSF will cover an approximate area of about 108 acres and has been designed to accommodate 3.67M tons of tailings at a settled dry density of 80 pcf. An overall layout of the site is presented on the Design Drawings.

6.2 Embankments and Storage Capacity

A shown on the Design Drawings, embankments will be constructed to impound the tailings on the north and west sides. The main embankment will cross the natural drainage to the north, and small secondary embankments will be constructed across saddles along the western ridge. The embankments with have a maximum overall upstream slope of flatter than 3H:1V (with staged benching) with a downstream slope of 2.5H:1V. The north and West embankment will have a maximum height of 84-feet and 30-feet, respectively. The crest width of the North embankment will be 50-feet, with a 30-foot wide crest for the smaller West embankment. To provide geotechnical stability for operation and long-term closure of the main embankment, a small downstream buttress will be constructed during Stages 2 and 3 at the tallest section to provide additional resisting mass at the downstream toe. A detailed discussion of the stability analyses is presented in Section 8.0.

The upstream slope of the embankments will be geomembrane-lined to maintain the continuous lining within the facility. A discussion on the lining system is presented in Section 6.3.

The TSF will be constructed in a maximum three stages (Stages 1 through 3) utilizing downstream construction techniques as shown on the Design Drawings. Embankment fill construction materials will be soil or rock fill sourced from on-site borrow areas as discussed in Section 9.0

Stages 1 and 2 will each provide between approximately 1.0M and 2.07M dry tons of tailings storage for between 5 and 9.3 years of operating capacity per stage, with a smaller Stage 3 adding an additional 1.6M tons of capacity equaling an additional 6.5 years of operating capacity. The stage-capacity relationship is based on an average tailings deposition rate of 680 dry short tons per day. The storage volume of the TSF has been calculated based on a settled dry density weight of 80 pcf estimated in the tailings consolidation modeling discussed in Section 5.3. A summary of the height-area-volume relationship for the TSF is presented in Table 11 below and is graphically presented on the Design Drawings.

Table 11: Stage Capacity Relationship Summary

Stage	Main Embankment Crest Elevation (ft)	Maximum Tailings Surface Elevation (ft)	Maximum Tailings Surface Area (acres)	Stage Storage Capacity (M tons)	Cumulative Storage Capacity (M tons)
1	Varies (Min. 3595)	3593	37.0	1.00	1.00
2	Varies (Min. 3609)	3607	59.5	1.07	2.07
3	Varies (Min. 3622)	3620	83.0	1.60	3.67

6.3 Lining System

The TSF impoundment area and upstream embankment slopes will be continuously lined with both primary and secondary lining systems to provide dual containment of process solution. The containment system is consistent throughout the facility, but the drainage system above the primary geomembrane liner will vary depending on the location as described in Section 6.4 and presented on the Design Drawings.

To meet the minimum guidelines of OAR 340-043-0130 (3), the secondary containment layer of the TSF dual containment system will be an enhanced geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 1×10^{-10} cm/sec. The enhanced GCL provides a slower conductivity than a compacted soil with a thickness of 36 inches and permeability of 1×10^{-7} cm/sec. Hydraulic conductivity comparison calculations for the enhanced GCL are presented in Appendix E.

Within the impoundment, the lining system will consist of (from bottom to top) a 6 to 12-inch thick native prepared subgrade, a 300-mil thick enhanced GCL, 80-mil high density polyethylene (HDPE) geomembrane liner, an 18-inch-thick drainage layer, and a 6 inch thick filter layer. Perforated piping will be located within the drainage layer to promote drainage of the tailings. The same lining system will be used for the waste rock dump (WRD).

On the upstream embankment slopes, the lining system will be the same, but without the overlying piping, drainage layer, and filter layer. Placement of a drainage layer above the geomembrane on the upstream embankment slopes will be impractical due to the relatively steep side slopes and erosion potential of a cover from tailings deposition. Additionally, the TSF underdrain channel, WRD underdrain channel, and tailings delivery channel from the process area will utilize the same lining system as the TSF embankment slopes.

6.4 Underdrain Collection System

As deposition continues, the tailings will consolidate due to increased vertical pressure as the tailings surface elevation increases. In addition to water bleeding upward into the tailings surface, water will also be released from the tailings downward. To reduce hydraulic head on the geomembrane liner and promote drainage of the tailings, the water released downward will be captured in an underdrain collection piping system installed above the geomembrane liner within the drainage layer in the TSF basin as shown on the Design Drawings.

This network of perforated pipes will capture and convey underflow via gravity to the reclaim pond located downstream of the main embankment as shown on the Design Drawings. The underdrain collection system will consist of variable diameter and pipe types depending on their location and vertical pressure. In general, primary collection pipes will be perforated 6-inch diameter HDPE DR17, secondary collection pipes will be perforated 6-inch diameter double-wall corrugated polyethylene (CPE), and tertiary collections pipes will be 4-inch diameter double-wall CPE. Tertiary collection pipes will be installed with greater density adjacent to the North embankment and beneath the supernatant pool.

Prior to passing below the North embankment, the perforated CPE primary collection pipes will transition to solid wall HDPE DR17 underdrain outlet pipes. The underdrain outlet pipes will penetrate through the geomembrane liner at the upstream toe of the North embankment and pass under the dam where they will convey all underdrain flows from the TSF and WRD to the reclaim pond.

Within the TSF, a total of four primary collection pipes exit the basin and report to the reclaim pond. The four primary collection pipes each independently collect or convey flows from the following areas:

- Within the TSF basin
- Below the supernatant pool
- Upstream toe of the North embankment
- WRD containment pad

Independently, each of the primary collection and underdrain outlet pipes has a full flow capacity of 249 gpm at the minimum one percent post-settlement grade. Golder used a maximum design flow rate of 99 gpm to account for potential pipe deformation and long-term scale build-up. Based the tailings consolidation modeling discussed in Section 5.0, the maximum anticipated steady-state seepage rate from the tailings mass is estimated to be about 21 gpm during operation, significantly lower than the design flow rate for each pipe. The peak underdrain flow rate estimated from the tailings consolidation modeling discussed in Section 5.0 is 99 gpm, which is lower than the design full flow rate for each pipe.

Since the primary collection pipes are perforated to the upstream toe of the North embankment, each pipe provides redundant capacity to the others in the event that one or more become blocked. Hydraulic sizing of the primary collection and underdrain outlets pipes is presented in Appendix H. As embankment construction and tailings deposition progresses, the primary underdrain outlets pipes will experience grade flattening due to foundation settlement of the embankments. The primary underdrain pipes are designed to accommodate the maximum design flow rate at a post-settlement grade of one percent. Foundation settlement is discussed in further detail in Section 8.2 and presented in Appendix C.

Where the underdrain outlets pipes pass beneath the embankment, they are located above a geomembrane-lined channel that provides secondary containment. Within this underdrain outlet channel, the outlet pipes are encased in reinforced concrete to protect against deformation and maintain the integrity of the pipes. The reinforced concrete encasement terminates beyond the ultimate Stage 3 downstream toe. Design of the reinforced concrete encasement is presented in Appendix H.

The underdrain outlet pipes will continue to the reclaim pond within the geomembrane lined underdrain channel. Prior to discharging into the reclaim pond, each underdrain pipe will enter a flume where flows can be measured and monitored. Additionally, upstream of the monitoring flumes, 6-inch diameter knife gate valves will be installed that can be used to restrict flow or closed in case of emergency.

6.4.1 Reclaim Pond

The reclaim pond will have double containment geomembrane liners and a leakage collection and recovery system (LCRS). The pond lining system, as shown on the Design Drawings, will consist of (from bottom to top):

- A compacted subgrade
- A minimum 6-inch thick soil bedding (Prepared Subgrade), either compacted in-place or from the identified borrow sources within the TSF basin
- A single secondary 60 mil HDPE single sided textured geomembrane liner, textured side up
- A 2-foot deep by 15-foot square leak detection sump with a 10-inch diameter HDPE DR17 leak detection riser extending up the side slope of the pond – the leak detection sump is filled with clean, free draining, gravel (Drain Gravel)

- An HDPE geonet liner above the secondary geomembrane
- A single primary 80 mil HDPE single sided textured geomembrane liner, textured side up

The reclaim pond is sized to contain, at a minimum, the total volume of water generated during the following:

- Gravity underdrain flow from the TSF for the duration of a 48-hour power outage
- 500-year, 24-hour design storm event falling on the surface of the reclaim pond
- Volume of water within the entire length of the reclaim water pipe between the reclaim pond and the mill

The reclaim pond has a total storage capacity of 146,000 gallons to the underdrain channel invert elevation which is 3.6 feet below the pond crest. The total storage capacity of the reclaim pond is 215,000 gallons while maintaining two feet of freeboard beneath the pond crest. In this scenario, water in the pond would also back up into a portion of the lined underdrain channel for additional emergency storage above the minimum required. Pond storage requirement calculations are presented in Appendix F.

6.5 Reclaim and Supernatant Return Water Pipelines

Water from the reclaim pond will be pumped back to the mill for reuse in the process circuit. The reclaim water pipe will be constructed beyond the toe of the Stage 3 embankment as shown on the Design Drawings. The reclaim pipe will be a dual containment pipe consisting of a 4-inch HDPE DR17 carrier pipe inside an 8-inch HDPE DR17 containment pipe. The reclaim pipe will be located along the light vehicle access road at the toe of the Stage 3 North embankment and continue to the northeast corner of the TSF. Hydraulic design of the reclaim water piping and pumping system is being performed by other parties and is not included in this design.

Near the crest of the TSF for each stage, the 8-inch diameter containment pipe will terminate above the TSF basin geomembrane liner and run adjacent to the tailings distribution line along the eastern impoundment access road as shown on the Design Drawings.

Water from the supernatant pool is evacuated utilizing a submersible or floating pumping system. Return water is pumped through a 4-inch diameter HDPE DR17 pipe from the supernatant pool to the eastern impoundment access roads as shown on the Design Drawings. Hydraulic design of the return water piping and pumping system is being performed by other parties and is not included in this design.

Along the eastern impoundment access road near the supernatant pool, the 4-inch diameter HDPE DR17 reclaim water and supernatant return water pipes will combined into single 4-inch diameter by 8-inch diameter HDPE DR17 dual containment pipe installed parallel to the tailings delivery pipe located along the access road from the mill to the TSF as shown on the Design Drawings.

At all times, process fluid pipelines will be located above secondary containment that consists of either geomembrane liners or concrete containment structures.

6.6 Tailings Distribution System

Tailings will be delivered to the TSF from the mill via the 6-inch diameter DR17 HDPE tailings delivery pipe. The tailings delivery pipe will be located within a HDPE-lined containment channel in the alignment shown on the Design Drawings. The tailings delivery pipe will route along the TSF perimeter access road where tailings will be deposited via discharge points called spigots. Spigots are 1-inch diameter drop pipes with manual control valves and are spaced at regular intervals to allow for tailings deposition as needed to maintain the appropriate

supernatant pool configuration and location. Hydraulic design of the tailings delivery pumping, piping, and discharge spigots is being performed by other parties and is not included in this design.

As the tailings are deposited and the solids settle out of the slurry, free water will accumulate at the low point on the tailings surface. This is referred to as the supernatant pool. The supernatant pool will be maintained on the eastern side of the facility away from the main embankments.

Water from the supernatant pool will be extracted via pumping and delivered back to the mill for reuse through a return water pipe. The supernatant pool is designed to fluctuate seasonally depending on climatological conditions. The supernatant pool will have an average operating depth of 5-feet that is controlled by the pumping system and is adequately deep enough to prevent drawing tailings solids from the pool bottom.

6.7 Leak Detection

6.7.1 TSF Basin and WRD

Independent leak detection and leakage collection recovery systems (LCRS) will be installed to monitor and manage potential leakage between primary and secondary containment layers within the TSF basin, underdrain outlet pipes and channel, reclaim pond, and WRD containment pad.

Below the primary geomembrane liner of the TSF and WRD, perforated 2-inch diameter schedule 80 polyvinyl chloride (PVC) piping will be installed immediately below the primary collection pipes and primary geomembrane as shown on the Design Drawings to monitor potential leak where concentrated flows are expected.

As perforated leak detection piping continues downgradient toward the downstream toe of the North embankment, the pipes transition to solid wall and additional perforated piping will start at each transition as shown on the Design Drawings. This provides leakage isolation to different areas within the TSF and WRD.

Each leak detection pipe will report to an independent leak detection riser near the reclaim pond and the WRD containment berm as shown on the Design Drawings. The leak detection risers will provide access for both monitoring of leakage flows and allow for the installation of small submersible pumps to evacuate any observed flows.

6.7.2 TSF Reclaim Pond

The reclaim pond is designed to include an independent LCRS between the primary 80 mil HDPE and secondary 60 mil HDPE geomembrane liners. The LCRS includes a geonet drainage layer and a LCRS collection sump and riser pipe. The riser consists of a 10-inch diameter HDPE DR17 pipe that extends from the LCRS sump along the slope of the reclaim pond to the pond crest for leakage monitoring and fluid evacuation as shown on the Design Drawings. The LCRS collection sump provides a storage capacity of 620 gallons within the Drainage Gravel, assuming a porosity of 0.3.

6.8 Water Balance

A deterministic spreadsheet-based monthly time step water balance was developed for each stage based on the proposed tailings deposition rate of 680 dry short tons per day. The inflows to the system include precipitation above lined areas, surface water run-on from up-gradient catchment areas below the permanent and temporary stormwater diversions, and water being deposited within the tailings slurry at a rate of 133 gpm.

Losses include evaporation from the tailings beach area, evaporation from the supernatant pool area, and interstitial water permanently stored within the tailings mass. Water will be pumped from the supernatant pool to

the mill for make-up water at a rate that maintains the minimum pool operating level. The underdrain flow rate from the collection system will drain into the reclaim pond and will be pumped to the mill to use as make-up water.

The average reclaim rate from the supernatant pool to the mill is 49 gpm for Stages 1 through 3 and varies between zero during summer months (July and August) and 106 gpm during winter months (December and January). Make-up water required was defined as the rate of evaporation from the tailings beach and supernatant pool (outflow) plus interstitial water loss (outflow) minus precipitation (inflow). The make-up water rate is less than or equal to the rate that water is reporting to the TSF in the tailings slurry. The average make-up water rate is 69 gpm for Stages 1 through 3 and varies between 133 gpm during summer months (July and August) to 1 gpm during winter months (December and January).

The water balance spreadsheet and supporting discussions are presented in Appendix F.

6.8.1 Freeboard

For tailings storage facilities (non-water impounding structures), freeboard is generally defined separately for the area with free water in the supernatant pool and dry tailings beach areas. The minimum freeboard definition presented in OAR 690-020-0042 is generally intended for water storage reservoirs where water is in contact with the embankments. However, for tailings storage facilities in arid climates, tailings deposition and reclaim water are managed to maintain specific supernatant pool geometries, similar to the TSF, as shown on the Design Drawings.

The TSF is designed to provide a minimum freeboard depth of five feet above the maximum operating supernatant pool water surface where it is impounded against the geomembrane-lined southern hillside. This freeboard will provide suitable dam storage height above the maximum water surface elevation to contain wave action above the 500-year, 24-hour storm event falling on the TSF impoundment and the up-gradient catchment areas below the permanent and temporary diversion channels. Wave run-up calculations were developed assuming the TSF had experienced a 500-year, 24-hour storm with waves generated from sustained wind loading using the average wind speed in the prevailing wind direction. Supernatant pool storage and wave run-up calculations have been included in Appendix G.

Tailings beach areas are defined as areas where the impoundment surface is free of pooled water and only comprised of tailings. The TSF is designed so that only tailings will impound against the embankments. In the tailings beach areas, a minimum freeboard of two feet will be provided from the highest beach elevation to the lowest dam crest elevation.

In addition to the above freeboard dimensions, the TSF is designed such that the lowest tailings surface and pool elevation is away from the perimeter embankments. This results in the overall tailings surface sloping away from the perimeter embankments southeast toward the supernatant pool. With appropriate fluid management, overtopping or freeboard encroachment is not expected. Therefore, an emergency spillway has not been included in the design.

6.9 Hydrologic Assessment and Stormwater Control

6.9.1 Synthetic Storm Events

The National Oceanic and Atmospheric Administration (NOAA) Atlas 2 was used to develop the probabilistic-based synthetic storm events for the calculation of the peak flows. Atlas 2, Volume 10 (Oregon) contains precipitation frequency estimates for the western United States (NOAA 1973). Atlas 2 generates the precipitation frequency estimates based on analysis of previously recorded weather patterns.

A frequency analysis was conducted to determine annual extreme daily rainfall depths for the 1 in 25-year, 24-hour and 1 in 500-year, 24-hour storm events that were not presented in the NOAA Atlas 2. Thirty-three years of maximum daily annual precipitation data from 1986 through 2018 was obtained from the Owyhee Ridge Oregon Remotely Automated Weather Station (RAWS) located approximately 8 miles southeast of the project site. Table 12 presents the precipitation data for the storms used in this analysis. Detailed synthetic storm development is presented in Appendix G.

Table 12: 24-Hour Storm Event Precipitation Depths

Recurrence Interval (years)	Precipitation Depth (in)	
	NOAA Atlas 2	Lognormal Analysis
2	0.99	-
25	Not Available	1.87
100	2.28	-
500	Not Available	3.03

6.9.2 Hydrologic Analysis

Peak stormwater runoff flows generated from the 25-year, 100-year, and 500-year, 24-hour storm events, presented in Table 12, were calculated using methodologies published in Technical Release 55 (TR-55) by the USDA NRCS (USDA 2011) and HEC-HMS Version 4.1, utilizing the SCS Rainfall Distribution Method (Type II), by the USACE (HEC 2015). Malheur County, Oregon is located in the western United States where there are distinct dry and wet seasons and the Type II SCS Rainfall Distribution Method is most applicable. Type II rainfall distribution was used for the hydrologic models presented in this report.

Soil characteristic curve numbers (CNs) used to predict stormwater run-off potential were determined using the WIN TR-55 software for each hydrologic basin using a weighted average of natural soil, vegetation, and ground conditions. Using the NRCS TR-55 Method and Golder's knowledge of the site conditions, CNs were assigned for the revegetated closure cover (placed above the TSF during closure), undisturbed existing ground, and newly graded areas.

Times of Concentration values (Tc) were calculated for each hydrologic catchment area using WIN TR-55 by inputting the longest flow path in each basin and the calculated composite CNs discussed in Section 3.2 (USDA 2011).

Temporary and permanent stormwater diversion channels were designed using the Manning's Equation via Bentley's hydraulic modeling software FlowMaster (FlowMaster 2009). Manning's roughness coefficients were selected for multiple channel lining systems based on Golder's experience and review of various technical publications.

Golder developed two hydrologic basin models for the Grassy Mountain TSF:

- Permanent Stormwater Diversion: The permanent stormwater diversion channels will collect stormwater runoff generated up-gradient of the TSF and divert the collected water around the TSF to existing natural

drainages. This scenario includes all channels that will remain in place during closure along with the drainage swale that will be constructed across the top of the reclaimed surface of the TSF during closure.

- Temporary Stormwater Diversion: During operation, temporary diversion channels will be constructed to divert stormwater falling downgradient of the permanent diversion channels around the TSF. These channels will be constructed during each stage.

The hydrologic assessment is presented in detail in Appendix G.

6.9.3 Stormwater Channel Hydraulic Design

Permanent and temporary stormwater diversion channels are designed to convey surface water run-off from up gradient catchment areas around the TSF to decrease the amount of run-on water that needs to be managed within the TSF. The stormwater channels are sized to contain the following:

- Permanent Channels: 100-year, 24-hour storm event with 9 inches of freeboard, or 500-year, 24-hour storm event without overtopping.
- Temporary Channels: 25-year, 24-hour storm event with 9 inches of freeboard, or 100-year, 24-hour storm event without overtopping.

A detailed summary of the hydraulic calculations is presented in Appendix G.

The initial upgradient portions of each permanent diversion channel will have a V-ditch shape with 2.5H:1V side slopes with channel grades along the flowline no steeper than one percent. The total depth of the V-ditch channels will range between 1.75 feet and 2.5 feet. As contributing areas and flow rates increase, the channel sections will transition to 10-foot wide trapezoidal channels with 2.5H:1V side slopes. The trapezoidal channel will have slopes ranging between one and five percent, with channel depths ranging between 1.75 feet and 4 feet. Typical channel cross sections are presented on the Design Drawings.

Channel velocities were reviewed during hydraulic design of the stormwater diversion channels to determine appropriate channel lining systems for erosion protection. In most areas, unless noted on the Design Drawings, the permanent diversion channels will either unlined or riprap-lined with variable stone sizes. In areas where channel velocities exceeded the reliability limits of a natural soil lining, riprap lining systems were used. Detailed discussion and design of the channel erosion protection are presented in Appendix G and detailed on the Design Drawings.

Dissipation aprons have been designed at two locations around the TSF where run-off is being discharged into existing natural drainages to encourage a smooth transition into the existing drainage and minimize erosion to the natural slopes. Detailed discussion and design of these structures are presented in Appendix G. Locations of the outlet dissipation aprons are shown on the Design Drawings.

7.0 WASTE ROCK DUMP FACILITY

Waste rock materials generated during mining will be stockpiled in a waste rock dump facility (WRD) near the TSF for use as either cement rock backfill to support the underground mining operation or as an operational layer above the tailings surface for closure as discussed in Section 12.0. The WRD is designed for an estimated storage capacity of 200,000 cubic yards. Geotechnical stability of the WRD is discussed in Section 0.

Waste rock will be stored above a geomembrane lined pad located south of the TSF as shown on the Design Drawings. The WRD pad will utilize the same lining system as the TSF basin as discussed in Section 6.3. The WRD pad is designed to capture and convey any precipitation infiltrating the waste rock to the TSF reclaim pond for independent monitoring and management. Generally, the WRD pad is slopes from south to north at an approximate one percent grade.

An underdrain collection system will be installed above the geomembrane liner similar to the TSF underdrain collection system (perforated piping within a drainage layer above the geomembrane liner). The collection system will consist of a series of perforated pipes installed within the drainage layer above the geomembrane liner. A single 6-inch diameter perforated double wall CPE primary collection pipe will capture flows from 4-inch diameter perforated double wall CPE pipes within the drainage layer.

Prior to exiting the WRD, the perforated 6-inch CPE primary collection pipe will transition to a solid-wall dual containment 6-inch diameter HDPE DR17 by 10-inch diameter HDPE DR17 pipe. The dual containment underdrain outlet pipe will penetrate through the lined perimeter berm of the WRD and travel above ground between the WRD and the edge of the TSF Stage 1 geomembrane liner limits.

At the Stage 1 TSF basin liner limits, the 10-inch diameter containment pipe will terminate, and the 6-inch diameter carrier pipe will continue to the TSF reclaim pond above the TSF basin geomembrane liner. The WRD underdrain collection system is presented in detail on the Design Drawings.

8.0 GEOTECHNICAL ANALYSES

8.1 TSF Embankment Slope Stability

Stability analyses were completed for cross-sections of the North and West TSF embankments and are presented in detail in Appendix C. The analyses were performed using the 2-D limit equilibrium methods provided by the software package Slide 2018 (Rocscience 2018). The analyzed cross-sections were evaluated for both static and pseudo-static loading conditions using the Morgenstern-Price Method of slices to calculate the FOS against failure along the critical surface (i.e., the failure surface with the minimum calculated FOS) that was identified through an automated search algorithm.

Based on the design criteria presented in Table 2, a minimum factor of safety of 1.5 is required for stability of the TSF embankments under static loading and a factor of safety of 1.1 is required for pseudo-static loading conditions. Both effective stress analysis (drained conditions) and total stress analysis (undrained conditions) were analyzed using the material properties summarized in Appendix C**.**

For pseudo-static stability analysis, a horizontal seismic coefficient (k) of half the design PGA was used (Hynes and Franklin 1984, and Seed 1982). For the TSF site, the seismic coefficient used is 0.075g, corresponding to half of the median MCE design seismic event.

Cross sections include the maximum embankment and dump heights of each facility, with additional sections developed at the North embankment to refine the need for a downstream buttress. Figure 1 in Appendix C presents the location of the cross sections analyzed for geotechnical stability assessment of the TSF embankments. Section A is within the North embankment and Section D is within the West embankment.

Section A extends through the highest North embankment height of 84 feet. Section D extends through the highest West embankment height of 30 feet.

The controlling method analysis was determined to be the static effective stress condition for all stages of both the North and West embankment. All minimum calculated factors of safety for Stage 1 (with downstream slope of 2.5H:1V) were found to be higher than the minimum criterion for both static and pseudo-static analyses for Sections A and D.

To achieve geotechnical stability, a small downstream buttress will be constructed for Stage 2 and 3. Sections B and C were used to determine the extents of the downstream buttress for the controlling condition (static, effective stress). The downstream buttress will be 15 feet high by 30 feet wide and constructed at the downstream toe as shown on the Design Drawings.

Stability analysis results for the TSF embankments are presented in Table 13 for effective stress analyses and Table 14 for total stress analyses .

Table 13: Summary of Critical Stability Results of TSF Embankments for Effective Stress Analyses

Stage	Static FOS (Target design minimum is 1.5)				Pseudo-static FOS (k = 0.075 g) (Target design minimum is 1.1)			
	North Embankment			West Embankment	North Embankment			West Embankment
	Section A	Section B	Section C	Section D	Section A	Section B	Section C	Section D
1	1.5	1.7	1.6	1.9	1.2	-	-	1.4
2	1.5	1.6	1.6	1.7	1.2	-	-	1.3
3	1.5	1.5	1.5	1.5	1.2	-	-	1.2

Table 14: Summary of Critical Stability Results of TSF Embankments for Total Stress Analyses

Stage	Static FOS (Target design minimum is 1.5)				Pseudo-static FOS (k = 0.075 g) (Target design minimum is 1.1)			
	North Embankment			West Embankment	North Embankment			West Embankment
	Section A	Section B	Section C	Section D	Section A	Section B	Section C	Section D
1	2.1	-	-	-	1.7	-	-	-
2	1.8	-	-	-	1.3	-	-	-
3	1.5	-	-	-	1.1	-	-	-

8.2 TSF Embankment Foundation Settlement

Settlement analysis was performed using Settle3D 4.0 (Rocscience 2019) software for a 150-foot thick clay layer with material properties summarized in Appendix C. The clay layer has been observed in boreholes down to the depth of about 120 feet below the North embankment as presented in Appendix A.

The actual thickness of the clay layer is not known. However, since the induced stresses, and consequently the settlements within the foundation caused by placement of the embankment fill material decrease with depth and the soil at depth is much stiffer, a thickness of 150 feet for compressible clay layer is considered to be sufficient for settlement estimations. Both elastic compression and primary consolidation were included in the settlement analysis presented in Appendix C. Settlements were estimated along the underdrain channel and pipe corridor (with maximum embankment height) of the North embankment of TSF.

A maximum settlement of about 3 feet was estimated under the crest of the embankment. Supporting figures and calculations are presented in Appendix C. To achieve the minimum underdrain pipe design grade of one percent, the underdrain piping will be installed below the North embankment at between 1.0 and 2.5 percent slopes. All calculated post-settlement grades meet the minimum required values for positive flow of the underdrain collection piping as discussed in Section 6.4.

8.3 TSF Embankment Crest Settlement

As staged construction progresses, primary settlements within the foundation and embankment will occur. Placement of subsequent construction fill lifts will be performed up to the final Stage 3 design crest elevation as shown on the Design Drawings. The consolidation of the foundation due to the additional lift at each stage of construction will take place after the immediate settlement and continue at a decreasing rate.

The minimum design freeboard of 2 feet from the maximum tailings surface to the dam crest will be large enough that long-term settlement of the embankment and foundation after tailings deposition is compete will not reduce the dam crest elevation such that it encroaches on the final tailings surface.

Upon completion of tailings deposition and during the active water management closure period, free water on the tailings surface will be evaporated and any settlement of the dam crest as a result of embankment and foundation settlement is expected to be less than settlement due to the foundation and tailings consolidation.

During long-term closure, once the tailings have consolidated and the closure cover installed, precipitation falling on the tailings surface will be routed through a closure spillway at the eastern abutment of the North embankment, as discussed Section 12.0. After installation of the closure cover, the impoundment surface and dam crest will be at the same relative elevation. The final closed TSF will not provide any water retention capacity above the closure cover.

8.4 WRD Stability Analysis

Stability analyses were completed for the WRD and are presented in detail in Appendix C. The analyses were performed using the 2-D limit equilibrium methods provided by the software package Slide 2018 (Rocscience 2018). Cross sections were evaluated for both static and pseudo-static loading conditions using the Morgenstern-Price Method of slices to calculate the FOS against failure along the critical surface identified through an automated search algorithm.

Based on the design criteria presented in Table 4, a minimum factor of safety of 1.5 is required for stability of the TSF embankments under static loading and a factor of safety of 1.1 is required for pseudo-static loading conditions.

The WRD is designed to remain in place during operation only. Due to the temporary nature of the WRD, geotechnical stability of the WRD was performed for static and pseudo-static conditions using an operational basis earthquake (OBE) with a return period of 475 years instead of the median MCE used for the TSF.

For pseudo-static stability analysis, a horizontal seismic coefficient (k) of half the design PGA was used (Hynes and Franklin 1984, and Seed 1982). For the WRD site, the seismic coefficient used is 0.04g, corresponding to half of the median 475-year return period.

The analyzed cross section (Section E) includes the maximum waste rock dump height of 35 feet. Figure 1 in Appendix C presents the location of the cross section analyzed for geotechnical stability assessment of the WRD.

To achieve stability of the WRD along the northern slope, the maximum height of the WRD is limited to 35 feet. Additionally, waste rock is required to be stacked against the geomembrane-lined perimeter containment berm with a maximum vertical separation of 2 feet from the crest of the berm to the toe waste rock dump slope as shown on the Design Drawings

Stability of the WRD should be reassessed if higher waste rock heights are to be constructed. Stability analysis results for the WRD are presented in Table 15 below.

Table 15: Summary of Critical Stability Analysis Results of WRD

Static FOS (Target design minimum is 1.5)		**Pseudo-static FOS (475-year, k = 0.04 g) (Target design minimum is 1.1)**	
Failure through Foundation	Waste Rock Slide over the Liner	Failure through Foundation	Waste Rock Slide over the Liner
1.8	1.6	1.5	1.3

9.0 CONSTRUCTION MATERIALS AND MONITORING

Detailed specifications for all construction materials required to construct the facilities discussed in this Report are presented in Appendix I.

The quality of the constructed facilities will be critical to the success of this project. Calico will assure that qualified personnel under the direction of an engineer registered in the State of Oregon will be on the site full-time during critical phases of construction. Their role will be to observe and/or provide quality assurance testing for topsoil stripping, subgrade preparation, basin/pad grading, fill placement, geomembrane bedding layer placement, geosynthetics installation, collection piping installation, drainage layer placement, filter fill placement, and piping installation. Recommendations provided by the Engineer of Record concerning suitability of construction materials, compaction, and liner construction will help expedite the project and help Calico ensure compliance with the technical specifications presented in Appendix I.

A Construction Quality Assurance (CQA) plan has been prepared to supplement and highlight the testing and verification requirements during construction outlined in the technical specification. The plan includes: type and

frequency of testing of materials during manufacturing and installation; guidelines on reporting and correcting deficiencies observed during construction or identified during materials testing; embankment material test fill procedures, daily field observation and material test documentation forms; and as-built documentation requirements for the completed project. The CQA plan for Appendix J.

Borrow material will be required for construction of the TSF embankments, TSF basin, WRD pad, containment systems, reclaim pond, and access roads. The following section presents general descriptions of each primary construction material used to construct the TSF embankments, TSF basin, and WRD pad.

9.1 Embankment Fill

Materials used as embankment fill are expected to vary in composition depending on their source but are expected to vary between blasted run-of-quarry rockfill compositions of poorly graded high quality angular rock containing few fine (passing the No. 200 screen) material (less than 20 percent) produced in the Basalt Borrow Quarry, and silty to clayey sand with varying amounts of gravel generated during grading operations within the TSF basin area.

Materials encountered in the Basalt Borrow Quarry may require ripping and/or blasting. Native foundation clay soils underlying the surficial alluvium within the TSF basin and blow the TSF embankments, described in Section 4.2, are not suitable for embankment fill construction.

Weathered arkosic sandstone is considered to be unsuitable for embankment as the material is generally brittle and erosive. If material meeting the requirements for embankment fill is used as fill beneath planned structures, screening may be required to remove over-sized material.

Technical specification for Embankment Fill construction material and placement methods are presented in Appendix I.

9.2 Grading Fill

General shape grading will be required within the TSF basin and WRD pad area to promote positive drainage to the designed low points of each facility. Within the TSF basin and in areas designated on the Design Drawings, excavations up to 9 feet and fills as high as 6 feet will be required. During Stage 2, an excavation of 13 feet will be required to construct the perimeter road between the North and West embankments along the northern portion of the facility.

During on-site grading operations, materials excavated will be used as fill to achieve the design grades. These native alluvial materials within the upper several feet are expected to be vary between high plasticity fine-grained soils to non-plastic coarse grained poorly graded sand with gravel. All native alluvial materials encountered during on-site basin grading operations may be used as Grading Fill.

Native foundation clay soils underlying the surficial alluvium within the TSF basin and blow the TSF embankments, described in Section 4.2, are not suitable for use as Grading Fill. If, during on-site grading operations, the underlying foundation clay soils are exposed, the exposed areas are to be graded to prevent water ponding. Within the TSF basin, Grading Fill will be placed over the foundation clay soils a minimum thickness of 12 inches.

Technical specification for Grading Fill construction material and placement methods are presented in Appendix I.

9.3 Prepared Subgrade

A smooth surface free of rocks greater than 1-inch diameter is required for placement of the geosynthetic lining systems. Native alluvial materials near surface within the TSF and WRD basin are suitable for use as Prepared Subgrade. In general, Prepared Subgrade will have a maximum particle size of 3-inches and may have a fines (No. 200 screen) content as high as 50 percent by weight, and a Plasticity Index less than or equal to 20.

In areas where native ground requires only smoothing and no fill placement, only surface preparation is required for geosynthetics placement. In areas where Grading Fill is placed to achieve the design grades, the upper surface will proof-rolled and areas not suitable for geosynthetics placement will be over excavated and native fill materials meeting the specifications for Prepared Subgrade will be placed to the design lines and grades.

Technical specification for Prepared Subgrade construction material and placement methods are presented in Appendix I.

9.4 Drainage Layer

The Drainage Layer above the geomembrane liner within the TSF basin and WRD pad are critical to the performance of the facilities. The Drainage Layer provides protection of the geomembrane liner from damage and promotes drainage of the tailings and waste rock stockpile. The Drainage Layer will be placed in a single 18-inch loose lift. The Drainage Layer will be uncompacted and placed using low ground pressure tracked equipment. After placement, the top surface of the Drainage Layer will be ripped or bladed to be free of ridges, mounds, or ponding areas.

The Drainage Layer material will be a processed material either from the Basalt Borrow Quarry or excavated during on-site grading operations. The Drainage Layer will have a maximum particle size of 3-inches and a maximum fines (No. 200 screen) content of 15 percent by weight, with a Plasticity Index less than or equal to 10. The Drainage Layer will have a hydraulic conductivity faster than 5×10^{-3} cm/sec when measured in a laboratory rigid wall permeameter per ASTM D5856.

Technical specification for Drainage Layer construction material and placement methods are presented in Appendix I.

9.5 Filter Layer

A filter layer will be placed above the Drainage Layer to restrict tailings migration into the Drainage Layer. The Filter Fill will be placed in a single 6-inch loose lift. The Filter Fill will be uncompacted and placed using low ground pressure tracked equipment. After placement, the top surface of the Filter Fill will be ripped or bladed to be free of ridges, mounds, or ponding areas.

The Filter Fill material is to be either a processed material from the Basalt Borrow Quarry or during on-site grading operations. The Filter Fill will have a maximum particle size of 1½-inches and a fines (No. 200 screen) content between 10 and 30 percent, but weight, with a Plasticity Index less than or equal to 10. The Filter Fill will have a hydraulic conductivity faster than 5×10^{-4} cm/sec when measured in a laboratory rigid wall permeameter per ASTM D5856.

Technical specification for Filter Fill construction material and placement methods are presented in Appendix I.

9.6 Drain Gravel

Drain Gravel will be placed around the primary underdrain collection pipes, within the underdrain outlet channel, and within the reclaim pond LCRS sump.

Drain Gravel will be crushed and screen material from the Basalt Borrow Quarry with a maximum particle size of 2-inches and a maximum fines (No. 200 screen) content of 5 percent by weight, with a Plasticity Index of less than or equal to 10.

Technical specification for the Drain Gravel construction material and placement methods are presented in Appendix I.

9.7 Leak Detection Fill

Leak Detection Fill will be placed around the perforated leak detection pipes between the primary and secondary liners of the TSF basin, underdrain channel, and WRD pad.

Leak Detection Fill will be crushed and screen material from the Basalt Borrow Quarry with a maximum particle size of 1-inch with a maximum fines (No. 200 screen) content of 10 percent, but weight, with a Plasticity Index of less than or equal to 5.

Technical specification for Leak Detection Fill construction material and placement methods are presented in Appendix I.

10.0 GEOTECHNICAL MONITORING

To monitor the performance and stability of the TSF and WRD during construction and operation, a geotechnical monitoring plan was prepared and is presented in Appendix K. The goals of monitoring the Grassy Mountain TSF and WRD are to:

- Monitor pore pressure in the foundation clay to detect development of excess pore pressures during the construction of the Stages 1 through 3 North Embankment to confirm short-term construction stability and to monitor pore pressures throughout the operating life of the facility.
- Monitor the pore pressure at the base of the impounded tailings above the toe drain pipe and primary underdrain collection pipes in the TSF and WRD to confirm that the drainage system continues to operate within design parameters.
- Monitor pore pressures in the foundation below the TSF basin and WRD pad lining systems to confirm the proper containment performance.
- Monitor leakage flow rates between the primary and secondary containment layers in the TSF and WRD liner systems.
- Monitor flow rates from the primary TSF collection pipes, and the TSF toe drain pipe, prior to discharge into the reclaim pond to verify proper functioning of the pipes and to support water balance estimates.
- Monitor displacements of the TSF dam embankment crest that could indicate instability and/or excessive settlement.

- Monitor potential subsurface displacements within the TSF dam embankment and in the underlying foundation soils to provide early indication of potential instability prior to development of evidence that can be measured or recognized at the surface.
- Visually inspect the operation and general condition of the TSF and WRD during operation and construction to monitor the overall performance of the facilities.

Monitoring is accomplished through both measurements of the monitoring points presented in Appendix K and visual observations of surface conditions. For the purposes of the geotechnical monitoring plan, a monitoring point is defined as any geotechnical instrument or dam crest survey monument installed to monitor the geotechnical field conditions at the TSF and WRD.

The geotechnical monitoring plan further defines the roles and responsibilities of key stakeholders for safe and stable construction and operation of the TSF and WRD. These include, the Owner/Operator, Engineer, Monitor, and Surveyor.

11.0 DAM BREACH ANALYSIS

As discussed in Section 2.1, based on Golder's assessment of the existing downstream conditions (habitable structures, utilities, life lines, and public access roads), the hazard rating is recommended to be "Low."

Although a dam breach inundation analysis is not required for low Hazard Dams per OAR 690-020-0120, Golder completed one for the ultimate Grassy Mountain TSF with the intent that it be used as a guide for OWRD in selecting an appropriate hazard rating for the TSF.

It is important to note that the purpose of this analysis is to evaluate the consequence of failure, and not the probability of failure. The simulated dam breach scenario presented is hypothetical and is not a reflection of the embankment integrity or stability of the TSF. Detailed discussion and results of the dam breach inundation analysis are presented in Appendix L.

Golder utilized two hydrodynamic model software packages to estimate the inundation area. These included FLDWAV (1998), and FLO-2D (2009). FLDWAV was used to model the potential breach North embankment. FLO-2D was used to route the non-Newtonian tailings dam breach flood hydrographs from the TSF along the downstream study reaches.

FLO-2D is a two-dimensional hydraulic model with an unsteady-state flow routing component. FLO-2D has been approved by the U.S. Federal Emergency Management Agency (FEMA) for riverine studies and unconfined flood analyses. FLO-2D can be applied to a number of complex flood problems including mud and debris consisting of non-homogenous, non-Newtonian flows. The high solids content of a tailings flow categorizes it as a non-Newtonian flow; therefore, FLO-2D is considered an appropriate method for tailings flood routing and has gained wide acceptance for routing of tailings.

For this analysis, Golder evaluated the following critical scenario:

- Full Capacity Breach: The TSF is filled to the ultimate capacity at the end of Stage 3 with a maximum operating pool.
- Rainy Day Breach Event: The breach would occur concurrent with the addition of water from the Inflow design flood generated from the 500-year, 24-hour storm event (storm depth of 2.91 inches) during operation of the facility.

- Full-Depth Breach: To justify use of a full-depth breach from an engineering view, Golder assumed that the embankment breach would occur due to piping failure at a location along the downstream toe of the North embankment corresponding to the location of the maximum embankment height.

In this scenario, an estimated total volume of 1.07 M cubic yards would be released. This volume includes tailings, embankment material, and free water on the tailings surface. The findings from the inundation analysis include:

- The TSF flood flows would follow an existing ephemeral drainage running adjacent to Rock Canyon Road.
- The total tailings slurry deposition area inundated would be approximately 834 acres.
- Golder reviewed aerial imagery, and it is our understanding that there are no occupied structures within the tailings slurry inundation area.
- The modeled maximum tailings runout distance from the TSF is approximately 12 miles, beyond which flows would not pose a significant risk to human life.
- The peak flood travel time from the TSF to the maximum tailings runout distance (12 miles) would be approximately 48 hours.
- No habitations or lifelines would be impacted by the simulated event.
- Public access to the project site and areas south along Rock Canyon Road and Twin Springs would either be inaccessible, or access limited, until tailings solids could be removed. Alternative public access routes would remain operational.

The results of this analysis will be incorporated into a facility-specific Emergency Action Plan (EAP) prepared prior to construction of the facility. The EAP will prepared in accordance with FEMA's *Federal Guidelines for Dam Safety, Emergency Action Planning for dams*, FEMA 64 (FEMA 2013).

12.0 CLOSURE

The conceptual closure design of the TSF is intended to meet the OAR requirements. In accordance with the OAR 340-043-0140 (5) requirement, the tailings surface will be covered with a composite cover designed to prevent water and air infiltration. Upon completion of mining operations, active deposition into the TSF will cease. During this time, water collected in the TSF reclaim pond will be recirculated to the supernatant pool for active water management. Over time, the supernatant pool will evaporate and the underdrain flows reporting from the TSF will reduce as the tailings consolidate and drain. This is considered the active management period of closure.

Once the tailings surface no longer has a free water surface and the tailings continue to desiccate and densify, a closure cover can be constructed over the tailings surface and TSF embankments. The closure cover should be installed at a point in time where the majority of tailings consolidation has occurred and is not expected to negatively impact drainage of the closure cover.

The TSF closure cover is presented on the Design Drawings and will be constructed with the following (bottom to top):

- Operational layer of waste rock (if available) or other materials to provide vehicle access
- 4 to 12 inches of Liner bedding (if required)

- Geomembrane liner
- 12 to 18 inches of non-acid generating drainage layer
- 12 to 24 inches of growth medium

Upon cessation of mining operations, the remaining waste rock (if any) stockpiled on the WRD will be removed and placed as an operation layer above the tailings surface when it is safe to do so. The WRD lining system will either be removed or buried upon completion of mining operations.

During this time, water collected in the TSF reclaim pond will be recirculated to the supernatant pool for active water management. Over time, the supernatant pool will evaporate and the underdrain flows reporting from the TSF will reduce as the tailings consolidate and drain. This is considered the active management period of closure.

Once tailings underdrain flow rates reduce to levels considered appropriate for passive water management, the reclaim pond will be retrofitted to a geomembrane-lined evaporation pond. With installation of the closure cover and gravity drainage from the underdrain collection system, it is expected that underdrain flows from the TSF will cease.

Upon completion of closure cover construction, stormwater falling on the TSF and upgradient catchment areas below the permanent diversion channels, will be routed over the covered impoundment surface to a closure drop chute channel located at the eastern abutment of the North embankment. The closure drop chute and impoundment surface swale are designed to safely convey stormwater flows resulting from the 500-year, 24-hour storm. Conceptual closure of the TSF and WRD are presented on the Design Drawings.

13.0 REFERENCES

Ausenco 2018. *Grassy Mountain Prefeasibility Study Mass Balance.* Prepared for Paramount Nevada Gold Corporation by Ausenco. Dated March 28, 2018.

FEMA 2013. *Federal Guidelines for Dam Safety, Emergency Action Planning for dams*, *FEMA 64.* US Department of Homeland Security, Federal Emergency Management Agency. July 2013.

Ferns, M.L., H.C. Brooks, J.G. Evans, and M.L. Cummings. 1993. Geologic Map of the Vale 30 x 60 Minute Quadrangle, Malheur County, Oregon, and Owyhee County, Idaho. State of Oregon, Department of Geology and Mineral Industries, GMS-77.

FLDWAV, 1998. FLDWAV, Version 1.0.0. Developed by Nation Weather Service. 1998.

FLO-2D Software, Inc. FLO-2D PRO Reference Manual, Version 2009.

FlowMaster 2009. Bentley® FlowMaster® V8i (SELECTseries 1) [software], build 08.11.01.03. Bentley Systems, Inc. November 4, 2009.

Golder 2017. Seismic Hazard Assessment, Grassy Mountain Mine Site, Malheur County, Oregon. Prepared for Calico Resources Corp., PN 1663524, Rev.0, dated July 14, 2017.

Golder 2019a. *Draft – Material Suitability and Slope Stability Assessment – Grassy Mountain Basalt Borrow Quarry, Malheur County, Oregon.* Prepared for Calico Resources USA Corp. by Golder Associates Inc. April 4, 2019.

Golder 2019b. *Abbreviated Operating Permit Application – Grassy Mountain Basalt Borrow Quarry.* Prepared for Calico Resources USA Corp. by Golder Associates Inc. May 2, 2019.

Gray, J.J., Geitgey, R.P., and Baxter, G.L. 1989. Bentonite in Oregon: Occurrences, Analyses, and Economic Potential. State of Oregon Department of Geology and Mineral Resources, Special Paper 20.

GWP Geo Software Inc. (GWP). 2014. FSConsol V3.48, Edmonton, AB, T6C 4R4, Canada

HEC 2015. Hydrologic Engineering Center – Hydrologic Modeling Software (HEC-HMS), Version 4.1, Build 1628, Date 31 July 2015. Developed by U.S. Army Corp of Engineers (USACE).

Hynes, M.E., Franklin, F.G. (1984). *Rationalizing the Seismic Coefficient Method*. Miscellaneous Paper GL-84-13, Geotechnical Laboratory, U.S. Army Engineering Waterways Experiment Station, Vicksburg, Mississippi.

Idriss, I.M., Abrahamson, N.A. and Archuleta, R.J. 2018. Chapter 13: Evaluation of Earthquake Ground Motions, Engineering Guidelines for the Evaluation of Hydropower Projects. Prepared for Division of Dam Safety and Inspections, Office of Energy Projects, Federal Energy Regulatory Commission (FERC).

NOAA 1973. *Precipitation-Frequency Atlas of the Western United States, Volume X – Oregon. Prepared for the US Department of Agriculture, Soil Conservation Service, Engineering Division*. 1973.

Paramount 2017. Paramount Gold Nevada Corp. Grassy Mountain Gold Project. http://www.paramountnevada.com/projects/grassy-mountain-gold-project/.

Rocscience 2018. Slide2 2018, build 8.027. Rocscience Inc. August 2, 2019.

Rocscience 2019. Settle v4.0, build v4.023. Rocscience Inc. April 12, 2019.

Seed, H.B. (1982). *The Selection of Design Earthquakes for Critical Structures*. Bulletin of the Seismological Society of America, Vol. 27, No. 6, pp. S7-S12.

SGS 2018. An Investigation into *Metallurgical Testing of Samples from the Grassy Mountain Gold Project, Project 15944-001 – Final Report.* Prepared for Ausenco Engineering Canada Inc. by SGS Canada Inc. March 16, 2018.

SPF 2019. *Grassy Mountain Gold Project Groundwater, Vol. II, Groundwater Characterization Report.* Prepared for Calico Resources USA Corp. by SPF Water Engineering, LLC. August 13, 2019.

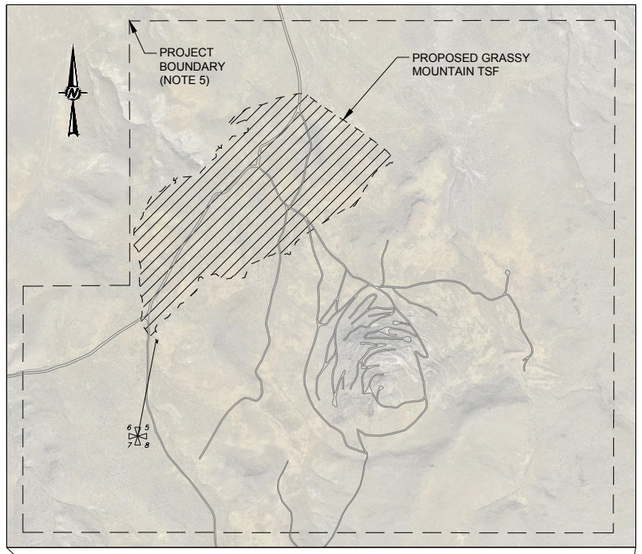
SRK 2019. *Grassy Mountain Tailings Amendment Assessment – Draft.* Prepared for Calico Resources USA Corp, by SRK Consulting (U.S.) Inc. February 8, 2019.

USDA 2011. WinTR-55 Small Watershed Hydrology, Technical Release 55. Version 1.00.10 Compiled on 1 April 2011. Developed by US Department of Agriculture, National Resource Conservation Society.

Yao, D.T.C., and D. Znidarcic. 1997. “Crust Formation and Desiccation Characteristics for Phosphatic Clays – User’s manual for computer program CONDES0”. The Florida institute of Phosphate Research, Publication No. 04-055-134.

CJM/MDB/RAB/kg

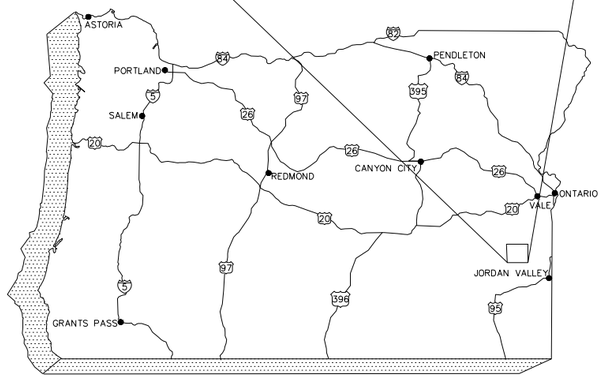
Design Drawings



SITE LOCATION MAP

(NOT TO SCALE)

NEAREST TOWNSHIP AND RANGE LOCATED IN S8 T22S R44E



STATE OF OREGON

(NOT TO SCALE)

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN PROJECT

TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP

MALHEUR COUNTY, OREGON

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GENERAL NOTES

1. EXISTING GROUND TOPOGRAPHY PROVIDED BY CALICO RESOURCES USA CORP. ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf".
2. AERIAL IMAGERY PROVIDED BY CALICO RESOURCES USA CORP. ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "Orthophoto_1ft_ExpandedArea.tif".
3. PROJECT AREA BOUNDARY PROVIDED BY CALICO RESOURCES USA CORP. ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".
4. DRAWINGS PRESENTED IN NAD83 DATUM, ZONE 11, VERTICAL DATUM (NAVD) 88.
5. UNLESS OTHERWISE NOTED, ALL ELEVATIONS ARE TO LINER SURFACE OR FINISH GROUND IN UNLINED AREAS.

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TITLE SHEET

PROJECT NO. 1663241 | REV. 0 | 1 of 42 | DRAWING T1

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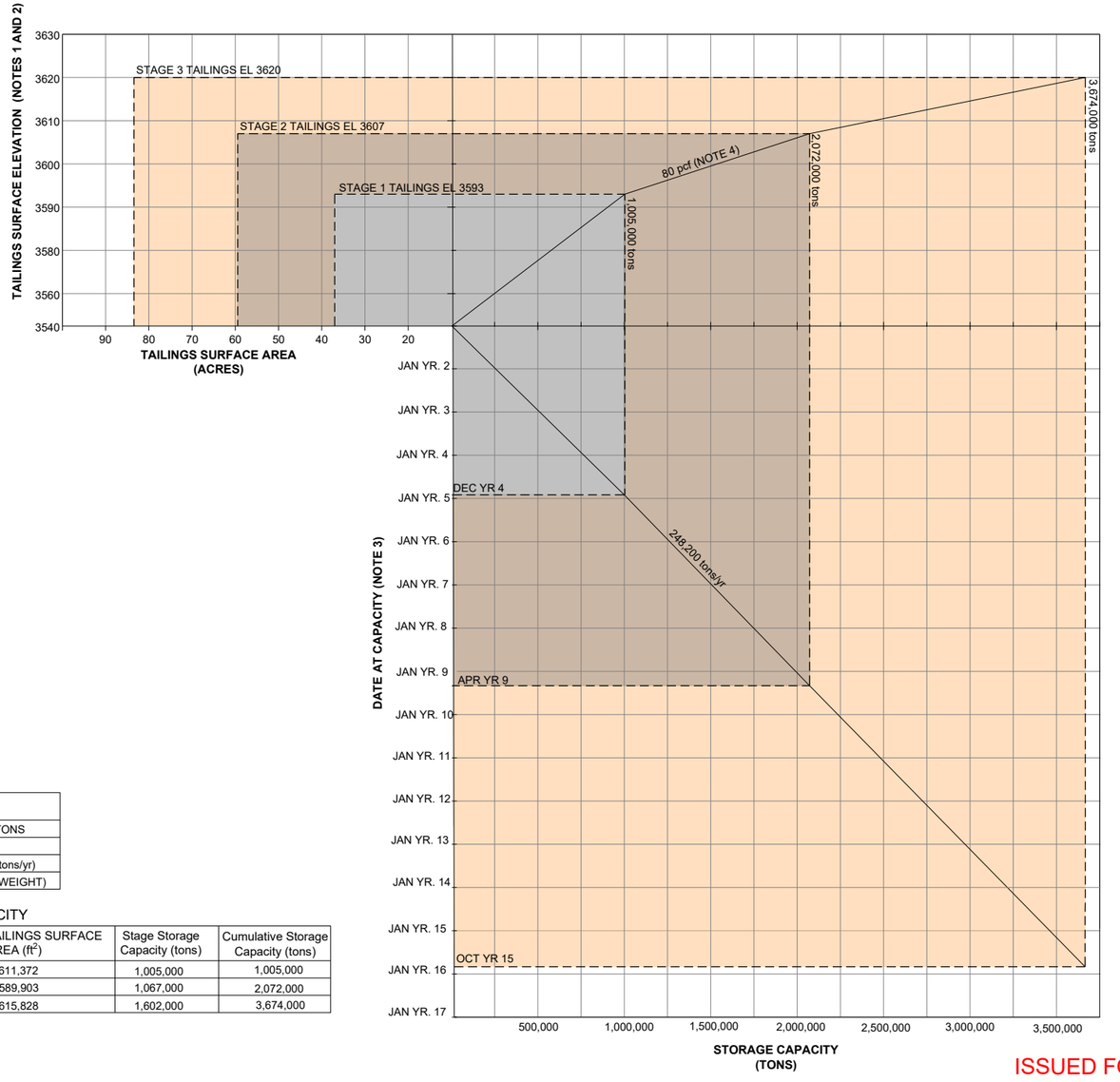
ABBREVIATIONS	
UNIT	TERMINOLOGY
DWG	DRAWING
ft	FEET
ft²	SQUARE FEET
PCF	POUND-FORCE PER CUBIC FOOT
mi	MILES
TP	TEST PIT
BH	BOREHOLE
CPT	CONE PENETRATION TEST
℄	REFERENCE LINE
CP	CONTROL POINT
YR	YEAR
N	NORTHING
E	EASTING
EL	ELEVATION
ST.	STAGE
STA.	STATION
INC	INCLINOMETER
SM	SURVEY MONUMENT
PZ-TF	FOUNDATION PIEZOMETER - BELOW TSF EMABNKMENTS
PZ-TI	IMPOUNDMENT PIEZOMETER - DRAINAGE LAYER ABOVE TSF LINING SYSTEM
PZ-TU	UNDERLINER PIEZOMETER - BELOW TSF LINING SYSTEM
PZ-WI	IMPOUNDMENT PIEZOMETER - DRAINAGE LAYER ABOVE WRD LINING SYSTEM
PZ-WU	UNDERLINER PIEZOMETER - BELOW WRD LINING SYSTEM
CPP	RECLAIM POND CONTROL POINTS
CPU	UNDERDRAIN CHANNEL CONTROL POINTS
CPW	WASTE ROCK DUMP CONTROL POINTS
C/C	CENTER-ON-CENTER
MIN	MINIMUM
MAX	MAXIMUM
DR	DIMENSION RATIO
S.S.	STAINLESS STEEL
STD.	STANDARD
MIL	MILLIMETER
GCL	GEOSYNTHETIC CLAY LINER
HDPE	HIGH-DENSITY POLYETHYLENE
CPE	CORRUGATED POLYETHYLENE
DIA.	DIAMETER
IN.	INCHES
SCH.	SCHEDULE

DESIGN PARAMETER

PARAMETERS	DESIGN
TARGET TAILINGS CAPACITY	3.67 MILLION TONS
AVERAGE TAILINGS DRY DENSITY	80 PCF
MAXIMUM THROUGHPUT RATE	680 tpd (248,200 tons/yr)
DESIGN SLURRY CONCENTRATION	~46% SOLIDS (BY WEIGHT)

PHASE ELEVATIONS AND CAPACITY

STAGE	MAXIMUM EMBANKMENT HEIGHT (ft)	MAIN EMBANKMENT CREST ELEVATION (ft)	MAXIMUM TAILINGS SURFACE AREA (ft²)	Stage Storage Capacity (tons)	Cumulative Storage Capacity (tons)
1	53	Varies (Max. 3595)	1,611,372	1,005,000	1,005,000
2	68	Varies (Max. 3609)	2,589,903	1,067,000	2,072,000
3	84	Varies (Max. 3622)	3,615,828	1,602,000	3,674,000



LEGEND

- STAGE I TAILINGS STORAGE
- STAGE II TAILINGS STORAGE
- STAGE III TAILINGS STORAGE

NOTES

1. TAILINGS SURFACE ELEVATION IS THE MAXIMUM ELEVATION OF THE TAILINGS ADJACENT TO THE NORTH EMBANKMENT.
2. MINIMUM FREEBOARD AT NORTH EMBANKMENT IS 2 FEET ABOVE MAXIMUM TAILINGS SURFACE ELEVATION.
3. ASSUMES TAILINGS DEPOSITION BEGINS JANUARY OF YEAR 1.
4. ASSUMED TAILS DENSITY BASED ON GOLDER'S 2019 CONSOLIDATION TESTING AND MODELING PROGRAM.

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TSF STORAGE CAPACITY CURVE

PROJECT NO. 1663241 | REV. 0 | | DRAWING G1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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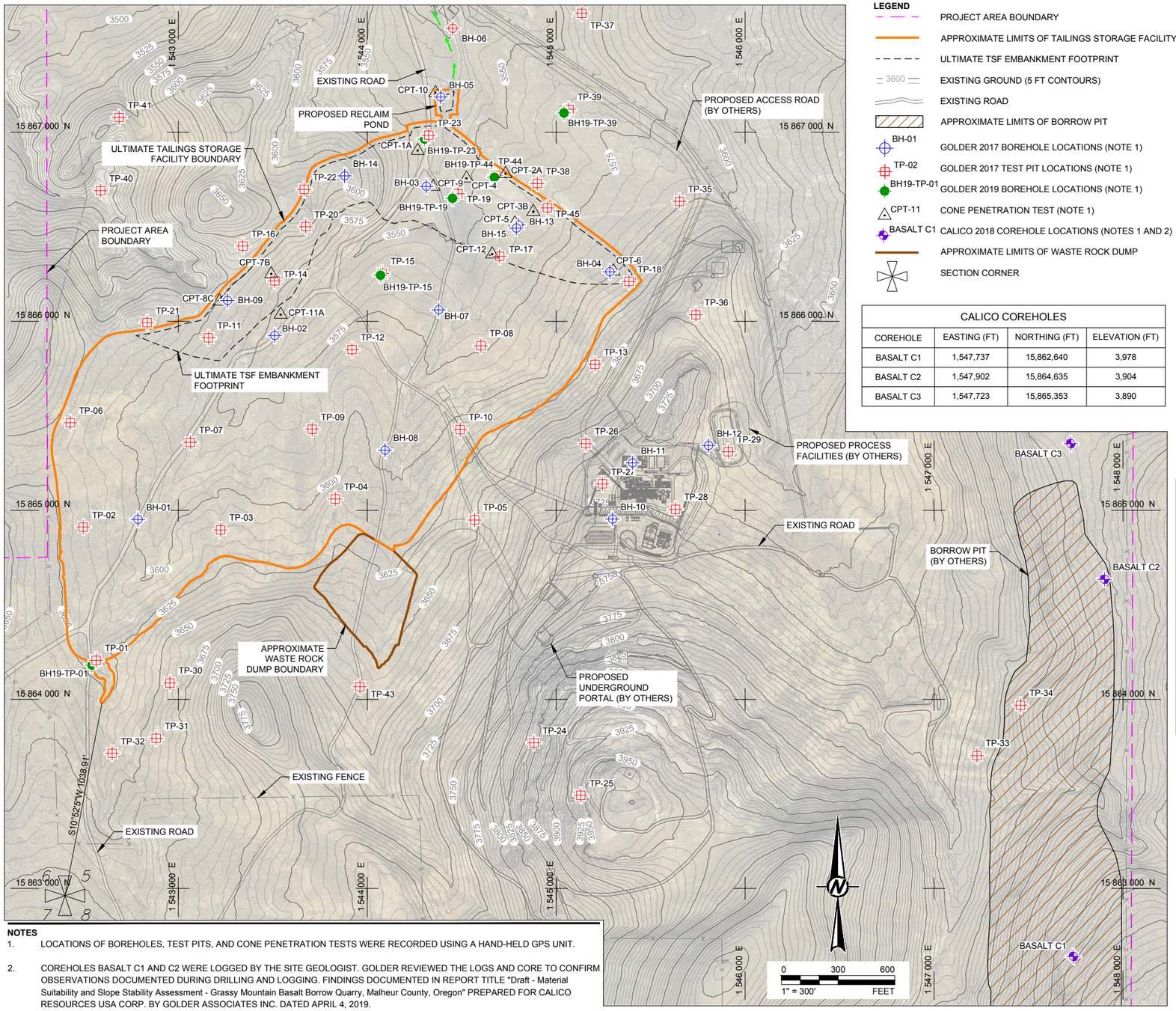

LEGEND

- PROJECT AREA BOUNDARY
- APPROXIMATE LIMITS OF TAILINGS STORAGE FACILITY
- ULTIMATE TSF EMBANKMENT FOOTPRINT
- 3600 EXISTING GROUND (5 FT CONTOURS)
- EXISTING ROAD
- APPROXIMATE LIMITS OF BORROW PIT
- BH-01 GOLDER 2017 BOREHOLE LOCATIONS (NOTE 1)
- TP-02 GOLDER 2017 TEST PIT LOCATIONS (NOTE 1)
- BH19-TP-01 GOLDER 2019 BOREHOLE LOCATIONS (NOTE 1)
- CPT-11 CONE PENETRATION TEST (NOTE 1)
- BASALT C1 CALICO 2018 COREHOLE LOCATIONS (NOTES 1 AND 2)
- APPROXIMATE LIMITS OF WASTE ROCK DUMP
- SECTION CORNER

CALICO COREHOLES			
COREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BASALT C1	1,547,737	15,862,640	3,978
BASALT C2	1,547,902	15,864,635	3,904
BASALT C3	1,547,723	15,865,353	3,890

TEST PIT COORDINATES			
TEST PIT	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
TP-01	1,542,565	15,864,207	3,618
TP-02	1,542,497	15,864,912	3,617
TP-03	1,543,224	15,864,896	3,609
TP-04	1,543,831	15,865,060	3,614
TP-05	1,544,568	15,864,949	3,648
TP-06	1,542,429	15,865,463	3,617
TP-07	1,543,064	15,865,360	3,622
TP-08	1,544,601	15,865,871	3,573
TP-09	1,543,709	15,865,430	3,586
TP-10	1,544,492	15,865,427	3,607
TP-11	1,543,160	15,865,912	3,595
TP-12	1,543,919	15,865,850	3,586
TP-13	1,545,206	15,865,772	3,634
TP-14	1,543,511	15,866,214	3,582
TP-15	1,544,079	15,866,253	3,565
TP-16	1,543,342	15,866,398	3,617
TP-17	1,544,701	15,866,344	3,559
TP-18	1,545,385	15,866,211	3,611
TP-19	1,544,480	15,866,675	3,546
TP-20	1,543,674	15,866,501	1,099
TP-21	1,542,835	15,865,993	3,619
TP-22	1,543,667	15,866,698	3,615

TEST PIT COORDINATES			
TEST PIT	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
TP-23	1,544,326	15,866,983	3,541
TP-24	1,544,883	15,863,771	3,840
TP-25	1,545,130	15,863,493	3,943
TP-26	1,545,157	15,865,353	3,697
TP-27	1,545,245	15,865,140	3,719
TP-28	1,545,631	15,865,005	3,722
TP-29	1,545,911	15,865,310	3,680
TP-30	1,542,956	15,864,087	3,659
TP-31	1,542,882	15,863,794	3,657
TP-32	1,542,650	15,863,715	3,637
TP-33	1,547,227	15,863,702	3,789
TP-34	1,547,458	15,863,969	3,826
TP-35	1,545,653	15,866,634	3,597
TP-36	1,545,740	15,866,034	3,669
TP-37	1,545,136	15,867,629	3,562
TP-38	1,544,900	15,866,729	3,563
TP-39	1,545,067	15,867,121	3,565
TP-40	1,542,589	15,866,691	3,501
TP-41	1,542,687	15,867,078	3,550
TP-43	1,543,961	15,864,067	3,662
TP-44	1,544,680	15,866,772	3,554
TP-45	1,544,954	15,866,599	3,564

BOREHOLE COORDINATES			
BOREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BH-01	1,542,787	15,864,952	3,600
BH-02	1,543,510	15,865,924	3,571
BH-03	1,544,313	15,866,714	3,531
BH-04	1,545,284	15,866,262	3,598
BH-05	1,544,389	15,867,186	3,528
BH-06	1,544,452	15,867,549	3,530
BH-07	1,544,378	15,866,060	3,567
BH-08	1,544,094	15,865,318	3,597
BH-09	1,543,260	15,866,110	3,597
BH-10	1,545,298	15,864,954	3,733
BH-11	1,545,404	15,865,251	3,718

BOREHOLE COORDINATES			
BOREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BH-12	1,545,806	15,865,342	3,691
BH-13	1,544,801	15,866,510	3,558
BH-14	1,543,881	15,866,769	3,601
BH-15	1,544,789	15,866,492	3,558
BH19-TP-01	1,542,543	15,864,181	3,618
BH19-TP-15	1,544,070	15,866,243	3,565
BH19-TP-19	1,544,451	15,866,651	3,546
BH19-TP-23	1,544,304	15,866,964	3,541
BH19-TP-39	1,545,041	15,867,102	3,565
BH19-TP-44	1,544,673	15,866,762	3,554

CONE PENETRATION TEST COORDINATES			
NAME	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
CPT-1A	1,544,267	15,866,903	3,545
CPT-2A	1,544,732	15,866,781	3,557
CPT-3B	1,544,879	15,866,580	3,560
CPT-4	1,544,525	15,866,756	3,548
CPT-5	1,544,781	15,866,518	3,558
CPT-6	1,545,303	15,866,264	3,599
CPT-7B	1,543,492	15,866,250	3,586
CPT-8C	1,543,219	15,866,106	3,599
CPT-9	1,544,351	15,866,712	3,542
CPT-10	1,544,361	15,867,209	3,538
CPT-11A	1,543,542	15,866,035	3,571
CPT-12	1,544,661	15,866,355	3,558

NOTES

1. LOCATIONS OF BOREHOLES, TEST PITS, AND CONE PENETRATION TESTS WERE RECORDED USING A HAND-HELD GPS UNIT.
2. COREHOLES BASALT C1 AND C2 WERE LOGGED BY THE SITE GEOLOGIST. GOLDER REVIEWED THE LOGS AND CORE TO CONFIRM OBSERVATIONS DOCUMENTED DURING DRILLING AND LOGGING. FINDINGS DOCUMENTED IN REPORT TITLE "Draft - Material Suitability and Slope Stability Assessment - Grassy Mountain Basalt Borrow Quarry, Malheur County, Oregon" PREPARED FOR CALICO RESOURCES USA CORP. BY GOLDER ASSOCIATES INC. DATED APRIL 4, 2019.

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL EXPLORATION LOCATION MAP

PROJECT NO. 1663241
REV. 0

DRAWING G2

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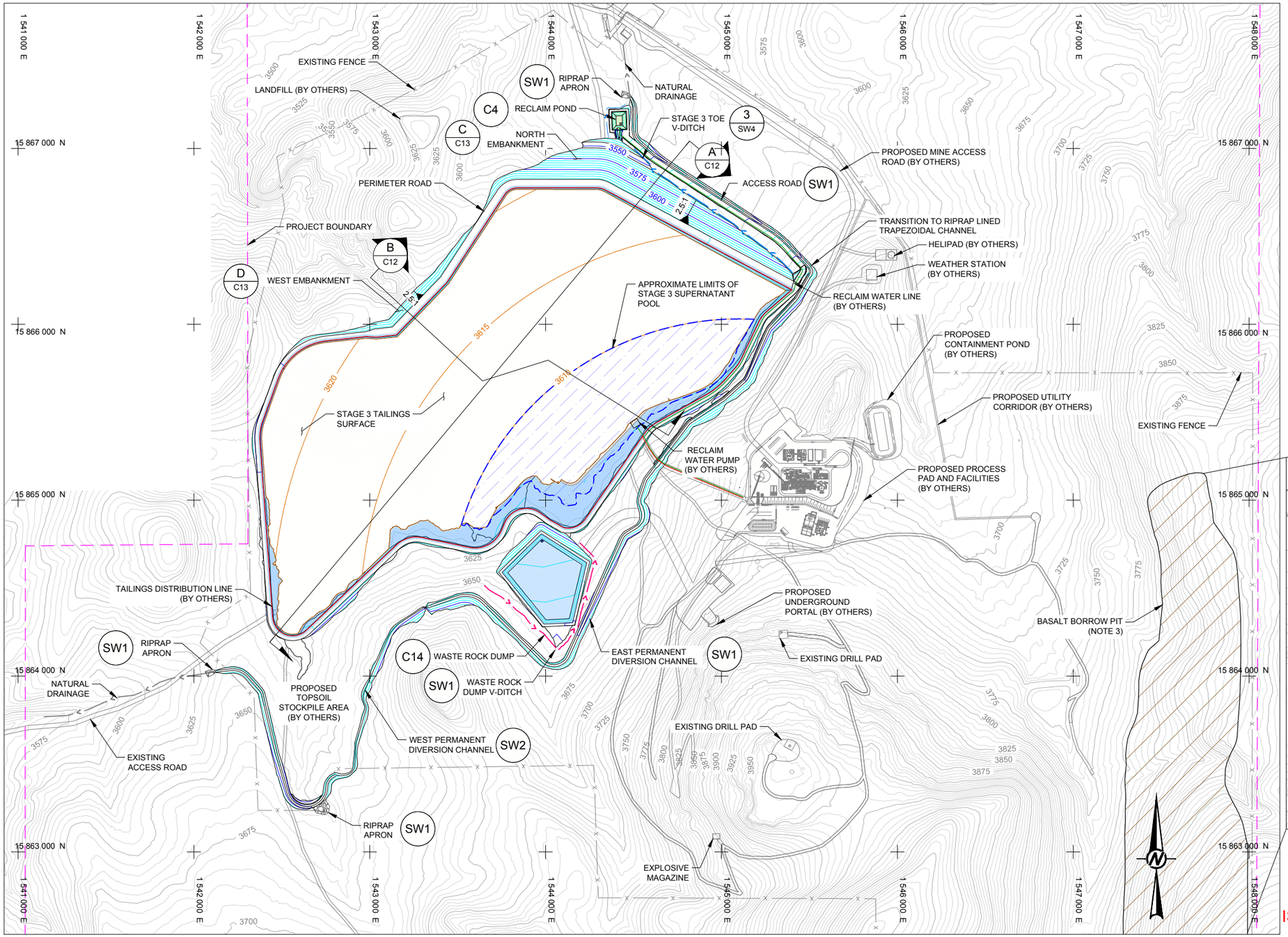

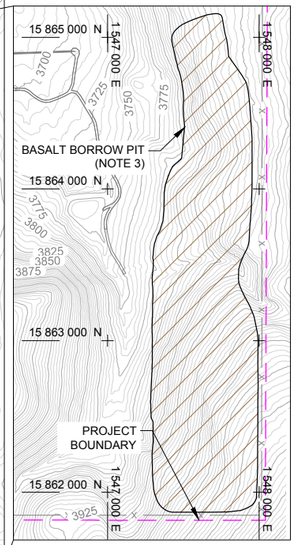

LEGEND

- EXISTING GROUND CONTOURS (5 FT CONTOURS) (GENERAL NOTE 1)
- PROPOSED CONTOURS (5 FT CONTOURS)
- PROPOSED TAILINGS SURFACE (5 FT CONTOURS)
- TAILINGS DISTRIBUTION LINE (BY OTHERS)
- RECLAIM WATER LINES (BY OTHERS)
- PROJECT BOUNDARY
- APPROXIMATE LIMITS OF SUPERNATANT POOL
- LIMITS OF RECLAIM POND LINING SYSTEM (42 / D6)
- EXISTING FENCING
- PERMANENT V-DITCH (3 / SW4)
- TEMPORARY V-DITCH
- NATURAL DRAINAGE
- LIMITS OF BASALT BORROW PIT
- LIMITS OF LINING SYSTEM (5 / D1)

NOTES

1. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.
2. LAYOUT AND TOPOGRAPHY SHOWN FOR MINE WASTE FACILITIES REPRESENT FINAL CONDITIONS AT THE END OF OPERATIONS.
3. PROPOSED BASALT QUARRY DESIGN PREPARED BY MINE DEVELOPMENT ASSOCIATES AND GOLDER IS PRESENTED AS APPENDIX V OF THE GRASSY MOUNTAIN PROJECT CONSOLIDATED PERMIT APPLICATION. DOCUMENT TITLED "ABBREVIATED OPERATING PERMIT APPLICATION - GRASSY MOUNTAIN BASALT BORROW QUARRY," REVISION 0. DATED MAY 2, 2019.

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON

ISSUED FOR CONSTRUCTION

EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
OVERALL FACILITY LAYOUT

PROJECT NO.	REV.		DRAWING
1663241	0	4 of 42	C1

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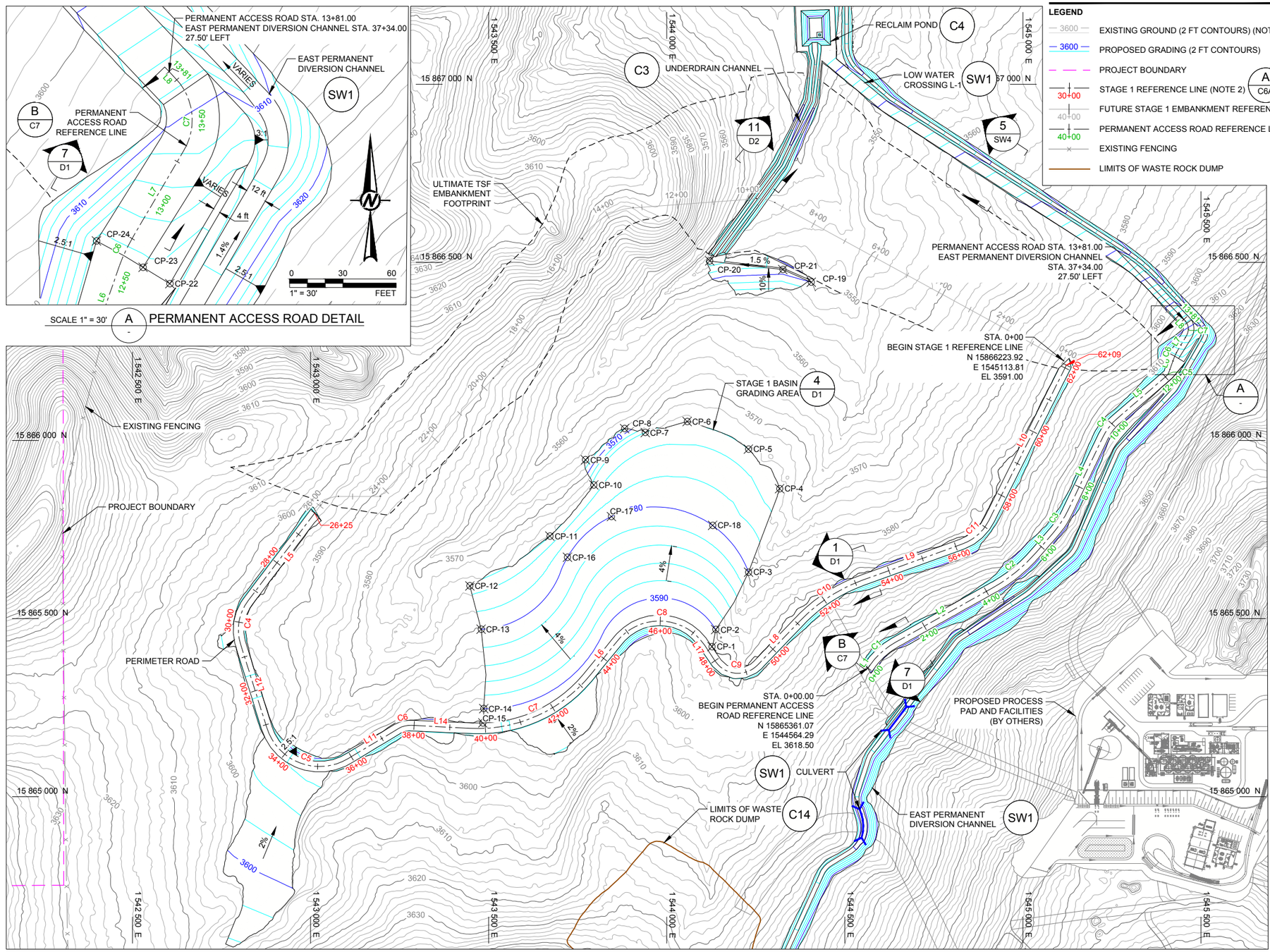
SCALE 1" = 30' A - PERMANENT ACCESS ROAD DETAIL



LEGEND

- EXISTING GROUND (2 FT CONTOURS) (NOTE 1)
- PROPOSED GRADING (2 FT CONTOURS)
- PROJECT BOUNDARY
- STAGE 1 REFERENCE LINE (NOTE 2) — A C6A
- FUTURE STAGE 1 EMBANKMENT REFERENCE LINE
- PERMANENT ACCESS ROAD REFERENCE LINE — B C7
- EXISTING FENCING
- LIMITS OF WASTE ROCK DUMP

STAGE 1 BASIN GRADING CONTROL POINTS

POINT NO.	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
CP-1	15865421.13	1544126.96	3591.98
CP-2	15865469.36	1544137.33	3590.00
CP-3	15865630.16	1544229.52	3580.00
CP-4	15865864.52	1544316.92	3575.00
CP-5	15865975.56	1544229.39	3574.00
CP-6	15866053.06	1544057.28	3575.00
CP-7	15866022.28	1543939.56	3574.00
CP-8	15866033.31	1543881.66	3568.00
CP-9	15865945.89	1543771.69	3565.82
CP-10	15865875.18	1543795.20	3575.00
CP-11	15865731.56	1543671.71	3576.00
CP-12	15865591.78	1543447.11	3575.00
CP-13	15865470.19	1543478.86	3580.00
CP-14	15865247.26	1543486.08	3590.00
CP-15	15865207.14	1543483.47	3591.97
CP-16	15865672.16	1543721.00	3580.00
CP-17	15865786.47	1543844.54	3580.00
CP-18	15865761.56	1544128.73	3580.00
CP-19	15866444.40	1544405.67	3550.01
CP-20	15866504.28	1544120.60	3544.50
CP-21	15866479.94	1544325.73	3548.70
CP-22	15866220.82	1545452.04	3618.51
CP-23	15866230.02	1545437.00	3618.54
CP-24	15866244.81	1545410.86	3618.59

NOTES

1. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.
2. SURVEY LAYOUT FOR STAGE 1 EMBANKMENT AND PERIMETER ROAD SHOWN ON DRAWING C6B AND C7, RESPECTIVELY.
3. OUTSIDE OF DEFINED GRADING AREAS, EXISTING TOPOGRAPHY IS TO BE CLEARED AND GRUBBED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS. FINAL GRADES TO BE BETWEEN 1% AND 10% AS SHOWN ON DETAIL 7/D1. TO PREVENT AREAS OF PONDING, POSITIVE DRAINAGE TO BE IN A GENERAL SOUTH TO NORTH DIRECTION.

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TAILINGS STORAGE FACILITY LAYOUT
STAGE 1 BASIN GRADING

PROJECT NO. 1663241 | REV. 0 | 5 of 42 | DRAWING C2

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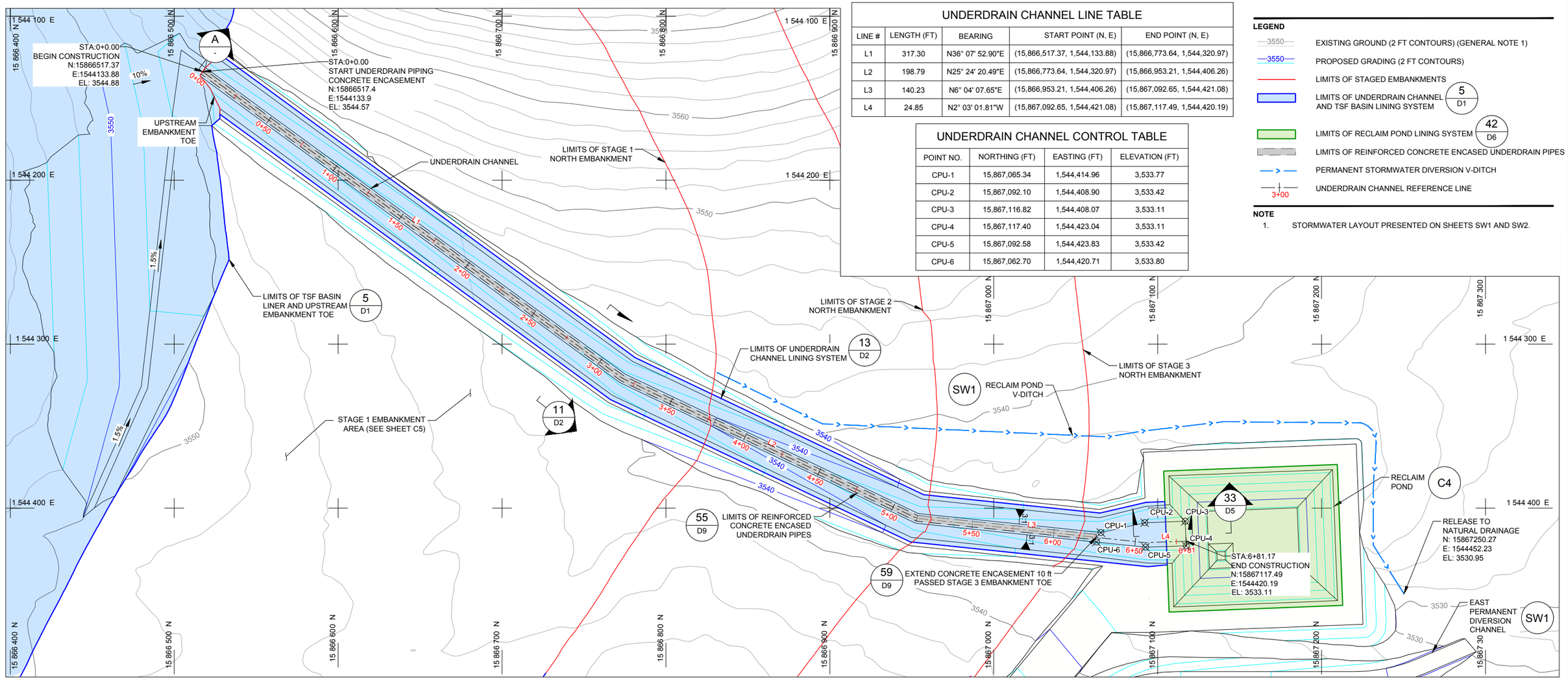


UNDERDRAIN CHANNEL LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L1	317.30	N36° 07' 52.90"E	(15,866,517.37, 1,544,133.88)	(15,866,773.64, 1,544,320.97)
L2	198.79	N25° 24' 20.49"E	(15,866,773.64, 1,544,320.97)	(15,866,953.21, 1,544,406.26)
L3	140.23	N6° 04' 07.65"E	(15,866,953.21, 1,544,406.26)	(15,867,092.65, 1,544,421.08)
L4	24.85	N2° 03' 01.81"W	(15,867,092.65, 1,544,421.08)	(15,867,117.49, 1,544,420.19)

UNDERDRAIN CHANNEL CONTROL TABLE

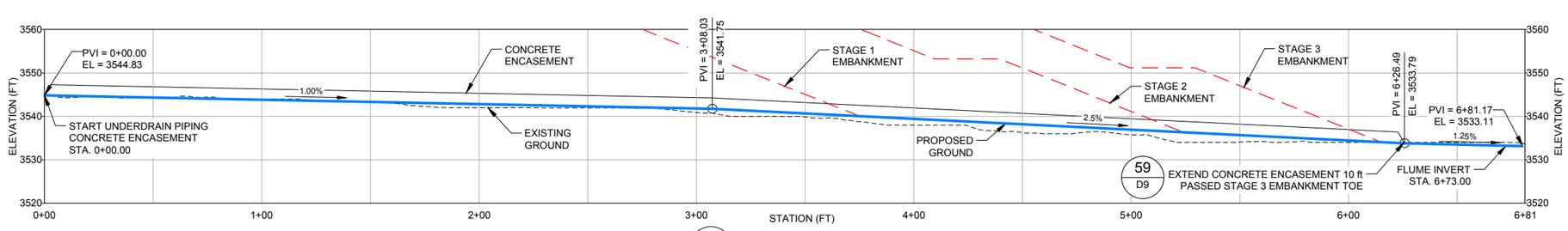
POINT NO.	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
CPU-1	15,867,065.34	1,544,414.96	3,533.77
CPU-2	15,867,092.10	1,544,408.90	3,533.42
CPU-3	15,867,116.82	1,544,408.07	3,533.11
CPU-4	15,867,117.40	1,544,423.04	3,533.11
CPU-5	15,867,092.58	1,544,423.83	3,533.42
CPU-6	15,867,062.70	1,544,420.71	3,533.80

LEGEND

- EXISTING GROUND (2 FT CONTOURS) (GENERAL NOTE 1)
- PROPOSED GRADING (2 FT CONTOURS)
- LIMITS OF STAGED EMBANKMENTS
- LIMITS OF UNDERDRAIN CHANNEL AND TSF BASIN LINING SYSTEM (5 / D1)
- LIMITS OF RECLAIM POND LINING SYSTEM (42 / D6)
- LIMITS OF REINFORCED CONCRETE ENCASED UNDERDRAIN PIPES
- PERMANENT STORMWATER DIVERSION V-DITCH
- UNDERDRAIN CHANNEL REFERENCE LINE (3+00)

NOTE

1. STORMWATER LAYOUT PRESENTED ON SHEETS SW1 AND SW2.



SCALE 1" = 30' / VERT. SCALE 1" = 15' — A / - — UNDERDRAIN CHANNEL PROFILE

0 30 60 FEET (1" = 30')

0 15 30 FEET (1" = 15')

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON

ISSUED FOR CONSTRUCTION 11/6/19

EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
UNDERDRAIN CHANNEL LAYOUT

PROJECT NO.	REV.		DRAWING
1663241	0	6 of 42	C3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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RECLAIM POND CONTROL TABLE

POINT NO.	NORTHING (FT)	EASTING (FT)	DESCRIPTION	ELEVATION (FT)
CPP-1	15,867,091.26	1,544,365.91	POND CREST	3,536.69
CPP-2	15,867,221.16	1,544,360.97	POND CREST	3,536.69
CPP-3	15,867,225.35	1,544,470.89	POND CREST	3,536.69
CPP-4	15,867,095.44	1,544,475.83	ACCESS ROAD TIE IN	3,536.69
CPP-5	15,867,071.93	1,544,475.80	ACCESS ROAD CREST	3,538.19
CPP-6	15,867,050.59	1,544,501.44	ACCESS ROAD CREST	3,540.34
CPP-7	15,867,024.94	1,544,485.09	ACCESS ROAD CREST	3,540.95
CPP-8	15,867,066.49	1,544,435.19	ACCESS ROAD TIE IN	3,536.78
CPP-9	15,867,106.81	1,544,380.33	POND CREST	3,536.69
CPP-10	15,867,206.74	1,544,376.53	POND CREST	3,536.69
CPP-11	15,867,209.79	1,544,456.47	POND CREST	3,536.69
CPP-12	15,867,109.86	1,544,460.27	POND CREST	3,536.69
CPP-13	15,867,130.15	1,544,401.96	POND TOE	3,527.69
CPP-14	15,867,185.12	1,544,399.87	POND TOE	3,527.69
CPP-15	15,867,186.45	1,544,434.84	POND TOE	3,527.69
CPP-16	15,867,131.49	1,544,436.93	POND TOE	3,527.69
CPP-17	15,867,130.92	1,544,421.94	SUMP CREST	3,527.69
CPP-18	15,867,145.91	1,544,421.37	SUMP CREST	3,527.69
CPP-19	15,867,146.48	1,544,436.36	SUMP CREST	3,527.69
CPP-20	15,867,107.49	1,544,397.95	CHANNEL TIE-IN	3,536.69
CPP-21	15,867,108.85	1,544,433.73	CHANNEL TIE-IN	3,536.69

LEGEND

- 3550 — EXISTING GROUND (2 FT CONTOURS) (GENERAL NOTE 1)
- 3550 — PROPOSED GRADING (2 FT CONTOURS)
- LIMITS OF UNDERDRAIN CHANNEL AND TSF BASIN LINING SYSTEM (13/D2, 5/D1)
- LIMITS OF POND LINING SYSTEM (42/D6)
- PERMANENT STORMWATER DIVERSION V-DITCH
- LIMITS OF REINFORCED CONCRETE ENCASED UNDERDRAIN PIPES
- UNDERDRAIN CHANNEL REFERENCE LINE (3+00, C3)
- LIMITS OF 80 MIL HDPE RUBSHEET (33/D5)

NOTE

1. STORMWATER LAYOUT PRESENTED ON SHEETS SW1 AND SW2.

0 10 20
1" = 10' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

ISSUED FOR CONSTRUCTION

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
RECLAIM POND LAYOUT

PROJECT NO. 1663241 | REV. 0 | 7 of 42 | DRAWING C4

Path: \\env\data\MDA\1663241 Grassy Mountain PFS 600_Drawings\PRODUCTION\CONSOLIDATED PERMIT\ | File Name: C9 UNDERDRAIN POND LAYOUT.dwg | Last Edited By: jeprice Date: 2019-11-06 Time:3:31:23 PM | Printed By: JePrice Date: 2019-11-06 Time:4:04:23 PM
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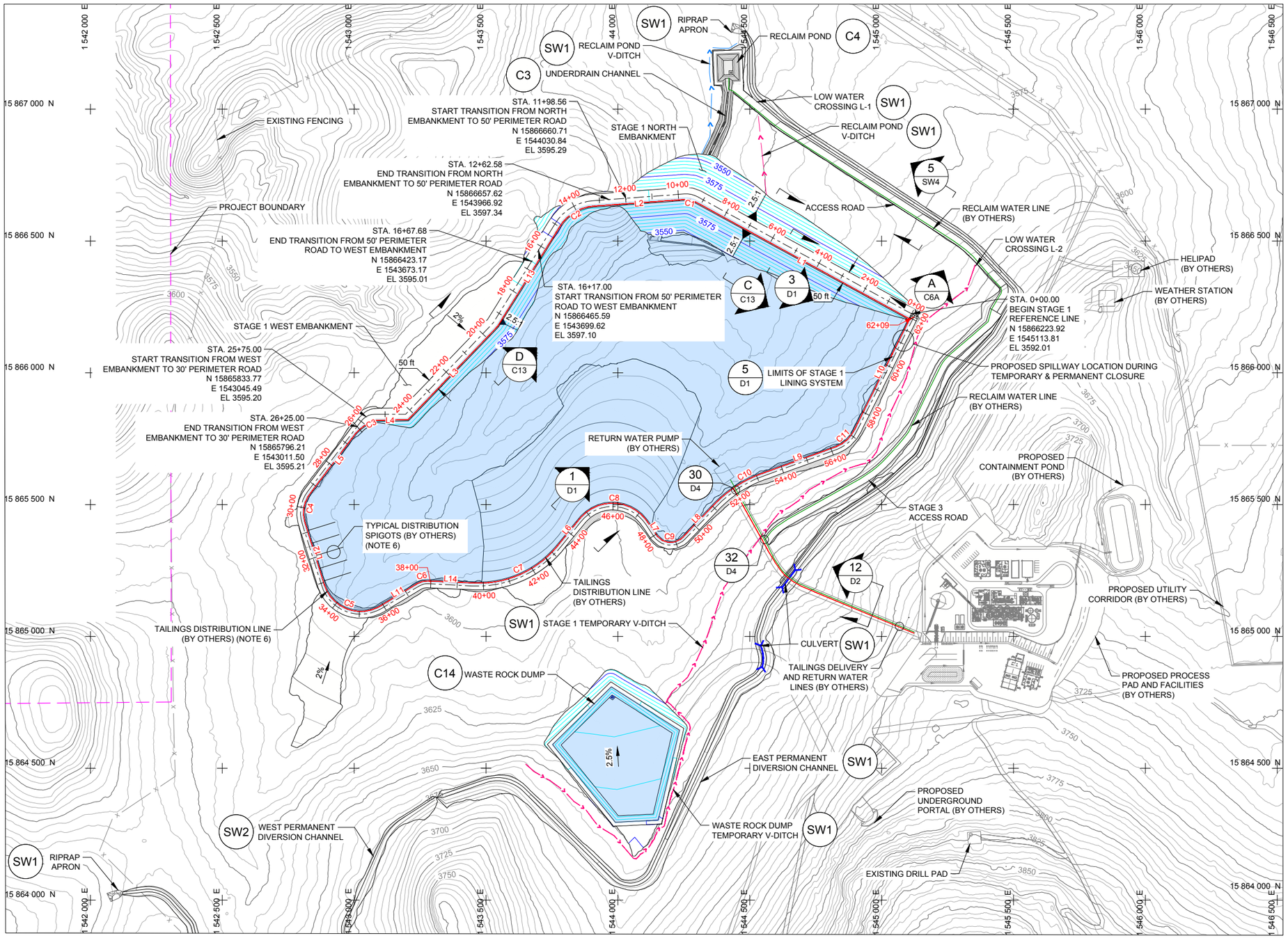

LEGEND

- EXISTING GROUND CONTOURS (5 FT CONTOURS) (GENERAL NOTE 1)
- PROPOSED GRADING (5 FT CONTOURS)
- TAILINGS DISTRIBUTION LINE (BY OTHERS)
- RECLAIM WATER LINE (BY OTHERS)
- PROJECT BOUNDARY
- LIMITS OF LINING SYSTEM (5 / D1)
- STAGE 1 REFERENCE LINE (NOTE 3) (30+00) (A / C6A)
- EXISTING FENCING
- PERMANENT V-DITCH (SW1)
- TEMPORARY V-DITCH (SW1)
- CULVERT
- LIMITS OF EXISTING LINING SYSTEM

NOTES

1. PERIMETER ACCESS ROAD CROSS SECTION SCHEDULE SHOWN ON DRAWING D1.
2. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.
3. SURVEY LAYOUT FOR STAGE 1 EMBANKMENT AND PERIMETER ROAD SHOWN ON DRAWING C6B.
4. IN AREAS WITH CONCENTRATED RUN-ON TO PERIMETER ROAD, TRAVEL SURFACE TO BE GRADED TO DRAIN INTO IMPOUNDMENT ABOVE GEOMEMBRANE LINER. ROAD SURFACE TO BE PROTECTED AS NEEDED FROM EROSION.
5. OUTSIDE OF DEFINED GRADING AREAS, EXISTING TOPOGRAPHY IS TO BE CLEARED AND GRUBBED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS. FINAL GRADES TO BE 1% AND 10% AS SHOWN ON DETAIL 4/D1. TO PREVENT AREAS OF PONDING, POSITIVE DRAINAGE TO BE MAINTAINED IN A GENERAL SOUTH TO NORTH DIRECTION.
6. TAILINGS DISTRIBUTION AND SPIGOTS TO EXTEND AROUND ENTIRE IMPOUNDMENT DESIGN BY OTHERS.

ISSUED FOR CONSTRUCTION

0 200 400 600
1" = 200' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT
GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TAILINGS STORAGE FACILITY LAYOUT
STAGE 1

PROJECT NO.	REV.		DRAWING
1663241	0	8 of 42	C5

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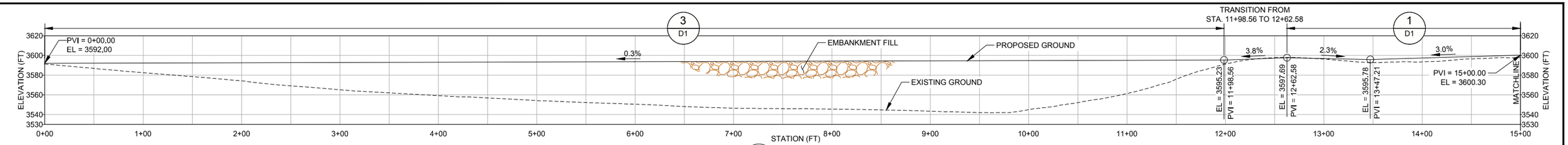
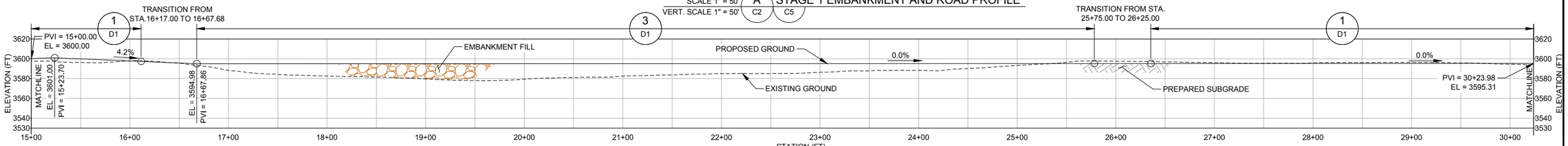
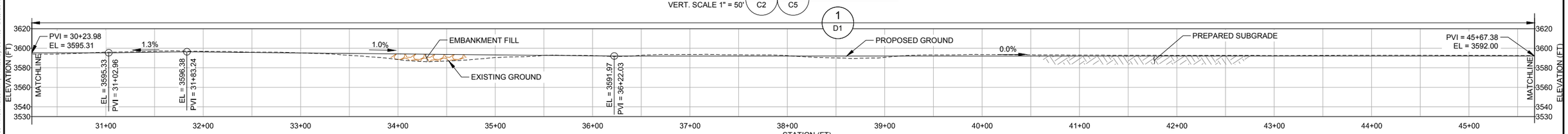


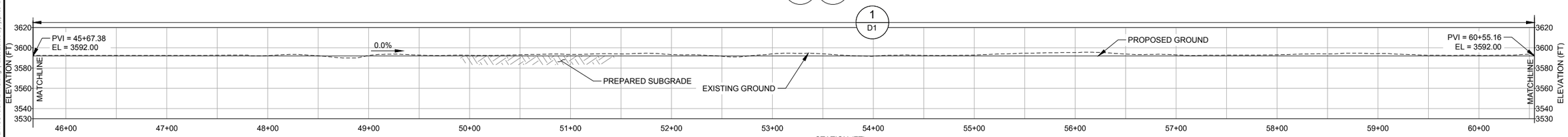
SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C5) — STAGE 1 EMBANKMENT AND ROAD PROFILE



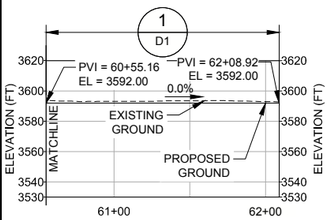
SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C5) — PROFILE CONTINUED



SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C5) — PROFILE CONTINUED



SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C5) — PROFILE CONTINUED



SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C5) — PROFILE CONTINUED

LEGEND

PROPOSED GROUND

EXISTING GROUND

ISSUED FOR CONSTRUCTION

1" = 50' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
EMBANKMENT AND ROAD PROFILE (1 OF 2)
STAGE 1

PROJECT NO. 1663241 | REV. 0 | 9 of 42 | DRAWING C6A

Path: \\envidata\MIDA\1663241 Grassy Mountain PFS\600_Drawings\PRODUCTION\CONSOLIDATED PERMIT\ | File Name: 1663241_C_010_UNDERDRAINPONDLAYOUT&GRADING.dwg | Last Edited By: jeprice Date: 2019-11-06 Time:9:12:38 AM | Printed By: JePrice Date: 2019-11-06 Time:3:05:42 PM
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
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STAGE 1 EMBANKMENT AND ROAD CURVE TABLE

CURVE	RADIUS (FT)	LENGTH (FT)	CHORD LENGTH (FT)	DELTA	CENTER (N)	CENTER (E)	START (N, E)	END (N, E)
C1	92.22	52.96	52.23	032°53'57.53"	15,866,586.62	1,544,258.98	(15,866,667.52,1,544,303.25)	(15866678.60,1544252.21)
C2	183.99	172.92	166.63	053°50'55.51"	15,866,469.59	1,543,918.94	(15,866,653.08,1,543,905.43)	(15866566.93,1543762.80)
C3	62.50	57.56	55.55	052°46'23.16"	15,865,780.48	1,543,078.04	(15,865,842.98,1,543,078.04)	(15865818.29,1543028.27)
C4	134.28	128.14	123.33	054°40'27.29"	15,865,468.76	1,542,931.37	(15,865,549.99,1,542,824.44)	(15865428.50,1542803.27)
C5	154.93	279.42	243.06	103°20'02.56"	15,865,239.60	1,543,025.05	(15,865,193.14,1,542,877.25)	(15865106.50,1543104.35)
C6	63.57	37.50	36.96	033°48'05.46"	15,865,136.92	1,543,279.62	(15,865,191.53,1,543,247.08)	(15865200.40,1543282.96)
C7	409.39	389.99	375.41	054°34'49.70"	15,865,600.60	1,543,468.19	(15,865,191.77,1,543,446.64)	(15865346.10,1543788.87)
C8	152.31	286.41	246.04	107°44'26.36"	15,865,340.99	1,543,979.26	(15,865,435.68,1,543,859.96)	(15865425.77,1544105.80)
C9	76.89	137.45	119.86	102°25'25.07"	15,865,423.22	1,544,200.06	(15,865,380.43,1,544,136.18)	(15865370.05,1544255.59)
C10	462.37	212.28	210.42	026°18'19.65"	15,865,173.19	1,544,707.24	(15,865,492.95,1,544,373.26)	(15865607.84,1544549.55)
C11	132.83	100.90	98.49	043°31'19.99"	15,865,834.73	1,544,785.43	(15,865,709.86,1,544,830.74)	(15865775.38,1544904.27)

STAGE 1 EMBANKMENT AND ROAD LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L1	924.01	N61° 18' 31.78"W	(15,866,223.92, 1,545,113.81)	(15,866,667.52, 1,544,303.25)
L2	347.71	S85° 47' 30.69"W	(15,866,678.60, 1,544,252.21)	(15,866,653.08, 1,543,905.43)
L3	479.64	S43° 46' 40.21"W	(15,866,189.31, 1,543,527.36)	(15,865,842.99, 1,543,195.51)
L4	117.47	S89° 59' 50.46"W	(15,865,842.99, 1,543,195.51)	(15,865,842.98, 1,543,078.04)
L5	336.94	S37° 13' 27.30"W	(15,865,818.29, 1,543,028.27)	(15,865,549.99, 1,542,824.44)
L6	114.36	N38° 26' 13.21"E	(15,865,346.10, 1,543,788.87)	(15,865,435.68, 1,543,859.96)
L7	54.58	S33° 49' 20.43"E	(15,865,425.77, 1,544,105.80)	(15,865,380.43, 1,544,136.18)
L8	170.15	N43° 45' 14.50"E	(15,865,370.05, 1,544,255.59)	(15,865,492.95, 1,544,373.26)
L9	299.12	N70° 03' 34.15"E	(15,865,607.84, 1,544,549.55)	(15,865,709.86, 1,544,830.74)
L10	487.62	N26° 32' 14.16"E	(15,865,775.38, 1,544,904.27)	(15,866,211.62, 1,545,122.13)
L11	166.15	N59° 12' 57.46"E	(15,865,106.50, 1,543,104.35)	(15,865,191.53, 1,543,247.08)

STAGE 1 EMBANKMENT AND ROAD LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L12	246.71	S17° 26' 59.98"E	(15,865,428.50, 1,542,803.27)	(15,865,193.14, 1,542,877.25)
L13	445.02	S31° 56' 35.18"W	(15,866,566.93, 1,543,762.80)	(15,866,189.31, 1,543,527.36)
L14	163.91	S86° 58' 57.08"E	(15,865,200.40, 1,543,282.96)	(15,865,191.77, 1,543,446.64)

ISSUED FOR CONSTRUCTION

0 50 100 150
1" = 50'
FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
EMBANKMENT AND ROAD PROFILE (2 OF 2)
STAGE 1

PROJECT NO. 1663241
REV. 0

DRAWING C6B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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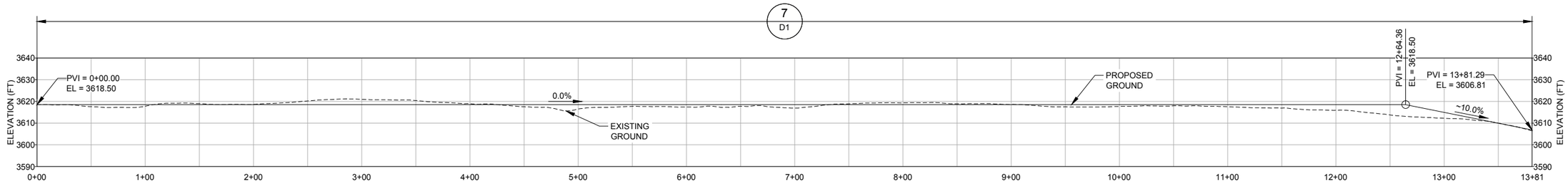

SCALE 1" = 50' / VERT. SCALE 1" = 25' — B / C5 — PERMANENT ACCESS ROAD PROFILE

PERMANENT ACCESS ROAD LINE TABLE				
LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L1	12.36	N35° 51' 16.75"E	(15,865,360.90, 1,544,564.53)	(15,865,370.92, 1,544,571.77)
L2	311.33	N60° 45' 46.62"E	(15,865,433.45, 1,544,641.97)	(15,865,585.51, 1,544,913.64)
L3	68.92	N41° 11' 19.78"E	(15,865,685.19, 1,545,036.63)	(15,865,737.05, 1,545,082.02)
L4	224.42	N25° 29' 05.33"E	(15,865,806.10, 1,545,127.44)	(15,866,008.69, 1,545,224.00)
L5	181.60	N49° 11' 21.86"E	(15,866,061.44, 1,545,264.24)	(15,866,180.12, 1,545,401.69)
L6	39.82	N19° 15' 00.00"E	(15,866,193.36, 1,545,410.69)	(15,866,230.95, 1,545,423.82)
L7	57.92	N30° 23' 56.09"E	(15,866,245.81, 1,545,430.69)	(15,866,295.77, 1,545,460.00)
L8	5.48	N43° 26' 38.87"W	(15,866,335.85, 1,545,455.41)	(15,866,339.83, 1,545,451.64)

PERMANENT ACCESS ROAD CURVE TABLE								
CURVE #	RADIUS (FT)	LENGTH (FT)	CHORD LENGTH (FT)	DELTA	CENTER (N)	CENTER (E)	START POINT (N, E)	END POINT (N, E)
C1	217.96	94.75	94.01	024°54'29.87"	15,865,243.25	1,544,748.43	(15,865,370.92, 1,544,571.77)	(15,865,433.45, 1,544,641.97)
C2	465.67	159.09	158.31	019°34'26.84"	15,865,991.85	1,544,686.20	(15,865,585.51, 1,544,913.64)	(15,865,685.19, 1,545,036.63)
C3	302.48	82.91	82.65	015°42'14.45"	15,865,936.25	1,544,854.38	(15,865,737.05, 1,545,082.02)	(15,865,806.10, 1,545,127.44)
C4	161.50	66.82	66.34	023°42'16.53"	15,865,939.20	1,545,369.79	(15,866,008.69, 1,545,224.00)	(15,866,061.44, 1,545,264.24)
C5	30.99	16.19	16.01	029°56'21.86"	15,866,203.58	1,545,381.43	(15,866,180.12, 1,545,401.69)	(15,866,193.36, 1,545,410.69)
C6	84.27	16.40	16.37	011°08'56.09"	15,866,203.17	1,545,503.37	(15,866,230.95, 1,545,423.82)	(15,866,245.81, 1,545,430.69)
C7	33.58	43.28	40.35	073°50'34.96"	15,866,312.76	1,545,431.03	(15,866,295.77, 1,545,460.00)	(15,866,335.85, 1,545,455.41)

LEGEND

PROPOSED GROUND

EXISTING GROUND

0 25 50 — 1" = 25' FEET

0 50 100 — 1" = 50' FEET

ISSUED FOR CONSTRUCTION

11/6/19

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
PERMANENT ACCESS ROAD PROFILE

PROJECT NO. 1663241 | REV. 0 | 11 of 42 | DRAWING C7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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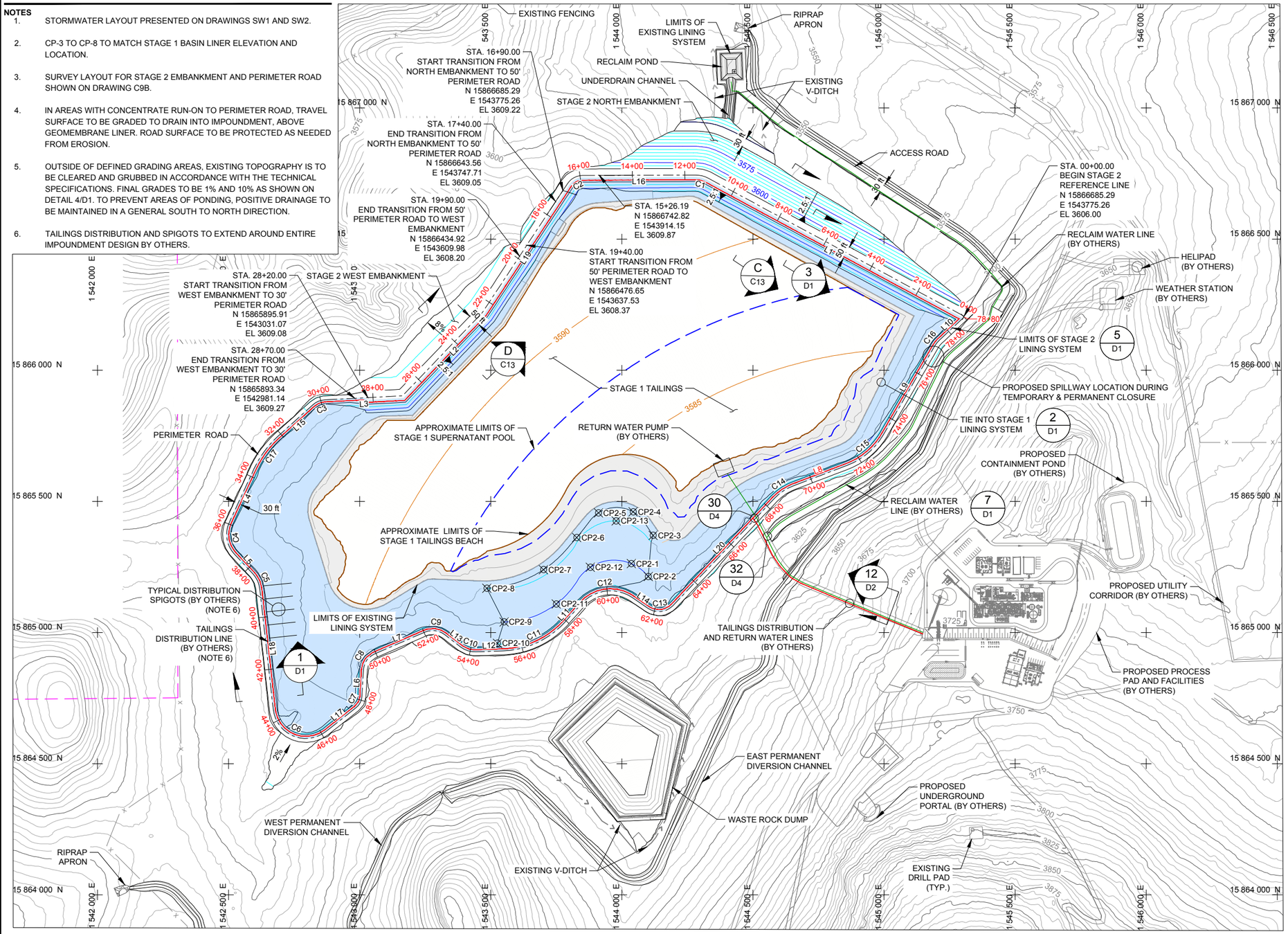
NOTES

1. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.
2. CP-3 TO CP-8 TO MATCH STAGE 1 BASIN LINER ELEVATION AND LOCATION.
3. SURVEY LAYOUT FOR STAGE 2 EMBANKMENT AND PERIMETER ROAD SHOWN ON DRAWING C9B.
4. IN AREAS WITH CONCENTRATE RUN-ON TO PERIMETER ROAD, TRAVEL SURFACE TO BE GRADED TO DRAIN INTO IMPOUNDMENT, ABOVE GEOMEMBRANE LINER. ROAD SURFACE TO BE PROTECTED AS NEEDED FROM EROSION.
5. OUTSIDE OF DEFINED GRADING AREAS, EXISTING TOPOGRAPHY IS TO BE CLEARED AND GRUBBED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS. FINAL GRADES TO BE 1% AND 10% AS SHOWN ON DETAIL 4/D1. TO PREVENT AREAS OF PONDING, POSITIVE DRAINAGE TO BE MAINTAINED IN A GENERAL SOUTH TO NORTH DIRECTION.
6. TAILINGS DISTRIBUTION AND SPIGOTS TO EXTEND AROUND ENTIRE IMPOUNDMENT DESIGN BY OTHERS.



LEGEND

- EXISTING GROUND (5 FT CONTOURS) (GENERAL NOTE 1)
- PROPOSED GRADING (5 FT CONTOURS)
- STAGE 1 TAILINGS SURFACE (5 FT CONTOURS)
- TAILINGS DISTRIBUTION LINE (BY OTHERS)
- RETURN AND RECLAIM WATERS LINE (BY OTHERS)
- PROJECT BOUNDARY
- APPROXIMATE LIMITS OF STAGE 1 TAILINGS BEACH
- LIMITS OF EXISTING LINING SYSTEM
- LIMITS OF STAGE 2 LINING SYSTEM (5 / D1)
- EXISTING V-DITCH
- APPROXIMATE LIMITS OF SUPERNATANT POOL
- EXISTING FENCING
- STAGE 2 REFERENCE LINE (NOTE 3) (A / C9A)

STAGE 2 BASIN GRADING CONTROL POINTS (NOTE 2)

POINT NO.	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
CP2-1	15,865,262.95	1,544,036.20	3,600.00
CP2-2	15,865,213.74	1,544,100.94	3,600.00
CP2-3	15,865,370.74	1,544,119.44	3,593.86
CP2-4	15,865,460.29	1,544,043.31	3,593.17
CP2-5	15,865,456.37	1,543,910.81	3,593.41
CP2-6	15,865,362.28	1,543,828.02	3,594.48
CP2-7	15,865,240.02	1,543,701.34	3,593.91
CP2-8	15,865,169.09	1,543,485.20	3,595.00
CP2-9	15,865,040.87	1,543,550.93	3,600.00
CP2-10	15,864,959.52	1,543,525.66	3,605.00
CP2-11	15,865,109.10	1,543,750.00	3,600.00
CP2-12	15,865,249.16	1,543,879.91	3,600.00
CP2-13	15,865,425.73	1,543,978.16	3,595.00

ISSUED FOR CONSTRUCTION

0 200 400 600
1" = 200' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT
GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TAILINGS STORAGE FACILITY LAYOUT
STAGE 2

PROJECT NO. 1663241 | REV. 0 | 12 of 42 | DRAWING C8

Path: \\reno\data\MDA\1663241 Grassy Mountain PFS\900 Drawings\PRODUCTION\CONSOLIDATED PERMIT\ | File Name: C4 PHASE 2 TAILINGS FACILITY.dwg | Last Edited By: jeprice Date: 2019-11-06 Time:3:33:49 PM | Printed By: JePrice Date: 2019-11-06 Time:4:06:10 PM
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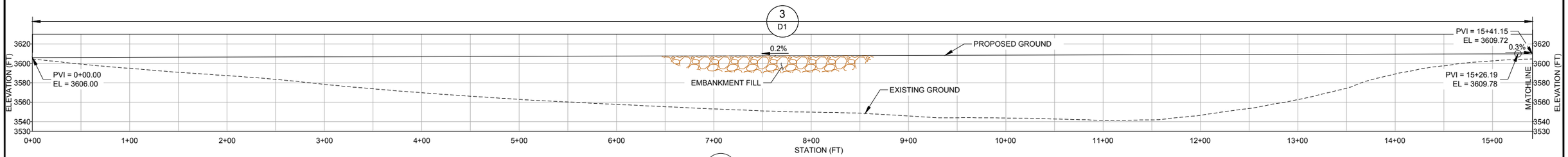

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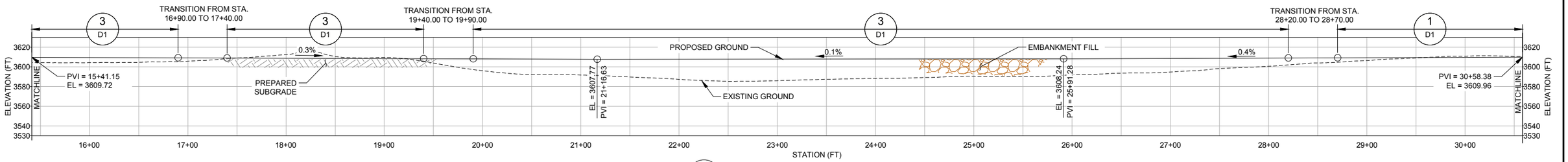

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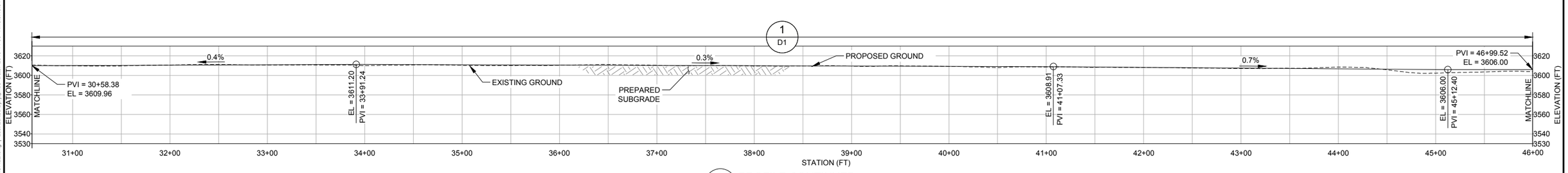

SCALE 1" = 50' / VERT. SCALE 1" = 50' — A / C8 — PROFILE CONTINUED

LEGEND

PROPOSED GROUND

EXISTING GROUND

ISSUED FOR CONSTRUCTION

0 50 100 150
1" = 50' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

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595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
EMBANKMENT AND ROAD PROFILE (1 OF 2)
STAGE 2

PROJECT NO. 1663241 | REV. 0 | 13 of 42 | DRAWING C9A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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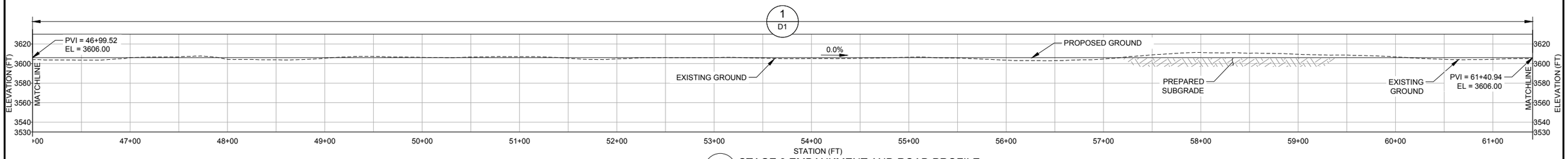
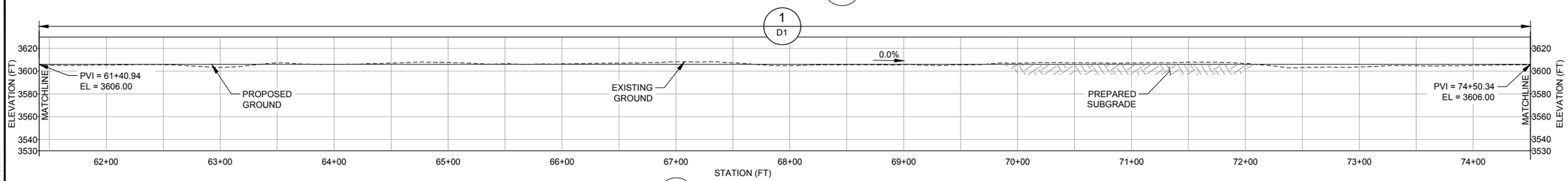


SCALE 1" = 50'
VERT. SCALE 1" = 50'

A
C8

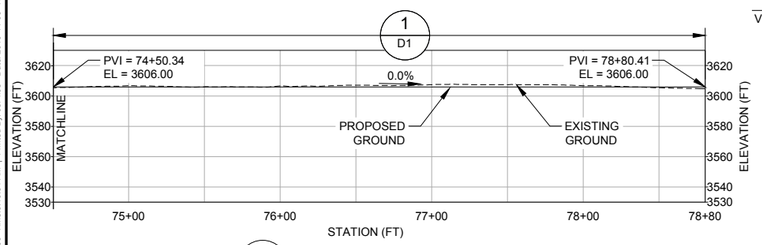
STAGE 2 EMBANKMENT AND ROAD PROFILE



SCALE 1" = 50'
VERT. SCALE 1" = 50'

A
C8

PROFILE CONTINUED



SCALE 1" = 50'
VERT. SCALE 1" = 50'

A
C8

PROFILE CONTINUED

STAGE 2 EMBANKMENT AND ROAD LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L1	1108.32	N61° 39' 57.22"W	(15,866,206.04, 1,545,305.58)	(15,866,732.07, 1,544,330.04)
L2	439.49	S43° 49' 19.75"W	(15,866,219.84, 1,543,468.01)	(15,865,902.75, 1,543,163.69)
L3	296.39	S87° 02' 46.97"W	(15,865,902.75, 1,543,163.69)	(15,865,887.48, 1,542,867.69)
L4	225.49	S24° 44' 42.64"W	(15,865,624.21, 1,542,596.87)	(15,865,419.43, 1,542,502.48)
L5	104.90	S42° 57' 52.02"E	(15,865,300.34, 1,542,521.58)	(15,865,223.58, 1,542,593.07)
L6	101.81	N3° 14' 04.89"E	(15,864,756.70, 1,543,008.92)	(15,864,858.35, 1,543,014.67)
L7	209.44	N66° 29' 45.38"E	(15,864,918.18, 1,543,056.35)	(15,865,001.71, 1,543,248.41)
L8	219.21	N69° 11' 47.36"E	(15,865,559.63, 1,544,654.54)	(15,865,637.49, 1,544,859.46)
L9	389.78	N30° 03' 21.90"E	(15,865,756.03, 1,544,998.88)	(15,866,093.40, 1,545,194.10)
L10	130.77	N46° 46' 22.22"E	(15,866,113.59, 1,545,210.11)	(15,866,203.15, 1,545,305.39)

STAGE 2 EMBANKMENT AND ROAD LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L11	92.30	N41° 51' 24.16"E	(15,865,041.50, 1,543,784.62)	(15,865,110.25, 1,543,846.21)
L12	104.60	N88° 00' 26.86"E	(15,864,926.70, 1,543,442.42)	(15,864,930.33, 1,543,546.95)
L13	77.19	S52° 17' 22.95"E	(15,864,992.22, 1,543,324.52)	(15,864,945.01, 1,543,385.59)
L14	73.42	S55° 42' 08.00"E	(15,865,133.75, 1,544,039.78)	(15,865,092.38, 1,544,100.43)
L15	178.90	S47° 58' 08.24"W	(15,865,868.23, 1,542,821.20)	(15,865,748.46, 1,542,688.32)
L16	432.14	S89° 45' 53.02"W	(15,866,744.33, 1,544,281.04)	(15,866,742.55, 1,543,848.90)
L17	146.74	N51° 40' 35.78"E	(15,864,623.29, 1,542,871.76)	(15,864,714.28, 1,542,986.88)
L18	463.16	S6° 24' 42.32"E	(15,865,167.41, 1,542,618.89)	(15,864,707.15, 1,542,670.61)
L19	590.21	S33° 25' 46.23"W	(15,866,712.41, 1,543,793.16)	(15,866,219.84, 1,543,468.01)
L20	563.82	N43° 28' 35.63"E	(15,865,102.45, 1,544,194.47)	(15,865,511.60, 1,544,582.41)

STAGE 2 EMBANKMENT AND ROAD CURVE TABLE

CURVE #	RADIUS (FT)	LENGTH (FT)	CHORD LENGTH (FT)	DELTA	CENTER (N)	CENTER (E)	START POINT (N, E)	END POINT (N, E)
C1	102.36	51.04	50.51	028°34'09.76"	15,866,641.97	1,544,281.46	(15,866,732.07, 1,544,330.04)	(15,866,744.33, 1,544,281.04)
C2	67.12	66.00	63.37	056°20'06.79"	15,866,675.43	1,543,849.18	(15,866,742.55, 1,543,848.90)	(15,866,712.41, 1,543,793.16)
C3	75.22	51.30	50.32	039°04'38.73"	15,865,812.36	1,542,871.57	(15,865,887.48, 1,542,867.69)	(15,865,868.23, 1,542,821.20)
C4	108.25	127.92	120.61	067°42'34.66"	15,865,374.12	1,542,600.79	(15,865,419.43, 1,542,502.48)	(15,865,300.34, 1,542,521.58)
C5	98.56	62.88	61.82	036°33'09.71"	15,865,156.40	1,542,520.95	(15,865,223.58, 1,542,593.07)	(15,865,167.41, 1,542,618.89)
C6	124.64	265.20	217.92	121°54'41.90"	15,864,721.07	1,542,794.47	(15,864,707.15, 1,542,670.61)	(15,864,623.29, 1,542,871.76)
C7	58.26	49.26	47.80	048°26'30.90"	15,864,759.99	1,542,950.75	(15,864,714.28, 1,542,986.88)	(15,864,756.70, 1,543,008.92)
C8	69.51	76.75	72.91	063°15'40.49"	15,864,854.43	1,543,084.07	(15,864,858.35, 1,543,014.67)	(15,864,918.18, 1,543,056.35)
C9	75.32	80.48	76.70	061°12'51.68"	15,864,932.63	1,543,278.45	(15,865,001.71, 1,543,248.41)	(15,864,992.22, 1,543,324.52)
C10	87.91	60.91	59.70	039°42'10.19"	15,865,014.55	1,543,439.36	(15,864,945.01, 1,543,385.59)	(15,864,926.70, 1,543,442.42)

STAGE 2 EMBANKMENT AND ROAD CURVE TABLE

CURVE #	RADIUS (FT)	LENGTH (FT)	CHORD LENGTH (FT)	DELTA	CENTER (N)	CENTER (E)	START POINT (N, E)	END POINT (N, E)
C11	334.72	269.61	262.38	046°09'02.71"	15,865,264.85	1,543,535.32	(15,864,930.33, 1,543,546.95)	(15,865,041.50, 1,543,784.62)
C12	147.95	212.88	194.99	082°26'27.84"	15,865,011.53	1,543,956.41	(15,865,110.25, 1,543,846.21)	(15,865,133.75, 1,544,039.78)
C13	72.95	102.90	94.58	080°49'16.37"	15,865,152.65	1,544,141.53	(15,865,092.38, 1,544,100.43)	(15,865,102.45, 1,544,194.47)
C14	194.68	87.39	86.66	025°43'11.73"	15,865,377.65	1,544,723.68	(15,865,511.60, 1,544,582.41)	(15,865,559.63, 1,544,654.54)
C15	273.18	186.61	183.01	039°08'25.46"	15,865,892.85	1,544,762.43	(15,865,637.49, 1,544,859.46)	(15,865,756.03, 1,544,998.88)
C16	88.62	25.86	25.77	016°43'00.32"	15,866,049.01	1,545,270.80	(15,866,093.40, 1,545,194.10)	(15,866,113.59, 1,545,210.11)
C17	383.24	155.34	154.28	023°13'25.60"	15,865,463.79	1,542,944.91	(15,865,748.46, 1,542,688.32)	(15,865,624.21, 1,542,596.87)

LEGEND

PROPOSED GROUND

EXISTING GROUND

ISSUED FOR CONSTRUCTION

0 50 100 150

1" = 50' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
EMBANKMENT AND ROAD PROFILE (2 OF 2)
STAGE 2

PROJECT NO. 1663241 | REV. 0 | 14 of 42 | DRAWING C9B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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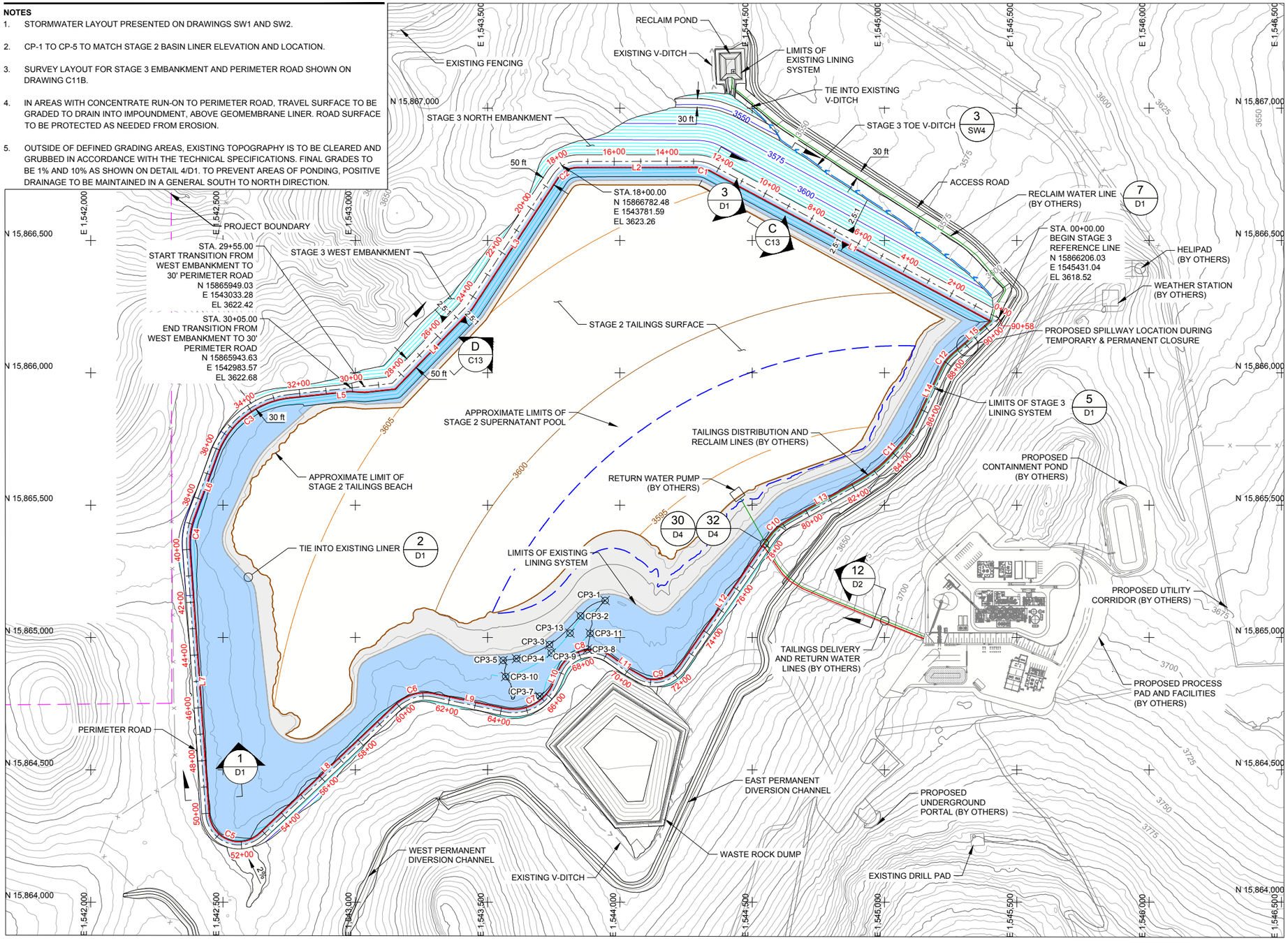
NOTES

1. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.
2. CP-1 TO CP-5 TO MATCH STAGE 2 BASIN LINER ELEVATION AND LOCATION.
3. SURVEY LAYOUT FOR STAGE 3 EMBANKMENT AND PERIMETER ROAD SHOWN ON DRAWING C11B.
4. IN AREAS WITH CONCENTRATE RUN-ON TO PERIMETER ROAD, TRAVEL SURFACE TO BE GRADED TO DRAIN INTO IMPOUNDMENT, ABOVE GEOMEMBRANE LINER. ROAD SURFACE TO BE PROTECTED AS NEEDED FROM EROSION.
5. OUTSIDE OF DEFINED GRADING AREAS, EXISTING TOPOGRAPHY IS TO BE CLEARED AND GRUBBED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS. FINAL GRADES TO BE 1% AND 10% AS SHOWN ON DETAIL 4/D1. TO PREVENT AREAS OF PONDING, POSITIVE DRAINAGE TO BE MAINTAINED IN A GENERAL SOUTH TO NORTH DIRECTION.



LEGEND

- EXISTING GROUND (5 FT CONTOURS) (GENERAL NOTE 1)
- PROPOSED GRADING (5 FT CONTOURS)
- STAGE 2 TAILINGS SURFACE (5 FT CONTOURS)
- TAILINGS DISTRIBUTION LINE (BY OTHERS)
- RECLAIM WATER LINE (BY OTHERS)
- APPROXIMATE LIMITS OF STAGE 2 TAILINGS BEACH
- LIMITS OF EXISTING LINING SYSTEM
- LIMITS OF STAGE 3 LINING SYSTEM (5 / D1)
- PROJECT BOUNDARY
- EXISTING V-DITCH (3 / SW4)
- PERMANENT V-DITCH (3 / SW4)
- APPROXIMATE LIMITS OF SUPERNATANT POOL
- EXISTING FENCING
- STAGE 3 REFERENCE LINE (NOTE 3) (A / C11A)

STAGE 3 BASIN GRADING CONTROL POINTS

POINT NO.	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
CP3-1	15,865,139.60	1,543,944.04	3,607.64
CP3-2	15,865,081.63	1,543,850.95	3,609.05
CP3-3	15,864,972.99	1,543,733.71	3,607.28
CP3-4	15,864,919.99	1,543,609.09	3,606.94
CP3-5	15,864,913.47	1,543,558.28	3,606.99
CP3-7	15,864,778.03	1,543,696.58	3,614.28
CP3-8	15,864,955.74	1,543,877.48	3,618.21
CP3-9	15,864,941.32	1,543,740.56	3,610.00
CP3-10	15,864,852.20	1,543,568.02	3,610.00
CP3-11	15,865,015.83	1,543,887.30	3,615.00
CP3-13	15,865,016.46	1,543,810.93	3,610.00

ISSUED FOR CONSTRUCTION

0 200 400 600
1" = 200' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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MALHEUR COUNTY, OREGON

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TAILINGS STORAGE FACILITY LAYOUT
STAGE 3

PROJECT NO.	REV.		DRAWING
1663241	0	15 of 42	C10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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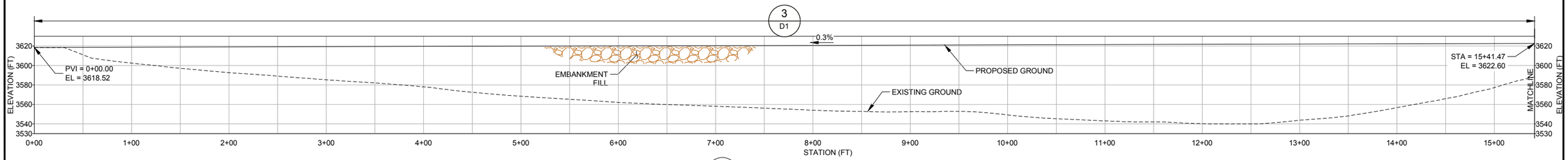
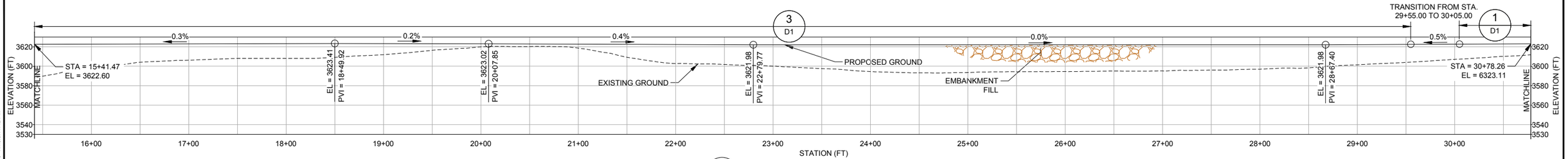
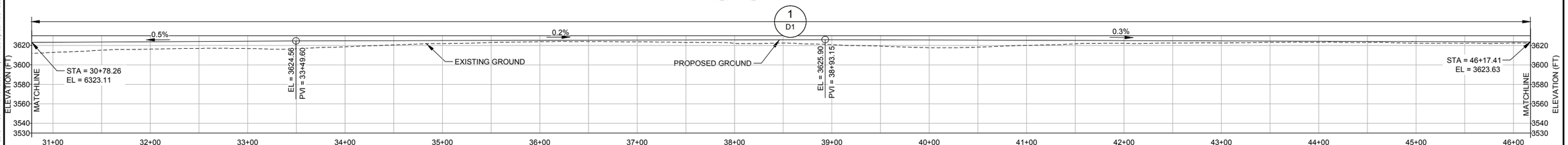


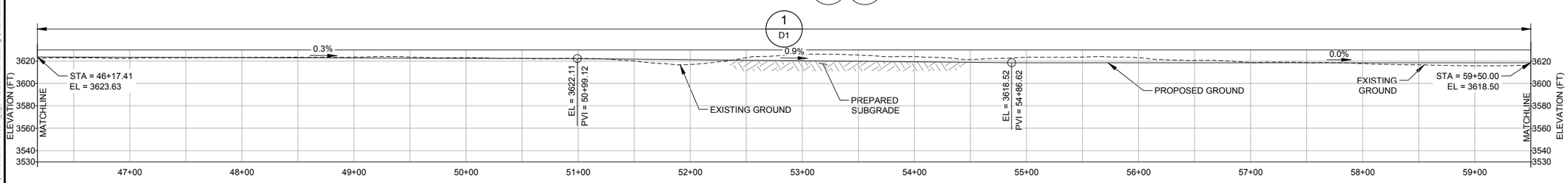
SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C10) — STAGE 3 EMBANKMENT AND ROAD PROFILE



SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C10) — PROFILE CONTINUED



SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C10) — PROFILE CONTINUED



SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C10) — PROFILE CONTINUED

LEGEND

PROPOSED GROUND

EXISTING GROUND

ISSUED FOR CONSTRUCTION

0 50 100 150
1" = 50' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
EMBANKMENT AND ROAD PROFILE (1 OF 2)
STAGE 3

PROJECT NO. 1663241 | REV. 0 | 16 of 42 | DRAWING C11A

Path: \\envidata\MDA\1663241 Grassy Mountain PFS\900_Drawings\PRODUCTION\CONSOLIDATED PERMIT\ | File Name: 1663241_C_STAGE 3 PROFILE.dwg | Last Edited By: rperkins Date: 2019-11-06 Time:10:15:06 AM | Printed By: JePrice Date: 2019-11-06 Time:3:11:42 PM
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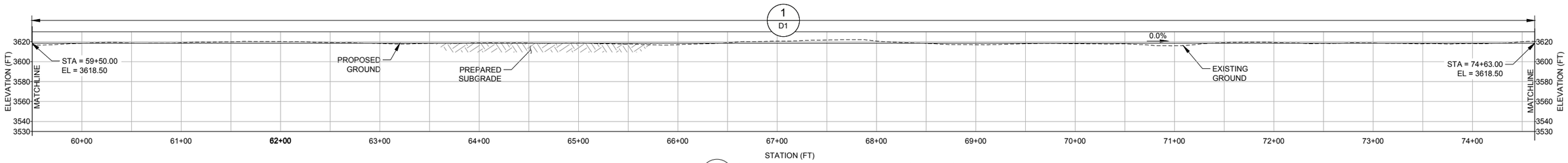

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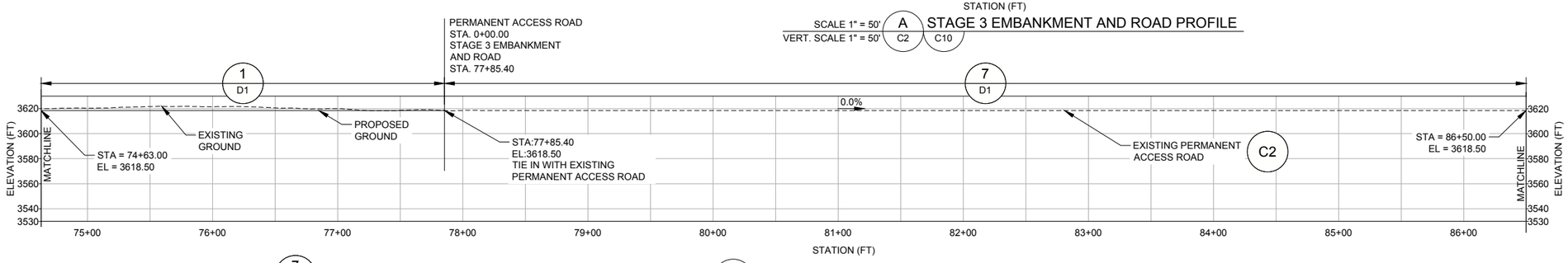

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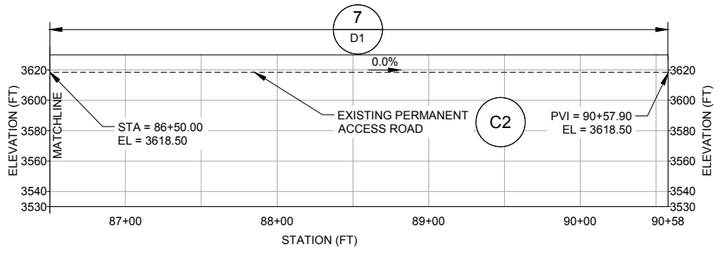

SCALE 1" = 50' / VERT. SCALE 1" = 50' — A (C2, C10) — PROFILE CONTINUED

STAGE 3 EMBANKMENT AND ROAD CURVE TABLE

CURVE #	RADIUS (FT)	LENGTH (FT)	CHORD LENGTH (FT)	DELTA	CENTER (N)	CENTER (E)	START POINT (N, E)	END POINT (N, E)
C1	130.55	64.3	63.62	028°12'14.52"	15,866,668.81	1,544,288.90	(15,866,783.92, 1,544,350.48)	(15,866,799.35, 1,544,288.76)
C2	108.32	107.1	102.80	056°39'27.37"	15,866,690.57	1,543,838.33	(15,866,798.89, 1,543,838.22)	(15,866,750.01, 1,543,747.78)
C3	339.28	377.3	358.15	063°42'58.23"	15,865,580.97	1,542,786.53	(15,865,918.26, 1,542,749.91)	(15,865,697.49, 1,542,467.90)
C4	288.75	122.1	121.16	024°13'14.68"	15,865,356.17	1,542,650.53	(15,865,455.35, 1,542,379.35)	(15,865,335.36, 1,542,362.53)
C5	125.77	283.8	227.32	129°18'06.60"	15,864,341.80	1,542,560.44	(15,864,332.73, 1,542,434.99)	(15,864,250.47, 1,542,646.91)
C6	149.28	144.0	138.45	055°15'20.25"	15,864,629.26	1,543,264.10	(15,864,737.66, 1,543,161.47)	(15,864,775.38, 1,543,294.68)
C7	176.37	242.8	224.10	078°53'07.78"	15,864,892.07	1,543,598.07	(15,864,719.44, 1,543,561.95)	(15,864,823.34, 1,543,760.50)
C8	121.19	217.8	189.64	102°57'52.83"	15,864,819.54	1,543,890.49	(15,864,866.76, 1,543,778.88)	(15,864,917.71, 1,543,961.55)
C9	132.22	210.6	189.02	091°15'03.53"	15,864,960.98	1,544,127.25	(15,864,853.88, 1,544,049.72)	(15,864,885.81, 1,544,236.02)
C10	217.39	99.1	98.23	026°06'49.40"	15,865,243.31	1,544,747.35	(15,865,366.91, 1,544,568.51)	(15,865,433.01, 1,544,641.17)
C11	581.76	358.2	352.56	035°16'38.41"	15,866,085.78	1,544,616.27	(15,865,578.13, 1,544,900.43)	(15,865,835.46, 1,545,141.43)
C12	142.80	59.1	58.66	023°42'16.53"	15,865,950.79	1,545,354.59	(15,866,012.23, 1,545,225.69)	(15,866,058.87, 1,545,261.27)

STAGE 3 EMBANKMENT AND ROAD LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L1	1225.39	N61° 51' 17.45"W	(15,866,205.89, 1,545,430.97)	(15,866,783.92, 1,544,350.48)
L2	450.55	S89° 56' 28.03"W	(15,866,799.35, 1,544,288.76)	(15,866,798.89, 1,543,838.22)
L3	593.80	S33° 17' 00.67"W	(15,866,750.01, 1,543,747.78)	(15,866,253.62, 1,543,421.91)
L4	406.79	S43° 55' 03.84"W	(15,866,253.62, 1,543,421.91)	(15,865,960.59, 1,543,139.75)
L5	392.13	S83° 48' 12.09"W	(15,865,960.59, 1,543,139.75)	(15,865,918.26, 1,542,749.91)
L6	257.83	S20° 05' 13.86"W	(15,865,697.49, 1,542,467.90)	(15,865,455.35, 1,542,379.35)
L7	1005.25	S4° 08' 00.82"E	(15,865,335.36, 1,542,362.53)	(15,864,332.73, 1,542,434.99)
L8	708.61	N46° 33' 52.58"E	(15,864,250.47, 1,542,646.91)	(15,864,737.66, 1,543,161.47)
L9	273.06	S78° 10' 47.18"E	(15,864,775.38, 1,543,294.68)	(15,864,719.44, 1,543,561.95)
L10	47.15	N22° 56' 05.05"E	(15,864,823.34, 1,543,760.50)	(15,864,866.76, 1,543,778.88)
L11	108.85	S54° 06' 02.13"E	(15,864,917.71, 1,543,961.55)	(15,864,853.88, 1,544,049.72)
L12	584.81	N34° 38' 54.35"E	(15,864,885.81, 1,544,236.02)	(15,865,366.91, 1,544,568.51)

STAGE 3 EMBANKMENT AND ROAD LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L13	297.11	N60° 45' 43.75"E	(15,865,433.01, 1,544,641.17)	(15,865,578.13, 1,544,900.43)
L14	195.83	N25° 29' 05.33"E	(15,865,835.46, 1,545,141.43)	(15,866,012.23, 1,545,225.69)
L15	224.67	N49° 11' 21.86"E	(15,866,058.87, 1,545,261.27)	(15,866,205.71, 1,545,431.31)

LEGEND

PROPOSED GROUND

EXISTING GROUND

ISSUED FOR CONSTRUCTION

0 50 100 150
1" = 50' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

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595 DOUBLE EAGLE COURT, SUITE 1000
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www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
EMBANKMENT AND ROAD PROFILE (2 OF 2)
STAGE 3

PROJECT NO. 1663241 | REV. 0 | 17 of 42 | DRAWING C11B

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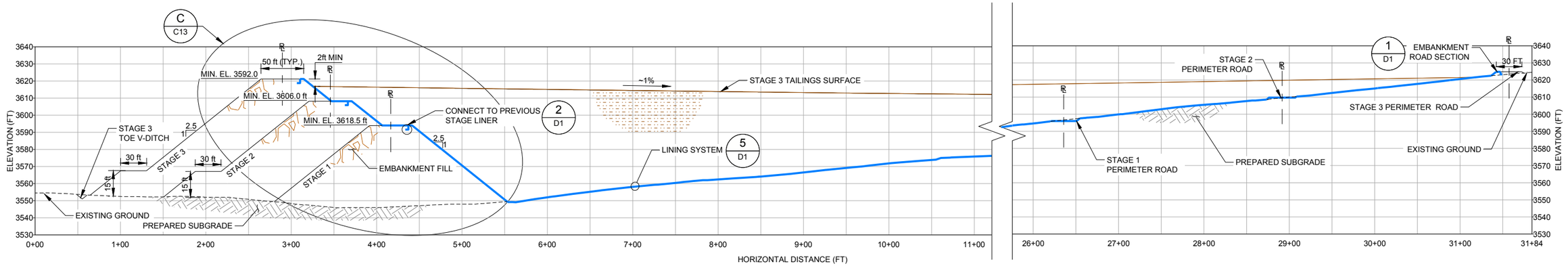
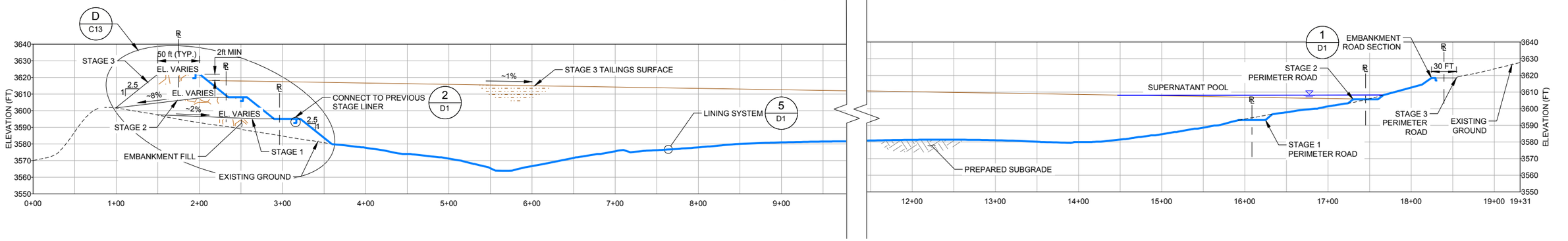


SCALE 1" = 60'
VERT. SCALE 1" = 30'

A C1 NORTH TO SOUTH TYPICAL SECTION



SCALE 1" = 60'
VERT. SCALE 1" = 30'

B C1 WEST TO EAST TYPICAL SECTION

LEGEND

- LINING SYSTEM (5 / D1)
- EXISTING GROUND
- TAILINGS SURFACE
- SUPERNATANT POOL SURFACE

ISSUED FOR CONSTRUCTION

0 30 60
1" = 30' FEET

0 60 120
1" = 60' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

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GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TAILINGS STORAGE FACILITY OVERALL SECTIONS

PROJECT NO. 1663241
REV. 0

DRAWING C12

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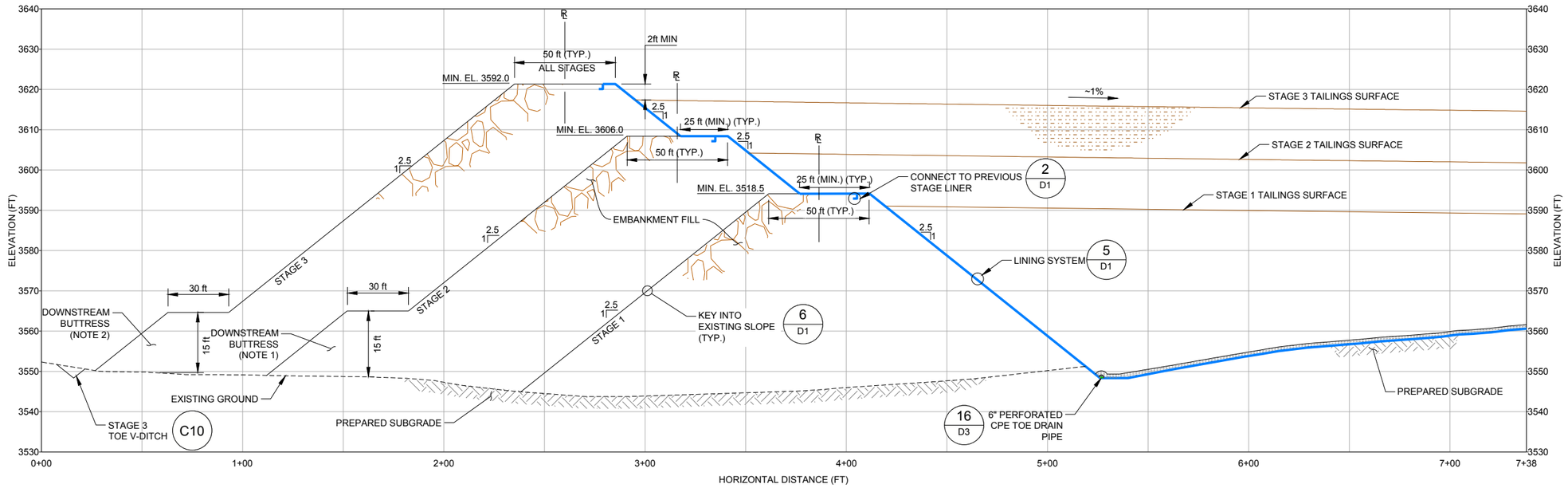
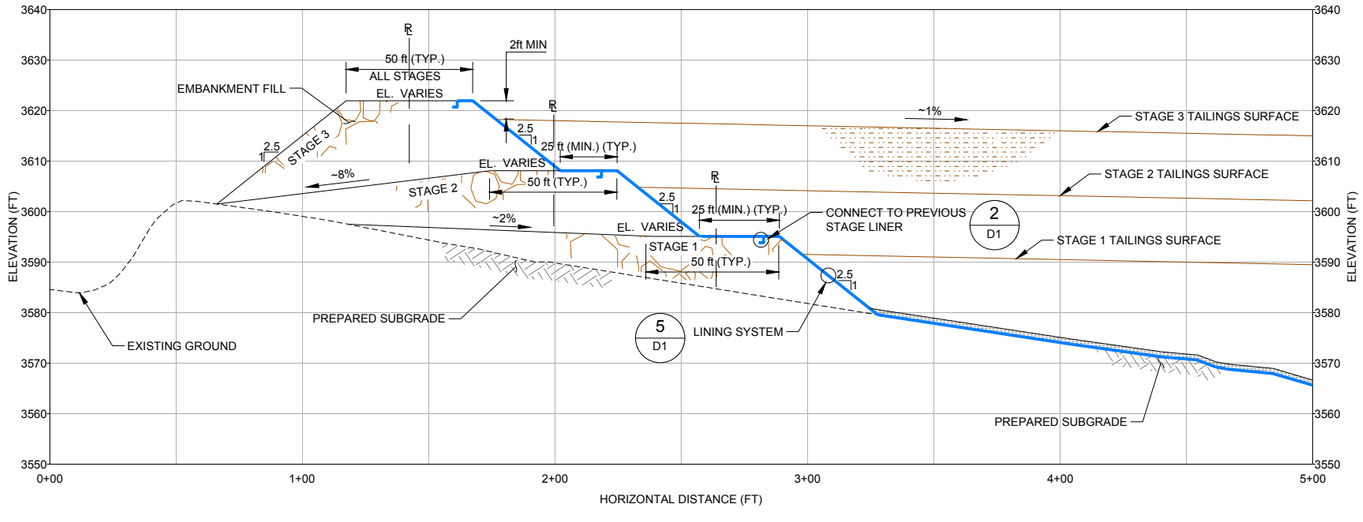


SCALE 1" = 30' VERT. SCALE 1" = 15' — C — C1 C5 C8 C10 C12 — NORTH EMBANKMENT TYPICAL SECTION



SCALE 1" = 30' VERT. SCALE 1" = 15' — D — C1 C5 C8 C10 C12 — WEST EMBANKMENT TYPICAL SECTION

LEGEND

- LINING SYSTEM (5 / D1)
- EXISTING GROUND
- TAILINGS SURFACE

NOTES

1. DOWNSTREAM BUTTRESS FROM STAGE 2 REFERENCE LINE STATIONS 9+16.00 TO 12+17.00 ONLY.
2. DOWNSTREAM BUTTRESS FROM STAGE 3 REFERENCE LINE STATIONS 10+48.00 TO 13+67.00 ONLY.

ISSUED FOR CONSTRUCTION

0 15 30 45 — 1" = 15' FEET

0 30 60 90 — 1" = 30' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

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www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TAILINGS STORAGE FACILITY EMBANKMENT SECTIONS

PROJECT NO. 1663241 | REV. 0 | 19 of 42 | DRAWING C13

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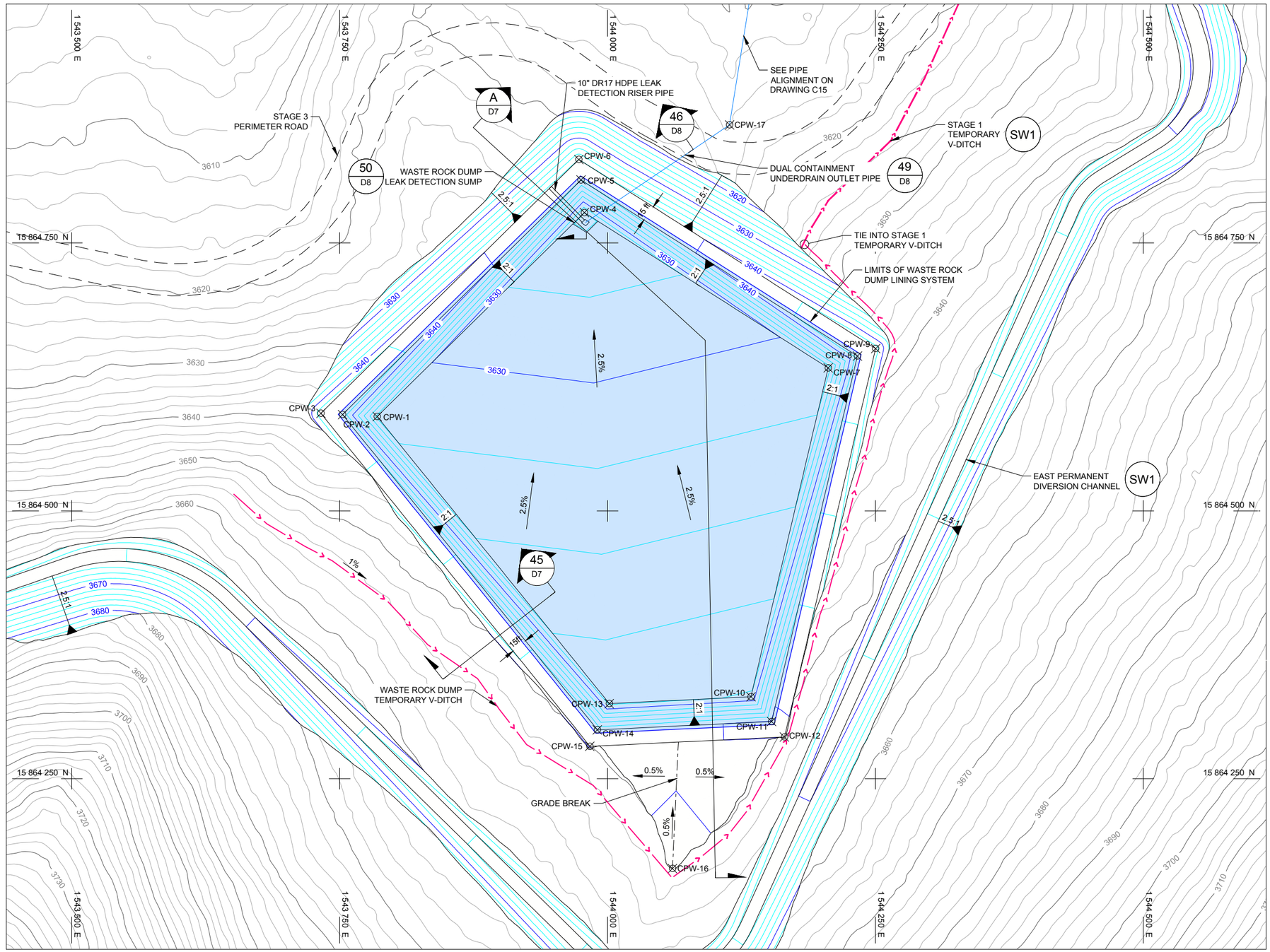

LEGEND

- 3600 — EXISTING GROUND (2 FT CONTOURS) (GENERAL NOTE 1)
- 3600 — PROPOSED GRADING (2 FT CONTOURS)
- TEMPORARY V-DITCH SW1
- LIMITS OF WASTE ROCK DUMP LINING SYSTEM 5 D1
- STAGE 3 PERIMETER ROAD

NOTE

1. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.

WASTE ROCK DUMP CONTROL TABLE

POINT NO.	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)	DESCRIPTION
CPW-1	15,864,588.04	1,543,785.09	3,631.43	BERM TOE
CPW-2	15,864,589.87	1,543,752.75	3,643.43	BERM CREST
CPW-3	15,864,591.02	1,543,732.54	3,643.43	BERM CREST
CPW-4	15,864,778.44	1,543,978.41	3,626.02	BERM TOE
CPW-5	15,864,808.95	1,543,975.19	3,638.02	BERM CREST
CPW-6	15,864,828.02	1,543,973.17	3,638.02	BERM CREST
CPW-7	15,864,633.47	1,544,205.90	3,630.98	BERM TOE
CPW-8	15,864,644.56	1,544,233.16	3,642.98	BERM CREST
CPW-9	15,864,651.49	1,544,250.19	3,642.98	BERM CREST
CPW-10	15,864,326.45	1,544,133.84	3,638.13	BERM TOE
CPW-11	15,864,303.35	1,544,153.07	3,650.13	BERM CREST
CPW-12	15,864,288.91	1,544,165.09	3,650.13	BERM CREST
CPW-13	15,864,320.11	1,544,001.63	3,637.49	BERM TOE
CPW-14	15,864,295.55	1,543,990.43	3,649.49	BERM CREST
CPW-15	15,864,280.20	1,543,983.43	3,649.49	BERM CREST
CPW-16	15,864,166.13	1,544,060.60	3,650.33	EXISTING GROUND TIE-IN
CPW-17	15,864,860.29	1,544,113.85	3,613.99	UNDERDRAIN OUTLET PIPE HINGE

0 50 100
1" = 50' FEET

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

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0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
WASTE ROCK DUMP LAYOUT

PROJECT NO. 1663241
REV. 0
20 of 42
DRAWING C14

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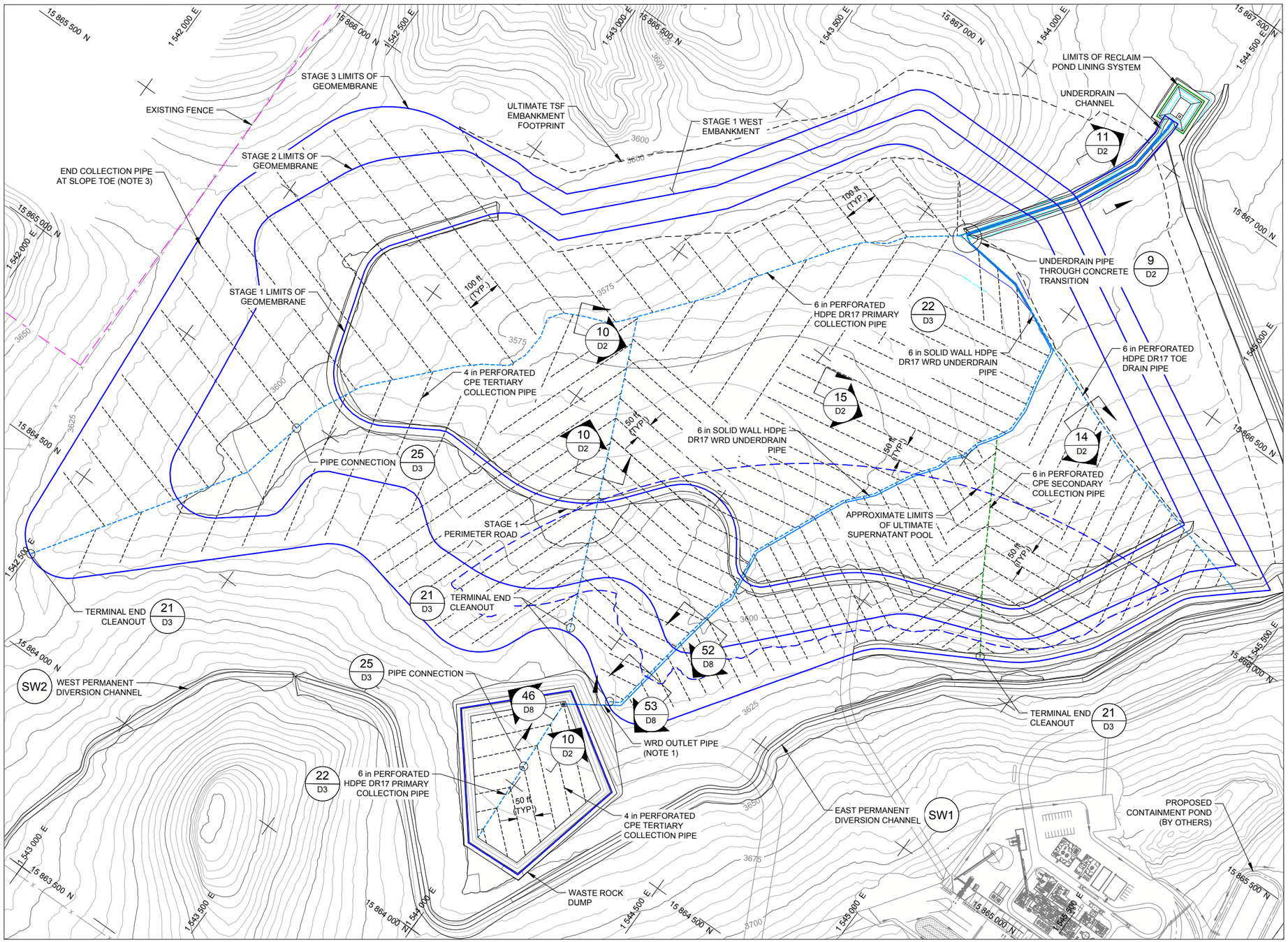
0 1 in



LEGEND

- EXISTING GROUND CONTOURS (5 FT CONTOURS) (GENERAL NOTE 1)
- PROJECT BOUNDARY
- 6 in SOLID WALL HDPE DR17 PRIMARY COLLECTION PIPE
- 4 in PERFORATED CPE TERTIARY COLLECTION PIPE
- 6 in PERFORATED CPE SECONDARY COLLECTION PIPE
- 6 in PERFORATED HDPE DR17 PRIMARY COLLECTION PIPE
- LIMITS OF RECLAIM POND LINING SYSTEM (42 / D6)
- LIMITS OF STAGED GEOMEMBRANE (5 / D1)
- EXISTING FENCE
- ULTIMATE TSF EMBANKMENT FOOTPRINT

NOTES

1. WASTE ROCK DUMP UNDERDRAIN OUTLET PIPE CONSTRUCTED DURING STAGE 1.
2. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.
3. EXTEND COLLECTION PIPING TO UPSTREAM TOE OF PERIMETER ROAD.

ISSUED FOR CONSTRUCTION

0 150 300 450
1" = 150' FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
UNDERDRAIN COLLECTION SYSTEM LAYOUT

PROJECT NO.	REV.		DRAWING
1663241	0	21 of 42	C15

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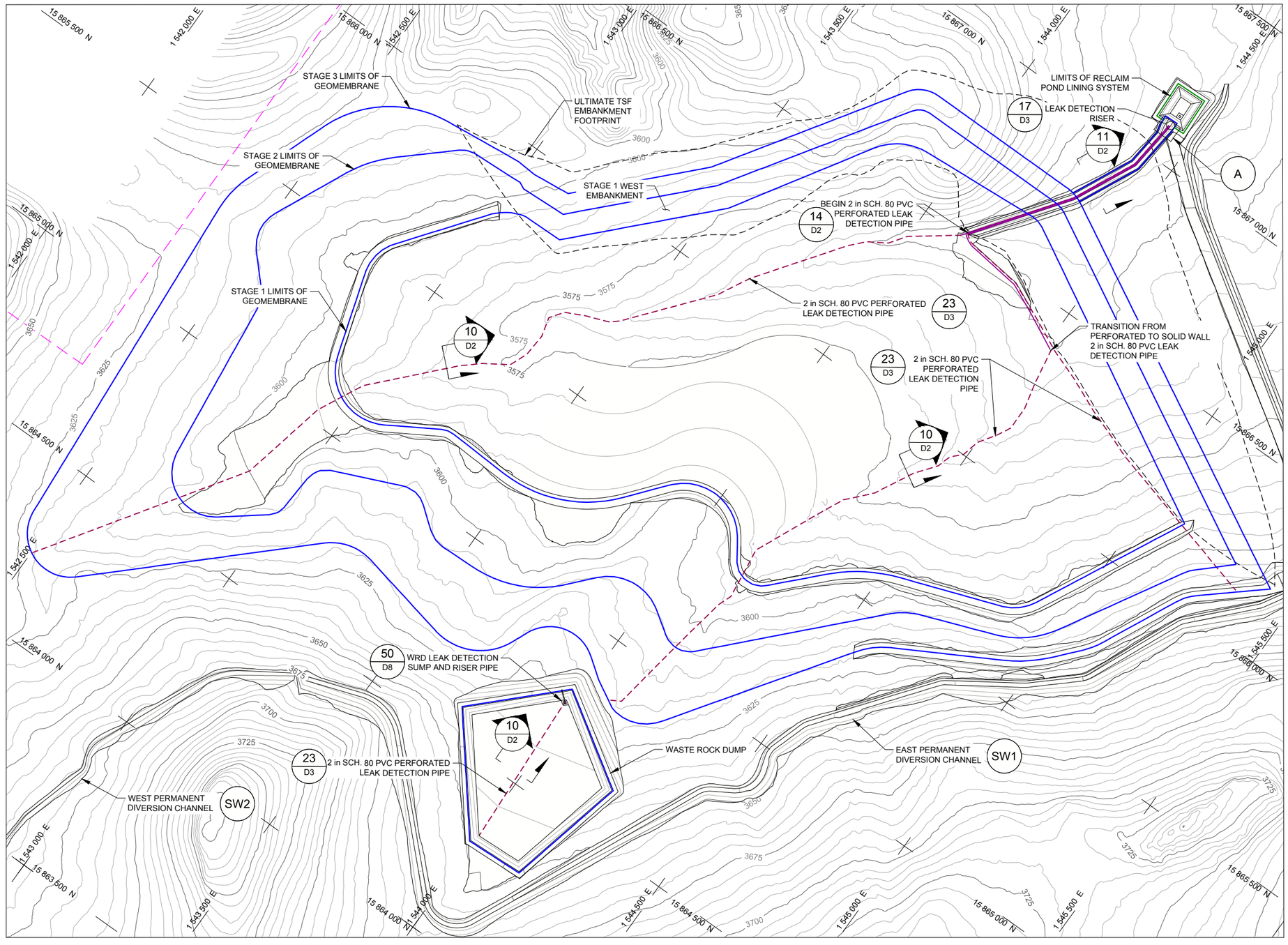
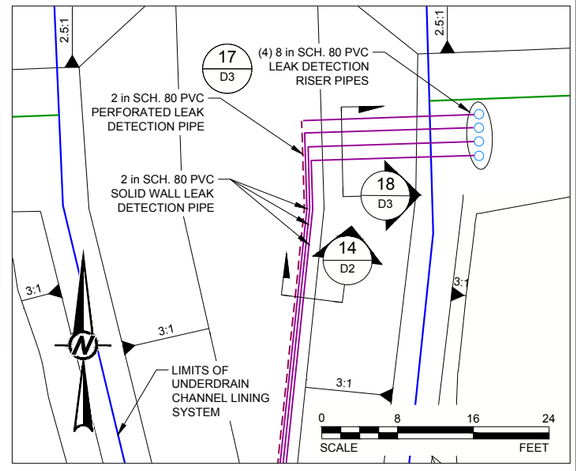


LEGEND

- 3600 — EXISTING GROUND CONTOURS (5 FT CONTOURS) (GENERAL NOTE 1)
- PROJECT BOUNDARY
- LIMITS OF RECLAIM POND LINING SYSTEM — 42 / D6
- LIMITS OF STAGED GEOMEMBRANE — 5 / D1
- 2 in SCH. 80 PVC PERFORATED LEAK DETECTION PIPE — 23 / C13
- 2 in SCH. 80 PVC SOLID WALL LEAK DETECTION PIPE
- ULTIMATE TSF EMBANKMENT FOOTPRINT

NOTE

1. STORMWATER LAYOUT PRESENTED ON SHEETS SW1 AND SW2.



NTS A - LEAK DETECTION RISER DETAIL

ISSUED FOR CONSTRUCTION

0 150 300 450
1" = 150' FEET

11/6/19

EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
LEAK DETECTION SYSTEM LAYOUT

PROJECT NO. 1663241 | REV. 0 | 22 of 42 | DRAWING C16

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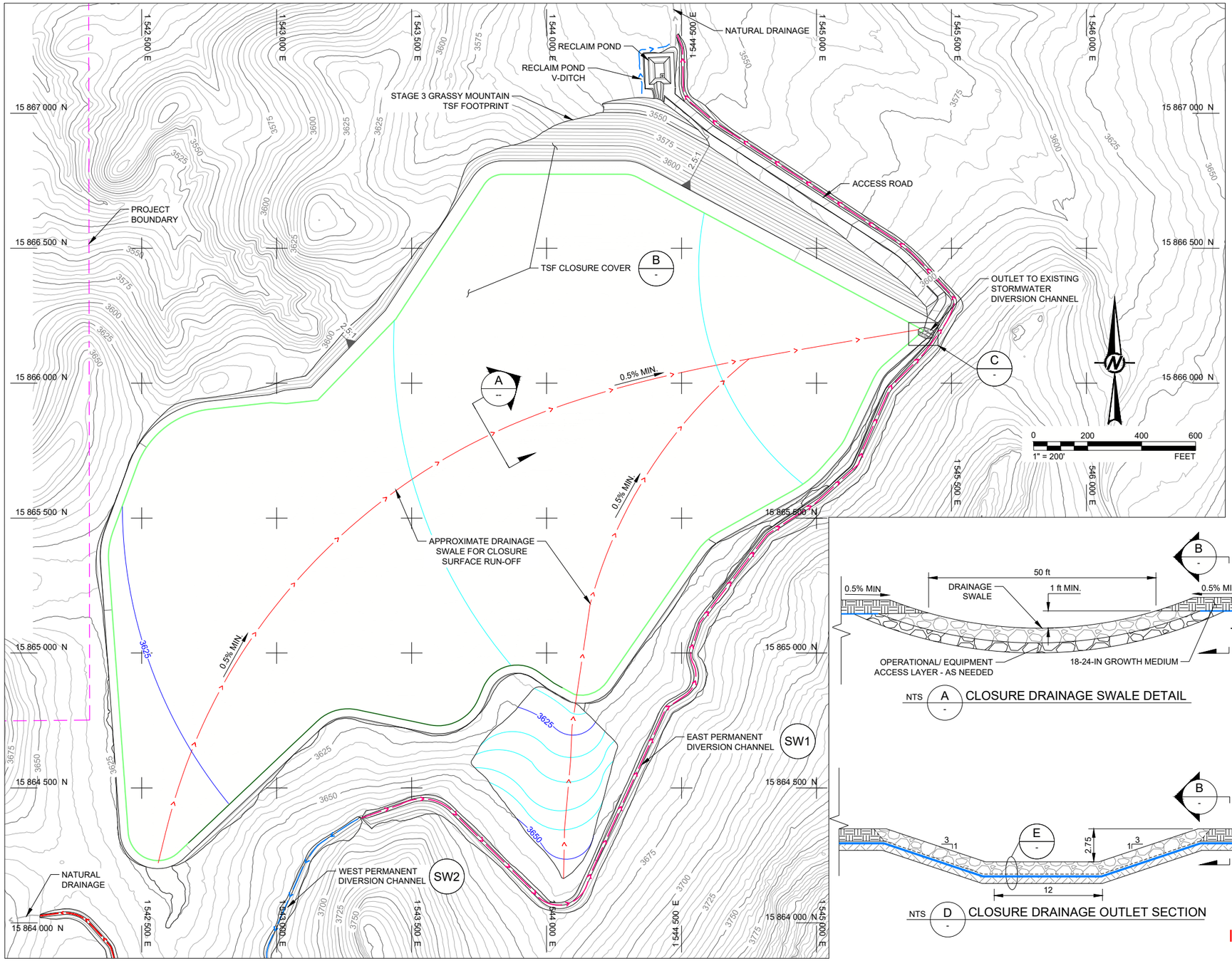
0 1 in

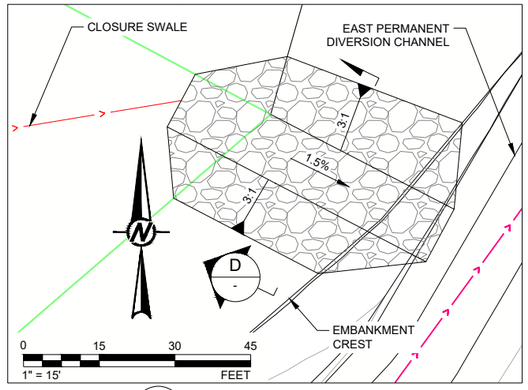


LEGEND

- 3600 — EXISTING GROUND CONTOURS (5 FT CONTOURS) (NOTE 1)
- PROJECT BOUNDARY
- PERMANENT TRAPEZOIDAL STORMWATER DIVERSION CHANNEL
- PERMANENT V-DITCH STORMWATER DIVERSION CHANNEL
- CLOSURE DRAINAGE SWALE
- 3600 — CONCEPTUAL CLOSURE GRADING (5 FT CONTOURS)
- NATURAL DRAINAGE
- LIMITS OF CLOSURE COVER — B / -

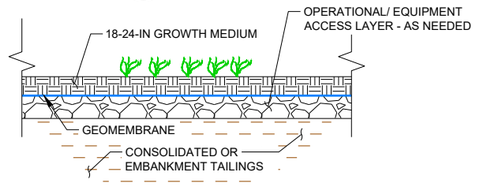
NOTES

1. EXISTING GROUND AS SHOWN COMPRISED OF 2017 TOPOGRAPHY (REFER TO GENERAL NOTE 1) AND THE STAGE 3 TSF LAYOUT.
2. STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.

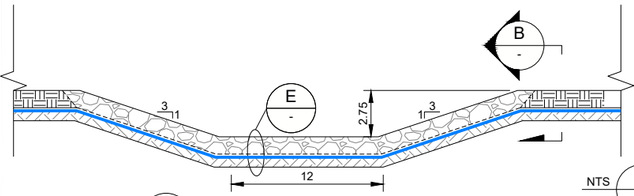


SCALE 1" = 15' C - CLOSURE DRAINAGE OUTLET DETAIL

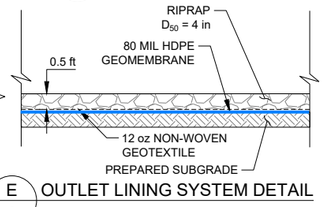
NTS A - CLOSURE DRAINAGE SWALE DETAIL



NTS B - TSF CLOSURE COVER SYSTEM DETAIL



NTS D - CLOSURE DRAINAGE OUTLET SECTION



NTS E - OUTLET LINING SYSTEM DETAIL

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

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[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
CONCEPTUAL CLOSURE PLAN

PROJECT NO. 1663241 | REV. 0 | 23 of 42 | DRAWING C17

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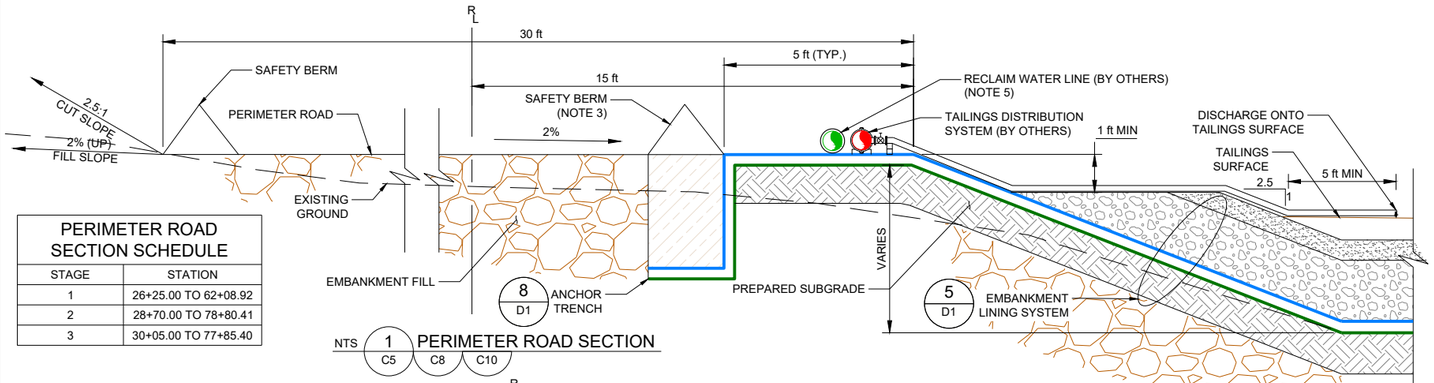
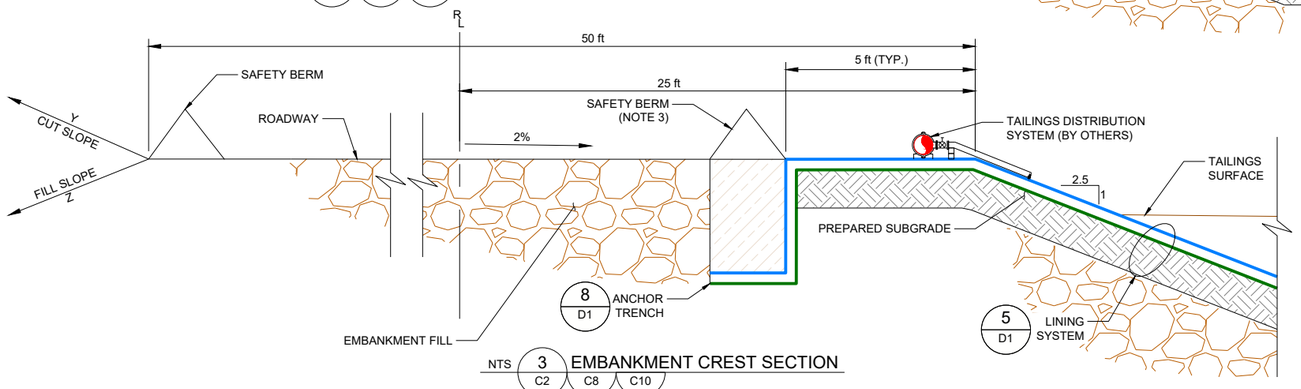
0 1 in



PERIMETER ROAD SECTION SCHEDULE	
STAGE	STATION
1	26+25.00 TO 62+08.92
2	28+70.00 TO 78+80.41
3	30+05.00 TO 77+85.40

NTS 1 C5 C8 C10 PERIMETER ROAD SECTION

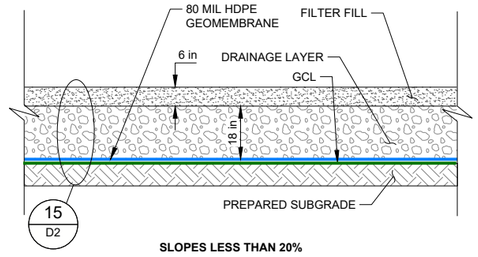


NTS 3 C2 C8 C10 EMBANKMENT CREST SECTION

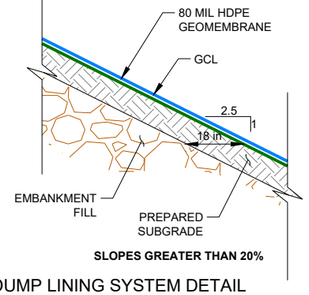
STAGE 1 EMBANKMENT CREST SECTION SCHEDULE		
STATION	CUT SLOPE (Y)	FILL SLOPE (Z)
0+00.00 TO 11+98.56 AND 16+67.68 TO 25+75.00	~2%	2.5:1
12+62.58 TO 16+17.00	2.5:1	2.5:1

STAGE 2 EMBANKMENT CREST SECTION SCHEDULE		
STATION	CUT SLOPE (Y)	FILL SLOPE (Z)
0+00.00 TO 16+90.00	~2%	2.5:1
17+40.00 TO 19+40.00	2.5:1	2.5:1
19+90.00 TO 28+20.00	2.5:1	~ 8%

STAGE 3 EMBANKMENT CREST SECTION SCHEDULE		
STATION	CUT SLOPE (Y)	FILL SLOPE (Z)
0+00.00 TO 29+55.00	~2%	2.5:1

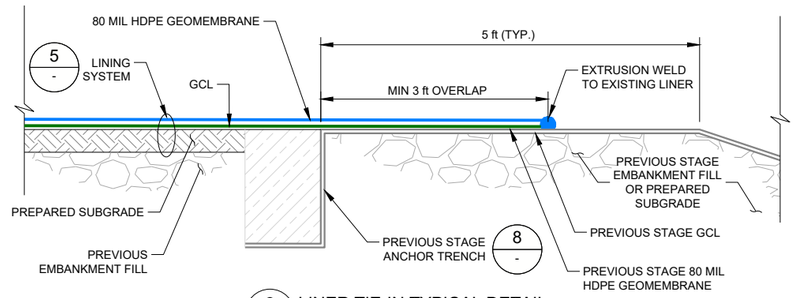


SLOPES LESS THAN 20%

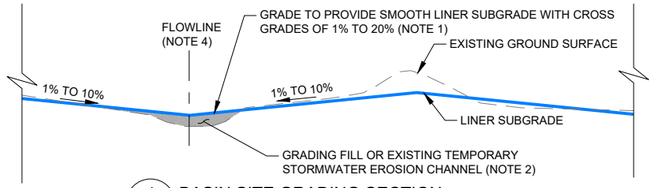


SLOPES GREATER THAN 20%

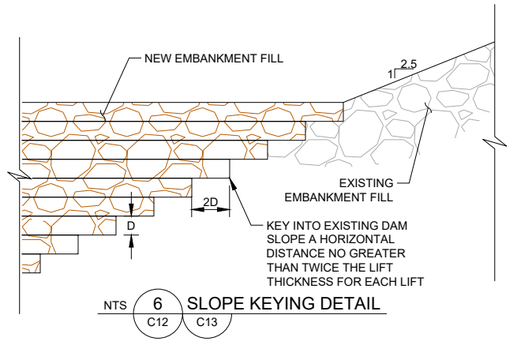
NTS 5 C1 C4 C5 C8 C10 C12 C13 C14 C15 C16 D2 D8 TYPICAL TSF BASIN AND WASTE ROCK DUMP LINING SYSTEM DETAIL



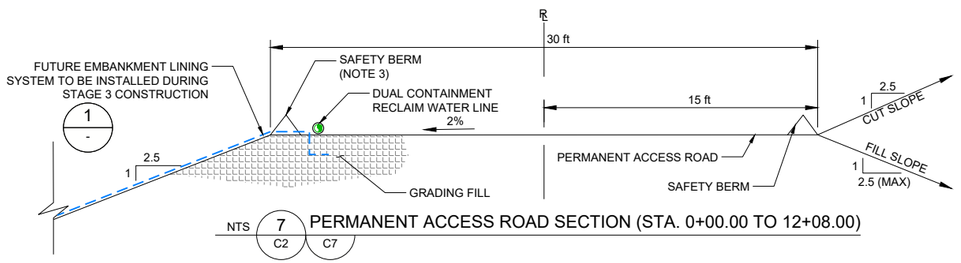
NTS 2 C8 C10 C12 C13 LINER TIE-IN TYPICAL DETAIL



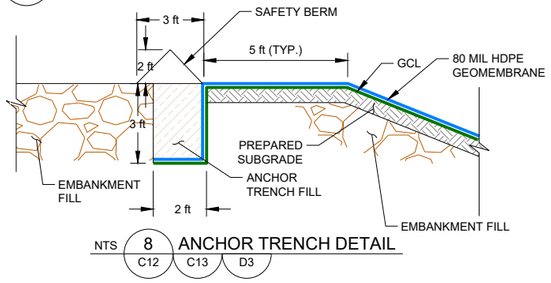
NTS 4 C2 BASIN SITE GRADING SECTION



NTS 6 C12 C13 SLOPE KEYING DETAIL



NTS 7 C2 C7 PERMANENT ACCESS ROAD SECTION (STA. 0+00.00 TO 12+08.00)



NTS 8 C12 C13 D3 ANCHOR TRENCH DETAIL

NOTES

1. TAILINGS STORAGE FACILITY SITE GRADING TO MAINTAIN A GENERAL SOUTHWEST TO NORTHEAST DIRECTION OF FLOW.
2. EXISTING TEMPORARY STORMWATER DIVERSION CHANNELS SHALL BE BACKFILLED.
3. CUT OPENINGS IN SAFETY BERM AS NEEDED TO PROMOTE ACCESS ROAD DRAINAGE INTO IMPOUNDMENT.
4. EXCAVATE FLOWLINE BETWEEN CONTROL POINT 19 AND CONTROL POINT 21 WITH A MINIMUM EXCAVATION WIDTH OF 10 FEET.
5. RECLAIM WATER LINE ONLY PRESENT ON STAGE 3 PERIMETER ROAD.

LEGEND

- GCL
- 80 MIL HDPE GEOMEMBRANE
- EXISTING LINING SYSTEM
- TAILINGS SURFACE

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (1 OF 9)
TAILINGS STORAGE FACILITY

PROJECT NO. 1663241 | REV. 0 | 24 of 42 | DRAWING D1

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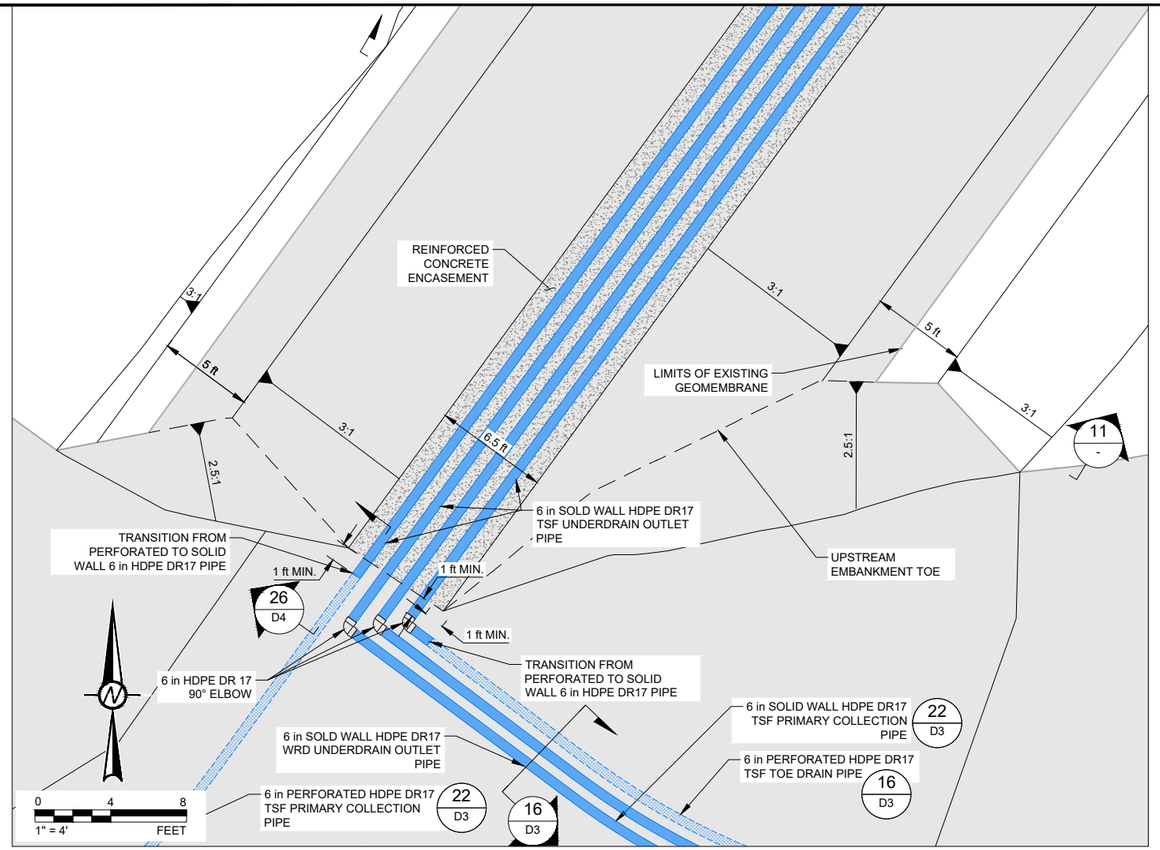
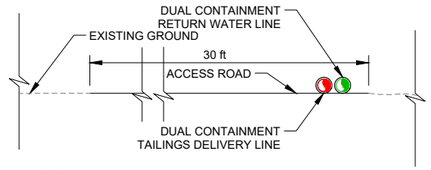
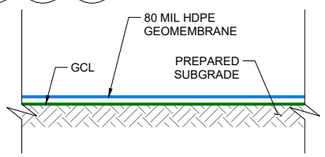


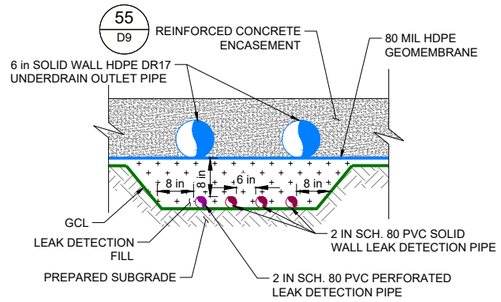
SCALE 1" = 4' 9 C15 UNDERDRAIN CHANNEL INLET



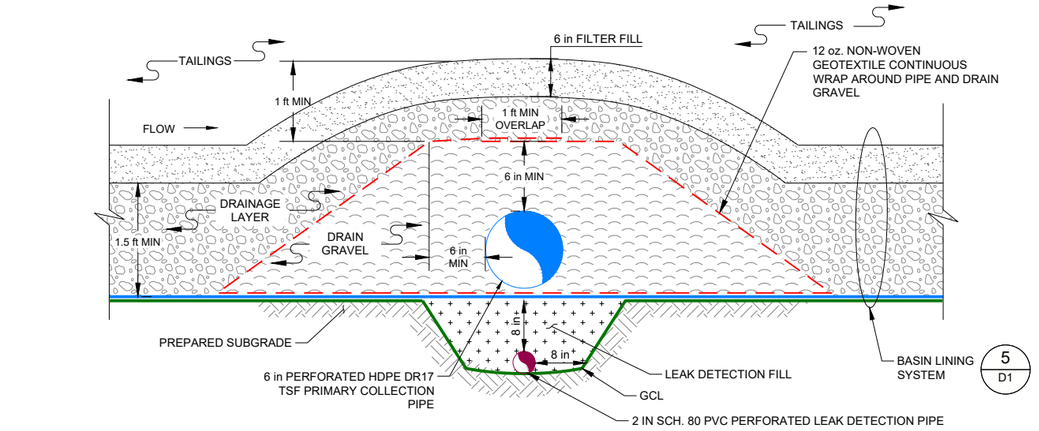
NTS 12 C5 C8 C10 PERMANENT ACCESS ROAD SECTION



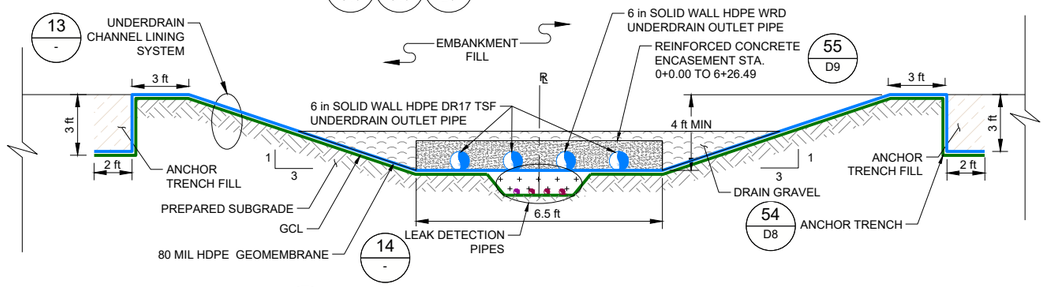
NTS 13 D1 D6 UNDERDRAIN CHANNEL LINING SYSTEM



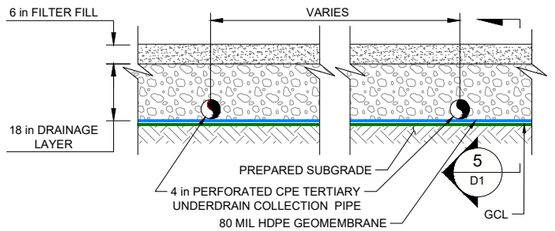
NTS 14 D9 LEAK DETECTION PIPES BENEATH CHANNEL DETAIL



NTS 10 C15 C16 D8 UNDERDRAIN COLLECTION PIPE TYPICAL DETAIL



NTS 11 C2 C3 C4 C15 C16 UNDERDRAIN CHANNEL BENEATH EMBANKMENT TYPICAL SECTION



NTS 15 C15 D1 BASIN PIPING AND LINING SYSTEM DETAIL

LEGEND

- 12 oz. NON-WOVEN GEOTEXTILE
- 80 MIL HDPE GEOMEMBRANE
- GCL
- EXISTING GROUND
- LIMITS OF EXISTING GEOMEMBRANE

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT
GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (2 OF 9)
UNDERDRAIN COLLECTION SYSTEM

PROJECT NO.	REV.	25 of 42	DRAWING
1663241	0		D2

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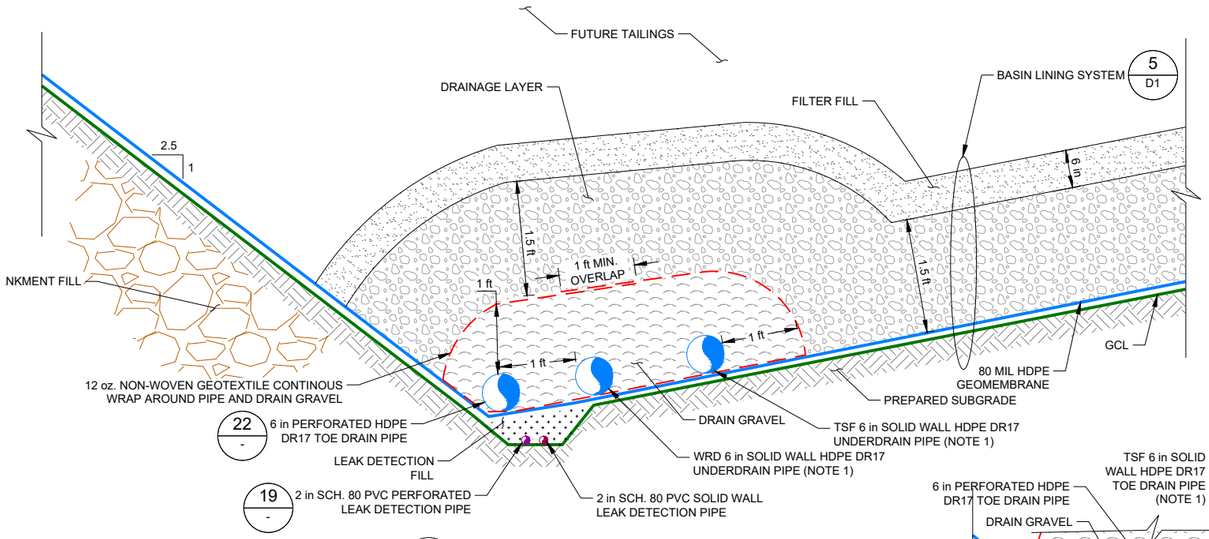
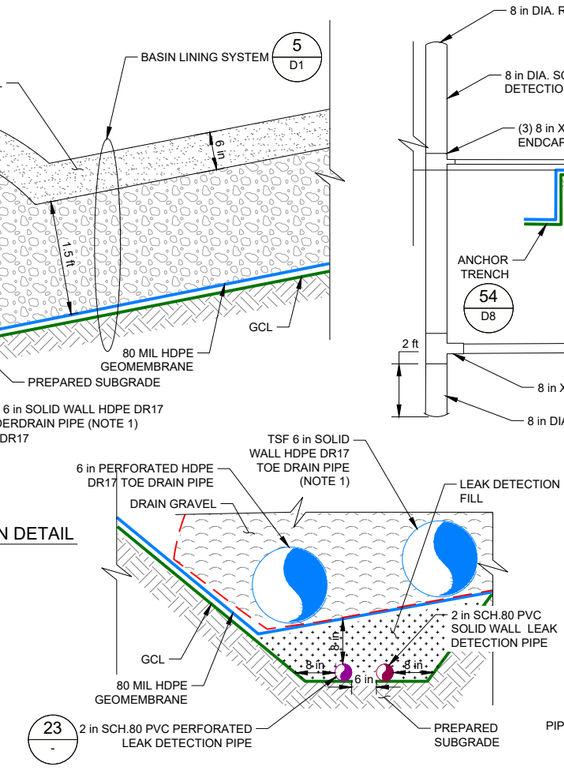
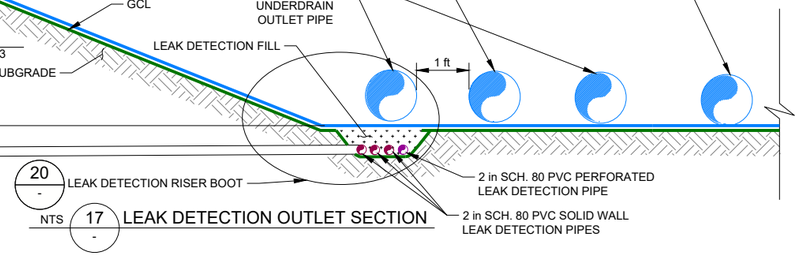
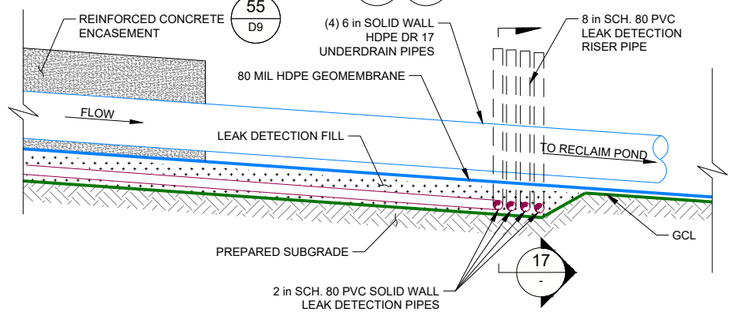


SCALE 1"=1' 16 C13 D2 TAILINGS STORAGE FACILITY BASIN TOE-DRAIN DETAIL



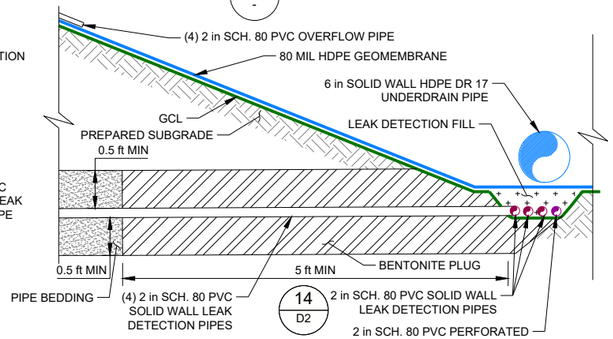


NTS 17 - LEAK DETECTION OUTLET SECTION



NTS 18 C16 LEAK DETECTION RISER DETAIL

NTS 19 - TOE DRAIN LEAK DETECTION DETAIL



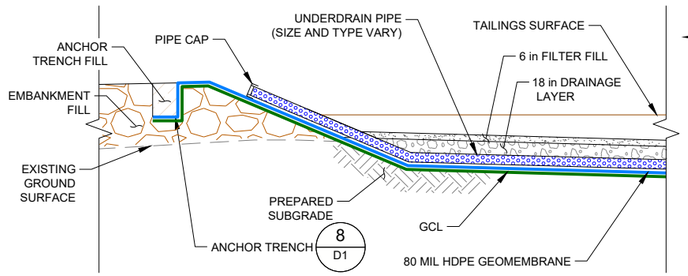
NTS 20 - LEAK DETECTION RISER BOOT DETAIL

LEGEND

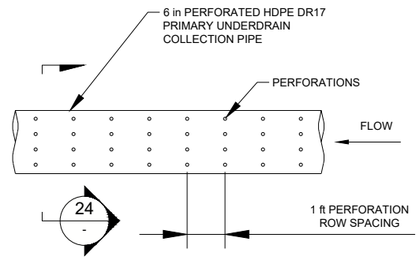
- GCL
- 80 MIL HDPE GEOMEMBRANE
- 12 oz. NON-WOVEN GEOTEXTILE

NOTE

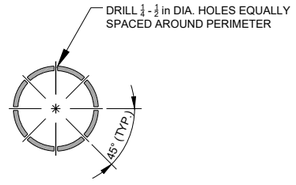
1. TSF AND WRD UNDERDRAIN PIPES ONLY WHERE SHOWN ON SHEET C15.



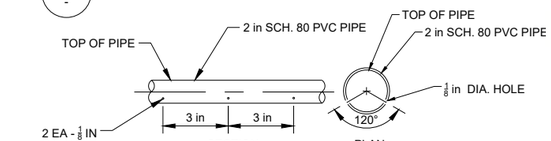
NTS 21 C15 TERMINAL END CLEANOUT DETAIL



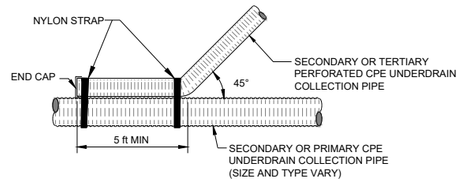
NTS 22 C15 D2 HDPE PERFORATED PIPE DETAIL



NTS 24 - HDPE PERFORATED PIPE SECTION



NTS 23 C16 LEAK DETECTION PIPE PERFORATION DETAIL



NTS 25 C15 UNDERDRAIN COLLECTION PIPE CONNECTION DETAIL

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

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PROJECT
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TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (3 OF 9)
UNDERDRAIN COLLECTION SYSTEM

PROJECT NO. 1663241
REV. 0
26 of 42
DRAWING D3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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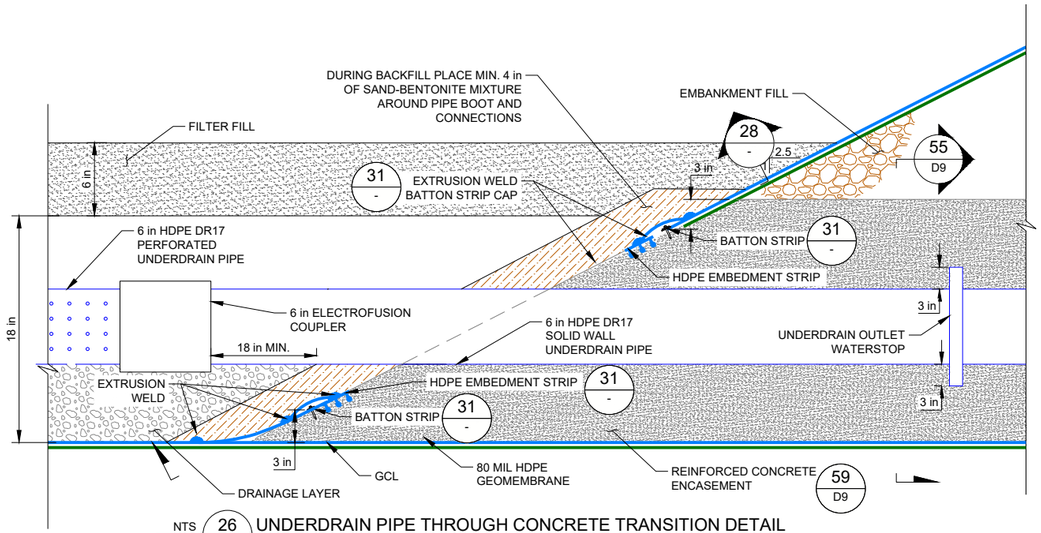
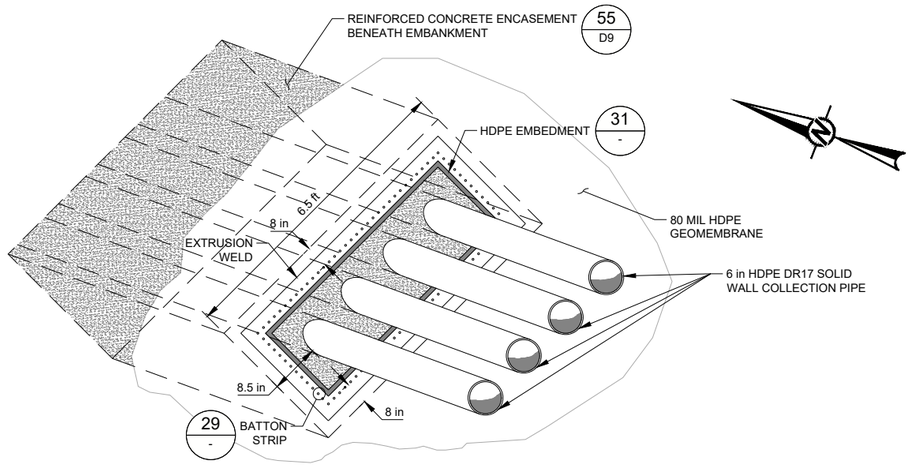
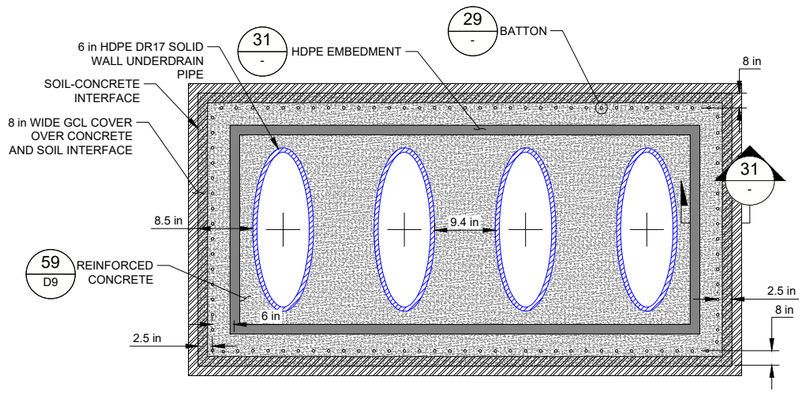


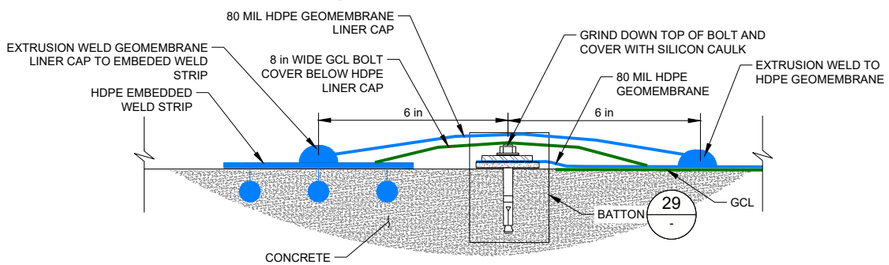
NTS 26 C15 UNDERDRAIN PIPE THROUGH CONCRETE TRANSITION DETAIL



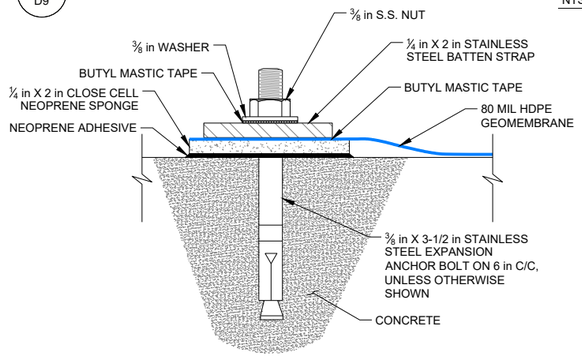
NTS 27 - UNDERDRAIN PIPE THROUGH CONCRETE TRANSITION ISOMETRIC



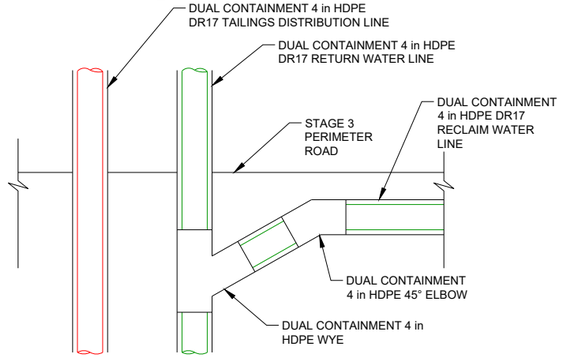
NTS 28 - ANCHOR BLOCK EMBED PLAN VIEW



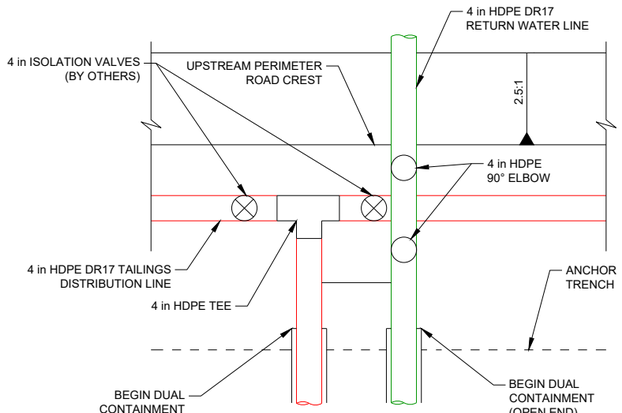
NTS 31 - BATTON STRIP CAP DETAIL



NTS 29 - BATTON STRIP DETAIL



NTS 32 C5 C8 C10 RECLAIM WATER LINE DETAIL



NTS 30 C5 C8 C10 TAILINGS DELIVERY LINE DETAIL

LEGEND

GCL

80 MIL HDPE GEOMEMBRANE

NOTE

1. TSF AND WRD UNDERDRAIN PIPES ONLY WHERE SHOWN ON SHEET C15.

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

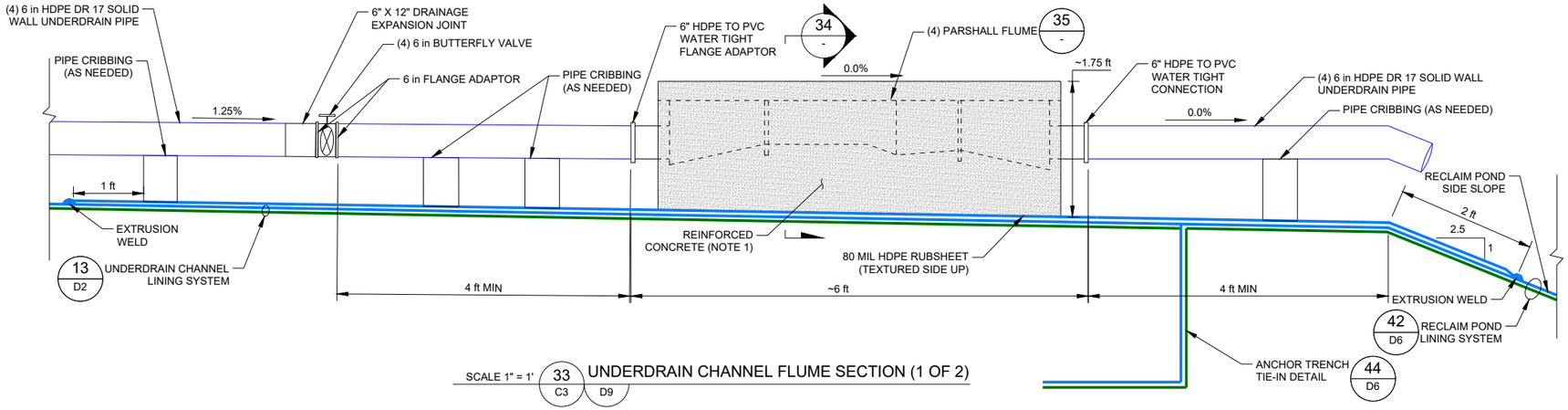
TITLE
DETAILS (4 OF 9)
UNDERDRAIN COLLECTION SYSTEM, RECLAIM WATER, AND TAILINGS DISTRIBUTION

PROJECT NO.	REV.		DRAWING
1663241	0	27 of 42	D4

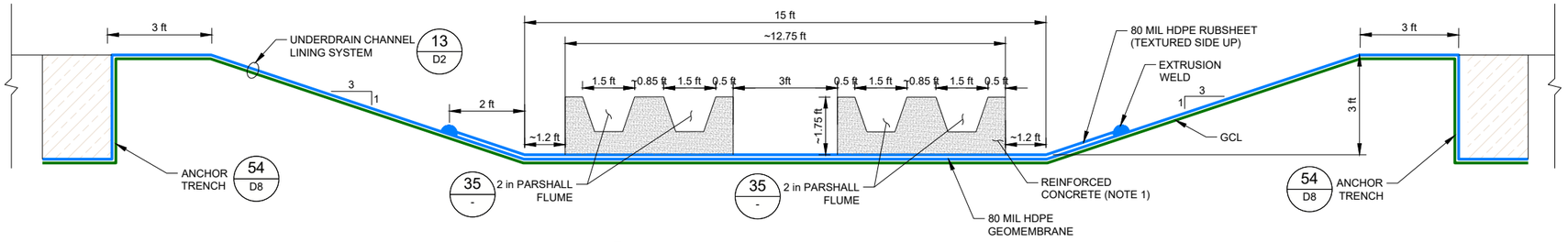
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 1 in

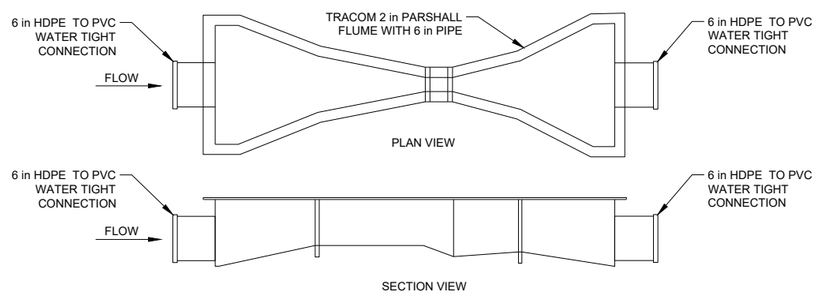
Path: \\reno\data\MDA\1663241 Grassy Mountain PFS\600 Drawings\PRODUCTION\CONSOLIDATED PERMIT\ | File Name: 1663241_D_004_COLLECTIONPIPESDETAIL.dwg | Last Edited By: mstengraeber Date: 2019-11-06 Time:3:50:59 PM | Printed By: MStengraeber Date: 2019-11-06 Time:4:05:57 PM



SCALE 1" = 1' 33 C3 D9 UNDERDRAIN CHANNEL FLUME SECTION (1 OF 2)



SCALE 1" = 2' 34 C4 UNDERDRAIN CHANNEL FLUME SECTION (2 OF 2)



NTS 35 - 2 in PARSHALL FLUME DETAIL

NOTE

1. CONCRETE REINFORCEMENT DETAILS SHOWN ON DRAWING D9.

LEGEND

80 MIL HDPE GEOMEMBRANE

GCL

0 1 2
1" = 1' FEET

0 1 2
1" = 1' FEET

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
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USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (5 OF 9)
UNDERDRAIN FLUME

PROJECT NO. 1663241 | REV. 0 | 28 of 42 | DRAWING D5

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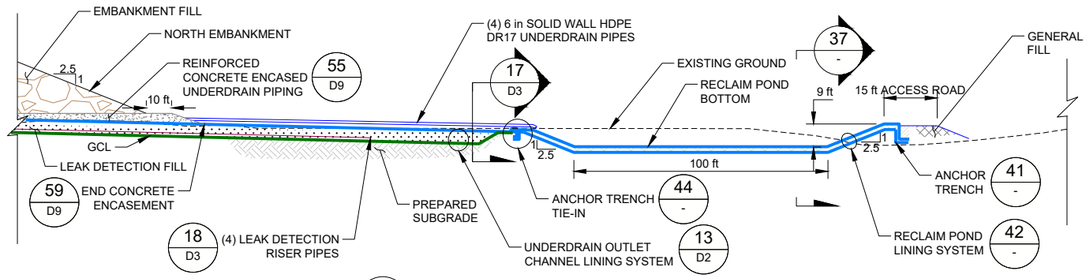
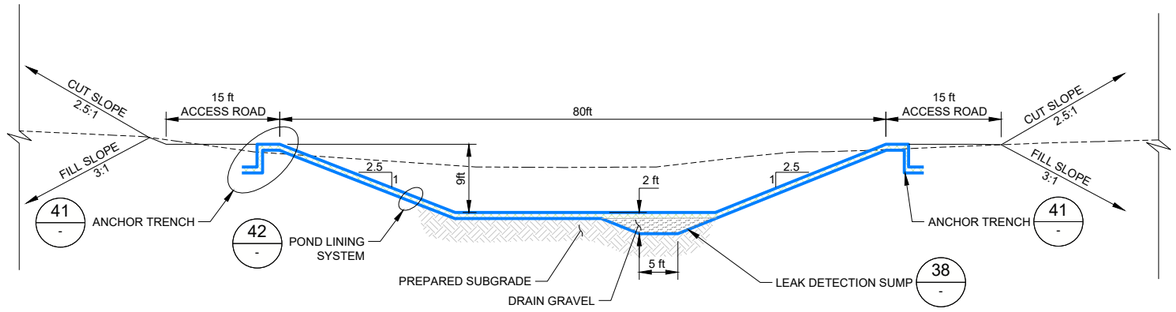
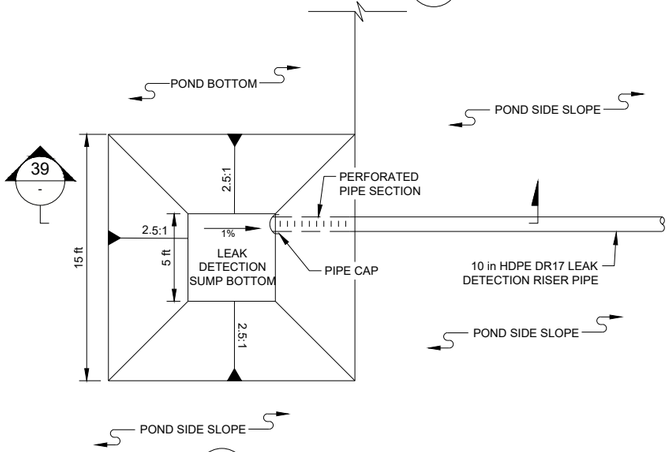
0 1 in



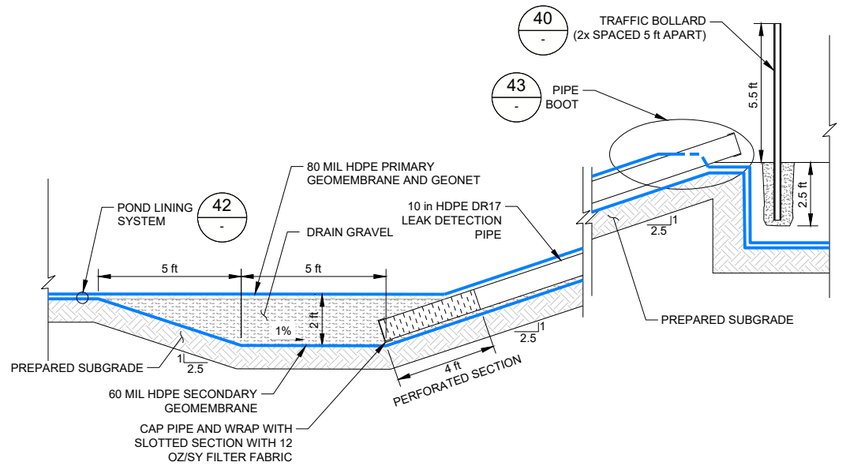
NTS 36 C3 RECLAIM OUTLET CHANNEL AND POND SECTION



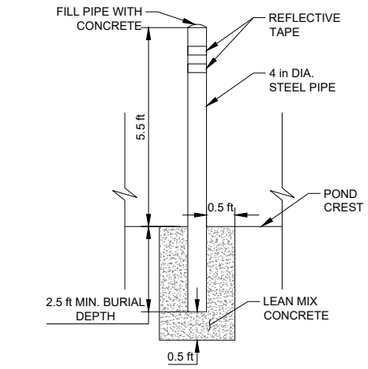
SCALE: 1" = 10' 37 C4 RECLAIM POND SECTION



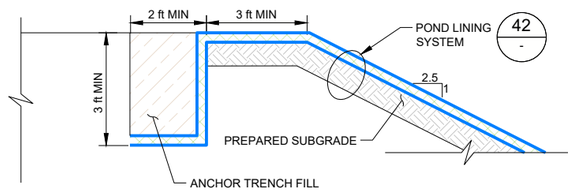
NTS 38 C3 LEAK DETECTION SUMP DETAIL



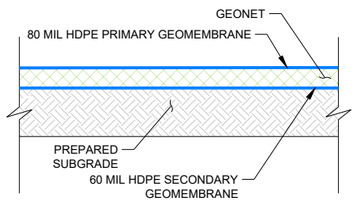
NTS 39 C3 LEAK DETECTION SUMP SECTION



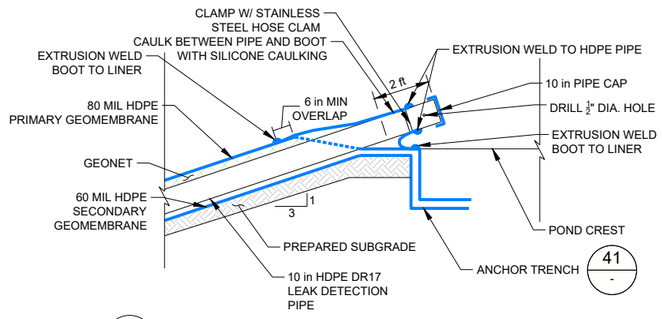
NTS 40 C4 D8 TRAFFIC BOLLARD TYPICAL DETAIL



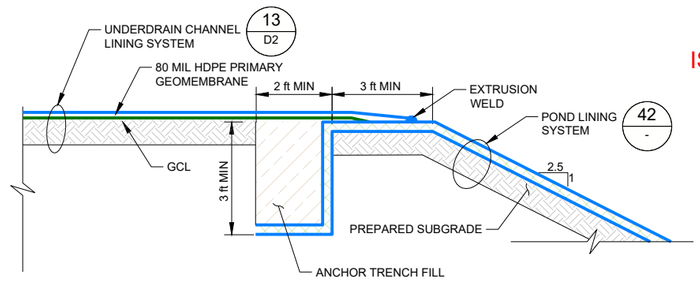
NTS 41 - POND ANCHOR TRENCH DETAIL



NTS 42 C1 C3 POND LINING SYSTEM



NTS 43 - POND LEAK DETECTION RISER PIPE BOOT DETAIL



NTS 44 - ANCHOR TRENCH TIE IN DETAIL

LEGEND

GCL

80 MIL HDPE GEOMEMBRANE

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (6 OF 9)
RECLAIM POND

PROJECT NO. 1663241 | REV. 0 | 29 of 42 | DRAWING D6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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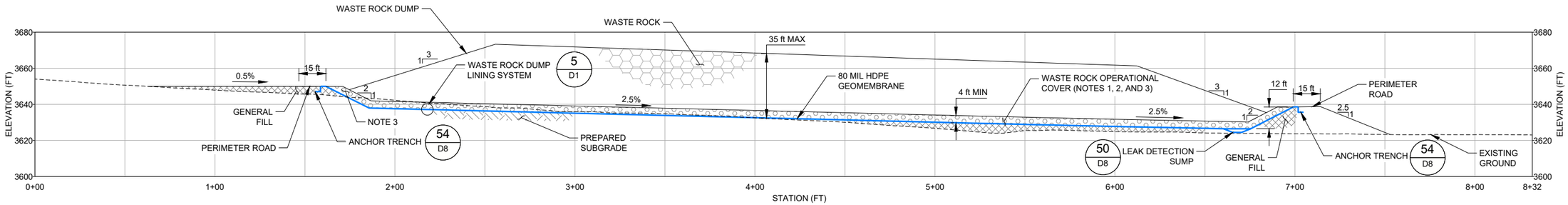
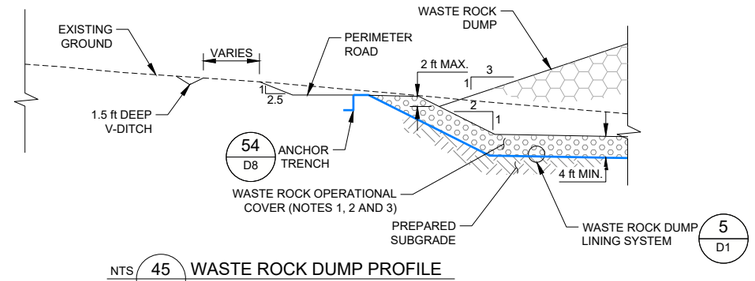


SCALE 1" = 30'
VERT. SCALE 1" = 15'
A
C14
WASTE ROCK DUMP PROFILE



NTS
45
C14
WASTE ROCK DUMP PROFILE

NOTES

1. MINIMUM 4 FT WASTE ROCK OPERATIONAL COVER SHALL REMAIN AT ALL TIMES DURING OPERATION TO BE REMOVED DURING RECLAMATION OF WASTE ROCK DUMP.
2. OPERATIONAL COVER SHALL BE WASTE ROCK WITH LESS THAN 3 in MAX PARTICLE SIZE.
3. OPERATIONAL COVER ON PAD SIDE SLOPES SHALL BE DOZER PLACED FROM TOE UP TO DESIGN ELEVATION.

LEGEND

WASTE ROCK DUMP LINING SYSTEM 5/D1

EXISTING GROUND

0 15 30
1" = 15' FEET

0 30 60
1" = 30' FEET

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

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GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (7 OF 9)
WASTE ROCK DUMP

PROJECT NO. 1663241
REV. 0

DRAWING D7

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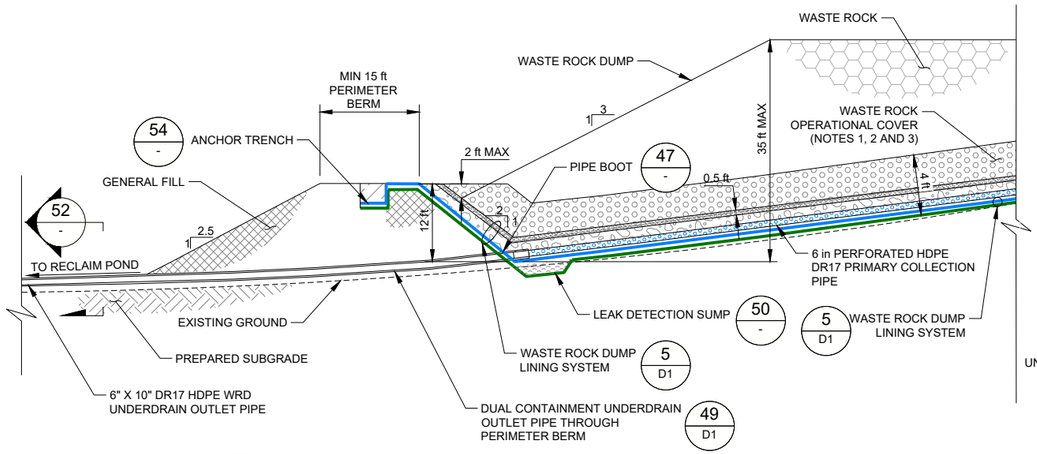
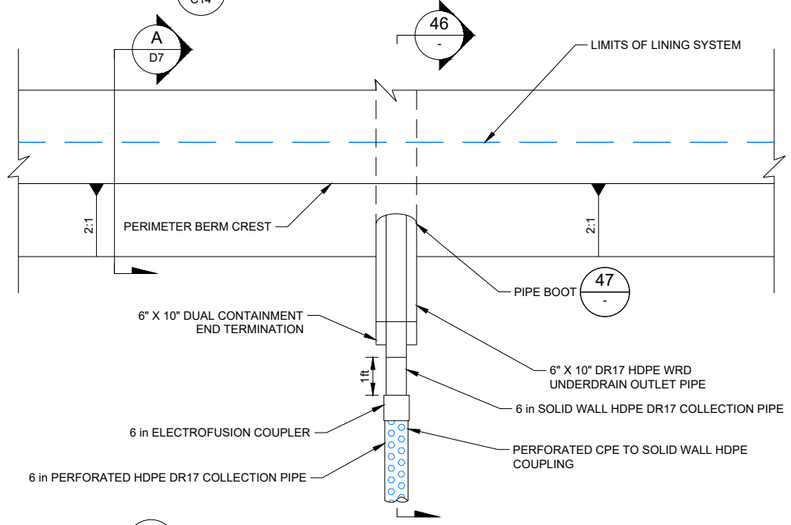
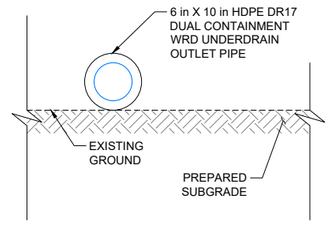
0 1 in



NTS 46 C14 WASTE ROCK DUMP AND UNDERDRAIN OUTLET SECTION

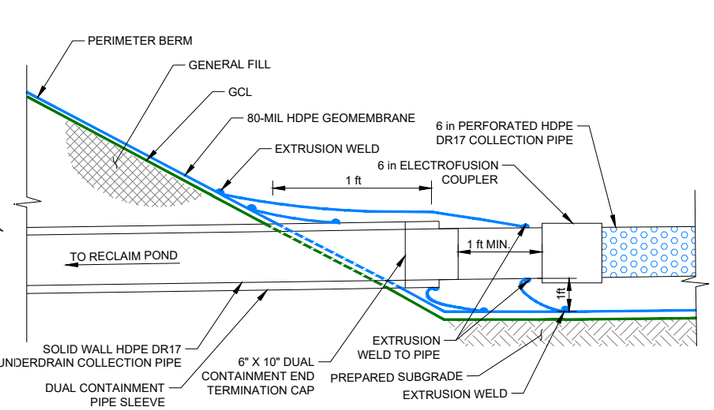


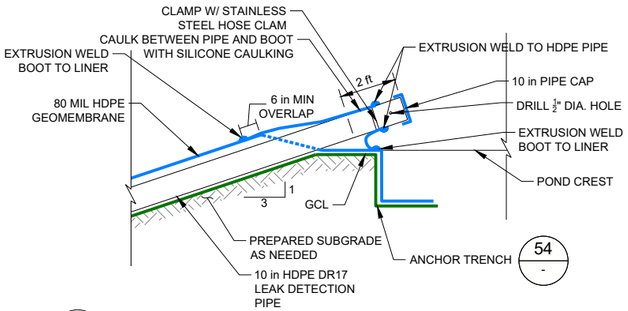
NTS 49 C14 WASTE ROCK DUMP UNDERDRAIN OUTLET PIPE DETAIL



STAGE 1 WRD DUAL CONTAINMENT UNDERDRAIN OUTLET PIPE DETAIL (NOTE 4)

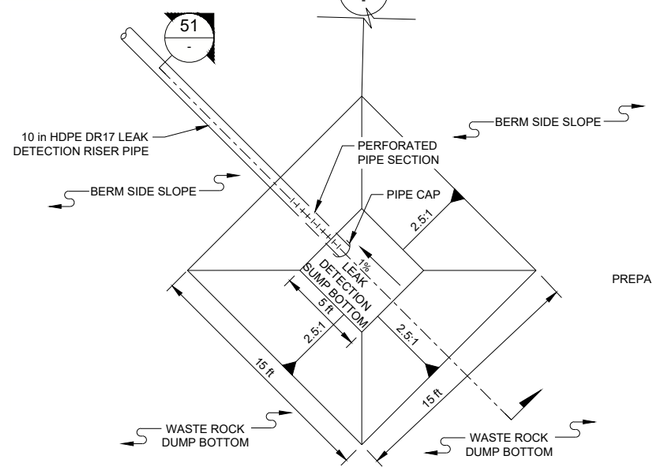
NTS 52 C15



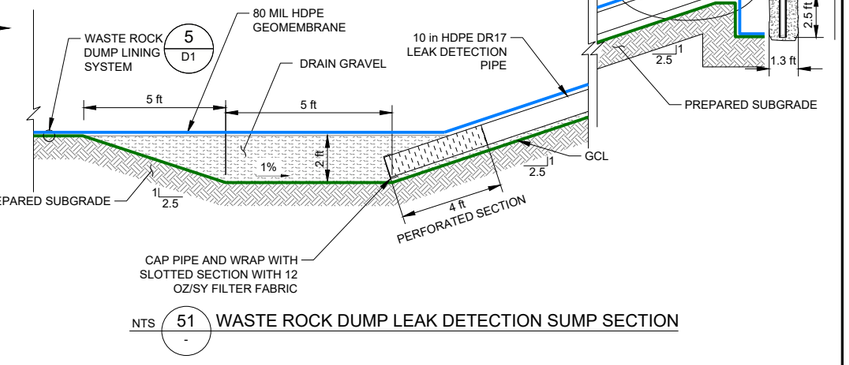


NTS 48 - WASTE ROCK DUMP LEAK DETECTION RISER PIPE BOOT DETAIL

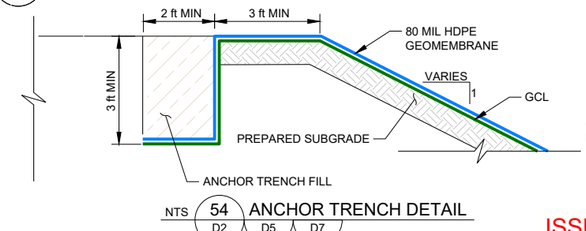
NTS 47 - WRD PIPE BOOT DETAIL



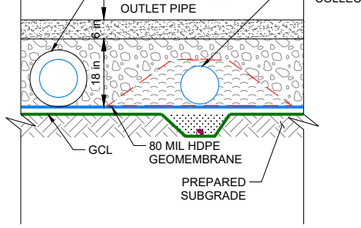
NTS 50 C14 WASTE ROCK DUMP LEAK DETECTION SUMP DETAIL



NTS 51 - WASTE ROCK DUMP LEAK DETECTION SUMP SECTION



NTS 54 D2 D5 D7 ANCHOR TRENCH DETAIL



STAGE 2 AND 3 WRD DUAL CONTAINMENT UNDERDRAIN OUTLET PIPE DETAIL

NTS 53 C15

NOTES

1. MINIMUM 4 FT WASTE ROCK OPERATIONAL COVER SHALL REMAIN AT ALL TIMES DURING OPERATION TO BE REMOVED DURING RECLAMATION OF WASTE ROCK DUMP.
2. OPERATIONAL COVER SHALL BE WASTE ROCK WITH LESS THAN 3 in MAX PARTICLE SIZE.
3. OPERATIONAL COVER ON PAD SIDE SLOPES SHALL BE DOZER PLACED FROM TOE UP TO DESIGN ELEVATION.
4. IN STAGES 2 AND 3 BASINS PRIOR TO STAGE.

LEGEND

GCL

80 MIL HDPE GEOMEMBRANE

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

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USA
[+1] (775) 828-9604
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (8 OF 9)
WASTE ROCK DUMP

PROJECT NO. 1663241
REV. 0

DRAWING D8

Path: \\reno\data\MDA\1663241 Grassy Mountain PFS\600_Drawings\PRODUCTION\CONSOLIDATED PERMIT\ | File Name: D1 DETAILS.dwg | Last Edited By: msteingraeber Date: 2019-11-06 Time:3:45:46 PM | Printed By: MSteingraeber Date: 2019-11-06 Time:4:07:57 PM
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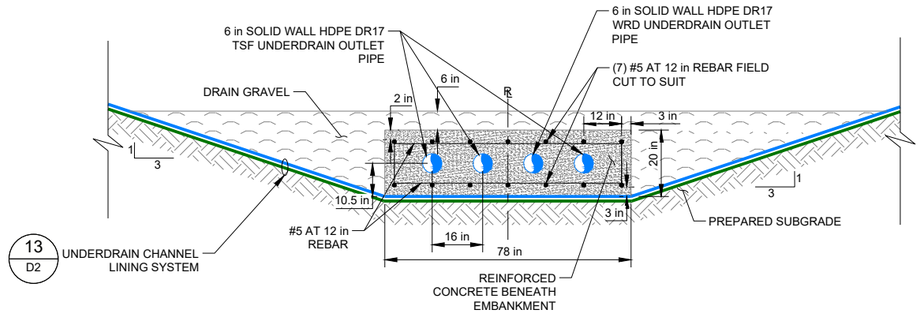
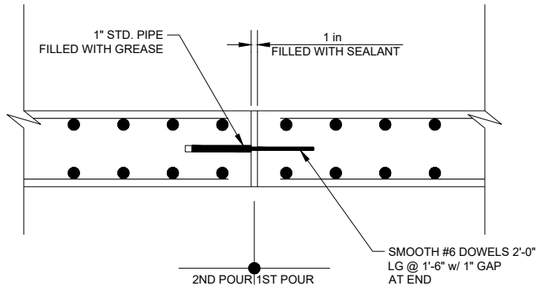
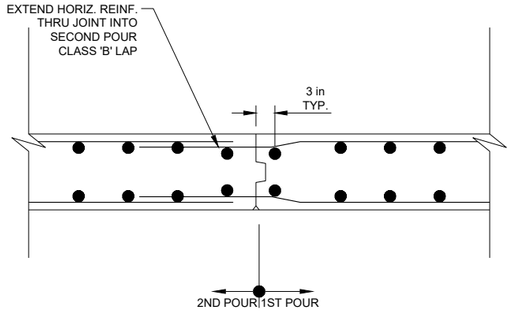


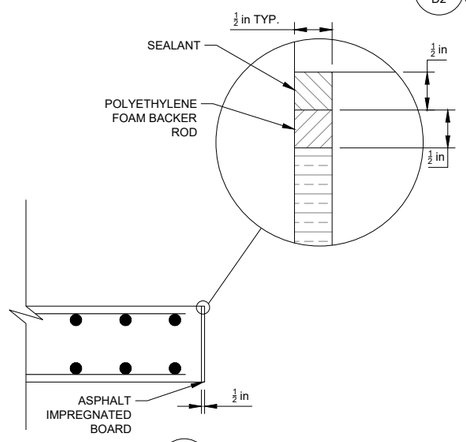
NTS 55 (D2 D4) CONCRETE ENCASED PIPES DETAIL



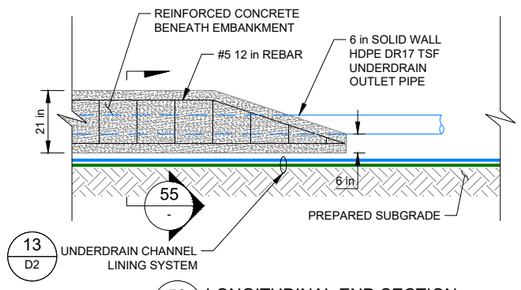
NTS 56 (-) FOUNDATION EXPANSION JOINT DETAIL



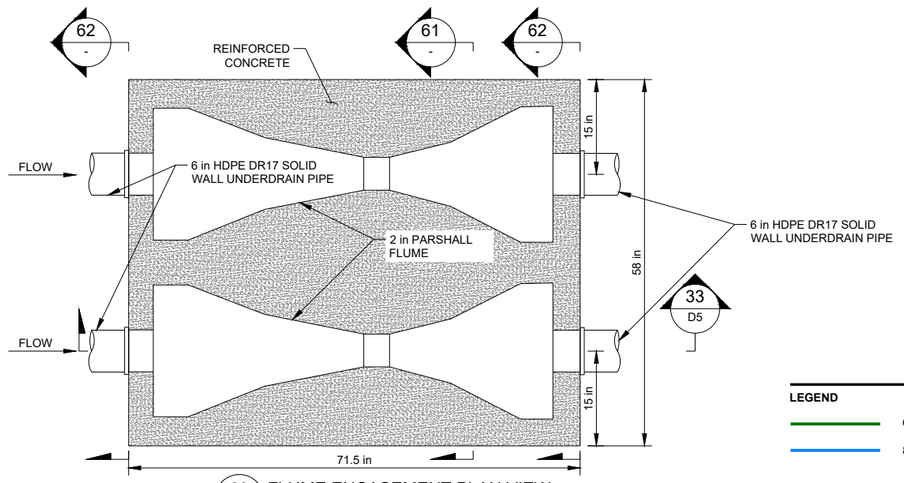
NTS 57 (-) CONSTRUCTION JOINT



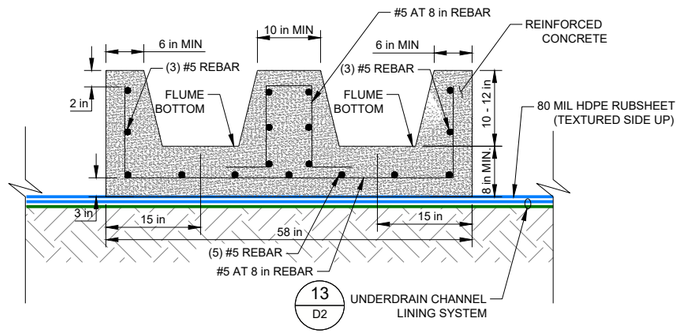
NTS 58 (-) ISOLATION JOINT



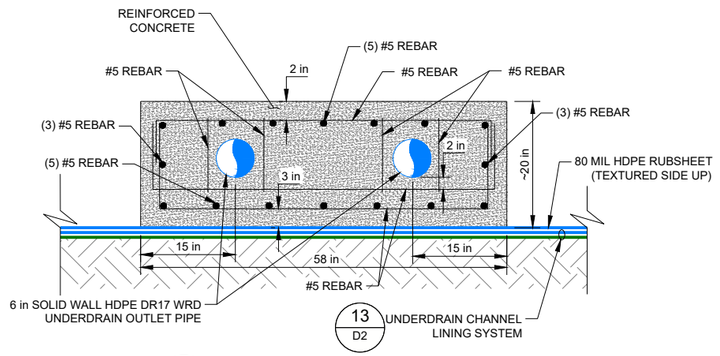
NTS 59 (C3 C4 D4) LONGITUDINAL END SECTION



NTS 60 (D5) FLUME ENCASEMENT PLAN VIEW



NTS 61 (-) FLUME ENCASEMENT SECTION



NTS 62 (-) FLUME ENCASEMENT END SECTION

LEGEND

GCL

80 MIL HDPE GEOMEMBRANE

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
DETAILS (9 OF 9)
STRUCTURAL CONCRETE

PROJECT NO. 1663241 | REV. 0 | 32 of 42 | DRAWING D9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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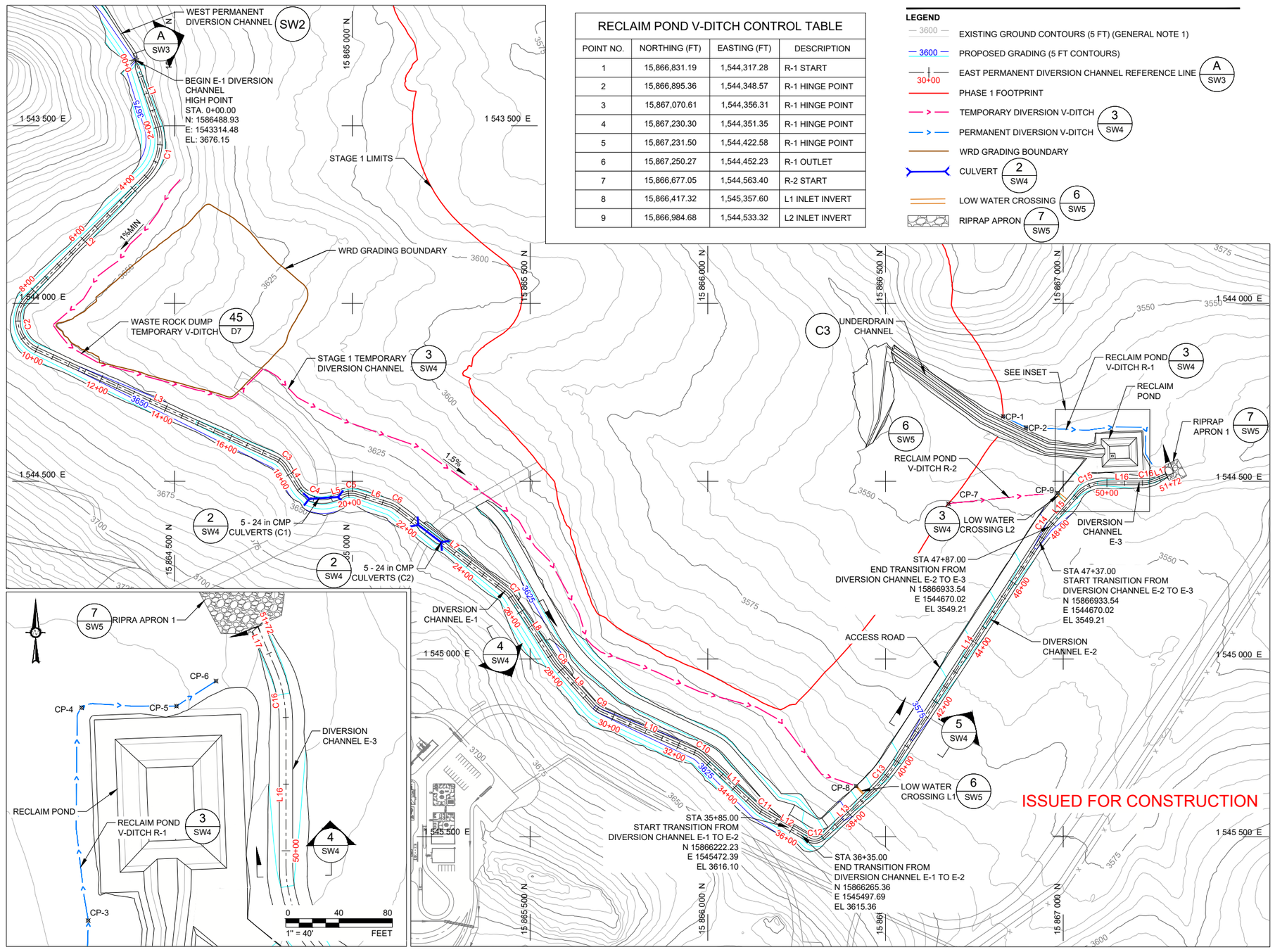

RECLAIM POND V-DITCH CONTROL TABLE

POINT NO.	NORTHING (FT)	EASTING (FT)	DESCRIPTION
1	15,866,831.19	1,544,317.28	R-1 START
2	15,866,895.36	1,544,348.57	R-1 HINGE POINT
3	15,867,070.61	1,544,356.31	R-1 HINGE POINT
4	15,867,230.30	1,544,351.35	R-1 HINGE POINT
5	15,867,231.50	1,544,422.58	R-1 HINGE POINT
6	15,867,250.27	1,544,452.23	R-1 OUTLET
7	15,866,677.05	1,544,563.40	R-2 START
8	15,866,417.32	1,545,357.60	L1 INLET INVERT
9	15,866,984.68	1,544,533.32	L2 INLET INVERT

LEGEND

- EXISTING GROUND CONTOURS (5 FT) (GENERAL NOTE 1)
- PROPOSED GRADING (5 FT CONTOURS)
- EAST PERMANENT DIVERSION CHANNEL REFERENCE LINE — A SW3
- PHASE 1 FOOTPRINT
- TEMPORARY DIVERSION V-DITCH — 3 SW4
- PERMANENT DIVERSION V-DITCH — 3 SW4
- WRD GRADING BOUNDARY
- CULVERT — 2 SW4
- LOW WATER CROSSING — 6 SW5
- RIPRAP APRON — 7 SW5

EAST DIVERSION CHANNEL CURVE TABLE

CURVE #	RADIUS (FT)	LENGTH (FT)	START POINT (N, E)	END POINT (N, E)
C1	145.24	160.68	(15,864,451.19, 1,543,496.75)	(15,864,417.28, 1,543,645.55)
C2	91.10	174.93	(15,864,085.47, 1,543,982.86)	(15,864,112.62, 1,544,129.63)
C3	64.03	38.13	(15,864,784.11, 1,544,435.78)	(15,864,812.22, 1,544,460.71)
C4	83.84	111.62	(15,864,843.62, 1,544,512.22)	(15,864,940.63, 1,544,548.47)
C5	62.33	38.77	(15,864,977.42, 1,544,536.76)	(15,865,015.57, 1,544,536.87)
C6	53.87	18.26	(15,865,106.98, 1,544,566.55)	(15,865,123.08, 1,544,575.00)
C7	60.58	19.99	(15,865,431.69, 1,544,811.02)	(15,865,445.29, 1,544,825.54)
C8	107.28	15.89	(15,865,567.11, 1,545,008.30)	(15,865,576.87, 1,545,020.82)
C9	81.80	34.60	(15,865,675.43, 1,545,129.63)	(15,865,703.32, 1,545,149.67)
C10	57.67	19.54	(15,865,965.10, 1,545,263.98)	(15,865,981.36, 1,545,274.65)
C11	34.36	7.56	(15,866,141.70, 1,545,424.19)	(15,866,147.75, 1,545,428.70)
C12	35.76	46.01	(15,866,282.37, 1,545,507.67)	(15,866,325.00, 1,545,502.84)
C13	474.84	113.90	(15,866,460.77, 1,545,374.80)	(15,866,533.52, 1,545,287.52)
C14	55.01	7.57	(15,866,956.03, 1,544,635.30)	(15,866,960.57, 1,544,629.25)
C15	94.55	81.15	(15,867,039.84, 1,544,537.47)	(15,867,111.39, 1,544,504.72)
C16	108.93	43.77	(15,867,219.05, 1,544,504.71)	(15,867,261.65, 1,544,496.03)

EAST DIVERSION CHANNEL LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L1	192.61	N71° 08' 28.55"E	(15,864,388.93, 1,543,314.48)	(15,864,451.19, 1,543,496.75)
L2	473.16	S45° 28' 13.55"E	(15,864,417.28, 1,543,645.55)	(15,864,085.47, 1,543,982.86)
L3	737.99	N24° 30' 33.79"E	(15,864,112.62, 1,544,129.63)	(15,864,784.11, 1,544,435.78)
L4	60.33	N58° 37' 48.37"E	(15,864,812.22, 1,544,460.71)	(15,864,843.62, 1,544,512.22)
L5	38.61	N17° 39' 09.23"W	(15,864,940.63, 1,544,548.47)	(15,864,977.42, 1,544,536.76)
L6	96.11	N17° 59' 14.29"E	(15,865,015.57, 1,544,536.87)	(15,865,106.98, 1,544,566.55)
L7	388.52	N37° 24' 31.45"E	(15,865,123.08, 1,544,575.00)	(15,865,431.69, 1,544,811.02)
L8	219.64	N56° 18' 51.85"E	(15,865,445.29, 1,544,825.54)	(15,865,567.11, 1,545,008.30)
L9	146.81	N47° 49' 35.02"E	(15,865,576.87, 1,545,020.82)	(15,865,675.43, 1,545,129.63)
L10	285.65	N23° 35' 19.29"E	(15,865,703.32, 1,545,149.67)	(15,865,965.10, 1,545,263.98)
L11	219.25	N43° 00' 09.68"E	(15,865,981.36, 1,545,274.65)	(15,866,141.70, 1,545,424.19)
L12	156.08	N30° 23' 46.91"E	(15,866,147.75, 1,545,428.70)	(15,866,282.37, 1,545,507.67)
L13	186.62	N43° 19' 15.91"W	(15,866,325.00, 1,545,502.84)	(15,866,460.77, 1,545,374.80)
L14	777.11	N57° 03' 52.62"W	(15,866,533.52, 1,545,287.52)	(15,866,956.03, 1,544,635.30)
L15	121.28	N49° 10' 51.37"W	(15,866,960.57, 1,544,629.25)	(15,867,039.84, 1,544,537.47)
L16	107.66	N0° 00' 23.68"W	(15,867,111.39, 1,544,504.72)	(15,867,219.05, 1,544,504.71)
L17	31.85	N23° 01' 49.58"W	(15,867,261.65, 1,544,496.03)	(15,867,290.97, 1,544,483.57)

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. Mac MAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
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USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
EAST PERMANENT DIVERSION CHANNEL ALIGNMENT

PROJECT NO.	REV.		DRAWING
1663241	0	33 of 42	SW1

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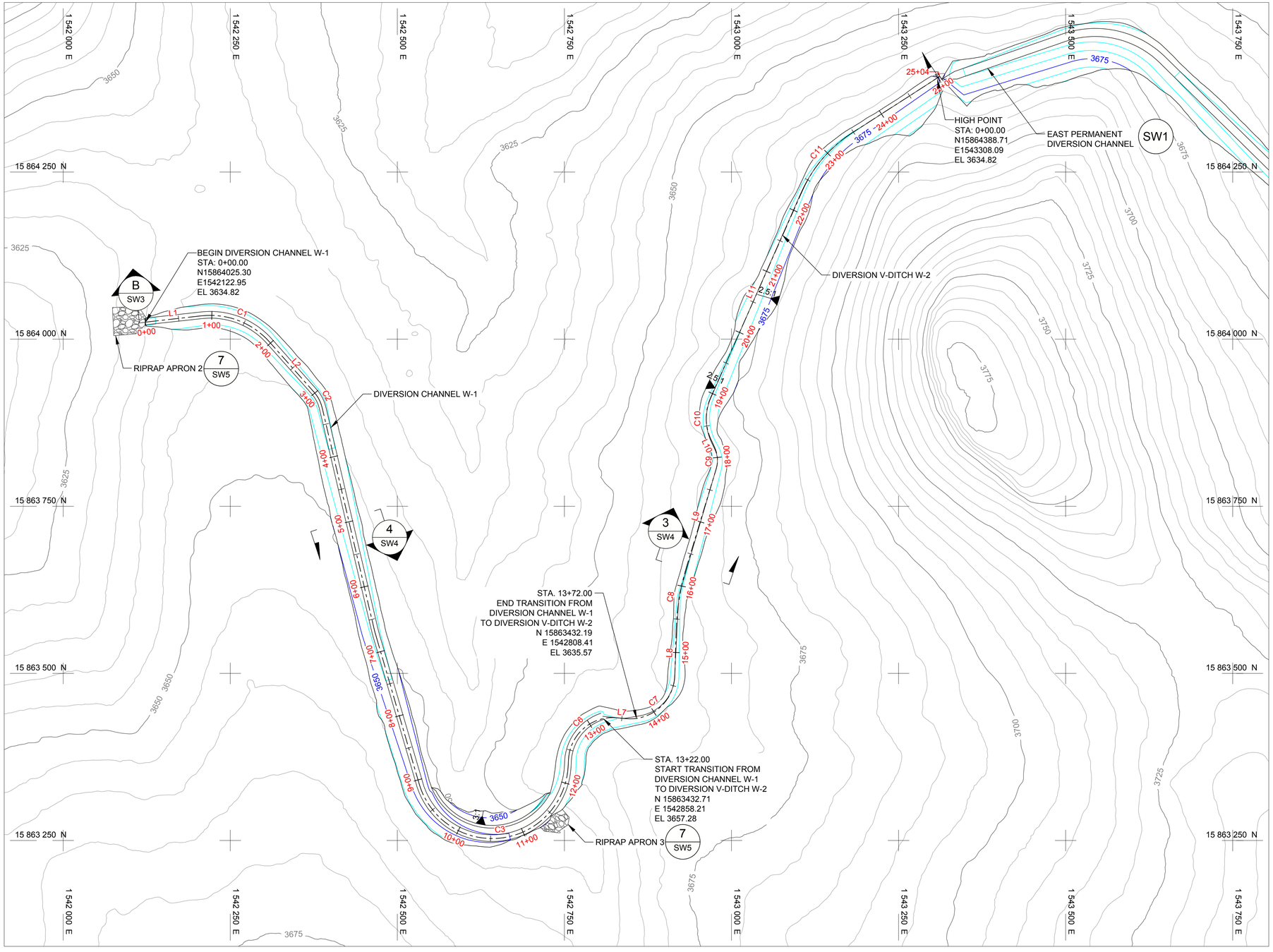

LEGEND

- 3600 — EXISTING GROUND CONTOURS (5 FT) (GENERAL NOTE 1)
- 3600 — PROPOSED GRADING (5 FT CONTOURS)
- 26+00 — WEST PERMANENT STORMWATER DIVERSION CHANNEL REFERENCE LINE
- RIPRAP APRON — 7 / SW5

B / SW3

WEST DIVERSION CHANNEL CURVE TABLE

CURVE #	RADIUS (FT)	LENGTH (FT)	START POINT (N, E)	END POINT (N, E)
C1	118.63	113.55	(15,864,034.89, 1,542,206.72)	(15,863,995.76, 1,542,308.74)
C2	54.30	26.90	(15,863,920.73, 1,542,375.36)	(15,863,897.10, 1,542,387.61)
C3	113.80	319.34	(15,863,334.74, 1,542,532.66)	(15,863,360.81, 1,542,755.54)
C6	66.20	107.07	(15,863,371.06, 1,542,756.07)	(15,863,433.55, 1,542,828.65)
C7	66.80	109.44	(15,863,432.25, 1,542,841.86)	(15,863,496.71, 1,542,915.16)
C8	367.18	96.75	(15,863,564.34, 1,542,917.21)	(15,863,659.55, 1,542,932.78)
C9	44.39	32.21	(15,863,806.18, 1,542,977.15)	(15,863,837.61, 1,542,974.98)
C10	75.00	63.66	(15,863,850.39, 1,542,969.09)	(15,863,912.16, 1,542,968.65)
C11	199.67	116.22	(15,864,221.58, 1,543,105.82)	(15,864,308.60, 1,543,180.36)

WEST DIVERSION CHANNEL LINE TABLE

LINE #	LENGTH (FT)	BEARING	START POINT (N, E)	END POINT (N, E)
L1	84.28	N83° 33' 26.52"E	(15,864,025.43, 1,542,122.97)	(15,864,034.89, 1,542,206.72)
L2	100.34	S41° 35' 54.21"E	(15,863,995.76, 1,542,308.74)	(15,863,920.73, 1,542,375.36)
L7	13.28	S84° 23' 26.76"E	(15,863,433.55, 1,542,828.65)	(15,863,432.25, 1,542,841.86)
L8	67.66	N1° 44' 16.82"E	(15,863,496.71, 1,542,915.16)	(15,863,564.34, 1,542,917.21)
L9	153.20	N16° 50' 07.00"E	(15,863,659.55, 1,542,932.78)	(15,863,806.18, 1,542,977.15)
L10	14.07	N24° 43' 51.20"W	(15,863,837.61, 1,542,974.98)	(15,863,850.39, 1,542,969.09)
L11	338.46	N23° 54' 30.19"E	(15,863,912.16, 1,542,968.65)	(15,864,221.58, 1,543,105.82)

ISSUED FOR CONSTRUCTION

0 80 160
1" = 80'
FEET

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

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GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
WEST PERMANENT DIVERSION CHANNEL ALIGNMENT

PROJECT NO. 1663241 | REV. 0 | 34 of 42 | DRAWING SW2

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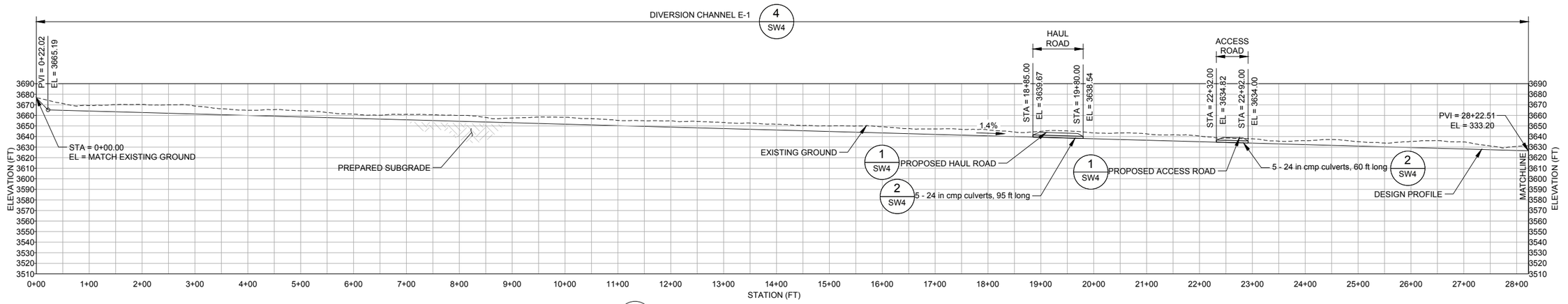
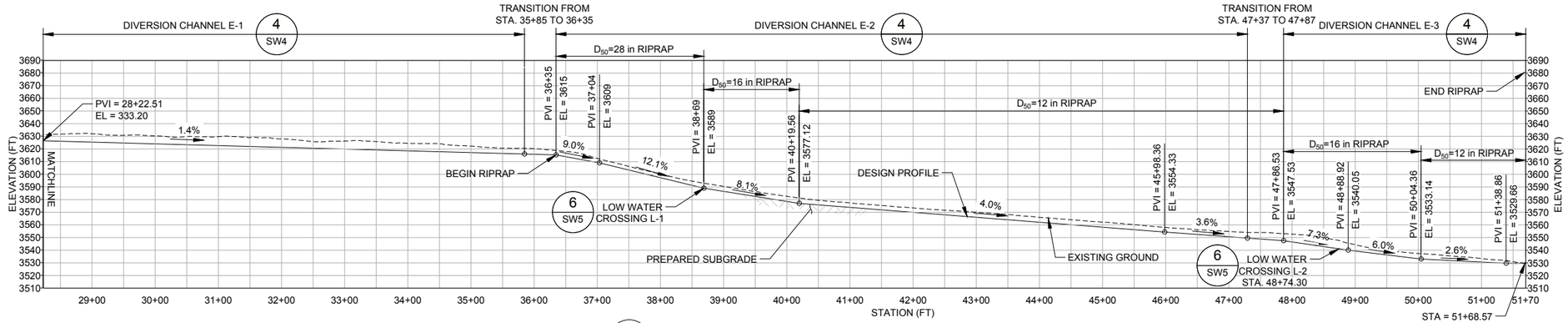


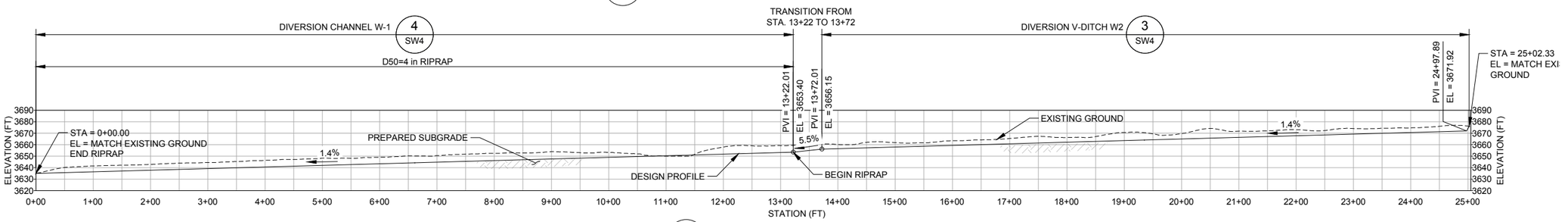
HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=50'

A SW1 EAST PERMANENT DIVERSION CHANNEL PROFILE



HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=50'

A SW1 EAST PERMANENT DIVERSION CHANNEL PROFILE



HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=50'

B SW2 WEST PERMANENT DIVERSION CHANNEL PROFILE

LEGEND

DESIGN PROFILE

EXISTING GROUND

0 100 200
1" = 100' FEET

0 50 100
1" = 50' FEET

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
STORMWATER DIVERSION CHANNEL PROFILES

PROJECT NO. 1663241
REV. 0
35 of 42
DRAWING SW3

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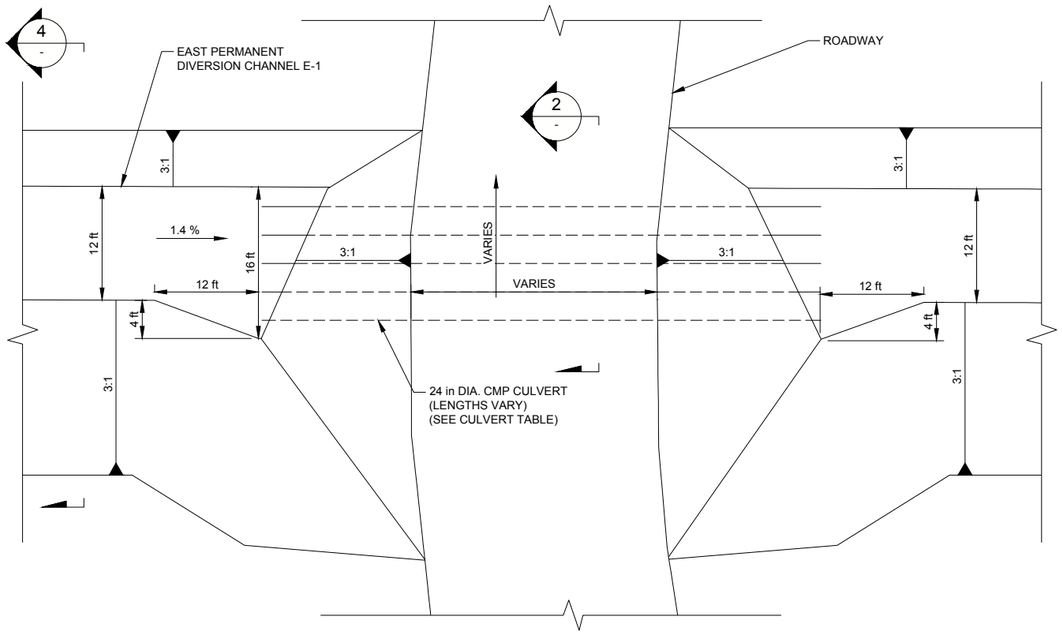
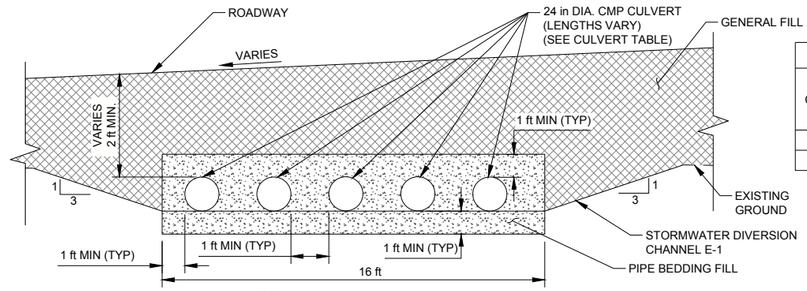
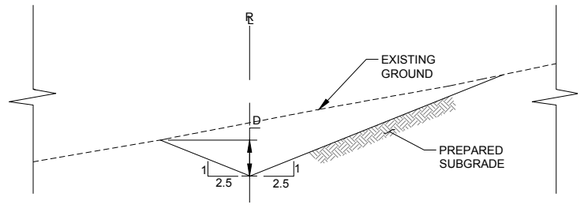


NTS 1 SW3 CULVERT CROSSING TYPICAL DETAIL



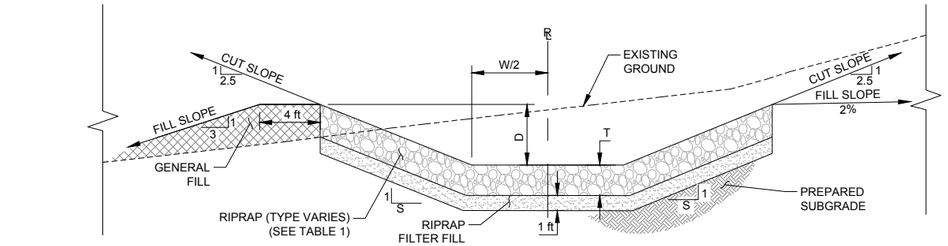
NTS 2 SW1 SW3 CULVERT SECTION

CULVERT TABLE				
CULVERT	BARREL DIAMETER (IN)	BARREL LENGTH (FT)	# BARRELS	CULVERT GRADE
C1	24	95	5	1.4 %
C2	24	60	5	1.4 %



SCALE 1:5 3 SW1 SW2 STORMWATER DIVERSION V-DITCH TYPICAL SECTION

STORMWATER DIVERSION V-DITCH TABLE					
CHANNEL	RPRAP TYPE (IN)	RIPRAP THICKNESS (T) (IN)	CHANNEL DEPTH (D) (FT)	WEST PERMANENT DIVERSION CHANNEL STATIONING	DETAIL
W-2	-	-	2.25	13+72 TO 25+04	3/SW4
STAGE 1 TEMPORARY	-	-	1.75	-	3/SW4
STAGE 3 TOE	-	-	1.75	-	3/SW4
R-1	-	-	1.50	-	3/SW4
R-2	-	-	1.75	-	3/SW4



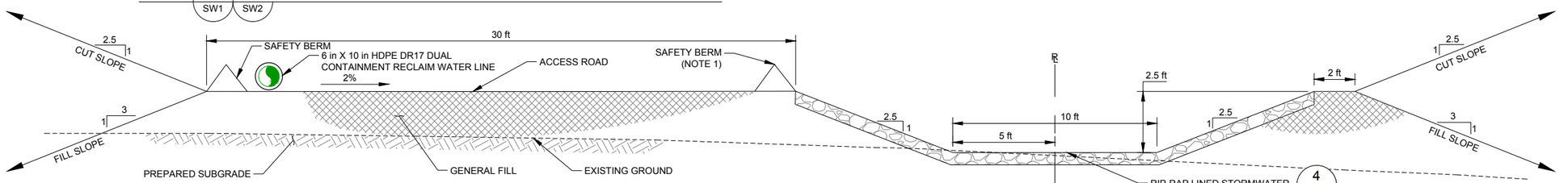
SCALE 1:5 4 SW1 SW2 STORMWATER DIVERSION TRAPAZOIDAL CHANNEL TYPICAL SECTION

STORMWATER DIVERSION TRAPAZOIDAL CHANNEL TABLE								
CHANNEL	SIDE SLOPE (S:1)	RIPRAP TYPE (IN)	RIPRAP THICKNESS (IN)	BOTTOM WIDTH (W) (FT)	CHANNEL DEPTH (D) (FT)	EAST PERMANENT DIVERSOIN CHANNEL STATIONING	WEST PERMANENT DIVERSION CHANNEL STATIONING	DETAIL
E-1	3.00	-	-	12.00	2.25	0+00 TO 35+85	-	4/SW4
E-1		-	-	16.00	2.25			
E-2	2.50	SEE CHANNEL RIPRAP TABLE		10.00	3.00	36+35 TO 47+37	-	4/SW4
E-3	2.50	SEE CHANNEL RIPRAP TABLE		10.00	3.00	47+87 TO 51+69	-	4/SW4
W-1	2.50	D_{50}=4	6	10.00	4.25	-	0+00 TO 13+22	4/SW4

CHANNEL RIPRAP TABLE		
SLOPE RANGE	RIPRAP TYPE (IN)	RIPRAP THICKNESS (T) (IN)
2-6%	D_{50} = 12	18
6-8.5%	D_{50} = 16	24
>8.5%	D_{50} = 28	40

NOTE

1. CUT OPENINGS IN SAFETY BERM AS NEEDED TO PROMOTE ACCESS ROAD DRAINAGE INTO IMPOUNDMENT.



NTS 5 C1 C2 C5 C8 C10 C15 C17 STORMWATER DIVERSION CHANNEL & ACCESS ROAD SECTION (STA. 37+35.00 TO 49+23.00)

0 5 10
1" = 5' FEET

0 6 12
1" = 6' FEET

ISSUED FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
STORMWATER DIVERSION DETAILS (1 OF 2)

PROJECT NO. 1663241
REV. 0

DRAWING SW4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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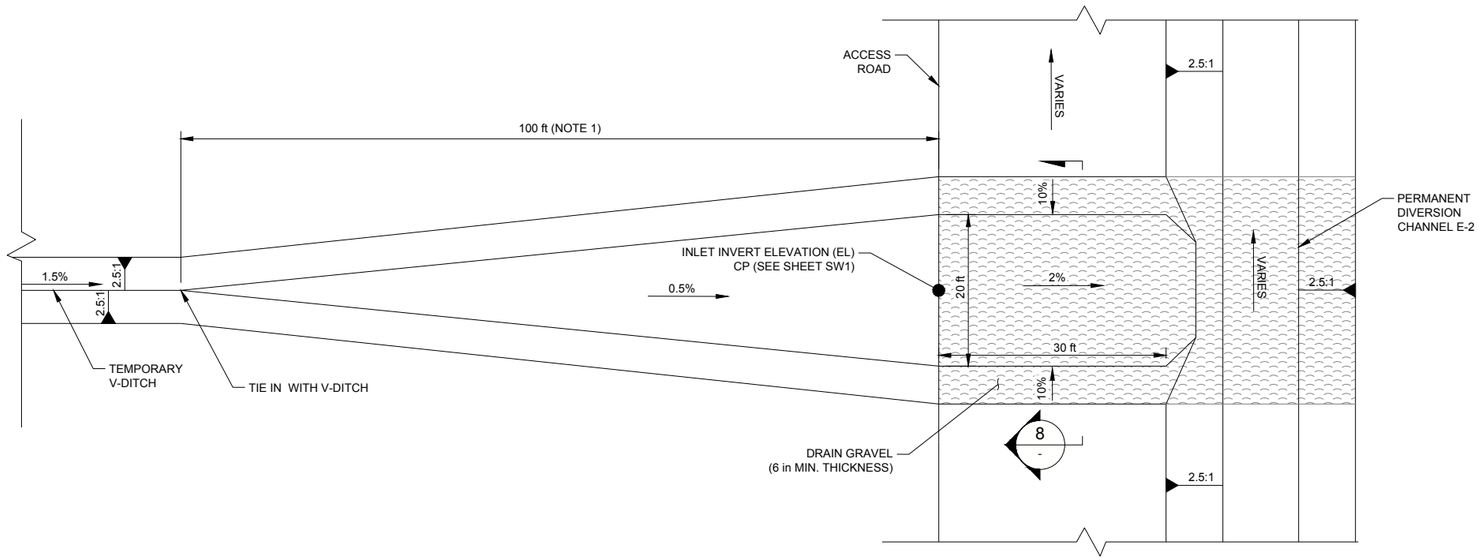
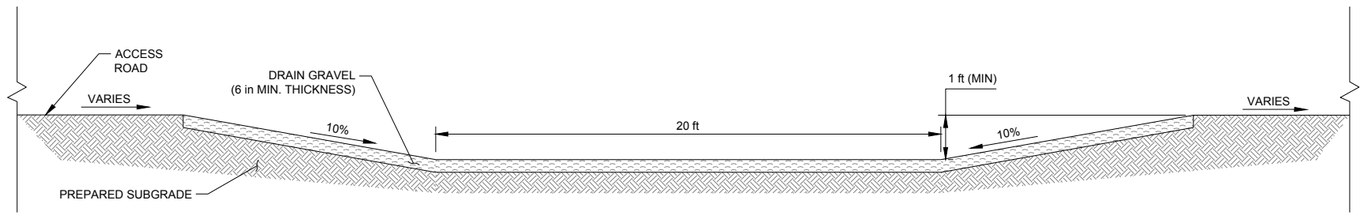
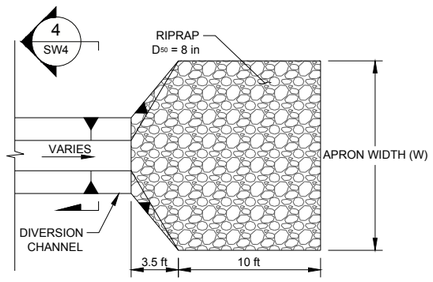


SCALE 1" = 10' 6 SW1 LOW WATER CROSSING TYPICAL DETAIL

LOW WATER CROSSING TABLE			
LOW WATER CROSSING	UPSTREAM V-DITCH	DOWNSTREAM DIVERSION CHANNEL	INLET INVERT ELEVATION (EL) (FT)
L1	STAGE 1 TEMPORARY DIVERSION CHANNEL	DIVERSION CHANNEL E-2	3691.67
L2	RECLAIM POND V-DITCH R-2	DIVERSION CHANNEL E-3	3544.07



NTS 8 - LOW WATER CROSSIN TYPICAL SECTION



NTS 7 SW1 RIPRAP APRON DETAIL

RIPRAP APRON TABLE		
APRON #	APRON WIDTH (W) (FT)	RIPRAP THICKNESS (IN)
1	30	12
2	30	12
3	40	12

NOTE

1. TRANSITION UNIFORMLY BETWEEN 2.5H:1V CHANNEL AND 5H:1 CROSSING.

ISSUED FOR CONSTRUCTION

0 10 20
1" = 10' FEET

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92393PE
OREGON
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CHRISTOPHER J. MacMAHON
11/6/19
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TITLE
STORMWATER DIVERSION DETAILS (2 OF 2)

PROJECT NO. 1663241 | REV. 0 | 37 of 42 | DRAWING SW5

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0 1 in

INCLINOMETERS CONTROL POINT TABLE

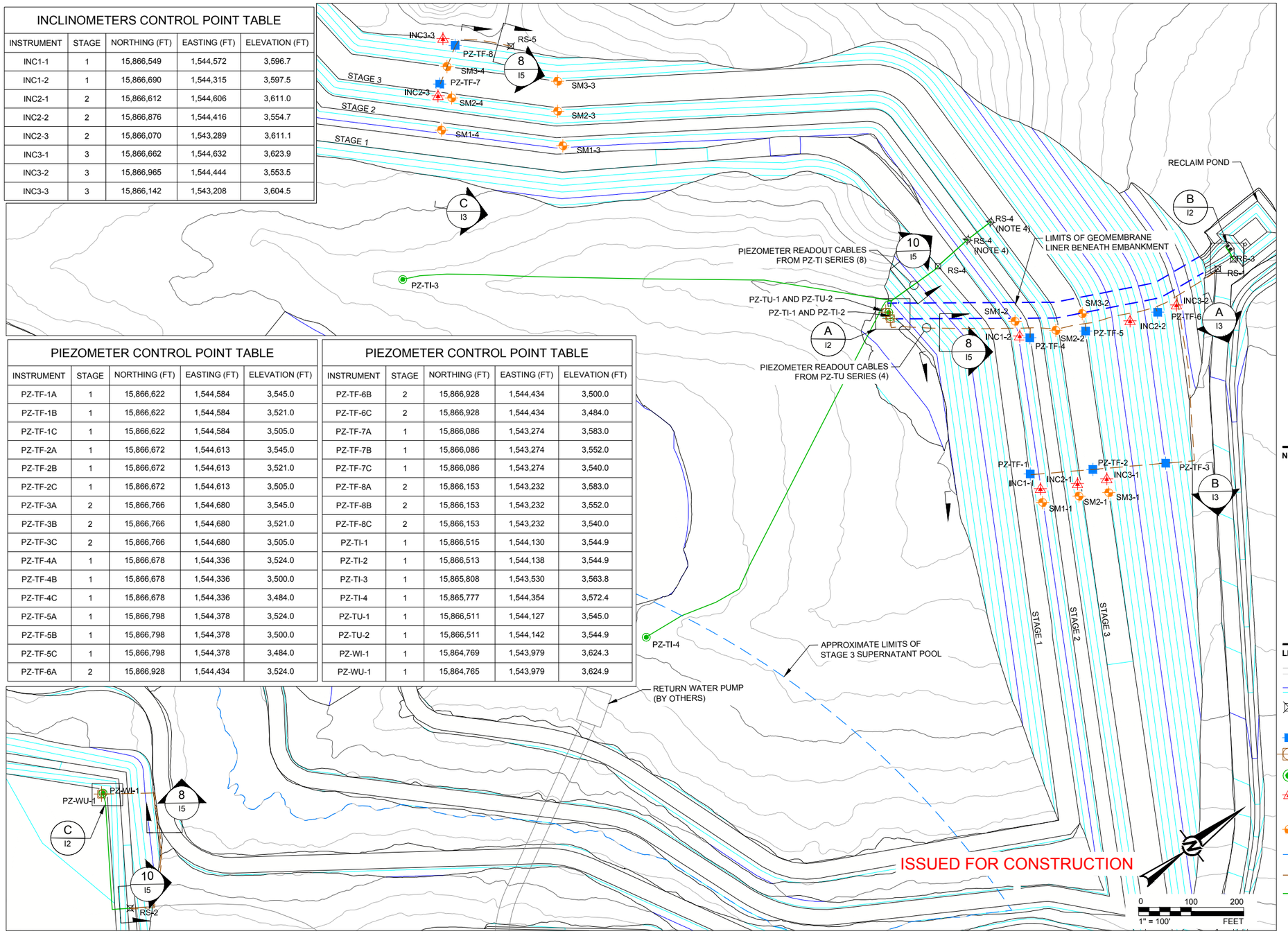
INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
INC1-1	1	15,866,549	1,544,572	3,596.7
INC1-2	1	15,866,690	1,544,315	3,597.5
INC2-1	2	15,866,612	1,544,606	3,611.0
INC2-2	2	15,866,876	1,544,416	3,554.7
INC2-3	2	15,866,070	1,543,289	3,611.1
INC3-1	3	15,866,662	1,544,632	3,623.9
INC3-2	3	15,866,965	1,544,444	3,553.5
INC3-3	3	15,866,142	1,543,208	3,604.5

PIEZOMETER CONTROL POINT TABLE

INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
PZ-TF-1A	1	15,866,622	1,544,584	3,545.0
PZ-TF-1B	1	15,866,622	1,544,584	3,521.0
PZ-TF-1C	1	15,866,622	1,544,584	3,505.0
PZ-TF-2A	1	15,866,672	1,544,613	3,545.0
PZ-TF-2B	1	15,866,672	1,544,613	3,521.0
PZ-TF-2C	1	15,866,672	1,544,613	3,505.0
PZ-TF-3A	2	15,866,766	1,544,680	3,545.0
PZ-TF-3B	2	15,866,766	1,544,680	3,521.0
PZ-TF-3C	2	15,866,766	1,544,680	3,505.0
PZ-TF-4A	1	15,866,678	1,544,336	3,524.0
PZ-TF-4B	1	15,866,678	1,544,336	3,500.0
PZ-TF-4C	1	15,866,678	1,544,336	3,484.0
PZ-TF-5A	1	15,866,798	1,544,378	3,524.0
PZ-TF-5B	1	15,866,798	1,544,378	3,500.0
PZ-TF-5C	1	15,866,798	1,544,378	3,484.0
PZ-TF-6A	2	15,866,928	1,544,434	3,524.0

PIEZOMETER CONTROL POINT TABLE

INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
PZ-TF-6B	2	15,866,928	1,544,434	3,500.0
PZ-TF-6C	2	15,866,928	1,544,434	3,484.0
PZ-TF-7A	1	15,866,086	1,543,274	3,583.0
PZ-TF-7B	1	15,866,086	1,543,274	3,552.0
PZ-TF-7C	1	15,866,086	1,543,274	3,540.0
PZ-TF-8A	2	15,866,153	1,543,232	3,583.0
PZ-TF-8B	2	15,866,153	1,543,232	3,552.0
PZ-TF-8C	2	15,866,153	1,543,232	3,540.0
PZ-TI-1	1	15,866,515	1,544,130	3,544.9
PZ-TI-2	1	15,866,513	1,544,138	3,544.9
PZ-TI-3	1	15,865,808	1,543,530	3,563.8
PZ-TI-4	1	15,865,777	1,544,354	3,572.4
PZ-TU-1	1	15,866,511	1,544,127	3,545.0
PZ-TU-2	1	15,866,511	1,544,142	3,544.9
PZ-WI-1	1	15,864,769	1,543,979	3,624.3
PZ-WU-1	1	15,864,765	1,543,979	3,624.9



READOUT STATION CONTROL POINT TABLE

READOUT STATION	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)	STAGE
RS-1	15,867,069	1,544,436	3,536.8	1
RS-2	15,864,680	1,544,186	3,642.2	1
RS-3	15,867,104	1,544,439	3,536.7	1
RS-4	15,866,643	1,544,116	3,595.0	1
RS-5	15,866,237	1,543,296	3,601.8	1

SURVEY MONUMENT CONTROL POINT TABLE

INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
SM1-1	1	15,866,537	1,544,596	3,593.4
SM1-2	1	15,866,699	1,544,287	3,594.6
SM1-3	1	15,866,204	1,543,507	3,595.0
SM1-4	1	15,866,036	1,543,346	3,595.1
SM2-1	2	15,866,600	1,544,627	3,608.0
SM2-2	2	15,866,751	1,544,347	3,608.7
SM2-3	2	15,866,236	1,543,448	3,607.9
SM2-4	2	15,866,088	1,543,308	3,608.1
SM3-1	3	15,866,649	1,544,655	3,620.9
SM3-2	3	15,866,811	1,544,351	3,621.8
SM3-3	3	15,866,269	1,543,402	3,622.0
SM3-4	3	15,866,116	1,543,255	3,622.0

NOTES

1. AT EACH DESIGNATED MONITORING POINT FOR PZ-TI, PZ-TU, PZ-WI, PZ-WU SERIES PLACE 2 PIEZOMETERS APPROXIMATELY 1 ft APART.
2. SEE DRAWING C15 FOR DETAILS AND UNDERDRAIN PIPING SYSTEM.
3. INCLINOMETER ELEVATIONS REPRESENT COLLAR ELEVATION 3 FT ABOVE PROPOSED GROUND.
4. READOUT STATION RS-4 AND REQUIRED CABLES TO BE RELOCATED TO NEW UPSTREAM DAM CREST WITH EACH DAM RAISE.
5. SURVEY MONUMENTS LOCATED ALONG DOWNSTREAM CREST OF EACH STAGE.

LEGEND

- 3600 — EXISTING GROUND (5 FT CONTOURS) (GENERAL NOTE 1)
- 3600 — PROPOSED GRADING (5 FT CONTOURS)
- RS-1 — READOUT STATION (9 I5)
- PZ-TF1 — FOUNDATION PIEZOMETER (7 I5)
- PZ-TU-1 — UNDERLINER PIEZOMETER (5 I5)
- PZ-TI-1 — IMPOUNDMENT PIEZOMETER
- INC1-1 — INCLINOMETER (NOTE 3) (1 I4)
- SM1-1 — SURVEY MONUMENT (3 I4)
- LIMITS OF SUPERNATANT POOL
- CABLE ROUTES BELOW LINER (8 I5)
- CABLE ROUTES ABOVE LINER (10 I5)

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TITLE
GEOTECHNICAL INSTRUMENTATION LAYOUT (1 OF 2)

PROJECT NO.	REV.		DRAWING
1663241	0	38 of 42	I1

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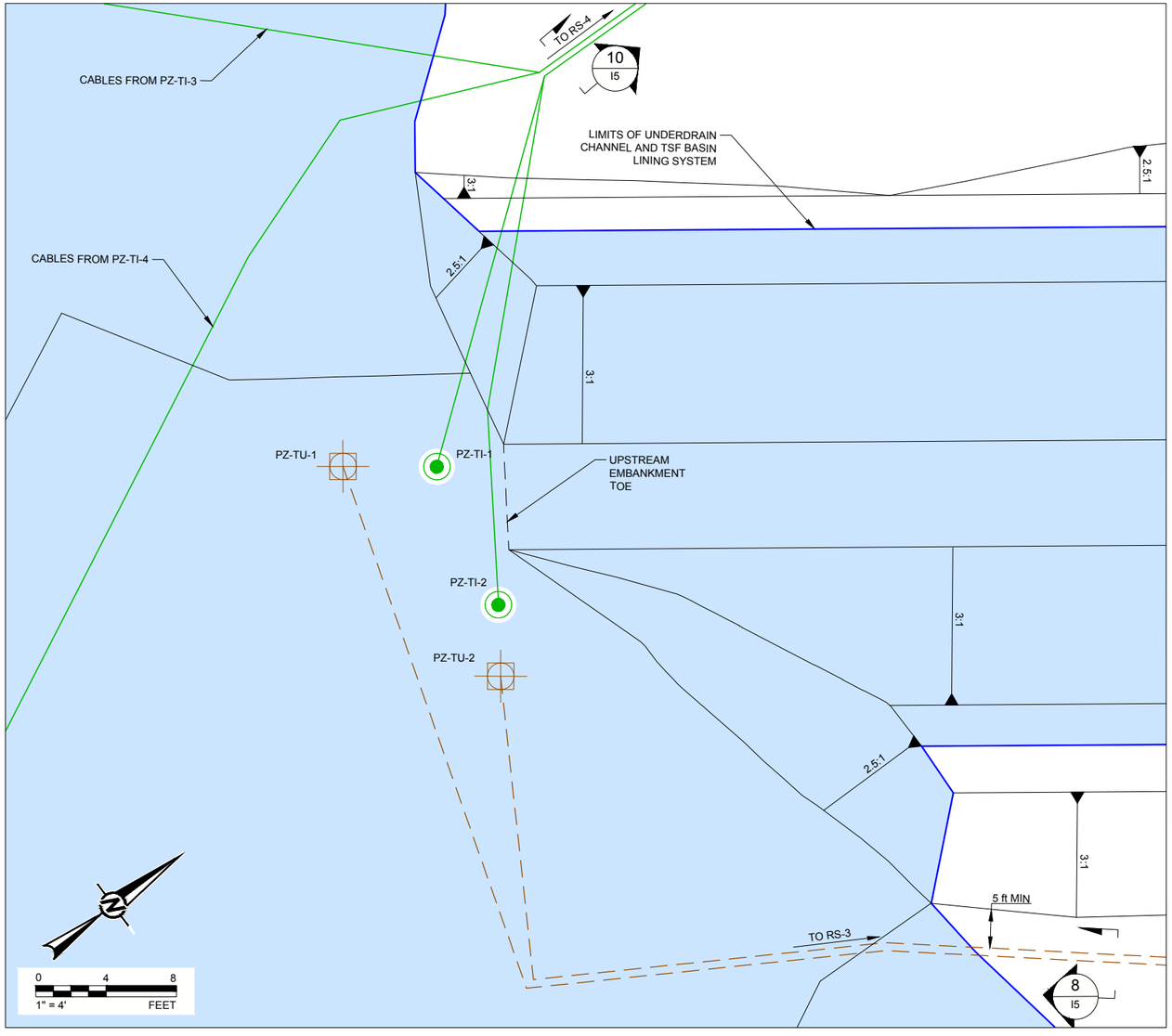
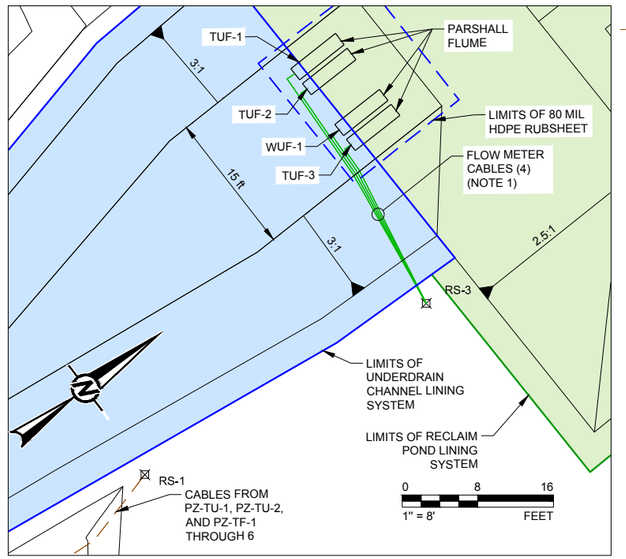
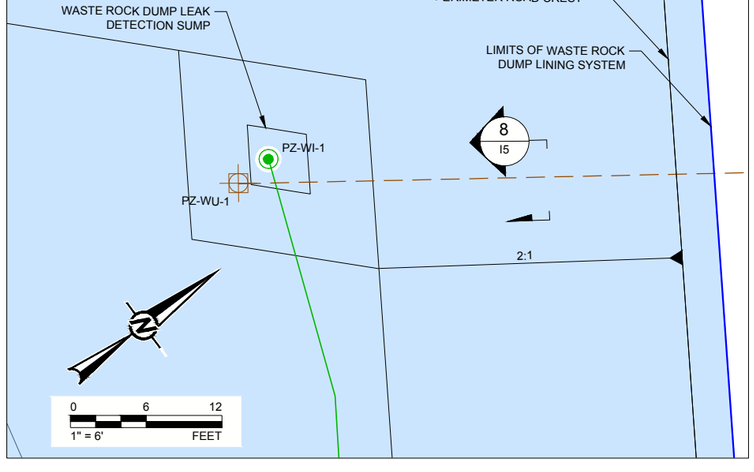


SCALE 1" = 4' A I1 INSTRUMENTATION DETAIL (1 OF 3)



SCALE 1" = 8' B I1 INSTRUMENTATION DETAIL (2 OF 3)



SCALE 1" = 6' C I1 INSTRUMENTATION DETAIL (3 OF 3)

LEGEND

- RS-1 READOUT STATION (9 / I5)
- PZ-TU-1 UNDERLINER PIEZOMETER (5 / I5)
- PZ-TI-1 IMPOUNDMENT PIEZOMETER
- CABLE ROUTES BELOW LINER (NOTE 2) (8 / I5)
- CABLE ROUTES ABOVE LINER (10 / I5)
- LIMITS OF UNDERDRAIN CHANNEL, WASTE ROCK DUMP, AND TSF BASIN LINING SYSTEM
- LIMITS OF RECLAIM POND LINING SYSTEM
- LIMITS OF 80 MIL HDPE RUBSHEET

ISSUED FOR CONSTRUCTION

NOTES

1. SIGNAL CABLES FOR FLUME SONIC TRANSDUCERS TO ROUTE ALONG GEOMEMBRANE LINER TO RS-3.
2. DETAILED SURVEY OF AS INSTALLED CABLE TRENCHES TO BE PERFORMED PRIOR TO BACKFILLING.

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TITLE
GEOTECHNICAL INSTRUMENTATION LAYOUT (2 OF 2)

PROJECT NO.	REV.		DRAWING
1663241	0	39 of 42	I2

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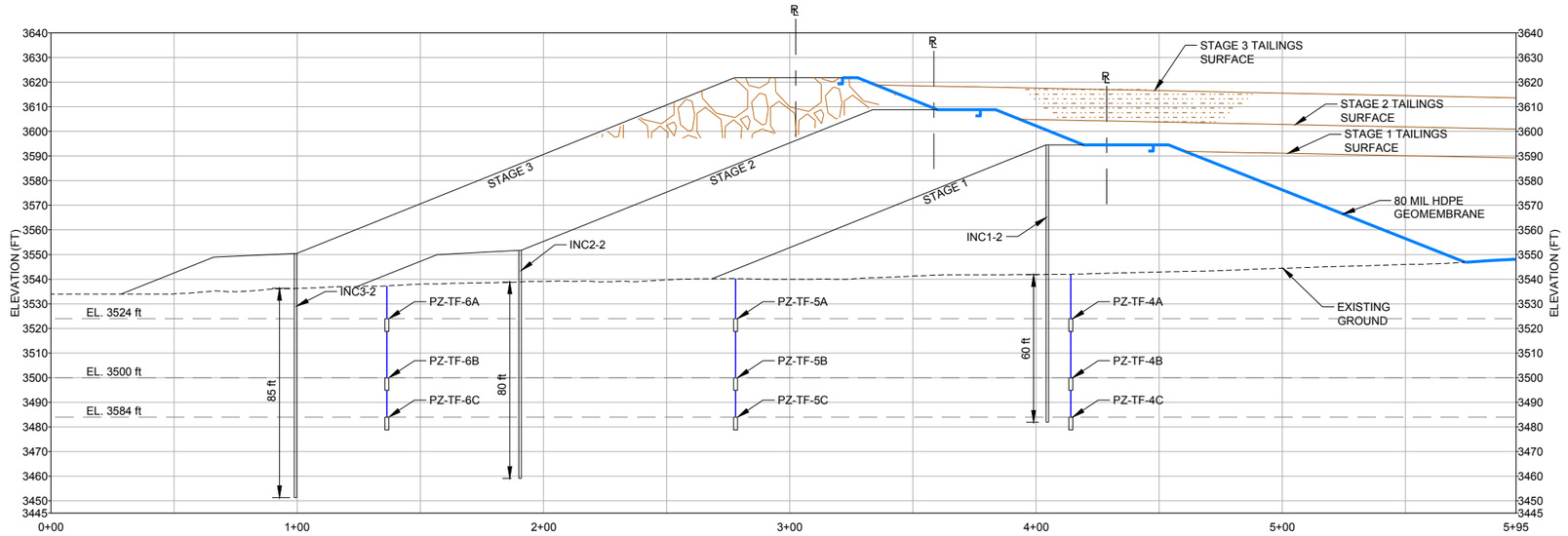
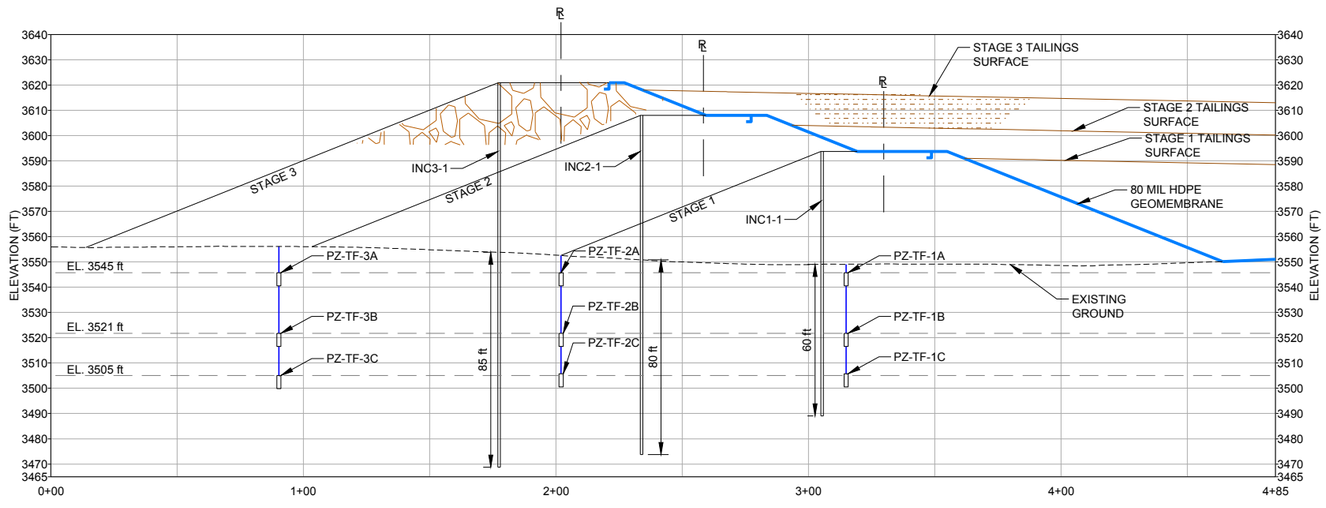


SCALE 1" = 30' (A / I1) NORTH EMBANKMENT PIEZOMETER LOCATIONS (1 OF 2)



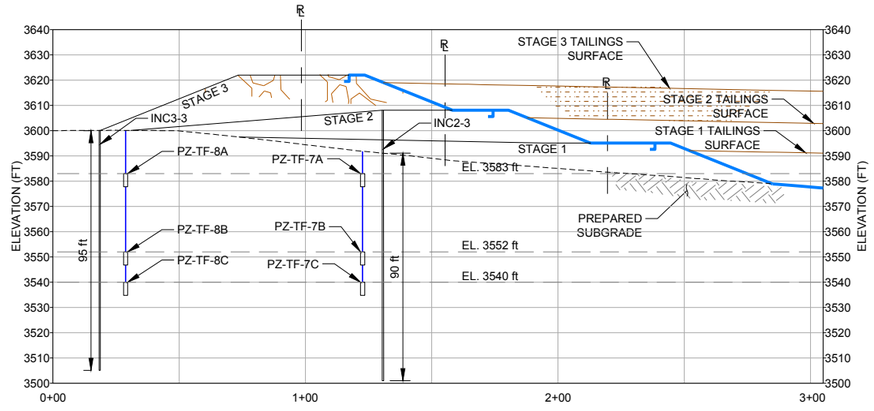
SCALE 1" = 30' (B / I1) NORTH EMBANKMENT PIEZOMETER LOCATIONS (2 OF 2)

LEGEND

- EMBANKMENT LINING SYSTEM (5 / D1)
- EXISTING GROUND
- TAILINGS SURFACE
- FOUNDATION PIEZOMETER (PZ-TF SERIES) (7 / I5)
- INCLINOMETER (1 / I4)

ISSUED FOR CONSTRUCTION

0 30 60 90
1" = 30' FEET



SCALE 1" = 30' (C / I1) WEST EMBANKMENT PIEZOMETER LOCATIONS

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92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
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GEOTECHNICAL INSTRUMENTATION SECTIONS

PROJECT NO. 1663241 | REV. 0 | 40 of 42 | DRAWING I3

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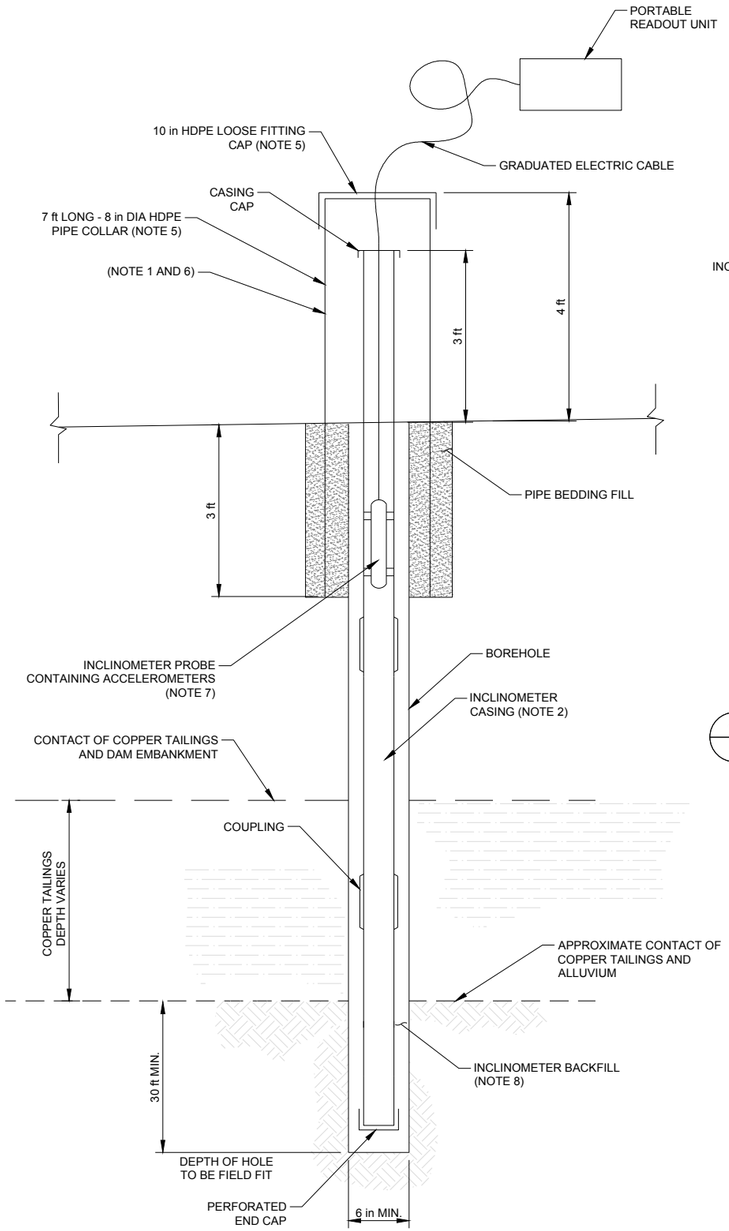
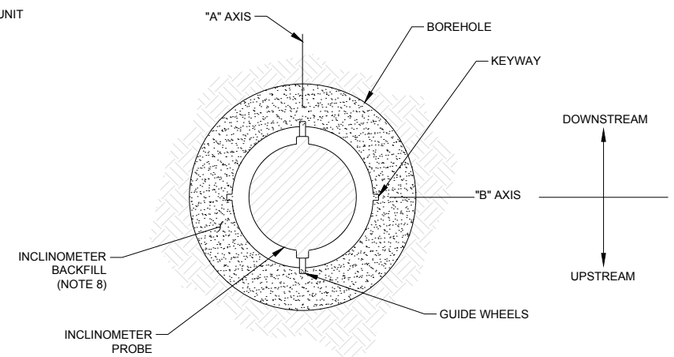
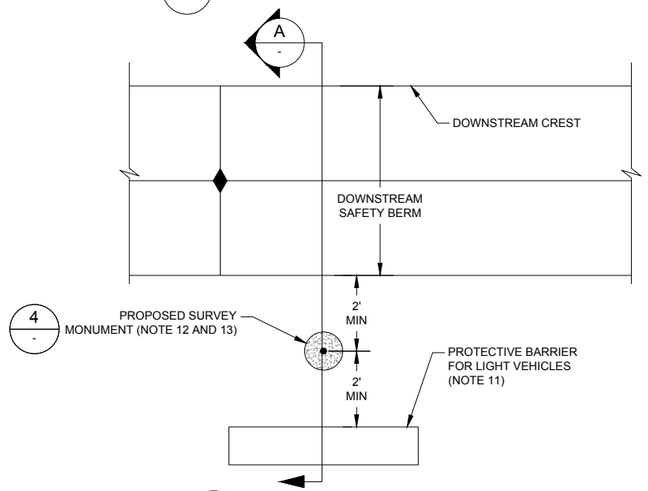


NTS 1 / I1 TYPICAL INCLINOMETER INSTALLATION DETAIL

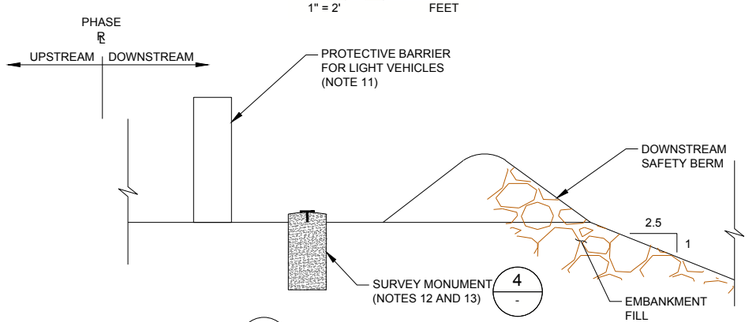


NTS 2 / - TYPICAL INCLINOMETER CASING DETAIL

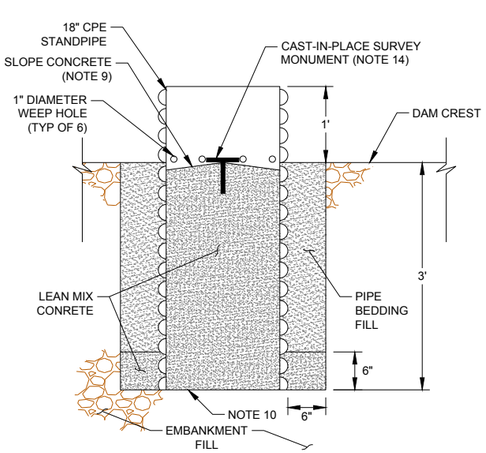


1" = 2' 3 / I1 TYPICAL SURVEY MONUMENT PLAN

0 2 4
1" = 2' FEET



NTS A / - SURVEY MONUMENT SECTION



NTS 4 / - SURVEY MONUMENT TYPICAL DETAIL

NOTES

1. THE LOCATION OF THE INCLINOMETERS ARE SHOWN ON DRAWING I1A.
2. 2.75" O.D. INCLINOMETER CASING SHALL INCLUDE FOUR KEYWAYS SET AT THE RIGHT ANGLES TO EACH OTHER AND SHALL BE SUPPLIED IN 10 FT LENGTHS WITH COUPLING AND END CAPS. THE KEYWAYS SHALL BE ORIENTATED SUCH THAT MOVEMENTS ARE MEASURED IN THE DIRECTIONS PERPENDICULAR AND PARALLEL TO THE REFERENCE LINE OF THE DAM WITH THE "A" AXIS ALWAYS PERPENDICULAR TO THE R_0. USE A COMPASS OR SURVEYING EQUIPMENT TO DOCUMENT THE BEARING OF THE "A" AXIS AFTER INSTALLATION.
3. THE ASSEMBLED TUBE SHALL BE LOWERED INTO A 6 INCH MIN. DIAMETER BOREHOLE.
4. ALL EQUIPMENT AND PERMANENT MATERIALS SHALL BE REVIEWED AND APPROVED BY THE ENGINEER BEFORE INSTALLATION.
5. THE INCLINOMETER CASING SHALL BE CASED AND PROTECTED AS SHOWN IN THE FIGURE AND SURROUNDED BY A SAFETY BERM. PAINT EXPOSED COLLAR AND CAP WITH ORANGE PAINT.
6. CLEARLY MARK THE INSTRUMENT NUMBER ON THE PIPE COLLAR.
7. ALTERNATIVE INCLINOMETER TYPES AND CONFIGURATIONS MAY BE EVALUATED FOR USE AND INSTALLED WITH THE APPROVAL OF THE ENGINEER.
8. ANNULAR SPACE BETWEEN BOREHOLES AND INCLINOMETERS SHALL BE BACKFILLED IN ACCORDING WITH MANUFACTURER RECOMMENDATIONS.
9. GRADE CONCRETE SURFACE TO CONVEY WATER AWAY FROM CENTER.
10. LEVEL BASE OF EXCAVATION AND BACKFILL MONUMENT WITH PIPE BEDDING FILL. HAND TAMP TO PROVIDE UNIFORM AND DENSE FILL.
11. AFTER INSTALLATION, PROTECT SURVEY MONUMENTS FROM DAMAGE FROM TRAFFIC AND CONSTRUCTION OPERATIONS.
12. CLEARLY MARK THE MONUMENT NUMBER ON TOP OF THE CONCRETE PIPE BACKFILL.
13. THE LOCATION OF EMBANKMENT CREST SURVEY MONUMENTS ARE SHOWN ON DRAWING I1.
14. CAST-IN-PLACE SURVEY MONUMENTS SHALL BE BRASS SURVEY MARKER MODEL NO. M/M/BCS-2½F (2-1/2 in) AS MANUFACTURED BY SURV-KAP, OR EQUIVALENT APPROVED BY THE ENGINEER.

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
11/6/19
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL INSTRUMENTATION DETAILS (1 OF 2)

PROJECT NO.	REV.		DRAWING
1663241	0	41 of 42	I4

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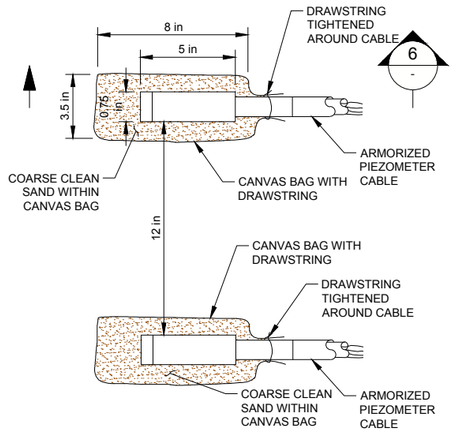
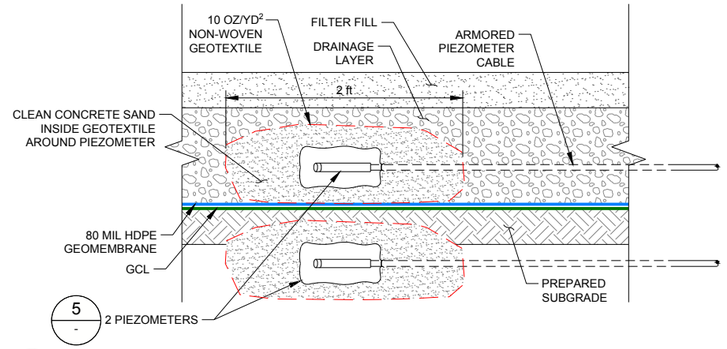


NTS 5 I1 IMPOUNDMENT AND UNDERLINER VIBRATING WIRE PIEZOMETER TYPICAL DETAIL



NTS 6 - IMPOUNDMENT AND UNDERLINER PIEZOMETER INSTALLATION TYPICAL DETAIL

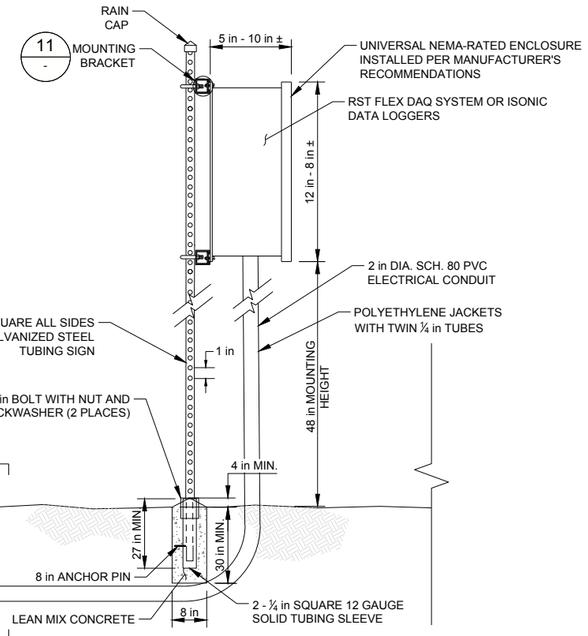
NOTES

1. REFER TO DRAWING I1A FOR SENSOR ELEVATION AND VERTICAL SPACING.
2. NESTED PIEZOMETERS AND CABLES SHALL BE PRE FABRICATED TO DESIGNED VERTICAL INTERVAL.

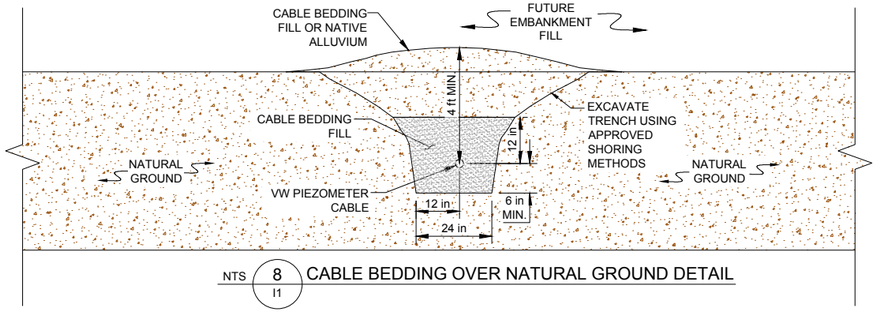
LEGEND

GCL

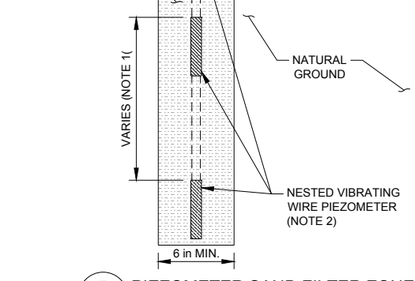
80 MIL HDPE GEOMEMBRANE



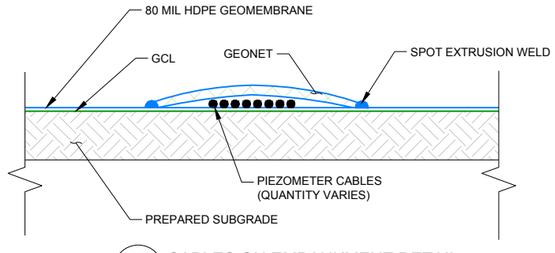
NTS 9 I1 I2 READOUT STATION DETAIL



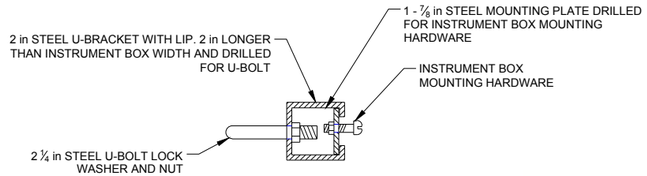
NTS 8 I1 CABLE BEDDING OVER NATURAL GROUND DETAIL



NTS 7 I1 PIEZOMETER SAND FILTER ZONE



NTS 10 I1 CABLES ON EMBANKMENT DETAIL



NTS 11 - MOUNTING BRACKET DETAIL

ISSUED FOR CONSTRUCTION

11/6/19

REGISTERED PROFESSIONAL ENGINEER
92393PE
OREGON
JULY 11, 2017
CHRISTOPHER J. MacMAHON
EXPIRES: 12/31/2020

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL INSTRUMENTATION DETAILS (2 OF 2)

PROJECT NO.	REV.		DRAWING
1663241	0	42 of 42	I5

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APPENDIX A

Geotechnical Data Report

November 6, 2019 Project No. 1663241-054-L-Rev0

Nancy Wolverson
Calico Resources USA Corp.
665 Anderson Street
Winnemucca, NV 89445

GEOTECHNICAL DATA REPORT
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
GRASSY MOUNTAIN MINE, MALHEUR COUNTY, OREGON

Dear Ms. Wolverson

This letter presents geotechnical data collected by Golder Associates Inc. (Golder) for Calico Resources USA Corp. (Calico) for the Grassy Mountain Mine located in Malheur County, Oregon. This letter documents the findings of geotechnical field exploration and laboratory testing programs conducted by Golder to support detailed design of the proposed tailings storage facility (TSF), waste rock dump (WRD) and mine process facilities, as well as assess potential soil borrow areas.

Golder has completed three geotechnical investigations between November 2017 and August 2019 to characterize the subsurface beneath the proposed TSF, WRD and process facilities.

1.0 SITE DESCRIPTION

The Grassy Mountain Mine site is located approximately at 43.673°N latitude, 117.364°W longitude in Malheur County, Oregon. The proposed TSF will be located in a broad valley immediately west of the proposed underground portal and process facilities. The TSF will fill the valley and require embankments on the north and west sides, with the main embankment located at the north end of the valley. The proposed WRD will be located immediately west of the underground portal, while the processing facilities will be located north of the underground portal. Figure 1 presents proposed facility locations as well as existing site topography.

The overall ground surface within the TSF footprint drains from the southwest to the north embankment at about two (2) percent, with valley wall slopes to the east and west ranging from about 10 percent to 15 percent, and about 5 percent in the south (refer to Figure 1). The north TSF embankment will extend east-west across the valley and will have an approximate maximum height of about 84 feet. Additional embankments will be required along the western boundary of the impoundment and will range in height from about 10 feet to about 30 feet.

The proposed WRD will be located immediately southeast and upslope from the TSF. The native slopes beneath the WRD generally slope between 10 and 12 percent in both the northwest and northeast directions.

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The mine process facilities will be situated east of the TSF on a saddle between the underground portal and a knoll about 600 feet north of the portal.

Vegetation across the site generally consisted of moderately dense native shrubs and grasses. No surface water, perennial streams, or springs were observed within the TSF footprint, WRD, or process facilities area.

2.0 SCOPE OF GEOTECHNICAL CHARACTERIZATION

Golder has completed three geotechnical investigations in support of the design of the surface facilities at the Grassy Mountain Mine. The purpose for the investigations included characterizing the subsurface conditions, identifying potential construction material borrow sources, and supporting preliminary foundation recommendations for the proposed process facilities.

The first investigation, completed in December 2017, investigated the subsurface beneath the proposed locations of the TSF, WRD and process facilities. Two additional geotechnical investigations were completed in 2019 to refine the geotechnical characterization of the lacustrine clay deposit beneath the TSF that was first identified in 2017.

The scope of the three geotechnical investigations is summarized below:

- November 30 to December 8, 2017 – Initial surface geology mapping and subsurface geotechnical investigation beneath the TSF, WRD and process facilities.
  - TSF and Permanent Stormwater Diversion Channel
    - **BH-01 through BH-09 and BH-13 through BH-15:** Drill twelve (12) hollow stem auger boreholes to depths ranging from 40 to 100 ft below the ground surface (bgs)
    - **TP-01 through -4, -14 through -23, -38, -44 and -45:** Excavate 24 test pits to depths of up to 20 ft bgs
    - Perform six (6) falling head permeability tests in completed boreholes to provide field permeability estimates of the various geologic units encountered in the subsurface exploration
  - Mine Processing/Admin/Maintenance Facilities
    - **BH-10 through BH-12:** Drill three (3) boreholes to depths ranging from 20 to 40 ft bgs
    - **TP-26 through TP-29:** Excavate four (4) test pits to depths of up to 15 ft bgs
  - Waste Rock Dump Area
    - **TP-05 and TP-43:** Excavate two test pits to a depth of 15 ft bgs
  - Borrow Source Areas
    - **TP-13, -24, -25, -30 through -37, and -39 through -41:** Excavate 14 test pits to depths of up to 10 ft bgs to assess the suitability of onsite material for use as various construction materials for the TSF

- March 19 to 30, 2019 – Geotechnical drilling program to obtain samples for laboratory testing to refine the geotechnical characterization of the clay beneath the North embankment of the TSF. These 6 boreholes were drilled at the same location as previously permitted and excavated test pits.
  - **BH19-TP-01, -15, -19, -23, -39, -44:** Drill six (6) boreholes to depths ranging from 50 to 120 bgs
- August 16 to 20, 2019 – Cone penetration test (CPT) program to investigate the presence of groundwater and to support the selection of material strength properties for the subsurface materials beneath the TSF embankments. Each CPT sounding was advanced to gather additional information at critical locations coinciding with previously permitted and investigated locations.
  - **CPT-1A through CPT-12:** Advance twelve (12) CPT's to depths ranging from approximately 11 to 61 feet bgs
    - Pore pressure dissipation tests were performed at depths chosen by Golder's field engineer
    - Seismic shear wave velocity tests were performed during five (5) of the CPT's at approximate 5-foot intervals

Calico provided utility clearance for all investigation locations in addition to surveying the location of all boreholes and test pits in the field. The geotechnical investigation locations are presented on Figure 1.

2.1 Drilling

Haz-Tech Drilling Inc (Haz-Tech) of Meridian, Idaho, a subcontractor of Calico and Golder, advanced boreholes for both the December 2017 and March 2019 geotechnical investigations to depths ranging between 25 to 100 feet below the ground surface (bgs) using a CME 75 truck-mounted drill rig with a 4.25-inch inner diameter (approx. 8-inch outer diameter) hollow stem auger.

Standard Penetration Testing (SPT, ASTM D 1586) was conducted in soils using a 140-pound automatic hammer with a drop height of 30 inches, driving either a 2-inch (outer diameter O.D.) split spoon or a 3-inch O.D. Modified California Sampler (MC). Each SPT and MC was driven with the hammer 18 inches in accordance with ASTM D1586. The SPTs were performed at 5-foot intervals until the borehole was advanced to depths between 30 to 50 feet bgs, with samples then collected at 10-foot intervals until the borehole was terminated. Disturbed SPT samples were collected and sealed in waterproof bags.

The number of blows for each 6-inches of penetration was recorded. The penetration resistance (N-value) of the soil is calculated by summing the total number of blows required to drive the sampler the final 12-inches. The N-value is an indication of the relative density of cohesionless soils and the relative consistency of cohesive soils. If a total of 50 blows was recorded for a 6-inch interval, the test was terminated, and blow count was recorded as 50 blows per the depth driven in that interval. All blow counts presented on the borehole logs are uncorrected values.

When using the MC sampler, 6-inch long steel tubes were inserted inside the sampler to obtain relatively undisturbed samples for testing. The MC sampler was utilized more frequently during the March 2019 investigation to obtain more samples for relatively undisturbed strength testing. When soil conditions allowed, Shelby tube (thin-walled tube) samples were advanced hydraulically to try to take relatively undisturbed samples of sensitive subsurface soils.

The boreholes were backfilled with bentonite chips upon completion. Standpipes installed in the boreholes for field permeability testing were also backfilled with bentonite chips following completion of the permeability tests. Borehole logs are presented in Attachment A. Prior to construction, the upper 10 feet of each borehole where a field falling head standpipe was installed should be excavated, removed, and replaced with compacted fill in accordance with Technical Specifications.

2.2 Test Pit Excavation

Test pit excavations were completed during the December 2017 geotechnical investigation by Andy Bentz, of Vale, Oregon, a subcontractor of Calico, using a Thunderbird 500RB tracked excavator with a 2.5-foot wide bucket. Test pits were excavated between 2 and 16 feet below ground surface. Each test pit was excavated o the maximum reach of the excavator or to practical refusal. Golder's field engineer gathered bulk bag samples of the varying soil types observed during the investigation. Upon completion, test pits were backfilled with the excavated material and tamped by the excavator.

Prior to construction, all loose material within test pits excavated below planned structures and facilities should be removed and replaced with compacted fill in accordance with project Specifications. Test pit logs are presented in Attachment B.

2.3 Logging and Sampling

All drilling and excavation activities were performed under the supervision of Golder field engineers and geologists. The borehole and test pit samples were logged in general accordance with ASTM D 2488 and photographed by Golder's field engineers and geologists. Stratigraphic contacts depicted in the logs represent approximate boundaries between geologic deposits, and actual transitions may be more gradual. Geologic conditions described are only for the dates and locations reported and, therefore, may not necessarily be representative of other locations and/or times.

Bulk and disturbed samples were placed in plastic bags or 5-gallon buckets and sealed to prevent moisture loss. Steel and Shelby tube samples collected during drilling were capped and sealed to reduce moisture loss and packaged to decrease the potential for additional disturbance during transport. At the completion of each of the programs, samples were transported to Golder's geotechnical laboratory located in Lakewood, Colorado for further classification and testing.

2.4 Field Hydraulic Conductivity Testing

Upon completion of drilling, hydraulic conductivity (permeability) testing was performed in selected boreholes within the footprint of the TSF to evaluate the unsaturated hydraulic conductivity of the encountered soils. The permeability testing focused on characterizing the major soil units and conditions encountered in the boreholes from the surface to a depth of approximately 100 feet bgs. Falling head tests were conducted in accordance with industry standard methods. The interval for each falling head permeability test was selected by Golder's field engineer based on the depth and soils encountered during the field investigation.

Falling head tests were conducted using a 2-inch diameter polyvinyl chloride (PVC) standpipe installed in the geotechnical boreholes. Perforated PVC pipe was installed at the chosen testing interval, with solid PVC pipe extending above the chosen interval to the ground surface.

The annular space between the standpipe and the borehole for the segments above and below the perforated portion of the PVC pipe were backfilled with ⅜-inch granular bentonite chips to form an impermeable plug. The annular space around the perforated portion of the pipe was backfilled with No. 30 concrete sand (a clean, free-draining sand). Once the pipe segments, bentonite plugs, and sand were in place, the pipe was filled with water to allow the bentonite plugs to hydrate overnight prior to testing. Testing involved completely filling the standpipe then measuring and recording the water level drop in the standpipe with time using a down-hole water level indicator. Multiple tests were completed within each standpipe and the average of the tests is presented as the estimated hydraulic conductivity in Section 5.1.1.

The hydraulic conductivity was calculated using the following equation (NAVFAC, 1986):

$$K = \left[\frac{\frac{365 r^2}{L} Ln \frac{L}{R}}{t} \right] \left[\frac{\Delta h}{H_1 + H_2} \right] \left(9.665 x 10^{-7} \right)$$

Where: K = Mean Permeability, cm/s

r = Standpipe Radius, ft

L = Length of Perforated Pipe Section, ft

R = Radius of Borehole, ft

t = time, day

H = Head, ft

Δh = incremental water level drop, ft

Field permeability test results are presented in Attachment C.

2.5 Cone Penetration Test Program

A cone penetration testing (CPT) program was completed from August 16 to 20, 2019. The program consisted of advancing 11 CPTs to support geotechnical characterization of the clay within the TSF footprint and the selection of material strength properties for geotechnical stability modelling. CPTs were advanced by Taber Drilling (Taber) of Sacramento, California, subcontracted to Calico, by direct push of an instrumented cone at a controlled rate with continuous data collection, and included pore water dissipation testing to obtain static water levels and hydraulic conductivity data, as well as seismic testing to support selection of material density and modulus, and determine shear wave velocities. Taber recorded the cone resistance, unit sleeve friction resistance and pore water pressure at 2-cm increments.

All CPTs were advanced until refusal on native material. Native alluvium and lacustrine deposits were very hard in some areas requiring the advance of multiple CPTs at a specific location. When shallow refusal (<10 feet) occurred, the rig was shifted approximately 5 feet laterally before attempting to advance another CPT. Only the deepest CPT at each location has been presented on Figure 1 and summarized in this report.

A Golder field engineer was on site throughout the investigation to support the program and identity depth intervals for pore pressure dissipation and seismic shear wave velocity testing. Pore pressure dissipation tests were completed at selected depths during each CPT sounding while seismic shear wave velocity tests were

completed at approximate 5-foot intervals within five (5) CPTs (CPT-1a, -2a, -7b, -11a, and -12). Interpretation of the CPT soundings is presented in Golder's geotechnical stability and settlement evaluation for the TSF and WRD that is appended to the main Design Report.

The plots for the CPT soundings, pore pressure dissipation tests, and seismic shear wave velocity tests are presented in Attachment D.

3.0 LABORATORY TESTING PROGRAM

Geotechnical laboratory testing was performed on selected soil samples deemed representative of the materials encountered during the investigation. The geotechnical laboratory testing program, summarized in Table 1, was developed to focus on classifying and characterizing the engineering properties of the foundation soils and potential construction materials. Geotechnical laboratory testing was completed at Golder's Lakewood, Colorado geotechnical testing laboratory. Selected samples were also subjected to x-ray diffraction (XRD) mineral composition testing. These tests were performed by Miles Industrial Mineral Research of Denver, Colorado, subcontracted to Calico. All geotechnical laboratory testing results are presented in Attachment E.

Table 1: Summary of Laboratory Testing Program

Laboratory Test	Test Method	Quantity
Grain Size Analysis	ASTM D 421/D 422	81
Moisture Content	ASTM D 2216	72
Atterberg Limits	ASTM D 4318	81
Flexible Wall Permeability	ASTM D 5084	5
Moisture-Density Relationship (Modified Proctor)	ASTM D 1557	1
Consolidated-Undrained Triaxial Shear Strength	ASTM D 4767	6
1-Dimensional Consolidation	ASTM D 2435	6
X-ray Diffraction	N/A	15

Index tests (grain size, moisture, and Atterberg limits tests) were performed on selected subsurface soils encountered during the investigations to assist in classifying the soils in accordance with ASTM D 2487 and the Unified Soil Classification System (USCS) for verification of soil descriptions logged in the field.

Hydraulic conductivity (permeability) tests were run on both relatively undisturbed samples and a remolded sample using a flexible wall permeameter. The remolded sample was tested to assess the permeability of the lacustrine deposits if the material were to be excavated and used during construction. The relatively undisturbed samples were tested to provide the permeability of in-situ lacustrine soils beneath the TSF. The modified Proctor (moisture-density relationship test) was utilized to obtain parameters for remolding the permeability sample.

Consolidated-undrained triaxial shear strength tests (CUTX) were performed on relatively undisturbed samples extruded from the MC and Shelby tubes to assess the in-situ strength of the lacustrine deposits. A majority of the MC and some of the Shelby tube samples delivered to the laboratory were too disturbed or too fractured to be utilized for CUTX testing. This was most likely due to disturbance while driving the samplers into stiff to hard clays.

One-dimensional consolidation tests were conducted on relatively undisturbed lacustrine clay samples to determine the estimated pre-consolidation pressure and soil parameters for use in assessing settlement of the soils under loading conditions.

In addition, XRD mineral composition testing was performed on 15 samples to identify clay and accessory mineral concentrations. Results are presented in Attachment E.

4.0 SITE GEOLOGY AND GEOLOGIC HAZARDS

The information presented in this section is based on Golder's observations at the time of the field exploration program and a review of available published data.

4.1 Geology

As described by Paramount (2017), the geology of the region surrounding the TSF and WRD site is a sequence of sedimentary and volcanic deposits within the Oregon-Idaho Graben. Contemporaneous deposition of sandstone and conglomerate (Tgs), olivine basalt emplacement (Tbi), and repeated episodes of calc-alkaline lava eruption and flow (Tgb) occurred during middle to upper Miocene time. The volcanoes of west-central to southeastern Oregon range in age from 15 to 2 million years ago (Ma). The Payette section of the Columbia Plateau, where the TSF and WRD site is located, is a relatively uniform area of basalt flows that overlie and cap the underlying older sedimentary deposits.

Grassy Mountain itself is mapped as underlain by calc-alkaline rich volcanic flow deposits (Tgb) and associated olivine basalt that crops out farther northeast. The TSF and WRD sites are located on a thick sequence of arkosic sandstones containing interbeds of conglomerate separated by the tuff of Kern Basin. Geologically, the site is within the upper arkosic (mid- to upper Miocene) and the lower (mid-Miocene) arkosic units. Erosion over about the last 11 Ma has removed some of the volcanic deposits that overlie and cap the sedimentary units to expose the upper arkosic unit at the site.

Bedrock outcrops within the site expose siltstone, sandstone, and conglomerate of the late Miocene Grassy Mountain Formation. These units are also exposed in the northeast–southwest trending drainage that the TSF will partially fill. Olivine-rich basalts are present immediately to the east and south. Igneous intrusions (Tbi) are mapped as isolated bodies surrounded by the sedimentary units (Tgs). The intrusive bodies are in places aligned along the mapped pre-Quaternary faults that may have controlled the locations and extent of these shallow intrusions.

The Grassy Mountain mine is located on a 150-foot high, highly resistant, silicified and iron-stained knoll. Bedding within the sandstone unit appears unaltered at the hilltop, dips at 10° to 25° toward the north-northeast on the northern and eastern flanks of the hill and steepens to 30° to 40° on the west side of the hill due to drag folding in the footwall along a fault striking about N20°W (Paramount 2017). Normal faulting of the Miocene-age units is common, with most faults striking either northwest–southeast or northeast–southwest (most common).

Golder's subsurface geotechnical investigations identified unconsolidated alluvium and colluvium overlying previously unmapped Miocene-aged lacustrine clays underlying most of the TSF and WRD site area. The lacustrine deposits are generally characterized as fat clay (with variable quantities of fine- to medium-grained sand, dark tan to brown with some blue-gray deposits) with lesser amounts of lean clay and poorly graded sand lenses. Based on Golder's research, these lacustrine deposits had not been previously mapped at the site; however, such clay deposits are not uncommon in the region. Similar deposits in the region were described as typically formed during the Upper Miocene due to hydrothermal alteration or deposition of ash fall infilling basin alkaline lakes (Gray et al. 1989) and were mapped by Ferns et al. (1993) in a nearby basin approximately 2 miles northeast of the project.

4.2 Faulting and Seismicity

Normal faulting of the Miocene-age units is common, with most faults striking either northwest–southeast or northeast–southwest (most common). Also, a number of mapped older faults strike approximately north–south, but these faults are generally located west of the Site. Golder completed a seismic and faulting hazard assessment appended to the main Design Report. No faults with evidence for Quaternary surface rupture have been mapped through the footprint of the TSF or WRD, and the surface fault rupture hazard is considered negligible (Golder 2019b).

As described in Golder's updated seismic and faulting hazard assessment (Golder 2019b), a probabilistic analysis (PSHA) using the United States Geological Survey (USGS) 2014 National Seismic Hazard Model indicates that the earthquakes for the 475-year return period has a mean peak ground accelerations (PGAs) of 0.08g.

A deterministic analysis (DSHA) indicates that the Cottonwood Mountain fault is the controlling Maximum Credible Earthquake (MCE) for the Project TSF. The Cottonwood Mountain fault has a surface trace mapped about 18 miles (28 km) from the TSF at its closest approach and generates an MCE **M**7.2 earthquake. Using the geometric mean of four equally weighted ground motion models, the median PGA value for the MCE is 0.15g. The median deterministic PGA has return periods estimated from the 2014 USGS NSHM at about 1,500 years.

4.3 Rock Slides

A localized rock slide was observed on the southwestern slope of Grassy Mountain that measured about 550 feet long by 250 feet wide. The head scarp was observed immediately below the crest of the hill. The head area included large blocks of arkosic sandstone up to about 10 feet in diameter. Internally, the rock slide graded to smaller arkosic sandstone blocks at the toe of the slide of less than about one foot in diameter.

No evidence of seeps, springs, or surface water was observed in the area of the rock slide at the time of Golder's investigations. The potential failure mechanism is unclear; however, it is possible the rock slide is the result of ground shaking or different climatic conditions, i.e., a past wetter environment. The slide is observable on aerial imagery dating back to 1994; however, an exact date is uncertain.

Currently, no structures or facilities are planned in this area.

5.0 SITE SUBSURFACE WATER CONDITIONS

5.1 Ground Water

No subsurface water was encountered during the field explorations to the maximum depth of the boreholes of approximately 120 feet bgs. In the *Groundwater Characterization Data Report*, prepared by SPF Water Engineering, LLC (SPF), it was reported that the ground water depth beneath the southern portion of the TSF basin ranged between 155 feet at the BLM well located within the TSF footprint and 232 feet at the GW-3 well located just southwest of the TSF (SPF 2019).

Inferred ground water contours presented in the same report indicate ground water beneath the reclaim pond area may be as shallow as 55-feet; however, no ground water was encountered in Golder's borehole BH-05 which were drilled to maximum depth of 100 feet bgs.

Ground water depths in the TSF area will be refined after the installation of proposed ground water monitoring wells as presented in SPF's report. In addition, no springs were observed in the TSF or mine facility areas during the field investigation.

5.2 Hydraulic Conductivity Testing

Golder completed both field and laboratory hydraulic conductivity (permeability) testing to characterize the permeability of the soils encountered during the field investigation.

Field falling head permeability tests were completed in six (6) boreholes using PVC standpipe piezometers with a screened interval installed a depth selected by Golder's field engineer. The procedure used to complete the in-situ permeability tests was summarized in Section 2.4. Table 2 summarizes the results of field falling head permeability testing with test data and results presented in Attachment C.

Table 2: Summary of Falling Head Permeability Test Results

Borehole ID	Test Interval (feet bgs)	Material Description (USCS Classification)	Estimated Hydraulic Conductivity (cm/s)
BH-2	20 to 25	Poorly Graded Sand (SP)	2.7×10^{-6}
BH-3	2 to 4	Poorly Graded Sand (SP)	7.1×10^{-6}
BH-5	10 to 15	Poorly Graded Sand (SP)	1.7×10^{-6}
BH-6	22.8 to 24.8	Fat Clay (CH)	5.2×10^{-7}
BH-7	14.5 to 19.5	Poorly Graded Sand with Clay and Gravel (SP)	5.8×10^{-6}
BH-9	3.6 to 8.6	Poorly Graded Sand (SP)	3.7×10^{-5}

As discussed in Section 7.3, flexible wall permeability testing was performed on relatively undisturbed samples collected from the borings. Field falling head permeability tests performed predominately targeted in-situ zones of higher permeability poorly-graded sands and not the lacustrine clays. One falling head test was conducted on in-situ lacustrine clay in Borehole BH-6. The measured in-situ permeability from the falling head test was lower than laboratory measurements.

Several factors can lead to faster field-measured permeabilities than laboratory measurements. These can include, but not limited to, inadequate seal zone around the screened interval, test intervals too short, and field measurements include both horizontal and vertical hydraulic conductivity whereas laboratory flexible wall permeability measures only vertical conductivity.

6.0 SUBSURFACE CONDITIONS

The following subsections summarize the geotechnical subsurface conditions encountered at the time of the investigations. Borehole, test pit, and CPT locations are presented on Figure 1. Subsurface conditions have been classified in accordance with the USCS classification system (ASTM D 2487). The following attachments should be referenced when reviewing the subsurface conditions:

- Attachment A – Borehole Logs and Borehole Photos
- Attachment B – Test Pit Logs and Test Pit Photos
- Attachment D – CPT Logs

The subsurface profile at the site generally consisted of alluvial and colluvial deposits underlain by lacustrine deposits, sandstone, and basalt as presented on the geologic sections shown on Figures 2B and 2C. Subsurface stratigraphy at the site is described as follows:

- **TOPSOIL:** Topsoil was estimated to have an average thickness of about ½ foot across a majority of the site. Dense rootlets were observed in the topsoil with scattered roots observed up to ¼-inch thick in the upper 2 feet to 3 feet of the subsurface profile. Topsoil was generally comprised of dark brown, silty- to clayey-sands with non-plastic to low plastic fines, and observed to contain few to little gravel, cobbles, and boulders in the south and northeast portions of the TSF and potential borrow areas.
- **QUATERNARY DEPOSITS:** These deposits include unconsolidated sediments deposited by water (alluvium) and accumulated material on exposed slopes (colluvium). Based on the previously-referenced mapped geology, these units are estimated to be Quaternary-age deposits. These materials were encountered across the site consisting of variable sands, gravels, clays, and silts with thicknesses ranging from ground surface to 25 feet bgs. Generally, the upper portion of the deposit was described as fine-grained soils classified as lean and fat clay with varying amounts of sand and gravel, which were underlain by more coarse-grained soils classified as clayey- to silty-sand, clayey- to silty-gravel, and poorly- to well-graded sand and gravel.
- **OLDER DEPOSITS:** These deposits include Miocene-age lacustrine, alluvial, beach, and sandstone deposits described as:
  - **LACUSTRINE DEPOSITS:** Underlying the Quaternary Deposits, Lacustrine deposits were encountered across a majority of the site and primarily classified as lean- to high-plasticity clay with varying sand content. Abundant evaporites were often found in the upper three (3) feet of the deposit and were occasionally observed throughout the formation. As previously discussed, these deposits were not identified on the referenced surface geologic map; however, based on similar units in the region, these units are estimated to be Miocene-age deposits.

- **ALLUVIUM AND BEACH SAND DEPOSITS:** Discontinuous alluvium and beach sand deposits were observed within the lacustrine clay deposits generally consisting of poorly-graded sand and silty sand. Due to the location of these deposits within the lacustrine clays, these deposits were estimated to be Miocene-age deposits.
- **ARKOSIC SANDSTONE:** Part of the Grassy Mountain Formation was encountered generally along the higher elevations with the valley the TSF is situated and was identified in Borehole BH-10 at a depth of 10 feet bgs and in Test Pits TP-13, 14, 16, 20, 26, 27, 30, and 40 at depths ranging between 2.5 feet 12 feet bgs. Arkosic sandstone generally consisted of silty sand to fine- to coarse-grained sands and mapped as mid-Miocene in age (Ferns et al, 1993).
- **BASALT:** Upper Miocene olivine basalt flows were observed in the geotechnical coreholes advanced for the proposed Basalt Borrow Quarry (Golder 2019a) and is generally encountered in the hills east of the project area (Ferns et al, 1993).

Geologic sections showing these stratigraphic units through the TSF and mine process facilities area are presented on Figures 2B and 2C.

6.1 TSF Area

Subsurface conditions within the TSF footprint have been grouped into three distinct areas: 1) North Embankment (includes Reclaim Pond area); 2) West Embankment; and 3) Main TSF footprint (impoundment). The subsurface conditions encountered at each of these areas have been summarized in the following sections.

6.1.1 North Embankment

Explorations:

- Test Pits TP-17, -18, -19, -23, -38, -44, -45
- Boreholes: BH-03 through-06, -13, -15; and BH19-TP-19, -23, -44
- Cone Penetration Tests: CPT-1A, -2A, -3B, -4, -5, -6, -9, -10, -12

Subsurface soils encountered in the test pits and boreholes within the North Embankment and pond area of the TSF footprint are summarized in Table 4.

Table 4: Summary of North Embankment Subsurface Profile

Exploration ID	Subsurface Profile (Depth, feet bgs)[3]				
	Quaternary Deposits		Older Deposits		
	Fine-grained[1]	Coarse-grained[2]	Lacustrine	Alluvium/Beach	Sandstone/Basalt
TP-17	0 to 2	-	2 to 14	-	-
TP-18	0 to 3	-	3 to 15	-	-
TP-19	0 to 0.5	0.5 to 4	4 to 14	-	-
TP-23	0 to 0.3	0.3 to 10	10 to 15	-	-
TP-38	0 to 0.5	0.5 to 5	5 to 14.5	-	-
TP-44	0 to 2	2 to 13	-	-	-

Exploration ID	Subsurface Profile (Depth, feet bgs)[3]				
	Quaternary Deposits		Older Deposits		
	Fine-grained[1]	Coarse-grained[2]	Lacustrine	Alluvium/Beach	Sandstone/Basalt
TP-45	0 to 4	-	4 to 15	-	-
BH-03	0 to 0.5	0.5 to 8	8 to 100	-	-
BH-04	0 to 0.5	-	0.5 to 51.5	-	-
BH-05	0 to 0.5	-	0.5 to 10 20 to 41.5	10 to 20	-
BH-06	0 to 0.5	0.5 to 10	10 to 26.5	-	-
BH-13	0 to 0.5	-	0.5 to 45 65 to 101.5	45 to 65	
BH-15	0 to 0.5	0.5 to 8	8 to 26.5	-	-
BH19-TP-19	0 to 0.5	-	0.5 to 92 110 to 121	92 to 110	-
BH19-TP-23	0 to 10	-	10 to 110 120 to 121	110 to 120	

Notes:
1) Fine-grained soils include the thickness of topsoil (~0.5 feet). Below the topsoil the fine-grained soils at the site generally consisted of lean and fat clay with varying amounts of sand and gravel.
1) Coarse-grained soils at the site generally consisted of clayey to silt sand, clayey to silty gravel, and poorly to well graded sand and gravel.
2) Cone penetration test results are not included in the subsurface profile as the soil behavior type presented on the CPT logs in Attachment D is inferred based on mechanical characteristics of the soils, not physical characteristics as measured through laboratory testing or visual classifications.

A thin layer of topsoil with an estimated thickness of 0.5 feet covered the site. Beneath the topsoil, subsurface conditions were generally classified as both fine- and coarse-grained alluvium overlying lacustrine deposits. Few angular gravel and cobbles were observed within the topsoil of Test Pit TP-17 and TP-23. The alluvium consisted of lean to fat clay and silty sand or poorly graded sand with gravel, was moist, dense to very dense or hard, and was light brown and gray to brown and olive. The plasticity of the alluvium ranged from low to high, and few fine subangular to sub-rounded gravels and trace cobbles up to 4 inches were observed within the soils excavated from the test pits. The lacustrine deposits were classified as lean to fat clay and silt with varying sand content, and moist, very stiff to hard, olive, gray, and brown.

Older alluvium and beach sand deposits were observed at varying depths in four boreholes (BH-05, BH-13, BH19-TP19 and BH19-TP23) classified as poorly graded and silty sand, moist, dense to very dense, light brown and gray to tan.

6.1.2 West Embankment

Explorations:

- Test Pits: TP-11, -14, -16, -20, -21, -22
- Boreholes: BH-02, -09, -14
- Cone Penetration Tests: CPT-7B, -8C, -11A

Subsurface soils encountered in the test pits and boreholes within the west embankment area of the TSF are summarized in Table 5.

Table 5: Summary of Subsurface Profile at the West TSF Embankment

Exploration ID	Subsurface Profile (Depth, feet bgs)[3]				
	Quaternary Deposits		Older Deposits		
	Fine-grained[1]	Coarse-grained[2]	Lacustrine	Alluvium / Beach	Sandstone / Basalt
TP-11	0 to 3.5	3.5 to 12	12 to 14.5	-	-
TP-14	0 to 5	-	5 to 12	-	12 to 13 (sandstone) (refusal on sandstone)
TP-16	0 to 5	-	5 to 11	-	11 to 14 (sandstone)
TP-21	0 to 5	-	5 to 13.5	-	-
TP-22	0 to 1.5	-	1.5 to 11.5	-	-
BH-02	0 to 0.5	0.5 to 10	10 to 25 31 to 41.5	25 to 31	-
BH-09	0 to 0.5	0.5 to 25	25 to 50 70 to 101.5	50 to 70	-
BH-14	0 to 0.5	-	-	-	0.5 to 26 (sandstone)

Notes:
1) Fine-grained soils at the site generally consisted lean and fat clay with varying amounts of sand and gravel.
2) Coarse-grained soils at the site generally consisted of clayey to silt sand, clayey to silty gravel, and poorly to well graded sand and gravel.
2) Cone penetration test results are not included in the subsurface profile as the soil behavior type presented on the CPT logs in Attachment D is inferred based on mechanical characteristics of the soils, not physical characteristics as measured through laboratory testing or visual classifications.

Subsurface conditions to the north and south of the west embankment (TP-14, -16, -21 and -22, BH-14) consisted of fine-grained alluvium classified as moist, stiff to hard, brown to light brown, lean to fat clay with varying sand content and trace to few subangular to sub-rounded gravel. Beneath the alluvium, lacustrine deposits classified as fat to lean clay with trace to few fine sand, moist, stiff to hard, olive/brown/tan/light gray. Weathered arkosic sandstone was encountered below the lacustrine deposits in Test Pits TP-14 and TP-16 and was classified as a silty fine to coarse sand with low plasticity fines, moist, very dense, and tan with iron staining. Little fine to coarse, rounded to subangular, gravels were observed within the topsoil in Test Pit TP-14.

Subsurface conditions in the central and south-central portion of the embankment (TP-11, BH-02, and BH-09) generally consisted of coarse-grained overburden classified as poorly graded sand with varying silt content and clayey sand, characterized as moist, dense to very dense, and light tan to brown. Few angular gravel and cobbles were observed within the topsoil of Test Pit TP-11. The alluvium was underlain by lacustrine deposits classified as fat clay with trace to some fine sand, moist, very stiff to hard, and olive/brown/tan/light gray.

Within the dominant lacustrine clay, zones of Beach sand deposits were encountered within Borehole BH-02 from 25 to 31 feet bgs and from 50 to 70 feet bgs in BH-09. These beach sands were underlain by lacustrine deposits classified as lean to fat clay with trace to some fine sand, and as moist, very stiff to hard, and tan to very light gray.

6.1.3 TSF Basin

Explorations:

- Test Pits: TP-01 through -04, TP-06 through-10, -12, -15
- Boreholes: BH-01, -07, and -08, BH19-TP-01 and -15

Subsurface soils encountered in the test pits and boreholes within the TSF basin are summarized in Table 6.

Table 6: Summary of Subsurface Profile within TSF Basin

Exploration ID	Subsurface Profile (Depth, feet bgs)[3, 4]				
	Quaternary Deposits		Older Deposits		
	Fine-grained[1]	Coarse-grained[2]	Lacustrine	Alluvium / Beach	Sandstone / Basalt
TP-01	0 to 3	3 to 5	5 to 9.5 (refusal on hard clay)	-	-
TP-02	0 to 2	2 to 5	5 to 15.5	-	-
TP-03	0 to 2	2 to 11	11 to 15	-	-
TP-04	-	0 to 15	-	-	-
TP-06	0 to 4.5	4.5 to 14	-	-	-
TP-07	0 to 2	2 to 4.5	4.5 to 14.5	-	-
TP-08	0 to 4	4 to 8	8 to 11.5 (refusal on hard clay)	-	-
TP-09	0 to 2	-	2 to 15	-	-
TP-10	0 to 4.5	-	4.5 to 15	-	-
TP-12	0 to 2	2 to 5	5 to 13	-	-
TP-15	0 to 2	2 to 5	5 to 14	-	-
BH-01	-	0 to 10	10 to 101.5	-	-
BH-07	-	0 to 25	25 to 41.5	-	-
BH-08	-	0 to 10	10 to 51.5	-	-
BH19-TP-01			0 to 51.5		
BH19-TP-15		0 to 10.5	10.5 to 81.5 90 to 121.4	81.5 to 90	

Notes:
1) Fine-grained soils at the site generally consisted lean and fat clay with varying amounts of sand and gravel
2) Coarse-grained soils at the site generally consisted of clayey to silt sand, clayey to silty gravel, and poorly to well graded sand and gravel
3) Cone penetration test results are not included in the subsurface profile as the soil behavior type presented on the CPT logs in Attachment D is inferred based on mechanical characteristics of the soils, not physical characteristics as measured through laboratory testing or visual classifications.

The subsurface within the TSF basin generally consisted of fine-grained Quaternary Alluvium classified as fat to lean clay with varying sand content and trace fine to coarse subrounded to subangular gravel, moist, hard, light brown to dark brown/gray/tan. Coarse-grained Quaternary alluvial soils encountered beneath the fine-grained

surface soils classified as silty to clayey sand with varying gravel content, and poorly graded sand and gravel with varying amounts of non-plastic to low plasticity fines content. These soils were further classified as moist, medium dense to dense, light to dark brown and tan. Cobbles and boulders were observed in the coarse-grained overburden up to 18-inches in diameter within Test Pits TP-4, TP-10, TP-7, and TP-15. The fine-grained overburden was not identified in the boreholes likely due to the sampling interval utilized during the investigation; therefore, the test pits provide a better representation of the near surface (<10 feet bgs) soils.

The Quaternary Alluvium was underlain by Lacustrine deposits classified as fat clay to sandy lean clay, moist, hard, olive/gray with pink and yellow. The Lacustrine deposits extended to the bottom of each borehole advanced.

Beach deposits, classified as silty sand, moist, dense, and blue gray, were encountered in Borehole BH19-TP-15 from 81.5 to 90 bgs. These beach sands were underlain by lacustrine deposits that classified as fat clay with few fine sand, moist, very stiff to hard.

Gravel, cobbles, and boulders were observed at the ground surface in the vicinity of Test Pits TP-6 and TP-7 up to 18-inches in diameter.

6.2 Mine Process Facility Area

Explorations:

- Test pits: TP-26, -27, -28, -29
- Boreholes: BH-10, -11, and -12

Subsurface soils encountered in the test pits and boreholes within the mine process facility area are summarized in Table 7.

Table 7: Summary of Mine Process Facilities Subsurface Profile

Exploration ID	Subsurface Profile (Depth, feet bgs)				
	Quaternary Deposits		Older Deposits		
	Fine-grained[1]	Coarse-grained[2]	Lacustrine	Alluvium / Beach	Sandstone / Basalt
TP-26	0 to 2	2 to 9	-	-	(refusal on sandstone)
TP-27	0 to 3.5	-	-	-	(refusal on sandstone)
TP-28	0 to 2	-	2 to 14.5	-	-
TP-29	0 to 5	-	5 to 15	-	-
BH-10	0 to 10	-	-	-	10 to 20(sandstone)
BH-11	0 to 10	10 to 39	-	-	-
BH-12	-	-	0 to 31.5	-	-

Notes:
1) Fine-grained soils at the site generally consisted lean and fat clay with varying amounts of sand and gravel
2) Coarse-grained soils at the site generally consisted of clayey to silt sand, clayey to silty gravel, and poorly to well graded sand and gravel

The subsurface profile in the east part of the process area consisted of fine-grained Quaternary Alluvium generally comprised of lean to fat clay with varying sand, content and trace to few fine subangular to angular gravel, and was described as moist, stiff to hard, and gray to brown, and as overlying lacustrine deposits. The lacustrine deposits were classified as fat clay with trace to fine sand, moist, hard, and olive to gray in color.

The west side of the process area was generally comprised of fine-grained and coarse-grained Quaternary Alluvium over Arkosic Sandstone. The fine-grained Quaternary Alluvium was generally classified as lean clay with fine subangular to angular gravel, moist, moist, stiff to hard, and brown. The fine-grained Quaternary Alluvium was overlying coarse-grained Quaternary Alluvium classified as silty to clayey sand and poorly graded gravel and sand with varying high plasticity fines content, moist, and dense to very dense. Cobbles and boulders up to 12-inches in diameter were observed in the coarse-grained Quaternary Alluvium in Test Pits TP-26 and TP-27 and were also observed at and near the ground surface in Test Pit TP-26.

6.3 Waste Rock Dump Area

Explorations:

- Test Pits: TP-05 and -43

Subsurface soils encountered in the test pits near the WRD area are summarized in Table 8.

Table 8: Summary of Waste Rock Dump Subsurface Profile

Exploration ID	Subsurface Profile (Depth, feet bgs)				
	Quaternary Deposits		Older Deposits		
	Fine-grained[1]	Coarse-grained[2]	Lacustrine	Alluvium / Beach	Sandstone / Basalt
TP-05	0 to 3	3 to 15	-	-	-
TP-43	0 to 4.5	4.5 to 15	-	-	-

Notes:
1) Fine-grained soils at the site generally consisted lean clay and slit with varying amounts of sand and gravel
2) Coarse-grained soils at the site generally consisted of clayey and silty sand with gravel

A thin layer of topsoil with an estimated thickness of 0.5 feet covered the area. Beneath the topsoil, subsurface conditions generally comprised both fine- and coarse-grained alluvium to the bottom of the test pits at 15 feet depth. The fine-grained alluvium consisted of sandy lean clay with gravel and light tan to pink tan sandy silt, moist, stiff to very stiff, and brown to dark brown. The fine-grained alluvium also had trace to some fine to coarse, subrounded to subangular gravel. Beneath the fine-grained alluvium, the coarse-grained alluvium generally consisted of silty and clayey sand with gravel, and was moist, medium dense to dense, and tan to brown. Sands were fine to coarse, and gravels subrounded to subangular.

6.4 Potential Borrow Areas

At this time, the TSF embankments have been designed assuming that all Embankment Fill will be sourced from the Basalt Borrow Quarry located east of the process facilities as shown on Figure 1 (Golder 2019a). Since the original December 2017 geotechnical investigation was completed before this decision was made, test pits were excavated on the slopes surrounding the TSF for evaluation as potential borrow material for embankment

construction. Explorations at these locations showed the native materials to be less favorable for use as Embankment Fill than the Basalt Borrow Quarry material (Golder 2019a). However, some of the test pits did encounter materials that may be suitable sources for reclamation materials once mining has been completed. These borrow sources would require additional investigation near the end of operation to further define their suitability and use as reclamation materials. The following summarizes the potential borrow areas within the project boundary that may be suitable for reclamation material:

- ***Borrow Area Northwest of the TSF:*** Soils in this area generally consisted of alluvium and colluvium observed to be 4 to 8 feet thick in Test Pits TP-40 and TP-41 overlying arkosic sandstone. These soils classified as lean to fat clay with gravel, cobbles, and boulders up to 12-inches in diameter and clayey sand.
- ***Borrow Area South of the TSF*****:** This area appeared to be highly variable. Lean clay overburden was observed in Test Pit TP-30 to about 2½ feet bgs overlying weathered sandstone classified as poorly graded sand with silt, moist, dense. Sandy lean clay colluvium was observed in Test Pits TP-31 and TP-32 to depths of about 2½ to 3 feet bgs, and poorly-graded sand with gravel with cobbles and boulders up to 12-inches in diameter from 3 to 6 feet in Test Pit TP-32 overlying lacustrine deposits (fat clay).
- ***Borrow Area North of the TSF and mine process facilities:*** This area was characterized through Test Pits TP-13, -35, -36, -37, and -39. The Quaternary Alluvium in these areas ranged in depth from 3 feet to over 15 feet and generally comprised 1 to 2 feet of lean to fat clays overlying poorly graded sand, silty to clayey sand with varying amounts of gravel, silty gravel and varying amounts of cobbles and boulders with a maximum diameter of 14-inches.

7.0 LABORATORY TESTING RESULTS

7.1 Index Testing

Geotechnical index testing was performed on 82 samples collected during the geotechnical investigations to support characterization of the subsurface geology beneath the proposed facilities. The results of the index testing were used to calibrate the visual field soil classifications presented on the borehole and test pits logs presented in Attachments A and B, respectively. Extensive laboratory testing was completed on the lacustrine clay deposit encountered beneath the proposed location of the TSF embankments to adequately characterize the material to a level sufficient to support detailed design of the TSF. Laboratory test results of lacustrine samples indicated the following:

- Sand contents ranged from 0 to 57 percent
- Liquid limit (LL) ranged from 35 to 227, and Plasticity Index (PI) ranged from 25 to 198
- As-received moisture content ranged from about 9.6 percent to 47.9 percent, with lower moisture contents observed in the sandy materials and higher moisture contents observed in the fat clay materials

A summary table with the index testing is presented at the beginning of Attachment E, followed by the individual laboratory testing results.

7.2 Shear Strength Testing

Six (6) consolidated-undrained (CU) triaxial shear strength tests were performed on intact relatively undisturbed tube samples obtained during the geotechnical investigations. Five (5) of the tests were performed using

individual samples for each pressure interval, and a single 3-stage test (BH19-TP-44) was performed on a single sample by limiting strain to less than 5 percent for the first and second pressure intervals. The third and final pressure interval was limited to 15 percent strain. Effective confining pressures ranging between 35 psi and 150 psi were used for the testing to simulate the range of stress anticipated in the foundation of the TSF embankment during and after construction. Golder developed Mohr-Coulomb linear peak effective strength parameters for each CU test, which are summarized in Table 9 below. The laboratory data sheets are presented in Attachment E.

Table 9: Summary of Mohr-Coulomb Liner Strength Parameters

Borehole Number	Sample Depth Interval (ft bgs)	Material Description	Mohr-Coulomb Peak Strength Parameters	
			Effective Friction Angle (Φ') (degrees)	Effective Cohesion (c') (psi)
BH-06[1]	20 to 25	Sandy Fat Clay (CH)	4.3[2]	1351
BH-13	2 to 4	Fat Clay (CH)	22.4	396
BH-15	10 to 15	Fat Clay (CH)	15.1	2814
BH19-TP-23	15 to 17	Fat Clay (CH)	12.7	1042
BH19-TP-23[1]	20 to 22	Fat Clay (CH)	14.5	88
BH19-TP-44[1]	10 to 12	Fat Clay (CH)	21.2	516

Notes:
1) Linear peak strength envelope for these samples was based on only two points.
2) Sample BH-06 @ 20 to 25 feet appears to have a flaw in the testing. Lacustrine deposits appear to be massive with no indication of distinct layers weak layers.

7.3 Flexible Wall Permeability Testing

In addition to the field permeability tests, laboratory flexible wall permeability testing was performed on one remolded sample (TP-09, 2 to 15 feet) and four relatively undisturbed samples of the lacustrine deposit. The remolded sample was tested using a remolded relative compaction of 90 percent of the maximum dry density and near the optimum moisture (78.5 pounds per cubic foot (pcf) and 35.7 percent moisture content), as determined by ASTM D 1557. The in-situ samples were tested at confining pressures representing in-situ conditions. The results of the laboratory flexible wall permeability tests are presented in Table 10 below and in Attachment E.

Table 10: Laboratory Flexible Wall Permeability Test Results

Test Pit or Borehole Number	Sample Depth Interval (feet bgs)	Material Description (USCS Classification)	Hydraulic Conductivity (cm/s)
TP-09[1]	2 to 15	Fat Clay (CH)	5.6×10^{-9}
BH-06	10 to 11.5	Fat Clay (CH)	1.7×10^{-8}
BH-19-TP-01	45 to 46.5	Fat Clay with Sand (CH)	5.7×10^{-8}
BH-19-TP-39	25 to 26.5	Fat Clay (CH)	2.4×10^{-8}
BH19-TP-39	35 to 36.5	Fat Clay (CH)	5.4×10^{-8}

Notes:
1) Remolded test.

7.4 Consolidation Testing

Six (6) one-dimensional (1D) consolidation tests were performed on in-situ samples obtained during the two geotechnical drilling programs. The results of these tests were used to estimate the pre-consolidation pressure and develop soil modulus parameters necessary to calculate the potential settlement of the foundation soils due to loads imposed by the TSF embankment. Test procedures involve inundating the samples with water during testing, and it should be noted that high confining pressures ranging between 0.28 ksf (thousand pounds per square foot) and 12.3 ksf were required to prevent swelling of the material during inundation. Interpretation of the consolidation test results is presented in Golder's geotechnical stability and settlement evaluation for the TSF and WRD that is appended to the main Design Report.

7.5 Mineralogy Testing

In addition to the geotechnical laboratory testing, 15 lacustrine deposit samples were tested for x-ray diffraction to identify and quantify clay and accessory minerals. The results indicate the clay in these deposits consists of montmorillonite, with 14 samples having concentrations between 7 to 84 percent and an average content of about 30 percent. The samples also show the dominant interlayer cations are divalent cations, such as calcium. Additional constituents included quartz, illite, kaolin, albite, and other amorphous materials. X-ray diffraction test results are presented in Attachment E.

8.0 USE OF THIS REPORT

This report has been prepared exclusively for the use of Calico and their consultants for the project described.

Golder encourages review of this report as it relates to factual data only (borehole logs, laboratory test results, conclusions, etc.). The conclusions presented in this report are based on the explorations and observations completed for this study, conversations regarding the existing site conditions, and Golder's understanding of the planned project. The conclusions are not intended nor should they be construed to represent a warranty regarding the project, but they are included to assist in the planning and design process.

Judgment has been applied in interpreting and presenting the results. Variations in subsurface conditions outside the exploration locations are common. Actual conditions encountered during construction might be different from those observed in the explorations.

The explorations were advanced and logged in general accordance with locally-accepted and industry standard geotechnical engineering practices, subject to the time limits and financial and physical constraints applicable to the services for this project, to provide information for the areas explored. There are possible variations in the subsurface conditions between the borehole locations and variations over time.

The professional services retained for this project include only geotechnical aspects of the subsurface conditions at the site. Environmental services were not included in the scope of work. The presence or implications of possible surface and/or subsurface contamination resulting from previous site activities and/or resulting from the introduction of materials from off-site sources were not addressed in this report.

9.0 CLOSING

Golder is pleased to present this geotechnical data letter report for the proposed TSF at the Grassy Mountain Project. If you have any questions or comments regarding the information presented herein, please contact the undersigned at (775) 828-9604.

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Figures
Attachments: A – Borehole Logs and Photos
B – Test Pit Logs and Photos
C – Field Permeability Testing
D – CPT Logs
E – Geotechnical Laboratory Test Results

https://golderassociates.sharepoint.com/sites/17031g/1663241 grassy mountain tsf/500_reporting/520_letters/529_geotech data/detailed design/final/1663241.054.l.rev0.docx

10.0 REFERENCES

American Society for Testing and Materials International (ASTM) D421. Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and determination of Soil Constants. ASTM International, West Conshohocken, PA, 1998, D 421 – 85 (Reapproved 1998), www.astm.org.

ASTM D422. Standard Test Method for Particle-Size Analysis of Soils. ASTM International, West Conshohocken, PA, 2007, D422 – 63 (Reapproved 2007), www.astm.org.

ASTM D1586. Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. ASTM International, West Conshohocken, PA, 2011, D1586 - 11, www.astm.org.

ASTM D1557. Standard Test method for Laboratory Compaction Characteristics of Soil (56,000 ft-lbf/ft3 (2,700 kN-m/m3)), ASTM International, West Conshohocken, PA, 2012, https://doi.org/10.1520/D1557-12E01.

ASTM D2216. Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. ASTM International, West Conshohocken, PA, 2010, D2216 - 10, www.astm.org.

ASTM D2435. 2011. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). ASTM International, West Conshohocken, PA, 2011, D2435-11, www.astm.org.

ASTM D2487. Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading. ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/D2487-11, www.astm.org.

ASTM D4318. Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. ASTM International, West Conshohocken, PA, 2011, D4318-11, www.astm.org.

ASTM D4767. Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soil. ASTM International, West Conshohocken, PA, 2011, D4767-11, www.astm.org.

ASTM D5084. Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using Flexible Wall Permeameter. ASTM International, West Conshohocken, PA, 2011, D5084-16, www.astm.org.

Ferns, M.L., H.C. Brooks, J.G. Evans, and M.L. Cummings. 1993. Geologic Map of the Vale 30 x 60 Minute Quadrangle, Malheur County, Oregon, and Owyhee County, Idaho. State of Oregon, Department of Geology and Mineral Industries, GMS-77.

Gray, J.J., Geitgey, R.P., and Baxter, G.L. 1989. Bentonite in Oregon: Occurrences, Analyses, and Economic Potential. State of Oregon Department of Geology and Mineral Resources, Special Paper 20.

Golder 2019a. Abbreviated Operating Permit Application – Grassy Mountain *Basalt Borrow Quarry.* Prepared for Calico Resources USA Corp. by Golder Associates Inc. May 2, 2019.

Golder 2019b. *Updated Seismic Hazard Assessment, Grassy Mountain TSF Site, Malheur County, Oregon*. Prepared for Calico Resources USA Corp. by Golder Associates Inc. Dated November 2019.

Madin, I.P. 2009. Oregon: A Geologic History, 150 years of Statehood, 150 Million Years in the Making. Oregon Department of Geology and Mineral Industries, Interpretive Map 28.

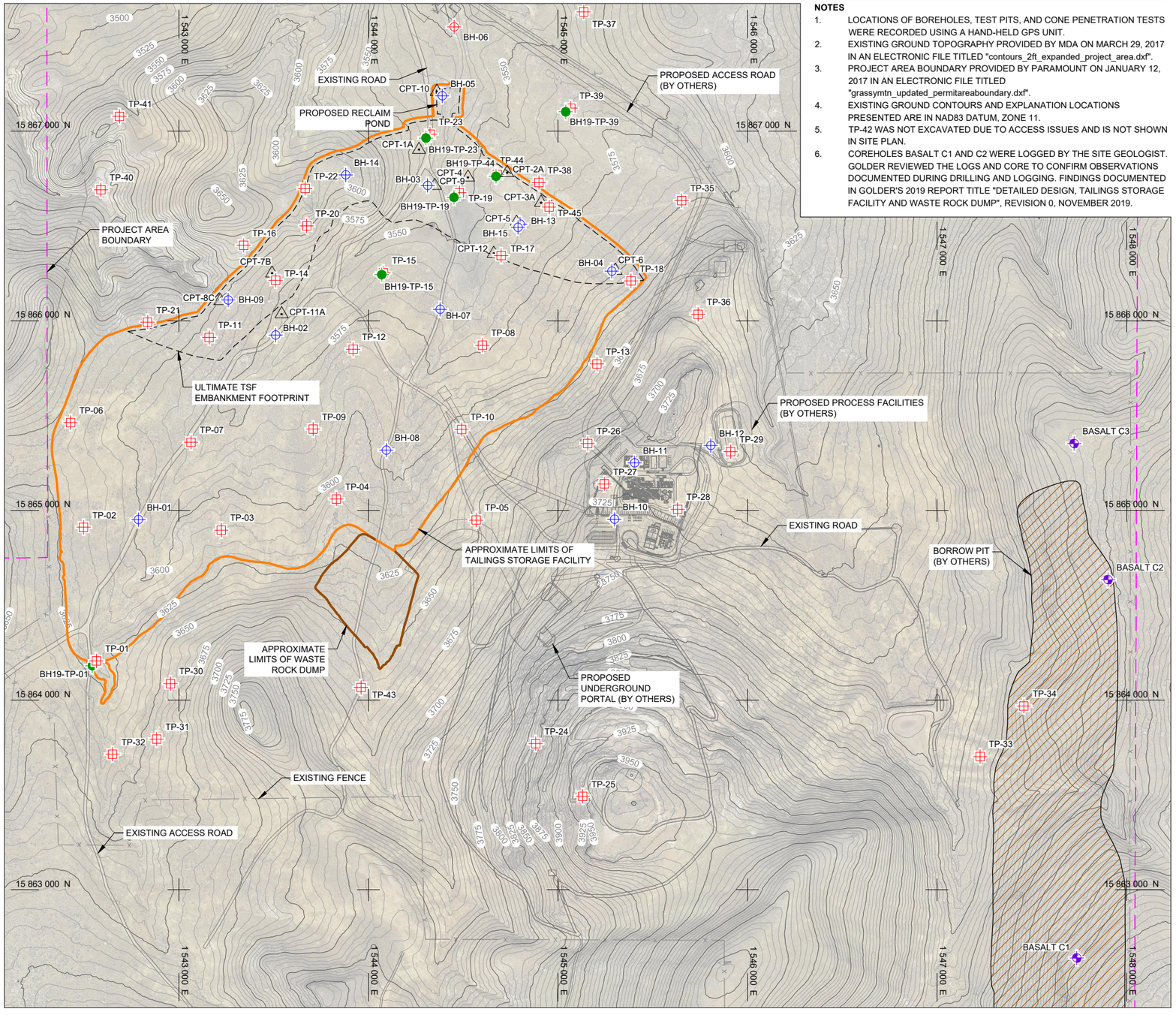
Naval Facilities Engineering Command (NAVFAC) 1986. Foundations and Earth Structures. Design Manual 7.02.

Paramount (Paramount Gold Nevada Corp.). 2017. Grassy Mountain Gold Project. http://www.paramountnevada.com/projects/grassy-mountain-gold-project/.

SPF 2019. *Grassy Mountain Gold Project Groundwater, Vol. II, Groundwater Characterization Report.* Prepared for Calico Resources USA Corp. by SPF Water Engineering, LLC. August 13, 2019.

U.S. Geological Survey (USGS). 2014. Unified Hazard Tool. Accessed June 2019 at https://earthquake.usgs.gov/hazards/interactive/.

Figures



NOTES

1. LOCATIONS OF BOREHOLES, TEST PITS, AND CONE PENETRATION TESTS WERE RECORDED USING A HAND-HELD GPS UNIT.
2. EXISTING GROUND TOPOGRAPHY PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf".
3. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".
4. EXISTING GROUND CONTOURS AND EXPLANATION LOCATIONS PRESENTED ARE IN NAD83 DATUM, ZONE 11.
5. TP-42 WAS NOT EXCAVATED DUE TO ACCESS ISSUES AND IS NOT SHOWN IN SITE PLAN.
6. COREHOLES BASALT C1 AND C2 WERE LOGGED BY THE SITE GEOLOGIST. GOLDER REVIEWED THE LOGS AND CORE TO CONFIRM OBSERVATIONS DOCUMENTED DURING DRILLING AND LOGGING. FINDINGS DOCUMENTED IN GOLDER'S 2019 REPORT TITLE "DETAILED DESIGN, TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP", REVISION 0, NOVEMBER 2019.

TEST PIT COORDINATES

TEST PIT	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
TP-01	1,542,565	15,864,207	3,618
TP-02	1,542,497	15,864,912	3,617
TP-03	1,543,224	15,864,896	3,609
TP-04	1,543,831	15,865,060	3,614
TP-05	1,544,568	15,864,949	3,648
TP-06	1,542,429	15,865,463	3,617
TP-07	1,543,064	15,865,360	3,622
TP-08	1,544,601	15,865,871	3,573
TP-09	1,543,709	15,865,430	3,586
TP-10	1,544,492	15,865,427	3,607
TP-11	1,543,160	15,865,912	3,595
TP-12	1,543,919	15,865,850	3,586
TP-13	1,545,206	15,865,772	3,634
TP-14	1,543,511	15,866,214	3,582
TP-15	1,544,079	15,866,253	3,565
TP-16	1,543,342	15,866,398	3,617
TP-17	1,544,701	15,866,344	3,559
TP-18	1,545,385	15,866,211	3,611
TP-19	1,544,480	15,866,675	3,546
TP-20	1,543,674	15,866,501	1,099
TP-21	1,542,835	15,865,993	3,619
TP-22	1,543,667	15,866,698	3,615

TEST PIT COORDINATES

TEST PIT	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
TP-23	1,544,326	15,866,983	3,541
TP-24	1,544,883	15,863,771	3,840
TP-25	1,545,130	15,863,493	3,943
TP-26	1,545,157	15,865,353	3,697
TP-27	1,545,245	15,865,140	3,719
TP-28	1,545,631	15,865,005	3,722
TP-29	1,545,911	15,865,310	3,680
TP-30	1,542,956	15,864,087	3,659
TP-31	1,542,882	15,863,794	3,657
TP-32	1,542,650	15,863,715	3,637
TP-33	1,547,227	15,863,702	3,789
TP-34	1,547,458	15,863,969	3,826
TP-35	1,545,653	15,866,634	3,597
TP-36	1,545,740	15,866,034	3,669
TP-37	1,545,136	15,867,629	3,562
TP-38	1,544,900	15,866,729	3,563
TP-39	1,545,067	15,867,121	3,565
TP-40	1,542,589	15,866,691	3,501
TP-41	1,542,687	15,867,078	3,550
TP-43	1,543,961	15,864,067	3,662
TP-44	1,544,680	15,866,772	3,554
TP-45	1,544,954	15,866,599	3,564

BOREHOLE COORDINATES

BOREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BH-01	1,542,787	15,864,952	3,600
BH-02	1,543,510	15,865,924	3,571
BH-03	1,544,313	15,866,714	3,531
BH-04	1,545,284	15,866,262	3,598
BH-05	1,544,389	15,867,186	3,528
BH-06	1,544,452	15,867,549	3,530
BH-07	1,544,378	15,866,060	3,567
BH-08	1,544,094	15,865,318	3,597
BH-09	1,543,260	15,866,110	3,597
BH-10	1,545,298	15,864,954	3,733
BH-11	1,545,404	15,865,251	3,718
BH-12	1,545,806	15,865,342	3,691

BOREHOLE COORDINATES

BOREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BH-13	1,544,801	15,866,510	3,558
BH-14	1,543,881	15,866,769	3,601
BH-15	1,544,789	15,866,492	3,558
BH19-TP-01	1,542,543	15,864,181	3,618
BH19-TP-15	1,544,070	15,866,243	3,565
BH19-TP-19	1,544,451	15,866,651	3,546
BH19-TP-23	1,544,304	15,866,964	3,541
BH19-TP-39	1,545,041	15,867,102	3,565
BH19-TP-44	1,544,673	15,866,762	3,554

CONE PENETRATION TEST COORDINATES

NAME	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
CPT-1A	1,544,267	15,866,903	3,545
CPT-2A	1,544,732	15,866,781	3,557
CPT-3A	1,544,911	15,866,623	3,563
CPT-4	1,544,525	15,866,756	3,548
CPT-5	1,544,781	15,866,518	3,558
CPT-6	1,545,303	15,866,264	3,599
CPT-7B	1,543,492	15,866,250	3,586
CPT-8C	1,543,219	15,866,106	3,599
CPT-9	1,544,351	15,866,712	3,640
CPT-10	1,544,361	15,867,209	3,538

CONE PENETRATION TEST COORDINATES

NAME	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
CPT-11A	1,543,542	15,866,035	3,571
CPT-12	1,544,661	15,866,355	3,558

CALICO COREHOLES

BOREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BASALT C1	1,547,737	15,862,640	3,978
BASALT C2	1,547,902	15,864,635	3,904
BASALT C3	1,547,723	15,865,353	3,890

LEGEND

- PROJECT AREA BOUNDARY
- APPROXIMATE LIMITS OF TAILINGS STORAGE FACILITY
- 3600 EXISTING GROUND (5 FT CONTOURS)
- EXISTING ROAD
- APPROXIMATE LIMITS OF BORROW PIT
- ULTIMATE TSF EMBANKMENT FOOTPRINT
- BH-01 GOLDER 2017 BOREHOLE LOCATIONS (NOTE 1)
- TP-02 GOLDER 2017 TEST PIT LOCATIONS (NOTE 1)
- BH19-TP-01 GOLDER 2019 BOREHOLE LOCATIONS (NOTE 1)
- CPT-11 CONE PENETRATION TEST (NOTE 1)
- BASALT C1 CALICO 2018 COREHOLE LOCATIONS (NOTES 1 AND 6)
- APPROXIMATE LIMITS OF WASTE ROCK DUMP

0 300 600
1" = 300' FEET

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
GEOTECHNICAL EXPLORATION LOCATION MAP

PROJECT NO. 1663241 | REV. 0 | FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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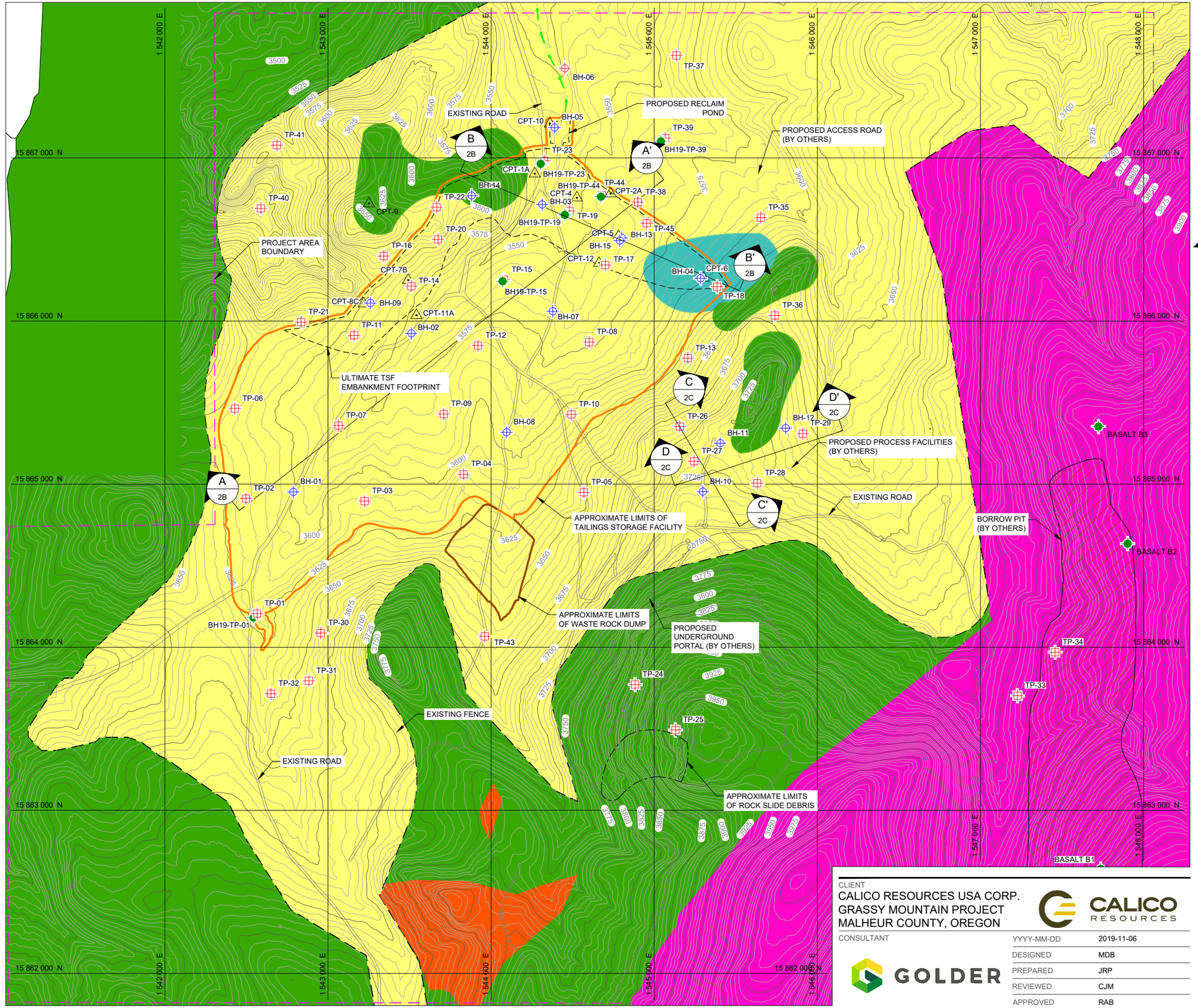

LEGEND

- PROJECT AREA BOUNDARY
- APPROXIMATE LIMITS OF TAILINGS STORAGE FACILITY
- 3600 EXISTING GROUND (5 FT CONTOURS)
- EXISTING ROAD
- APPROXIMATE LIMITS OF BORROW PIT
- ULTIMATE TSF EMBANKMENT FOOTPRINT
- APPROXIMATE LIMITS OF WASTE ROCK DUMP
- BH-01 GOLDER 2017 BOREHOLE LOCATIONS (NOTE 1)
- TP-02 GOLDER 2017 TEST PIT LOCATIONS (NOTE 1)
- BH19-TP-01 GOLDER 2019 BOREHOLE LOCATIONS (NOTES 1 AND 2)
- CPT-11 CONE PENETRATION TEST (NOTE 1)
- A / 2B — A' / 2B GEOLOGIC CROSS SECTION

SURFICIAL GEOLOGIC UNITS (NOTE 6)

- Qai - QUATERNARY ALLUVIUM / COLLUVIUM
- Tgb - UPPER MIOCENE OLIVINE BASALT FLOWS
- Tbi - MIOCENE MAFIC DIKES AND SILLS
- Tgs - MID-UPPER MIOCENE ARKOSIC SANDSTONE AND CONGLOMERATE (GRASSY MOUNTAIN FORMATION)
- TL - MIOCENE LACUSTRINE DEPOSITS

NOTE

1. LOCATIONS OF BOREHOLES, TEST PITS, AND CONE PENETRATION TESTS WERE RECORDED USING A HAND-HELD GPS UNIT.
2. EXISTING GROUND TOPOGRAPHY PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf".
3. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".
4. EXISTING GROUND CONTOURS AND EXPLANATION LOCATIONS PRESENTED ARE IN NAD83 DATUM, ZONE 11.
5. TP-42 WAS NOT EXCAVATED DUE TO ACCESS ISSUES AND IS NOT SHOWN IN SITE PLAN.
6. SURFACE GEOLOGY BASED ON FIELD MAPPING AND GEOLOGY MAP REFERENCE: FERNS AND RAMP (1989).
7. BOREHOLES BASALT B1 AND B2 WERE LOGGED BY THE SITE GEOLOGIST. GOLDER REVIEWED THE LOGS AND CORE TO CONFIRM OBSERVATIONS DOCUMENTED DURING DRILLING AND LOGGING. FINDINGS DOCUMENTED IN GOLDER'S 2019 REPORT TITLED "DETAILED DESIGN, TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP", DATED OCTOBER 25, 2019.

0 300 600
1" = 300' FEET

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
SURFACE GEOLOGY MAP

PROJECT NO.	REV.	FIGURE
1663241	0	2A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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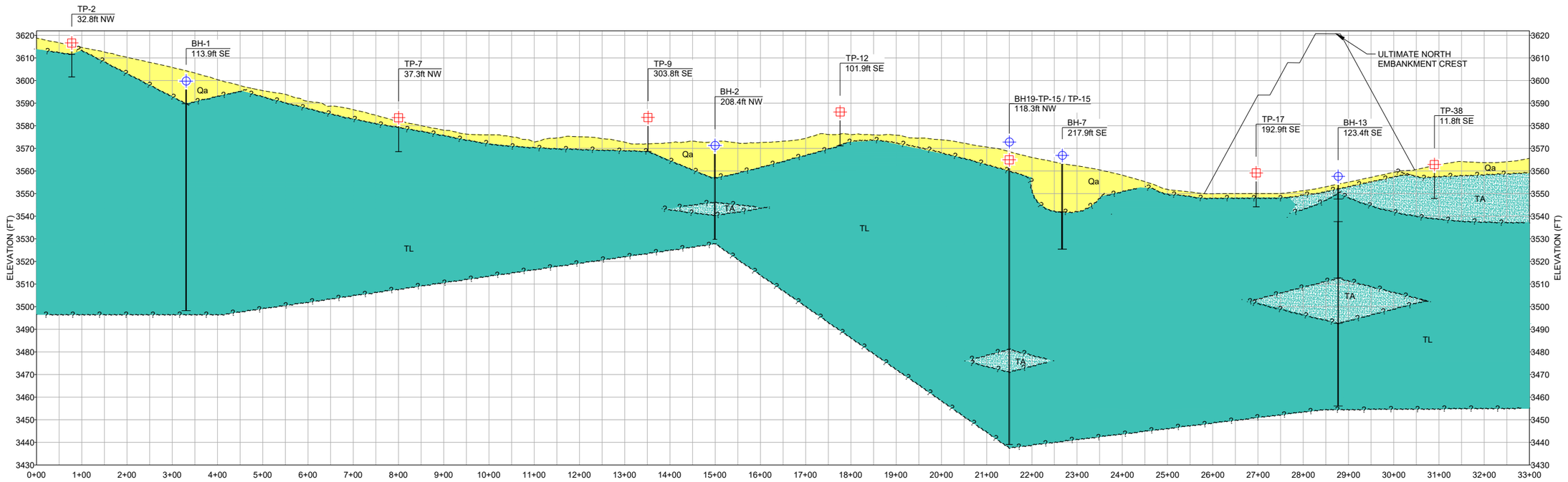
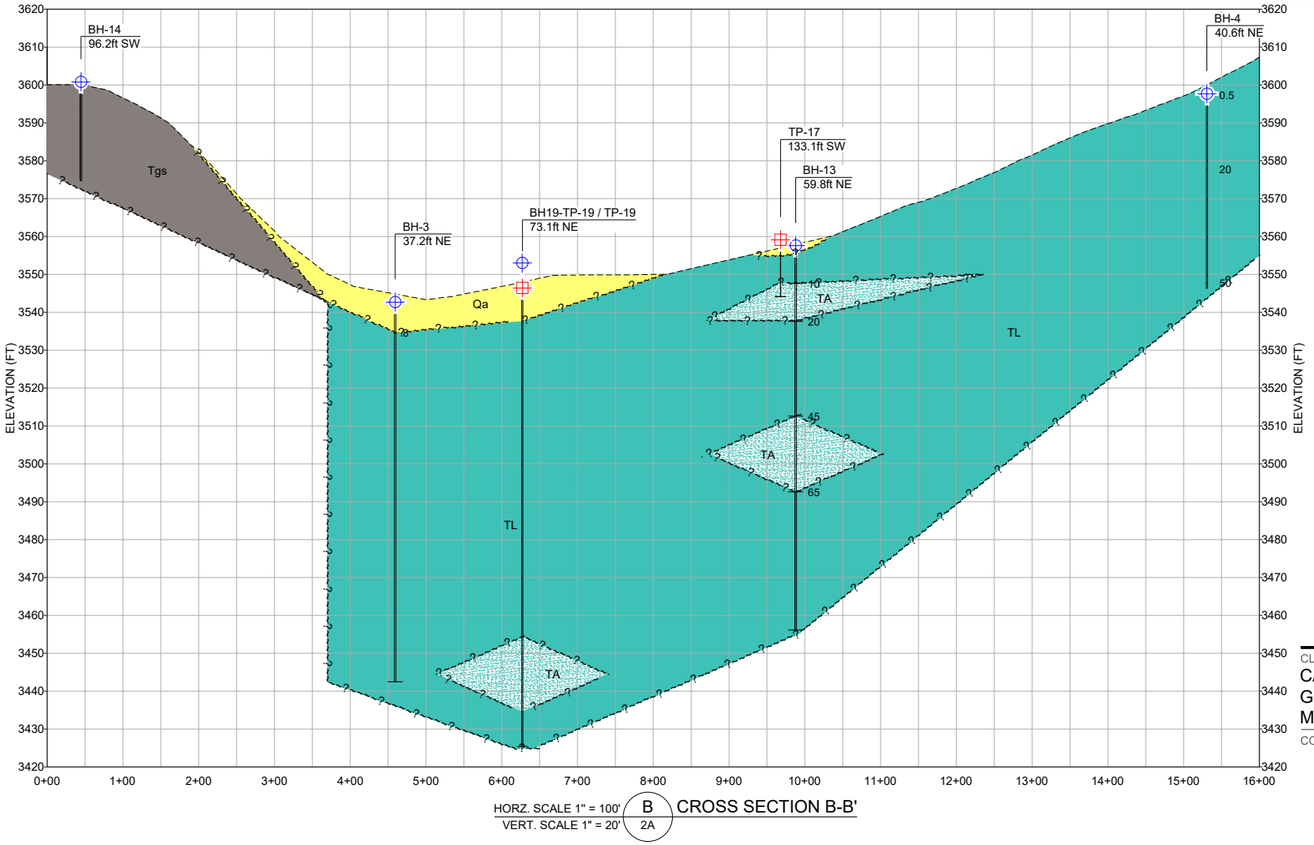


HORZ. SCALE 1" = 120' / VERT. SCALE 1" = 24' — A / 2A — CROSS SECTION A-A'



HORZ. SCALE 1" = 100' / VERT. SCALE 1" = 20' — B / 2A — CROSS SECTION B-B'

0 20 40
1" = 20' FEET

0 24 48
1" = 24' FEET

0 100 200
1" = 100' FEET

0 120 240
1" = 120' FEET

LEGEND

GEOLOGIC UNITS

- Qa - QUATERNARY ALLUVIUM / COLLUVIUM
- TL - MIOCENE LACUSTRINE DEPOSITS
- TA - MICOENE ALLUVIUM AND BEACH DEPOSITS
- Tgs - MID-UPPER MIOCENE ARKOSIC SANDSTONE AND CONGLOMERATE (GRASSY MOUNTAIN FORMATION)

BH-1 / XX.X — EXPLORATION NAME / OFFSET DISTANCE AND DIRECTION FROM CROSS SECTION LINE

?~~~~ — APPROXIMATE LITHOLOGIC CONTACT

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
GEOLOGIC CROSS SECTIONS A AND B
TAILINGS STORAGE FACILITY

PROJECT NO. 1663241 | REV. 0 | FIGURE 2B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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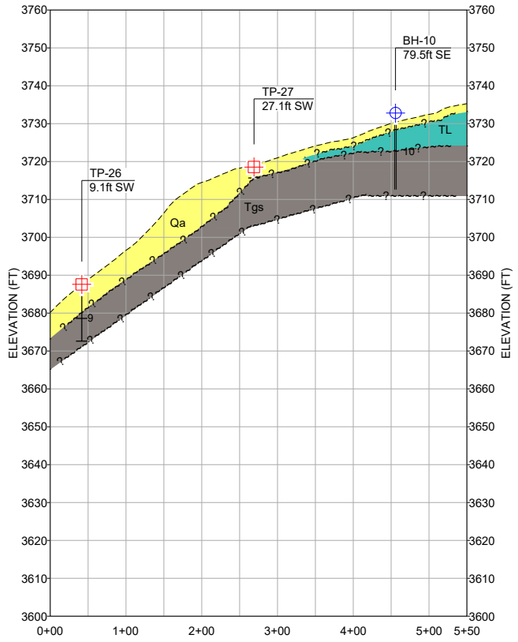
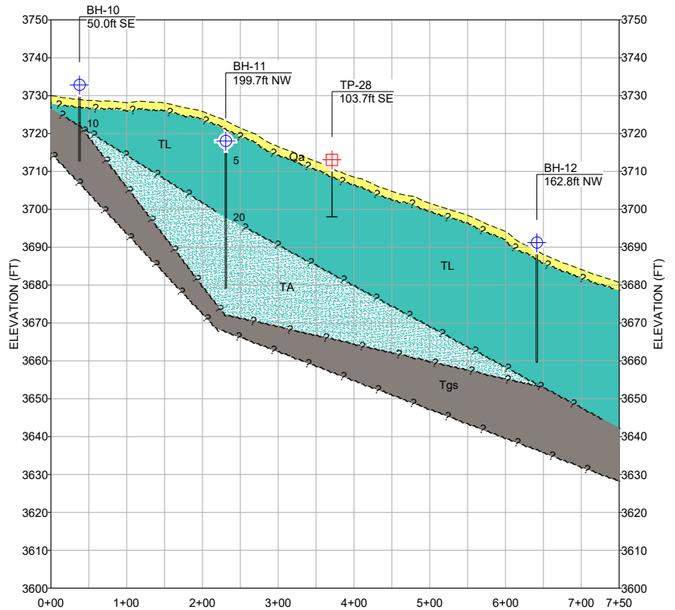


HORZ. SCALE 1" = 100' / VERT. SCALE 1" = 20' — C / 2A — CROSS SECTION C-C'



HORZ. SCALE 1" = 100' / VERT. SCALE 1" = 20' — D / 2A — CROSS SECTION D-D'

0 20 40
1" = 20' FEET

0 100 200
1" = 100' FEET

LEGEND

GEOLOGIC UNITS

- Qa - QUATERNARY ALLUVIUM / COLLUVIUM
- TL - MIOCENE LACUSTRINE DEPOSITS
- TA - MICOENE ALLUVIUM AND BEACH DEPOSITS
- Tgs - MID-UPPER MIOCENE ARKOSIC SANDSTONE AND CONGLOMERATE (GRASSY MOUNTAIN FORMATION)

BH-1 / XX.X — EXPLORATION NAME / OFFSET DISTANCE AND DIRECTION FROM CROSS SECTION LINE

?~~~~ — APPROXIMATE LITHOLOGIC CONTACT

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
GEOLOGIC SECTIONS C AND D
PROCESS FACILITIES

PROJECT NO. 1663241 | REV. 0 | FIGURE 2C

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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ATTACHMENT A

Borehole Logs

RECORD OF BOREHOLE BH-01

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 10:00
DRILLING END: December 6, 2017 15:45
COORDINATES: N: 15,864,952 E: 1,542,787

SHEET: 1 of 3
GS ELEV.: 3,599.7 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20, 40, 60, 80)	WATER CONTENT (%) (W_p, W, W_l) (20, 40, 60, 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SP), SAND, fine to medium sand, trace low plasticity fines, homogeneous; dense, moist, (ALLUVIUM/COLLUVIUM)	SP		SS S1	11-19-22 **(41)**	14/18	41			
10		10.0	(CL), LEAN CLAY, few fine sand, gray-olive to brown, homogeneous; very stiff to hard, moist, (LACUSTRINE)	CH		SS S2	13-43-49 **(92)**	19/18	92		Sample S2: %Fines = 89; %Sand = 11; PI = 25; LL = 46; %MC = 16	
15						SS S3	19-25-29 **(54)**	18/18	54			
20		20.0	(CH), FAT CLAY, trace fine sand, blue-gray to brown, homogeneous; hard, moist, (LACUSTRINE)			SS S4	5-7-13 **(20)**	20/18	20			
25						SS S5	9-12-18 **(30)**	22/18	30			
30				CH		SS S6	6-10-12 **(22)**	24/18	22			
35												
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-01

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 10:00
DRILLING END: December 6, 2017 15:45
COORDINATES: N: 15,864,952 E: 1,542,787

SHEET: 2 of 3
GS ELEV.: 3,599.7 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, trace fine sand, blue-gray to brown, homogeneous; hard, moist, (LACUSTRINE) *(continued)*	CH		SS S7	9-14-50/1" **(64/7")**	20 / 13			
45											
50						SS S8	8-15-38 **(53)**	22 / 18	53		
55											
60						SS S9	12-23-38 **(61)**	20 / 18	61		
65											
70						SS S10	38-50/1" **(50/1")**	7 / 7	100		
75											
80											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-01

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 10:00
DRILLING END: December 6, 2017 15:45
COORDINATES: N: 15,864,952 E: 1,542,787

SHEET: 3 of 3
GS ELEV.: 3,599.7 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0									
	Hollow Stem Auger		(CH), FAT CLAY, trace fine sand, blue-gray to brown, homogeneous; hard, moist, (LACUSTRINE) *(continued)*	CH		SS S11	13-19-21 **(40)**	24/18	40		
85											
90						SS S12	9-13-47 **(60)**	20/18	60		
95											
100						SS S13	13-19-35 **(54)**	20/18	54		
		101.5	Bottom of borehole at 101.5 ft.								
105											
110											
115											
120											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-02

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 08:40
DRILLING END: December 6, 2017 09:30
COORDINATES: N: 15,865,924 E: 1,543,510

SHEET: 1 of 2
GS ELEV.: 3,571.3 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SP), POORLY GRADED SAND WITH GRAVEL, fine to coarse sand, little fine to coarse subrounded to subangular gravel, trace high plasticity fines, light brown, heterogeneous, iron oxide staining; very dense, moist, (ALLUVIUM/COLLUVIUM)	SW							
5						SS S1	12-22-33 **(55)**	18/18	55		
10		10.0	(SC), CLAYEY SAND, tan, friable; very dense, moist, (ALLUVIUM/COLLUVIUM)	SC		SS S2	15-24-43 **(67)**	19/18	67		
15		15.0	(CH), FAT CLAY, trace fine sand, tan-gray to pink-brown, homogeneous; hard, moist, (LACUSTRINE)	CH		SS S3	9-9-15 **(24)**	18/18	24		
20						SS S4	5-5-10 **(15)**	22/18	15		
25		25.0	(SP), POORLY GRADED SAND, fine to medium sand, trace low plasticity fines, very light gray, homogeneous; very dense, moist, (BEACH DEPOSITS)	SP		SS S5	8-24-37 **(61)**	20/18	61		
30		31.0	(CH), FAT CLAY, trace fine sand, light pink-brown to light tan, moderately fissured; hard, moist, (LACUSTRINE)	CH		SS S6	7-15-18 **(33)**	20/18	33	Increasing clay content with depth	
35											
40											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-02

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 08:40
DRILLING END: December 6, 2017 09:30
COORDINATES: N: 15,865,924 E: 1,543,510

SHEET: 2 of 2
GS ELEV.: 3,571.3 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40		40.0									
		41.5		CH		SS S7	14-24-29 **(53)**	22 / 18	53		
			Bottom of borehole at 41.5 ft.								
45											
50											
55											
60											
65											
70											
75											
80											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-02
2 of 2

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-03

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 5, 2017 08:40
DRILLING END: December 5, 2017 14:30
COORDINATES: N: 15,866,714 E: 1,544,313

SHEET: 1 of 3
GS ELEV.: 3,530.9 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL								
			(SP), POORLY GRADED SAND, fine to medium sand, few fine rounded to subrounded gravel, trace high plasticity fines, light brown, heterogeneous; dense, moist, (ALLUVIUM/COLLUVIUM)	SW							
5						SS S1	3-6-10 **(16)**	16/18	16		
		8.0	(CH), FAT CLAY WITH SAND, little fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist, (LACUSTRINE)							Driller observed a change in material based on drill action	
10						SS S2	12-15-14 **(29)**	18/18	29	Sample S2: %Fines = 78; %Sand = 22; PI = 55; LL = 89; %MC = 29.9	
15						SS S3	6-8-11 **(19)**	18/18	19		
20						SS S4	7-7-15 **(22)**	14/18	22		
25				CH		SS S5	8-7-10 **(17)**	18/18	17		
30						SS S6	8-13-16 **(29)**	20/18	29		
35											
40		40.0	Log continued on next page								

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-03
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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-03

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 5, 2017 08:40
DRILLING END: December 5, 2017 14:30
COORDINATES: N: 15,866,714 E: 1,544,313

SHEET: 2 of 3
GS ELEV.: 3,530.9 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, trace to few fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist, (LACUSTRINE)	CH		SS S7	7-11-18 **(29)**	480 / 18	29		Sample S7: %Fines = 96; % Sand = 4; PI = 99; LL = 124;%MC = 34.7	
45												
50						SS S8	8-14-25 **(39)**	20 / 18	39		Sample S8: %Fines = 93; %Sand = 7; PI = 198; LL = 227; %MC = 34.5	
55												
60						SS S9	8-14-20 **(34)**	22 / 18	34			
65												
70						SS S10	13-25-49 **(74)**	20 / 18	74			
75												
80												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-03

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 5, 2017 08:40
DRILLING END: December 5, 2017 14:30
COORDINATES: N: 15,866,714 E: 1,544,313

SHEET: 3 of 3
GS ELEV.: 3,530.9 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0									
	Hollow Stem Auger		(CH), FAT CLAY, trace to few fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist, (LACUSTRINE) *(continued)*			SS S11	20-41-50/5" **(91/11")**	20/17			
85											
90				CH		SS S12	48-50/2" **(50/2")**	12/8			
95											
100		100.2				SS S13	50/2" **(50/2")**	2/2			
			Bottom of borehole at 100.2 ft.								
105											
110											
115											
120											

PENETRATION RESISTANCE BLOWS / ft: 20 40 60 80
WATER CONTENT (%): W_p W W_l 20 40 60 80
100 100 100

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-03
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RECORD OF BOREHOLE BH-04

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 14:40
DRILLING END: December 1, 2017 17:45
COORDINATES: N: 15,866,262 E: 1,545,284

SHEET: 1 of 2
GS ELEV.: 3,597.7 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0							20 40 60 80	W_p W W_l 20 40 60 80		
		0.5	TOPSOIL									
			(CH), FAT CLAY, light tan and light brown, moderately fissured, iron oxide staining; very stiff to hard, dry to moist, (LACUSTRINE)									
5						SS S1	6-7-16 **(23)**	18/18	23			
10				CH		SS S2	4-11-19 **(30)**	19/18	30			
15						SS S3	4-11-19 **(30)**	11/18	30			
20		20.0										
			(CH), FAT CLAY, few fine to medium sand, light tan and gray, homogeneous; hard, dry to moist, (LACUSTRINE)			SS S4	15-15-17 **(32)**	20/18	32			
25						SS S5	11-22-41 **(63)**	20/18	63			
30				CL		SS S6	5-12-15 **(27)**	20/18	27			
35						SS S7	10-22-28 **(50)**	20/18	50			
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-04

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 14:40
DRILLING END: December 1, 2017 17:45
COORDINATES: N: 15,866,262 E: 1,545,284

SHEET: 2 of 2
GS ELEV.: 3,597.7 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, few fine to medium sand, light tan and gray, homogeneous; hard, dry to moist, (LACUSTRINE) *(continued)*	CL		SS S8	19-40-50/5" **(90/11")**	20 / 17	100	Sand content increases with depth	
45						SS S9	9-18-35 **(53)**	20 / 18	53		
50		51.5				SS S10	5-10-17 **(27)**	20 / 18	27		
			Bottom of borehole at 51.5 ft.								
55											
60											
65											
70											
75											
80											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-05

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 16:00
DRILLING END: December 6, 2017 17:30
COORDINATES: N: 15,867,186 E: 1,544,389

SHEET: 1 of 2
GS ELEV.: 3,528.2 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: USCS	SOIL PROFILE: GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL									
			(CH), FAT CLAY, trace sand, brown, heterogeneous; hard, dry to moist, (LACUSTRINE)	CH		SS S1	9-13-18 **(31)**	12/18	31			
10		10.0	(SP), POORLY GRADED SAND, fine to coarse sand, few fine rounded to subrounded gravel, trace high plasticity fines, light brown, heterogeneous; dense, moist, (ALLUVIUM/COLLUVIUM)	SP		SS S2	15-20-25 **(45)**	0/18	45			
						SS S3	10-18-20 **(38)**	19/18	38			
20		20.0	(CH), FAT CLAY, few fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist, (LACUSTRINE)	CH		SS S4	6-11-17 **(28)**	26/18	28			
25						SS S5	11-16-24 **(40)**	20/18	40			
30						SS S6	7-14-14 **(28)**	26/18	28			
35												
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-05

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 16:00
DRILLING END: December 6, 2017 17:30
COORDINATES: N: 15,867,186 E: 1,544,389

SHEET: 2 of 2
GS ELEV.: 3,528.2 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40		40.0									
		41.5		CH		SS S7	20-31-30 **(61)**	19 / 18	61		
			Bottom of borehole at 41.5 ft.								
45											
50											
55											
60											
65											
70											
75											
80											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-05
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RECORD OF BOREHOLE BH-06

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 15:00
DRILLING END: December 7, 2017 15:45
COORDINATES: N: 15,867,549 E: 1,544,452

SHEET: 1 of 1
GS ELEV.: 3,529.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	TOPSOIL								
		0.5	(SP), POORLY GRADED SAND WITH GRAVEL, fine to coarse sand, some fine to coarse, subangular to angular gravel, trace low plasticity fines, brown, heterogeneous; dense to very dense, moist, (ALLUVIUM/COLLUVIUM)	SP		SS S1	30-50/3" **(50/3")**	11 / 9	100		
10		10.0	(CH), FAT CLAY, tan to olive-green, homogeneous, iron oxide staining; very stiff to hard, dry to moist, (LACUSTRINE)	CH		MC S2	16-14-16 **(30)**	18 / 18	30		
15		15.0	(CH), FAT CLAY WITH SAND, little fine to medium sand, tan to light brown, homogeneous, iron oxide staining; hard, moist, (LACUSTRINE)	CH		MC S3	14-20-26 **(46)**	20 / 18	46		
20				CH		SS S4	18-23-20 **(43)**	18 / 18	43		
25		25.0	(CH), FAT CLAY, olive-green, homogeneous, iron oxide staining; hard, dry to moist, (LACUSTRINE)	CH		MC S5	9-11-23 **(34)**	18 / 18	34		
		26.5	Bottom of borehole at 26.5 ft.								
30											
35											
40											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-06
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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-07

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 11:40
DRILLING END: December 1, 2017 13:10
COORDINATES: N: 15,866,060 E: 1,544,378

SHEET: 1 of 2
GS ELEV.: 3,566.9 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL									
			(SP-SC), POORLY GRADED SAND WITH GRAVEL AND CLAY, fine to coarse sand, little fine to coarse, subrounded to subangular gravel, few medium plasticity fines, light tan to gray, heterogeneous, iron oxide staining; very dense, dry to moist, (ALLUVIUM/COLLUVIUM)	SP-SC		SS S1	19-25-27 **(52)**	12/18	52			
5												
10						SS S2	25-29-33 **(62)**	18/18	62			
15						SS S3	19-29-36 **(65)**	17/18	65		Stained red from 15 to 25 feet	
20						SS S4	23-28-30 **(58)**	20/18	58			
25		25.0	(CH), FAT CLAY, few fine sand, light gray-green to red-brown, moderately fissured, iron oxide staining; hard, moist, (LACUSTRINE)	CH		SS S5	13-18-20 **(38)**	20/18	38		Samples S5/S6/S7:% Fines = 91; %Sand = 9; PI = 45; LL = 66	
30						SS S6	9-11-19 **(30)**	20/18	30			
35						SS S7	8-12-24 **(36)**	22/18	36			
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-07

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 11:40
DRILLING END: December 1, 2017 13:10
COORDINATES: N: 15,866,060 E: 1,544,378

SHEET: 2 of 2
GS ELEV.: 3,566.9 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40		40.0									
		41.5	CH	CH		SS S8	13-25-29 **(54)**	20 / 18	54		
			Bottom of borehole at 41.5 ft.								
45											
50											
55											
60											
65											
70											
75											
80											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-07
2 of 2

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-08

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 08:36
DRILLING END: December 1, 2017 10:50
COORDINATES: N: 15,865,318 E: 1,544,094

SHEET: 1 of 2
GS ELEV.: 3,596.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0									
		0.5	TOPSOIL								
			(SC), CLAYEY SAND, fine to coarse sand, fine subrounded to subangular gravel, high plasticity fines, brown, heterogeneous; medium dense, moist, (ALLUVIUM/COLLUVIUM)	SC		SS S1	6-11-6 **(17)**	12/18	17		
5											
10		10.0				SS S2	5-8-10 **(18)**	18/18	18		
			(CH), FAT CLAY WITH SAND, little fine to medium sand, olive-brown brown, heterogeneous; very stiff to hard, moist, (LACUSTRINE)								
15						SS S3	8-10-14 **(24)**	20/18	24		
20						SS S4	6-10-14 **(24)**	19/18	24		
25				CH		SS S5	7-16-26 **(42)**	19/18	42		
30						SS S6	6-10-10 **(20)**	20/18	20		
35						SS S7	8-13-17 **(30)**	20/18	30		
40											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-08

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 08:36
DRILLING END: December 1, 2017 10:50
COORDINATES: N: 15,865,318 E: 1,544,094

SHEET: 2 of 2
GS ELEV.: 3,596.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY WITH SAND, little fine to medium sand, olive-brown brown, heterogeneous; very stiff to hard, moist, (LACUSTRINE) *(continued)*	CH		SS S8	8-17-19 **(36)**	20/18	36		
45						SS S9	7-11-15 **(26)**	20/18	26		
50		51.5				SS S10	9-23-26 **(49)**	20/18	49		
			Bottom of borehole at 51.5 ft.								
55											
60											
65											
70											
75											
80											

PENETRATION RESISTANCE BLOWS / ft: 20 40 60 80
WATER CONTENT (%): W_p W W_l 20 40 60 80

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-09

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 08:30
DRILLING END: December 7, 2017 14:30
COORDINATES: N: 15,866,110 E: 1,543,260

SHEET: 1 of 3
GS ELEV.: 3,596.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SP), POORLY GRADED SAND, fine to medium sand, few high plasticity fines, tan and dark brown, homogeneous, iron oxide staining; very dense, dry to moist, (ALLUVIUM/COLLUVIUM)	SP		SS S1	27-34-40 **(74)**	16/18	74			
5												
10						SS S13	9-13-33 **(46)**	20/18	46			
15						SS S3	50/2" **(50/2")**	1/2		100		
20						SS S4	41-50/5" **(50/5")**	14/11		100		
25		25.0	(CH), SANDY FAT CLAY, some fine to coarse sand, brown-yellowish and pink-brown, moderately fissured, iron oxide staining; very stiff, moist, (LACUSTRINE)	CH		SS S5	9-11-13 **(24)**	17/18	24		Sample S5: %Fines = 68; %Sand =32; PI = 62, LL = 96	
30						SS S6	8-11-13 **(24)**	20/18	24			
35												
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-09

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 08:30
DRILLING END: December 7, 2017 14:30
COORDINATES: N: 15,866,110 E: 1,543,260

SHEET: 2 of 3
GS ELEV.: 3,596.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), SANDY FAT CLAY, some fine to coarse sand, brown-yellowish and pink-brown, moderately fissured, iron oxide staining; very stiff, moist, (LACUSTRINE) *(continued)*	CH		SS S7	6-10-14 **(24)**	26/18		24		
45												
50		50.0	(SP), POORLY GRADED SAND, fine to medium sand, trace medium plasticity fines, tan, homogeneous; very dense, moist, (BEACH DEPOSITS)	SP		SS S8	17-35-46 **(81)**	20/18		81		
55												
60						SS S9	48-50/5" **(50/5")**	12/11		100		
65												
70		70.0	(CL), SANDY LEAN CLAY, some fine to medium sand, gray and blue-gray, homogeneous, iron oxide staining; hard, moist, (LACUSTRINE)	CL		SS S10	17-24-29 **(53)**	20/18		53		
75												
80		80.0	Log continued on next page									

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-09

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 08:30
DRILLING END: December 7, 2017 14:30
COORDINATES: N: 15,866,110 E: 1,543,260

SHEET: 3 of 3
GS ELEV.: 3,596.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0							20 40 60 80		
	Hollow Stem Auger		(CH), FAT CLAY, light blue-gray and dark blue-gray, homogeneous; hard, dry to moist, (LACUSTRINE)	CH		SS S11	50/5" **(50/5")**	6/5	W_p 20 40 60 80 W_l; W; 100		
85											
90						SS 12	12-19-30 **(49)**	20/18	49		
95											
100						SS S13	9-13-33 **(46)**	20/18	46		
		101.5	Bottom of borehole at 101.5 ft.								
105											
110											
115											
120											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-10

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: November 30, 2017 11:15
DRILLING END: November 30, 2017 12:45
COORDINATES: N: 15,864,954 E: 1,545,298

SHEET: 1 of 1
GS ELEV.: 3,732.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	TOPSOIL			S1	0-0					
		1.0	(CL), LEAN CLAY WITH SAND, little fine sand, trace fine subrounded to subangular gravel, light tan, homogeneous; hard, moist, (ALLUVIUM/COLLUVIUM)	CL		SS S2	10-15-18 **(33)**	16/18	33			
10		10.0	(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, light gray, heterogeneous, iron oxide staining; very dense, dry, (WEATHERED ARKOSIC SANDSTONE)	SM		SS S3	12-19-33 **(52)**	16/18	52			
15						SS S4	26-50/2" **(50/2")**	8/8		100		
20		20.2	Bottom of borehole at 20.2 ft.			SS	50/2" **(50/2")**	1/2		100		
25												
30												
35												
40												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-10
1 of 1

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
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RECORD OF BOREHOLE BH-11

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: November 30, 2017 13:20
DRILLING END: November 30, 2017 15:00
COORDINATES: N: 15,865,251 E: 1,545,404

SHEET: 1 of 1
GS ELEV.: 3,718.0 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL									
			(CH), SANDY FAT CLAY, some fine to coarse sand, trace fine subrounded to subangular gravel, light tan to olive, homogeneous; stiff to hard, moist, (ALLUVIUM/COLLUVIUM)	CH		SS S1	7-5-8 **(13)**	20/18	13		Sample S2: %Fines = 60; %Sand = 37; %Gravel = 3%; PI = 62, LL = 97	
5												
10						SS S2	12-13-19 **(32)**	19/18	32		S2 mottled with evaporite deposits but deposits do not react to HCL	
15						SS S3	12-14-15 **(29)**	18/18	29			
20		20.0	(SC), CLAYEY SAND, fine to coarse sand, some high plasticity fines, light green-gray and, heterogeneous; very dense, dry, (ALLUVIUM/ COLLUVIUM)	SC		SS S4	50 **(50/")**	7/6		100		
25		25.0	(SP-SM), POORLY GRADED SAND WITH GRAVEL AND CLAY, fine to coarse sand, little fine subangular to angular gravel, few high plasticity fines, light brown, heterogeneous; very dense, moist, (ALLUVIUM/COLLUVIUM)	SP-SC		SS S5	50 **(50/")**	8/6		100	No recovery from 25 to 39 feet, grab samples of cuttings taken at about 30 and 39 feet	
30						SS S6	50/1" **(50/1")**	0/1		100		
35						SS S7	50/1" **(50/1")**	0/1		100		
		39.0				SS S8						
40			Bottom of borehole at 39.0 ft.									

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-11
1 of 1

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-12

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: November 30, 2017 15:40
DRILLING END: November 30, 2017 16:40
COORDINATES: N: 15,865,342 E: 1,545,806

SHEET: 1 of 1
GS ELEV.: 3,691.2 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0							20 40 60 80; W_p W W_l 20 40 60 80		
		0.5	TOPSOIL								
			(CH), FAT CLAY, trace fine to medium sand, gray to very dark gray, moderately fissured, iron oxide staining; very stiff to hard, moist, (LACUSTRINE)								
5						SS S1	12-12-11 **(23)**	10 / 18	23		
10						SS S2	5-10-13 **(23)**	19 / 18	23		
15			Color change to gray to dark gray.	CH		SS S3	9-13-14 **(27)**	22 / 18	27		
20						SS S4	10-14-17 **(31)**	19 / 18	31		
25						SS S5	11-12-16 **(28)**	21 / 18	28		
30						SS S6	9-14-18 **(32)**	20 / 18	32	Sample S6: %Fines = 97; %Sand = 3; PI = 62, LL = 103	
		31.5	Bottom of borehole at 31.5 ft.								
35											
40											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-12
1 of 1

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-13

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 2, 2017 08:30
DRILLING END: December 2, 2017 16:00
COORDINATES: N: 15,866,510 E: 1,544,801

SHEET: 1 of 3
GS ELEV.: 3,557.6 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (CH), FAT CLAY WITH SAND, little fine to medium sand, tan, moderately fissured, iron oxide staining; very stiff, moist, (LACUSTRINE)	CH		SS S1	7-9-11 **(20)**	18/18	20	Sample S1: %Fines = 86; %Sand = 14; PI = 63; LL = 92	
5											
10		10.0	(CH), SANDY FAT CLAY, some fine to coarse sand, heterogeneous, iron oxide staining; medium dense to dense, moist, (LACUSTRINE)			SS S2	11-16-22 **(38)**	19/18	38		
15						SS S3	10-11-16 **(27)**	20/18	27	Sample S3: %Fines = 52; %Sand = 48; PI = 62; LL = 85	
20						SS S4	16-50/5" **(50/5")**	12/11	100		
25				SC		SS S5	10-12-18 **(30)**	24/18	30	Sample S5: %Fines = 67; %Sand = 33; PI = 55; LL = 77	
30						MC S6	10-12-18 **(30)**	18/18	30	Sample S6: %Fines = 97; %Sand = 3; PI = 62, LL = 103	
35						SS S7	6-10-18 **(28)**	20/18	28		
40											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-13

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 2, 2017 08:30
DRILLING END: December 2, 2017 16:00
COORDINATES: N: 15,866,510 E: 1,544,801

SHEET: 2 of 3
GS ELEV.: 3,557.6 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), SANDY FAT CLAY, some fine to coarse sand, heterogeneous, iron oxide staining; medium dense to dense, moist, (LACUSTRINE) *(continued)*	SC		SS S8	8-13-23 **(36)**	20/18	36			
45		45.0	(SM), SILTY SAND, fine to medium, subangular to angular, and medium plasticity fines, tan, friable, iron oxide staining; dense, moist, (ALLUVIUM/ COLLUVIUM)	SM		SS S9	8-4-50/4" **(54/10")**	20/16		100		
50						SS S10	22-49-50/2" **(99/8")**	18/14		100		
55						SS S11	18-47-50/5" **(97/11")**	24/17		100		
60						SS S12	18-38-50/5" **(88/11")**	20/17		100		
65		65.0	(CH), FAT CLAY, gray and dark blue-gray, homogeneous; hard, moist, (LACUSTRINE)	CH		SS S13	9-13-47 **(60)**	20/18	60			
70												
75						SS S14	13-27-34 **(61)**	20/18	61			
80			Log continued on next page									

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-13

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 2, 2017 08:30
DRILLING END: December 2, 2017 16:00
COORDINATES: N: 15,866,510 E: 1,544,801

SHEET: 3 of 3
GS ELEV.: 3,557.6 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0	(CH), FAT CLAY, gray and dark blue-gray, homogeneous; hard, moist, (LACUSTRINE) *(continued)*								
85	Hollow Stem Auger			CH		SS 15	28-34-38 **(72)**	24/18	72		
90											
95											
100						SS S16	11-18-34 **(52)**	20/18	52		
		101.5	Bottom of borehole at 101.5 ft.								
105											
110											
115											
120											

PENETRATION RESISTANCE BLOWS / ft: 20 40 60 80
WATER CONTENT (%): W_p W W_l 20 40 60 80

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-14

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 8, 2017 08:45
DRILLING END: December 8, 2017 09:30
COORDINATES: N: 15,866,769 E: 1,543,881

SHEET: 1 of 1
GS ELEV.: 3,600.8 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SW-SM), WELL-GRADED SAND WITH SILT, fine to medium, well graded, some fine rounded to subrounded gravel, trace low plasticity fines, tan, homogeneous, iron oxide staining; dense to very dense, dry, trace gravel (ALLUVIUM/ COLLUVIUM)	SW-SM		S0						
5						SS S1	31-38-43 **(81)**	17/18	81			
10						SS S2	15-18-27 **(45)**	14/18	45			
15						SS S3	8-14-15 **(29)**	12/18	29			
20						SS S4	13-15-21 **(36)**	14/18	36			
25		26.1				SS S5	19-29-38 **(67)**	13/18	67		S5 mottled with calcite deposits (reacts to HCL)	
30			Bottom of borehole at 26.1 ft.									
35												
40												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Colin Bloom
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-14
1 of 1

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 8, 2017 10:15
DRILLING END: December 8, 2017 10:45
COORDINATES: N: 15,866,714 E: 1,544,313

SHEET: 1 of 1
GS ELEV.: 3,532.1 ft
TOC ELEV.: na
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	TOPSOIL								
		0.5	(SC), CLAYEY SAND, fine to coarse sand, some high plasticity fines, trace fine rounded to subrounded gravel, light brown, heterogeneous; dense, moist, (ALLUVIUM/ COLLUVIUM)	SW							
5											
		8.0	(CH), FAT CLAY, trace fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist, (LACUSTRINE)	CH							
10											
15						MC S1	9-11-18 **(29)**	18/18	29		
20											
25						MC S2	9-12-16 **(28)**	18/18	28	Sample S2:% Fines = 98; %Sand = 2%; PI = 157; PI = 191	
		26.5	Bottom of borehole at 26.5 ft.								
30											
35											
40											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Colin Bloom
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-15
1 of 1

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/15/19 08:39
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2016 FIELD PROGRAM\BORINGS\GRASSYMOUNTAINBORINGLOGS 5-1-2018.GPJ

RECORD OF BOREHOLE BH19-TP-01

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 20, 2019 09:30
DRILLING END: March 20, 2019 12:30
COORDINATES: N: 15,864,181.3 E: 1,542,543.4

SHEET: 1 of 2
GS ELEV.: 3590.0
TOC ELEV.: 3617.7
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	(CH), FAT CLAY, high plasticity fines, some sand, some coarse subrounded to subangular gravel, tan; soft, moist, (LACUSTRINE)	3590.0	CH							
5			light gray mottled orange, hard				SS 1	12-10-28 **(38)**	18/18	38		
10			gray, blocky, stiff, moist, black stain on some joint surfaces				SS 2	3-5-8 **(13)**	18/18	13	Sample 2: %Fines= 96; %Sand= 3; PI=69; LL=97; %MC= 37.4	
12		12.0	(SC), CLAYEY SAND, high plasticity fines, light gray mottled orange, very dense, moist, (LACUSTRINE)	3578.0								
15					SC		SS 3	19-50/4" **(50/4")**	10/10	100		
20							SS 4	15-20-39 **(59)**	18/18	59	Sample 4: %Fines= 48; %Sand= 52; PI=21; LL=36; %MC= 11.7	
25		25.0		3565.0								
			(CH), FAT CLAY, high plasticity fines, few fine sand, light gray mottled orange, hard, (LACUSTRINE)				SS 5	18-19-20 **(39)**	18/18	39	Sample 5: %Fines= 94; %Sand= 6; PI=58; LL=78; %MC= 29.0	
30			Becomes dark gray and olive green below ~26ft		CH		MC 6	22-32-50 **(82)**	17/18	82		
35		35.5		3554.5								
			(CH), FAT CLAY WITH SAND, medium plasticity fines, some fine sand, gray-green, hard, (LACUSTRINE)		CH		MC 7	15-18-32 **(50)**	18/18	50		
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-01
1 of 2

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-01

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 20, 2019 09:30
DRILLING END: March 20, 2019 12:30
COORDINATES: N: 15,864,181.3 E: 1,542,543.4

SHEET: 2 of 2
GS ELEV.: 3590.0
TOC ELEV.: 3617.7
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40		40.0		3550.0								
	Hollow Stem Auger		(CH), FAT CLAY WITH SAND, high plasticity fines, gray mottled, hard, (LACUSTRINE)		CH		MC 8	15-21-50 **(71)**	17/18	71		
45							MC 9	15-32-50 **(82)**	17/18	82	Sample 9: %Fines= 82; %Sand= 15; PI=44; LL=68; %MC= 32.4	
50							MC 10	15-22-50 **(72)**	18/18	72		
		51.5	Bottom of borehole at 51.5 ft. Backfilled with bentonite chips.	3538.5								
55												
60												
65												
70												
75												
80												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-01
2 of 2

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 26, 2019 09:15
DRILLING END: March 26, 2019 15:45
COORDINATES: N: 15,866,243.5 E: 1,544,070.2

SHEET: 1 of 4
GS ELEV.: 3595.0
TOC ELEV.: 3564.9
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	(SM), SILTY SAND WITH GRAVEL, fine to coarse sand, non plastic fines, yellow-brown, loose to dense, dry, density increasing with depth, (LACUSTRINE)	3595.0	SM							
5							SS 1	16-20-30 **(50)**	16/18	50		
10		10.5		3584.5			MC 2	8-16-25 **(41)**	13/18	41		
15			(CH), FAT CLAY, high plastic fines, trace fine sand, gray and white, hard, dry, sand content decreasing with depth, (LACUSTRINE)		CH		MC 3	17-29-38 **(67)**	17/18	67	Sample 3: %Fines= 96; %Sand= 4; PI=38; LL=66; %MC= 18.9	
20			light brown-gray				MC 4	13-38-48 **(86)**	16/18	86	Sample 4: %Fines= 90; %Sand= 10; PI=30; LL=52; %MC= 13.6	
25			light gray mottled orange; very dense				MC 5	19-23-28 **(51)**	17/18	51	Sample 5: %Fines= 94; %Sand= 4; PI=40; LL=62; %MC= 15.0	
30		30.0		3565.0								
			(CL), LEAN CLAY, high plasticity fines, trace fine sand, light gray, hard, orange stain on surfaces, (LACUSTRINE)		CL		MC 6	17-28-45 **(73)**	16/18	73	Sample 6: %Fines= 56; %Sand= 44; PI=29; LL=48; %MC= 13.4	
35		35.0	30-30.7 - mottled orange	3560.0								
			(SC), CLAYEY SAND, fine sand, medium to high plasticity fines, light gray, blocky, very dense, dry to moist, (LACUSTRINE)		SC		MC 7	29-48-50/3" **(98/9")**	15/15	100	Sample 7: %Fines= 43; %Sand= 57; PI=14; LL=35; %MC= 9.6	
40		40.0		3555.0								

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 26, 2019 09:15
DRILLING END: March 26, 2019 15:45
COORDINATES: N: 15,866,243.5 E: 1,544,070.2

SHEET: 2 of 4
GS ELEV.: 3595.0
TOC ELEV.: 3564.9
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(SC), CLAYEY SAND, fine sand, medium to high plasticity fines, light gray and light yellow, hard, (LACUSTRINE)	3555.0	SC		MC 8	15-31-45 **(76)**	15/18	76		Sample 8: %Fines= 45; %Sand= 55; PI=17; LL=35; %MC= 11.5	
		42.0	40.5-41ft -very dense, dry	3553.0									
45			(CL), LEAN CLAY, low plasticity fines, trace fine sand, light brown-gray and dark brown, laminated, hard, (LACUSTRINE)		CL		MC 9	12-20-28 **(48)**	18/18	48			
			medium plasticity, olive-gray										
			50-51ft - mottled orange (~30%)										
50		50.0		3545.0									
			(CH), FAT CLAY, high plasticity fines, trace fine sand, brown-gray mottled orange; hard, (LACUSTRINE)		CH		MC 10	8-17-28 **(45)**	18/18	45		Sample 10: %Fines= 98; %Sand= 2; PI=62; LL=87; %MC= 32.3	
55													
60		60.0		3535.0									
			(CL), LEAN CLAY, low plasticity fines, some fine sand, gray with black; hard, (LACUSTRINE)		CL		MC 11	12-17-28 **(45)**	18/18	45			
65													
70		70.0		3525.0									
			(CH), FAT CLAY, high plasticity fines, little fine sand, dark brown, stratified, hard, (LACUSTRINE)		CH		MC 12	17-26-28 **(54)**	18/18	54		Sample 12: %Fines= 87; %Sand= 13; PI=78; LL=116; %MC= 47.9	
			dark blue-gray										
75													
80													

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 26, 2019 09:15
DRILLING END: March 26, 2019 15:45
COORDINATES: N: 15,866,243.5 E: 1,544,070.2

SHEET: 3 of 4
GS ELEV.: 3595.0
TOC ELEV.: 3564.9
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80	Hollow Stem Auger	80.0		3515.0									
		81.5	(CH), FAT CLAY, high plasticity, little fine sand, blue-gray, hard, (LACUSTRINE) *(continued)*	3513.5	CH		MC 13	17-27-40 **(67)**	18/18		67		
85			(SM), SILTY SAND, fine sand, low plasticity fines, dark blue-gray, very dense, dry to moist, (LACUSTRINE)		SM								
90		90.0		3505.0			MC 14	21-43-50/5" **(93/11")**	17/17		100	Sample 14: %Fines= 92; %Sand= 8; LL=101; PI=65; %MC= 36.5	
95			(CH), FAT CLAY, high plasticity fines, dark blue-gray, few fine sand, hard, white clay fleck and vein scattered throughout, (LACUSTRINE)		CH								
100			varying sand content				MC 15	17-28-32 **(60)**	18/18		60		
105			gray-blue										
110							MC 16	18-28-50/5" **(78/11")**	17/17		100	Sample 16: %Fines= 93; %Sand= 7; PI=64; LL=90; %MC= 33.6	
115					CH								
120					CH								

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 26, 2019 09:15
DRILLING END: March 26, 2019 15:45
COORDINATES: N: 15,866,243.5 E: 1,544,070.2

SHEET: 4 of 4
GS ELEV.: 3595.0
TOC ELEV.: 3564.9
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
120		120.0		3475.0								
		121.4	(CH), FAT CLAY, high plasticity fines, few sand, green-gray, hard, white clay fleck scattered throughout , (LACUSTRINE) *(continued)*	3473.6	CH		MC 17	18-27-50/5" **(77/11")**	17/17	100	Sample 17: %Fines= 91; %Sand= 9; PI=43; LL=66; %MC= 24.6	
			Bottom of borehole at 121.4 ft. Backfilled with bentonite chips.									
125												
130												
135												
140												
145												
150												
155												
160												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-15
4 of 4

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 14:45
DRILLING END: March 23, 2019 13:45
COORDINATES: N: 15,866,650.7 E: 1,544,451.3

SHEET: 1 of 4
GS ELEV.: 3535.0
TOC ELEV.: 3546.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	(CL), LEAN CLAY, low plasticity fines, gray and light gray,very stiff, density increasing with depth, (LACUSTRINE)	3535.0	CL								
							SS 1	8-11-13 **(24)**	12/18	24			
10		10.0	(CH), FAT CLAY, high plasticity fines, trace fine sand, light gray-green, stiff, white clay fleck scattered throughout (possible tuff/zeolite), (LACUSTRINE)	3525.0	CH		SH 2		22/24				
							SS 3	4-8-11 **(19)**	14/18	19		Sample 3: %Fines= 99; %Sand= 1; PI=72; LL=98; %MC= 27.4	
15			Increasing plasticity with depth				MC 4	9-11-13 **(24)**	14/18	24		Sample 4: %Fines= 99; %Sand= 1; PI=100; LL=133; %MC= 34.4	
							SH 5		18/24				
20							SS 6	4-7-9 **(16)**	18/18	16			
25		25.0	(CH), FAT CLAY WITH SAND, high plasticity fines, light grey-green, orange staining, hard, moist, (LACUSTRINE)	3500.0	CH		MC 7	10-24-28 **(52)**	18/18		52	Sample 7: %Fines= 84; %Sand= 6; PI=135; LL=158; %MC= 23.2	
30		30.0	(SC), CLAYEY SAND, fine to medium sand, high plasticity fines, light yellow-brown; very dense, moist, (LACUSTRINE)	3505.0	SC		SH 8		0/0				
							MC 9	19-24-28 **(52)**	18/18		52	Sample 9: %Fines= 41; %Sand= 57; PI=101; LL=127; %MC= 27.1	
35			37-42ft - gravelly layer				MC 10	16-32-32 **(64)**	18/18		64	Sample 10: %Fines= 49; %Sand= 51; PI=117; LL=137; %MC= 26.3	
40		40.0	40ft - few fine gravel	3495.0									

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 14:45
DRILLING END: March 23, 2019 13:45
COORDINATES: N: 15,866,650.7 E: 1,544,451.3

SHEET: 2 of 4
GS ELEV.: 3535.0
TOC ELEV.: 3546.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, high plasticity fines, light gray, moist; hard, (LACUSTRINE) 40.5ft - some orange mottle	3495.0	CH		MC 11	19-21-25 **(46)**	18/18	46		Sample 11: %Fines= 100; %Sand= 0; PI=117; LL=141; %MC= 45.5	
45		45.0	(ML), SILT, non plastic fines, fine sand, olive-gray; hard, dry to moist, sand content increasing with depth, (LACUSTRINE)	3490.0	ML		MC 12	28-50 **(50/")**	12/12		100		
50		50.0	(CH), FAT CLAY, high plasticity fines, few fine sand, yellow-brown; hard, moist, (LACUSTRINE)	3485.0	CH		MC 13	10-19-22 **(41)**	18/18	41		Sample 13: %Fines= 93; %Sand= 7; PI=179; LL=206; %MC= 42.2	
55													
60			varying sand content, color changes to dark grey				MC 14	25-48-50 **(98)**	18/18		98	Sample 14: %Fines= 96; %Sand= 4; PI=51; LL=73; %MC= 22.1	
65													
70		71.5		3463.5			MC 15	20-29-50 **(79)**	18/18	79		Sample 15: %Fines= 87; %Sand= 13; PI=61; LL=89; %MC= 30.3	
75			(CL), LEAN CLAY, low plasticity fines, fine sand, gray; hard, moist, (LACUSTRINE)		CL								
80		75.0	(CH), FAT CLAY, high plasticity fines, dark gray; hard, moist, (LACUSTRINE)	3460.0	CH								

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 14:45
DRILLING END: March 23, 2019 13:45
COORDINATES: N: 15,866,650.7 E: 1,544,451.3

SHEET: 3 of 4
GS ELEV.: 3535.0
TOC ELEV.: 3546.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
80	Hollow Stem Auger	80.0	(CH), FAT CLAY, high plasticity fines, dark gray; hard, moist, (LACUSTRINE) *(continued)*	3455.0	CH		MC 16	21-39-50 **(89)**	18/18	89	Sample 16: %Fines= 97; %Sand= 3; PI=41; LL=62; %MC= 20.9	
85			87.5-88.5ft - drilling through cobble									
90			90-90.5ft - drilling through cobble				MC 17	50/4" **(50/4")**	4/4	100		
		92.0		3443.0								
95			(SP-SM), POORLY GRADED SAND WITH SILT, fine sand, poorly graded, some non plastic fines, light gray, homogeneous; very dense, dry, (LACUSTRINE)		SP-SM							
100							MC 18	49-50/3" **(50/3")**	9/9	100		
105												
110		110.0		3425.0								
			(CL), LEAN CLAY, high plasticity fines, gray; hard, moist, (LACUSTRINE)		CL		MC 19	28-38-50/3" **(88/9")**	15/15	100	Sample 19: %Fines= 99; %Sand= 1; PI=24; LL=48; %MC= 17.8	
115		115.0		3420.0								
120			(CH), FAT CLAY WITH SAND, high plasticity fines, little fine sand, gray; hard, moist, (LACUSTRINE)		CH							

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 14:45
DRILLING END: March 23, 2019 13:45
COORDINATES: N: 15,866,650.7 E: 1,544,451.3

SHEET: 4 of 4
GS ELEV.: 3535.0
TOC ELEV.: 3546.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
120		120.0		3415.0								
		121.4	(CH), FAT CLAY WITH SAND, high plasticity, gray; hard, moist, (LACUSTRINE) *(continued)*	3413.6	CH		MC 20	25-45-50/5" **(95/11")**	17 / 17	100	Sample 20: %Fines= 80; %Sand= 20; PI=37; LL=59; %MC= 20.9	
			Bottom of borehole at 121.4 ft. Backfilled with bentonite chips.									
125												
130												
135												
140												
145												
150												
155												
160												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-19
4 of 4

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 12:00
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\SCANNED LOGS\GRASSYMOUNTAINBORINGLOGS 3-29

RECORD OF BOREHOLE BH19-TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 20, 2019 13:30
DRILLING END: March 21, 2019 11:15
COORDINATES: N: 15,866,963.8 E: 1,544,303.6

SHEET: 1 of 4
GS ELEV.: 3550.0
TOC ELEV.: 3541.1
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	(CH), FAT CLAY, high plasticity fines, coarse subrounded to subangular gravel, trace fine sand, light brown-gray; soft, (LACUSTRINE)	3550.0	CH							
5		5.0	(GC), CLAYEY GRAVEL WITH SAND, coarse, subrounded to subangular gravel, fine sand, high plasticity fines, gray, some boulders; dense, dry, (LACUSTRINE)	3545.0	GC		SS 1	12-50/4" **(50/4")**	10/10	100		
10		10.5	(CH), FAT CLAY, high plasticity fines, gray, stiff to very stiff, (LACUSTRINE)	3539.5	CH		SS 2	16-9-10 **(19)**	18/18	19		
15							SH 3		24/24			
							SS 4	5-6-6 **(12)**	18/18	12		
20							SH 5		24/24			
							SS 6	5-8-10 **(18)**	18/18	18		
25							SH 7		20/20			
		26.5	(SC), CLAYEY SAND, fine, high plasticity fines, light gray mottled orange, iron oxide staining, medium dense, moist, some black stain on surfaces, (LACUSTRINE)	3523.5	SC		SS 8	5-8-10 **(18)**	18/18	18		
30		30.0	(CH), FAT CLAY, high plasticity fines, trace fine sand, green-gray; hard, moist, (LACUSTRINE)	3520.0	CH		MC 9	17-25-18 **(43)**	18/18	43	Sample 9: %Fines= 97; %Sand= 3; PI=68; LL=99; %MC= 41.7	
35							MC 10	10-20-25 **(45)**	17/18	45	Sample 10: %Fines= 96; %Sand= 4; PI=101; LL=135; %MC= 41.7	
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\GRASSY MOUNTAIN\BORING LOGS 3-29-2011.GPJ

RECORD OF BOREHOLE BH19-TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 20, 2019 13:30
DRILLING END: March 21, 2019 11:15
COORDINATES: N: 15,866,963.8 E: 1,544,303.6

SHEET: 2 of 4
GS ELEV.: 3550.0
TOC ELEV.: 3541.1
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, high plasticity fines, green-gray; hard, moist, (LACUSTRINE) *(continued)* 40-41 ft - orange mottle, increasing with depth	3510.0	CH		MC 11	12-15-50/4" **(65/10")**	16/16			100 Sample 11: %Fines= 99; %Sand= 1; PI=58; LL=82; %MC= 29.4	
45		45.0	41.5ft - becomes pink gray	3505.0									
			(CL), LEAN CLAY, low to medium plasticity fines, few fine sand, light gray mottled orange, hard, moist, (LACUSTRINE)		CL		MC 12	15-28-48 **(76)**	18/18		76	Sample 12: %Fines= 93; %Sand= 7; PI=26; LL=49; %MC= 22.8	
50		50.0		3500.0									
			(CH), FAT CLAY WITH SAND, high plasticity fines, little fine sand, green-gray; hard, moist, (LACUSTRINE) 50ft - becomes dark gray 50.5ft - with trace fine sand		CH		MC 13	30-38-50/4" **(88/10")**	16/16			100 Sample 13: %Fines= 82; %Sand= 18; PI=50; LL=70; %MC= 19.5	
55													
60		60.0		3490.0									
			(MH), ELASTIC SILT, high plasticity fines, trace fine sand, light gray, hard, moist, (LACUSTRINE)		MH		MC 14	35-49-50 **(99)**	18/18			99 Sample 14: %Fines= 96; %Sand= 4; PI=21; LL=53; %MC= 26.0	
65		65.0		3485.0									
			(CH), FAT CLAY, gray, hard, moist, (LACUSTRINE)		CH								
70		70.0		3480.0									
			(SC), CLAYEY SAND, fine sand, low plasticity fines, light gray, very dense, dry, (LACUSTRINE)		SC		MC 15	50/5" **(50/5")**	0/5			100	
75													
80			Log continued on next page										

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\GRASSY MOUNTAIN\BORING LOGS 3-29-2011.GPJ

RECORD OF BOREHOLE BH19-TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 20, 2019 13:30
DRILLING END: March 21, 2019 11:15
COORDINATES: N: 15,866,963.8 E: 1,544,303.6

SHEET: 3 of 4
GS ELEV.: 3550.0
TOC ELEV.: 3541.1
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0	(SC), CLAYEY SAND, fine sand, low plasticity fines, light gray; very dense,dry,(LACUSTRINE) *(continued)*	3470.0	SC		MC 16	49-50/4" **(50/4")**	10/10			
85												
90							MC 17	50/4" **(50/4")**	4/4			
95												
100	Hollow Stem Auger	98.0	(CH), FAT CLAY, trace fine sand, dark brown, stratified; hard, moist, (LACUSTRINE)	3452.0	CH		MC 18	14-21-24 **(45)**	18/18	45	Sample 18: %Fines= 95; %Sand= 5; PI=45; LL=70; %MC= 26.1	
105												
110		110.0	(SP-SC), POORLY GRADED SAND WITH CLAY, fine sand, poorly graded, some low plasticity fines, light gray; very dense, moist, (LACUSTRINE)	3440.0	SP-SC		MC 19	37-50/3" **(50/3")**	9/9			
115												
120		120.0	Log continued on next page	3430.0								

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-23
3 of 4

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\GRASSY MOUNTAIN BORING LOGS 3-29-2011.GPJ

RECORD OF BOREHOLE BH19-TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 20, 2019 13:30
DRILLING END: March 21, 2019 11:15
COORDINATES: N: 15,866,963.8 E: 1,544,303.6

SHEET: 4 of 4
GS ELEV.: 3550.0
TOC ELEV.: 3541.1
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
120		120.0		3430.0								
			(CH), FAT CLAY, light gray; hard, moist		CH		MC 20	17-37-50/4" **(87/10")**	16 / 16	100	Sample 20: %Fines= 100; %Sand= 0; PI=40; LL=64; %MC= 25.1	
		121.3	(LACUSTRINE)	3428.7								
			Bottom of borehole at 121.4 ft. Backfilled with bentonite chips.									
125												
130												
135												
140												
145												
150												
155												
160												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-23
4 of 4

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\GRASSY MOUNTAIN\BORING LOGS 3-29-2011.GPJ

RECORD OF BOREHOLE BH19-TP-39

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 21, 2019 13:00
DRILLING END: March 21, 2019 15:15
COORDINATES: N: 15,867,102.0 E: 1,545,040.8

SHEET: 1 of 2
GS ELEV.: 3531.0
TOC ELEV.: 3565.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	(SM), SILTY SAND, fine sand, non plastic fines, some coarse subrounded to subangular gravel, pink-gray, some cobbles; loose to medium dense, dry, , gravel and sand content decreasing with depth, (LACUSTRINE)	3531.0	SM							
							SS 1	8-5-10 **(15)**	11/18	15		
		8.5	(ML), SANDY SILT, low plasticity fines, trace gravel, trace fine sand, yellow-brown, hard,moist, (LACUSTRINE)	3522.5	ML							
							MC 2	20-29-45 **(74)**	15/18	74	Sample 2: %Fines= 54; % Sand= 44; PI=10; LL=36; %MC= 16.0	
		15.5	(SC), CLAYEY SAND, fine to medium sand, medium plasticity fines, light gray and white, very dense, dry to moist, some yellow mottle, coarser with depth, (LACUSTRINE)	3515.5	SC		MC 3	39-48-50 **(98)**	17/18	98	Sample 3: %Fines= 37; % Sand= 63; PI=31; LL=80; %MC= 14.5	
		21.5	fine to coarse sand, rounded to subrounded, medium plasticity fines, yellow	3509.5			MC 4	29-39-40 **(79)**	16/18	79		
			(CH), FAT CLAY, high plasticity fines, trace sand, olive-gray and dark red, cohesive, hard, some orange mottle , becomes gray pink, (LACUSTRINE)		CH		MC 5	17-29-13 **(42)**	18/18	42	Sample 5: %Fines= 88; %Sand= 12; PI=85; LL=120; %MC= 39.3	
		26.5	(CL), LEAN CLAY, low plasticity fines, fine sand, gray with dark red, some orange mottle, (LACUSTRINE)	3504.5	CL							
		29.0	(SC), CLAYEY SAND, fine to medium sand, low plasticity fines, gray, very dense, moist, (LACUSTRINE)	3502.0	SC		MC 6	50/3" **(50/3")**	0/3	100		
		35.0	(CH), FAT CLAY, high plasticity fines, trace fine sand, gray to gray-olive, hard, moist, (LACUSTRINE)	3496.0	CH		MC 7	10-11-15 **(26)**	17/18	26	Sample 7: %Fines= 98; % Sand= 2; PI=78; LL=109; % MC= 38.8	
		40.0	Log continued on next page	3491.0								

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\GRASSYMOUNTAINBORINGLOGS 3-29-2011.GPJ

RECORD OF BOREHOLE BH19-TP-39

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 21, 2019 13:00
DRILLING END: March 21, 2019 15:15
COORDINATES: N: 15,867,102.0 E: 1,545,040.8

SHEET: 2 of 2
GS ELEV.: 3531.0
TOC ELEV.: 3565.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40		40.0		3491.0								
	Hollow Stem Auger		(SC), CLAYEY SAND, fine sand, poorly graded, low plasticity fines, light gray with orange, very dense, dry to moist, (LACUSTRINE)		SC		MC 8	39-50/4" **(50/4")**	10/10	100		
45							MC 9	50/4" **(50/4")**	0/4	100		
50		50.3		3480.7			MC 10	50/4" **(50/4")**	0/4	100		
			Bottom of borehole at 50.4 ft. Backfilled with bentonite chips.									
55												
60												
65												
70												
75												
80												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-39
2 of 2

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241, GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\GRASSYMOUNTAINBORINGLOGS 3-29-2011.GPJ

RECORD OF BOREHOLE BH19-TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 08:00
DRILLING END: March 22, 2019 14:00
COORDINATES: N: 15,866,761.8 E: 1,544,672.9

SHEET: 1 of 4
GS ELEV.: 3608.0
TOC ELEV.: 3554.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	(ML), SANDY SILT, non plastic fines, fine to coarse subrounded to subangular gravel, fine sand, light yellow-brown; loose to medium dense, (LACUSTRINE)	3608.0	ML							
5		5.0	(SP), POORLY GRADED SAND, fine sand, poorly graded, trace non plastic fines, white and brown-gray; medium dense, dry, (LACUSTRINE)	3603.0	SP		SS 1	9-11-12 **(23)**	12/18	23		
		9.0		3599.0								
10		10.0	(SC), CLAYEY SAND, fine sand, medium plasticity fines, yellow-brown; medium dense, dry to moist, (LACUSTRINE)	3598.0	SC							
			(CH), SANDY FAT CLAY, high plasticity fines, some fine sand, red-brown, stiff, moist, becomes yellow brown, (LACUSTRINE)		CH		SH 2		24/24		Sample 2: %Fines= 56; %Sand= 44; PI=60; LL=82; %MC= 27.3	
							SS 3	5-6-7 **(13)**	16/18	13		
15							MC 4	40-50/3" **(50/3")**	9/9	100		
20		20.0		3588.0								
			(CH), FAT CLAY, high plasticity fines, little fine sand, yellow-brown, very stiff to hard, moist, white clay fleck scattered throughout, (LACUSTRINE)		CH		SH 5		24/24			
							SS 6	9-8-10 **(18)**	17/18	18	Sample 6: %Fines= 81; % Sand= 19; PI=90; LL=111; %MC= 35.5	
25							MC 7	8-12-14 **(26)**	17/18	26	Sample 7: %Fines= 95; %Sand= 5; PI=62; LL=92; %MC= 36.7	
			decreasing sand content with depth									
30							SH 8		24/24		Sample 9: %Fines= 97; %Sand= 3; PI=70; LL=98; %MC= 40.3	
							SS 9	8-9-11 **(20)**	18/18	20		
35							MC 10	11-16-21 **(37)**	18/18	37	Sample 10: %Fines= 97; %Sand= 3; PI=74; LL=103; %MC= 39.8	
		38.0		3570.0								
40			(SC), CLAYEY SAND, fine sand, high plasticity fines, yellow-brown, very dense, moist, (LACUSTRINE)		SC							

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

BH19-TP-44
1 of 4

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
C:\USERS\MSTEINGRAEBER\GOLDER ASSOCIATES\1663241 GRASSY MOUNTAIN - 1663241 GRASSY MOUNTAIN TSF\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM\BORING LOGS\GRASSYMOUNTAINBORINGLOGS 3-29-2011.GPJ

RECORD OF BOREHOLE BH19-TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 08:00
DRILLING END: March 22, 2019 14:00
COORDINATES: N: 15,866,761.8 E: 1,544,672.9

SHEET: 2 of 4
GS ELEV.: 3608.0
TOC ELEV.: 3554.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(SC), CLAYEY SAND, fine sand, high plasticity fines, yellow-brown, very dense, moist, (LACUSTRINE) *(continued)*	3568.0	SC		MC 11	16-24-29 **(53)**	18/18	53	Sample 11: %Fines= 36; %Sand= 64; PI=58; LL=84; %MC= 28.3	
45			fine to coarse sand, trace fine gravel				MC 12	29-47-50 **(97)**	15/18	97	Sample 12: %Fines= 28; %Sand= 72; PI=33; LL=55; %MC= 17.8	
50			fine sand, and medium plasticity fines				MC 13	15-32-40 **(72)**	18/18	72	Sample 13: %Fines= 26; %Sand= 74; PI=52; LL=79; %MC= 22.5	
55			decreasing sand content with depth									
60			becomes light gray with orange staining				MC 14	20-37-43 **(80)**	18/18	80	Sample 14: %Fines= 35; %Sand= 60; PI=66; LL=85; %MC= 21.0	
65												
70		70.0	(CH), FAT CLAY WITH SAND, high plasticity fines, fine to coarse sand, brown-gray mottled orange-red; hard, moist, (LACUSTRINE)	3538.0	CH		MC 15	17-27-50/5" **(77/11")**	17/17	100	Sample 15: %Fines= 84; %Sand= 15; PI=62; LL=86; %MC= 30.7	
75			gray-brown, white clay fleck scattered throughout									
80		80.0	Log continued on next page	3528.0								

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
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RECORD OF BOREHOLE BH19-TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 08:00
DRILLING END: March 22, 2019 14:00
COORDINATES: N: 15,866,761.8 E: 1,544,672.9

SHEET: 3 of 4
GS ELEV.: 3608.0
TOC ELEV.: 3554.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
80	Hollow Stem Auger	80.0	(CL), LEAN CLAY, high plasticity fines, few fine sand, becomes dark gray with white clay scattered throughout, moist, (LACUSTRINE)	3528.0	CL		MC 16	17-29-33 **(62)**	18/18	62	Sample 16: %Fines= 93; %Sand= 7; PI=40; LL=61; %MC= 24.9	
85												
90		90.0	(CH), FAT CLAY, high plasticity, trace fine sand, becomes black brown and stratified with white clay flecks throughout, moist, (LACUSTRINE)	3518.0	CH		MC 17	37-38-50 **(88)**	18/18	88	Sample 17: %Fines= 99; %Sand= 1; PI=48; LL=72; %MC= 26.3	
95												
100		100.0	(CL), LEAN CLAY, low to medium plasticity fines, trace fine sand, very light gray, hard, moist, (LACUSTRINE)	3508.0	CL		MC 18	41-50/3" **(50/3")**	6/9	100		
105												
110							MC 19	35-42-50 **(92)**	18/18	92	Sample 19: %Fines= 98; %Sand= 2; PI=16; LL=41; %MC= 17.9	
115												
120												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
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RECORD OF BOREHOLE BH19-TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: March 22, 2019 08:00
DRILLING END: March 22, 2019 14:00
COORDINATES: N: 15,866,761.8 E: 1,544,672.9

SHEET: 4 of 4
GS ELEV.: 3608.0
TOC ELEV.: 3554.4
DATUM: NAD83 Zone 11

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
120		120.0		3488.0									
		120.4		3487.6			MC 20	50/5" **(50/5")**	0 5		100		
			Bottom of borehole at 120.5 ft. Backfilled with bentonite chips.										
125													
130													
135													
140													
145													
150													
155													
160													

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: Matt Barton
REVIEWED: Chris MacMahon

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 10/11/19 15:16
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ATTACHMENT B

Test Pit Logs

Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-01

DATE: 12-2-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,322.3 **Easting:** 1,542,563.2

Datum: NAD83 Zone 11

Elevation ft: 3614.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3614.0						
	0.5	TOPSOIL	3613.5						
		(SC) CLAYEY SAND, fine to coarse sand, some low plasticity fines, trace fine to coarse subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); medium dense, moist		SC		GB S1	medium dense	moist	PP=1.75 @ 2 ft.
		(CL) SANDY LEAN CLAY, some fine to medium sand, trace fine subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); stiff, moist		CL			stiff	moist	
		(CH) FAT CLAY WITH GRAVEL, little fine to coarse rounded to subrounded gravel, few fine to coarse sand, gray brown; (ALLUVIUM/COLLUVIUM); stiff, moist		CH		GB S2	stiff	moist	
5	5.0	(GP) POORLY GRADED GRAVEL, fine to coarse rounded to subrounded gravel, few fine to coarse sand, trace low plasticity fines, brown; (ALLUVIUM/ COLLUVIUM); medium dense, moist	3609.0	GP			medium dense	moist	
		(CH), FAT CLAY, trace fine sand, olive with light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH		GB S3	hard	moist	PP=4.25 @ ~8 ft.
	9.5		3604.5						
10		Practical refusal at 9.5 ft on hard lacustrine deposits. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:22
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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-02

DATE: 12-2-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,912.3 **Easting:** 1,542,394.9

Datum: NAD83 Zone 11

Elevation ft: 3615.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3615.0						
	0.5	TOPSOIL	3614.5						PP=1.25 @ 0.5 ft.
	2.0	(CH), FAT CLAY, few fine sand, trace gravel, light brown; (ALLUVIUM/COLLUVIUM); stiff, moist	3613.0	CH			stiff	moist	
	3.5	(SM), SILTY SAND WITH GRAVEL, fine to coarse sand, some fine to coarse subrounded to subangular gravel, some nonplastic fines, tan;(ALLUVIUM/COLLUVIUM); dense, moist	3611.5	SM		GB S1	dense	moist	
5	5.0	(SP-SC), POORLY GRADED SAND WITH CLAY AND GRAVEL, fine to coarse sand, little fine to coarse subrounded to subangular gravel, little low plasticity fines, brown to light brown, iron oxide staining; (ALLUVIUM/COLLUVIUM); dense, moist	3610.0	SP-SC		GB S2	dense	moist	
		(CL), SANDY LEAN CLAY, some fine to coarse sand, tan; (LACUSTRINE); stiff, moist		CL			stiff	moist	PP=1.75 @ ~ 8 ft.
10	10.0		3605.0						
	14.0	(CH), FAT CLAY, trace fine sand, very light brown; (LACUSTRINE); hard, moist	3601.0	CH		GB S3	hard	moist	PP >4.5 @ ~ 12 ft.
15	15.5	(CL), SANDY LEAN CLAY, some fine to coarse sand, very dark to very dark brown, laminated; (LACUSTRINE); stiff, moist	3599.5	CL		GB S4	stiff	moist	PP=1.25 @ ~ 14 ft.
		Bottom of test pit at 15.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:22
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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-03

DATE: 12-5-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,839.8 **Easting:** 1,543,301.9

Datum: NAD83 Zone 11

Elevation ft: 3614.9 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Johnson

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3614.9						
	0.5	TOPSOIL	3614.4						
		(CH), SANDY FAT CLAY, some fine to coarse sand, little fine to coarse subangular to angular gravel, brown; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated		CH			hard	moist	PP=4.25 @ 1 ft.
	2.0		3612.9						
		(SC), CLAYEY SAND, fine to medium sand, some low plasticity fines, light brown to tan; (ALLUVIUM/COLLUVIUM); medium dense to dense, moist		SC		GB S1	medium dense to dense	moist	
5									
	8.0		3606.9						
		(SP-SC), POORLY GRADED SAND WITH CLAY, fine to medium sand, little low plasticity fines, tan, iron oxide staining; (ALLUVIUM/COLLUVIUM); dense, moist, moderately indurated		SP-SC		GB S2	dense	moist	
10									
	11.0		3603.9						
		(CH), FAT CLAY, trace fine sand, olive to gray, homogeneous; (LACUSTRINE); hard, moist		CH		GB S3	hard	moist	PP >4.5 @ ~13 ft.
15	15.0		3599.9						
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:22
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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-04

DATE: 12-5-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,053.4 **Easting:** 1,543,846.7

Datum: NAD83 Zone 11

Elevation ft: 3615.1 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Johnson

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3615.1						
	0.5	TOPSOIL	3614.6						
		(GP-GC), POORLY GRADED GRAVEL WITH SAND AND CLAY, fine to coarse subrounded to subangular gravel, little fine to coarse sand, little low plasticity fines, light brown; subrounded to subangular cobbles and boulders up to 12 inches in diameter; (ALLUVIUM/COLLUVIUM); dense, moist		GP-GC		GB S2	dense	moist	
5	7.0		3608.1						
		(SP), POORLY GRADED SAND, fine to medium sand, trace low plasticity fines, red to light brown; (ALLUVIUM/COLLUVIUM); dense, moist, moderately indurated				GB S1			
10				SP			dense	moist	
15	15.0		3600.1						
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:23
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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-05

DATE: 12-5-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,805.2 **Easting:** 1,544,478.4

Datum: NAD83 Zone 11

Elevation ft: 3613.2 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Johnson

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3613.2						
	0.5	TOPSOIL	3612.7						
		(CL), SANDY LEAN CLAY WITH GRAVEL, some fine to coarse sand, little fine to coarse subangular to angular gravel, brown; (ALLUVIUM/COLLUVIUM); very stiff, moist		CL			very stiff	moist	PP=3.5 @ 1 ft.
	3.0		3610.2						
5		(SC), CLAYEY SAND WITH GRAVEL, fine to coarse sand, some high plasticity fines, little fine to coarse subrounded to subangular gravel, few cobbles and boulders up to 18 inches in diameter, brown to olive-brown, heterogeneous; (ALLUVIUM/COLLUVIUM); medium dense, moist		SC		GB S1	medium dense	moist	
10		11.0-11.5 ft: Clay lens 11.5: Decrease in cobbles and boulders content				GB S2			
15	15.0		3598.2			GB S3			
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:23
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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-06

DATE: 12-2-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,452.0 **Easting:** 1,542,478.9

Datum: NAD83 Zone 11

Elevation ft: 3613.5 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3613.5						
	0.5	TOPSOIL	3613.0						
	1.5	(CL), LEAN CLAY, few fine to coarse sand, trace fine to coarse subrounded to subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); hard, moist	3612.0	CL			hard	moist	PP=4.25 @ 1 ft.
	4.5	(CL), SANDY LEAN CLAY, some fine to coarse sand, few fine to coarse subrounded to subangular gravel, brown-red to tan, iron oxide staining; (ALLUVIUM/COLLUVIUM); very stiff, moist	3609.0	CL		GB S1	very stiff	moist	PP=3.5 @ 3 ft.
5		(SP-SC), POORLY GRADED SAND WITH CLAY, fine to medium sand, few to little low plasticity fines, light brown-orange to pale tan; (ALLUVIUM/COLLUVIUM); dense, moist, increasing fines content with depth		SP-SC		GB S2	dense	moist	
10									
	14.0		3599.5			GB S3			
15		Bottom of test pit at 14.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:23
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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-07

DATE: 12-5-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,427.7 **Easting:** 1,543,085.7

Datum: NAD83 Zone 11

Elevation ft: 3581.6 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3581.6						
	0.5	TOPSOIL	3581.1						
		(CH), FAT CLAY, trace fine to coarse sand, trace fine to coarse subrounded to subangular gravel, brown, homogeneous; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated		CH			hard	moist	PP=3.5 @ 1 ft.
	2.0		3579.6						
		(GP), POORLY GRADED GRAVEL WITH SAND, fine to coarse subrounded to subangular gravel, cobbles, and boulders up to 18 inches in diameter, little fine to coarse sand, tan to pale tan; (ALLUVIUM/COLLUVIUM); dense, moist, calcite		GP			dense	moist	
	4.5		3577.1						
5		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous; (LACUSTRINE); hard, moist, lime stringers and nodules		CH			hard	moist	PP >4.5 @ ~ 8 ft.
10									
	14.5		3567.1						
15		Bottom of test pit at 14.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-08

DATE: 12-4-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,870.8 **Easting:** 1,544,601.4

Datum: NAD83 Zone 11

Elevation ft: 3567.3 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3567.3						
	0.5	TOPSOIL	3566.8						PP >4.5 @ 1 ft.
	2.0	(CL), LEAN CLAY, few fine to coarse sand, trace fine to coarse subrounded to subangular gravel, gray to brown; (ALLUVIUM/COLLUVIUM); hard, moist	3565.3	CL			hard	moist	
	4.0	(CH), FAT CLAY, few fine to coarse sand, light brown; (ALLUVIUM/COLLUVIUM); stiff, moist	3563.3	CH			stiff	moist	
5	8.0	(SM), SILTY SAND, fine to medium sand, some low plasticity fines, light tan; (ALLUVIUM/COLLUVIUM); dense, moist	3559.3	SM			dense	moist	
10	11.5	(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules, mottled spots, calcite in top 2 ft, LACUSTRINE	3555.8	CH		GB S1	hard	moist	PP >4.5 @ 9 ft.
15		Practical refusal at 11.5 ft. on hard lacustrine deposits. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-09

DATE: 12-7-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,440.7 **Easting:** 1,543,675.0

Datum: NAD83 Zone 11

Elevation ft: 3581.8 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3581.8						
	0.5	TOPSOIL	3581.3						
		(CH), FAT CLAY, few fine to coarse sand, light brown; (ALLUVIUM/COLLUVIUM); stiff to very stiff, moist		CH			stiff to very stiff	moist	PP=1.75 @ 1 ft.
	2.0		3579.8						
		(CH), FAT CLAY, few to little fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH		GB BULK	hard	moist	
5									
10									PP=4.0 @ ~12 ft.
15	15.0		3566.8						
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-10

DATE: 12-5-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,452.5 **Easting:** 1,544,575.5

Datum: NAD83 Zone 11

Elevation ft: 3610.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3610.0						
	0.5	TOPSOIL	3609.5						
	2.0	(CL), SANDY LEAN CLAY WITH GRAVEL, little fine to coarse sand, little fine to coarse subrounded to subangular gravel and cobbles up to 4 inches in diameter, brown; (ALLUVIUM/COLLUVIUM); hard, moist, Desiccated	3608.0	CL			hard	moist	PP=4.0 @ 1 ft.
	4.5	(CH), FAT CLAY, few fine to coarse sand, few to little fine to coarse subrounded to subangular gravel and subrounded cobbles up to 4 inches in diameter, very light brown to light tan; (ALLUVIUM/ COLLUVIUM); stiff, moist,	3605.5	CH			stiff	moist	
5		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules							PP >4.5 @ ~6 ft.
10				CH			hard	moist	
		13.0 ft: Increasing sand and gravel content							
15	15.0		3595.0						
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-11

DATE: 12-1-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,934.8 **Easting:** 1,543,212.8

Datum: NAD83 Zone 11

Elevation ft: 3591.7 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3591.7						
	0.5	TOPSOIL	3591.2						
		(CL), LEAN CLAY, trace to few fine to coarse sand, brown to light brown; (ALLUVIUM/COLLUVIUM); very stiff, moist		CL		GB S1	very stiff	moist	PP=3.25 @ 3 ft.
5									
	9.0		3582.7						
		(SC), CLAYEY SAND, fine to medium sand, some low plasticity fines, light tan, iron oxide staining; (ALLUVIUM/COLLUVIUM); dense, moist, indurated near bottom of layer		SC		GB S3	dense	moist	
10	12.0		3579.7						
		(CH), FAT CLAY WITH SAND, little fine to coarse sand, light brown to gray; (LACUSTRINE); hard, moist		CH		GB S2	hard	moist	
	14.5		3577.2						
15		Bottom of test pit at 14.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-12

DATE: 12-5-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,934.8 **Easting:** 1,543,212.8

Datum: NAD83 Zone 11

Elevation ft: 3586.1 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] [2] OR DENSITY	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3586.1						
	0.5	TOPSOIL	3585.6						
		(CH), FAT CLAY, few fine to coarse sand, trace fine to coarse subrounded to subangular gravel, brown, homogeneous; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated		CH			hard	moist	PP=4.25 @ 1 ft.
	2.0		3584.1						
		(SM), SILTY SAND WITH GRAVEL, fine to coarse sand, some low plasticity fines, little fine to coarse subrounded to subangular gravel, tan to light tan, heterogeneous; (ALLUVIUM/COLLUVIUM); stiff, moist, gravel lenses		SM			stiff	moist	
5	5.0		3581.1						
		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH		GB BULK	hard	moist	
10	12.0		3574.1						
		(CL), SANDY LEAN CLAY, some fine to medium sand, tan, homogeneous; (LACUSTRINE); stiff, moist		CL			stiff	moist	
	13.0		3573.1						
15		Bottom of test pit at 13.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-13

DATE: 12-4-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,770.3 **Easting:** 1,545,200.7

Datum: NAD83 Zone 11

Elevation ft: 3610.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3610.0						
	0.5	TOPSOIL	3609.5						
		(CL), LEAN CLAY, few fine to coarse sand, few fine to coarse subrounded to subangular gravel, brown, homogeneous; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated		CL			hard	moist	PP=4.0 @ 1 ft.
	2.0		3608.0						
		(GM), SILTY GRAVEL WITH SAND, fine to coarse, subrounded to subangular gravel, some fine to coarse sand, little to some low plasticity fines, light brown; (ALLUVIUM/COLLUVIUM); dense, moist		GM			dense	moist	
	4.0		3606.0						
5		(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, tan-orange, iron oxide staining; (WEATHERED ARKOSIC SANDSTONE); dense, moist		SM			dense	moist	
	9.0		3601.0						
10		Practical refusal at 9.0 ft. on Arkosic Sandstone. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-14

DATE: 12-1-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,182.7 **Easting:** 1,543,453.3

Datum: NAD83 Zone 11

Elevation ft: 3583.8 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] [2] OR DENSITY	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	OTHER TESTS & NOTES
0	0.0		3583.8						
	0.5	TOPSOIL	3583.3						
	1.0	(CH), FAT CLAY, trace fine to coarse sand, trace fine to coarse subrounded gravel, brown; (ALLUVIUM/COLLUVIUM); hard, moist	3582.8	CH		GB S1	hard	moist	
		(CL), LEAN CLAY, trace fine to coarse sand, trace fine to coarse subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); very stiff, moist		CL		GB S2	very stiff	moist	PP=2.75 @ 2 ft.
	3.5		3580.3						
5		(CH), FAT CLAY, trace fine sand, brown; (LACUSTRINE); stiff, moist		CH			stiff	moist	PP=1.75@ ~6 ft.
	8.0		3575.8						
10		(CH), FAT CLAY, high plasticity, trace fine sand, olive to light brown, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules, heavily indurated		CH		GB S3	hard	moist	PP >4.25 @ ~11 ft.
	12.0		3571.8						
	13.0	(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, tan, iron oxide staining; (WEATHERED ARKOSIC SANDSTONE); very dense, moist	3570.8	SM			very dense	moist	
15		Practical refusal at 13.0 ft. on Arkosic Sandstone. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-15

DATE: 12-4-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,253.4 **Easting:** 1,544,078.8

Datum: NAD83 Zone 11

Elevation ft: 3564.9 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3564.9						
	0.5	TOPSOIL	3564.4						
	2.0	(CL), LEAN CLAY, few fine to coarse sand, trace fine to coarse subrounded to subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated	3562.9	CL			hard	moist	PP=4.0 @ 1 ft.
5	5.0	(GP), POORLY GRADED GRAVEL, fine to coarse subrounded to subangular gravel, few fine to coarse sand, trace low plasticity fines, light brown to tan; (ALLUVIUM/COLLUVIUM); dense, moist	3559.9	GP			dense	moist	
10		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH			hard	moist	PP=4.25 @ ~12 ft.
15	15.0	Bottom of test pit at 14.0 ft. Backfilled with excavated material and tamped with bucket.	3549.9						

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-16

DATE: 12-1-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,365.1 **Easting:** 1,543,303.2

Datum: NAD83 Zone 11

Elevation ft: 3616.1 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3616.1						
	0.5	TOPSOIL	3615.6						
		(CL), LEAN CLAY, few fine sand, trace fine subrounded to subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); stiff, moist		CL		GB S1	stiff	moist	PP=1.25 @ 1.5 ft.
5	5.0		3611.1						
		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules, heavily indurated		CH			hard	moist	PP=4.25 @ 8ft.
10	11.0		3605.1						
		(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, tan, iron oxide staining; (WEATHERED ARKOSIC SANDSTONE); very dense, moist		SM			very dense	moist	
	14.0		3602.1						
15		Bottom of test pit at 14.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-17

DATE: 12-4-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,253.4 **Easting:** 1,544,658.7

Datum: NAD83 Zone 11

Elevation ft: 3561.7 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3561.7						
	0.5	TOPSOIL	3561.2						
		(CL), LEAN CLAY, few fine to coarse sand, light brown; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated		CL			hard	moist	PP=4.0 @ 1.5 ft.
	2.0		3559.7						
5		(CH), FAT CLAY, little fine sand, tan to brown; (LACUSTRINE); hard, moist		CH		GB BULK	hard	moist	PP=4.25 @ 5 ft.
10	14.0		3547.7						
15		Bottom of test pit at 14.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-18

DATE: 12-4-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,144.4 **Easting:** 1,545,316.4

Datum: NAD83 Zone 11

Elevation ft: 3615.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3615.0						
	0.5	TOPSOIL	3614.5						
	1.5	(CL), LEAN CLAY, few fine to coarse sand, few fine to coarse subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated	3613.5	CL			hard	moist	PP=4.0 @ 1 ft.
	3.0	(CH), FAT CLAY, few fine to coarse sand, brown; (ALLUVIUM/COLLUVIUM); very stiff, moist, desiccated	3612.0	CH			very stiff	moist	
5		(CH), FAT CLAY, trace fine sand, olive to light red-brown, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH			hard	moist	PP=4.0 @ ~8 ft.
10		10.0 - 12.0 ft: Layer of Elastic Silt, possibly diatoms.				GB S1			
15	15.0		3600.0						
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-19

DATE: 11-30-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,536.3 **Easting:** 1,544,410.1

Datum: NAD83 Zone 11

Elevation ft: 3549.8 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3549.8						
	0.5	TOPSOIL	3549.3						
	1.0	(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, few fine to coarse subrounded to subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); dense, moist	3548.8	SM			dense	moist	
		(GC), CLAYEY GRAVEL WITH SAND, fine to coarse, subrounded gravel, little to some high plasticity fines, little fine to coarse sand, dark brown; (ALLUVIUM/COLLUVIUM); dense, moist, few cobbles up to 4 inches in diameter 3.0-4.0 ft: Approximately 10% cobbles		GC			dense	moist	
	4.0		3545.8						
5		(CH), FAT CLAY, trace fine sand, olive to light brown, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules, mottled black 5.0-9.0 ft: Increase in sand content		CH			hard	moist	
10		9.0-14.0 ft: Heavily indurated							PP=4.25 @ ~12 ft.
	14.0		3535.8						
15		Bottom of test pit at 14.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-20

DATE: 12-7-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,483.7 **Easting:** 1,543,671.4

Datum: NAD83 Zone 11

Elevation ft: 3605.1 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3605.1						
	0.5	TOPSOIL	3604.6						
	1.5	(GM), SILTY GRAVEL WITH SAND, fine to coarse, rounded to subrounded gravel, some medium plasticity fines, little fine to coarse sand, brown-red, iron oxide staining; (ALLUVIUM/COLLUVIUM); dense, moist	3603.6	GM		GB S1	dense	moist	
5	5.0	(GP-GM), POORLY GRADED GRAVEL WITH SILT AND SAND, fine to coarse subrounded to rounded gravel, little fine to coarse sand, litte low plasticity fines, gray, stratified, iron oxide staining; (ALLUVIUM/COLLUVIUM); dense to very dense, moist	3600.1	GP-GM			dense to very dense	moist	
10		Practical refusal at 5.0 ft. on Arkosic Sandstone Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-21

DATE: 12-2-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,022.8 **Easting:** 1,542,914.4

Datum: NAD83 Zone 11

Elevation ft: 3614.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3614.0						
	0.5	TOPSOIL	3613.5						
		(CL), SANDY LEAN CLAY, some fine to medium sand, trace to few fine subrounded to subangular gravel, brown-pink to tan; (ALLUVIUM/COLLUVIUM); very stiff, moist		CL		GB S1	very stiff	moist	PP=3.75 @ 2 ft.
5	5.0		3609.0						
		(CH), FAT CLAY, trace fine sand, olive to light brown, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist		CH			hard	moist	
	7.0		3607.0						
		(CH), SANDY FAT CLAY, some fine to coarse medium sand, gray-pink to tan, iron oxide staining; (LACUSTRINE); very dense, moist, heavily indurated near bottom of soil layer		CH			very dense	moist	
10	11.0		3603.0						
		(CH), FAT CLAY, trace fine sand, light gray; (LACUSTRINE); hard, moist		CH			hard	moist	PP=4.25 @ 12 ft.
	13.5		3600.5						
15		Bottom of test pit at 13.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-22

DATE: 12-1-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,721.6 **Easting:** 1,543,826.3

Datum: NAD83 Zone 11

Elevation ft: 3602.9 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3602.9						
	0.5	TOPSOIL	3602.4						
	1.5	(CL), SANDY LEAN CLAY, some fine to coarse sand, brown-red; (ALLUVIUM/COLLUVIUM); hard, moist	3601.4	CL			hard	moist	
5		(CH), FAT CLAY, trace medium to coarse sand, light brown to pink, iron oxide staining; (LACUSTRINE); medium stiff, moist		CH		GB S1	medium stiff	moist	PP=0.75 @ 4 ft.
10	10.5		3592.4						
	11.5	(CH), FAT CLAY, trace fine sand, light gray to white, l(LACUSTRINE); hard, moist	3591.4	CH		GB S2	hard	moist	
15		Bottom of test pit at 11.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-23

DATE: 11-30-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,882.6 **Easting:** 1,544,244.3

Datum: NAD83 Zone 11

Elevation ft: 3546.6 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	OTHER TESTS & NOTES
0	0.0		3546.6						
	0.3	TOPSOIL	3546.4						
		(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, few fine to coarse subrounded to subangular gravel, light green-brown; (ALLUVIUM/COLLUVIUM); medium dense, moist		SM		GB S1 GB S2	medium dense	moist	
	4.5		3542.1						
5		(GP), POORLY GRADED GRAVEL, fine to coarse, subrounded to subangular gravel, few fine to coarse sand, trace low plasticity fines, light brown; (ALLUVIUM/COLLUVIUM); very dense, moist		GP			very dense	moist	
10	10.0		3536.6						
		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH		GB S3	hard	moist	
15	15.0		3531.6						
		Bottom of test pit at 16.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-24

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,863,770.9 **Easting:** 1,544,882.5

Datum: NAD83 Zone 11

Elevation ft: 3840.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3840.0						
	0.5	TOPSOIL	3839.5						
	1.0	(CH), FAT CLAY, few fine to coarse sand, few fine to coarse subrounded to subangular gravel, brown, homogeneous; (ALLUVIUM/COLLUVIUM); hard, moist	3839.0	CH			hard	moist	
		(CH), FAT CLAY, white to red-brown, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, heavily indurated near bottom of excavation				GB S1			
5									
				CH			hard	moist	
10									PP=4.25 @ 11 ft.
	13.0		3827.0						
		Practical refusal at 13.0 ft. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-25

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,863,492.7 **Easting:** 1,545,130.2

Datum: NAD83 Zone 11

Elevation ft: 3942.5 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3942.5						
	0.5	TOPSOIL	3942.0						
	1.5	(CL), LEAN CLAY, few fine to coarse sand, trace fine to coarse subrounded to subangular gravel, light brown, iron oxide staining; (ALLUVIUM/COLLUVIUM); stiff, moist	3941.0	CL			stiff	moist	
	4.0	(CH), FAT CLAY, trace fine sand, gray-red to light olive-green, heterogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules	3938.5	CH			hard	moist	
5		Practical refusal at 4.0 ft. on hard lacustrine deposit. Backfilled with excavated material and tamped with bucket.							
10									
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-26

DATE: 12-7-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,223.0 **Easting:** 1,545,202.9

Datum: NAD83 Zone 11

Elevation ft: 3712.1 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3712.1						
	0.5	TOPSOIL	3711.6						
		(CL), LEAN CLAY, few fine to coarse sand, trace to few fine to coarse subrounded to subangular gravel, brown, homogeneous; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated		CL			hard	moist	
	2.0		3710.1						
		(GP-GC), POORLY GRADED GRAVEL WITH SAND AND CLAY, fine to coarse subrounded to subangular gravel, little fine to coarse sand, little low plasticity fines, few cobbles and boulders up to 12 inches in diameter, light brown; (ALLUVIUM/COLLUVIUM); dense, moist,		GP-GC			dense	moist	
	4.0		3708.1						
5		(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, few fine to coarse subrounded to subangular gravel and cobbles up to 9 inches in diameter, light brown; (ALLUVIUM/COLLUVIUM); medium dense, moist, few cobbles up to 6 inches in diameter		SM		GB S1	medium dense	moist	
	9.0		3703.1						
10		Practical refusal at 9.0 ft. on Arkosic Sandstone. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-27

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,972.9 **Easting:** 1,545,209.2

Datum: NAD83 Zone 11

Elevation ft: 3731.4 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3731.4						
	0.5	TOPSOIL	3730.9						
	1.5	(CL), LEAN CLAY, few fine to coarse sand, trace to few fine to coarse subrounded to subangular gravel and cobbles up to 6 inches in diameter, brown; (ALLUVIUM/COLLUVIUM); hard, moist	3729.9	CL			hard	moist	
	3.5	(CH), FAT CLAY, few fine to coarse sand, trace fine to coarse angular gravel, light brown to green-gray; (ALLUVIUM/COLLUVIUM); stiff, moist	3727.9	CH			stiff	moist	
5		Practical refusal on Arkosic Sandstone at 3.5 ft. Backfilled with excavated material and tamped with bucket.							
10									
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-28

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,726.0 **Easting:** 1,545,505.1

Datum: NAD83 Zone 11

Elevation ft: 3747.9 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3747.9						
	0.5	TOPSOIL	3747.4						
		(CL), LEAN CLAY, few fine to coarse sand, trace to few fine to coarse subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); hard, moist		CL			hard	moist	PP=4.0 @ 1 ft.
	2.0		3745.9						
5		(CH), FAT CLAY, trace fine sand, olive to light brown, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH			hard	moist	
10									PP=4.0 @ 10 ft.
	14.5		3733.4						
15		Bottom of test pit at 14.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-29

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,865,071.5 **Easting:** 1,545,819.2

Datum: NAD83 Zone 11

Elevation ft: 3697.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3697.0						
	0.5	TOPSOIL	3696.5						
		(CL), LEAN CLAY, few fine to coarse sand, trace to few fine to coarse subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); hard, moist		CL			hard	moist	
	2.0		3695.0						
		(CH), SANDY FAT CLAY, some fine to medium sand, trace fine to coarse subrounded to subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); stiff, moist, gravel content increases with depth in soil layer		CH			stiff	moist	PP=1.5 @ 3 ft.
5	5.0		3692.0						
		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules		CH			hard	moist	PP=4.25 @ ~7 ft.
10									
15	15.0		3682.0						
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-30

DATE: 12-2-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,089.7 **Easting:** 1,543,057.8

Datum: NAD83 Zone 11

Elevation ft: 3673.7 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	OTHER TESTS & NOTES
0	0.0		3673.7						
	0.5		3673.2						
		(CL), SANDY LEAN CLAY, some fine to coarse sand, few fine to coarse subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); hard, moist		CL		GB S1	hard	moist	PP=4.25 @ 1 ft.
	2.5		3671.2			GB S2			
		(SP-SM), POORLY GRADED SAND WITH SILT, fine to medium sand, little low plasticity fines, gray-white, heterogeneous; (WEATHERED ARKOSIC SANDSTONE); dense, moist				GB S3			
5				SP-SM			dense	moist	
	9.0		3664.7						
10		Practical refsual at 9.0 ft. on Arkosic Sandstone. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-31

DATE: 12-2-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,863,762.4 **Easting:** 1,543,067.5

Datum: NAD83 Zone 11

Elevation ft: 3679.5 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3679.5						
	0.5	TOPSOIL	3679.0						
	1.0	(CL), SANDY LEAN CLAY WITH GRAVEL, some fine to coarse sand, little fine to coarse subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); firm, moist	3678.5	CL			firm	moist	
	2.5	(CL), SANDY LEAN CLAY, some fine to coarse sand, trace to few fine to coarse subrounded to subangular gravel, very light brown to tan; (ALLUVIUM/COLLUVIUM); hard, moist	3677.0	CL			hard	moist	
5		(CH), FAT CLAY, trace fine sand, olive to tan, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules, variable coloring, heavily indurated at bottom		CH		GB S1	hard	moist	PP >4.5@ ~5 ft.
10	12.5		3667.0			GB S2			
15		Practical refusal at 12.5 ft. on hard lacustrine deposits. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-32

DATE: 12-2-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,863,714.5 **Easting:** 1,542,650.3

Datum: NAD83 Zone 11

Elevation ft: 3636.5 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	OTHER TESTS & NOTES
0	0.0		3636.5						
	0.5	TOPSOIL	3636.0						
		(CL), SANDY LEAN CLAY WITH GRAVEL, some fine to coarse sand, few fine to coarse subrounded to subangular gravel, little fine to coarse subrounded to subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); firm, moist		CL		GB S1 GB S2	firm	moist	
	3.0		3633.5						
5		(GP), POORLY GRADED GRAVEL WITH SAND, fine to coarse, subrounded to subangular gravel and cobbles up to 12 inches in diameter, little fine to coarse sand, trace low plasticity fines, tan-gray; (ALLUVIUM/COLLUVIUM); dense, moist		GP		GB S3	dense	moist	
	6.0		3630.5						
		(CH), FAT CLAY, trace fine sand, olive to tan, iron oxide staining; (LACUSTRINE); hard, moist, lime stringers and nodules, heavily indurated at bottom		CH			hard	moist	
10	11.5		3625.0						
		Practical refusal at 11.5 ft. on hard lacustrine deposits. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-33

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,863,702.5 **Easting:** 1,547,227.2

Datum: NAD83 Zone 11

Elevation ft: 3788.9 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3788.9						
	0.5	TOPSOIL	3788.4						
		(GM), SILTY GRAVEL, fine to coarse subrounded to subangular gravel,, cobbles, and boulders up to 12 inches in diameter, few elastic fines, few fine to coarse sand, brown; (ALLUVIUM/COLLUVIUM); dense, moist		GM			dense	moist	
	2.5		3786.4						
		(CL), LEAN CLAY WITH SAND, few fine to coarse sand, trace to few fine to coarse subrounded to subangular gravel, brown; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated		CL			hard	moist	
	4.0		3784.9						
5		(GM), SILTY GRAVEL, fine to coarse subrounded to subangular gravel, few low plastic fines, few fine to coarse sand, little cobbles and boulders up to 30 inches in diameter, brown; (ALLUVIUM/COLLUVIUM); very dense, moist, lime nodules, heavily indurated		GM		GB S1	very dense		
10		Practical refsual at 7.5 ft. on cobbles and boulders. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-34

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,863,968.9 **Easting:** 1,547,457.6

Datum: NAD83 Zone 11

Elevation ft: 3825.7 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3825.7						
	0.5	TOPSOIL	3825.2						
		(GM), SILTY GRAVEL, fine to coarse, subrounded to subangular gravel, few elastic plasticity fines, trace to few fine to coarse sand, light brown; (ALLUVIUM/COLLUVIUM); dense, moist		GM		GB S1	dense	moist	
	2.0		3823.7						
		Practical refusal 2.0 ft. on Basalt bedrock. Backfilled with excavated material and tamped with bucket.							
5									
10									
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-35

DATE: 12-4-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,596.2 **Easting:** 1,545,659.3

Datum: NAD83 Zone 11

Elevation ft: 3613.1 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3613.1						
	0.5	TOPSOIL	3612.6						PP=3.25 @ 2 ft.
	1.5	(CH), FAT CLAY, few fine to coarse sand, few fine to coarse subrounded to subangular gravel, cobbles, and boulders up to 12 inches in diameter brown-red; (ALLUVIUM/COLLUVIUM); hard, moist, desiccated	3611.6	CH			hard	moist	
5	7.0	(CH), FAT CLAY, trace fine to coarse sand, trace fine to coarse subrounded to subangular gravel, light brown; (ALLUVIUM/COLLUVIUM); very stiff, moist	3606.1	CH			very stiff	moist	
10	12.0	(SP), POORLY GRADED SAND WITH GRAVEL, fine to coarse sand, little fine to coarse rounded to subrounded gravel, light brown to olive-gray; (ALLUVIUM/COLLUVIUM); medium dense, moist	3601.1	SP		GB S1	medium dense	moist	
	13.0	(CH), FAT CLAY, trace fine to medium sand, olive; (LACUSTRINE); hard, moist	3600.1	CH			hard	moist	
15		Bottom of test pit at 13.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-36

DATE: 12-4-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,034.1 **Easting:** 1,545,739.5

Datum: NAD83 Zone 11

Elevation ft: 3665.8 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3665.8						
	0.5	TOPSOIL	3665.3						
	1.0	(CH), FAT CLAY, few fine to coarse sand, trace fine to coarse subrounded to subangular gravel, brown-red; (ALLUVIUM/COLLUVIUM); hard, moist	3664.8	CH		GB S1	hard	moist	
5		(SC), CLAYEY SAND, fine to medium sand, some low plasticity fines, gray, iron oxide staining; (ALLUVIUM/COLLUVIUM); medium dense, moist, decreasing fines content with depth		SC			medium dense	moist	
10									
15	15.5		3650.3						
		Bottom of test pit at 15.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-37

DATE: 11-30-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,867,628.8 **Easting:** 1,545,135.8

Datum: NAD83 Zone 11

Elevation ft: 3550.7 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	OTHER TESTS & NOTES
0	0.0		3550.7						
	0.5	TOPSOIL	3550.2						
	1.5	(CH), FAT CLAY, trace fine to coarse sand, brown;(ALLUVIUM/ COLLUVIUM); very stiff, moist	3549.2	CH			very stiff	moist	
5		(SM), SILTY SAND WITH GRAVEL, some fine to coarse sand, some fine to coarse subrounded to subangular gravel, little cobbles and boulders up to 12 inches in diameter, little nonplastic fines, very light brown; (ALLUVIUM/ COLLUVIUM); dense, moist,		SM		GB S1	dense	moist	
						GB S2			
10	11.0		3539.7						
		Practical refusal at 11.0 ft. oncobbles and boulders. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-38

DATE: 11-30-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,756.3 **Easting:** 1,544,910.7

Datum: NAD83 Zone 11

Elevation ft: 3555.3 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3555.3						
	0.5	TOPSOIL	3554.8						
		(SC), CLAYEY SAND WITH GRAVEL, some fine to coarse, some fine to coarse subrounded to subangular gravel, cobbles and boulders up to 14 inches in diameter, little low plasticity fines, light brown; dense, moist (ALLUVIUM/COLLUVIUM)		SC			dense	moist	
5	5.0		3550.3						
		(CH), FAT CLAY, trace fine sand, olive to light gray, homogeneous, iron oxide staining; hard, moist, lime stringers and nodules (LACUSTRINE)		CH		GB S1	hard	moist	
10									
		13.5 ft: Increase in sand content and heavily indurated							
	14.5		3540.8						
15		Bottom of test pit at 14.5 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-39

DATE: 11-30-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,867,121.1 **Easting:** 1,545,067.3

Datum: NAD83 Zone 11

Elevation ft: 3565.4 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	OTHER TESTS & NOTES
0	0.0		3565.4						
	0.5	TOPSOIL	3564.9						
	1.0	(CH), FAT CLAY, trace fine to coarse sand, brown; (ALLUVIUM/COLLUVIUM); hard, moist	3564.4	CH			hard	moist	
5		(GM), SILTY GRAVEL, fine to coarse, subrounded to subangular gravel, little low plasticity fines, few fine to coarse sand, very light brown; (ALLUVIUM/COLLUVIUM); very dense, moist		GM			very dense	moist	
	6.0		3559.4						
		(SP-SM), POORLY GRADED SAND WITH SILT, fine to coarse sand, few to little low plasticity fines, light brown; (ALLUVIUM/COLLUVIUM); medium dense, moist		SP-SM			medium dense	moist	
	9.5		3555.9						
10		(GP-GM), POORLY GRADED GRAVEL WITH SILT AND SAND, fine to coarse, subrounded to subangular gravel, little fine to coarse sand, little low plasticity fines, light brown; (ALLUVIUM/COLLUVIUM); dense, moist		GP-GM			dense	moist	
	11.0		3554.4						
		(CH), FAT CLAY, trace fine sand, olive; (LACUSTRINE); hard, moist		CH			hard	moist	
	12.0		3553.4						
15		Bottom of test pit at 12.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-40

DATE: 12-1-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,701.9 **Easting:** 1,542,445.8

Datum: NAD83 Zone 11

Elevation ft: 3510.7 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE: Depth	DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0	TOPSOIL	3510.7						
	1.0	(CL), LEAN CLAY, light brown; (LACUSTRINE); hard, moist	3509.7	CL			hard	moist	
	4.0	Practical refusal at 4.0 ft. on Arkosic Sandstone. Backfilled with excavated material and tamped with bucket.	3506.7						
5									
10									
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-41

DATE: 12-1-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,867,078.2 **Easting:** 1,542,686.7

Datum: NAD83 Zone 11

Elevation ft: 3549.6 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE: Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	OTHER TESTS & NOTES
0	0.0		3549.6						
	0.5	TOPSOIL	3549.1						
		(CH), FAT CLAY WITH GRAVEL, few fine to coarse sand, few fine to coarse subrounded to subangular gravel, cobbles and boulders up to 12 inches in diameter, brown; (ALLUVIUM/COLLUVIUM); hard, moist		CH			hard	moist	
	2.0		3547.6						
		(SC), CLAYEY SAND, fine to coarse sand, some low plasticity fines, trace coarse rounded to subrounded gravel, light brown, stratified; (ALLUVIUM/COLLUVIUM); medium dense, moist				GB S1			
5				SC			medium dense	moist	
	8.0		3541.6						
		(SP-SM), POORLY GRADED SAND WITH SILT, fine to coarse sand, little low plasticity fines, very light brown; (ALLUVIUM/COLLUVIUM); dense, moist							
10				SP-SM		GB S2	dense	moist	
	14.0		3535.6			GB S3			
15		Bottom of test pit at 14.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-43

DATE: 12-6-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,864,001.2 **Easting:** 1,544,016.8

Datum: NAD83 Zone 11

Elevation ft: 3659.9 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3659.9						
	0.5	TOPSOIL	3659.4						
		(CL), SANDY LEAN CLAY WITH GRAVEL, some fine to coarse sand, little fine to coarse subrounded to subangular gravel, dark brown; (ALLUVIUM/COLLUVIUM); stiff, moist		CL			stiff	moist	
	2.5		3657.4						
		(ML), SANDY SILT, some fine to coarse sand, trace fine to coarse subrounded to subangular gravel, light tan to pink-tan; (ALLUVIUM/COLLUVIUM); stiff, moist		ML			stiff	moist	
	4.5		3655.4						
5		(SM), SILTY SAND WITH GRAVEL, fine to coarse sand, some low plasticity fines, trace fine to coarse subrounded to subangular gravel, light tan to pale tan; (ALLUVIUM/COLLUVIUM); dense, moist							
		9 ft: Gravel content decreases		SM			dense	moist	
10									
15	15.0		3644.9			GB S1			
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

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Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-44

DATE: 11-30-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,688.5 **Easting:** 1,544,624.8

Datum: NAD83 Zone 11

Elevation ft: 3550.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3550.0						
	0.5	TOPSOIL	3549.5						
	1.5	(CH), FAT CLAY, trace fine to coarse sand, brown; (ALLUVIUM/COLLUVIUM); hard, moist	3548.5	CH			hard	moist	
	2.0	(CL), LEAN CLAY WITH SAND, medium plasticity, few fine to coarse sand, light brown; (ALLUVIUM/COLLUVIUM); hard, moist	3548.0	CL			hard	moist	
	3.0	(SM), SILTY SAND, fine to coarse, low plasticity fines, trace fine to coarse subrounded to subangular gravel, very light brown; (ALLUVIUM/COLLUVIUM); medium dense, moist	3547.0	SM			medium dense	moist	
5		(SM), SILTY SAND, fine to coarse, low plasticity fines, trace fine to coarse subrounded to subangular gravel, tan-green to pale tan; (ALLUVIUM/COLLUVIUM); dense, moist		SM			dense	moist	
10	13.0		3537.0						
		Bottom of test pit at 13.0 ft. Backfilled with excavated material and tamped with bucket.							
15									

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:29
C:\USERS\CBLOOM\DESKTOP\GRASSYMTNLOGS\TP_LOGS_V2.GPJ

Golder Associates Inc

RECORD OF TEST PIT LOG

TEST PIT NUMBER TP-45

DATE: 11-30-17

PROJECT: MDA/Grassy Mountain

PROJECT No.: 1663241

LOCATION: Malheur County, OR

Northing: 15,866,480.6 **Easting:** 1,544,964.4

Datum: NAD83 Zone 11

Elevation ft: 3565.0 **Length x Width ft:** 20.0 x 4.5

Contractor: (Andy Bentz)

Logged By: C. Bloom

Equipment: RB 500

Water Conditions:
NA

Surface Conditions:
Scrub Brush

DEPTH (ft)	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	CONSISTENCY[1] OR DENSITY[2]	INSITU, LABORATORY TESTING[1] & NOTES: WATER CONTENT (%)	INSITU, LABORATORY TESTING[1] & NOTES: OTHER TESTS & NOTES
0	0.0		3565.0						
	0.5	TOPSOIL	3564.5						
		(ML), SILT, trace fine to coarse sand, trace fine to coarse subrounded to subangular gravel, light brown to tan; (ALLUVIUM/COLLUVIUM); very stiff, moist		ML		GB S1	very stiff	moist	
	4.0		3561.0						
5		(CH), FAT CLAY, trace fine sand, olive to light gray; (LACUSTRINE); hard, moist, lime stringers and nodules		CH			hard	moist	
	6.0		3559.0						
		(CH), SANDY FAT CLAY, some fine sand, very light brown; (LACUSTRINE); hard, moist, lime stringers and nodules		CH			hard	moist	
10									
15	15.0		3550.0						
		Bottom of test pit at 15.0 ft. Backfilled with excavated material and tamped with bucket.							

Notes: [1] See Legend Sheet for Definition of Terms, Symbols and Abbreviations
[2] Consistency or Density values are estimated based on excavation resistance and/or visual/manual assessment of samples

Checked: MLP
Reviewed: RAB

03 - GOLDER - TEST PIT LOG WITH PHOTO - TEST V7 2012_01_22B E-M 1A.GPJ - 5/1/18 11:29
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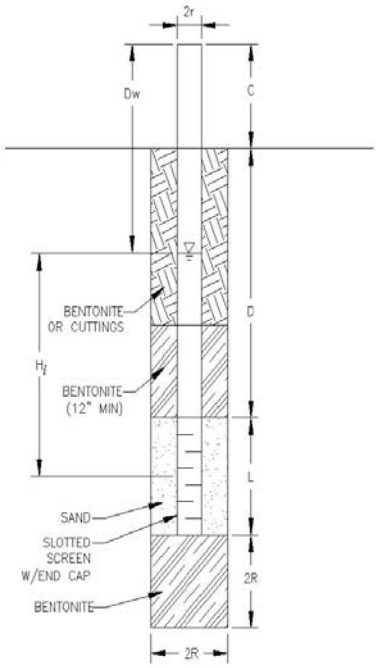
ATTACHMENT C

Field Permeability Testing

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

Borehole: BH-02 - Test 1

Setup Date Date: 12/6/2017
Test Date: 12/8/2017
Tested By: C. Johnson
Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	20.0 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	3.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
1	5.0	0.21	0.00	---	---	---
1	10.0	0.33	0.12	25.2	25.1	9.0E-07
1	15.0	0.50	0.17	25.1	25.0	1.3E-06
1	20.0	0.70	0.20	25.0	24.8	1.5E-06
1	25.0	1.00	0.30	24.8	24.5	2.3E-06
1	30.0	1.20	0.20	24.5	24.3	1.6E-06
					Average:	1.5E-06

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

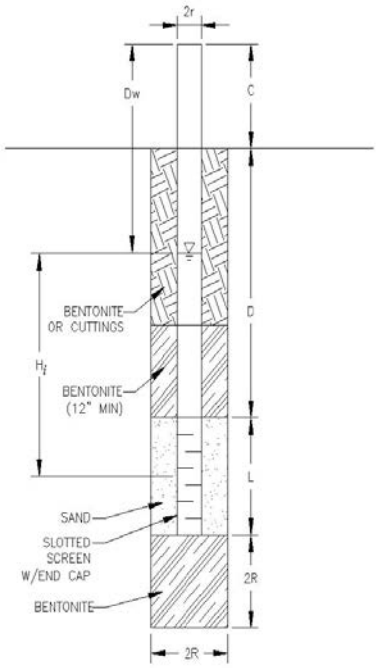
Borehole: BH-02 - Test 2

Setup Date Date: 12/6/2017

Test Date: 12/8/2017

Tested By: C. Johnson

Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	20.0 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	3.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
2	5.0	0.0	0.0	---	---	---
2	19.0	1.5	1.5	25.5	24.0	4.1E-06
2	30.0	1.6	0.1	24.0	23.9	3.6E-07
2	35.0	1.9	0.3	23.9	23.6	2.4E-06
					Average:	2.3E-06

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

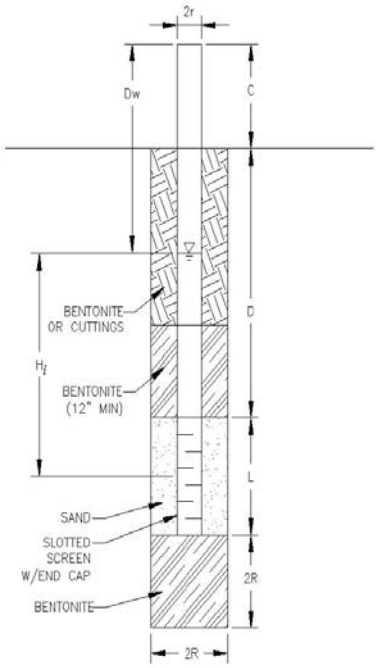
Borehole: BH-02 - Test 3

Setup Date Date: 12/6/2017

Test Date: 12/8/2017

Tested By: C. Johnson

Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	20.0 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	3.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

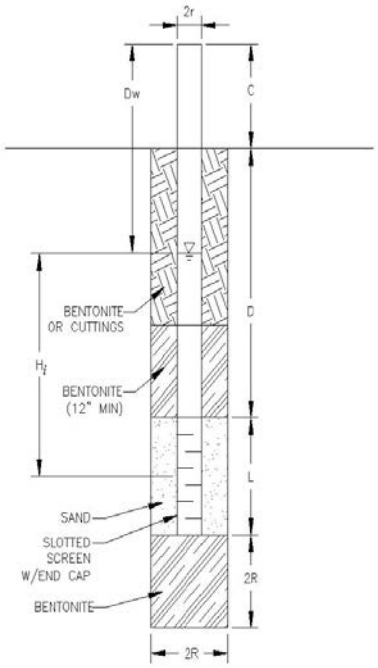
Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
3	0.5	0.3	0.0	---	---	---
3	1.0	0.4	0.1	25.2	25.1	7.5E-06
3	2.0	0.6	0.2	25.1	24.9	7.6E-06
3	4.0	0.9	0.3	24.9	24.6	5.7E-06
3	8.0	1.1	0.2	24.6	24.4	1.9E-06
3	16.0	1.4	0.3	24.4	24.1	1.5E-06
3	30.0	1.8	0.4	24.1	23.7	1.1E-06
					Average:	4.2E-06

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

GOLDER

Borehole: BH-03 - Test 1
Setup Date Date: 12/5/2017
Test Date: 12/6/2017
Tested By: C. Johnson
Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	2.0 ft	
length of Screen, L =	2.0 ft	
length of Collar, C =	1.5 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

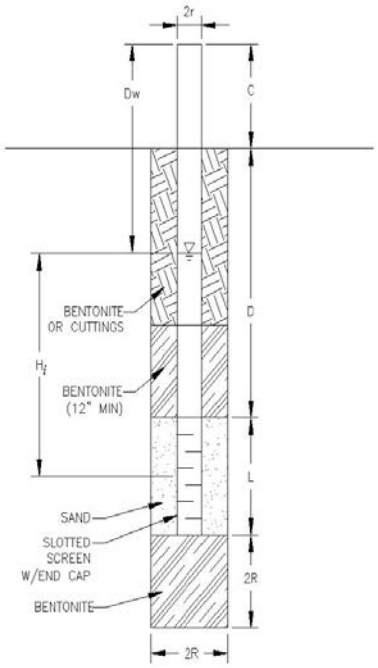
$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
1	5.0	0.2	0.0	---	---	---
1	15.0	0.3	0.1	4.3	4.2	3.7E-06
1	20.0	0.5	0.2	4.2	4.0	1.5E-05
1	25.0	0.6	0.1	4.0	3.9	7.9E-06
1	30.0	0.8	0.2	3.9	3.7	1.6E-05
1	35.0	0.9	0.1	3.7	3.6	8.5E-06
1	40.0	1.1	0.2	3.6	3.4	1.8E-05
1	45.0	1.2	0.1	3.4	3.3	9.3E-06
1	50.0	1.2	0.0	3.3	3.3	0.0E+00
1	60.0	1.2	0.0	3.3	3.3	0.0E+00
1	55.0	1.2	0.0	3.3	3.3	0.0E+00
1	60.0	1.3	0.1	3.3	3.2	9.6E-06
1	65.0	1.4	0.2	3.3	3.1	1.9E-05
					Average:	9.0E-06

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

Borehole: BH-03 - Test 2
Setup Date Date: 12/5/2017
Test Date: 12/6/2017
Tested By: C. Johnson
Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	2.0 ft	
length of Screen, L =	2.0 ft	
length of Collar, C =	1.5 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

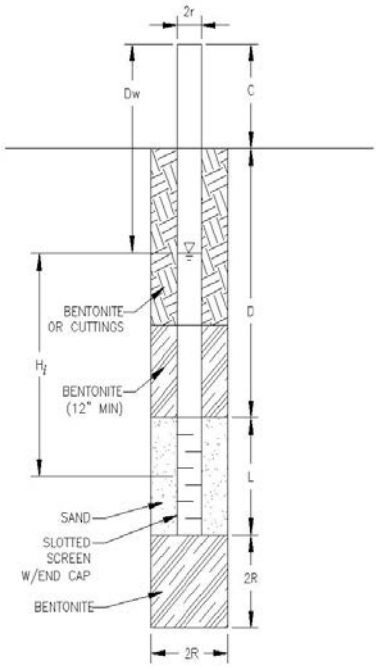
$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
2	1.0	0.1	0.0	---	---	---
2	5.0	0.1	0.0	4.4	4.4	0.0E+00
2	10.0	0.2	0.1	4.4	4.3	7.1E-06
2	15.0	0.2	0.0	4.3	4.3	0.0E+00
2	20.0	0.2	0.0	4.3	4.3	0.0E+00
2	25.0	0.3	0.1	4.3	4.2	7.3E-06
2	30.0	0.3	0.0	4.2	4.2	0.0E+00
2	35.0	0.4	0.1	4.2	4.1	7.5E-06
2	40.0	0.5	0.1	4.1	4.0	7.7E-06
2	45.0	0.6	0.1	4.0	3.9	7.9E-06
2	50.0	0.6	0.0	3.9	3.9	0.0E+00
2	55.0	0.7	0.1	3.9	3.8	8.1E-06
2	60.0	0.8	0.2	3.9	3.7	8.2E-06
					Average:	4.5E-06

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

Borehole: BH-03 - Test 3
Setup Date Date: 12/5/2017
Test Date: 12/6/2017
Tested By: C. Johnson
Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	2.0 ft	
length of Screen, L =	2.0 ft	
length of Collar, C =	1.5 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

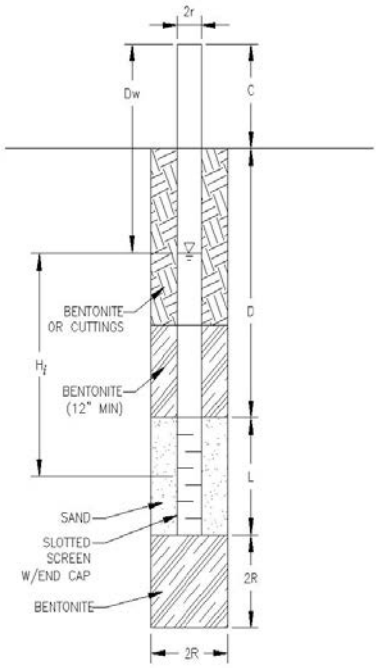
$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
3	0.0	0.3	0.0	---	---	---
3	5.0	0.4	0.1	4.2	4.1	7.5E-06
3	10.0	0.5	0.1	4.1	4.0	7.7E-06
3	15.0	0.6	0.1	4.0	3.9	7.9E-06
3	20.0	0.7	0.1	3.9	3.8	8.1E-06
					Average:	7.8E-06

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

Borehole: BH-05 - Test 1
Setup Date Date: 12/7/2017
Test Date: 12/8/2017
Tested By: C. Johnson
Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	10.0 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	1.8 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
1	5.0	0.0	0.00	---	---	---
1	10.0	0.0	0.01	14.3	14.3	1.4E-07
1	16.0	0.0	0.01	14.3	14.3	1.1E-07
1	21.0	0.1	0.01	14.3	14.2	1.4E-07
1	27.0	0.1	0.01	14.2	14.2	1.2E-07
1	34.0	0.1	0.02	14.2	14.2	2.0E-07
					Average:	1.4E-07

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

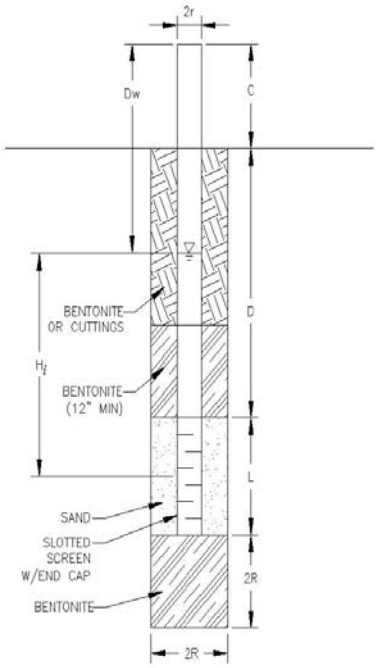
Borehole: BH-05 - Test 2

Setup Date Date: 12/7/2017

Test Date: 12/8/2017

Tested By: C. Johnson

Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	10.0 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	1.8 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
2	5.0	0.0	0.00	---	---	---
2	10.0	0.1	0.08	14.3	14.2	1.1E-06
2	16.0	0.1	0.02	14.2	14.2	2.2E-07
2	22.0	0.1	0.02	14.2	14.2	2.2E-07
2	25.0	0.2	0.02	14.2	14.1	4.4E-07
2	30.0	0.2	0.05	14.1	14.1	6.7E-07
					Average:	5.2E-07

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

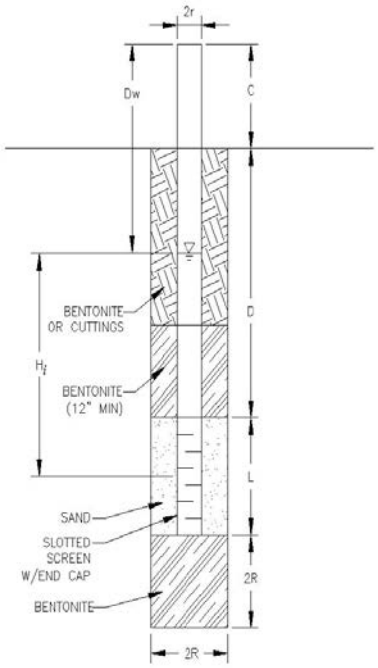
Borehole: BH-05 - Test 3

Setup Date Date: 12/7/2017

Test Date: 12/8/2017

Tested By: C. Johnson

Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	10.0 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	1.8 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

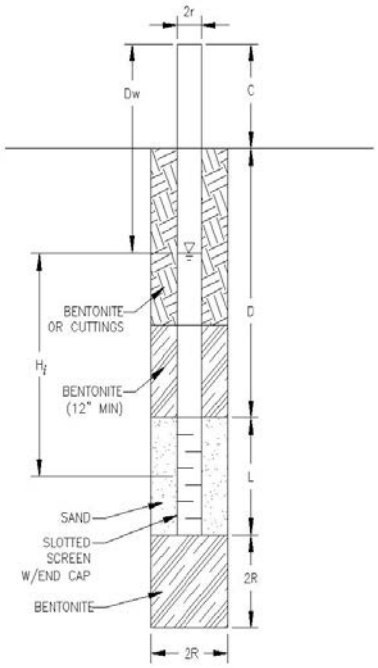
Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
3	5.0	0.0	0.0	---	---	---
3	10.0	0.4	0.4	14.3	13.9	5.1E-06
3	15.0	0.7	0.3	13.9	13.6	4.1E-06
3	20.0	1.0	0.3	13.6	13.3	4.2E-06
3	25.0	1.3	0.3	13.3	13.0	4.3E-06
3	33.0	1.8	0.5	13.0	12.5	4.6E-06
					Average:	4.5E-06

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

Borehole: BH-06 - Test 1

Setup Date Date: 12/7/2017
Test Date: 12/8/2017
Tested By: C. Johnson
Material Tested: Fat Clay



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	22.8 ft	
length of Screen, L =	2.0 ft	
length of Collar, C =	0.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

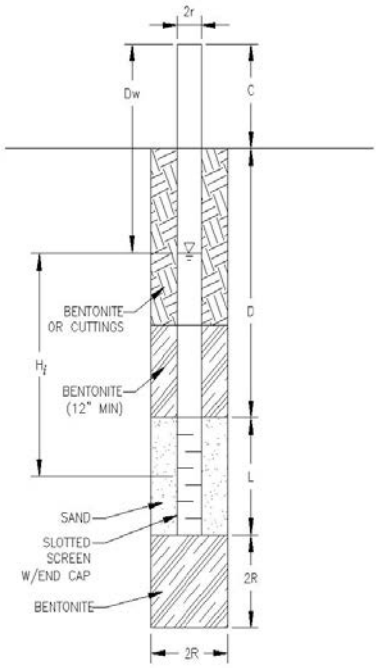
$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
1	5.0	0.1	0.0	---	---	---
1	10.0	0.1	0.0	23.8	23.7	1.3E-07
1	20.0	0.8	0.7	23.7	23.1	4.6E-06
1	26.0	0.8	0.1	23.1	23.0	5.6E-07
1	32.0	0.9	0.1	23.0	22.9	1.1E-06
1	39.0	1.0	0.0	22.9	22.9	4.8E-07
1	45.0	1.1	0.2	22.9	22.7	1.7E-06
1	50.0	1.2	0.0	22.7	22.7	6.8E-07
1	55.0	1.2	0.1	22.7	22.6	6.9E-07
1	60.0	1.3	0.1	22.6	22.6	6.9E-07
					Average:	1.2E-06

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

Borehole: BH-06 - Test 2
Setup Date Date: 12/7/2017
Test Date: 12/8/2017
Tested By: C. Johnson
Material Tested: Fat Clay



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	22.8 ft	
length of Screen, L =	2.0 ft	
length of Collar, C =	3.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

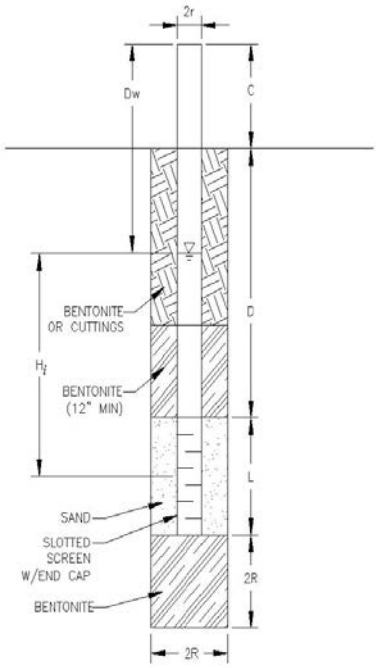
Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
2	5.0	0.02	0.00	---	---	---
2	10.0	0.03	0.01	26.8	26.8	1.2E-07
2	15.0	0.05	0.02	26.8	26.8	2.3E-07
2	20.0	0.08	0.03	26.8	26.7	3.5E-07
2	25.0	0.08	0.00	26.7	26.7	0.0E+00
2	30.0	0.09	0.01	26.7	26.7	1.2E-07
2	35.0	0.09	0.00	26.7	26.7	0.0E+00
2	40.0	0.09	0.00	26.7	26.7	0.0E+00
2	45.0	0.10	0.01	26.7	26.7	1.2E-07
2	50.0	0.11	0.01	26.7	26.7	1.2E-07
2	55.0	0.12	0.01	26.7	26.7	1.2E-07
2	60.0	0.13	0.01	26.7	26.7	1.2E-07
					Average:	1.2E-07

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

Borehole: BH-06 - Test 3
Setup Date Date: 12/7/2017
Test Date: 12/8/2017
Tested By: C. Johnson
Material Tested: Fat Clay

Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	22.8 ft	
length of Screen, L =	2.0 ft	
length of Collar, C =	3.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)



$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
1	5.0	1.00	0.00	---	---	---
1	10.0	1.05	0.05	25.8	25.8	6.0E-07
1	15.0	1.07	0.02	25.8	25.7	2.4E-07
1	20.0	1.09	0.02	25.7	25.7	2.4E-07
1	25.0	1.10	0.01	25.7	25.7	1.2E-07
1	30.0	1.10	0.00	25.7	25.7	0.0E+00
1	35.0	1.12	0.02	25.7	25.7	2.4E-07
1	40.0	1.15	0.03	25.7	25.7	3.6E-07
1	45.0	1.20	0.05	25.7	25.6	6.1E-07
1	50.0	1.22	0.02	25.6	25.6	2.4E-07
1	55.0	1.23	0.01	25.6	25.6	1.2E-07
1	60.0	1.25	0.02	25.6	25.6	2.4E-07
					Average:	2.7E-07

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

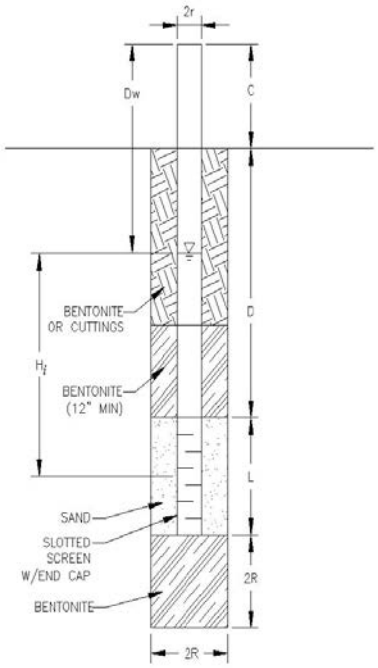
Borehole: BH-07 - Test 1

Setup Date Date: 12/1/2017

Test Date: 12/2/2017

Tested By: C. Johnson

Material Tested: Poorly Graded Sand w/Gravel & Clay



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	14.5 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	1.7 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
1	1.0	0.2	0.0	---	---	---
1	2.0	0.4	0.2	18.5	18.3	1.0E-05
1	3.0	0.5	0.2	18.3	18.1	7.8E-06
1	4.0	0.6	0.1	18.1	18.0	5.2E-06
1	5.0	0.8	0.2	18.0	17.9	7.9E-06
1	12.0	1.6	0.9	17.9	17.0	6.6E-06
1	18.0	2.2	0.6	17.0	16.4	5.7E-06
1	32.0	3.4	1.2	16.4	15.2	5.1E-06
					Average:	6.9E-06

Date:	1/2/2018	Calculated By:	CPJ
Proj. No.:	1663241	Checked By:	MLP
Project :	Grassy Mountain TSF Design		

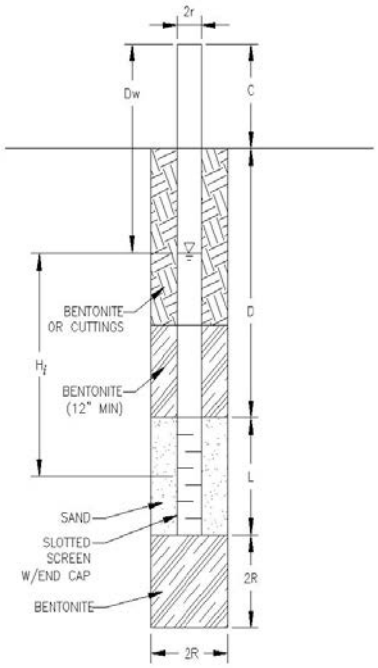
Borehole: BH-07 - Test 2

Setup Date Date: 12/1/2017

Test Date: 12/2/2017

Tested By: C. Johnson

Material Tested: Poorly Graded Sand w/Gravel & Clay



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	14.5 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	1.7 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

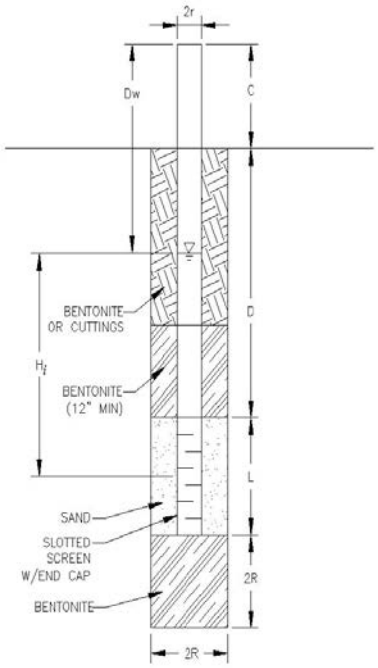
$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
2	5.0	0.6	0.0	---	---	---
2	10.0	1.1	0.5	18.0	17.6	4.8E-06
2	15.0	1.5	0.5	17.6	17.1	4.9E-06
2	20.0	2.0	0.5	17.1	16.7	5.0E-06
2	25.0	2.4	0.4	16.7	16.3	4.6E-06
2	30.0	2.7	0.3	16.3	16.0	3.5E-06
					Average:	4.6E-06

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

Borehole: BH-09 - Test 2
Setup Date Date: 12/7/2017
Test Date: 12/8/2017
Tested By: C. Johnson
Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	3.6 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	2.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

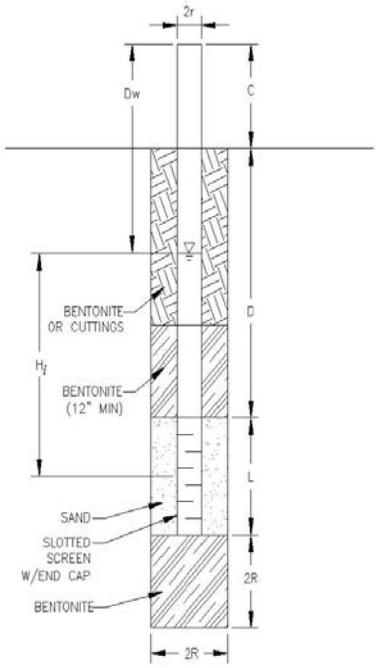
$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = $9.665x10^{-7}$

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
1	1.0	1.6	0.0	---	---	---
1	3.0	3.8	2.1	6.5	4.4	1.9E-04
1	14.0	6.5	2.8	4.4	1.6	7.9E-05
1	20.0	6.7	0.2	1.6	1.4	2.1E-05
1	25.0	6.9	0.1	1.4	1.3	2.1E-05
1	33.0	7.1	0.2	1.3	1.1	2.1E-05
						2.1E-05

Date: 1/2/2018 Calculated By: CPJ
Proj. No.: 1663241 Checked By: MLP
Project : Grassy Mountain TSF Design

Borehole: BH-09 - Test 2
Setup Date Date: 12/7/2017
Test Date: 12/8/2017
Tested By: C. Johnson
Material Tested: Poorly Graded Sand



Well Dimensions

Standpipe Diameter, 2r =	0.17 ft	(2-inch PVC Pipe)
Depth to top of Screen, D =	3.6 ft	
length of Screen, L =	5.0 ft	
length of Collar, C =	2.0 ft	
Diameter of Borehole, 2R =	0.69 ft	(8.25-inches)

$$H_i = D + \frac{L}{2} + C - D_w$$

$$K(cm/s) = \left[\frac{\frac{365r^2}{L} Ln\frac{L}{R}}{t}\right]\left[\frac{\Delta h}{H_1 + H_2}\right]\left(9.665x10^{-7}\right)$$

Note: ft/day to cm/s = 9.665×10^{-7}

Test	Elapsed Time (min)	Depth of Water, D_w (ft)	Incremental Water Level Drop (ft)	Beginning Head (ft)	Ending Head (ft)	Hydraulic Conductivity, K (cm/s)
2	1.0	2.0	0.0	---	---	---
2	5.0	4.0	2.0	6.1	4.1	9.3E-05
2	12.0	5.6	1.6	4.1	2.5	6.5E-05
2	17.0	6.3	0.7	2.5	1.8	6.2E-05
2	25.0	7.1	0.8	1.8	1.0	6.7E-05
2	30.0	7.4	0.3	1.0	0.8	5.4E-05
						5.4E-05

ATTACHMENT D

CPT Logs

536 Galveston Street
West Sacramento, CA 95691-2116
Office **(916) 371-8234**
Fax (916) 371-8283

October 2, 2019

Golder Associates, Inc.
Attention: Chris MacMahon, PE
595 Double Eagle Court, Suite 1000
Reno, Nevada 89521

Subject: CPT – Data Transmittal
Grassy Mountain Project
Malheur County, OR

Greetings:

This letter transmits the Data Results of Electronic Cone Penetrometer testing performed at your request on the Grassy Mountain Project during the period August 15-22, 2019. Results include data plots, seismic profiles and text files.

Testing is performed with equipment and in a manner consistent with the ASTM standard for Electronic Cone Penetrometer (CPT) developed in 1986, ASTM D3441. Equipment used includes a Standard 10-ton, 10sq cm cone tip (which measures tip resistance, cohesive strength [with a friction sleeve] and a pressure transducer [which determines pore water pressure], a rod system for pushing (3.6cm cross-section), a special 10-ton cone with geo-phones for developing seismic data (as required for the test program) and a ten-wheeled truck unit ballasted to 40,000lbs for push resistance with two hydraulic rams mounted inside the truck capable of generating 20-tons of downward push.

Data is collected by advancing the cone at a controlled rate (between 1.5-2.5cm per second) with measurements taken at 2cm increments. Seismic and pore pressure measurements are taken at discrete depths as dictated by the study program. Data is collected and recorded in real time and with Vertek-Hogentogler Electronics and processed and presented with Vertek-Hogentogler Software.

We appreciate this opportunity to be of service.

Very truly yours,
TABER DRILLING

Tim d'Arcy
Exploration Supervisor

Attachments: Data Plots
Text Files
Raw Data Files

Parameter	Description	Symbol / Equation	Reference
Depth	Depth of the centroid of the sensor		
Elevation	Elevation of centroid of the sensor	Ground Surface - Depth	
Sleeve Stress	Sleeve Stress – interpolated to the depth of the tip	f_s	
Tip Stress, Uncorrected	Measured Tip Stress	q_c	
Tip Stress, Corrected	Tip Stress, corrected for probe geometry	$q_t = q_c + u_2 \times (1 - a)$	
Friction Ratio	Friction Ratio	$R_f = \frac{f_s}{q_t} \times 100\%$	
Pore Pressure	Measured Pore Pressure	u_2	
Inclination X	Measured probe inclination in the X axis		
Inclination Y	Measured probe inclination in the Y axis		
Resistivity	Measured Soil Resistivity		

Soil Behavior Type	Soil Behavior Type Options • R_f Robertson 1986 • B_q Roberson 1986 • F_r Robertson 1990 • B_q Robertson 1990	SBT	Lunne, Roberson and Powell, 1997, Figures 5.7 and 5.8
Classification Index		$I_c = \sqrt{(1.95 - \log_{10} Q_t)^2 + (\log_{10} F_r + 1.78)^2}$	Frank Syms, Bechtel Corporation
Overburden		$\sigma_{vo} = \sum_{i=1}^{n} \gamma_i \times h_i$	
Effective Overburden		$\sigma'_{vo} = \sigma_{vo} - u_o$	
Normalized Tip Stress		$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}}$	Lunne, Roberson and Powell, 1997, Equation 5.4
Parameter	**Description**	**Symbol / Equation**	**Reference**
Normalized Friction Ratio		$F_r = \frac{f_s}{q_t - \sigma_{vo}}$	Lunne, Roberson and Powell, 1997, Equation 5.5
Normalized Pore Pressure		$B_q = \frac{\Delta u}{q_t - \sigma_{vo}}$ where $\Delta u = u_2 - u_o$	Lunne, Roberson and Powell, 1997, Equation 5.6
Over Consolidation Ratio		$OCR = 0.33 \times \left(\frac{\Delta u}{\sigma'_{vo}} \right)^{1.42}$	InSitu '86, Mayne Equation 8, pg. 789
Undrained Shear Strength		$S_u = \frac{q_c - \sigma_{vo}}{N_k}$ where $N_k = 15$	Lunne, Roberson and Powell, 1997, Equation 5.16
Friction Angle		$\phi = \arctan\left[0.38 \times \log_{10}\left(\frac{q_c}{\sigma_{vo}} \right) + 0.1 \right] \times \frac{180}{\pi}$	Robertson and Campanella, 1988, pg. 94.

EQUATION USED TO CALCULATE SPT

Reference(s):

Equation:

if (SBT = 1, 5 or 12)	SPTRAT = 2.00
if (SBT = 2, 3 or 11)	SPTRAT = 1.00
if (SBT = 4)	SPTRAT = 1.50
if (SBT = 6)	SPTRAT = 2.50
if (SBT = 7)	SPTRAT = 3.00
if (SBT = 8)	SPTRAT = 4.00
if (SBT = 9)	SPTRAT = 5.00
if (SBT = 10)	SPTRAT = 6.00

$$N_{60} = \frac{q_t}{SPTRAT}$$

$$N_{60}Cor = N_{60} \times \sqrt{\left(\frac{1.0}{\sigma_{ve}}\right)}$$

Where:

SBT	= Soil Behavior Type (Friction Ratio, Robertson 1986)
SPTRAT	= SPT Ratio (used in calculation)
Q_t	= Corrected Tip Stress (tsf)
σ_{ve}	= Overburden (tsf)

HT Series™

10 cm² Digital Cone

Available in 2.5 Ton, 5 Ton, and 10 Ton Cone Configurations

The digital electronic 10 cm² cone is designed to address the accuracy, sensitivity and durability problems inherent in other cone designs of the same or lower capacity. This cone provides excellent data for softer materials and provides excellent resolution in most materials. This cone has a 10 sq. cm tip.

The Cones consists of two strain guage transducers, with the cone electronics packaged directly behind the transducers. In all configurations the cone channels are temperature compensated to provide stable readings during testing. The cone tip, sleeve (local friction element) and pore pressure element (filter) are easily and quickly changed when necessary by the operator.

The cone is available with our standard channels (tip, local friction, pore pressure, inclinometer, seismic, and temperature) and can be used in conjunction with our Vision or Resistivity modules.

Pore Pressure can be measured in either U1 or U2 position (on the face of the tip or just behind the tip) (U2 shown at left)

Cone Channels:
- Tip
- Local Friction
- Pore Pressure
- Temperature
- Inclination
- Seismic
- Resistivity Module (optional)
- Vision Module (optional)

CPTSound Penetration Screen

Calibration data for tip, local friction and pore pressure channels is stored in CPU nonvolatile memory. Digital cones conform to all international standards.

CERTIFIED ISO 9001:2008

HT Series™

10cm² Cone Specifications

Max Tip Force	2.5 Ton	5Ton	10Ton
Resolution	1.1uV	1.1uV	1.1uV
Maximum Sensor input	3.5V	3.5V	3.5V
Power Requirements	12VDC	12VDC	12VDC
Tip			
area	10cm²	10cm²	10cm²
range(kn)	22	45	100
range(lb)	5,000	10,000	22,000
range(mpa)	22	45	100
overload capacity	150%	150%	150%
accuracy	0.2%	0.2%	0.2%
Sleeve			
area	150cm²	150cm²	150cm²
range(kn)	20	20	20
range(lb)	4,400	4,400	4,400
range(mpa)	1.3	1.3	1.3
Pore Pressure Transducer			
standard range (kpa)	6,900	6,900	6,900
standard range (psi)	1,000	1,000	1,000
burst pressure	200%	200%	200%
accuracy	0.5%	0.5%	0.5%
Inclinator (Dual Axis)			
range (degrees)	15	15	15
resolution (degree)	0.1	0.1	0.1
Seismic			
standard tri-axial geophone			
true DC response			
capacity: +/-	2g	2g	2g

Seismic signal is gained downhole
by 1,10,100, or,100 and digitalized in the Datapack
no extra wires ir analog measurement required

CERTIFIED ISO 9001:2008

A Division of ARA

VERTEK

CONE PENETROMETER PRODUCTS

Our products are serviced, calibrated and

MADE IN U. S. A.

HT Series™

15 cm² Digital Cone

Available in 2.5 Ton, 5 Ton and 20 Ton Cone Configurations

The digital electronic 15 cm² cone is designed to address the accuracy, sensitivity and durability problems inherent in other cone designs of the same or lower capacity. This cone has a 15 sq. cm tip.

The Cones consists of two strain gauge transducers, with the cone electronics packaged directly behind the transducers. The cone channels are temperature compensated to provide stable readings during,testing. The cone tip, sleeve (local friction element) and pore pressure element (filter) are easily and quickly changed when necessary by the operator.

The cone is available with our standard channels (tip, local friction, pore pressure, inclinometer, seismic, and temperature) and can be used in conjunction with our Vision or Resistivity modules.

Pore Pressure can be measured in either U1 or U2 position (on the face of the tip or just behind the tip) (U2 shown at left)

Cone Channels:
- Tip
- Local Friction
- Pore Pressure
- Temperature
- Inclination
- Seismic

CPTSound Penetration Screen

Calibration data for tip, local friction and pore pressure channels is stored in CPU nonvolatile memory. Digital cones conform to all international standards.

CERTIFIED ISO 9001:2008

HT Series™

15cm² Cone Specifications

Max Tip Force	2.5 Ton	5 Ton	20 Ton
Resolution	1.1 uV	1.1 uV	1.1 uV
Maximum Sensor Input	3.5 V	3.5 V	3.5 V
Power Requirements	12 VDC	12 VDC	12 VDC
Tip			
area	15 cm^2	15 cm^2	15 cm^2
range (kn)	22	44	225
range (lb)	5,000	10,000	50,000
range (mpa)	15	30	150
overload capacity	150%	150%	150%
accuracy	0.2%	0.2%	0.2%
Sleeve			
area	225 cm^2	225 cm^2	225 cm^2
range (kn)	45	45	45
range (lb)	10,000	10,000	10,000
range (mpa)	2	2	2
overload capacity	150%	150%	150%
accuracy	0.5%	0.5%	0.5%
Pore Pressure Transducer			
standard range (kpa)	6,900	6,900	6,900
standard range (psi)	1,000	1,000	1,000
burst pressure	200%	200%	200%
accuracy	0.5%	0.5%	0.5%
Inclinometer (Dual Axis)			
range (degrees)	15	15	15
resolution (degree)	0.1	0.1	0.1
Seismic			
standard tri-axial geophone	2g	2g	2g
true DC response			
capacity: (+/-) -			

Seismic signals are gained downhole by 1, 10, 100, or 1,000 and digitized in the DataPack

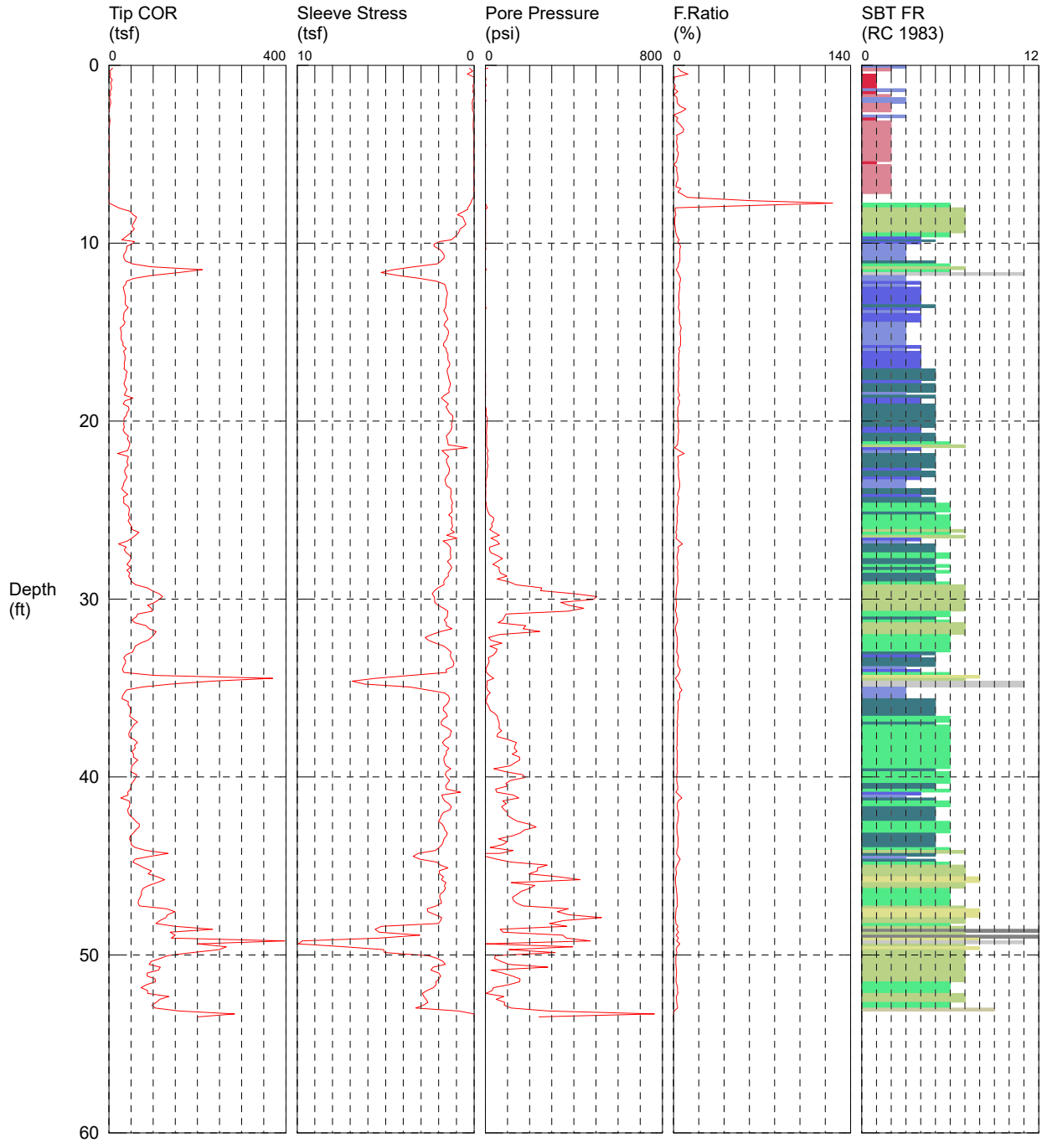
CERTIFIED ISO 9001:2008

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION:

JOB NUMBER:
HOLE NUMBER: CPT-1a
TEST DATE: 8/16/2019 9:04:47 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION:
LOCATION:
LOCATION:



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

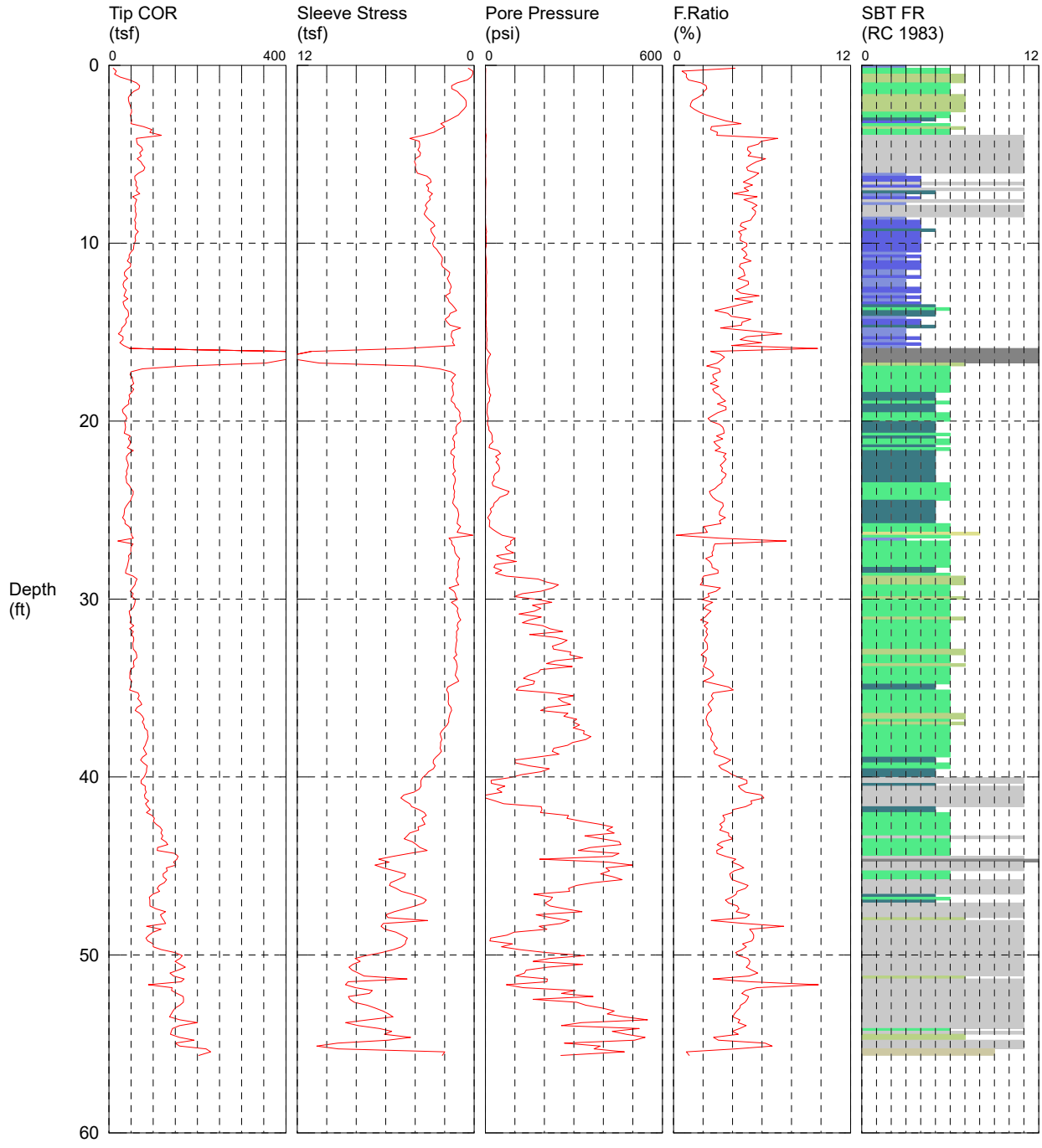
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION:

JOB NUMBER:
HOLE NUMBER: CPT-2a
TEST DATE: 8/16/2019 1:06:07 PM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION:
LOCATION:
LOCATION:



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

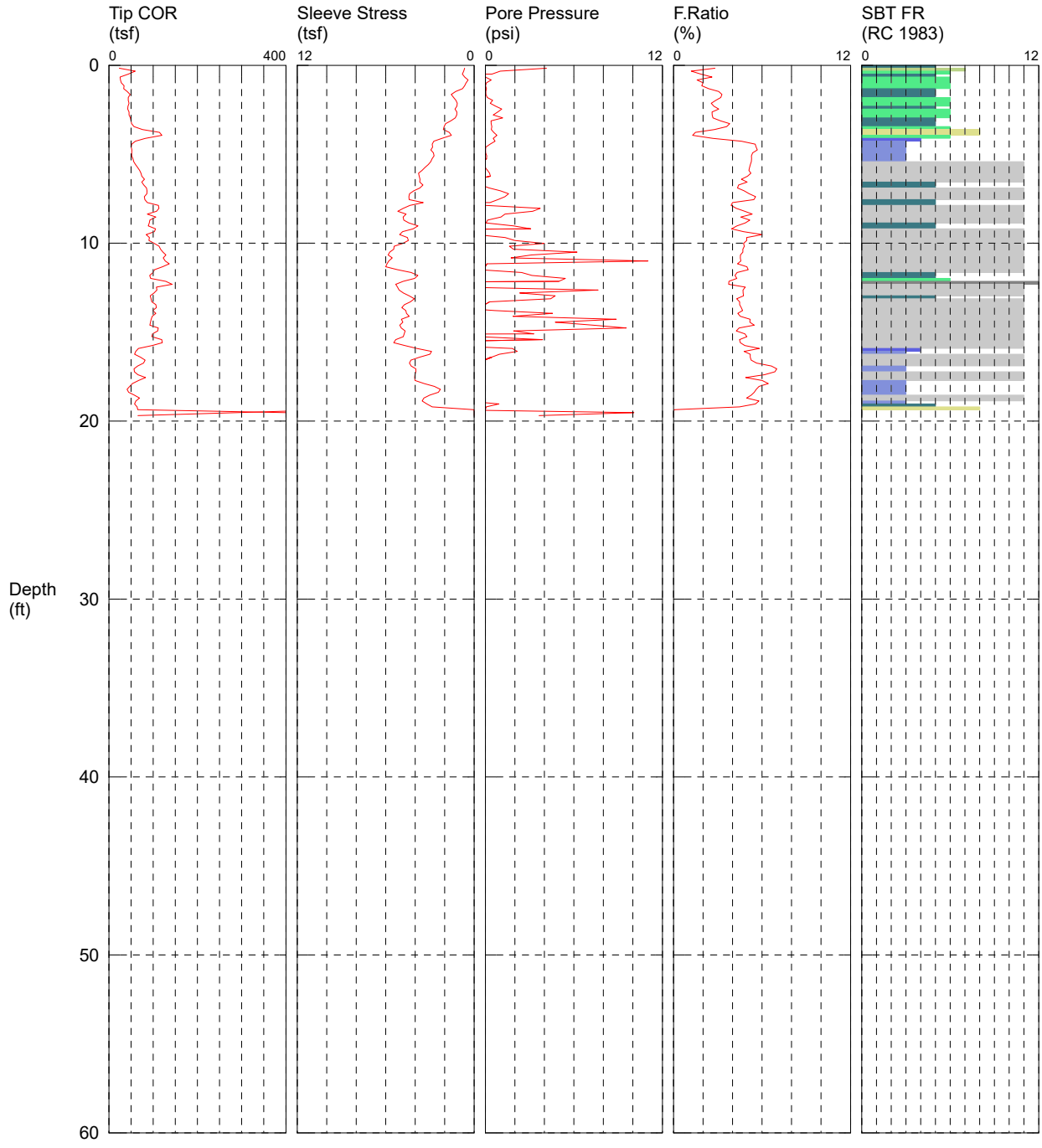
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: TP-45

JOB NUMBER:
HOLE NUMBER: CPT-3b
TEST DATE: 8/17/2019 9:07:47 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: TP-45
LOCATION: TP-45
LOCATION: TP-45



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

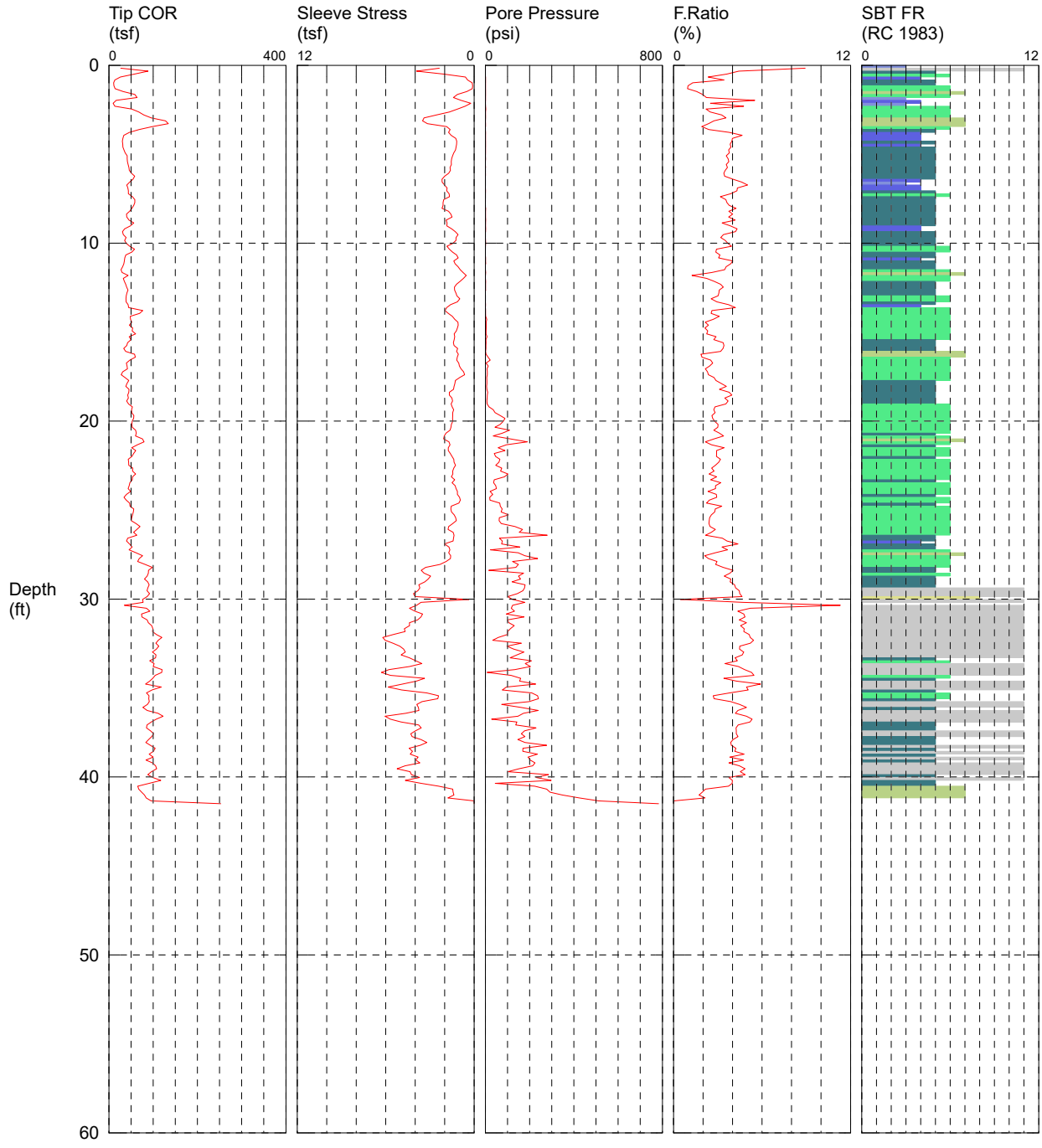
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: TP-19

JOB NUMBER:
HOLE NUMBER: CPT-4
TEST DATE: 8/17/2019 10:16:42 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: TP-19
LOCATION: TP-19
LOCATION: TP-19



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

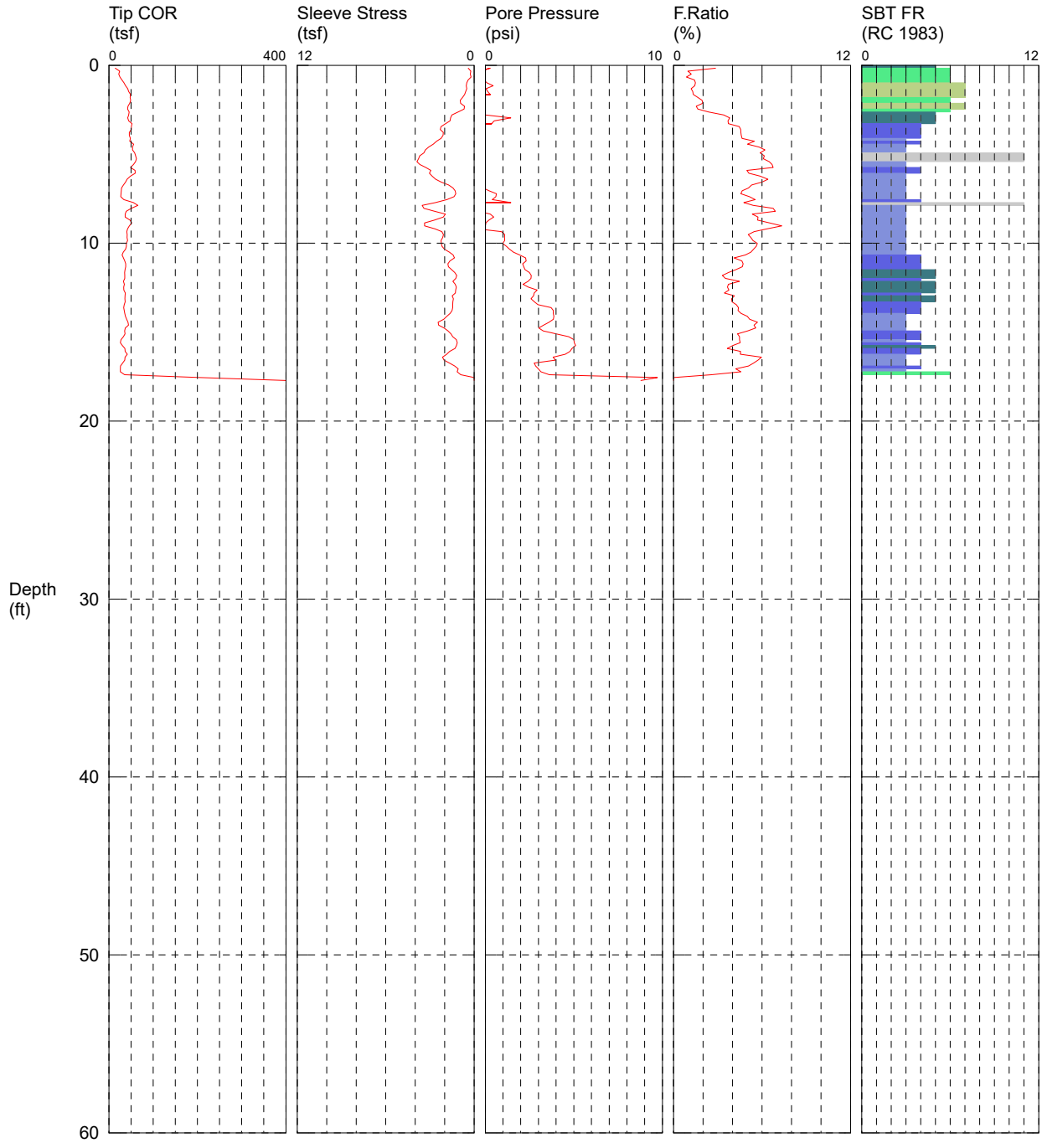
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: BH-15

JOB NUMBER:
HOLE NUMBER: CPT-5
TEST DATE: 8/17/2019 11:58:32 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: BH-15
LOCATION: BH-15
LOCATION: BH-15



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

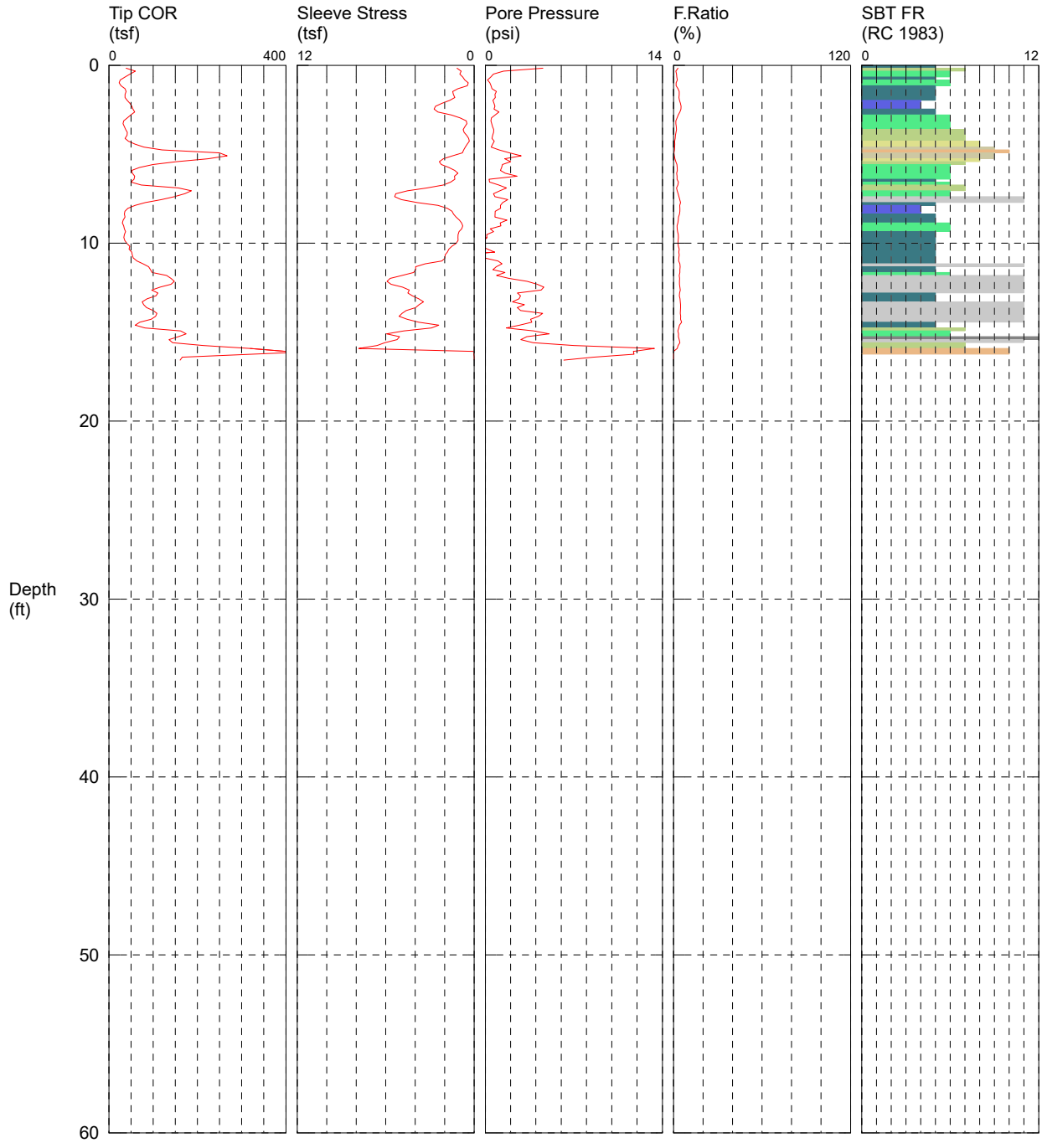
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: BH-4

JOB NUMBER:
HOLE NUMBER: CPT-6
TEST DATE: 8/18/2019 8:17:17 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: BH-4
LOCATION: BH-4
LOCATION: BH-4



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

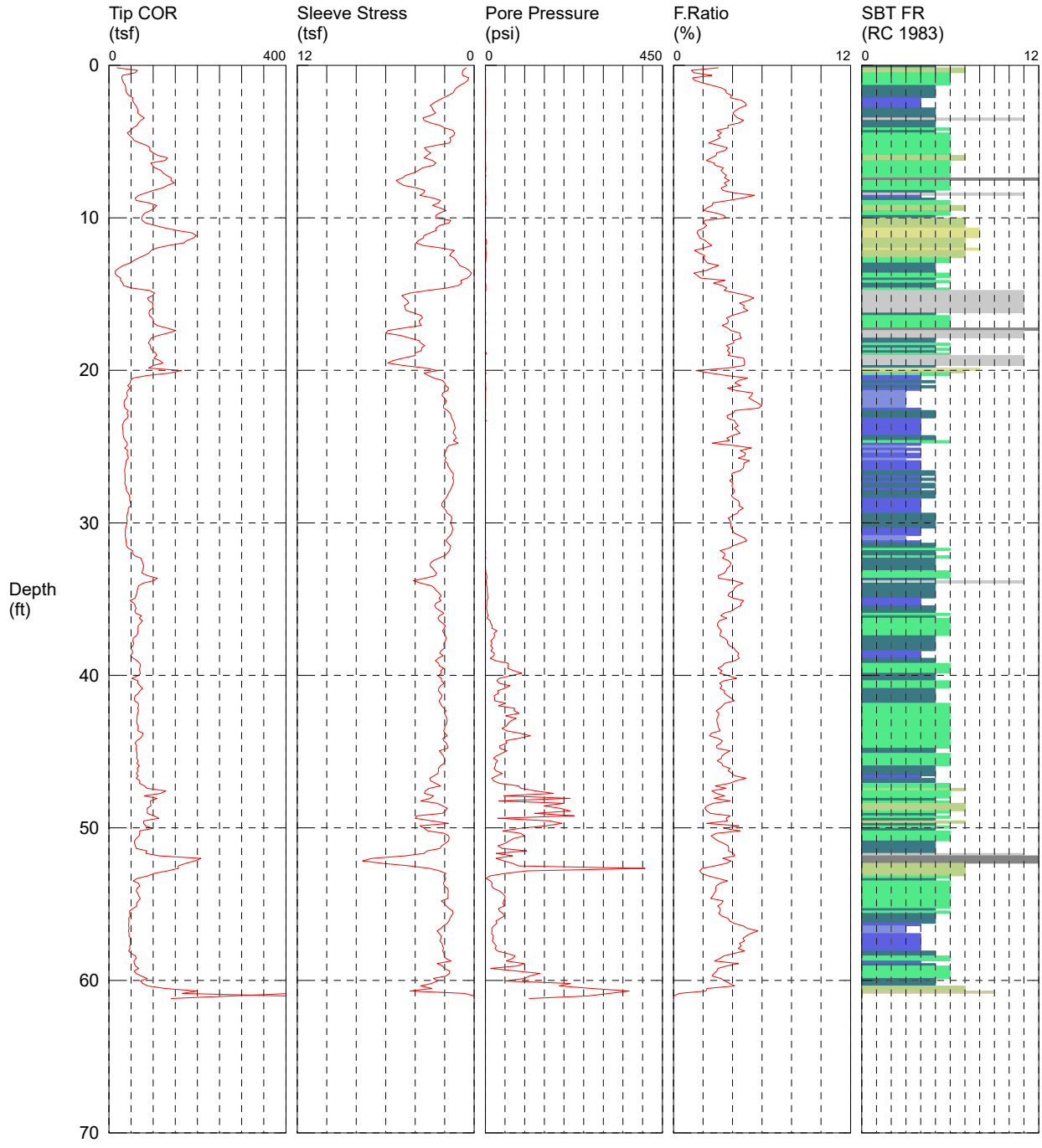
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: TP-14

JOB NUMBER:
HOLE NUMBER: CPT-7b
TEST DATE: 8/18/2019 11:02:13 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: TP-14
LOCATION: TP-14
LOCATION: TP-14



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

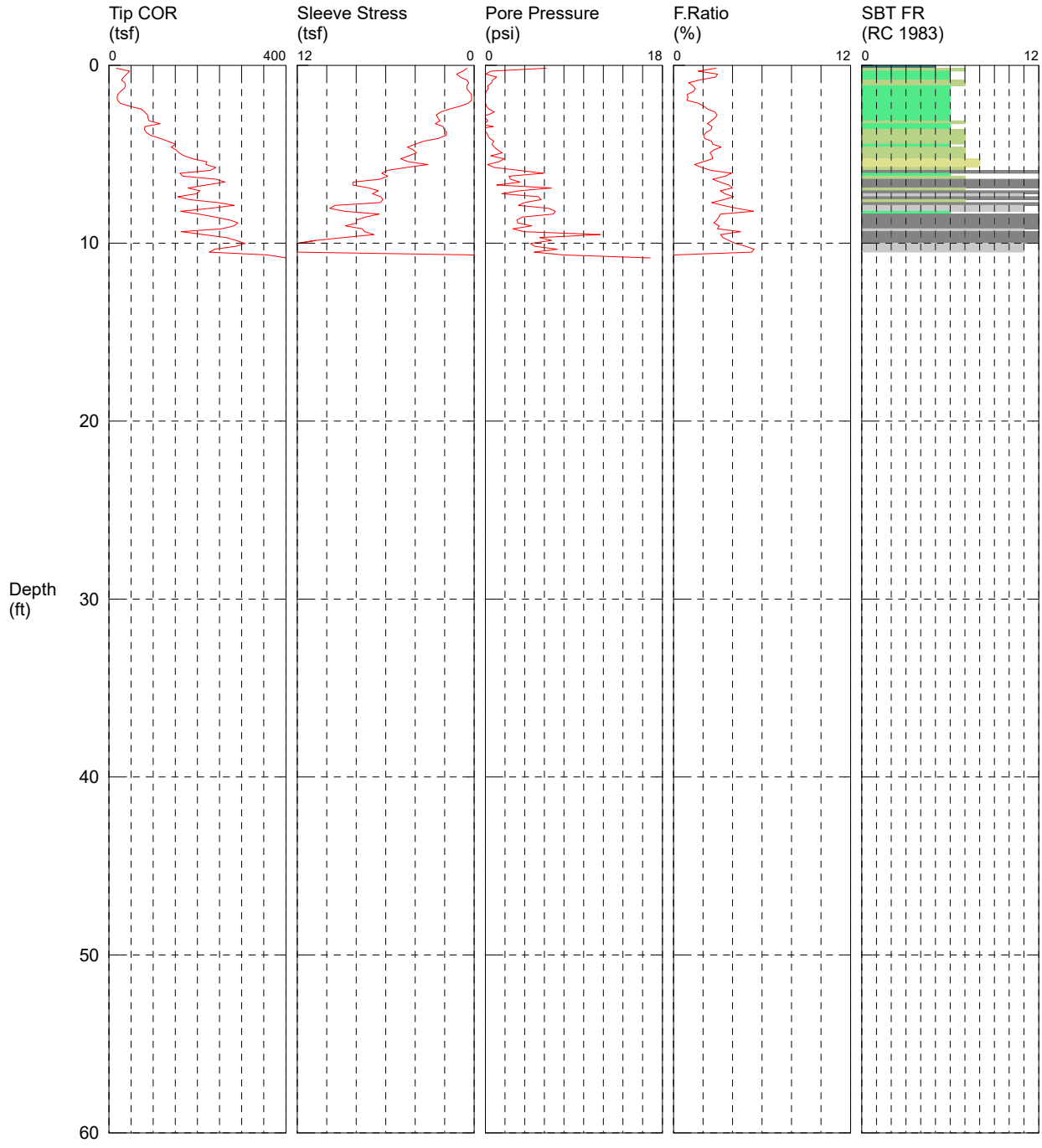
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: BH-9

JOB NUMBER:
HOLE NUMBER: CPT-8c
TEST DATE: 8/19/2019 9:40:12 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: BH-9
LOCATION: BH-9
LOCATION: BH-9



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

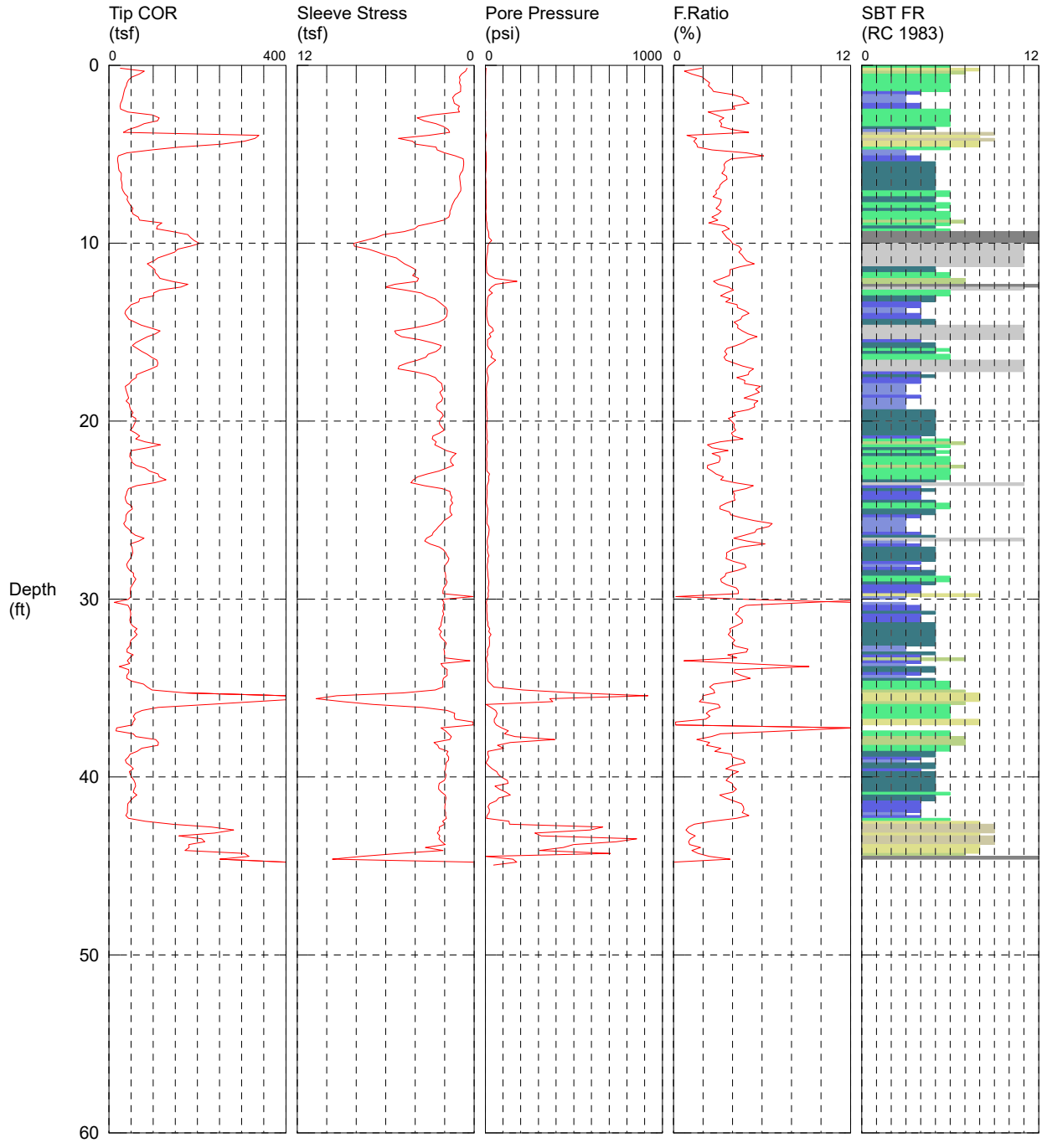
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: BH-3

JOB NUMBER:
HOLE NUMBER: CPT-9
TEST DATE: 8/19/2019 10:26:31 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: BH-3
LOCATION: BH-3
LOCATION: BH-3



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

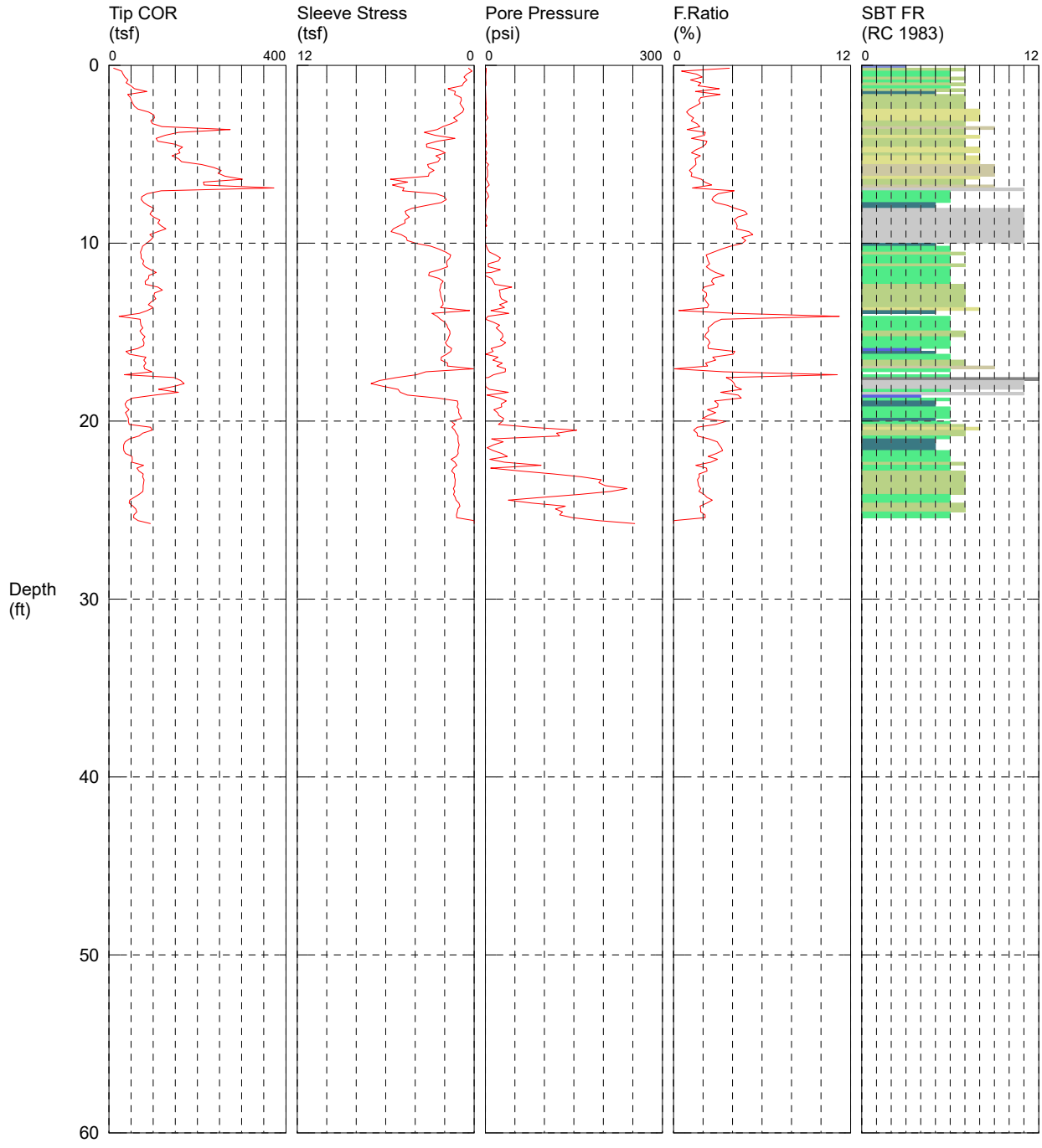
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: BH-5

JOB NUMBER:
HOLE NUMBER: CPT-10
TEST DATE: 8/19/2019 1:36:02 PM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: BH-5
LOCATION: BH-5
LOCATION: BH-5



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

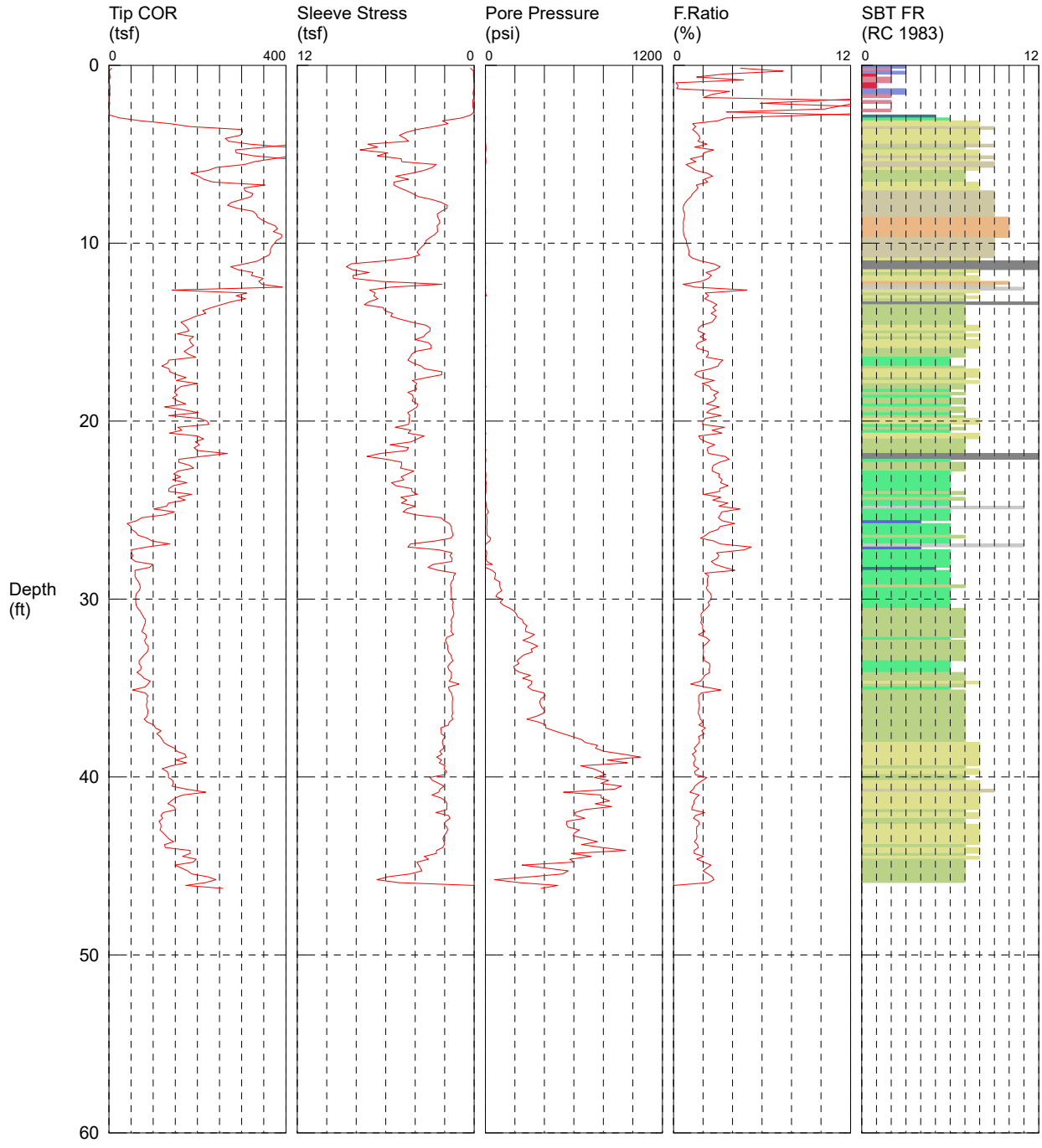
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: BH-7

JOB NUMBER:
HOLE NUMBER: CPT-11a
TEST DATE: 8/20/2019 8:29:13 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: BH-7
LOCATION: BH-7
LOCATION: BH-7



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

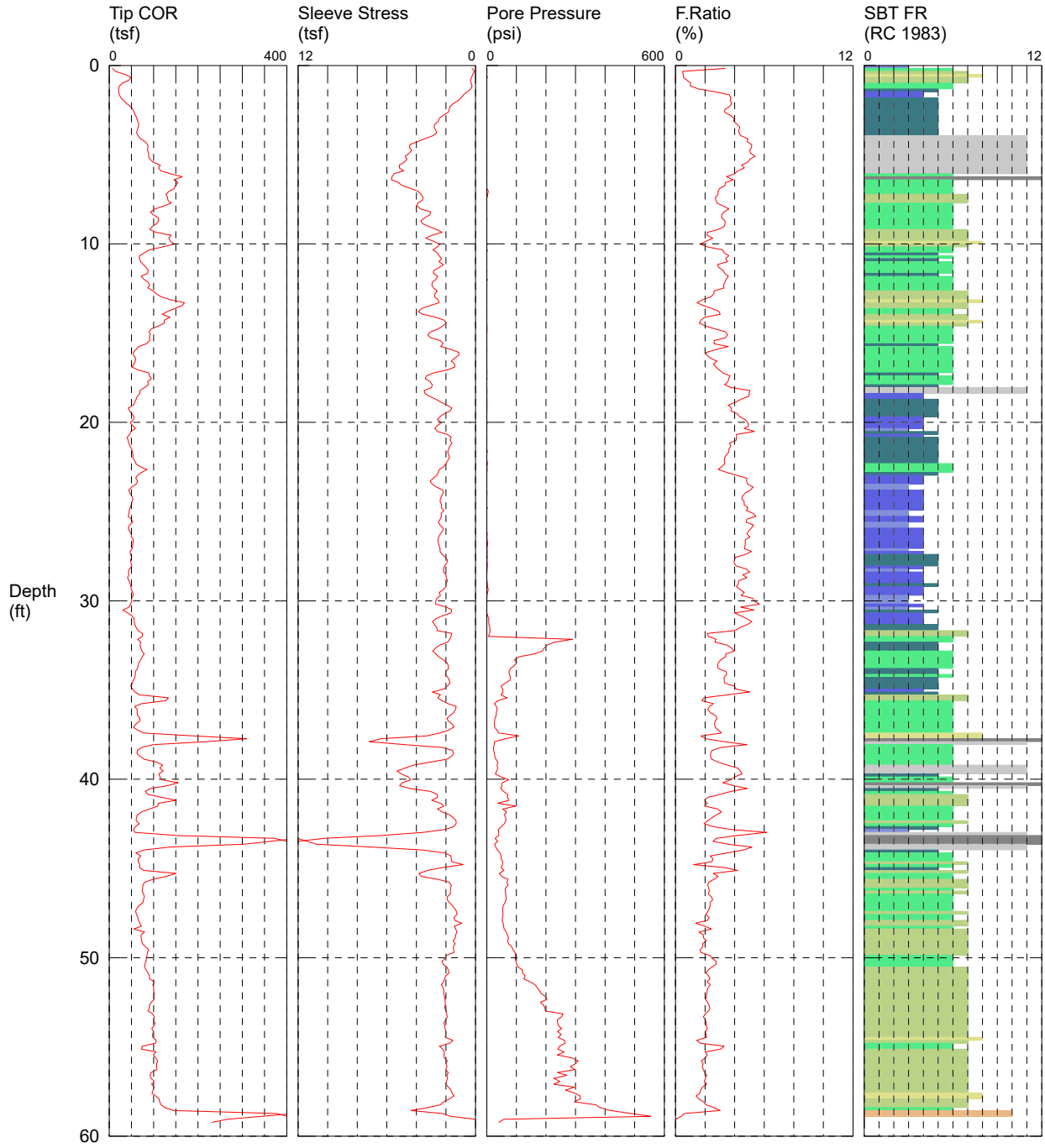
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION: TP-17

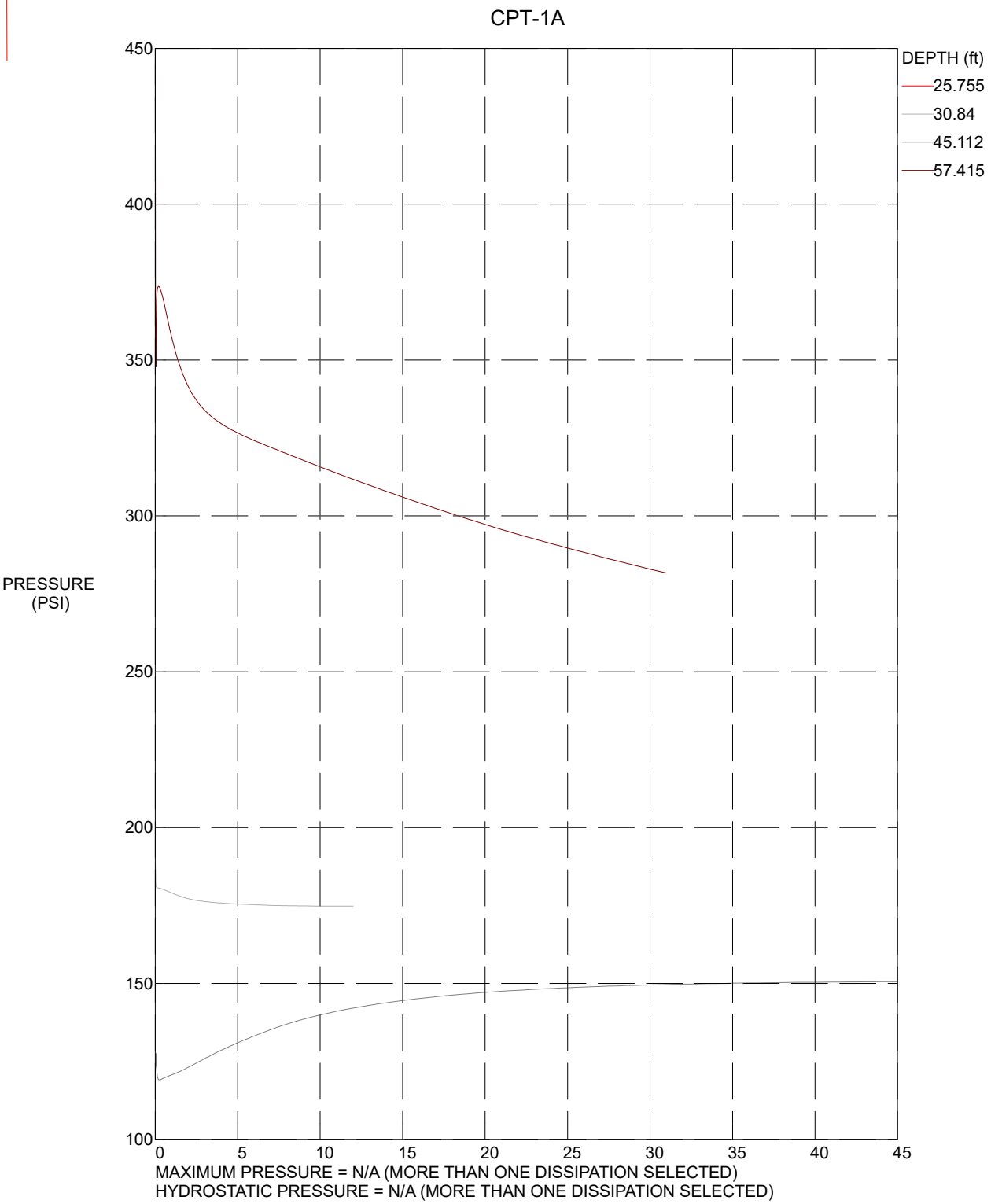
JOB NUMBER:
HOLE NUMBER: CPT-12
TEST DATE: 8/20/2019 9:53:20 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

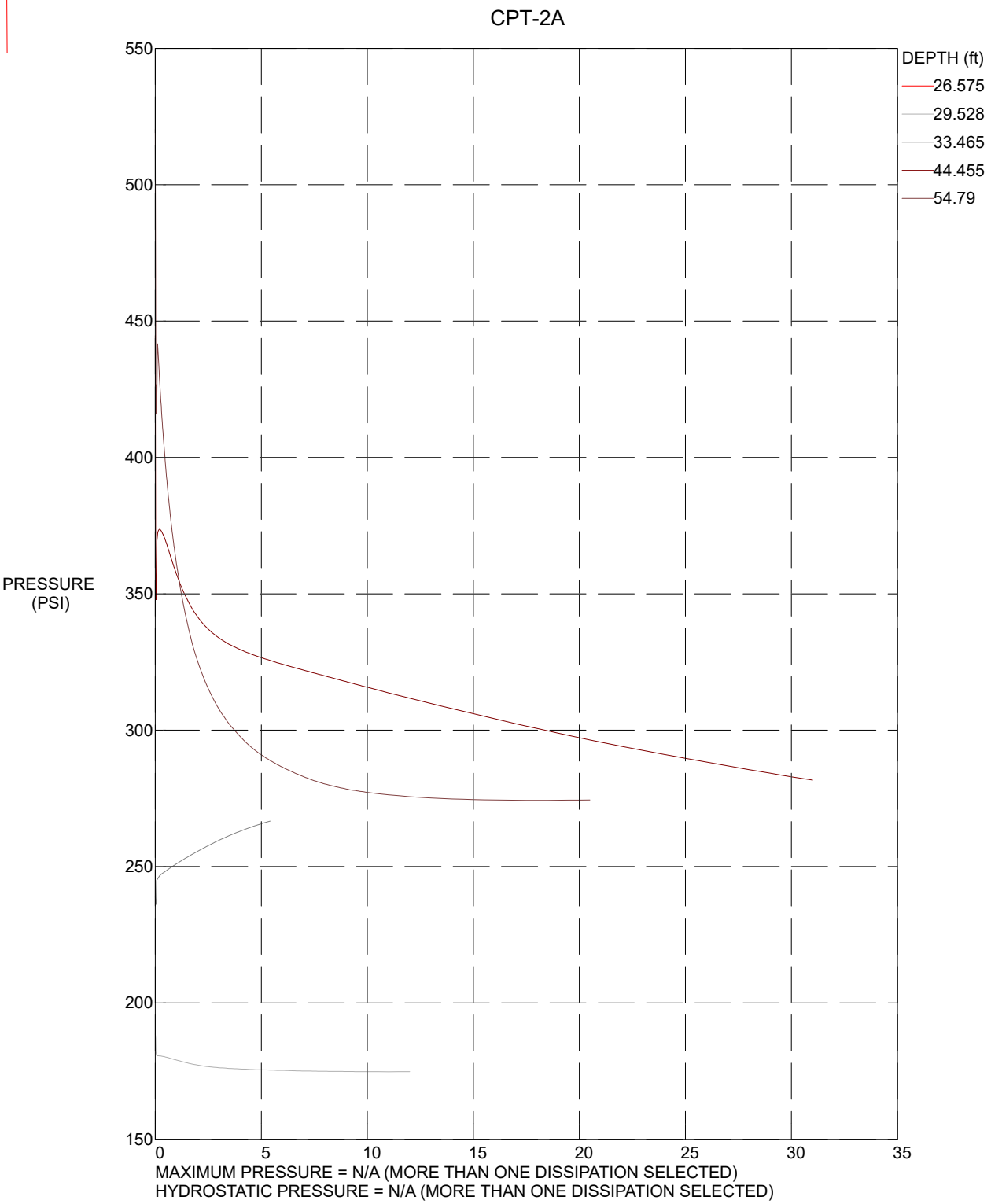
COMMENT:
GPS (LAT,LON,ALT): 0.00,0.00,0.0
LOCATION: TP-17
LOCATION: TP-17
LOCATION: TP-17



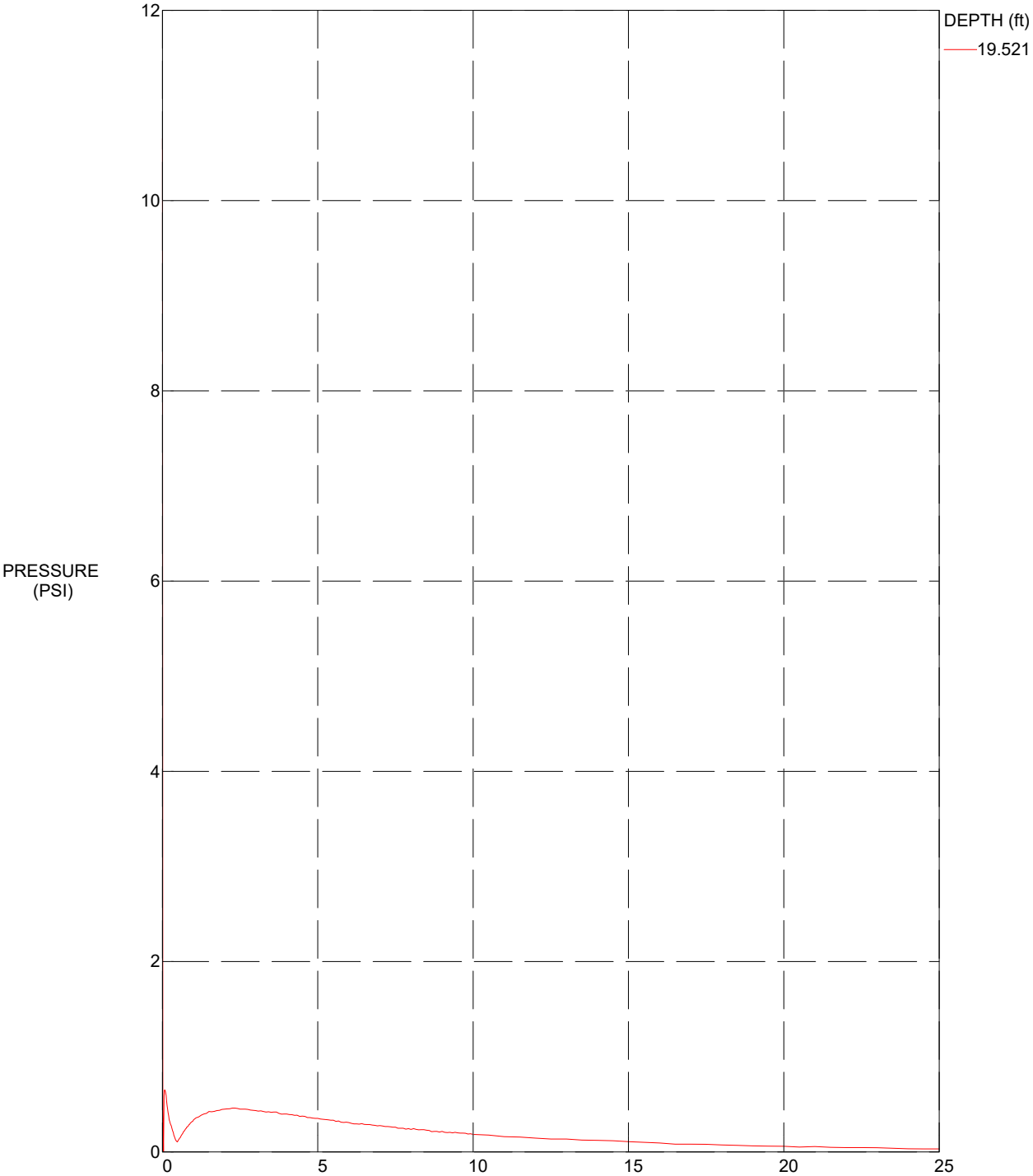
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983


CPT-1A
DEPTH (ft)
25.755
30.84
45.112
57.415
PRESSURE (PSI)
450
400
350
300
250
200
150
100
0
5
10
15
20
25
30
35
40
45
MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)

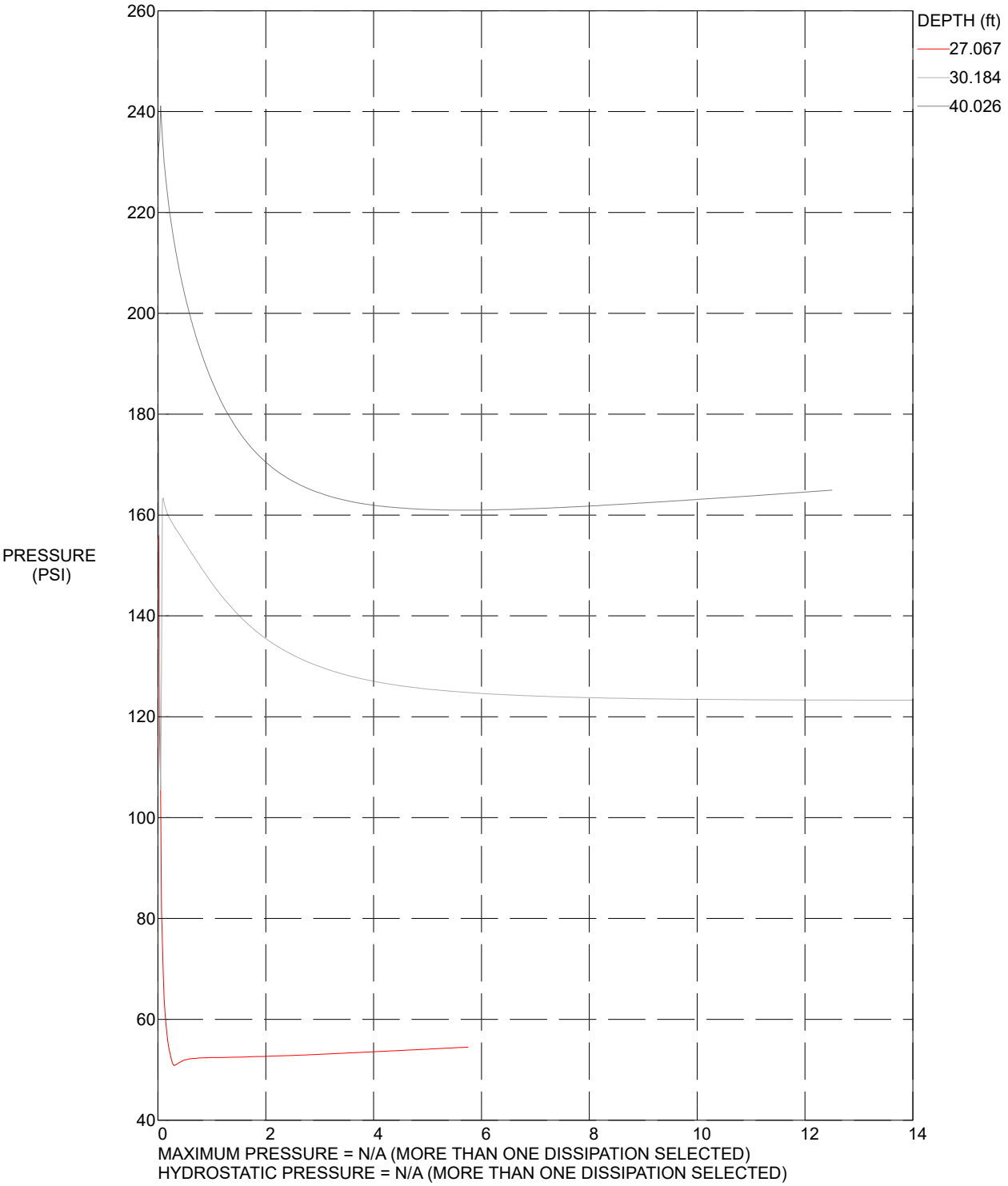

CPT-2A
DEPTH (ft)
26.575
29.528
33.465
44.455
54.79
PRESSURE (PSI)
550
500
450
400
350
300
250
200
150
0
5
10
15
20
25
30
35
MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)

CPT-3B



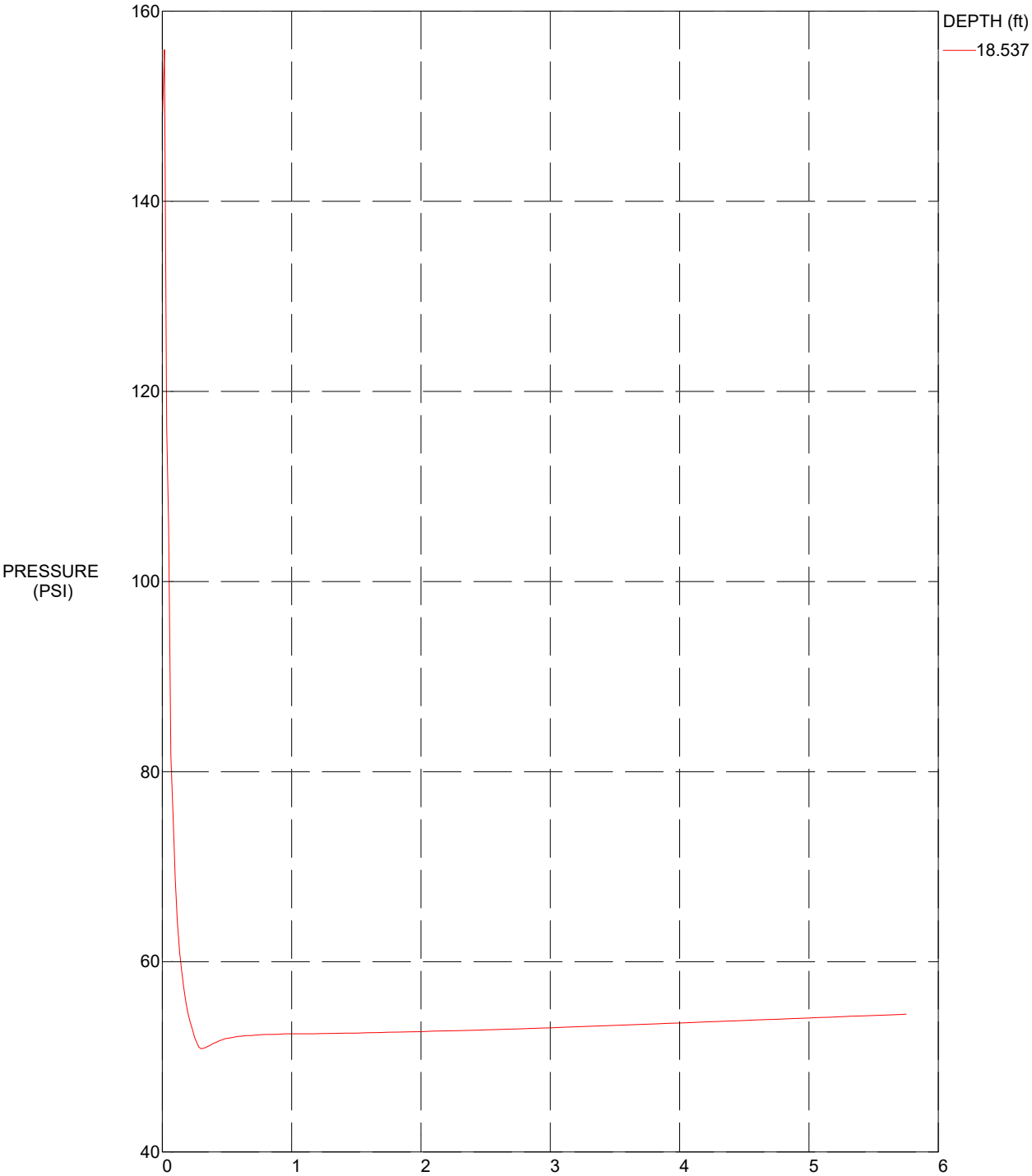
MAXIMUM PRESSURE = 10.651 (PSI) TIME: (MINUTES)
HYDROSTATIC PRESSURE = 8.46 (PSI), WATER TABLE: 0.00 ft

CPT-4



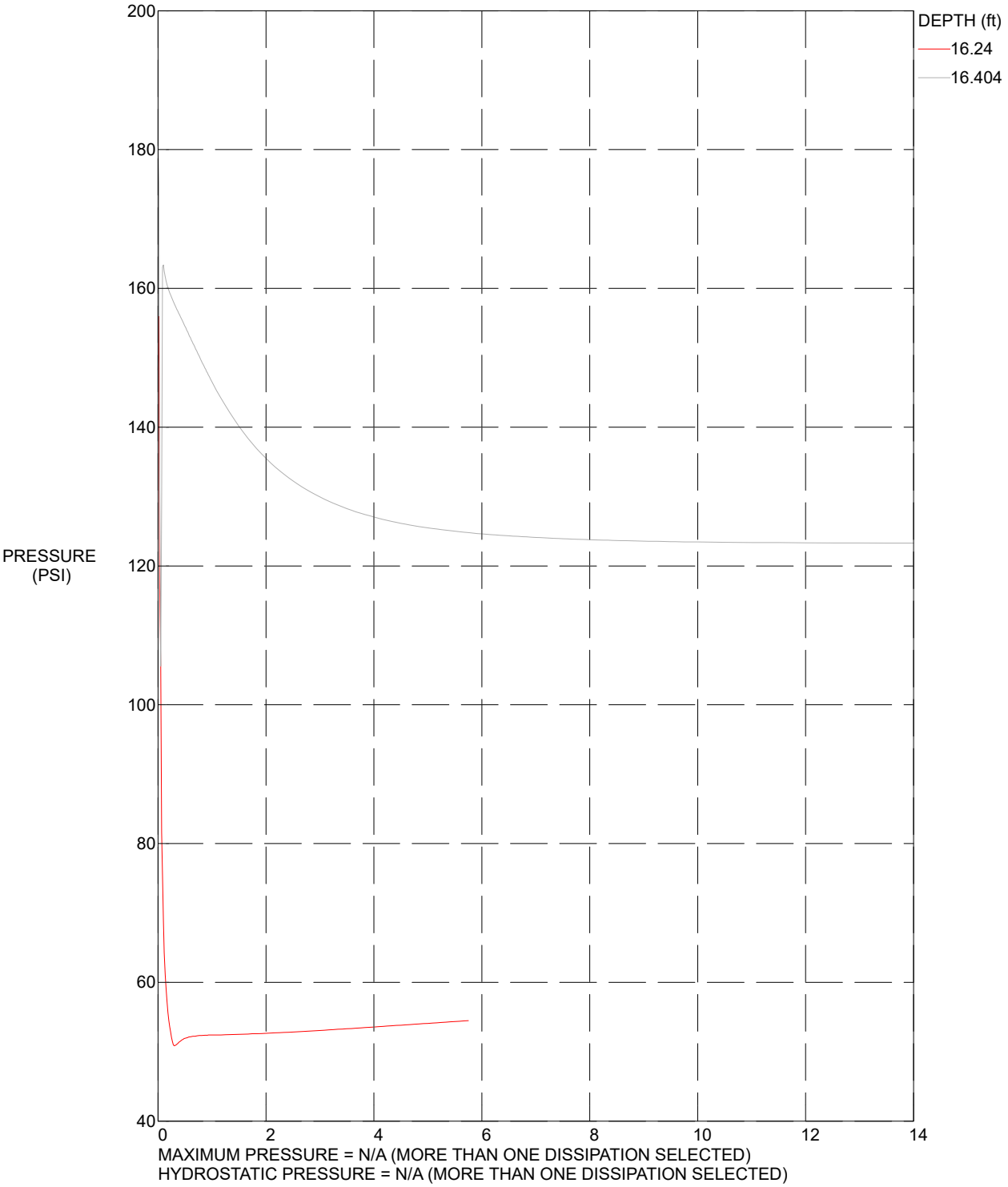
MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)

CPT-5A

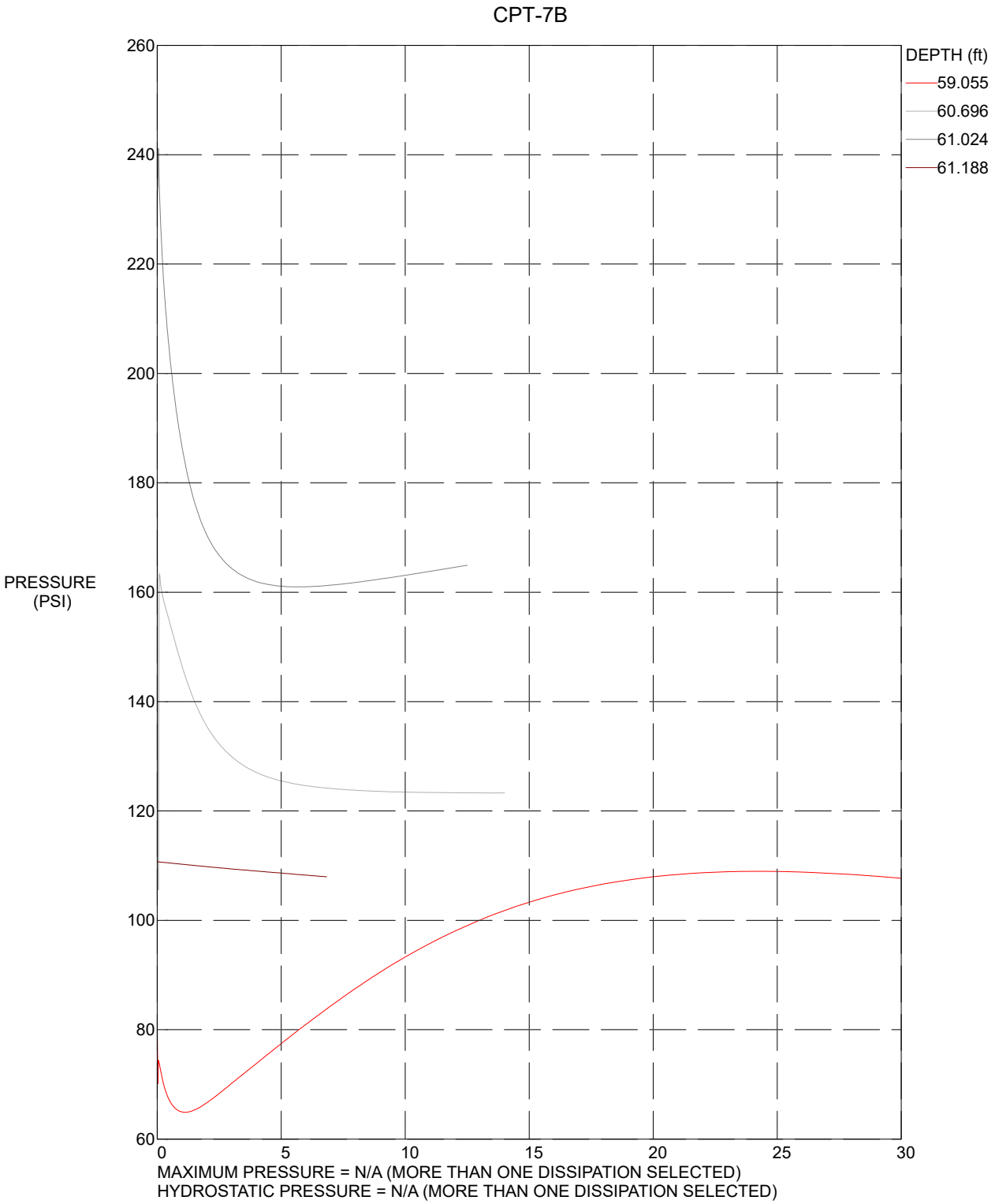


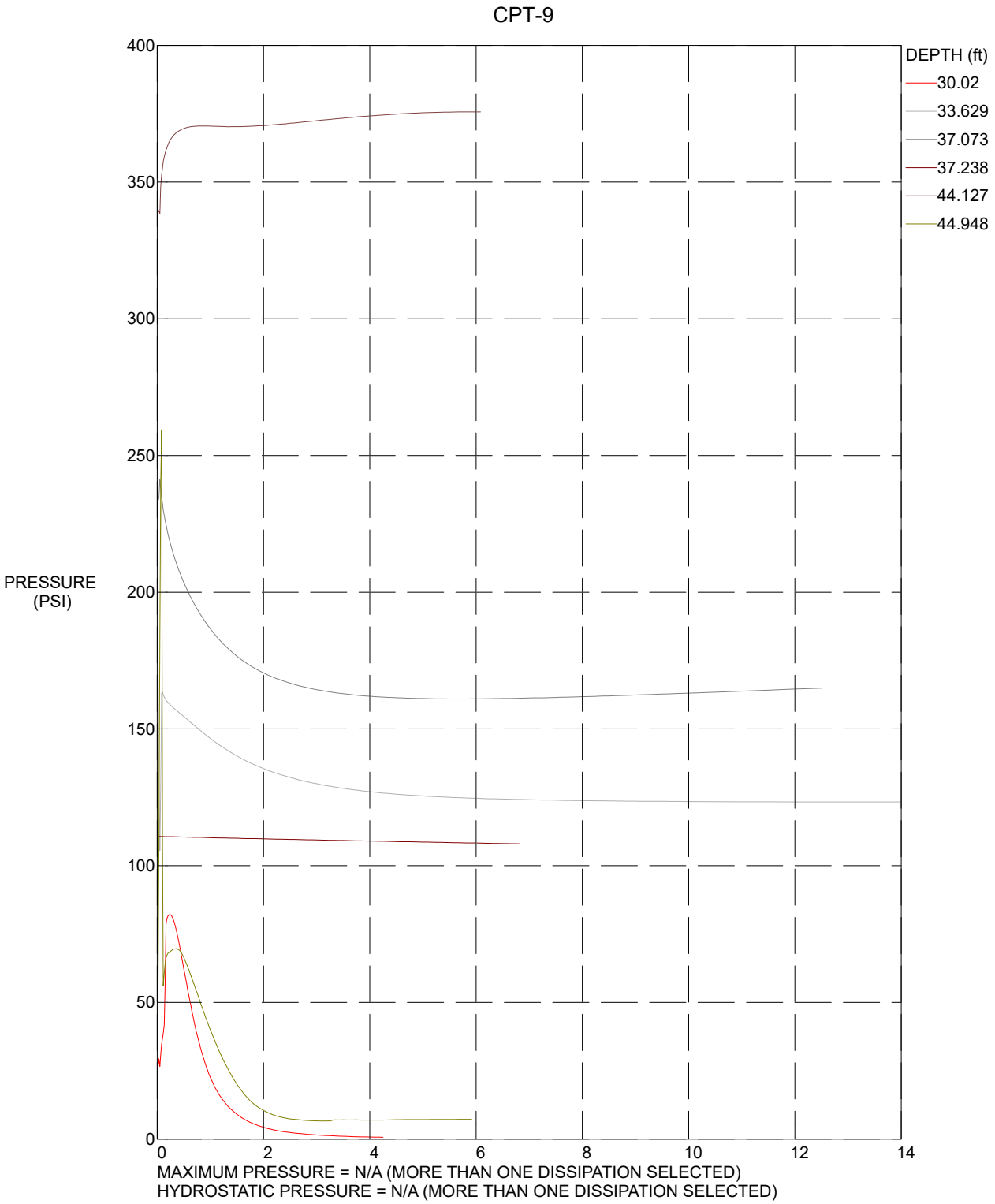
MAXIMUM PRESSURE = 155.929 (PSI)TIME: (MINUTES)
HYDROSTATIC PRESSURE = 8.034 (PSI), WATER TABLE: 0.00 ft

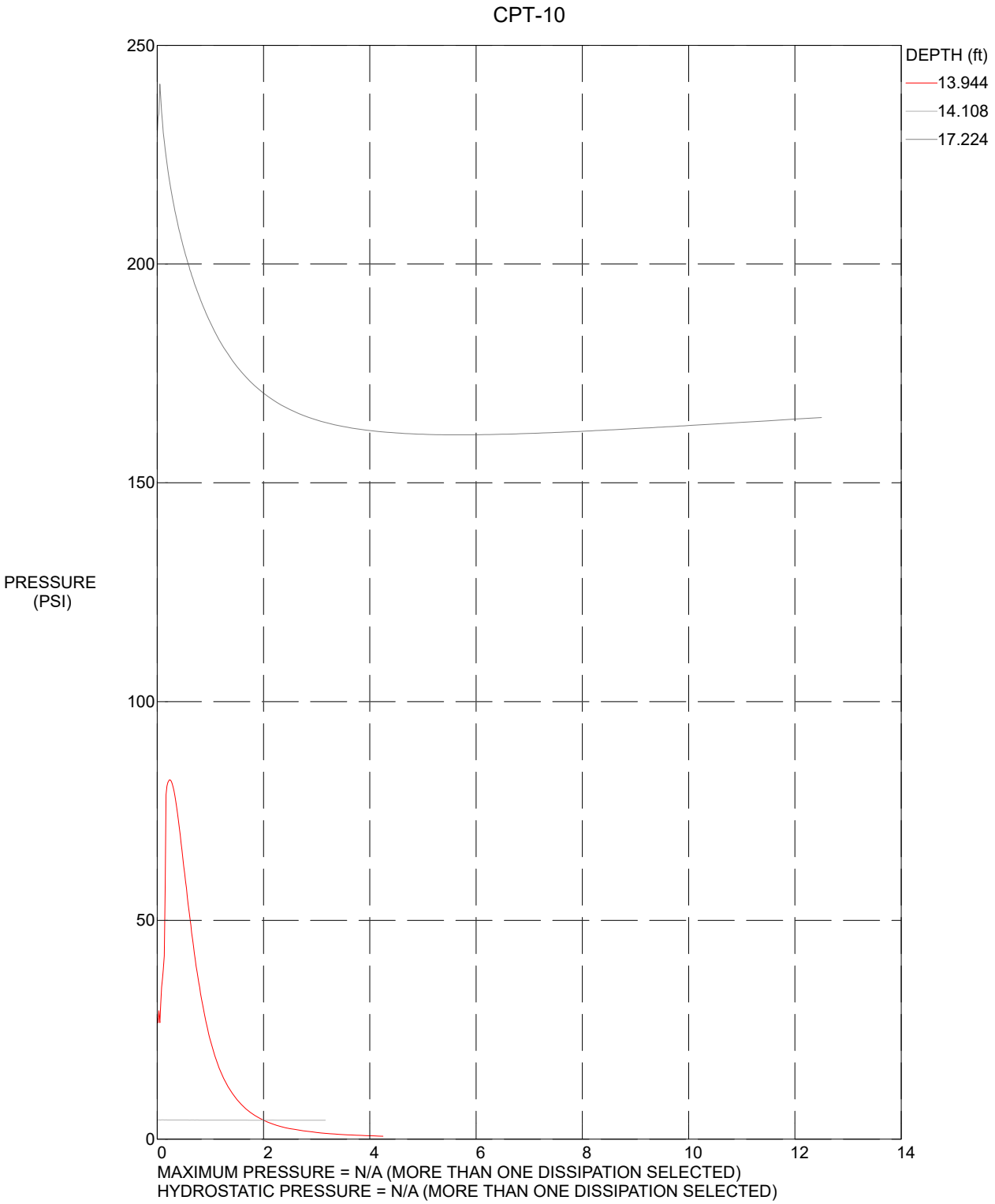
CPT-6



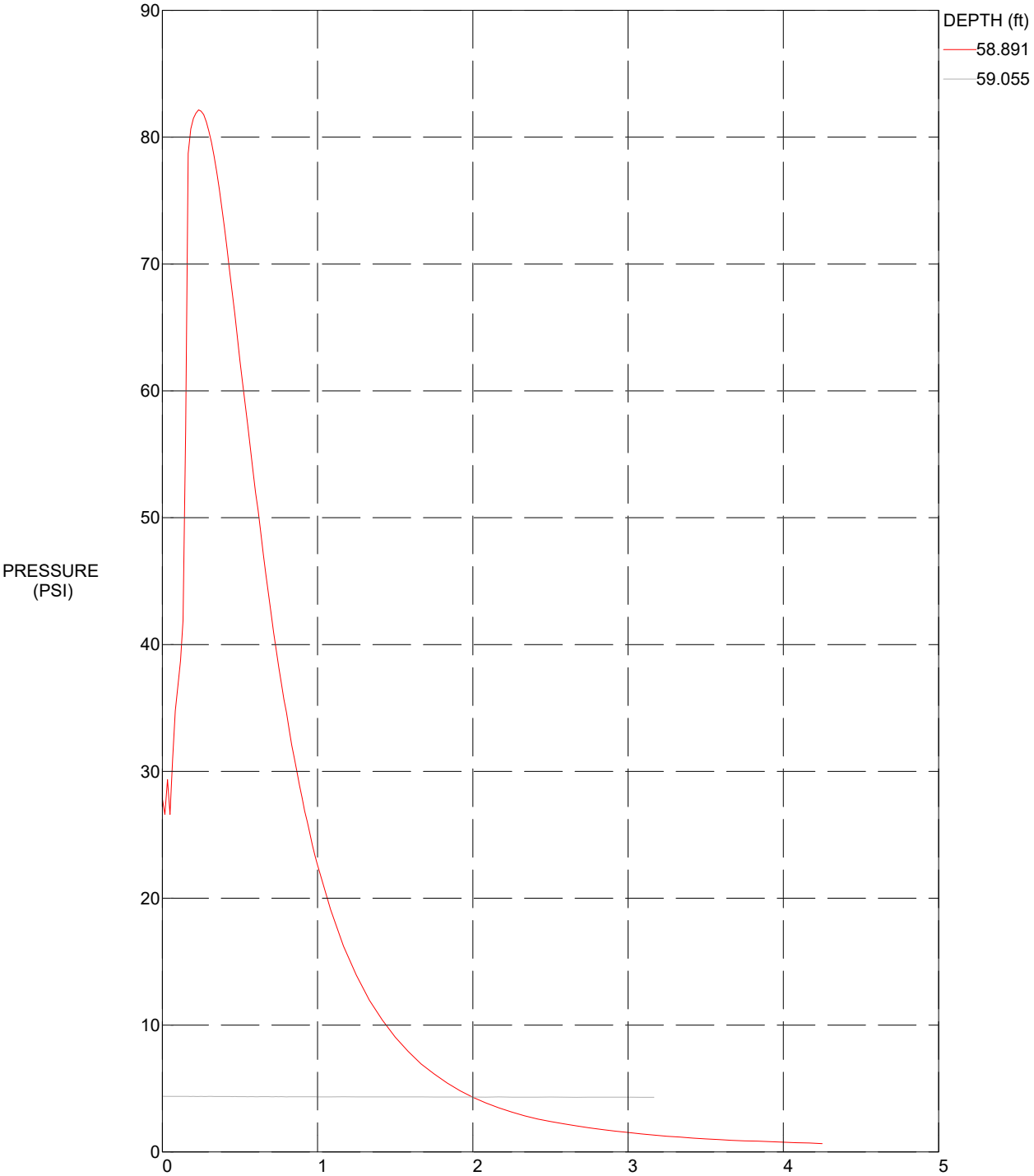
MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)


CPT-7B
DEPTH (ft)
59.055
60.696
61.024
61.188
PRESSURE (PSI)
260
240
220
200
180
160
140
120
100
80
60
0
5
10
15
20
25
30
MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)


CPT-9
DEPTH (ft)
30.02
33.629
37.073
37.238
44.127
44.948
PRESSURE (PSI)
400
350
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)

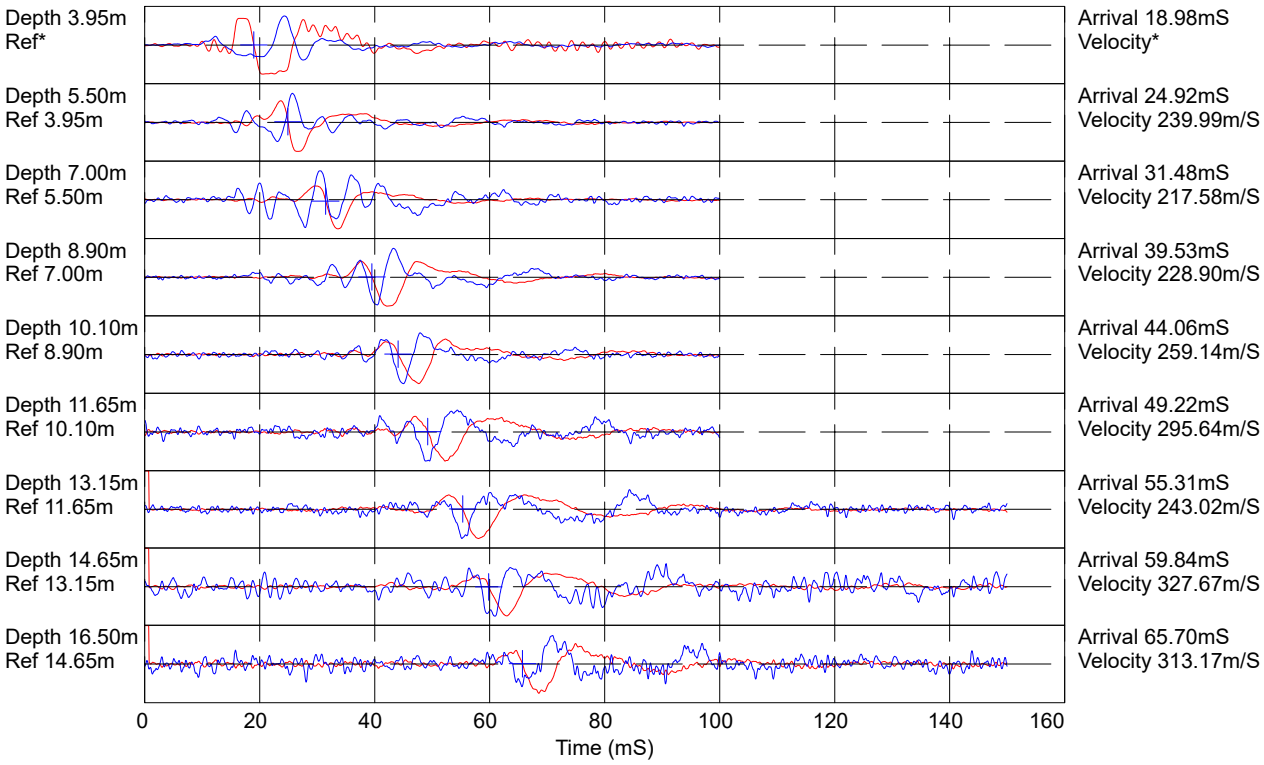

CPT-10
DEPTH (ft)
13.944
14.108
17.224
250
200
150
100
50
0
PRESSURE
(PSI)
0
2
4
6
8
10
12
14
MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)

CPT-12



MAXIMUM PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)
HYDROSTATIC PRESSURE = N/A (MORE THAN ONE DISSIPATION SELECTED)

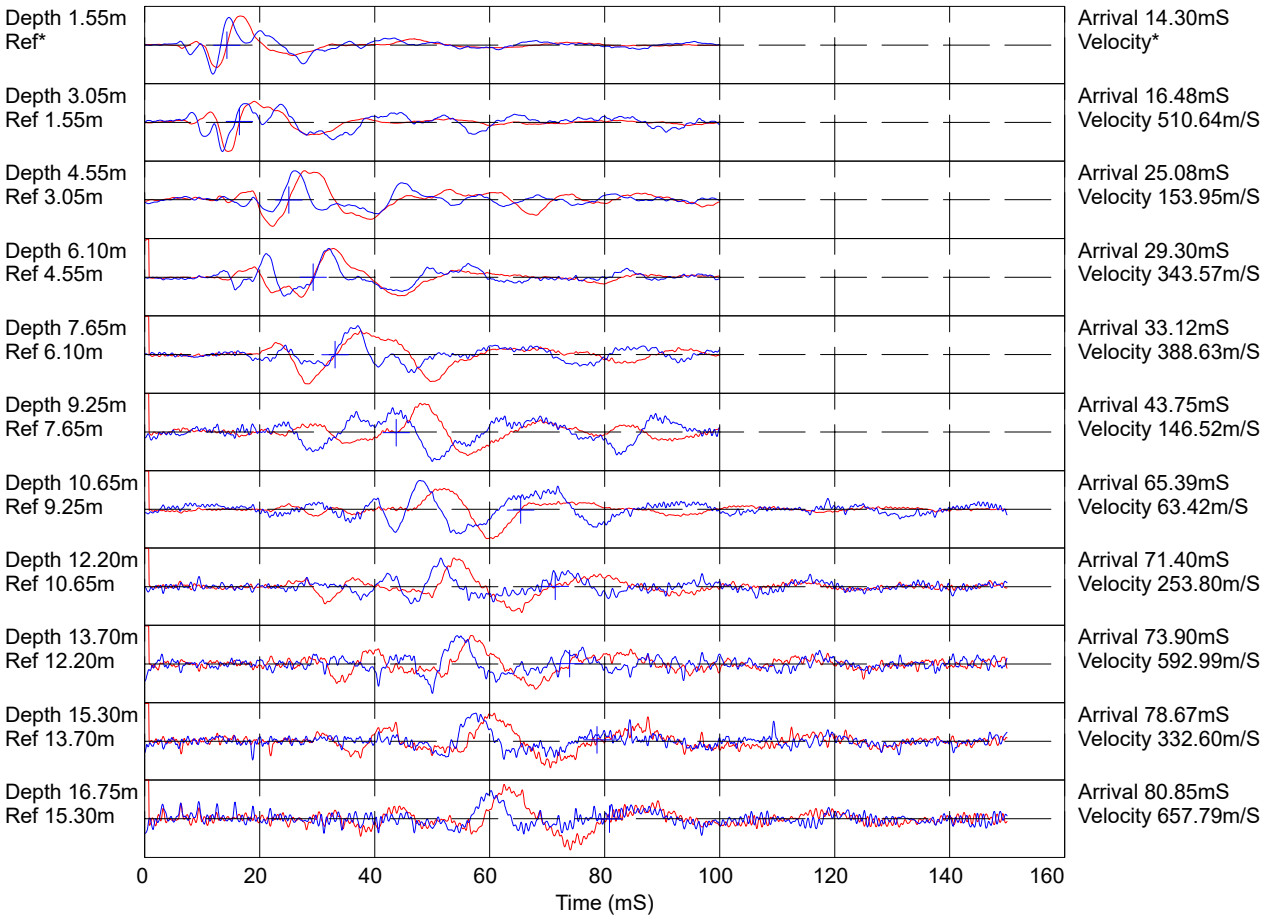
SEISMIC TEST



Hammer to Rod String Distance (m): 2.00
* = Not Determined

CPT-1a

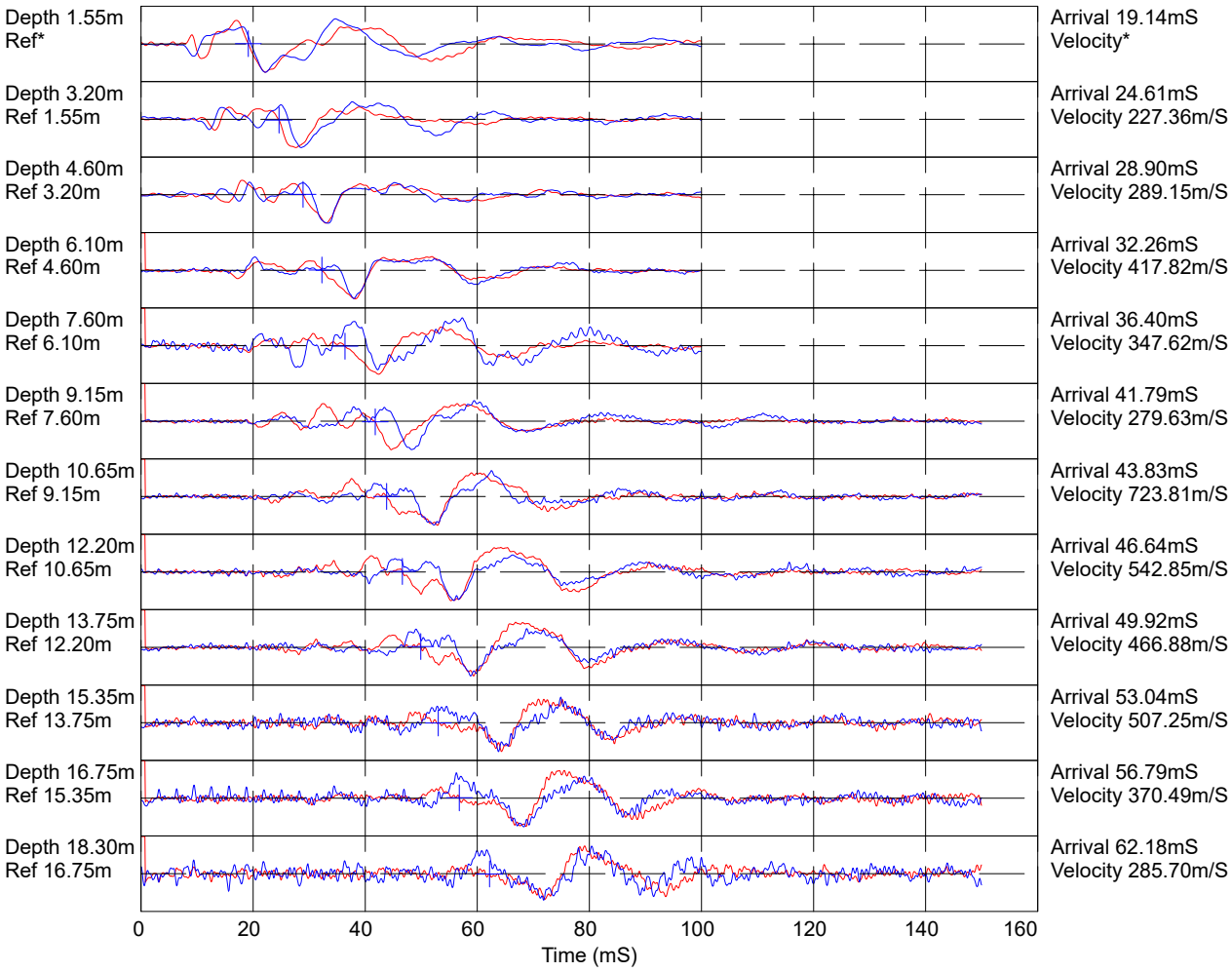
SEISMIC TEST



Hammer to Rod String Distance (m): 2.00
* = Not Determined

CPT-2a

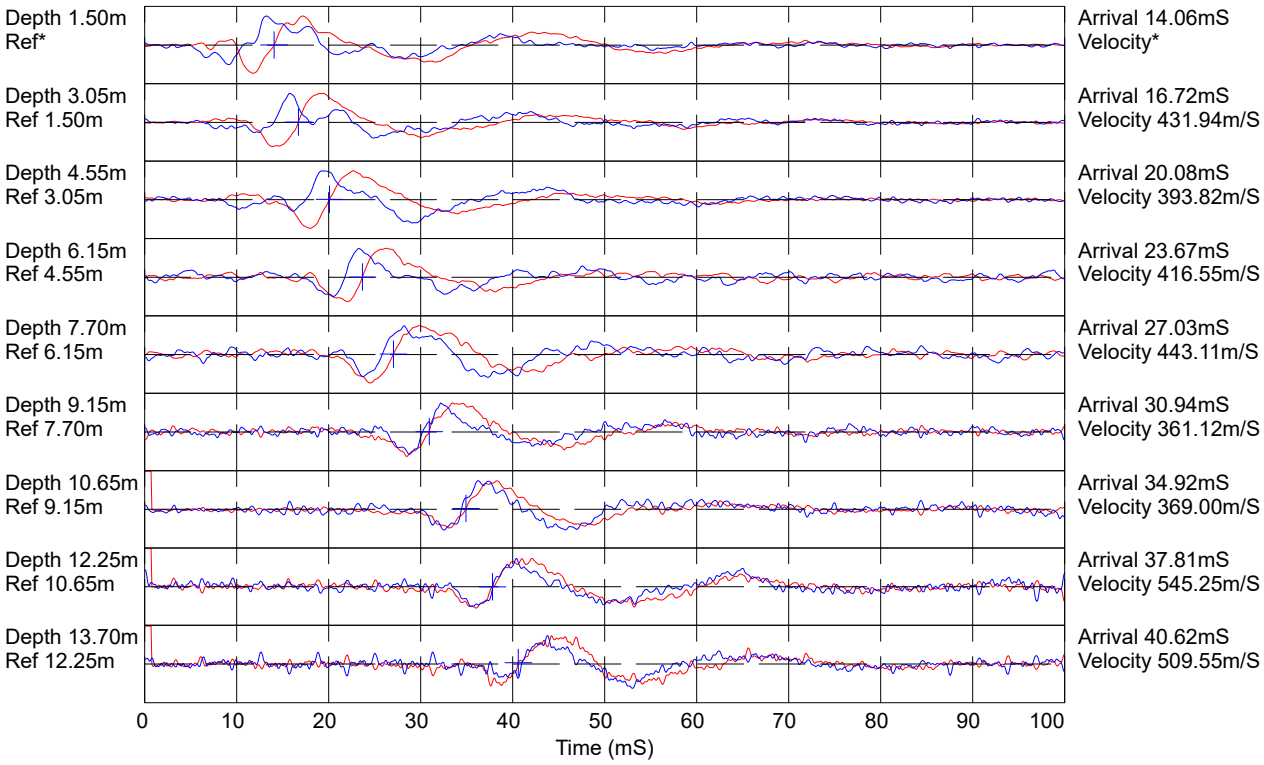
SEISMIC TEST



Hammer to Rod String Distance (m): 2.00
* = Not Determined

CPT-7b

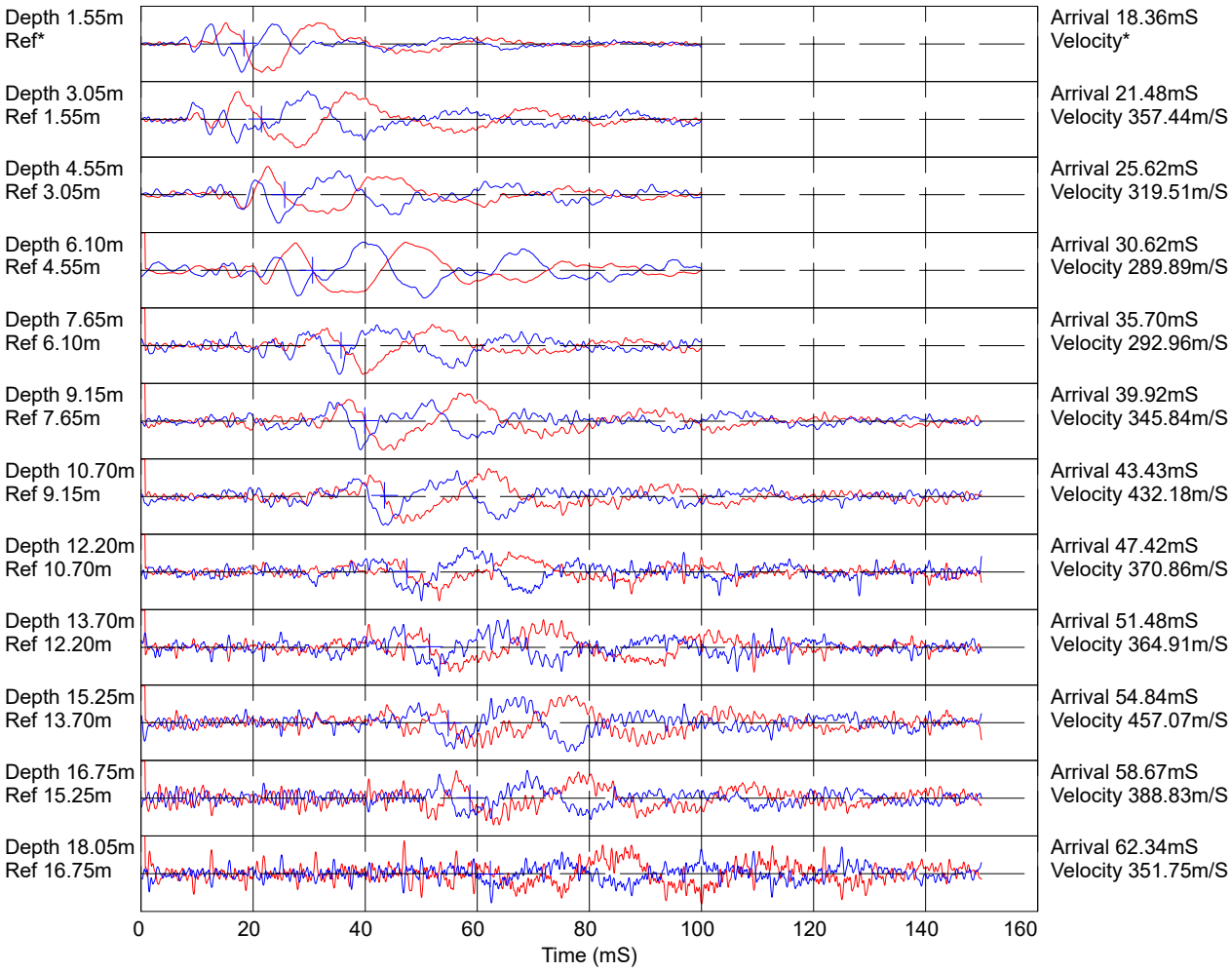
SEISMIC TEST



Hammer to Rod String Distance (m): 2.00
* = Not Determined

CPT-11a

SEISMIC TEST



Hammer to Rod String Distance (m): 2.00
* = Not Determined

CPT-12

ATTACHMENT E

Geotechnical Laboratory Test Results

GEOTECHNICAL LABORATORY TESTING
INDEX TESTING SUMMARY TABLE

Sample Type	Sample Identification	Sample Depth (ft.)	USCS Soil Classification	Delivered Moisture (%)	Atterberg Limits			Grain Size Distribution			Additional Tests/ Comments
					LL	PL	PI	% Finer 3/4"	% Finer #4	% Finer #200	
Bag	TP-02	2 - 3	SP-SM	--	NP	NP	NP	72	55	9	
Bag	TP-05	8 - 9, 13 - 14	SC	23.3	54	25	29	80	65	25	
Pail	TP-09	2 - 15	CH	35.7	104	29	75	100	100	88	Permeability: 5.6E-09 cm/s
Bag	TP-11	12-14.5	CH	--	118	40	78	100	100	79	
Pail	TP-17	2 - 14	CH	--	52	18	34	100	100	82	
Bag	TP-23	10 - 11	CH	35.8	206	33	173	100	100	95	
Bag	TP-23	2 - 3	SM	--	49	29	20	98	90	44	
Bag	TP-30	1.5 - 2.5	CL	11.9	47	22	25	97	92	50	
Bag	TP-33, TP-34	TP33: 4.5-5.5, TP34: 1-3	GM	19.8	58	32	26	22	19	10	
Bag	TP-37	3 - 9	SM	--	NP	NP	NP	81	69	14	
Bag	TP-41	2 - 3	SC	9.7	37	15	22	98	96	49	
Bag	BH-01	10 - 11.5	CL	15.8	46	21	25	100	100	89	
Bag	BH-03	10 - 11.5	CH	29.9	89	34	55	100	100	78	
Bag	BH-03	40 - 41.5	CH	34.7	124	25	99	100	100	96	
Bag	BH-03	50 - 51.5	CH	34.5	227	29	198	100	100	93	
Bag	BH-04	20 - 21.5	CH	--	68	20	48	100	100	91	
Tube	BH-06	10 - 11.5	CH	40.1	121	36	85	100	100	95	Permeability: 1.7E-08 cm/s
Tube	BH-06	20-21.5	CH	33	74	22	52	100	100	65	
Bag	BH-07	25-26.5, 30-31.5, 35-36.5	CH	--	66	21	45	99	99	91	
Bag	BH-9	25 - 26.5	CH	35.2	96	34	62	100	100	68	
Bag	BH-11	10 - 11.5	CH	--	78	29	49	100	98	57	
Bag	BH-12	30 - 31.5	CH	37.2	103	41	62	100	100	97	
Bag	BH-13	5 - 6.5	CH	22.8	92	29	63	100	100	87	
Bag	BH-13	15 - 16.5	CH	35.8	84	23	62	100	100	52	
Bag	BH-13	25 - 26.5	CH	--	77	22	55	100	100	67	
Bag	BH-13	30 - 31.5	--	33.2	--	--	--	--	--	--	
Bag	BH-14	10-11.5, 15-16.5	SW-SM	--	NP	NP	NP	100	100	10	
Tube	BH-15	15 - 16.5	CL	38.5	134	40	94	100	100	81	
Tube	BH-15	25 - 26.5	CH	38	191	34	157	100	100	98	
Bag	BH19-TP-01	10 - 11.5	CH	37.4	97	28	69	100	99	96	
Bag	BH19-TP-01	20 - 21.5	SC	11.7	36	15	21	100	100	48	
Bag	BH19-TP-01	25 - 26.5	CH	29.0	78	20	58	100	100	94	
Tube	BH19-TP-01	45 - 46.5	CH	32.4	68	24	44	100	97	82	Permeability: 5.7E-08 cm/s
Tube	BH19-TP-39	10 - 11.5	ML	16.0	36	26	10	100	98	54	
Tube	BH19-TP-39	15 - 16.5	SC	14.5	80	29	31	100	100	37	
Tube	BH19-TP-39	25 - 26.5	CH	39.3	120	35	85	100	100	88	Permeability: 2.4E-08 cm/s
Tube	BH19-TP-39	35 - 36.5	CH	38.8	109	31	78	100	100	98	Permeability: 5.4E-08 cm/s

GEOTECHNICAL LABORATORY TESTING
INDEX TESTING SUMMARY TABLE

Sample Type	Sample Identification	Sample Depth (ft.)	USCS Soil Classification	Delivered Moisture (%)	Atterberg Limits			Grain Size Distribution			Additional Tests/ Comments
								% Finer	% Finer	% Finer	
					LL	PL	PI	3/4"	#4	#200	
Tube	BH19-TP-15	10 - 11.5	CH	25.7	71	29	42	100	100	93	
Tube	BH19-TP-15	15 - 16.5	CH	18.9	66	28	38	100	100	96	
Tube	BH19-TP-15	20 - 21.5	CH	13.6	52	22	30	100	100	90	
Tube	BH19-TP-15	25 - 26.5	CH	15.0	62	22	40	100	100	94	
Tube	BH19-TP-15	30 - 31.5	CL	13.4	48	19	29	100	100	56	
Tube	BH19-TP-15	35 - 36.5	SC	9.6	35	21	14	100	100	43	
Tube	BH19-TP-15	40 - 41.5	SC	11.5	35	18	17	100	100	45	
Tube	BH19-TP-15	50 - 51.5	CH	32.3	87	25	62	100	100	98	
Tube	BH19-TP-15	70 - 71.5	CH	47.9	116	38	78	100	100	87	
Tube	BH19-TP-15	90 - 91.5	CH	36.5	101	36	65	100	100	92	
Tube	BH19-TP-15	110 - 111.5	CH	33.6	90	26	64	100	100	93	
Tube	BH19-TP-15	120 - 121.4	CH	24.6	66	23	43	100	100	91	
Bag	BH19-TP-19	12 - 13.5	CH	27.4	98	26	72	100	100	99	
Tube	BH19-TP-19	15 - 16.5	CH	34.4	133	33	100	100	100	99	
Tube	BH19-TP-19	25 - 26.5	CH	23.2	158	23	135	100	100	84	
Tube	BH19-TP-19	30.3 - 31.8	SC	27.1	127	26	101	100	98	41	
Tube	BH19-TP-19	35 - 36.5	SC	26.3	137	20	117	100	100	49	
Tube	BH19-TP-19	40 - 41.5	CH	45.5	141	24	117	100	100	100	
Tube	BH19-TP-19	50 - 51.5	CH	42.2	206	27	179	100	100	93	
Tube	BH19-TP-19	60 - 61.5	CH	22.1	73	22	51	100	100	96	
Tube	BH19-TP-19	70 - 71.5	CH	30.3	89	28	61	100	100	87	
Tube	BH19-TP-19	80 - 81.5	CH	20.9	62	21	41	100	100	97	
Tube	BH19-TP-19	110 - 111.5	CL	17.8	48	24	24	100	100	99	
Tube	BH19-TP-19	120 - 121.4	CH	20.9	59	22	37	100	100	80	
Tube	BH19-TP-23	30 - 31.5	CH	41.7	99	31	68	100	100	97	
Tube	BH19-TP-23	35 - 36.5	CH	41.7	135	34	101	100	100	96	
Tube	BH19-TP-23	40 - 41.5	CH	29.4	82	24	58	100	100	99	
Tube	BH19-TP-23	45 - 46.5	CL	22.8	49	23	26	100	100	93	
Tube	BH19-TP-23	50 - 51.5	CH	19.5	70	20	50	100	100	82	
Tube	BH19-TP-23	60 - 61.5	MH	26.0	53	32	21	100	100	96	
Tube	BH19-TP-23	100 - 101.5	CH	26.1	70	25	45	100	100	95	
Tube	BH19-TP-23	120 - 121.3	CH	25.1	64	24	40	100	100	100	

GEOTECHNICAL LABORATORY TESTING
INDEX TESTING SUMMARY TABLE

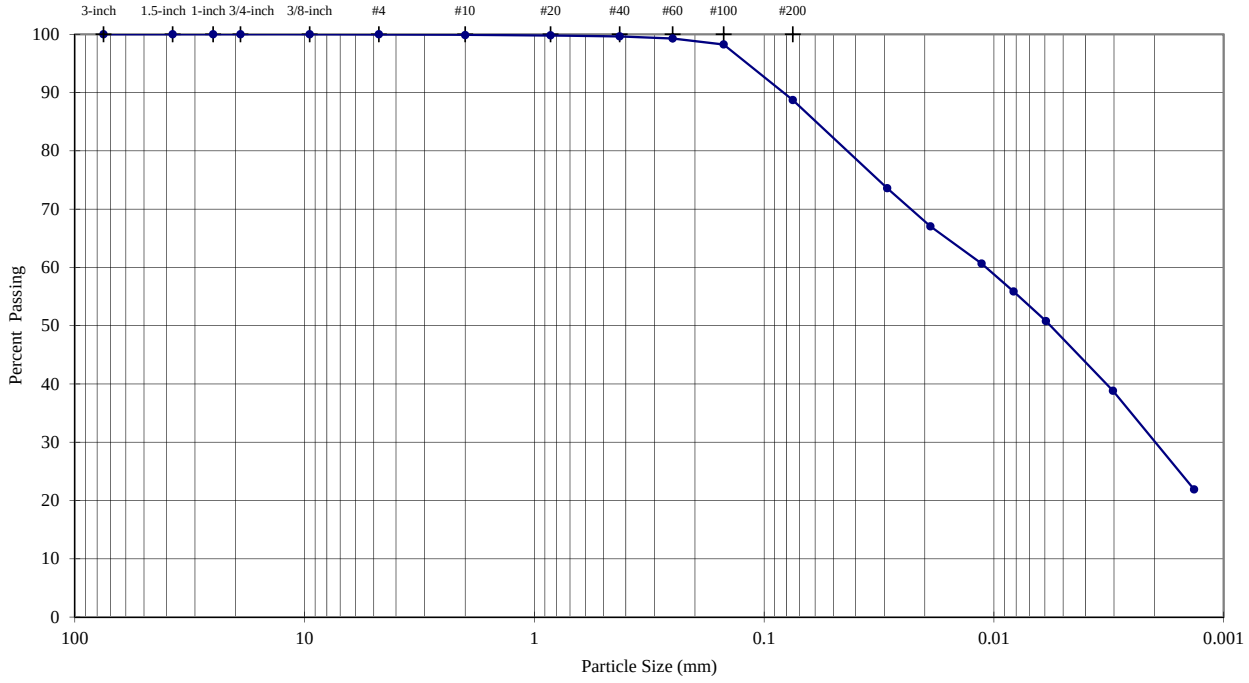
Sample Type	Sample Identification	Sample Depth (ft.)	USCS Soil Classification	Delivered Moisture (%)	Atterberg Limits			Grain Size Distribution			Additional Tests/ Comments
								% Finer	% Finer	% Finer	
					LL	PL	PI	3/4"	#4	#200	
Shelby Tube	BH19-TP-44	10 - 12	CH	27.3	82	22	60	100	100	56	
Bag	BH19-TP-44	22 - 23.5	CH	35.5	111	21	90	100	100	81	
Tube	BH19-TP-44	25 - 26.5	CH	36.7	92	30	62	100	100	95	
Bag	BH19-TP-44	32 - 33.5	CH	40.3	98	28	70	100	100	97	
Tube	BH19-TP-44	35 - 36.5	CH	39.8	103	29	74	100	100	97	
Tube	BH19-TP-44	40 - 41.5	SC	28.3	84	26	58	100	100	36	
Tube	BH19-TP-44	45 - 46.5	SC	17.8	55	22	33	100	100	28	
Tube	BH19-TP-44	50 - 51.5	SC	22.5	79	27	52	100	100	26	
Tube	BH19-TP-44	60 - 61.5	SC	21.0	85	19	66	100	95	35	
Tube	BH19-TP-44	70 - 71.5	CH	30.7	86	24	62	100	99	84	
Tube	BH19-TP-44	80 - 81.5	CL	24.9	61	21	40	100	100	93	
Tube	BH19-TP-44	90 - 91.5	CH	26.3	72	24	48	100	100	99	
Tube	BH19-TP-44	110 - 111.5	CL	17.9	41	25	16	100	100	98	

March-18 **1663241**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

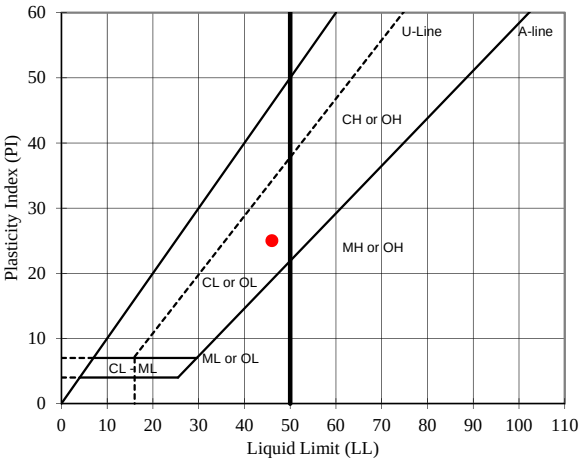
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-01 / S2** DEPTH (ft): **10-11.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.0	**99.9**	Coarse Sand	**0.14**
#20	0.85	**99.8**	Medium Sand	**0.22**
#40	0.425	**99.6**		
#60	0.25	**99.3**		
#100	0.15	**98.3**	Fine Sand	**10.93**
#200	0.075	**88.7**		
	0.029	**73.6**		
	0.019	**67.0**		
	0.011	**60.7**		
	0.008	**55.9**	Silt or Clay Fines	**88.71**
	0.006	**50.8**		
	0.003	**38.8**		
	0.001	**21.9**		

Sieve Analysis (Initial Separation on No. 4 Sieve)

Hydrometer Analysis



USCS Description (ASTM D 2487):

Lean clay, very pale brown, moist

LL	PL	PI	SpG
46	**21**	**25**	**0.00**

As-Received Moisture Content (%): **15.8**

USCS Group Symbol: CL

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

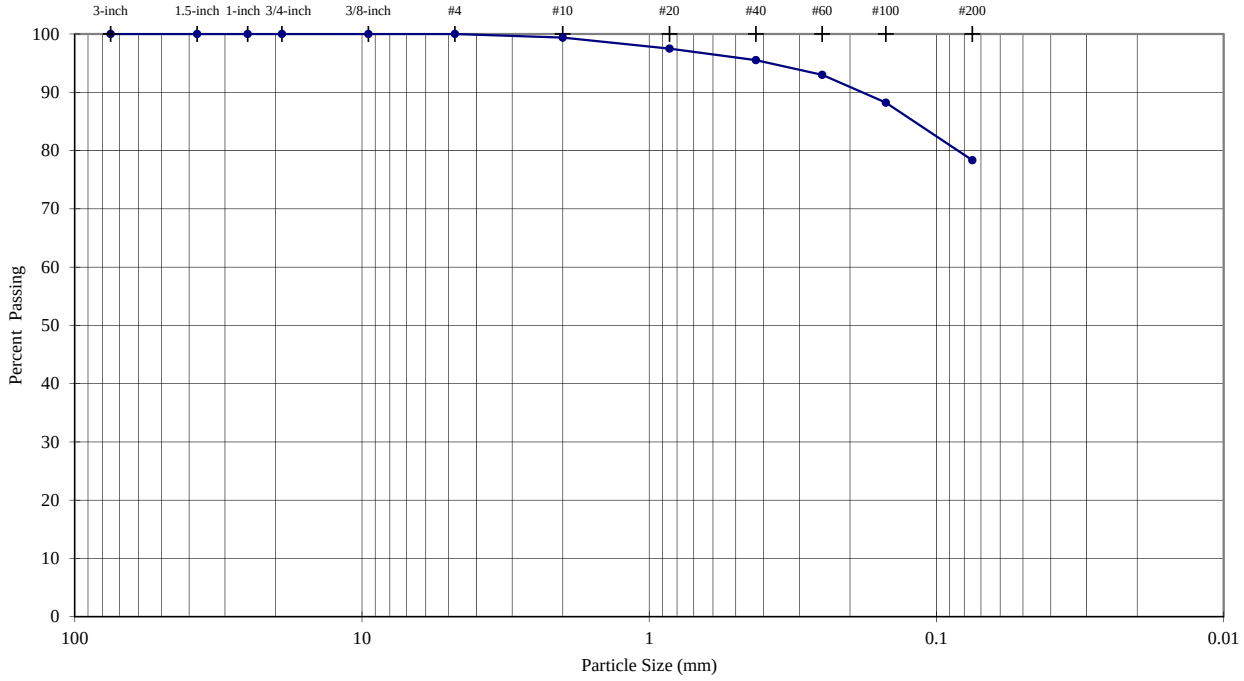
TECH	JP
DATE	22-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

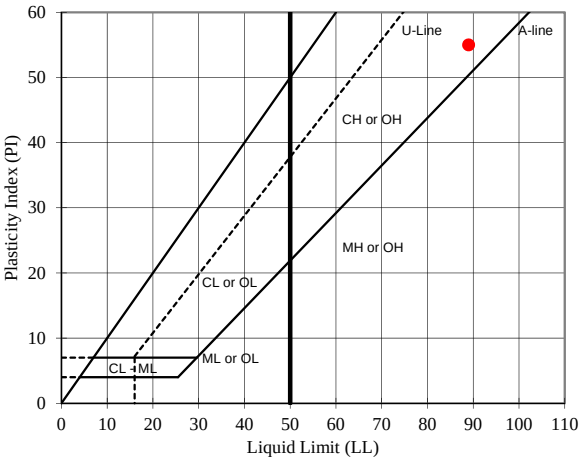
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-3 / S2** DEPTH (ft): **10-11.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.4**
#20	0.850	**97.5**
#40	0.425	**95.5**
#60	0.250	**93.0**
#100	0.150	**88.2**
#200	0.075	**78.3**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.61**
Medium Sand	**3.87**
Fine Sand	**17.18**
Silt or Clay Fines	**78.34**



USCS Description (ASTM D 2487):

Fat clay with sand, light yellowish brown, moist

LL	PL	PI
89	**34**	**55**

As-Received Moisture Content (%): **29.9**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

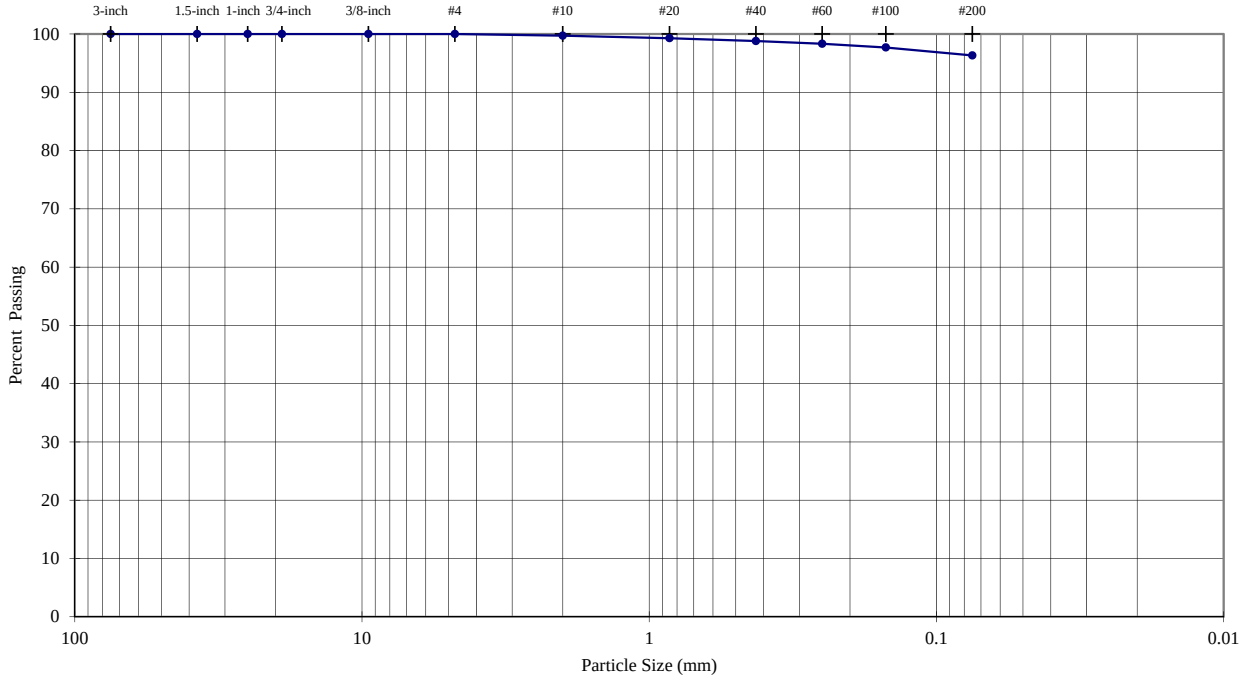
TECH	JP
DATE	24-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

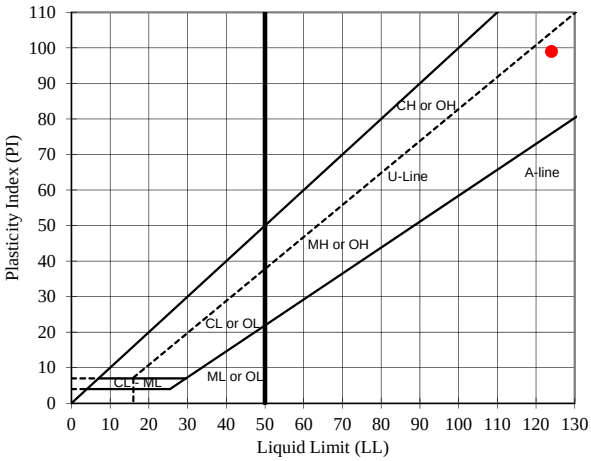
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-3 / S7** DEPTH (ft): **40-41.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.7**
#20	0.850	**99.3**
#40	0.425	**98.8**
#60	0.250	**98.3**
#100	0.150	**97.7**
#200	0.075	**96.3**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.29**
Medium Sand	**0.92**
Fine Sand	**2.48**
Silt or Clay Fines	**96.31**



USCS Description (ASTM D 2487):

Fat clay, grayish brown, moist

LL	PL	PI
124	**25**	**99**

As-Received Moisture Content (%): **34.7**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

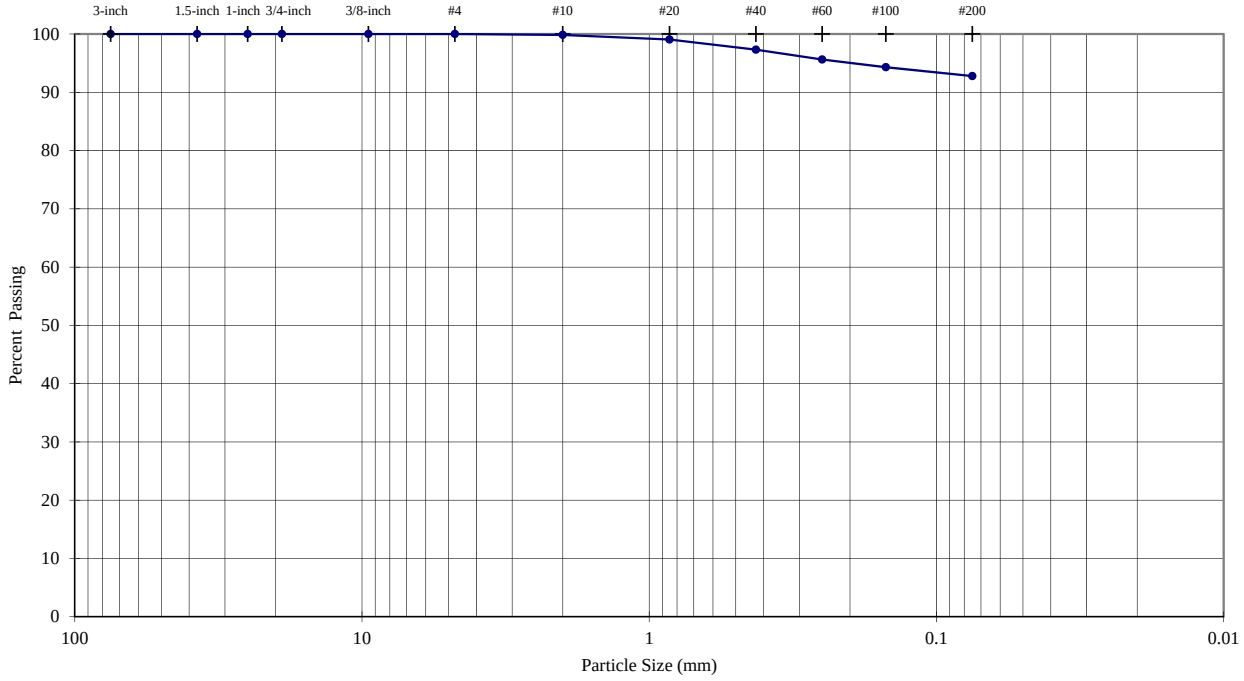
TECH	JP
DATE	23-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

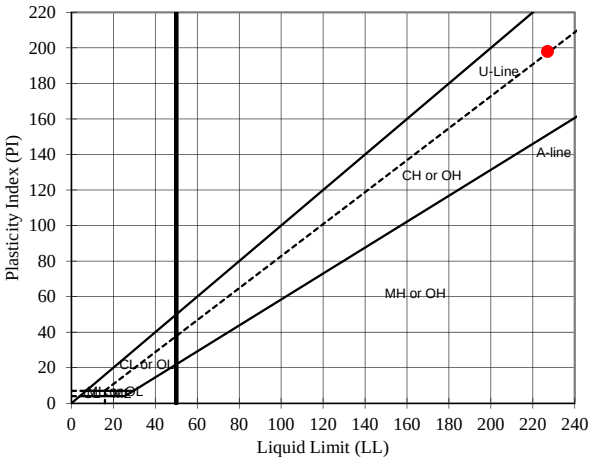
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-3 / S8** DEPTH (ft): **50-51.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.8**
#20	0.850	**99.1**
#40	0.425	**97.3**
#60	0.250	**95.6**
#100	0.150	**94.3**
#200	0.075	**92.8**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.16**
Medium Sand	**2.53**
Fine Sand	**4.54**
Silt or Clay Fines	**92.77**



USCS Description (ASTM D 2487):

Fat clay, grayish brown, moist

LL	PL	PI
227	**29**	**198**

As-Received Moisture Content (%): **34.5**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

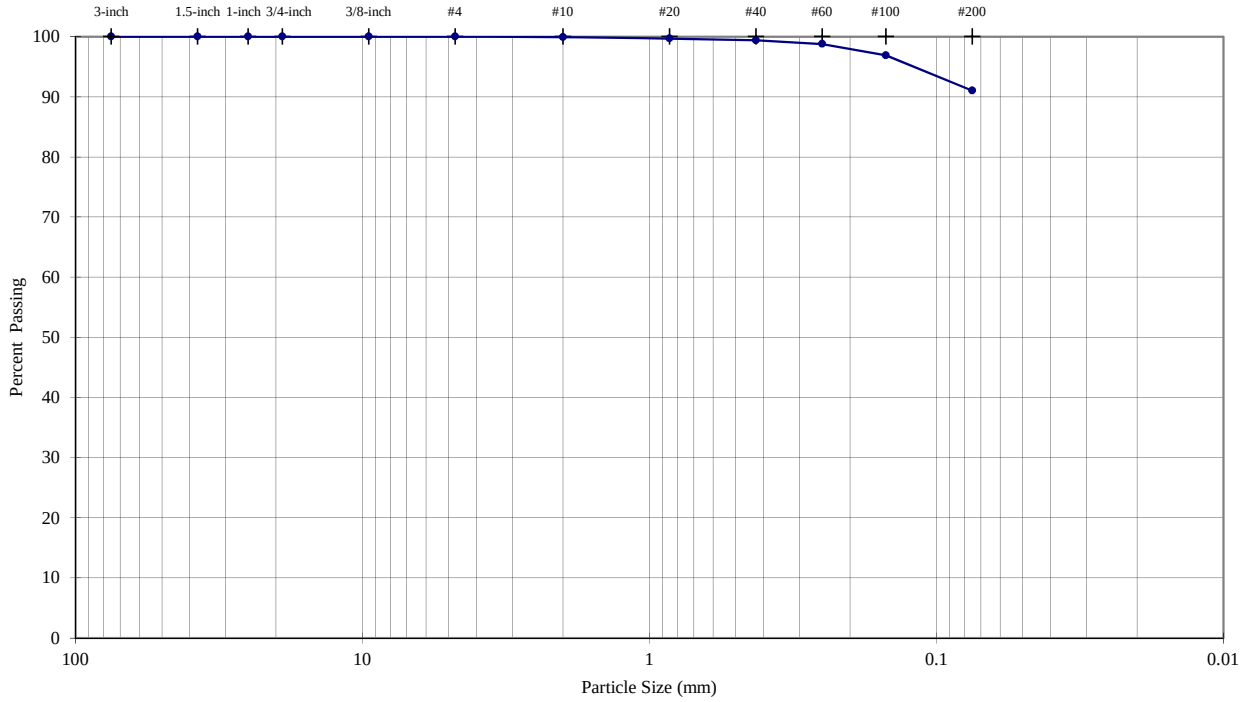
TECH	JP
DATE	23-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

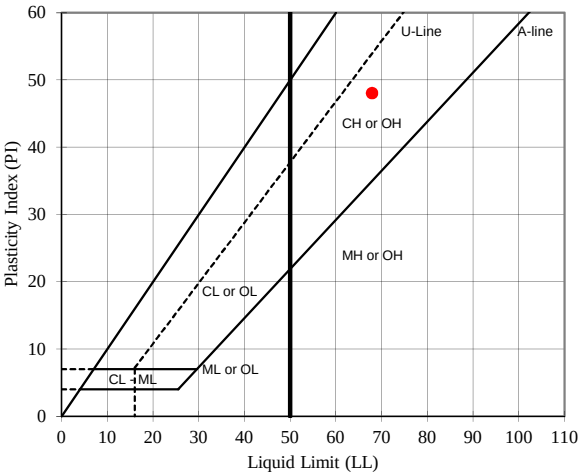
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-4 / S4** DEPTH (ft): **20-21.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.9**
#20	0.850	**99.7**
#40	0.425	**99.4**
#60	0.250	**98.8**
#100	0.150	**96.9**
#200	0.075	**91.0**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.10**
Medium Sand	**0.51**
Fine Sand	**8.37**
Silt or Clay Fines	**91.02**



USCS Description (ASTM D 2487):

Fat clay, light gray, moist

LL	PL	PI
68	**20**	**48**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	MGC
DATE	21-Mar-2018
REVIEW	MB

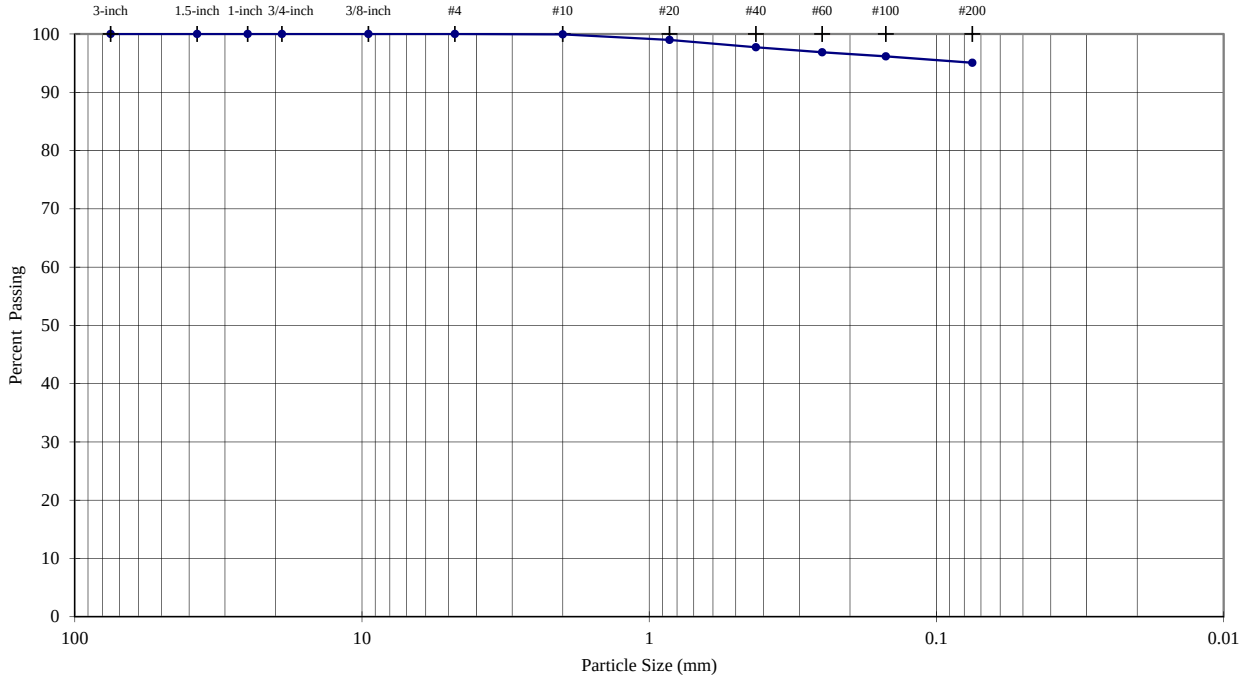
Golder Associates

April-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

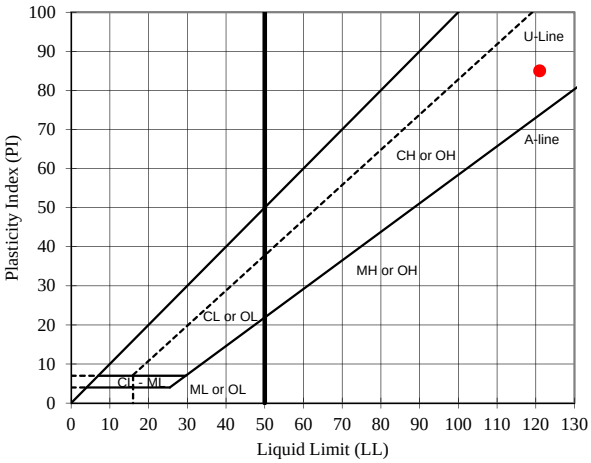
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-6 / S2** DEPTH (ft.): **10-11.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.9**
#20	0.850	**99.0**
#40	0.425	**97.7**
#60	0.250	**96.9**
#100	0.150	**96.2**
#200	0.075	**95.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.07**
Medium Sand	**2.21**
Fine Sand	**2.66**
Silt or Clay Fines	**95.06**



USCS Description (ASTM D 2487):

Fat clay, olive gray, moist

LL	PL	PI
121	**36**	**85**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	24-Apr-2018
REVIEW	MB

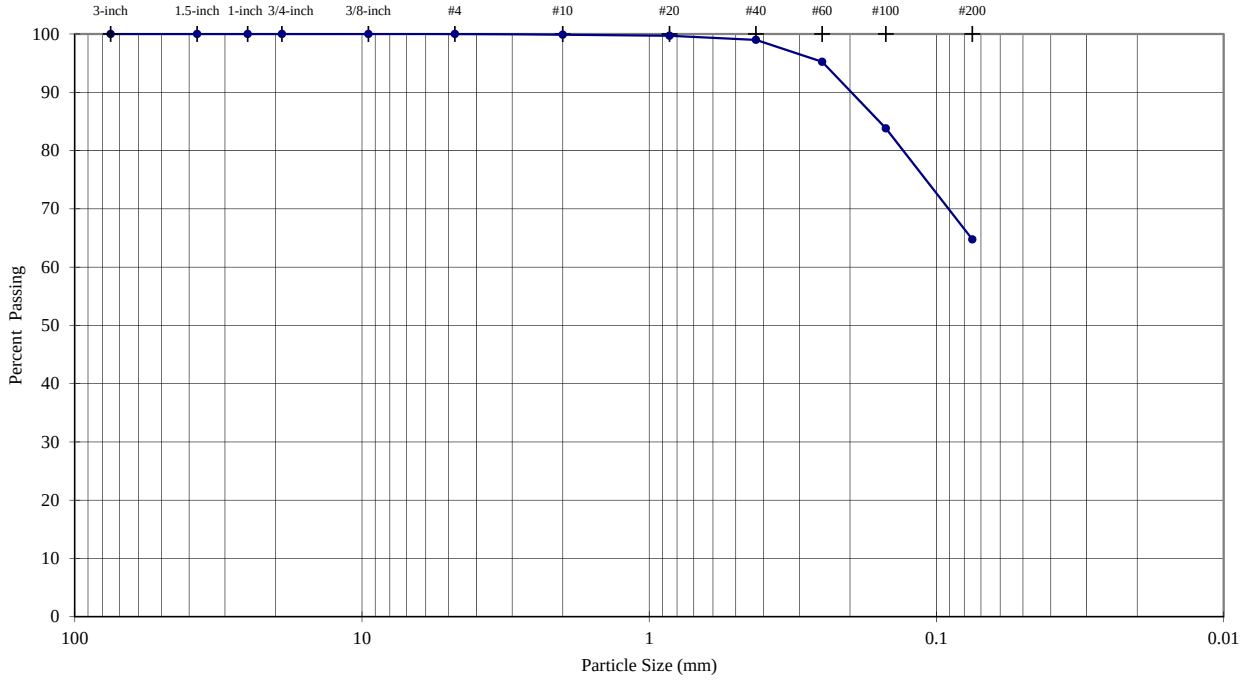
Golder Associates

April-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

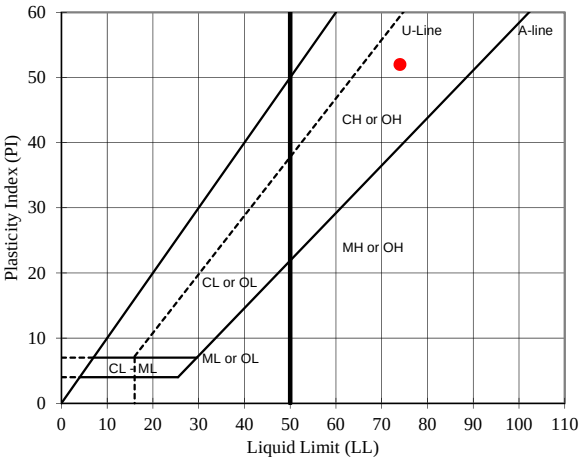
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-6 / S4** DEPTH (ft.): **20-21.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.9**
#20	0.850	**99.7**
#40	0.425	**99.0**
#60	0.250	**95.2**
#100	0.150	**83.8**
#200	0.075	**64.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.12**
Medium Sand	**0.89**
Fine Sand	**34.24**
Silt or Clay Fines	**64.75**



USCS Description (ASTM D 2487):

Sandy fat clay, light olive brown, dry

LL	PL	PI	SpG
74	**22**	**52**	**2.52**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

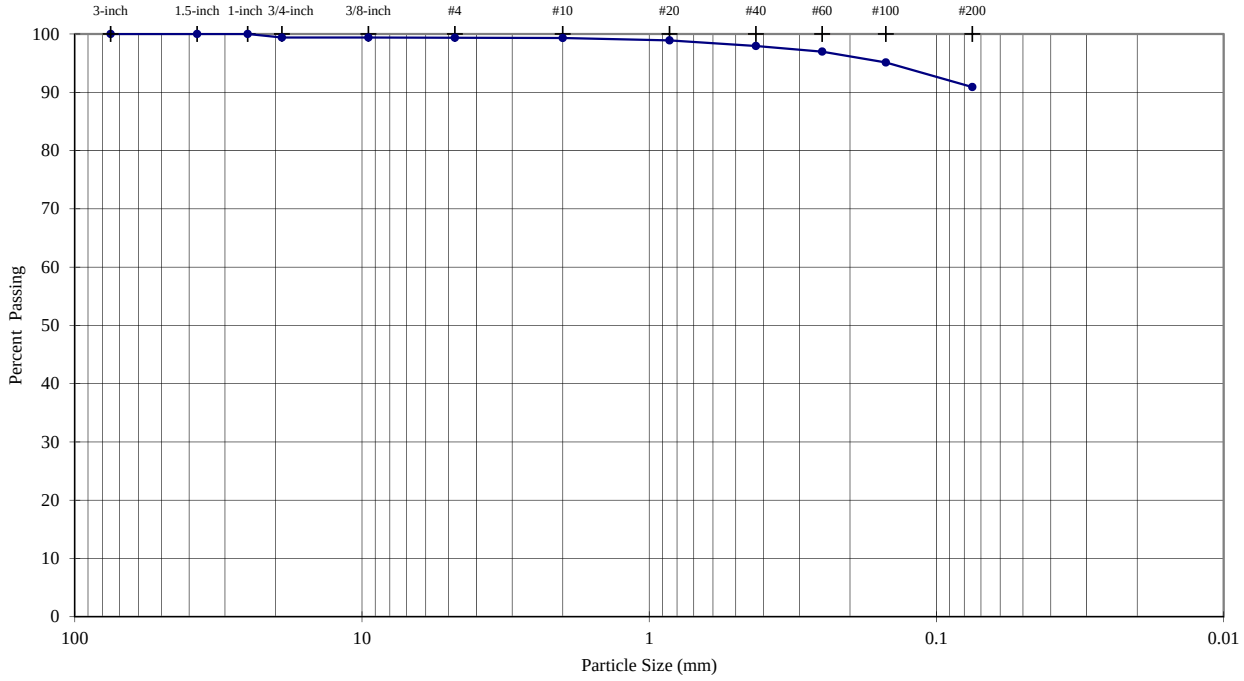
TECH	BC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

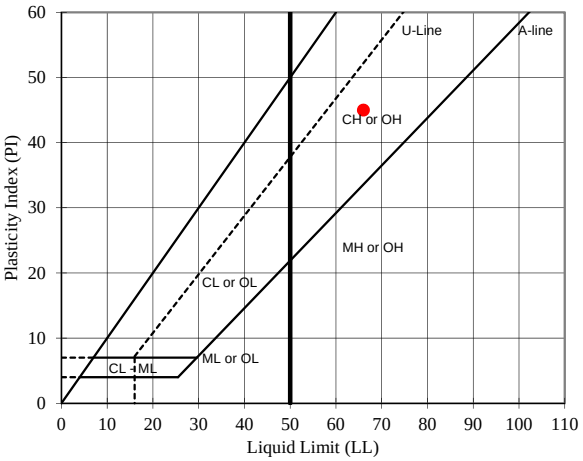
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-7 Combined / S5, S6 & S7** DEPTH (ft.): --
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**99.4**
3/8-inch	9.5	**99.4**
#4	4.75	**99.4**
#10	2.00	**99.3**
#20	0.85	**98.9**
#40	0.43	**97.9**
#60	0.25	**97.0**
#100	0.15	**95.1**
#200	0.075	**90.9**

Description	Percentage
Coarse Gravel	**0.60**
Fine Gravel	**0.04**
Coarse Sand	**0.05**
Medium Sand	**1.37**
Fine Sand	**7.05**
Silt or Clay Fines	**90.89**



USCS Description (ASTM D 2487):

Fat clay, light yellowish brown, moist

LL	PL	PI
66	**21**	**45**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 25.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

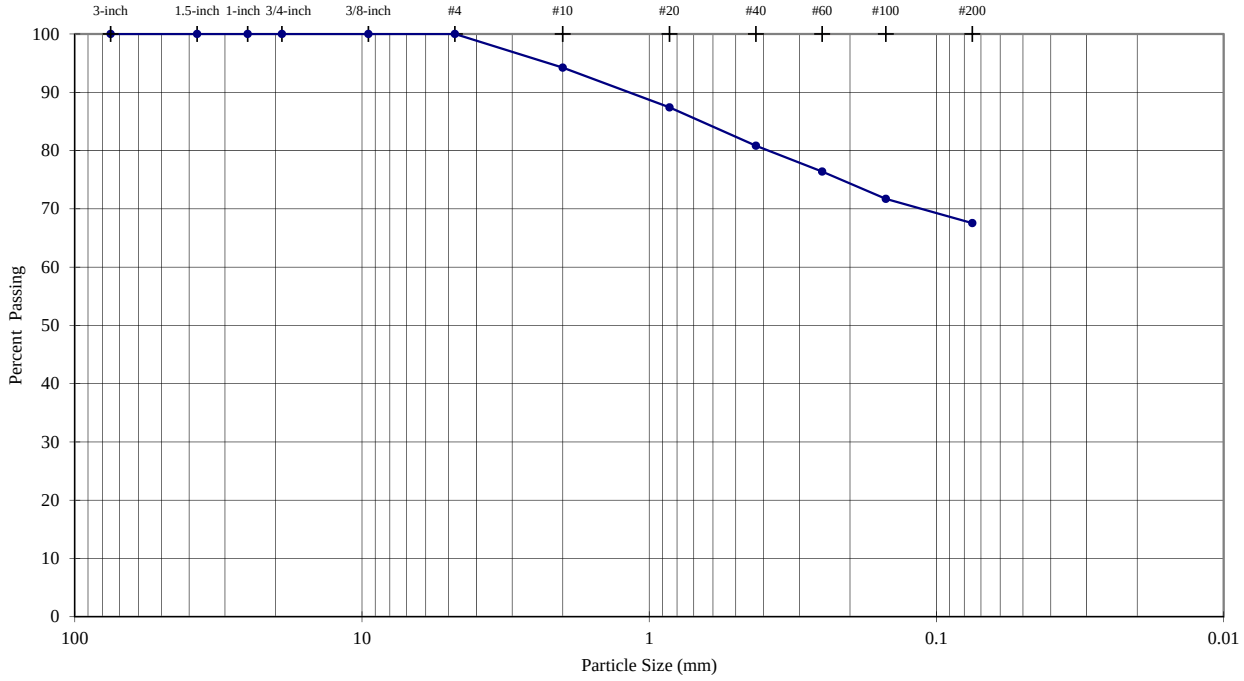
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

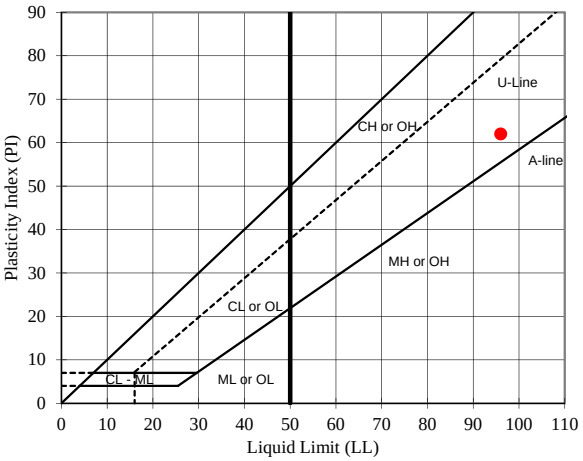
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-9/ S5** DEPTH (ft): **25-26.5**
TYPE: **Bag**



Sieve Analysis

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**94.2**
#20	0.850	**87.4**
#40	0.425	**80.8**
#60	0.250	**76.4**
#100	0.150	**71.7**
#200	0.075	**67.5**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**5.78**
Medium Sand	**13.41**
Fine Sand	**13.27**
Silt or Clay Fines	**67.54**



USCS Description (ASTM D 2487):

Sandy fat clay, dark yellowish brown, moist

LL	PL	PI
96	**34**	**62**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

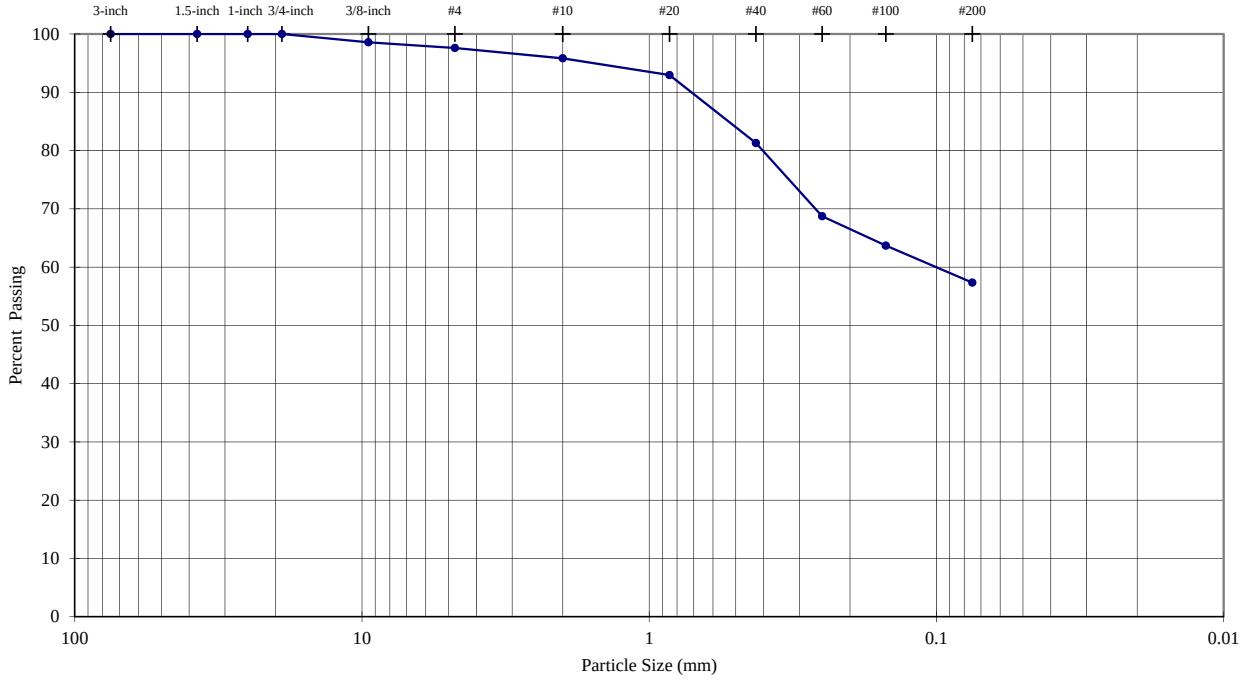
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

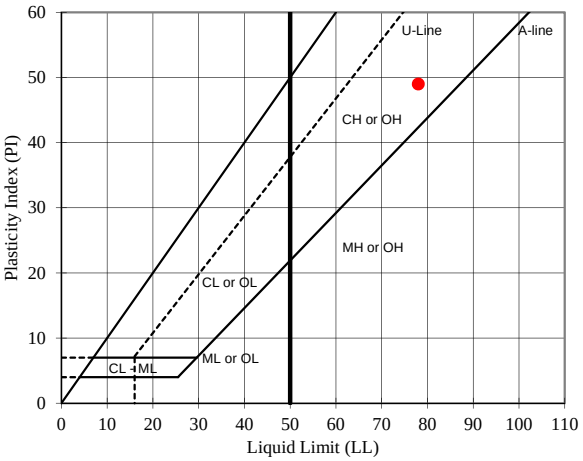
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-11/ S2** DEPTH (ft.): **10-11.5**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**98.6**
#4	4.75	**97.6**
#10	2.00	**95.8**
#20	0.85	**92.9**
#40	0.43	**81.3**
#60	0.25	**68.7**
#100	0.15	**63.7**
#200	0.075	**57.3**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**2.40**
Coarse Sand	**1.78**
Medium Sand	**14.53**
Fine Sand	**23.96**
Silt or Clay Fines	**57.33**



USCS Description (ASTM D 2487):

Sandy fat clay, light yellowish brown, moist

LL	PL	PI
78	**29**	**49**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 19.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

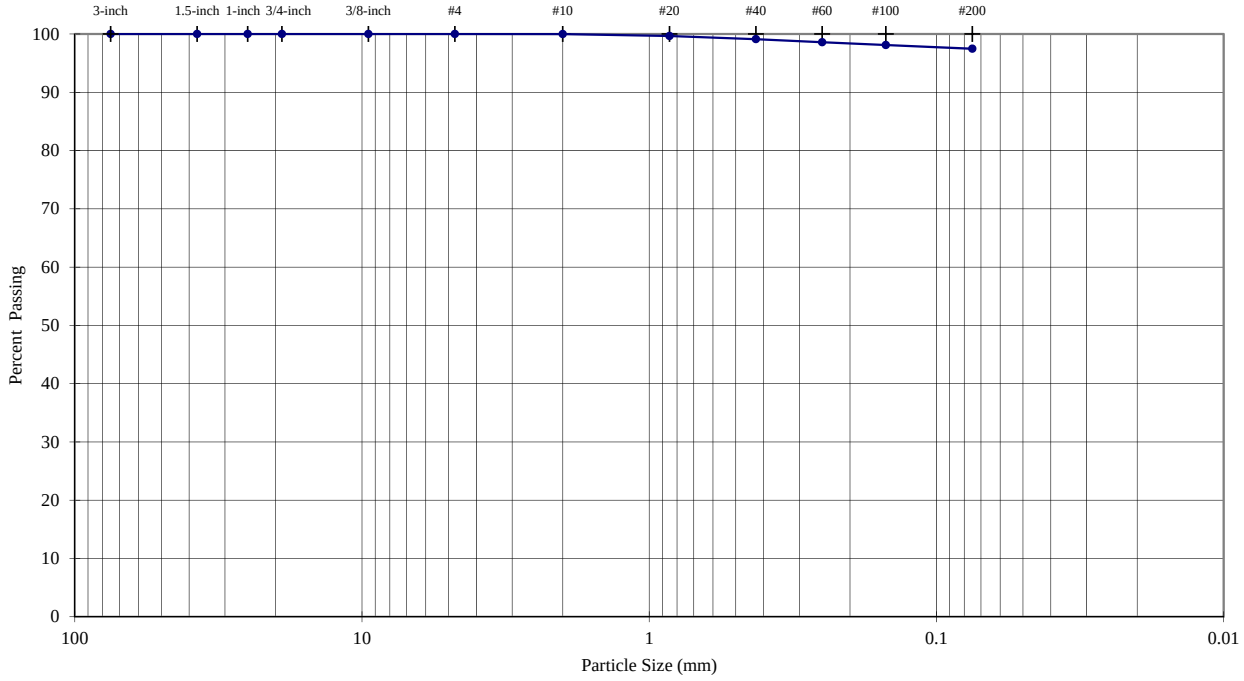
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

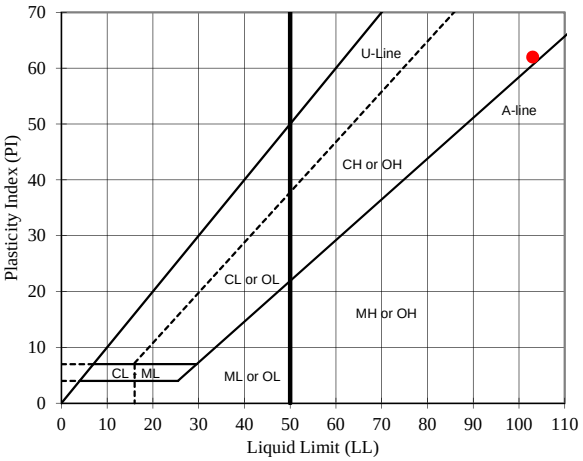
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-12 / S6** DEPTH (ft): **30-31.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**100.0**
#20	0.850	**99.7**
#40	0.425	**99.1**
#60	0.250	**98.6**
#100	0.150	**98.1**
#200	0.075	**97.5**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.01**
Medium Sand	**0.88**
Fine Sand	**1.65**
Silt or Clay Fines	**97.47**



USCS Description (ASTM D 2487):

Fat clay, gray, moist

LL	PL	PI
103	**41**	**62**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

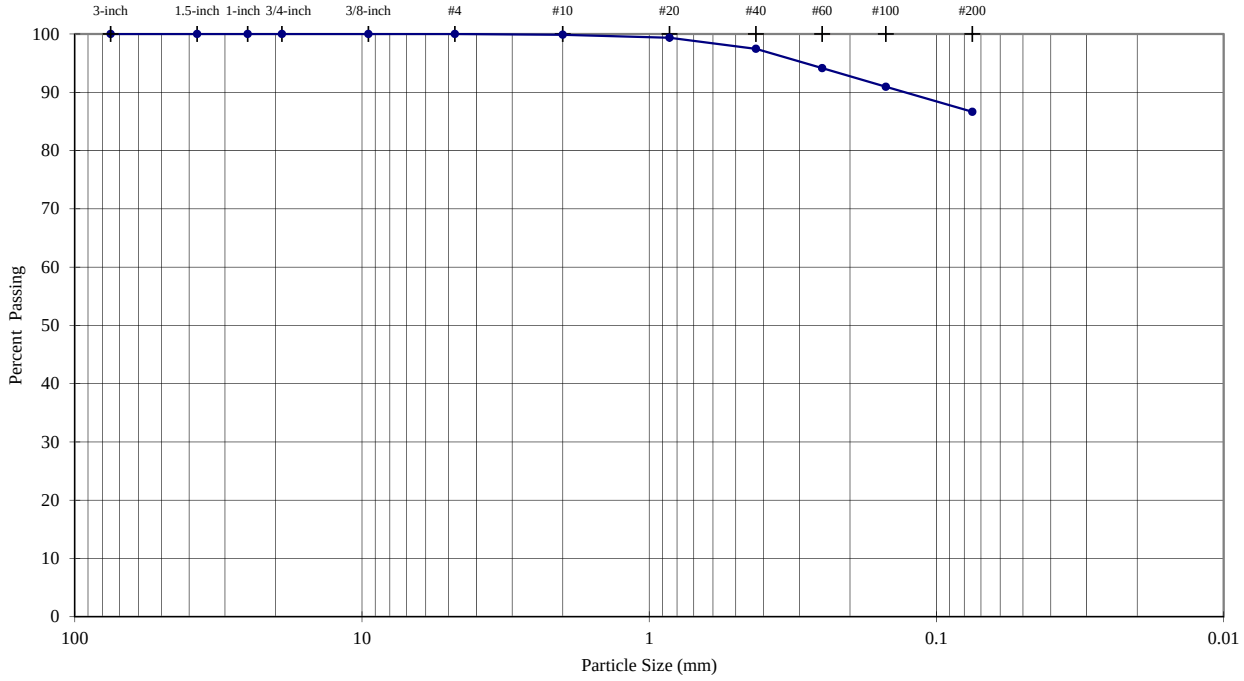
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 1663241.11000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

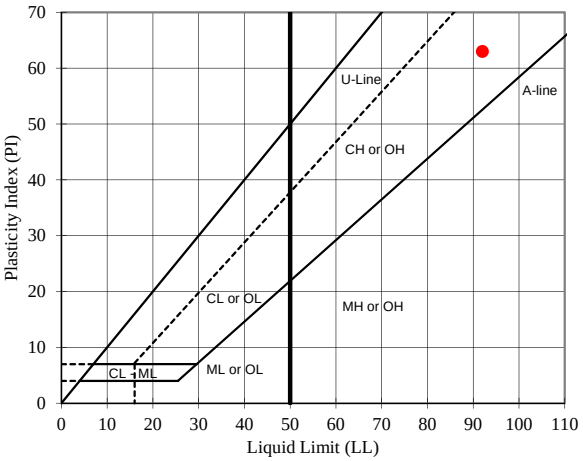
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-13 / S1** DEPTH (ft): **5-6.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.9**
#20	0.850	**99.4**
#40	0.425	**97.5**
#60	0.250	**94.1**
#100	0.150	**90.9**
#200	0.075	**86.6**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.13**
Medium Sand	**2.42**
Fine Sand	**10.81**
Silt or Clay Fines	**86.64**



USCS Description (ASTM D 2487):

Fat clay, light yellowish brown, moist

LL	PL	PI
92	**29**	**63**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

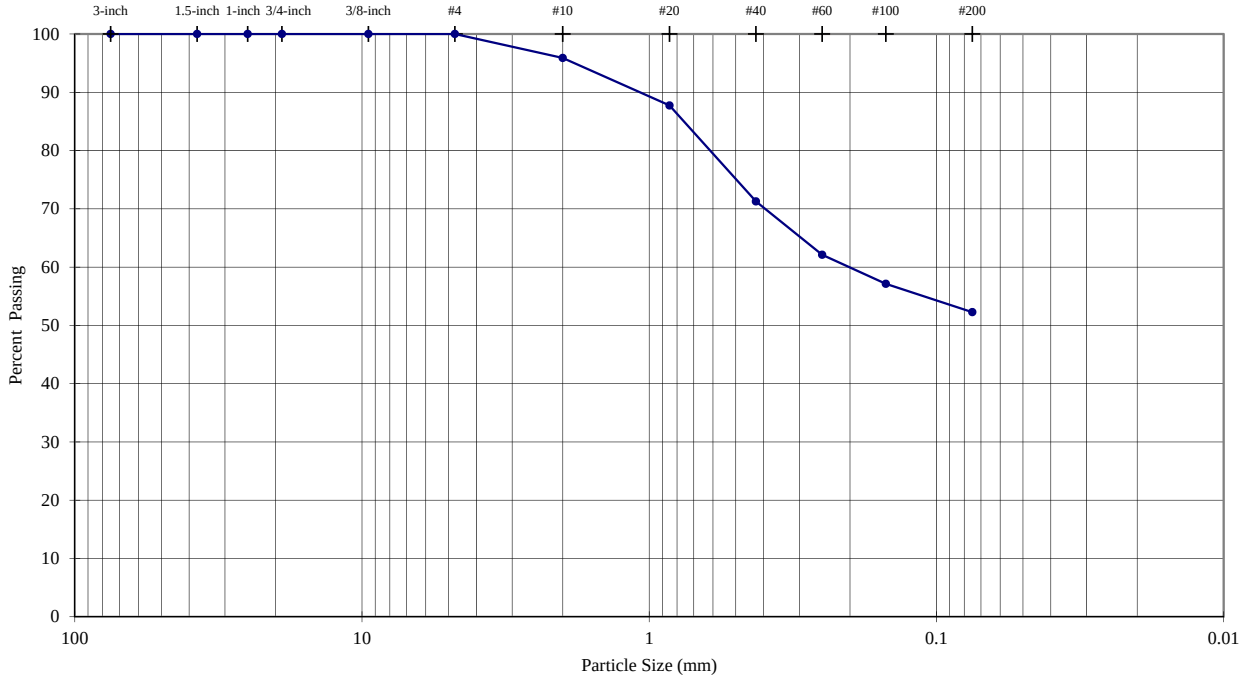
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

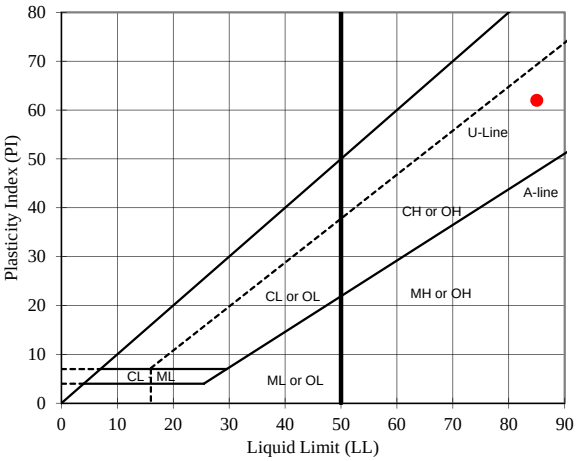
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-13 / S3** DEPTH (ft): **15-16.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**95.9**
#20	0.850	**87.7**
#40	0.425	**71.3**
#60	0.250	**62.1**
#100	0.150	**57.1**
#200	0.075	**52.3**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**4.12**
Medium Sand	**24.62**
Fine Sand	**19.00**
Silt or Clay Fines	**52.27**



USCS Description (ASTM D 2487):

Sandy fat clay, light brown, moist

LL	PL	PI
85	**23**	**62**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

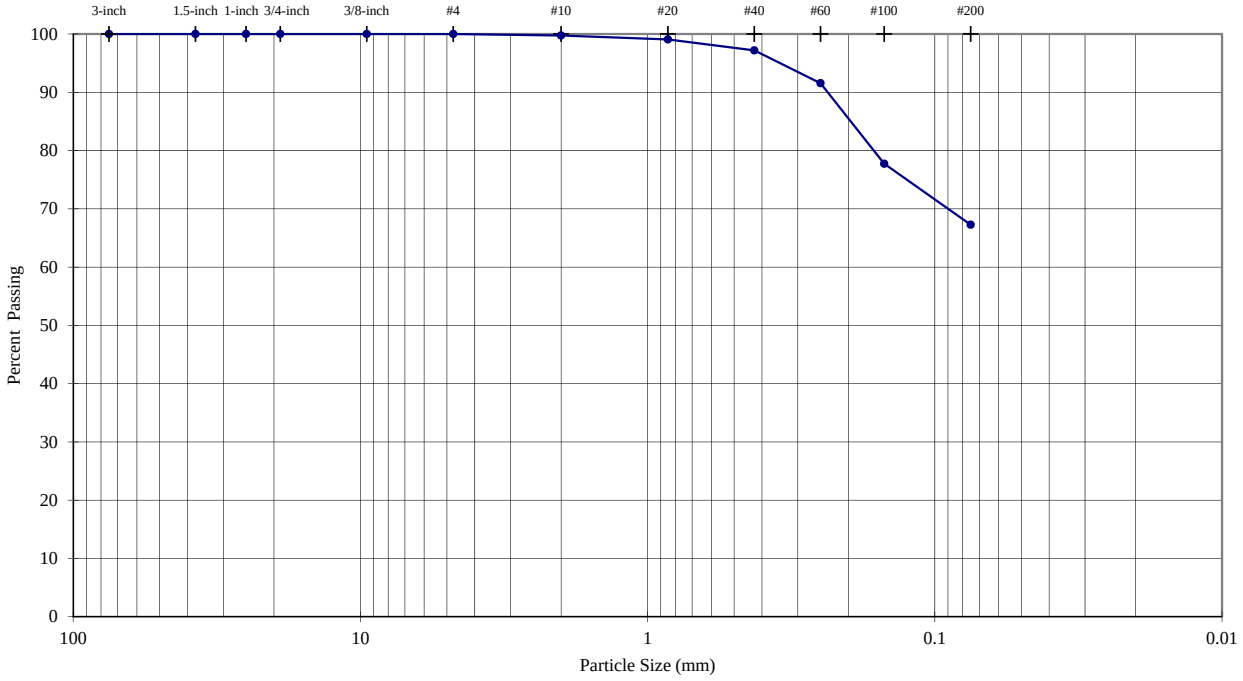
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

March-18 1663241.11000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

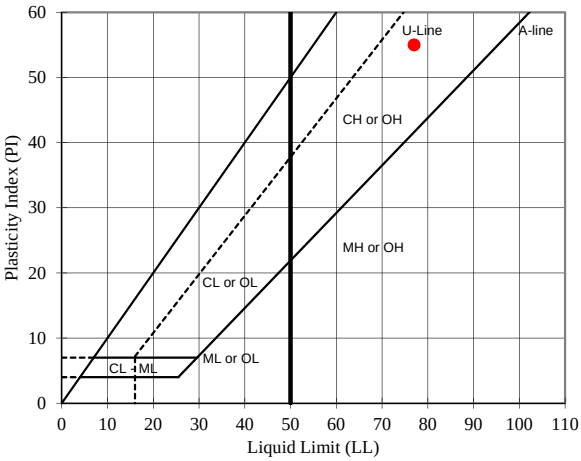
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-13 / S5** DEPTH (ft): **25-26.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.7**
#20	0.850	**99.1**
#40	0.425	**97.2**
#60	0.250	**91.5**
#100	0.150	**77.7**
#200	0.075	**67.3**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.26**
Medium Sand	**2.55**
Fine Sand	**29.92**
Silt or Clay Fines	**67.27**



USCS Description (ASTM D 2487):

Sandy fat clay, light yellowish brown, moist

LL	PL	PI
77	**22**	**55**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

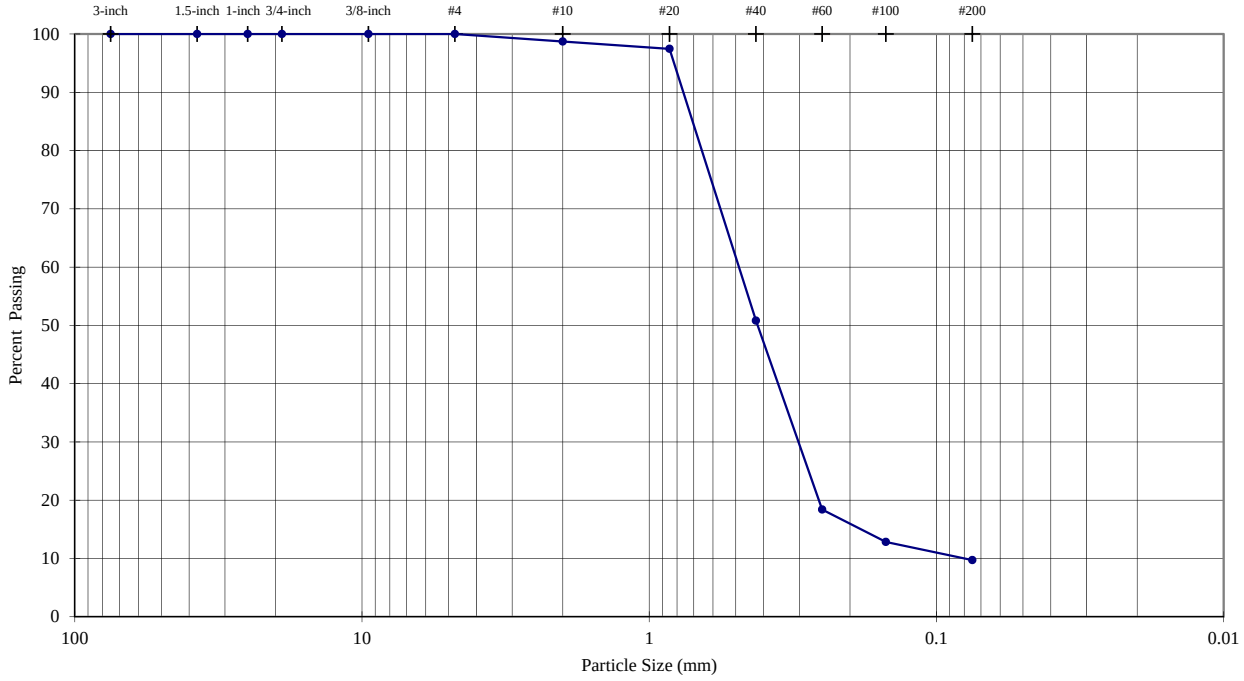
TECH	EH
DATE	13-Mar-2018
REVIEW	PRH

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

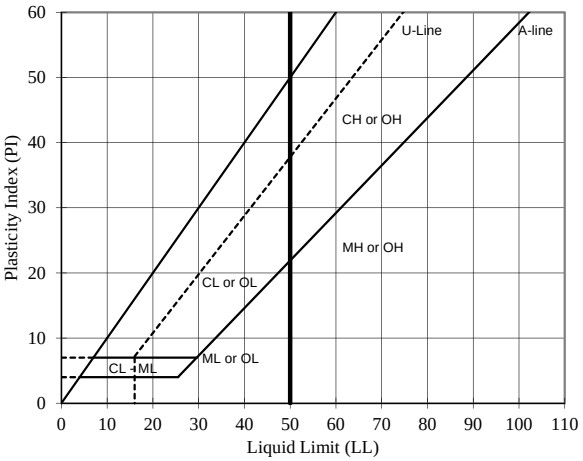
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-14 / S2, S3 COMB** DEPTH (ft): **10-11.5 & 15-16.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**98.7**
#20	0.850	**97.5**
#40	0.425	**50.8**
#60	0.250	**18.4**
#100	0.150	**12.8**
#200	0.075	**9.7**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**1.29**
Medium Sand	**47.90**
Fine Sand	**41.09**
Silt or Clay Fines	**9.72**



USCS Description (ASTM D 2487):

Well-graded sand with silt, tan, dry

LL	PL	PI
NP	**NP**	**NP**

As-Received Moisture Content (%): --

USCS Group Symbol: SW-SM

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

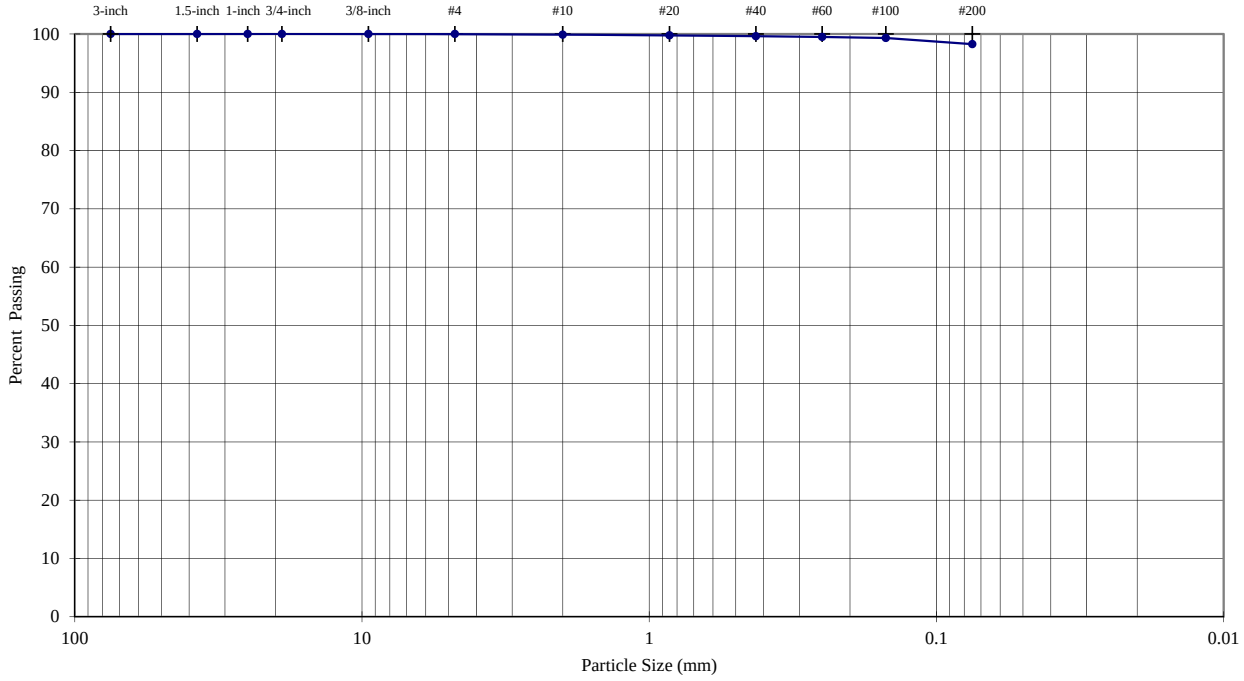
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

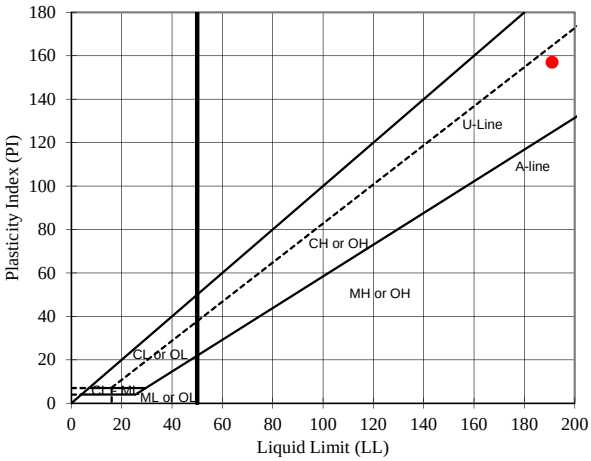
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-15 / S2** DEPTH (ft): **25-26.5**
TYPE: **Tube**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.9**
#20	0.850	**99.8**
#40	0.425	**99.6**
#60	0.250	**99.5**
#100	0.150	**99.3**
#200	0.075	**98.3**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.12**
Medium Sand	**0.27**
Fine Sand	**1.36**
Silt or Clay Fines	**98.25**



USCS Description (ASTM D 2487):

Fat clay, light olive gray, dry

LL	PL	PI	SpG
191	**34**	**157**	**2.76**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	12-Mar-2018
REVIEW	PRH

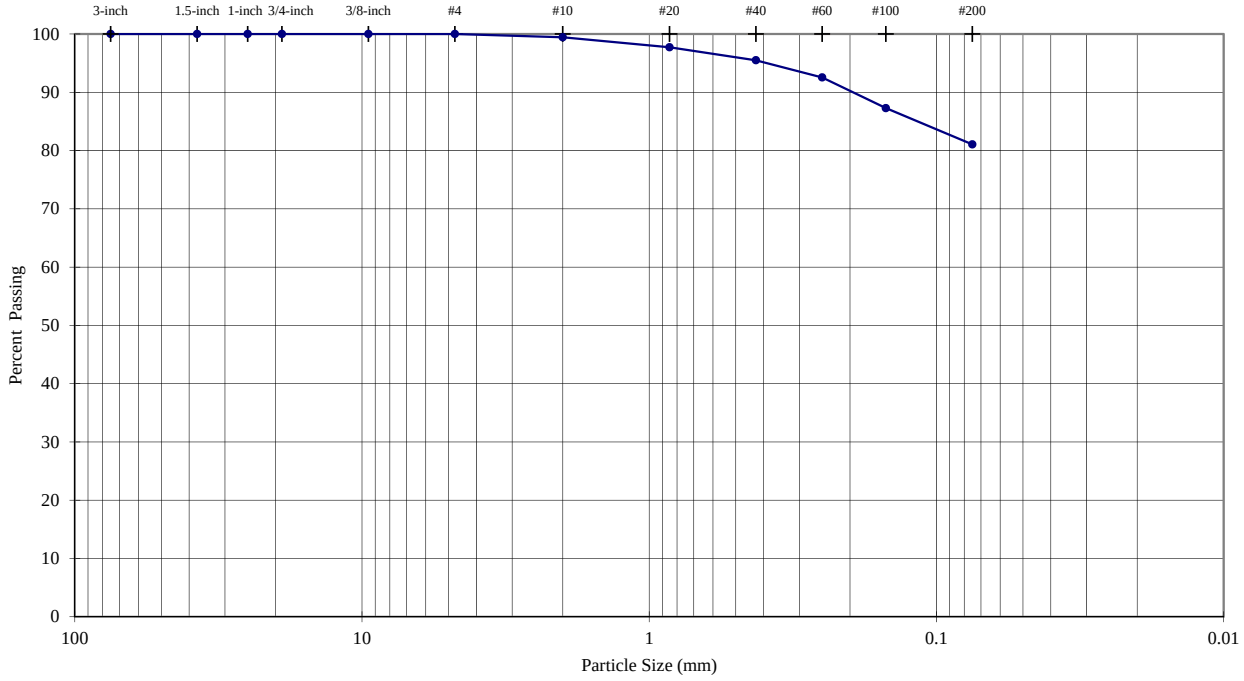
Golder Associates

April-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

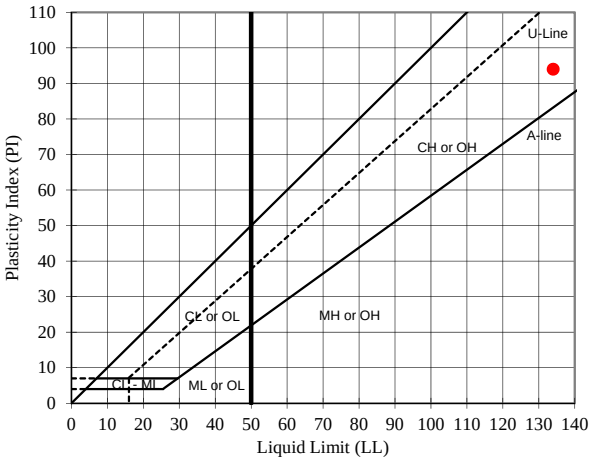
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH-15 / S-1** DEPTH (ft.): **15-16.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.4**
#20	0.850	**97.7**
#40	0.425	**95.5**
#60	0.250	**92.5**
#100	0.150	**87.3**
#200	0.075	**81.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.57**
Medium Sand	**3.94**
Fine Sand	**14.43**
Silt or Clay Fines	**81.06**



USCS Description (ASTM D 2487):

Lean clay with sand, olive, moist

LL	PL	PI
134	**40**	**94**

As-Received Moisture Content (%): --

USCS Group Symbol: CL

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

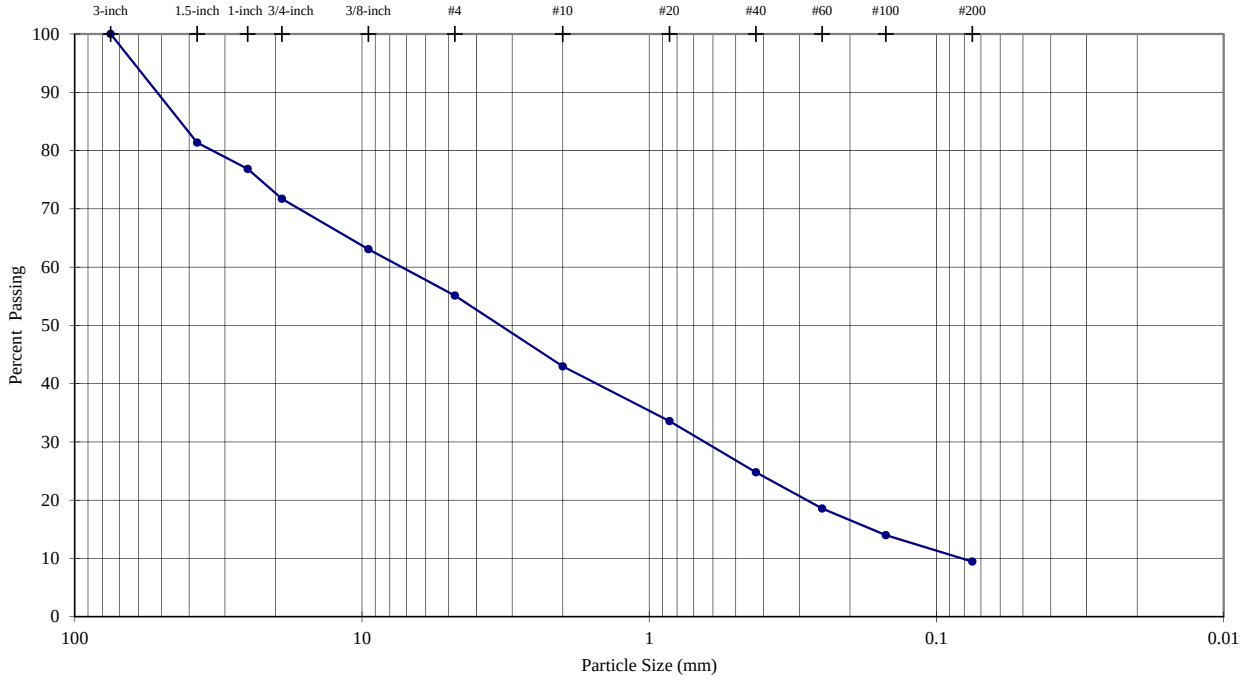
TECH	BC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

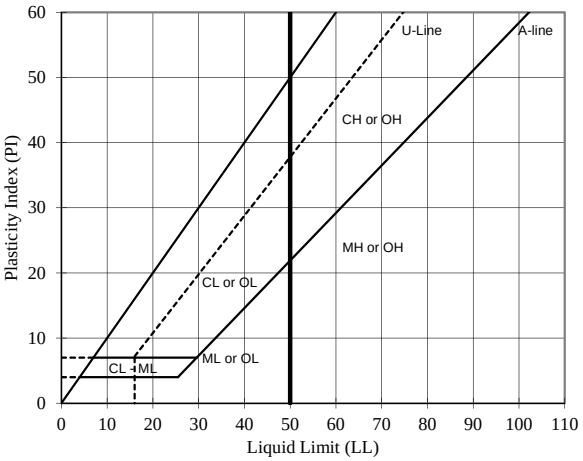
ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-02** DEPTH (ft.): **2-3**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**81.4**	Coarse Gravel	**28.29**
1-inch	25.0	**76.8**		
3/4-inch	19.0	**71.7**		
3/8-inch	9.5	**63.1**	Fine Gravel	**16.60**
#4	4.75	**55.1**		
#10	2.00	**43.0**	Coarse Sand	**12.14**
#20	0.85	**33.6**	Medium Sand	**18.18**
#40	0.43	**24.8**		
#60	0.25	**18.6**	Fine Sand	**15.33**
#100	0.15	**14.0**		
#200	0.075	**9.5**		
			Silt or Clay Fines	**9.46**

Sieve Analysis (Initial Separation on No. 4 Sieve)



USCS Description (ASTM D 2487):

Poorly graded sand with silt and gravel, yellowish brown, moist

LL	PL	PI
NP	**NP**	**NP**

As-Received Moisture Content (%): --

USCS Group Symbol: SP-SM

Notes: 0 g of particles up to 75.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

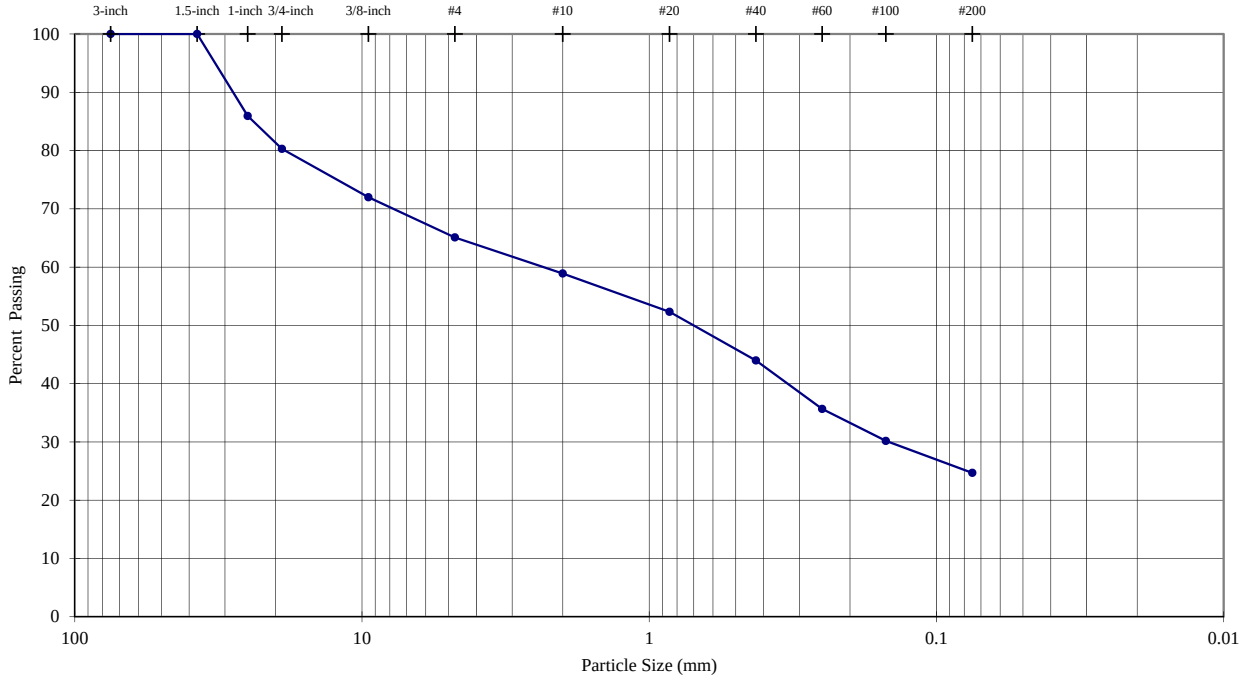
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

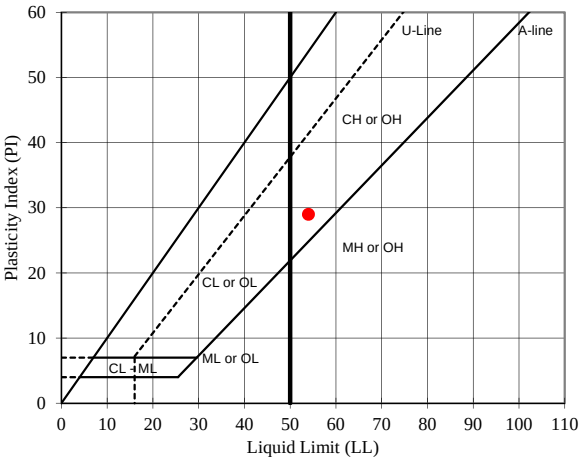
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-5** DEPTH (ft.): **8-9 & 13-14 COMB**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**85.9**
3/4-inch	19.0	**80.3**
3/8-inch	9.5	**72.0**
#4	4.75	**65.1**
#10	2.00	**58.9**
#20	0.850	**52.3**
#40	0.425	**44.0**
#60	0.250	**35.7**
#100	0.150	**30.2**
#200	0.075	**24.7**

Description	Percentage
Coarse Gravel	**19.71**
Fine Gravel	**15.20**
Coarse Sand	**6.18**
Medium Sand	**14.93**
Fine Sand	**19.29**
Silt or Clay Fines	**24.69**



USCS Description (ASTM D 2487):

Clayey sand with gravel, light olive brown, moist

LL	PL	PI
54	**25**	**29**

As-Received Moisture Content (%): **23.3**

USCS Group Symbol: SC

Notes: 0 g of particles up to 37.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

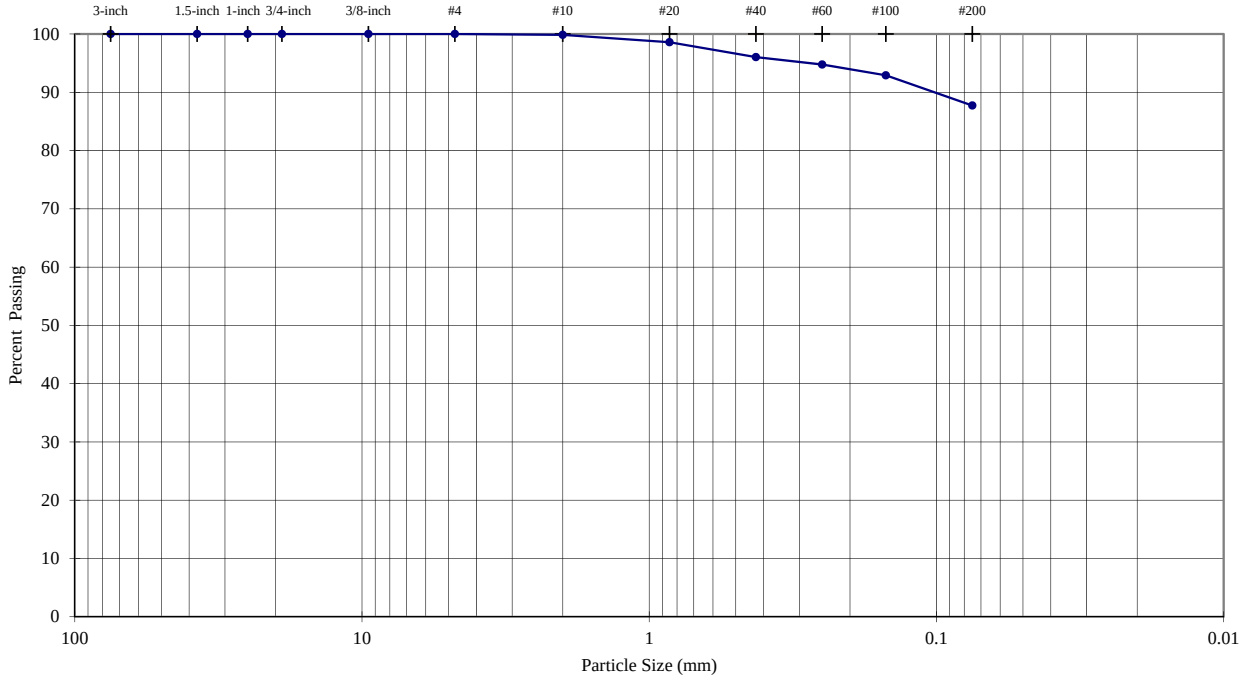
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

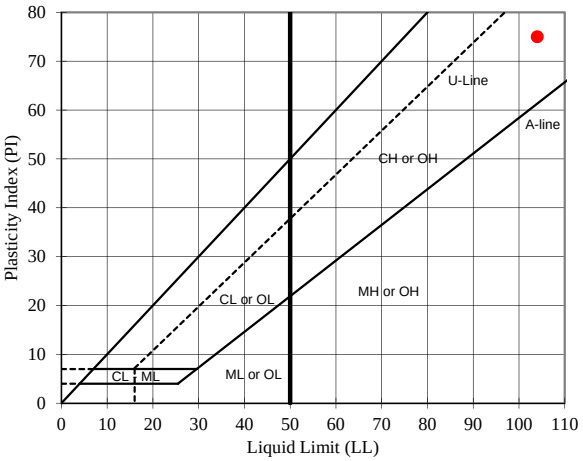
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-9** DEPTH (ft): **2-15**
TYPE: **Pail**



Sieve Analysis

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**99.8**
#20	0.850	**98.6**
#40	0.425	**96.0**
#60	0.250	**94.8**
#100	0.150	**92.9**
#200	0.075	**87.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.15**
Medium Sand	**3.81**
Fine Sand	**8.31**
Silt or Clay Fines	**87.72**



USCS Description (ASTM D 2487):

Fat clay, pale olive, moist

LL	PL	PI
104	**29**	**75**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

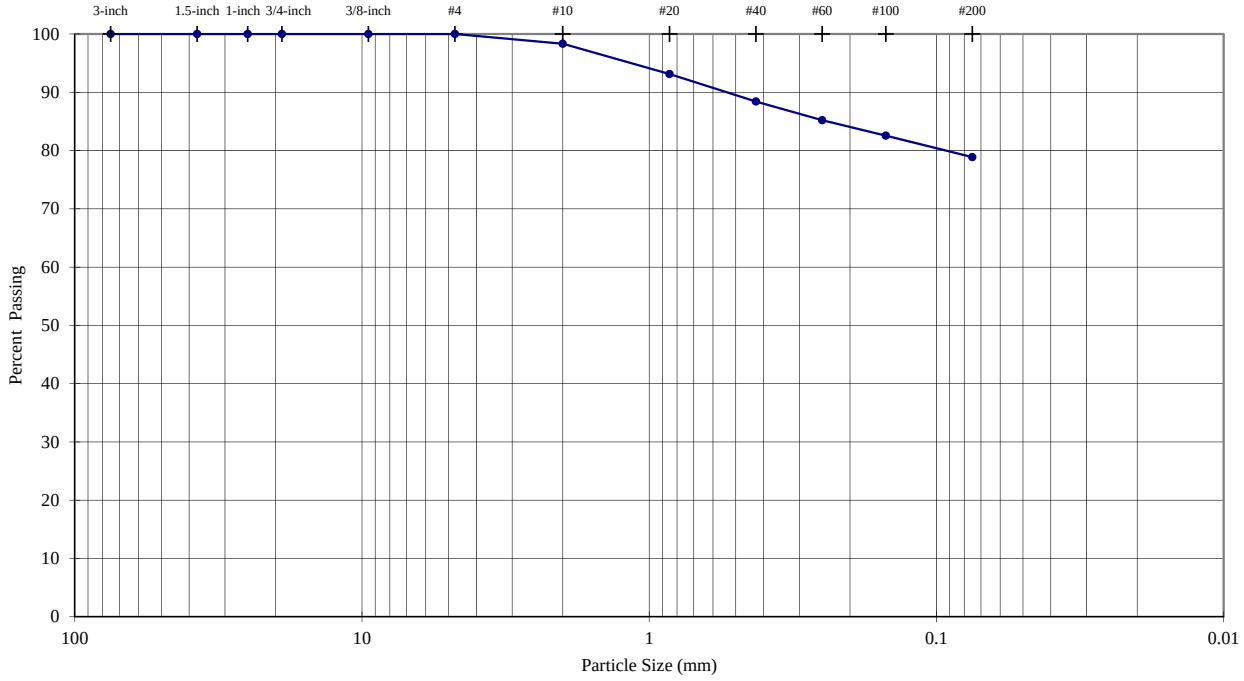
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

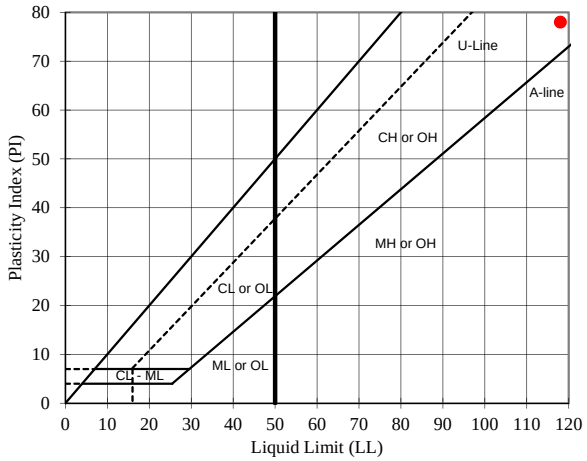
ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-11 / S2** DEPTH (ft): **12-14.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**	Coarse Gravel	**0.00**
1.5-inch	37.5	**100.0**		
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**98.3**	Coarse Sand	**1.67**
#20	0.850	**93.1**	Medium Sand	**9.92**
#40	0.425	**88.4**		
#60	0.250	**85.2**	Fine Sand	**9.54**
#100	0.150	**82.6**		
#200	0.075	**78.9**		
			Silt or Clay Fines	**78.87**

Sieve Analysis



USCS Description (ASTM D 2487):

Sandy clay, light yellowish brown, moist

LL	PL	PI
118	**40**	**78**

As-Received Moisture Content (%): --

USCS Group Symbol: 0

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

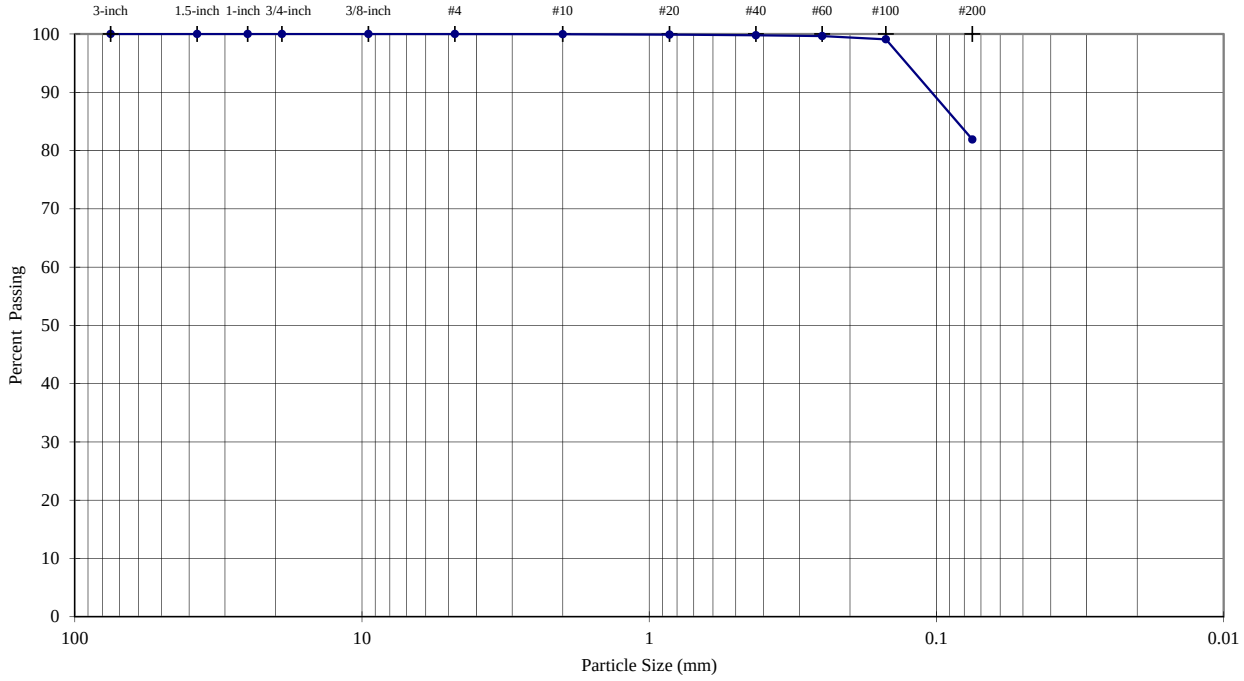
TECH	TC/JP
DATE	21-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

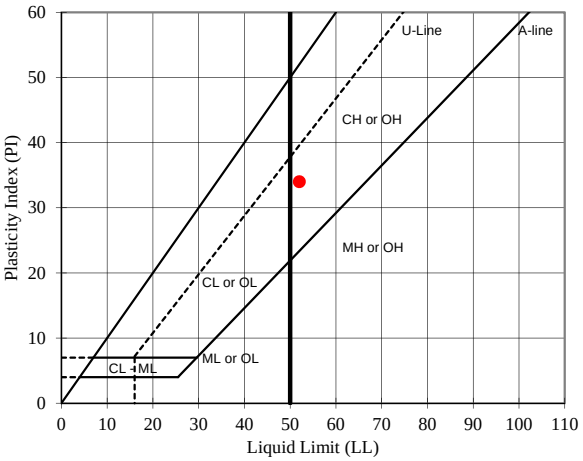
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-17** DEPTH (ft): **2-14**
TYPE: **Pail**



Sieve Analysis

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**100.0**
#20	0.850	**99.9**
#40	0.425	**99.8**
#60	0.250	**99.6**
#100	0.150	**99.1**
#200	0.075	**81.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.05**
Medium Sand	**0.17**
Fine Sand	**17.88**
Silt or Clay Fines	**81.90**



USCS Description (ASTM D 2487):

Fat clay with sand, light brown, moist

LL	PL	PI
52	**18**	**34**

As-Received Moisture Content (%): --

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

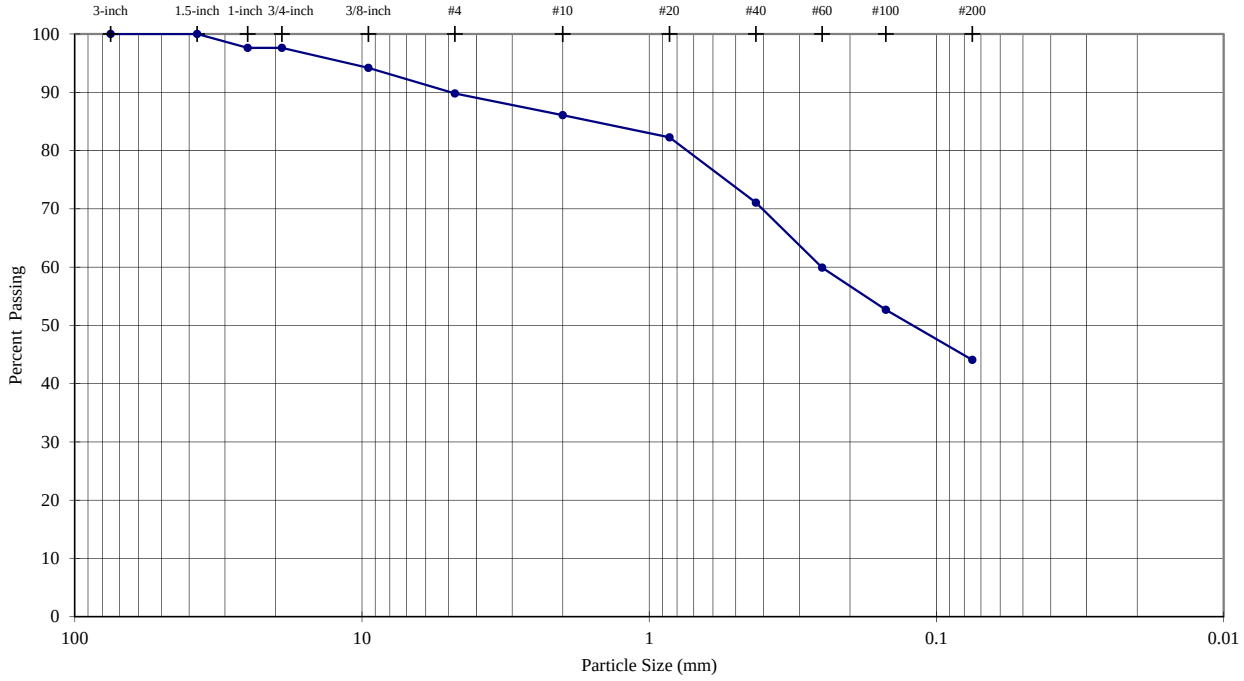
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

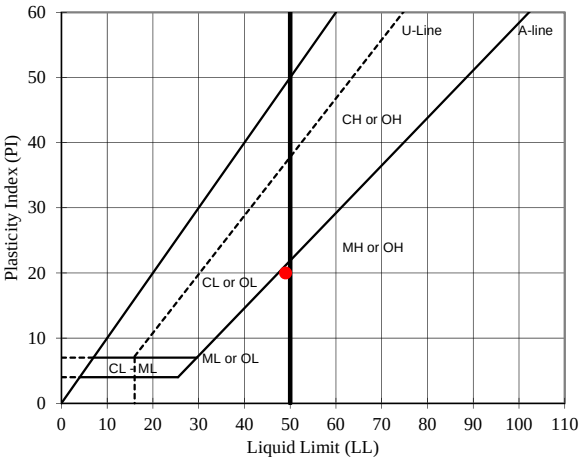
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-23** DEPTH (ft.): **2-3**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**97.6**
3/4-inch	19.0	**97.6**
3/8-inch	9.5	**94.2**
#4	4.75	**89.8**
#10	2.00	**86.1**
#20	0.85	**82.3**
#40	0.43	**71.0**
#60	0.25	**59.9**
#100	0.15	**52.7**
#200	0.075	**44.1**

Description	Percentage
Coarse Gravel	**2.39**
Fine Gravel	**7.82**
Coarse Sand	**3.73**
Medium Sand	**15.02**
Fine Sand	**26.98**
Silt or Clay Fines	**44.07**



USCS Description (ASTM D 2487):

Silty sand, light brown, dry

LL	PL	PI
49	**29**	**20**

As-Received Moisture Content (%): --

USCS Group Symbol: SM

Notes: 0 g of particles up to 37.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the wet/dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A/B Liquid Limit test performed using mechanical device

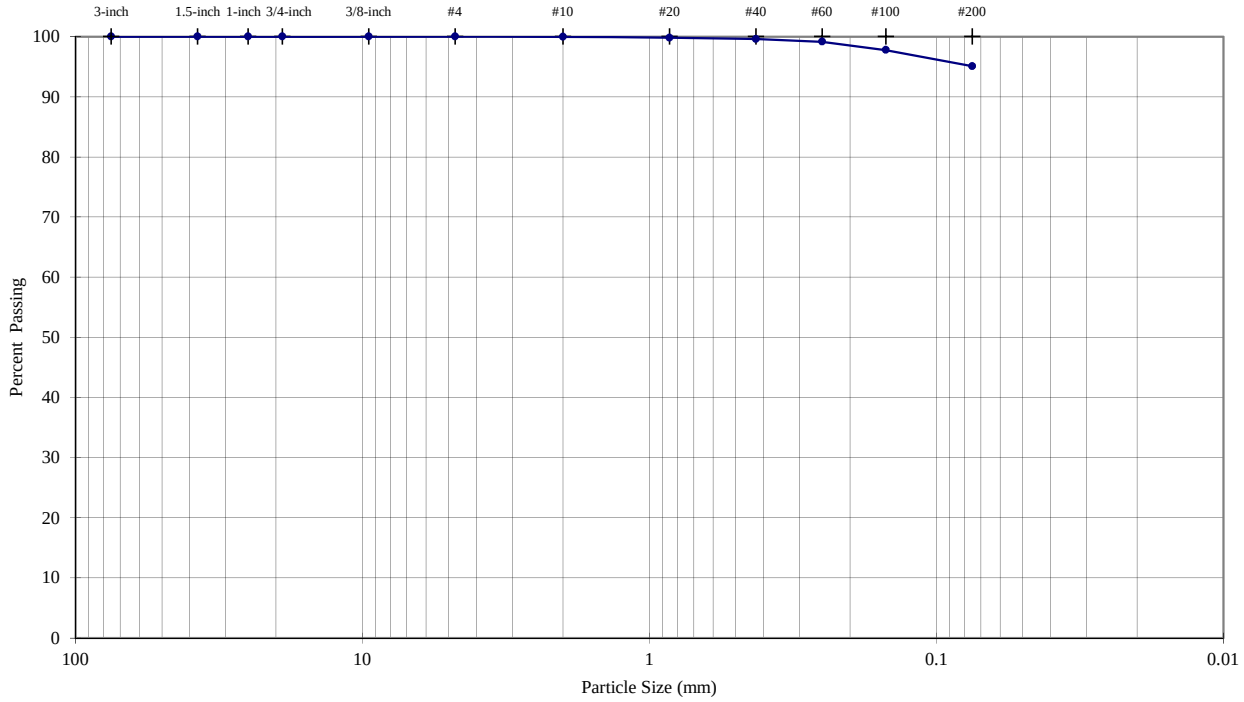
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

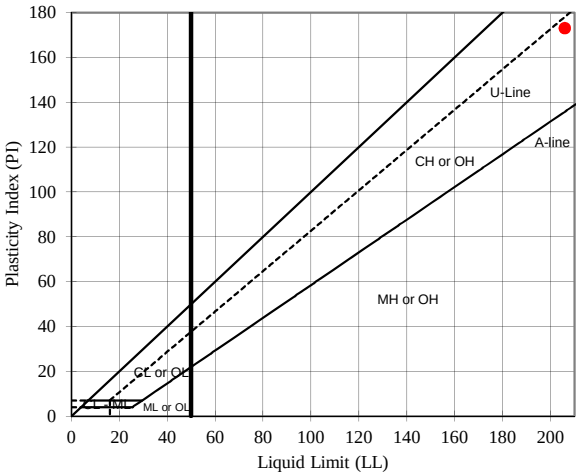
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-23** DEPTH (ft): **10-11**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.00	**100.0**
#20	0.850	**99.8**
#40	0.425	**99.6**
#60	0.250	**99.1**
#100	0.150	**97.7**
#200	0.075	**95.1**

Sieve Analysis

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.03**
Medium Sand	**0.37**
Fine Sand	**4.52**
Silt or Clay Fines	**95.08**



USCS Description (ASTM D 2487):

Fat clay, light olive, dry

LL	PL	PI
206	**33**	**173**

As-Received Moisture Content (%): **35.8**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

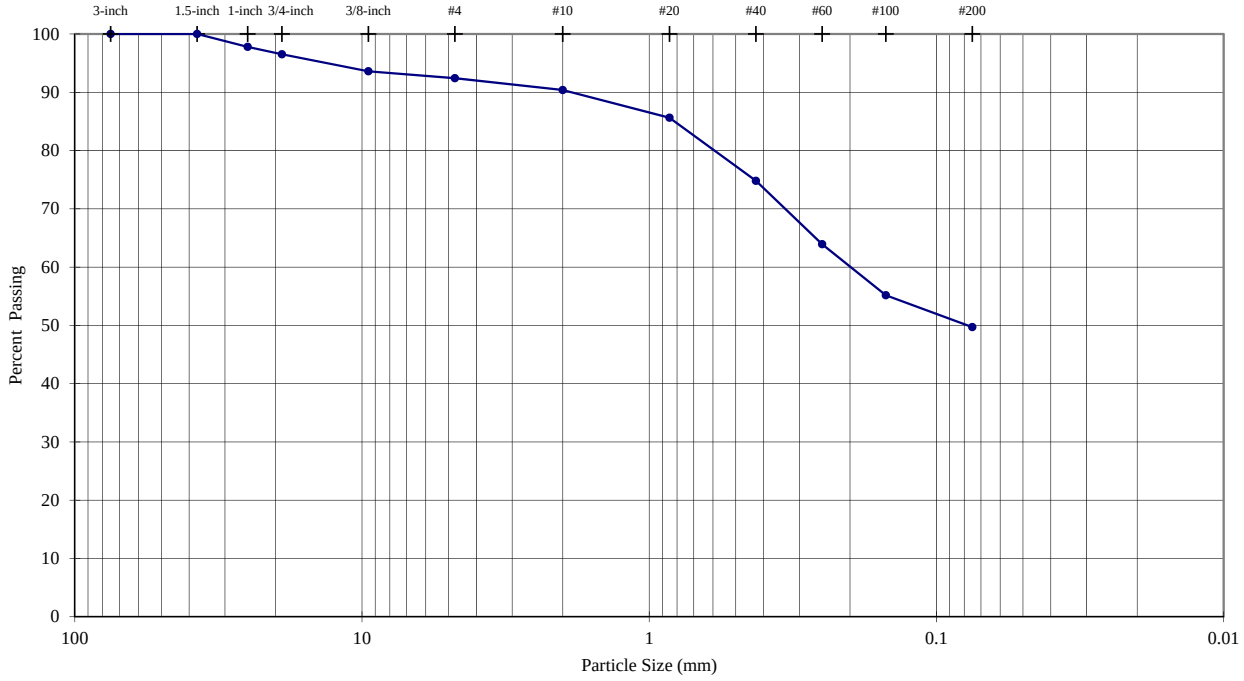
TECH	TC/JP
DATE	21-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

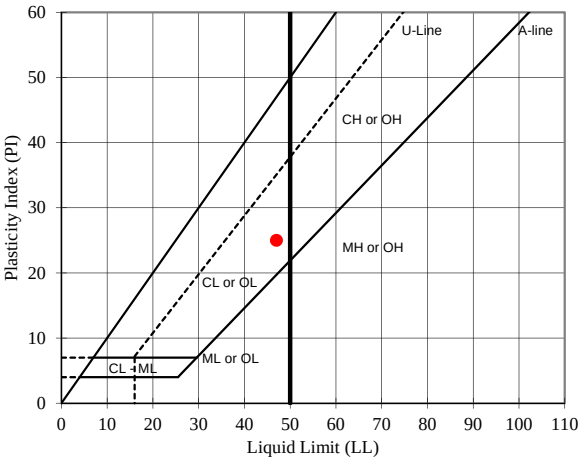
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-30** DEPTH (ft.): **1.5-2.5**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**97.8**
3/4-inch	19.0	**96.5**
3/8-inch	9.5	**93.6**
#4	4.75	**92.4**
#10	2.00	**90.4**
#20	0.850	**85.6**
#40	0.425	**74.8**
#60	0.250	**63.9**
#100	0.150	**55.2**
#200	0.075	**49.7**

Description	Percentage
Coarse Gravel	**3.48**
Fine Gravel	**4.11**
Coarse Sand	**2.03**
Medium Sand	**15.58**
Fine Sand	**25.10**
Silt or Clay Fines	**49.70**



USCS Description (ASTM D 2487):

Sandy lean clay, yellowish brown, moist

LL	PL	PI
47	**22**	**25**

As-Received Moisture Content (%): **11.9**

USCS Group Symbol: CL

Notes: 0 g of particles up to 37.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

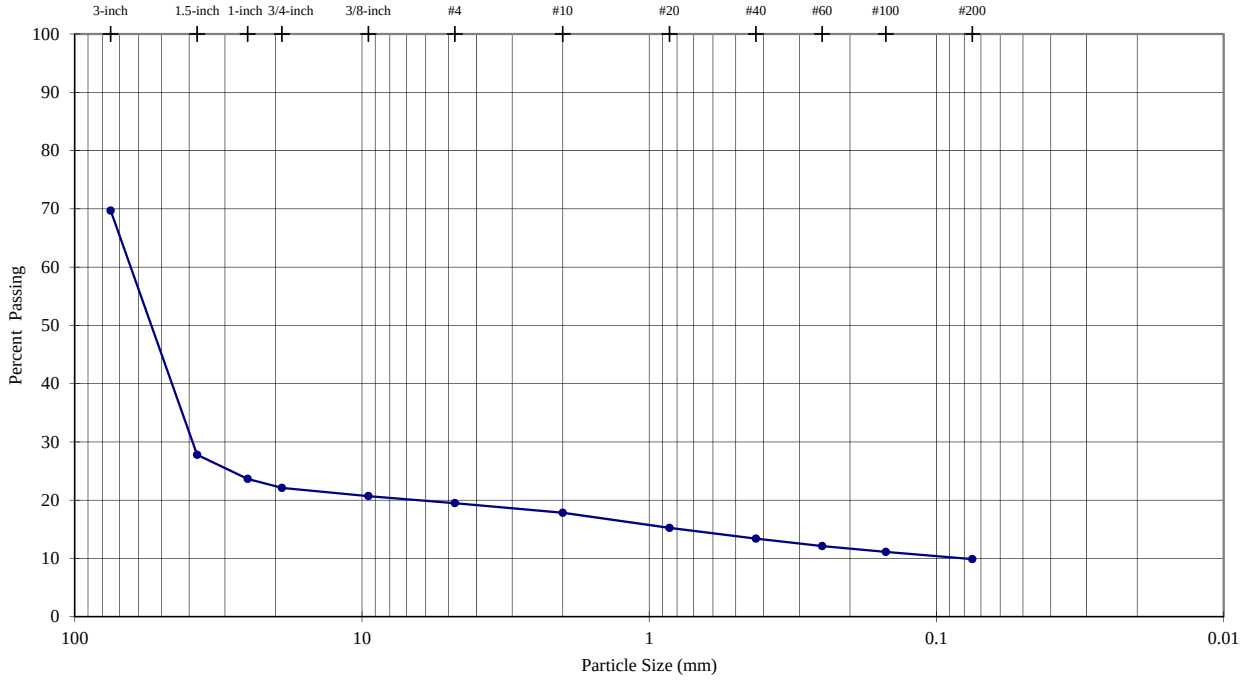
TECH	JP
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

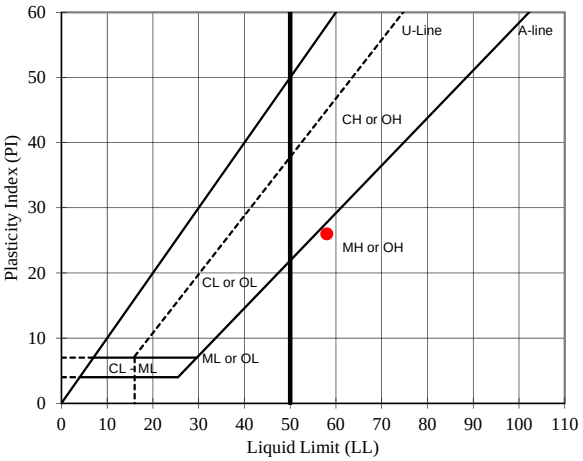
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-33 & TP-34** DEPTH (ft.): **4.5-5.5' & 1-3' COMB**
TYPE: **0**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**69.7**
1.5-inch	37.5	**27.8**
1-inch	25.0	**23.7**
3/4-inch	19.0	**22.1**
3/8-inch	9.5	**20.7**
#4	4.75	**19.5**
#10	2.00	**17.8**
#20	0.850	**15.3**
#40	0.425	**13.4**
#60	0.250	**12.1**
#100	0.150	**11.1**
#200	0.075	**9.9**

Description	Percentage
Coarse Gravel	**47.58**
Fine Gravel	**2.62**
Coarse Sand	**1.65**
Medium Sand	**4.44**
Fine Sand	**3.51**
Silt or Clay Fines	**9.89**



USCS Description (ASTM D 2487):

Silty gravel with cobbles, brown, moist

LL	PL	PI
58	**32**	**26**

As-Received Moisture Content (%): **19.8**

USCS Group Symbol: GM

Notes: 0 g of particles up to 75.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

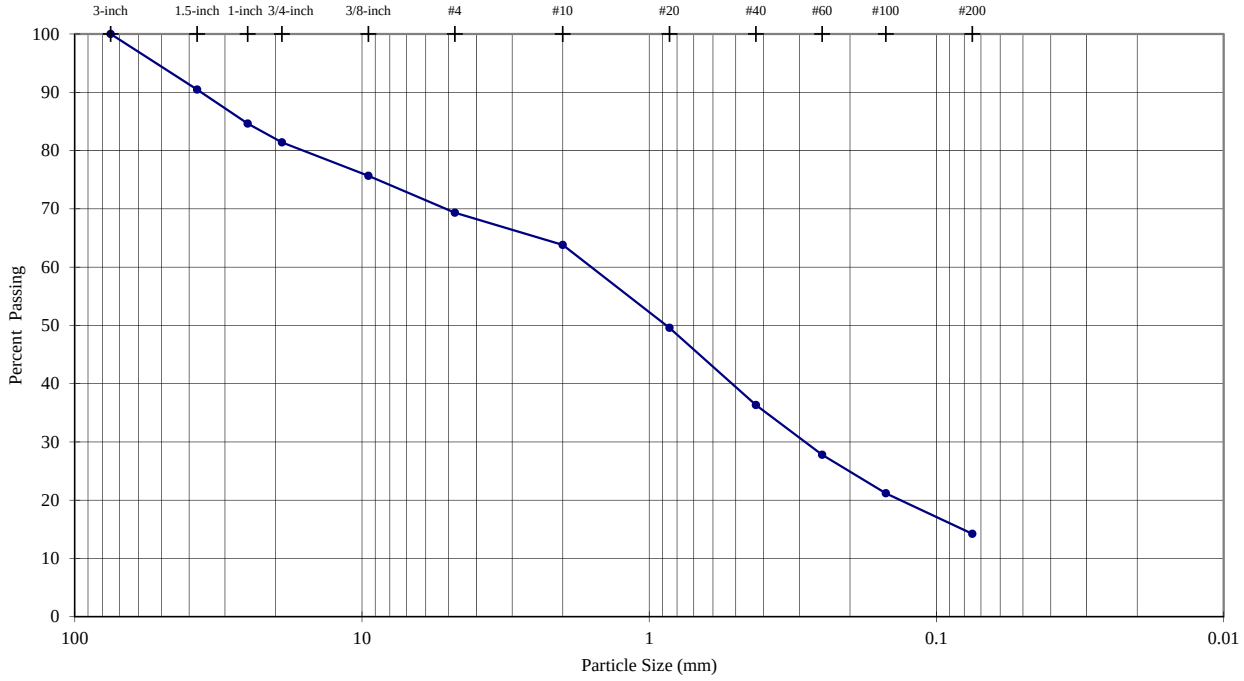
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

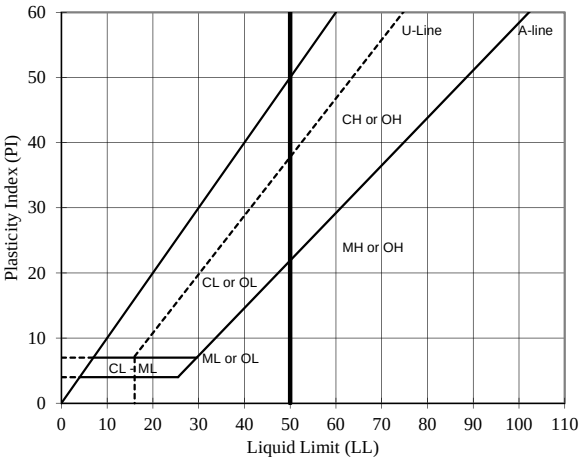
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-37** DEPTH (ft.): **3-9**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**90.5**
1-inch	25.0	**84.6**
3/4-inch	19.0	**81.4**
3/8-inch	9.5	**75.7**
#4	4.75	**69.3**
#10	2.00	**63.8**
#20	0.85	**49.6**
#40	0.43	**36.3**
#60	0.25	**27.8**
#100	0.15	**21.2**
#200	0.08	**14.2**

Description	Percentage
Coarse Gravel	**18.61**
Fine Gravel	**12.06**
Coarse Sand	**5.53**
Medium Sand	**27.47**
Fine Sand	**22.10**
Silt or Clay Fines	**14.23**



USCS Description (ASTM D 2487):

Silty sand with gravel, light brown, moist

LL	PL	PI
NP	**NP**	**NP**

As-Received Moisture Content (%): --

USCS Group Symbol: SM

Notes: 0 g of particles up to 75.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

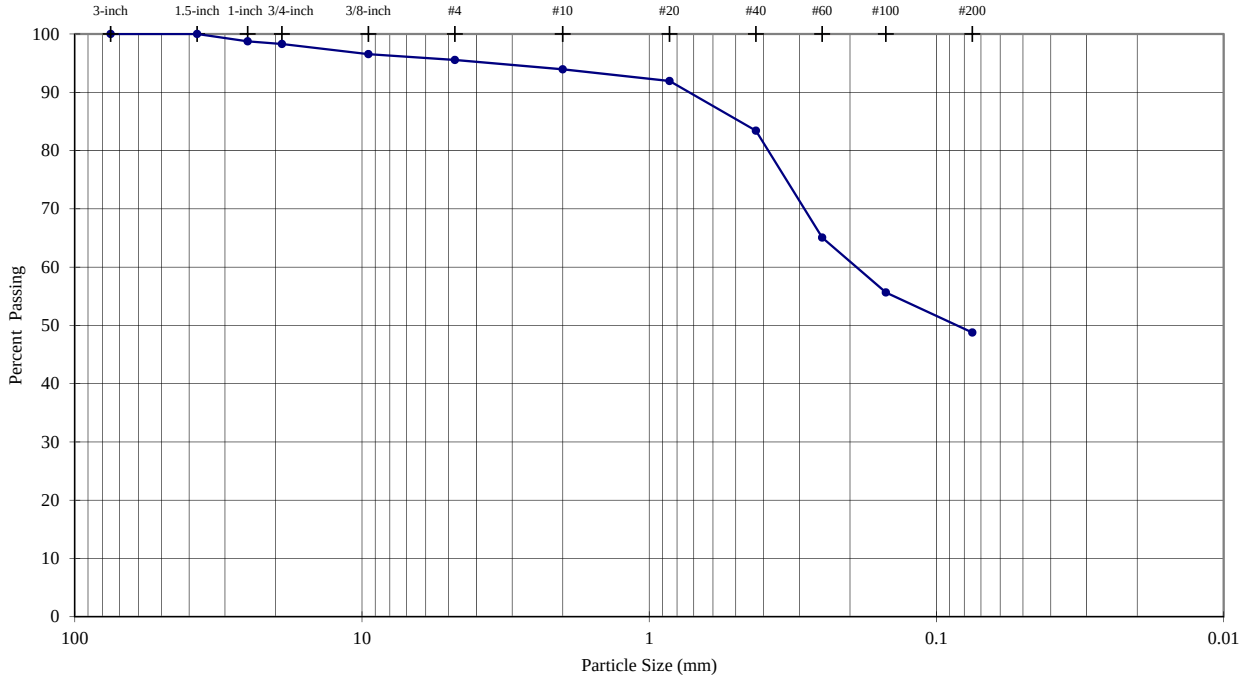
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

March-18 **1663241.11000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

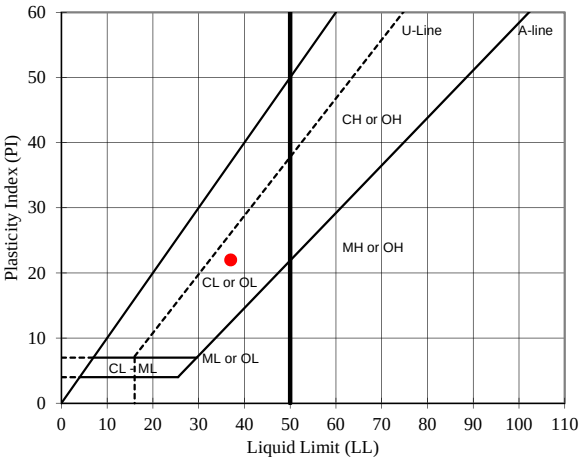
ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-41 / S1** DEPTH (ft.): **2-3**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**1.71**
1-inch	25.0	**98.7**		
3/4-inch	19.0	**98.3**		
3/8-inch	9.5	**96.5**	Fine Gravel	**2.74**
#4	4.75	**95.5**		
#10	2.00	**93.9**	Coarse Sand	**1.61**
#20	0.850	**91.9**	Medium Sand	**10.53**
#40	0.425	**83.4**		
#60	0.250	**65.1**	Fine Sand	**34.63**
#100	0.150	**55.6**		
#200	0.075	**48.8**		
			Silt or Clay Fines	**48.77**

Sieve Analysis (Initial Separation on No. 4 Sieve)



USCS Description (ASTM D 2487):

Clayey sand, dark brown, moist

LL	PL	PI
37	**15**	**22**

As-Received Moisture Content (%): **9.7**

USCS Group Symbol: SC

Notes: 0 g of particles up to 37.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

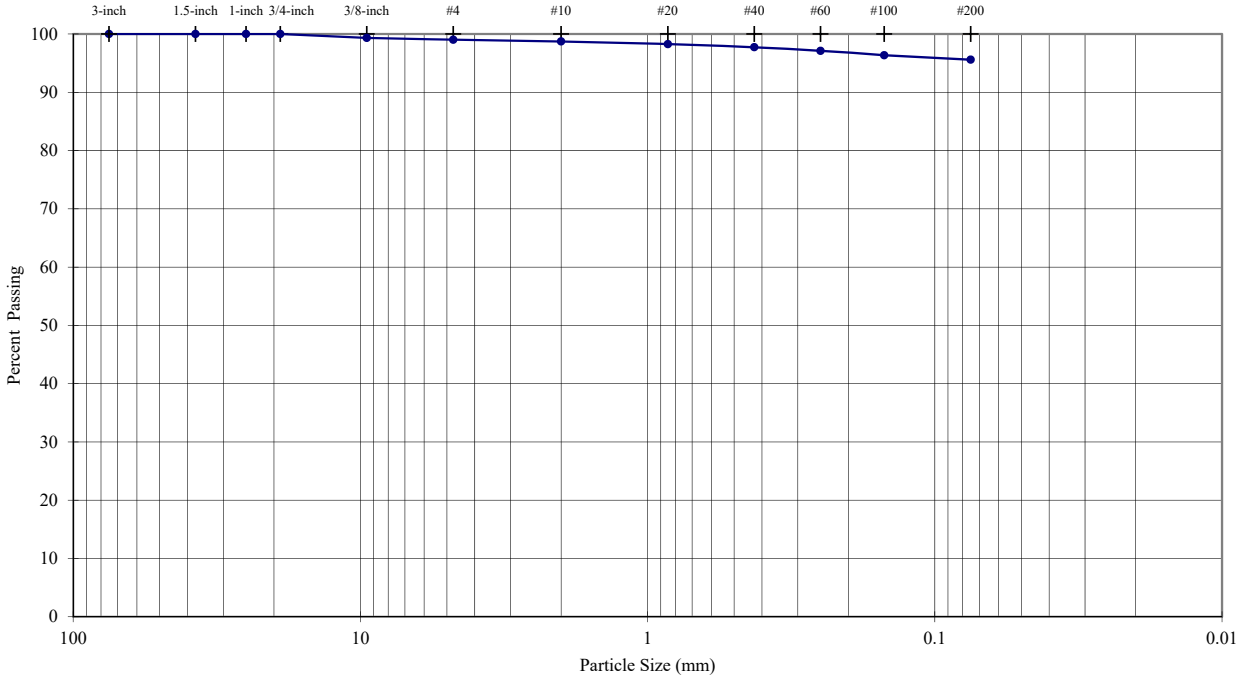
TECH	TC
DATE	20-Mar-2018
REVIEW	MB

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

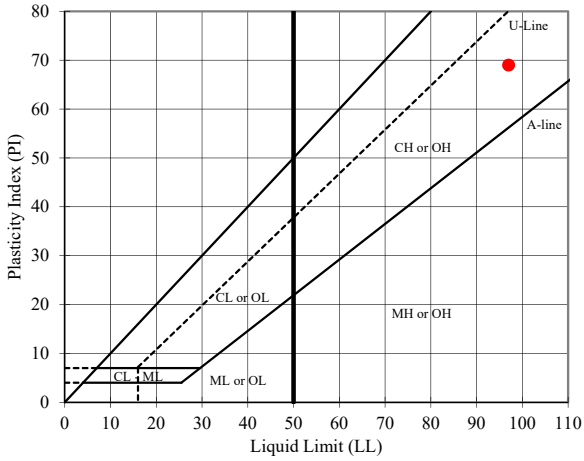
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-01** DEPTH (ft): **10 - 11.5**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.3**
#4	4.75	**99.0**
#10	2.0	**98.7**
#20	0.850	**98.3**
#40	0.425	**97.7**
#60	0.250	**97.1**
#100	0.150	**96.4**
#200	0.075	**95.6**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.99**
Coarse Sand	**0.29**
Medium Sand	**0.99**
Fine Sand	**2.15**
Silt or Clay Fines	**95.58**



USCS Description (ASTM D 2487):

Fat clay, light gray, moist

LL	PL	PI
97	**28**	**69**

As-Received Moisture Content (%): **37.4**

USCS Group Symbol: CH

Notes: 0 g of particles up to 19.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	EH
DATE	23-May-2019
REVIEW	MB

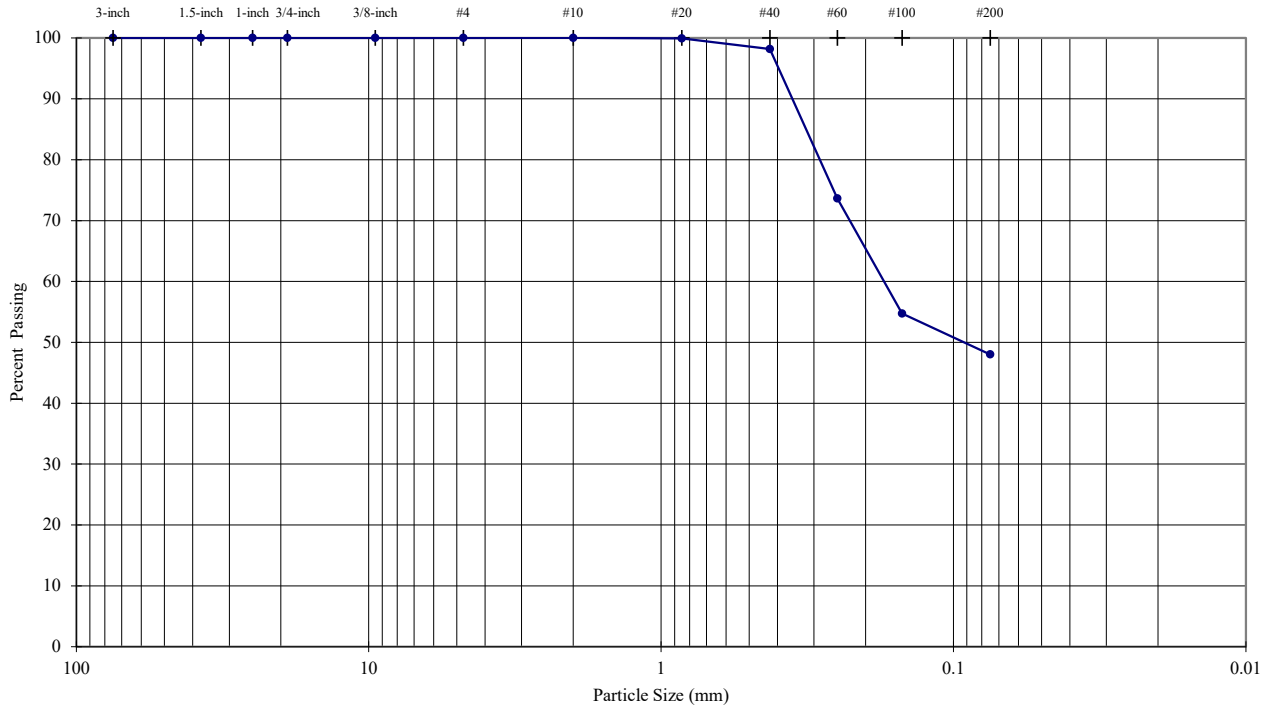
GOLDER

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

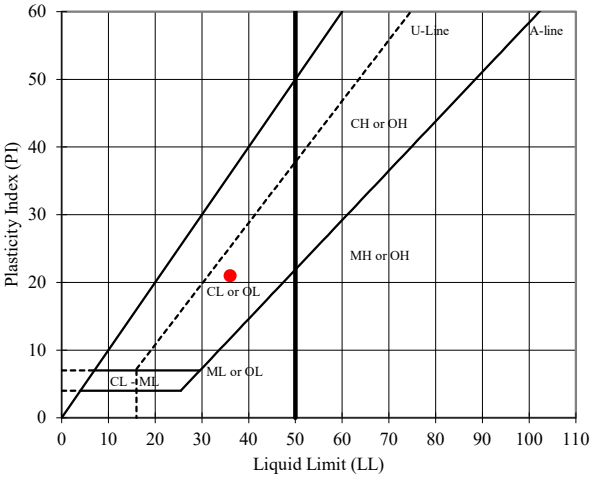
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-01** DEPTH (ft): **20 - 21.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.9**
#40	0.425	**98.2**
#60	0.250	**73.6**
#100	0.150	**54.7**
#200	0.075	**48.0**

Sieve Analysis (Initial Separation on No. 4 Sieve)

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**1.80**
Fine Sand	**50.19**
Silt or Clay Fines	**48.01**



USCS Description (ASTM D 2487):

Clayey sand, yellowish brown, moist

LL	PL	PI
36	**15**	**21**

As-Received Moisture Content (%): **11.7**

USCS Group Symbol: SC

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	23-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

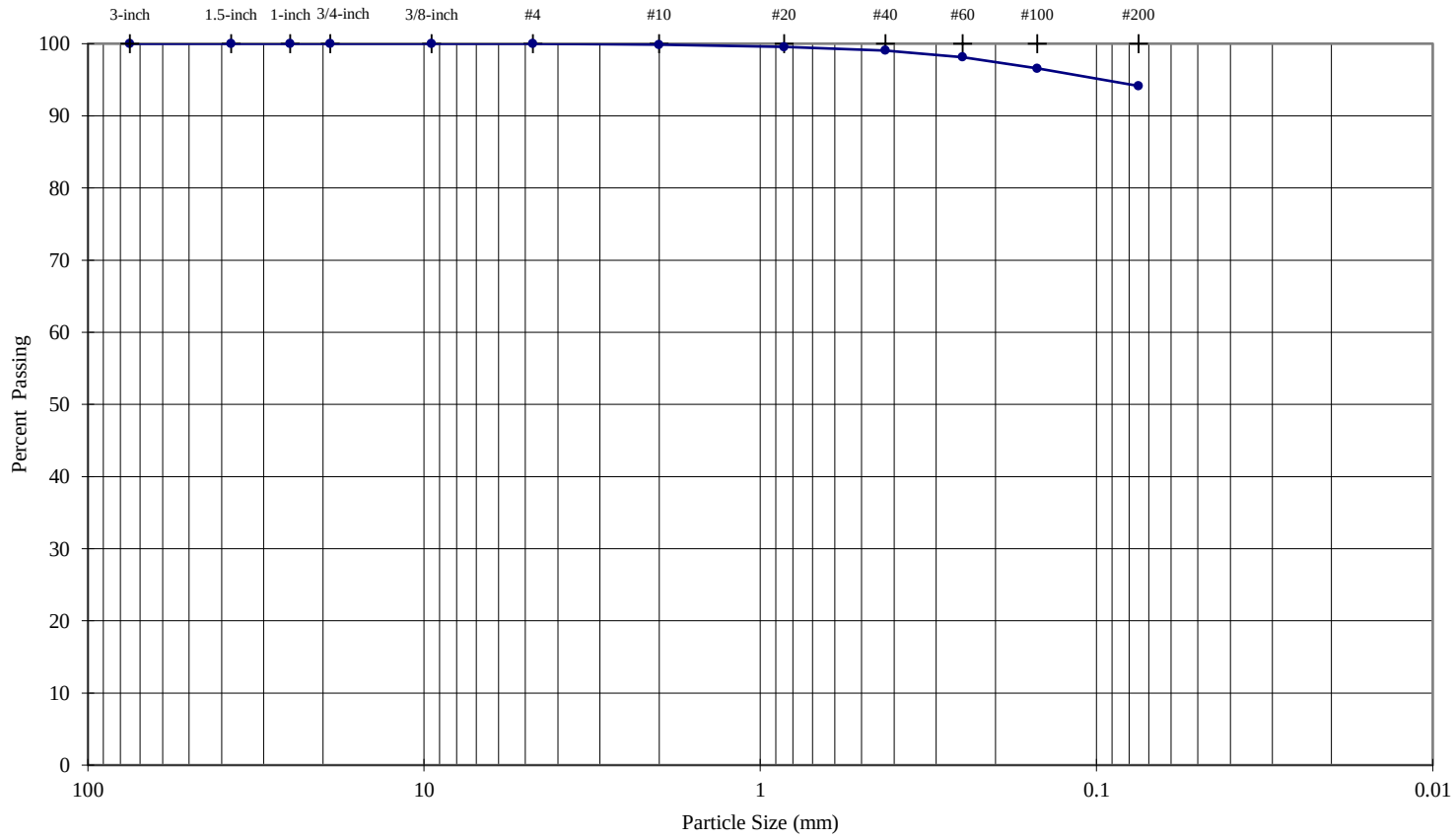
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-01** DEPTH (ft): **25 - 26.5**

TYPE: **Bag**

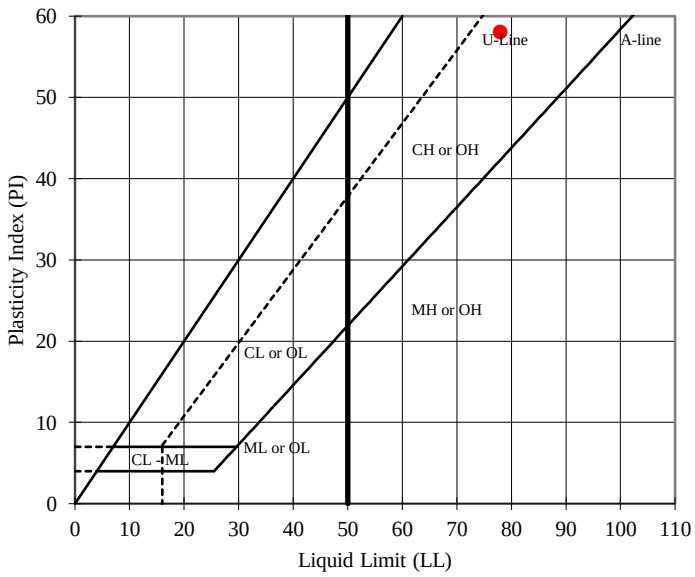


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.9**
#20	0.850	**99.5**
#40	0.425	**99.1**
#60	0.250	**98.1**
#100	0.150	**96.6**
#200	0.075	**94.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.14**
Medium Sand	**0.79**
Fine Sand	**4.92**
Silt or Clay Fines	**94.14**



USCS Description (ASTM D 2487):

Fat clay, pale brown, moist

LL	PL	PI
78	**20**	**58**

As-Received Moisture Content (%): **29.0**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	23-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

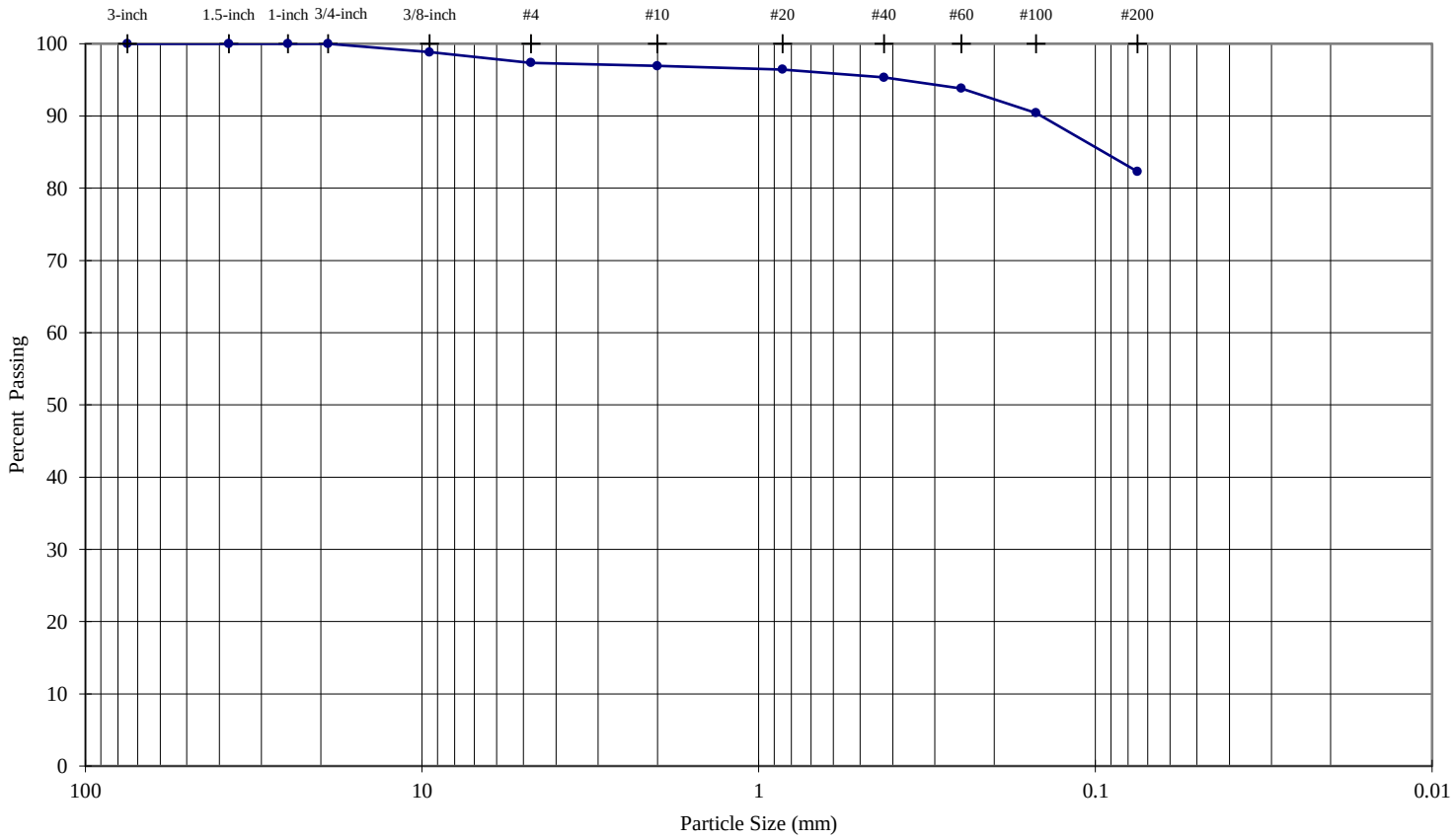
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-01** DEPTH (ft): **45 - 46.5**

TYPE: **Tube**

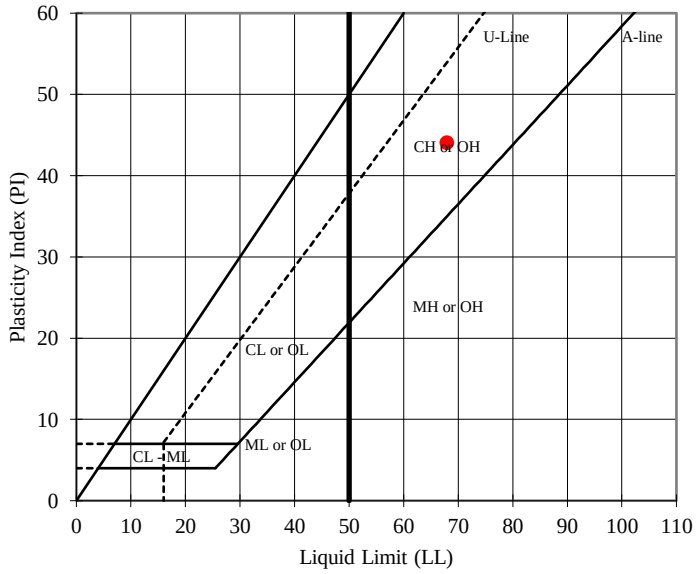


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**98.8**
#4	4.75	**97.4**
#10	2.0	**96.9**
#20	0.850	**96.4**
#40	0.425	**95.3**
#60	0.250	**93.8**
#100	0.150	**90.4**
#200	0.075	**82.3**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**2.63**
Coarse Sand	**0.45**
Medium Sand	**1.60**
Fine Sand	**13.02**
Silt or Clay Fines	**82.30**



USCS Description (ASTM D 2487):

Fat clay with sand, gray, moist

LL	PL	PI
68	**24**	**44**

As-Received Moisture Content (%): **32.4**

USCS Group Symbol: CH

Notes: 0 g of particles up to 19.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	EH
DATE	29-Apr-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

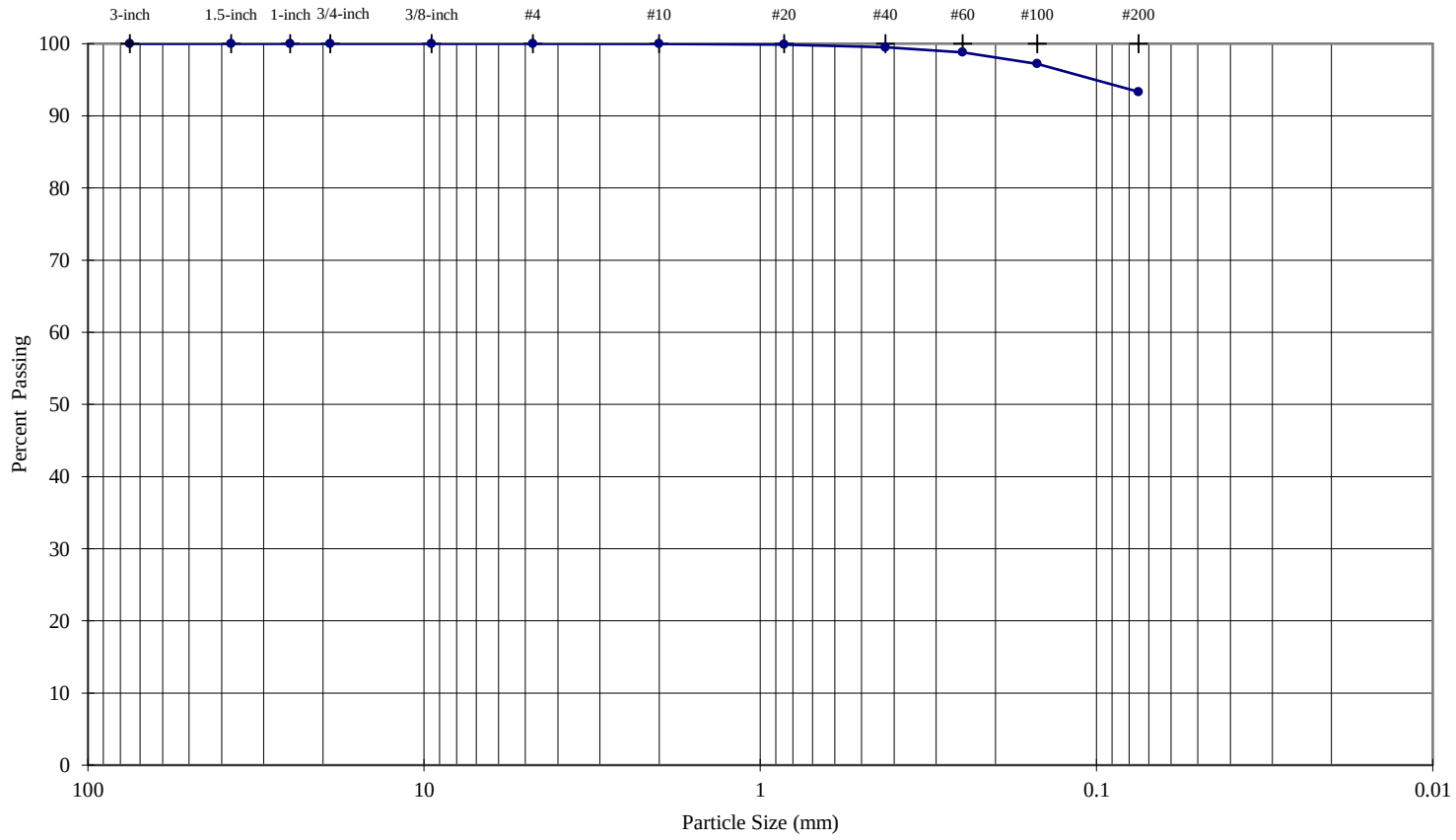
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **10.0-11.5**

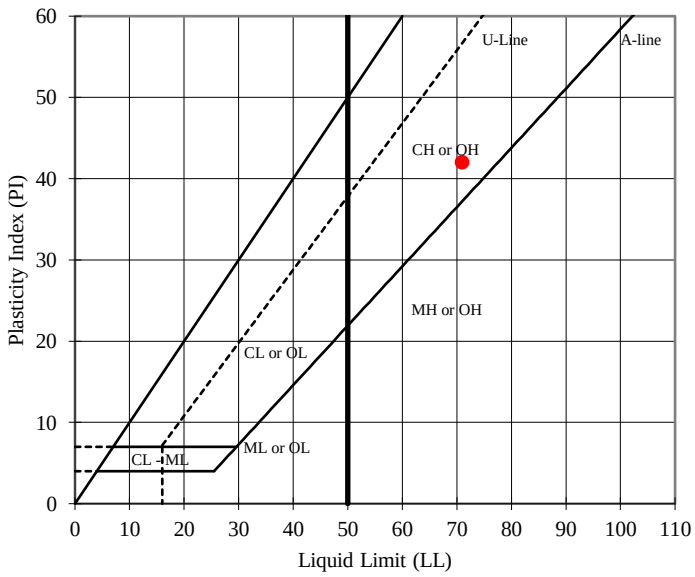
TYPE: **Tube**



Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**		
1-inch	25.0	**100.0**	Coarse Gravel	**0.00**
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**		
#4	4.75	**100.0**	Fine Gravel	**0.00**
#10	2.0	**100.0**	Coarse Sand	**0.02**
#20	0.850	**99.9**		
#40	0.425	**99.5**	Medium Sand	**0.47**
#60	0.250	**98.8**		
#100	0.150	**97.2**	Fine Sand	**6.17**
#200	0.075	**93.3**		
			Silt or Clay Fines	**93.33**



USCS Description (ASTM D 2487):

Fat clay, pale olive, moist

LL	PL	PI
71	**29**	**42**

As-Received Moisture Content (%): **25.7**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	6-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

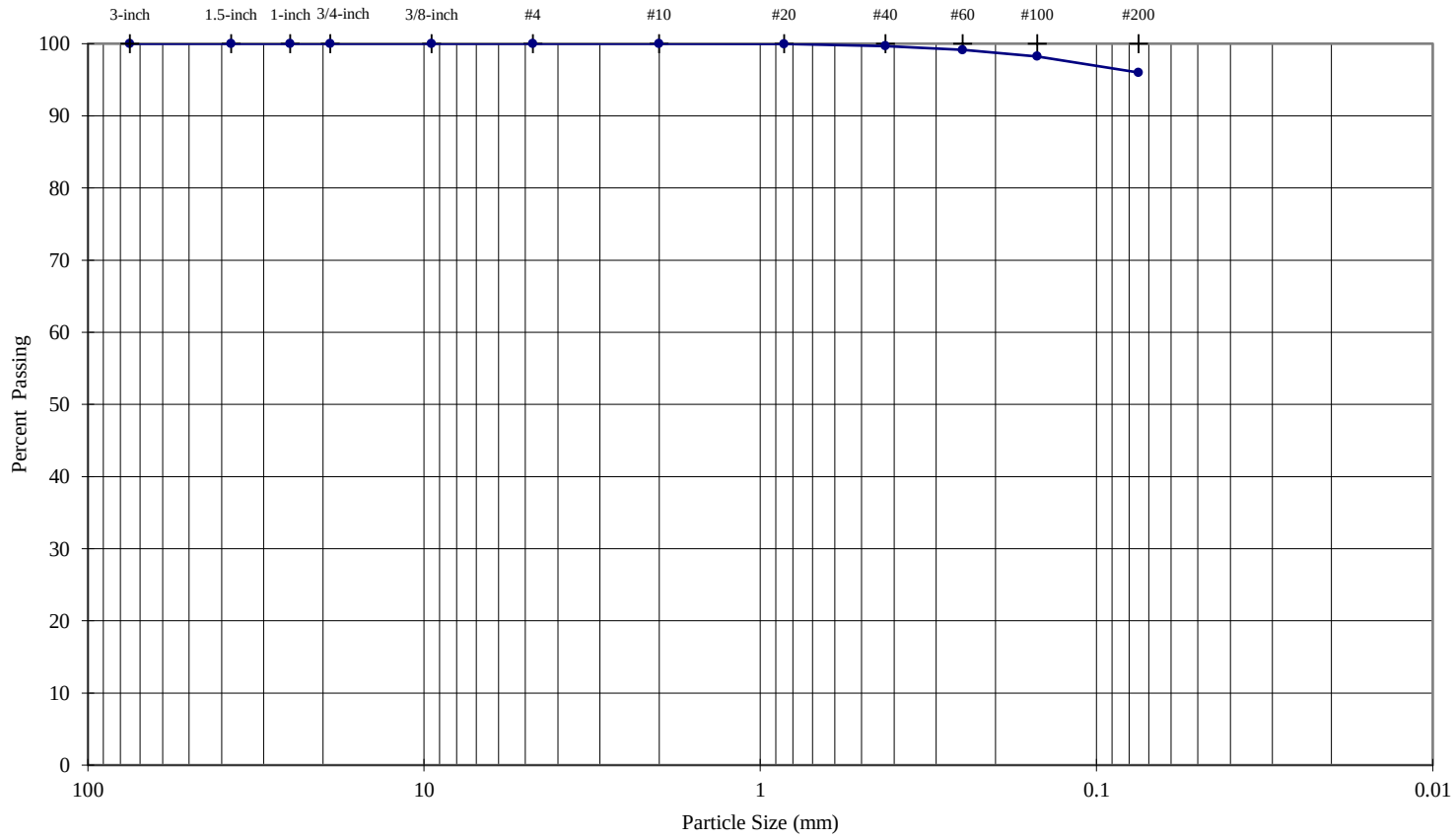
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **15-16.5**

TYPE: **Tube**

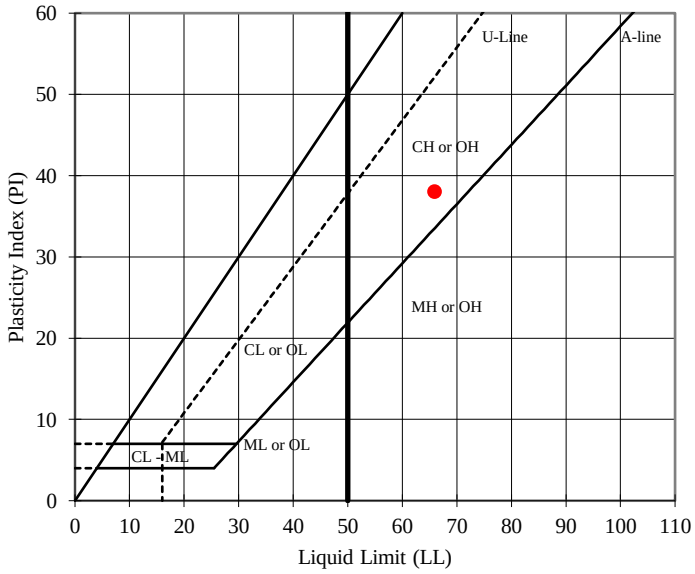


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.7**
#60	0.250	**99.1**
#100	0.150	**98.2**
#200	0.075	**96.0**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.31**
Fine Sand	**3.69**
Silt or Clay Fines	**96.00**



USCS Description (ASTM D 2487):

Fat clay, light brownish gray, moist

LL	PL	PI
66	**28**	**38**

As-Received Moisture Content (%): **18.9**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	30-Apr-2019
REVIEW	PRH

GOLDER

May-19 **1663241.22000**

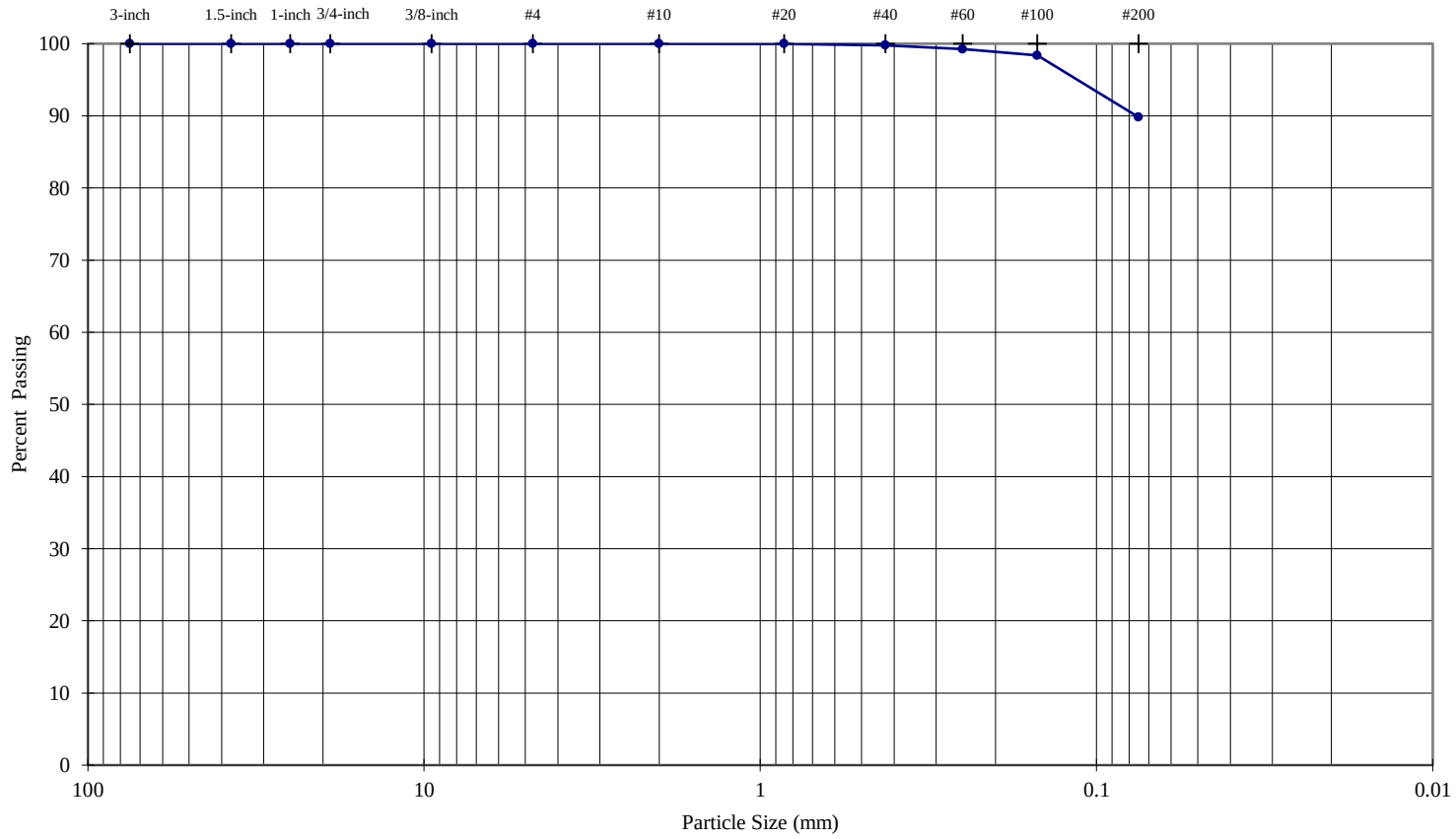
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **20 - 21.5**

TYPE: **Tube**

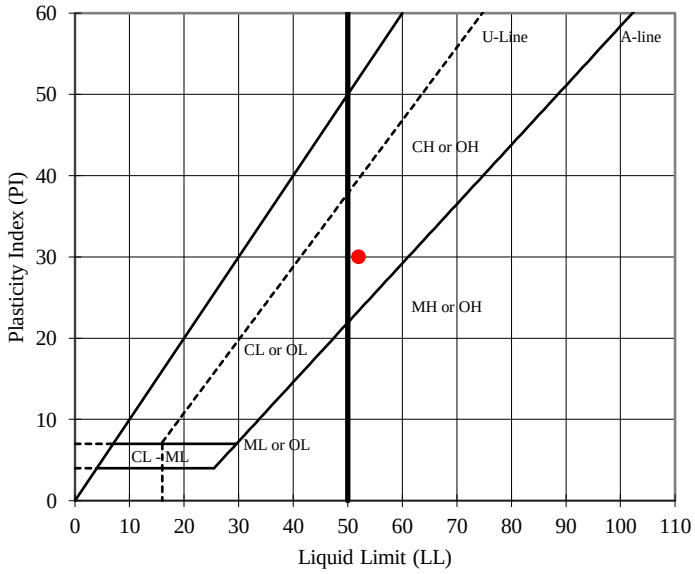


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.8**
#60	0.250	**99.2**
#100	0.150	**98.4**
#200	0.075	**89.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.21**
Fine Sand	**9.97**
Silt or Clay Fines	**89.82**



USCS Description (ASTM D 2487):

Fat clay, light gray, moist

LL	PL	PI
52	**22**	**30**

As-Received Moisture Content (%): **13.6**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	2-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

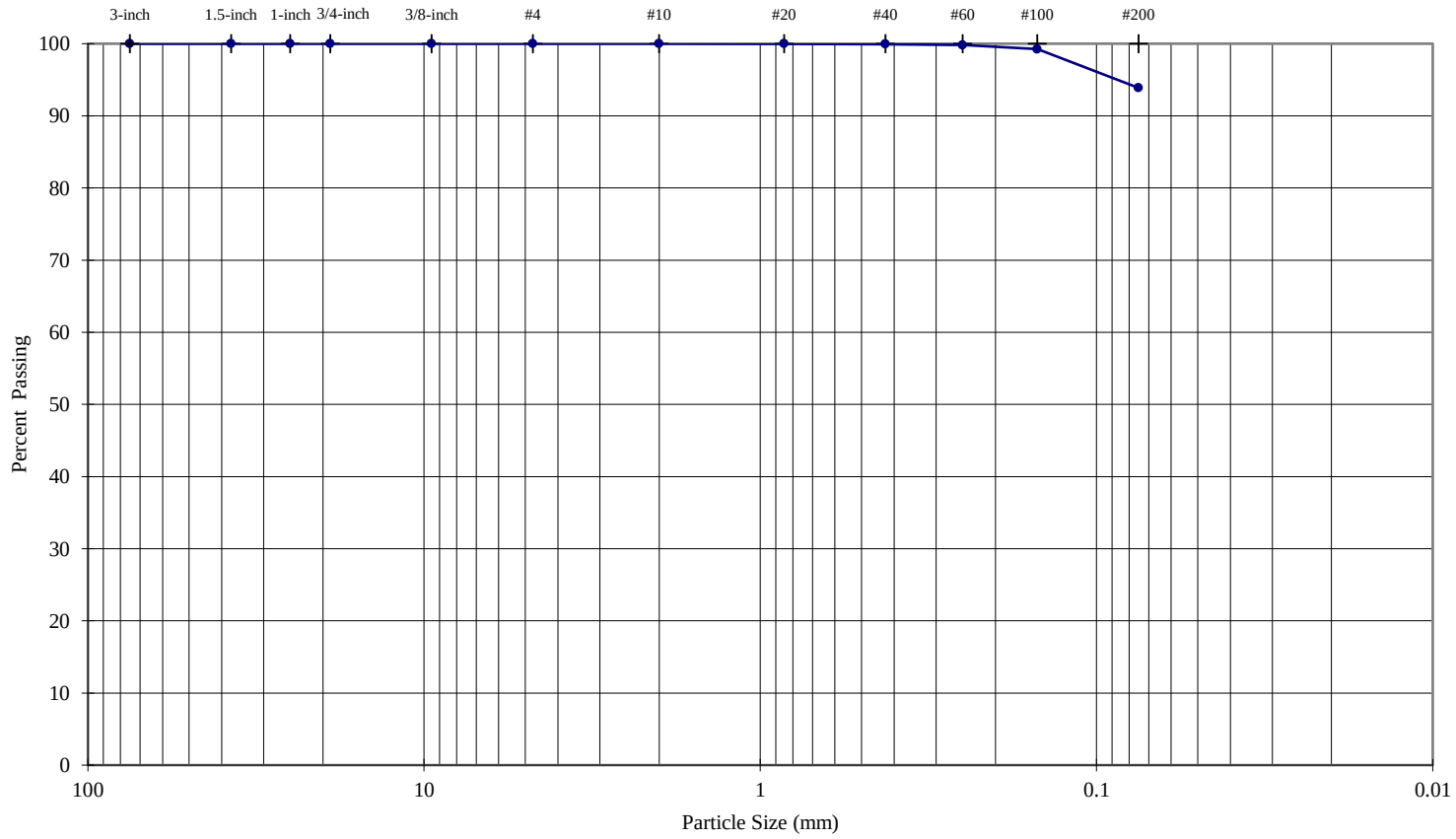
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **25 - 26.5**

TYPE: **Tube**

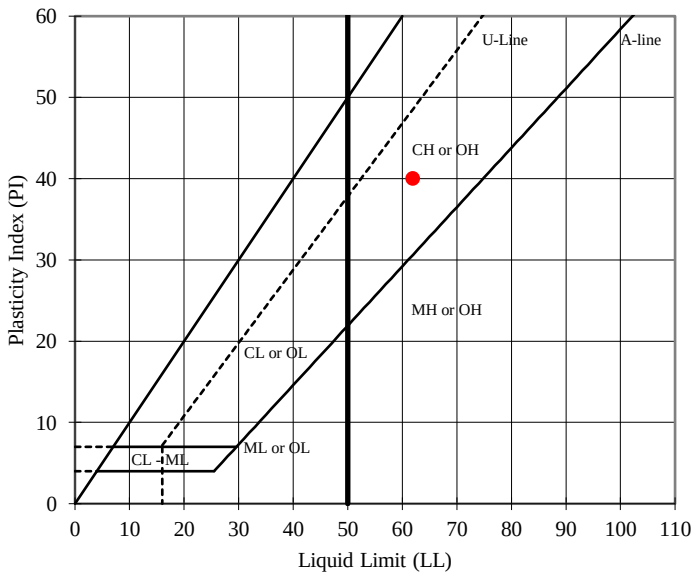


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.9**
#60	0.250	**99.8**
#100	0.150	**99.2**
#200	0.075	**93.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.06**
Fine Sand	**6.06**
Silt or Clay Fines	**93.88**



USCS Description (ASTM D 2487):

Fat clay, light gray, moist

LL	PL	PI
62	**22**	**40**

As-Received Moisture Content (%): **15.0**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	2-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

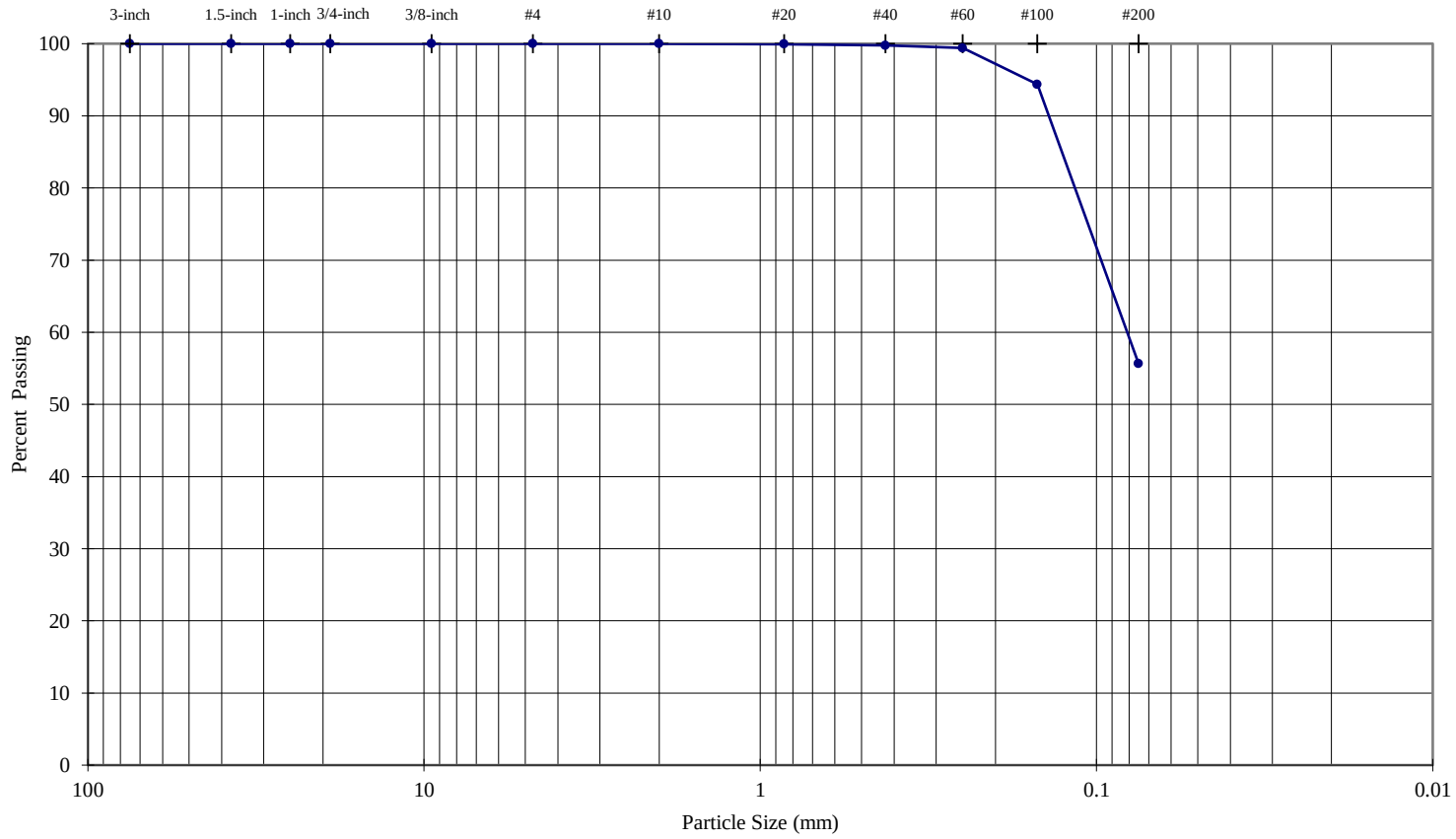
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **30 - 31.5**

TYPE: **Tube**

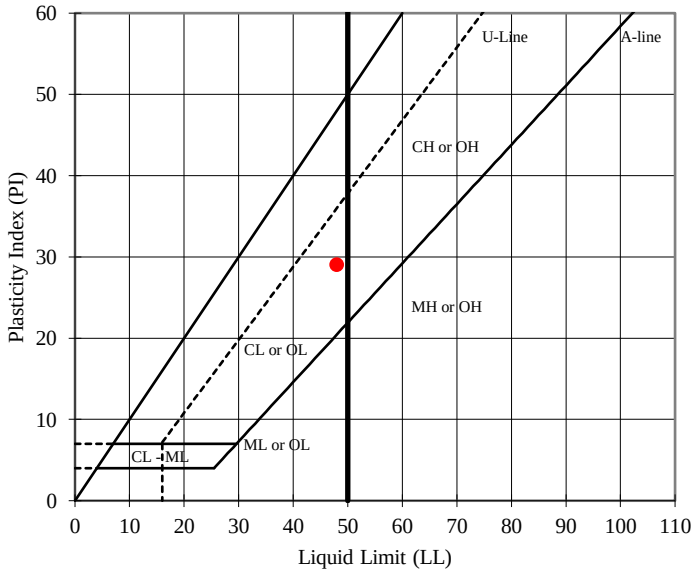


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.9**
#40	0.425	**99.8**
#60	0.250	**99.4**
#100	0.150	**94.4**
#200	0.075	**55.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.25**
Fine Sand	**44.09**
Silt or Clay Fines	**55.67**



USCS Description (ASTM D 2487):

Sandy lean clay, light olive brown, moist

LL	PL	PI
48	**19**	**29**

As-Received Moisture Content (%): **13.4**

USCS Group Symbol: CL

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	30-Apr-2019
REVIEW	MB

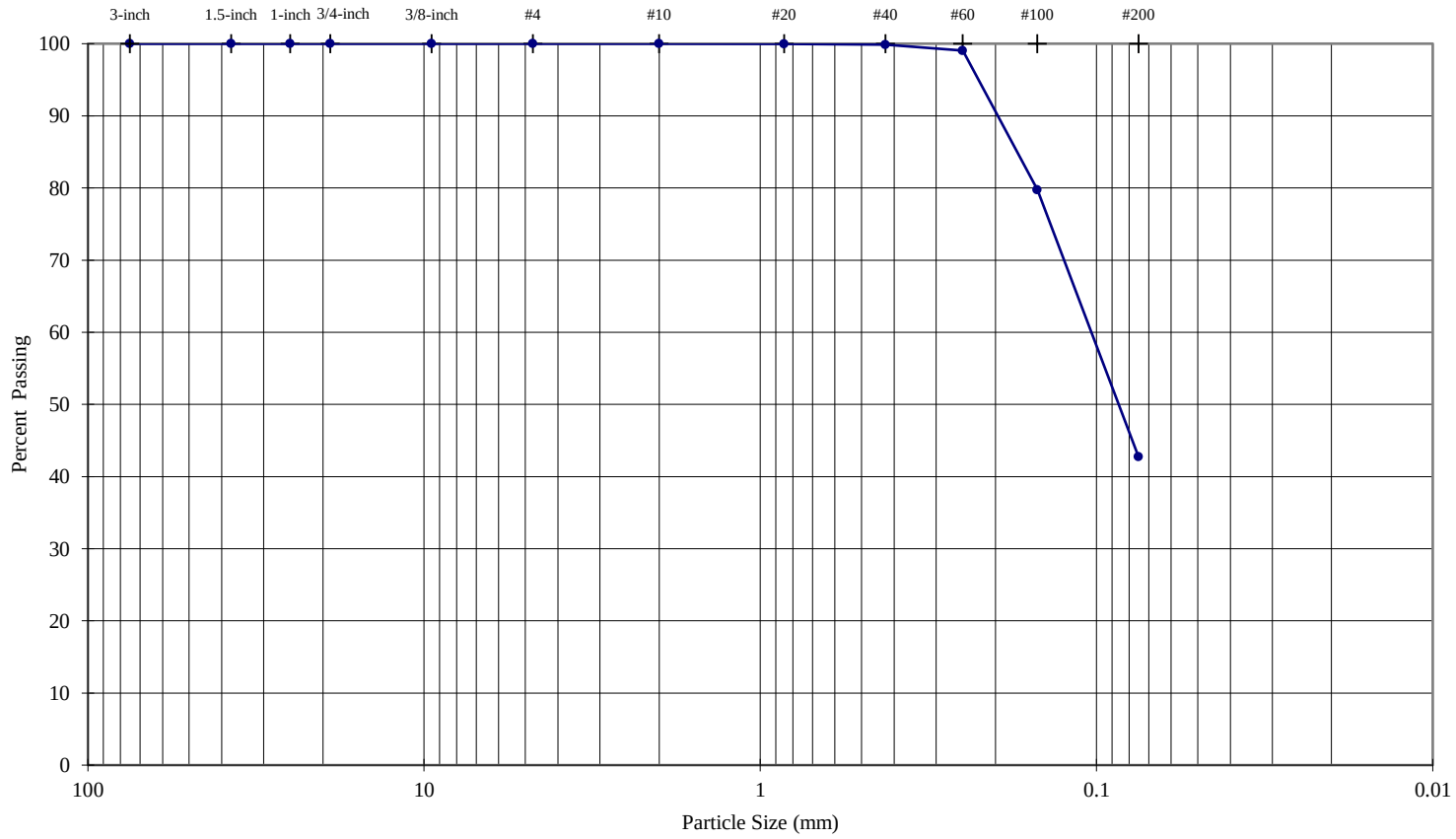
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-15** DEPTH (ft): **35 - 36.5**
TYPE: **Tube**

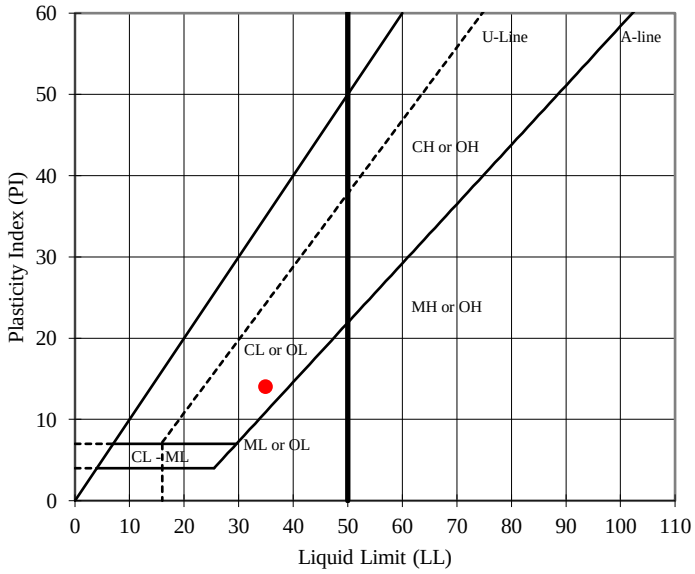


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.9**
#60	0.250	**99.0**
#100	0.150	**79.7**
#200	0.075	**42.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.13**
Fine Sand	**57.13**
Silt or Clay Fines	**42.74**



USCS Description (ASTM D 2487):

Clayey sand, very pale brown, moist

LL	PL	PI
35	**21**	**14**

As-Received Moisture Content (%): **9.6**

USCS Group Symbol: SC

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	30-Apr-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

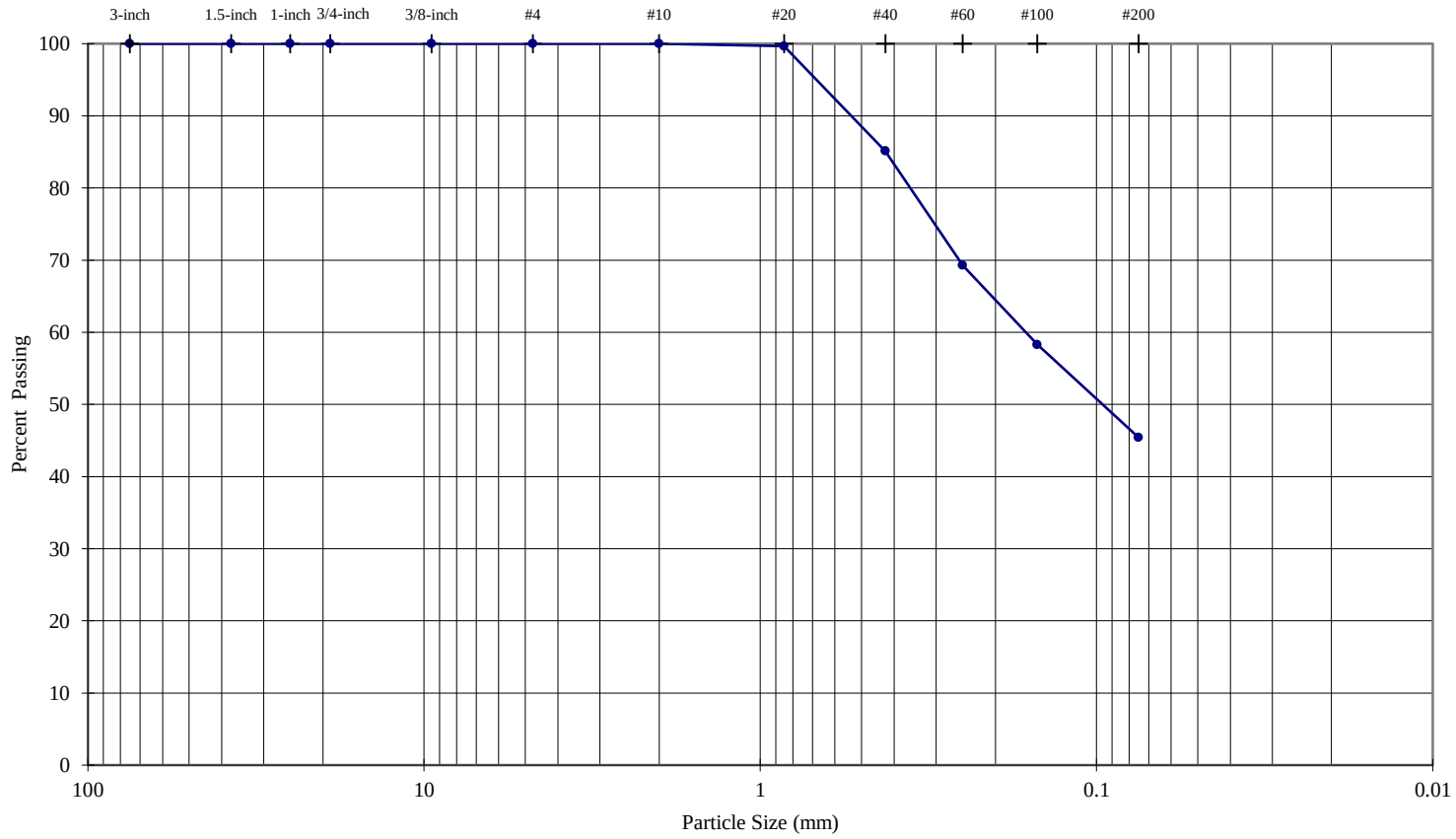
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **40 - 41.5**

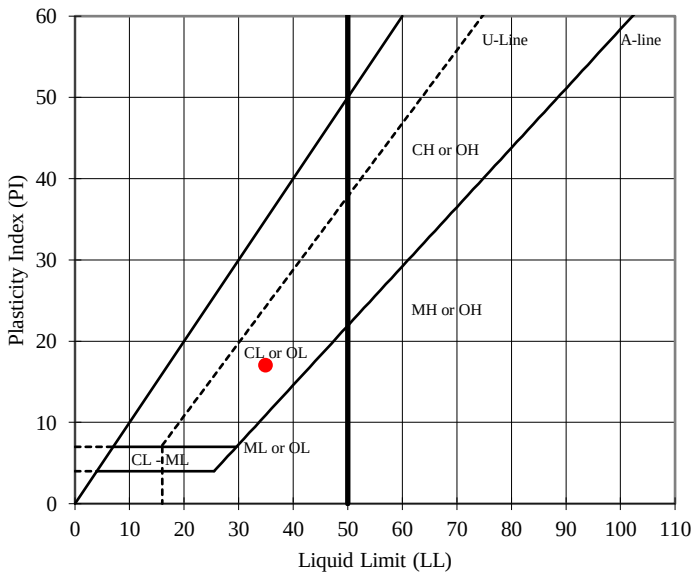
TYPE: **Tube**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.7**
#40	0.425	**85.1**
#60	0.250	**69.3**
#100	0.150	**58.3**
#200	0.075	**45.4**

Sieve Analysis (Initial Separation on No. 4 Sieve)

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**14.88**
Fine Sand	**39.70**
Silt or Clay Fines	**45.42**



USCS Description (ASTM D 2487):

Clayey sand, light gray, moist

LL	PL	PI
35	**18**	**17**

As-Received Moisture Content (%): **11.5**

USCS Group Symbol: SC

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	30-Apr-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

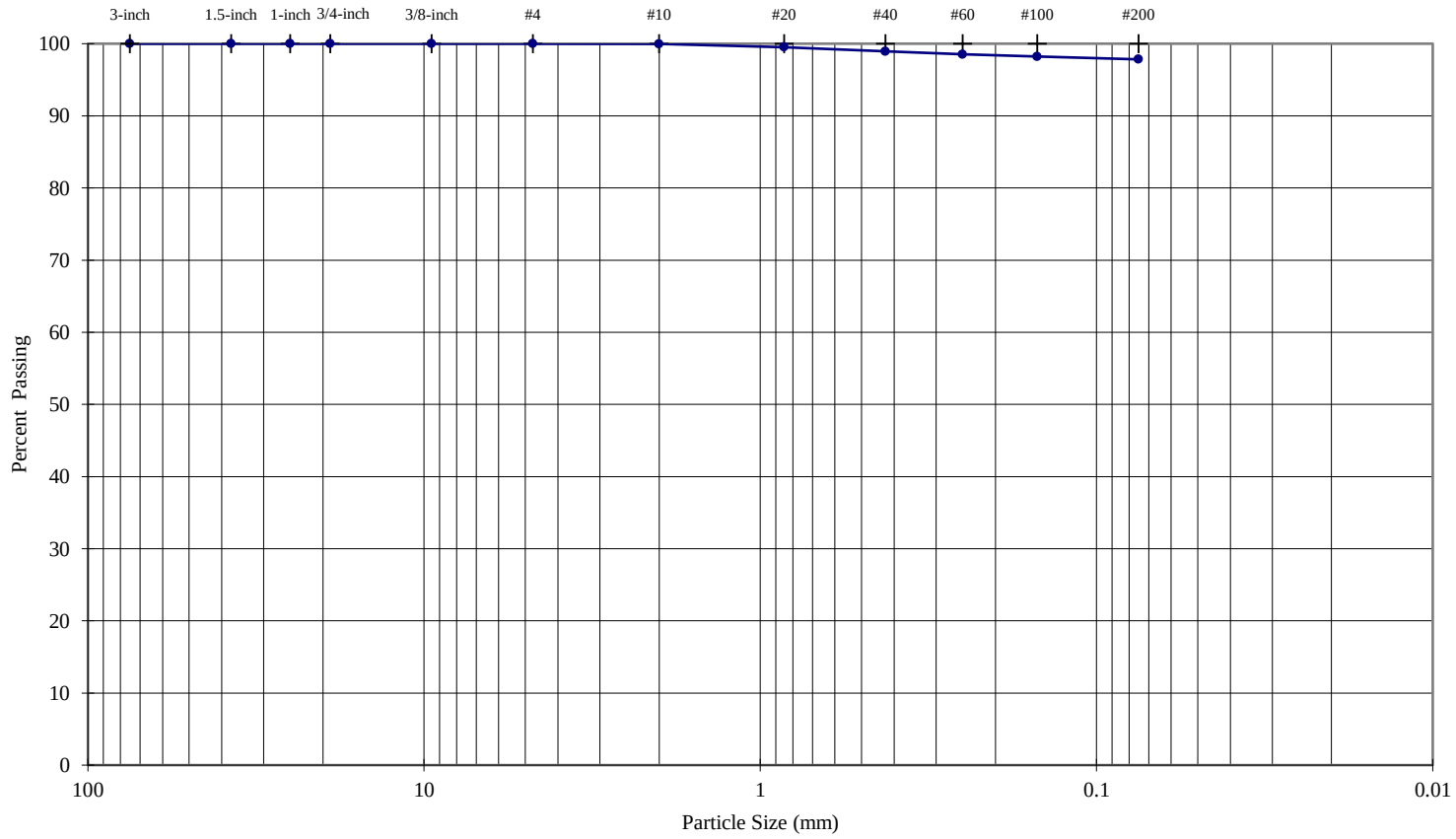
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **50 - 51.5**

TYPE: **Tube**

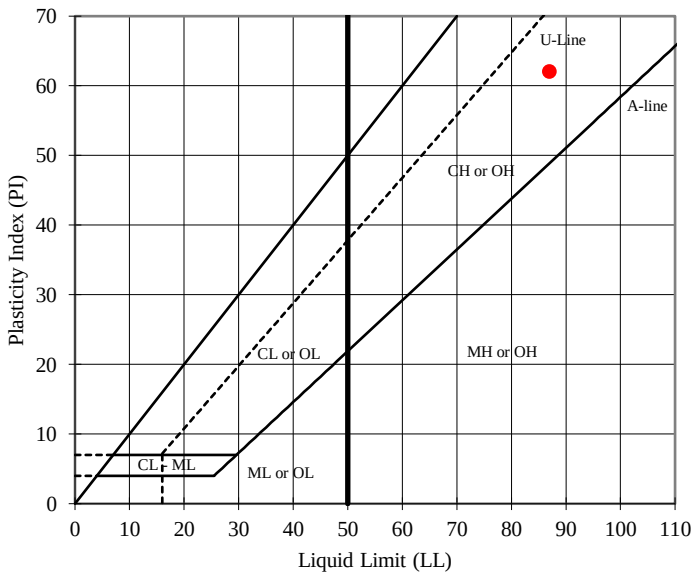


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.5**
#40	0.425	**98.9**
#60	0.250	**98.5**
#100	0.150	**98.2**
#200	0.075	**97.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.04**
Medium Sand	**1.02**
Fine Sand	**1.11**
Silt or Clay Fines	**97.83**



USCS Description (ASTM D 2487):

Fat clay, greenish gray, moist

LL	PL	PI
87	**25**	**62**

As-Received Moisture Content (%): **32.3**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	2-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

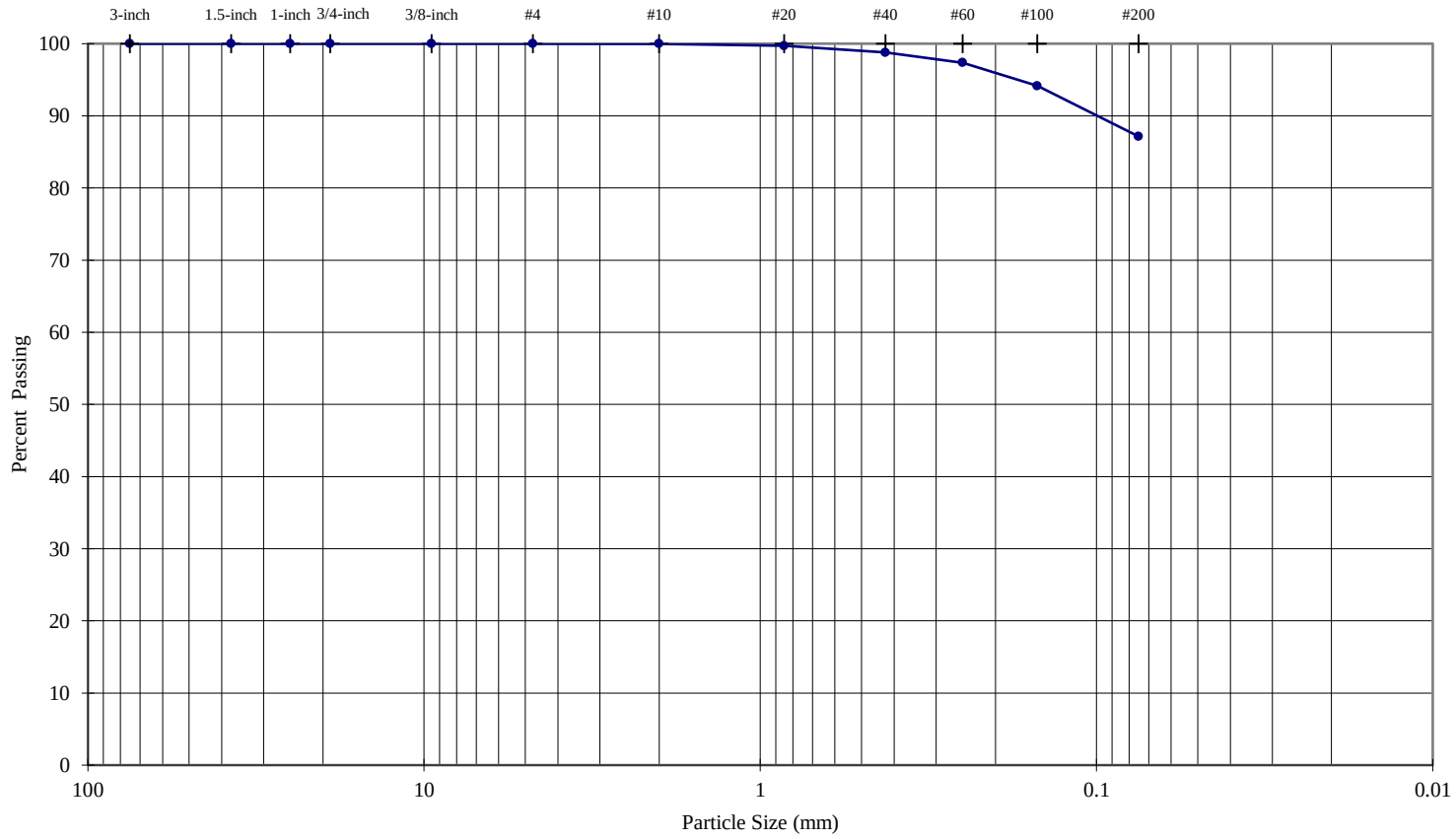
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **70 - 71.5**

TYPE: **Tube**

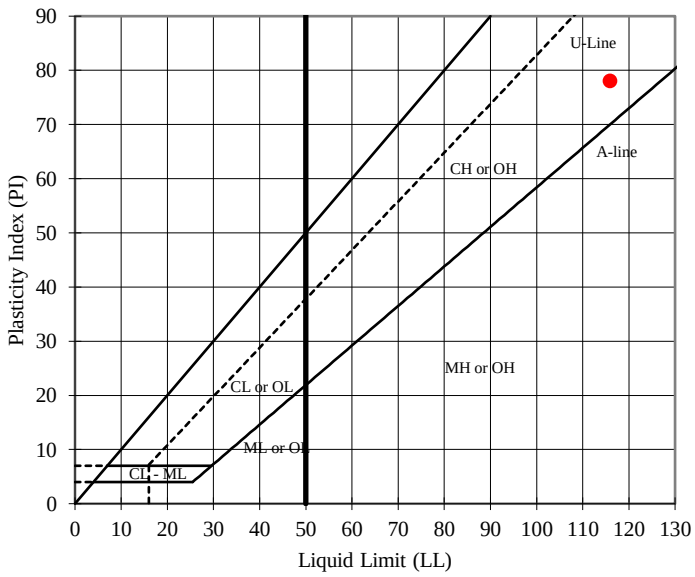


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.7**
#40	0.425	**98.8**
#60	0.250	**97.4**
#100	0.150	**94.2**
#200	0.075	**87.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.02**
Medium Sand	**1.21**
Fine Sand	**11.63**
Silt or Clay Fines	**87.14**



USCS Description (ASTM D 2487):

ELASTIC SILT, some sand, dark bluish gray, moist

LL	PL	PI
116	**38**	**78**

As-Received Moisture Content (%): **47.9**

USCS Group Symbol: MH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	2-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

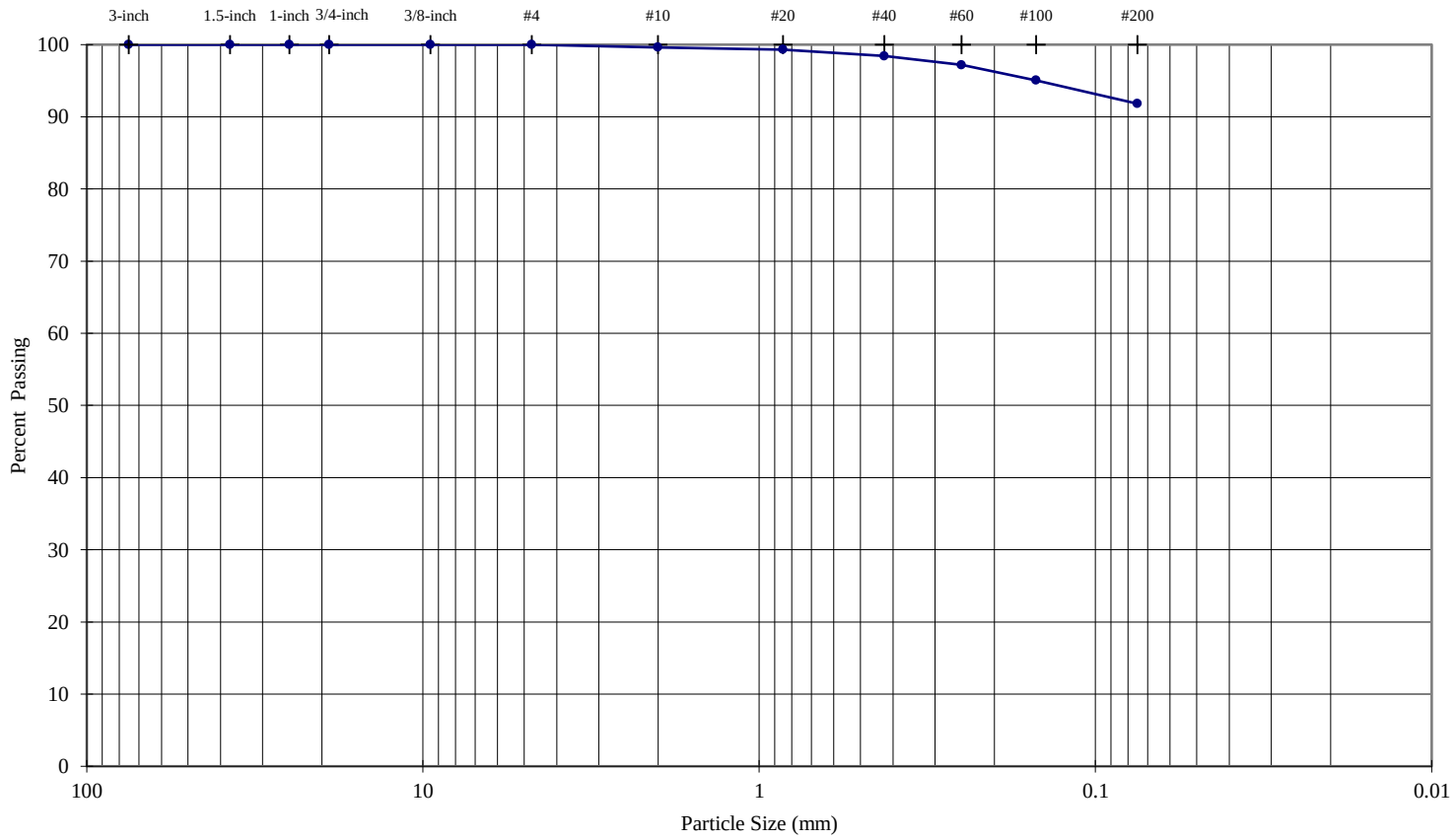
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **TP-15** DEPTH (ft): **90 - 91.5**

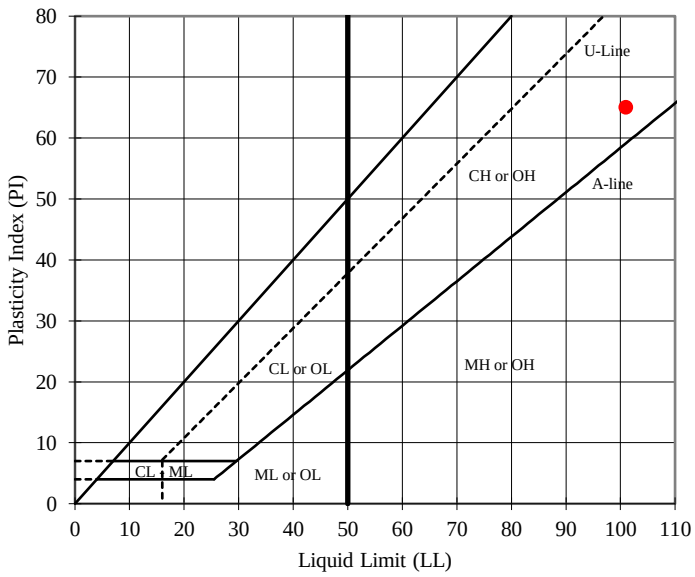
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.6**
#20	0.850	**99.3**
#40	0.425	**98.4**
#60	0.250	**97.2**
#100	0.150	**95.1**
#200	0.075	**91.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.38**
Medium Sand	**1.19**
Fine Sand	**6.62**
Silt or Clay Fines	**91.81**



USCS Description (ASTM D 2487):

Fat clay, dark bluish gray, moist

LL	PL	PI
101	**36**	**65**

As-Received Moisture Content (%): **36.5**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	3-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

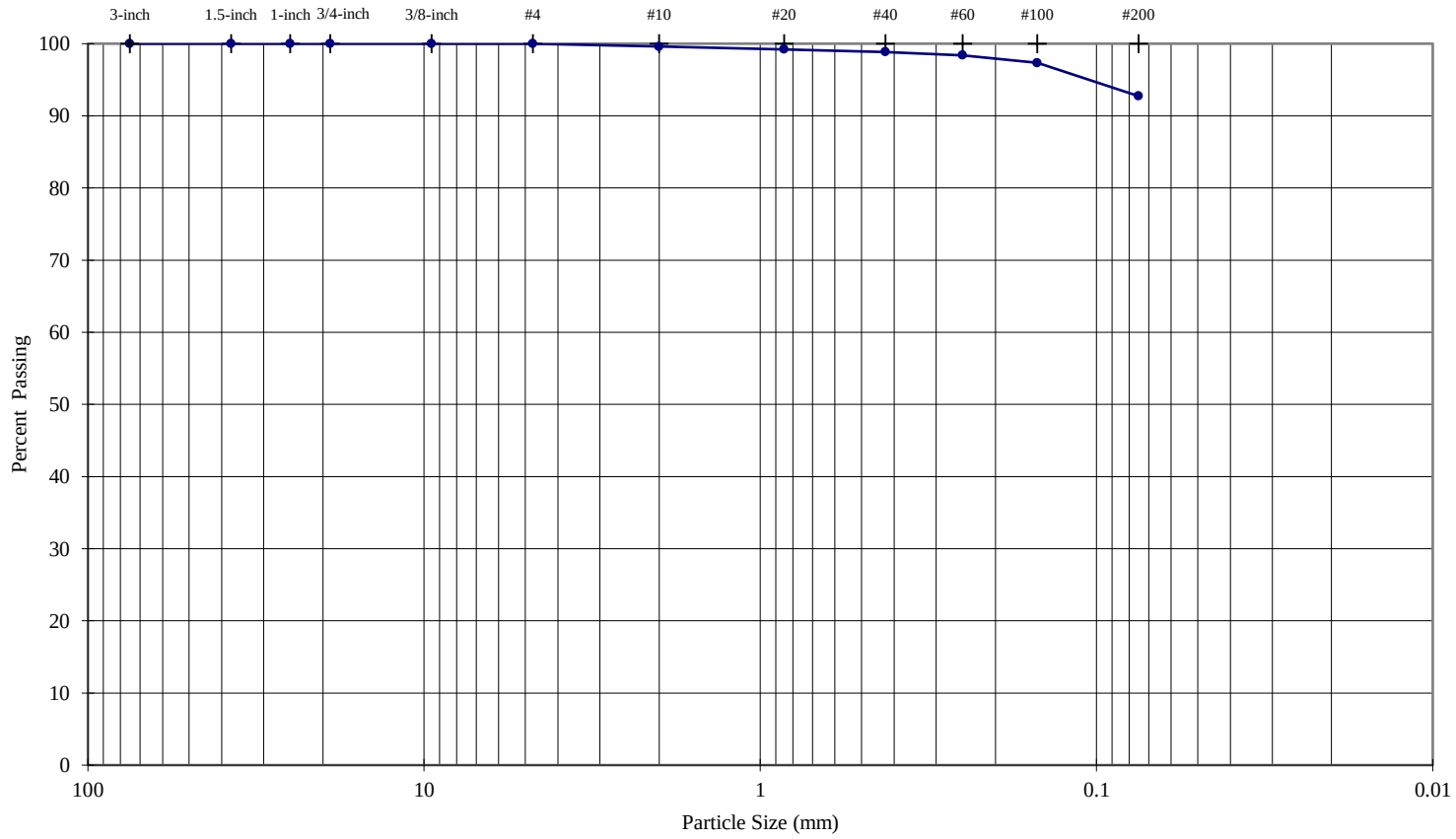
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **110-111.5**

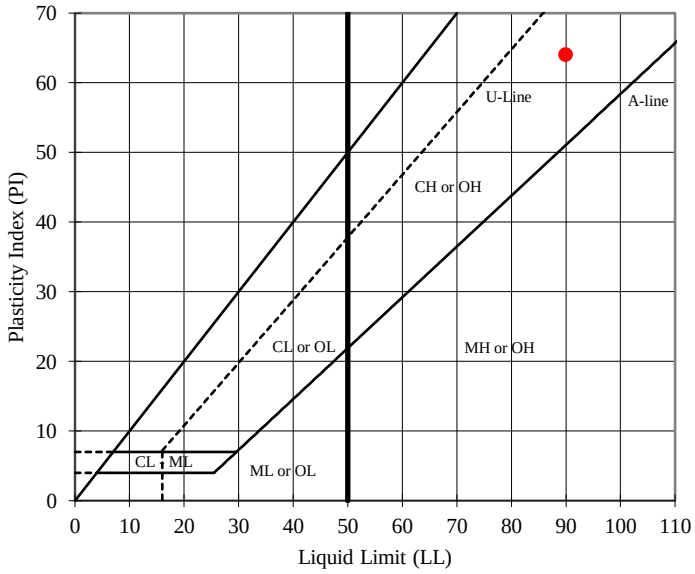
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.6**
#20	0.850	**99.2**
#40	0.425	**98.9**
#60	0.250	**98.4**
#100	0.150	**97.3**
#200	0.075	**92.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.40**
Medium Sand	**0.74**
Fine Sand	**6.12**
Silt or Clay Fines	**92.73**



USCS Description (ASTM D 2487):

Fat clay, bluish gray, moist

LL	PL	PI
90	**26**	**64**

As-Received Moisture Content (%): **33.6**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	6-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

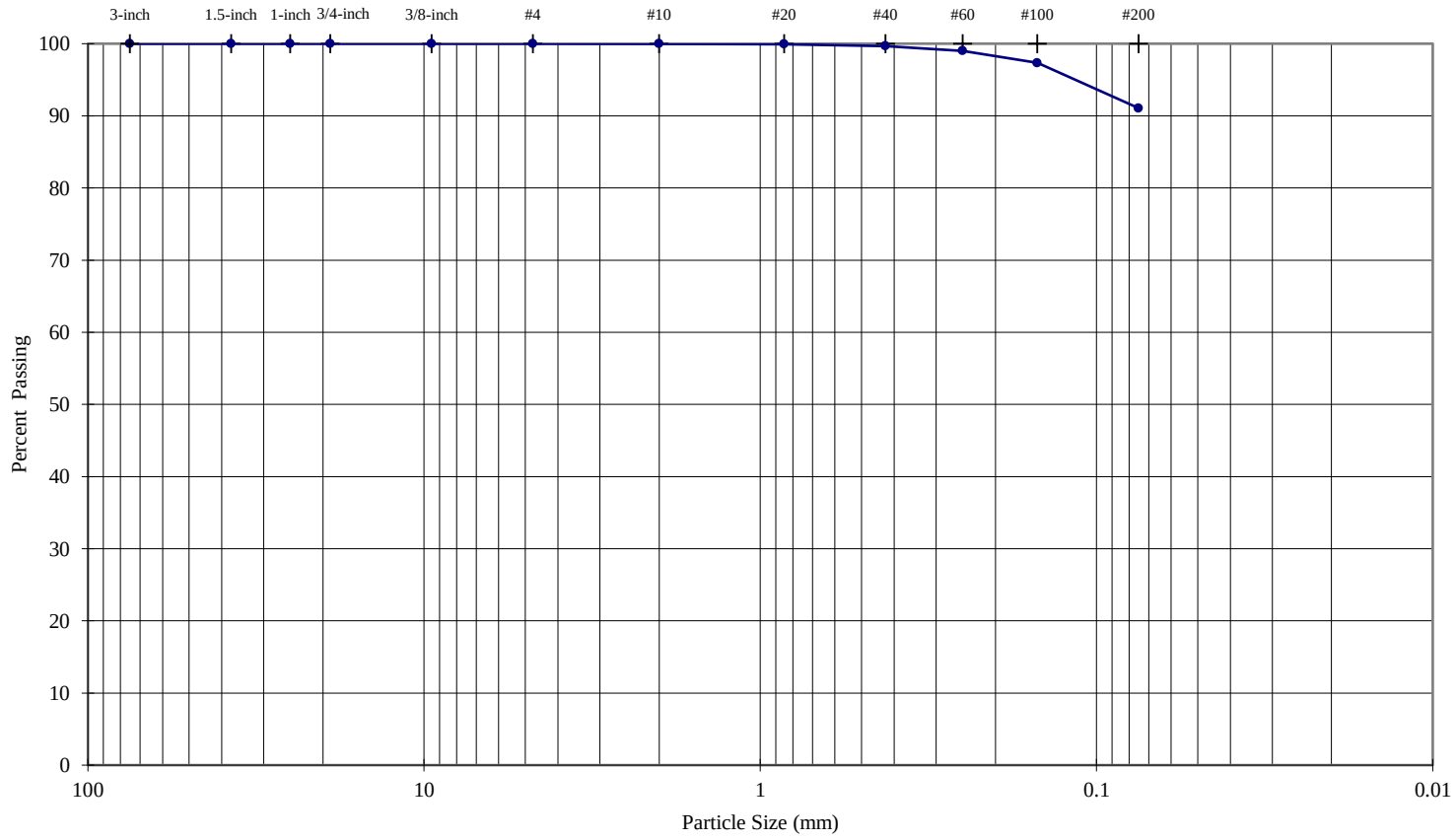
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-15** DEPTH (ft): **120-121.4**

TYPE: **Tube**

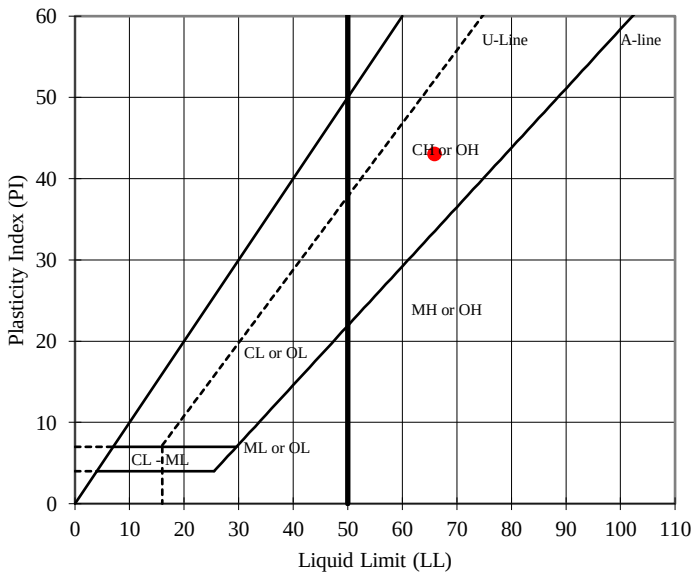


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.9**
#40	0.425	**99.7**
#60	0.250	**99.0**
#100	0.150	**97.3**
#200	0.075	**91.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.02**
Medium Sand	**0.31**
Fine Sand	**8.60**
Silt or Clay Fines	**91.07**



USCS Description (ASTM D 2487):

Fat clay, greenish gray, moist

LL	PL	PI
66	**23**	**43**

As-Received Moisture Content (%): **24.6**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	7-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

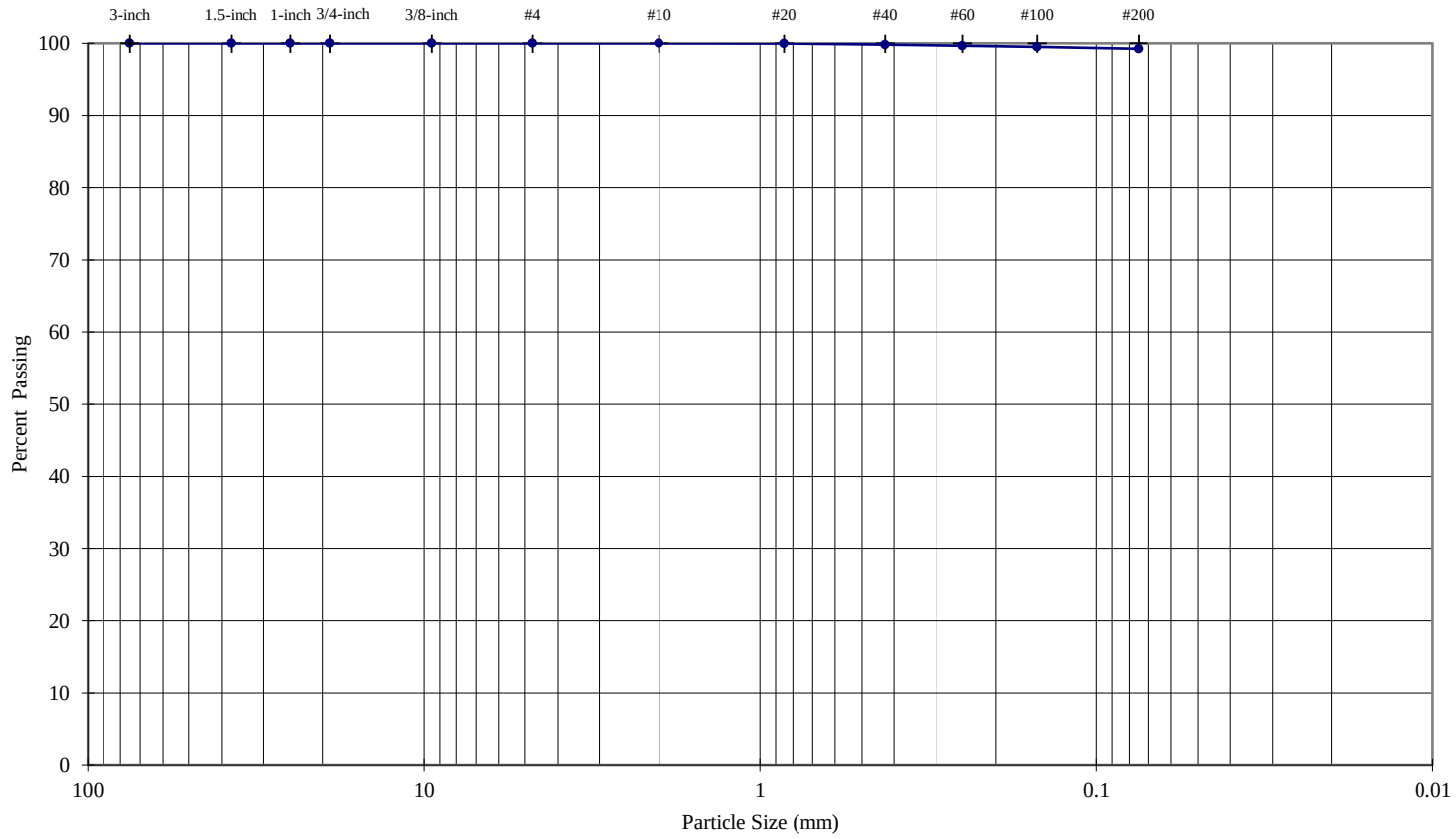
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-19** DEPTH (ft): **12 - 13.5**

TYPE: **Bag**

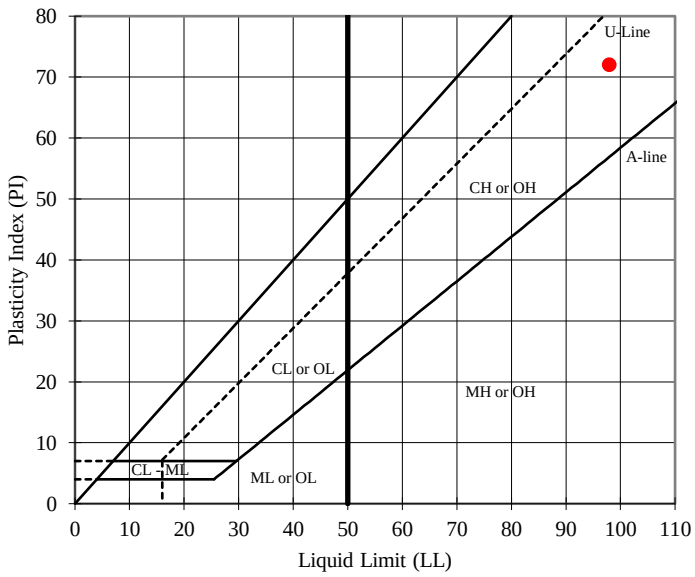


Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.8**
#60	0.250	**99.7**
#100	0.150	**99.5**
#200	0.075	**99.2**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.18**
Fine Sand	**0.57**
Silt or Clay Fines	**99.25**



USCS Description (ASTM D 2487):

Fat clay, white, moisst

LL	PL	PI
98	**26**	**72**

As-Received Moisture Content (%): **27.4**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	23-May-2019
REVIEW	MB

GOLDER

May-19 **1663241.22000**

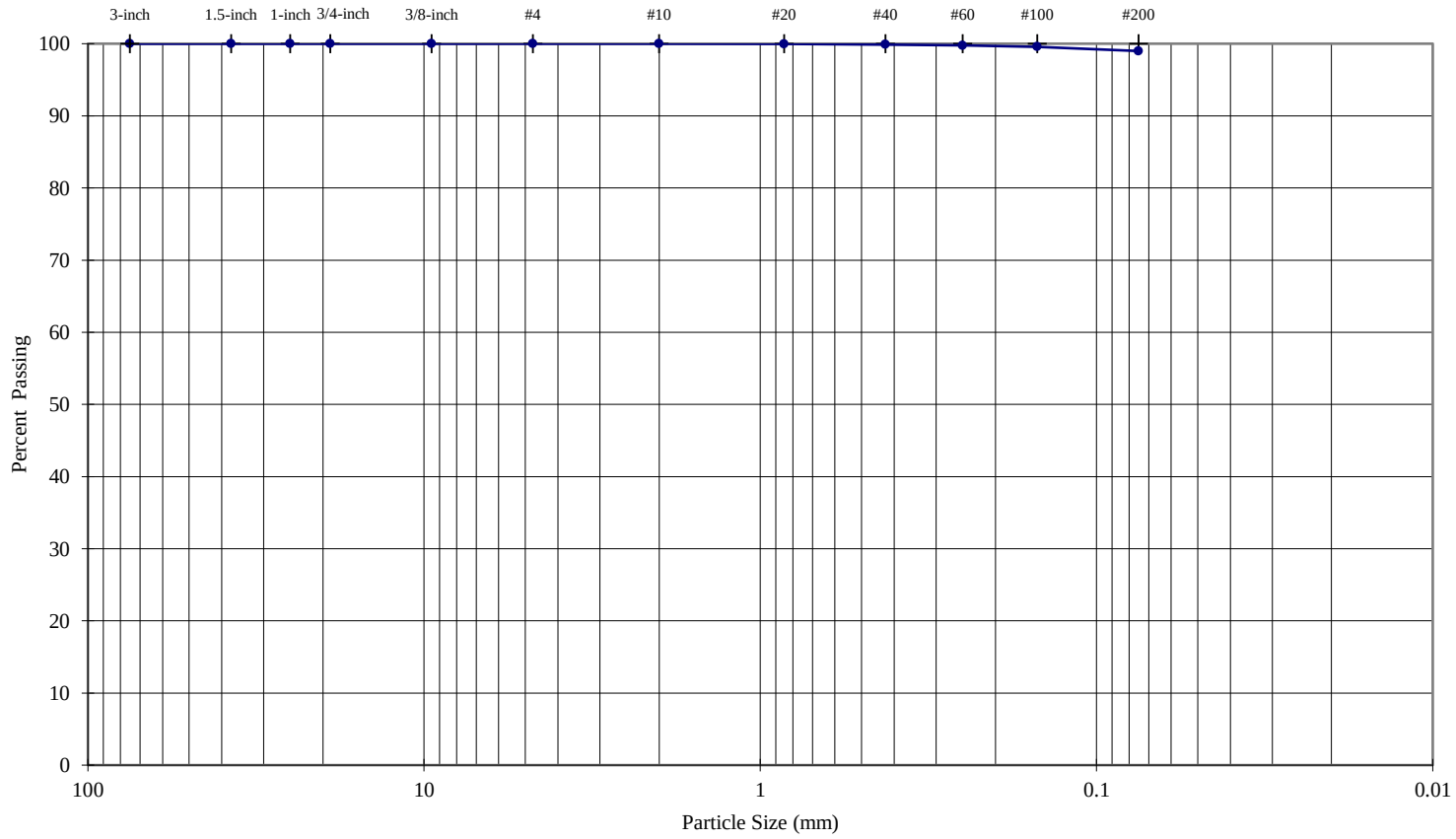
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**

SAMPLE ID: **BH19-TP-19** DEPTH (ft): **15 - 16.5**

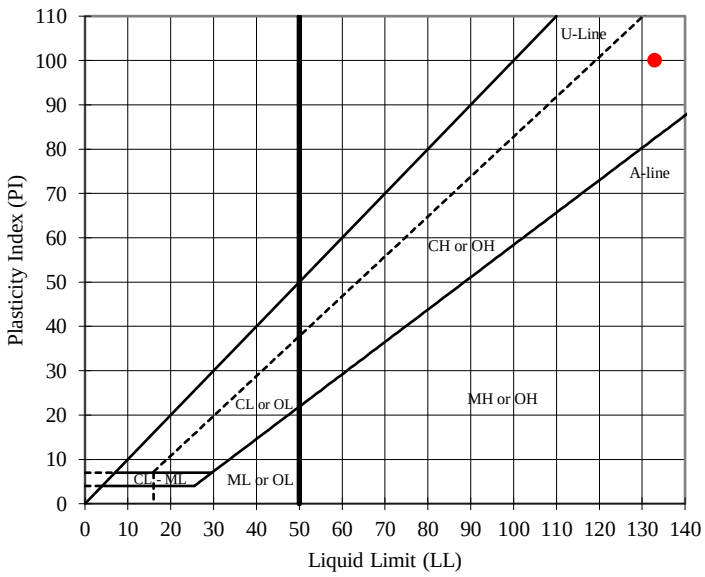
TYPE: **Tube**



Particle Size (mm)

Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**	Coarse Gravel	**0.00**
1.5-inch	37.5	**100.0**		
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.0	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.12**
#40	0.425	**99.9**		
#60	0.250	**99.8**	Fine Sand	**0.89**
#100	0.150	**99.6**		
#200	0.075	**99.0**		
			Silt or Clay Fines	**98.99**



USCS Description (ASTM D 2487):

Fat clay, light gray , moist

LL	PL	PI
133	**33**	**100**

As-Received Moisture Content (%): **34.4**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	6-May-2019
REVIEW	MB

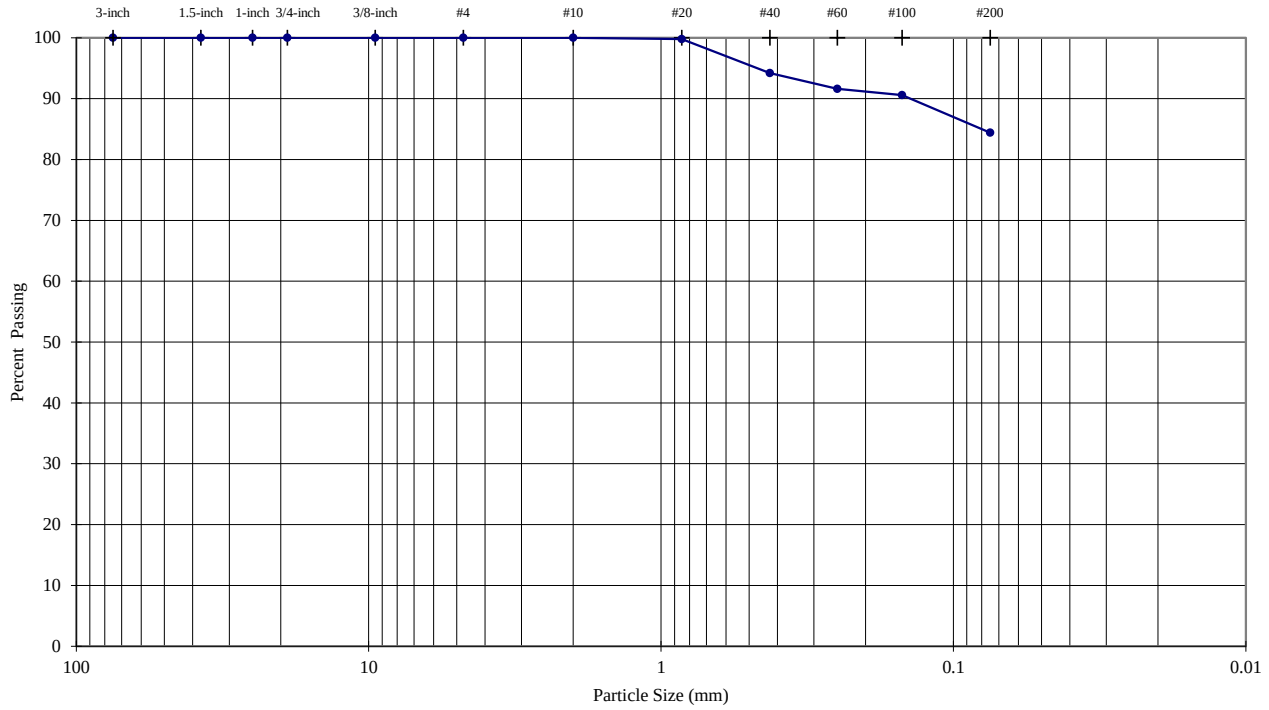
GOLDER

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

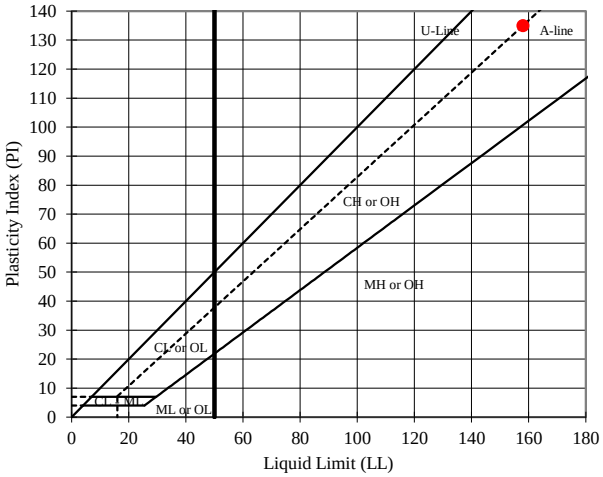
ASTM D421, D422, D4318

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **25 - 26.5**
TYPE: **Tube**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.0	**100.0**	Coarse Sand	**0.00**
#20	0.850	**99.8**	Medium Sand	**5.80**
#40	0.425	**94.2**		
#60	0.250	**91.6**	Fine Sand	**9.79**
#100	0.150	**90.6**		
#200	0.075	**84.4**		
			Silt or Clay Fines	**84.42**

Sieve Analysis (Initial Separation on No. 4 Sieve)



USCS Description (ASTM D 2487):

Fat clay with sand, pale yellow, moist

LL	PL	PI
158	**23**	**135**

As-Received Moisture Content (%): **23.2**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	7-May-2019
REVIEW	MB

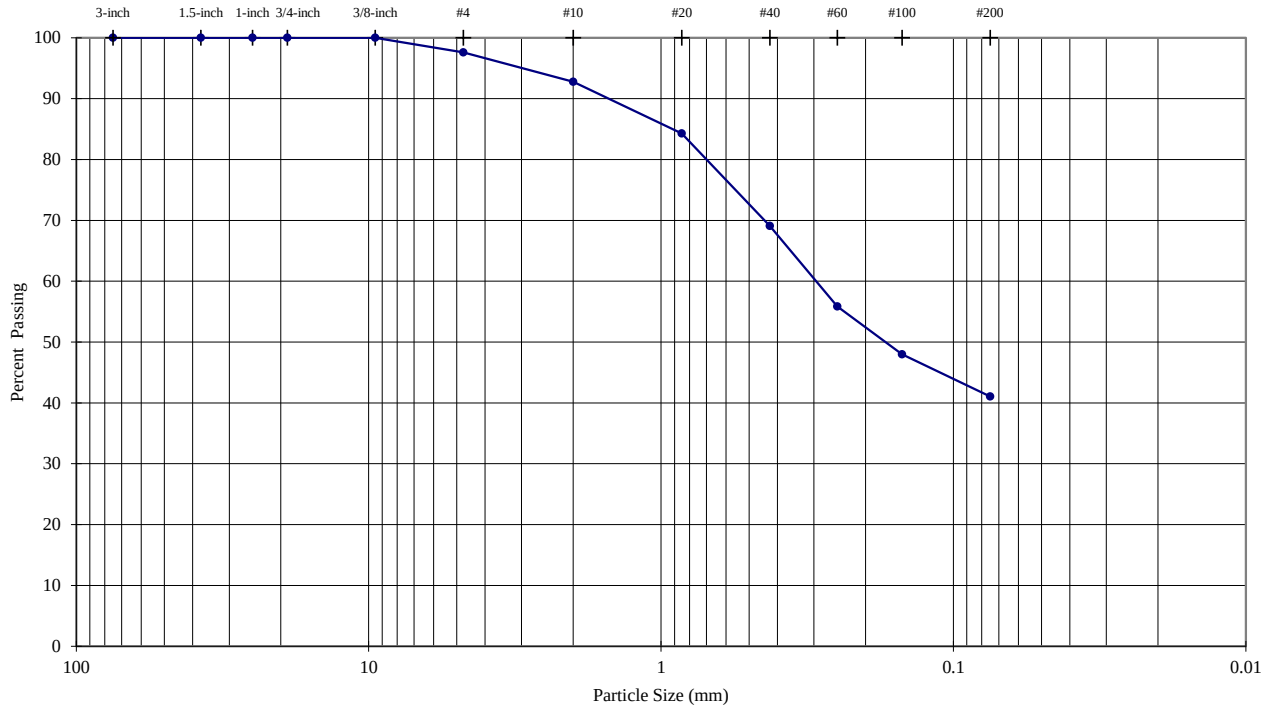
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

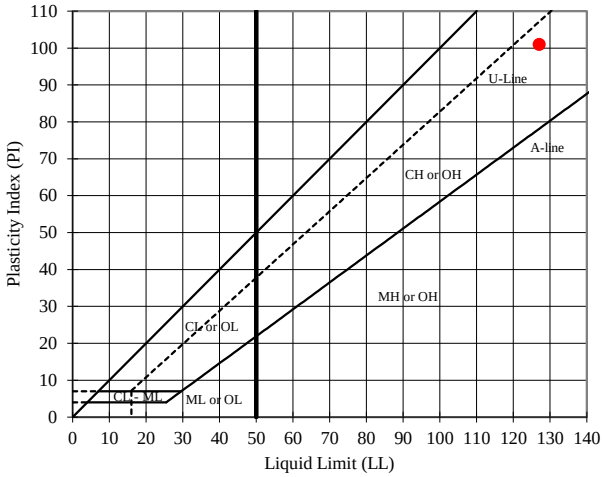
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **30.3 - 31.8**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**97.6**
#10	2.0	**92.8**
#20	0.850	**84.3**
#40	0.425	**69.1**
#60	0.250	**55.9**
#100	0.150	**48.0**
#200	0.075	**41.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**2.39**
Coarse Sand	**4.83**
Medium Sand	**23.68**
Fine Sand	**28.03**
Silt or Clay Fines	**41.06**



USCS Description (ASTM D 2487):

Clayey sand, pale yellow, moist

LL	PL	PI
127	**26**	**101**

As-Received Moisture Content (%): **27.1**

USCS Group Symbol: SC

Notes: 0 g of particles up to 9.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	7-Jun-2019
REVIEW	MB

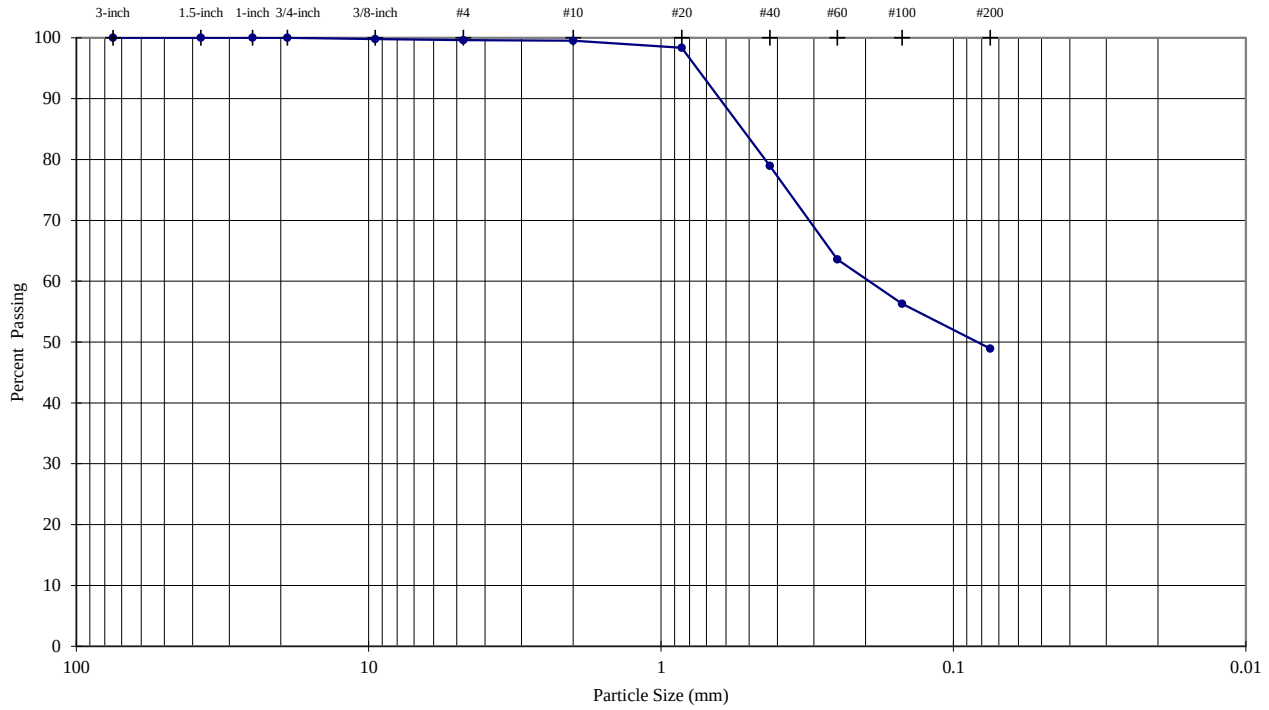
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

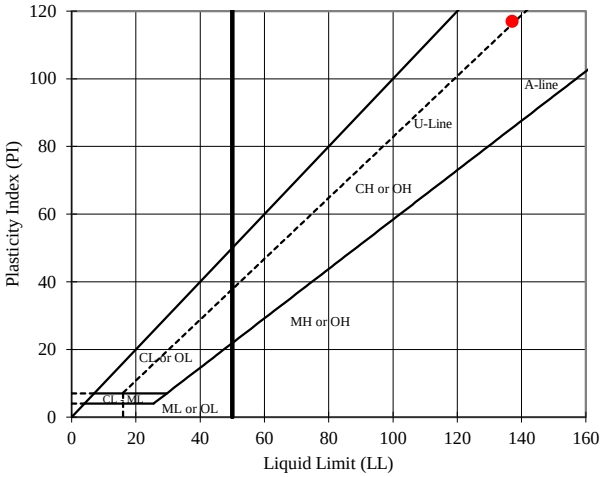
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **35 - 36.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.8**
#4	4.75	**99.6**
#10	2.0	**99.5**
#20	0.850	**98.4**
#40	0.425	**79.0**
#60	0.250	**63.6**
#100	0.150	**56.3**
#200	0.075	**48.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.40**
Coarse Sand	**0.08**
Medium Sand	**20.54**
Fine Sand	**30.04**
Silt or Clay Fines	**48.94**



USCS Description (ASTM D 2487):

Clayey sand, brownish yellow, moist

LL	PL	PI
137	**20**	**117**

As-Received Moisture Content (%): **26.3**

USCS Group Symbol: SC

Notes: 0 g of particles up to 19.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	9-May-2019
REVIEW	MB

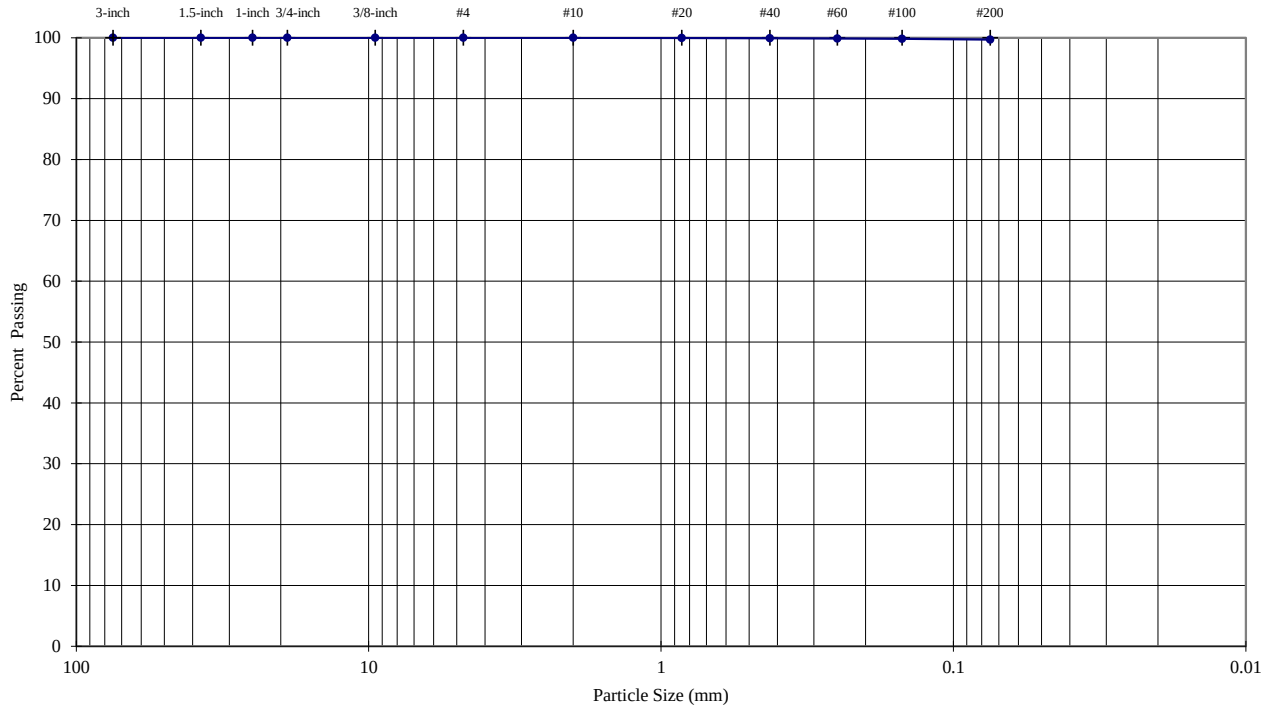
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

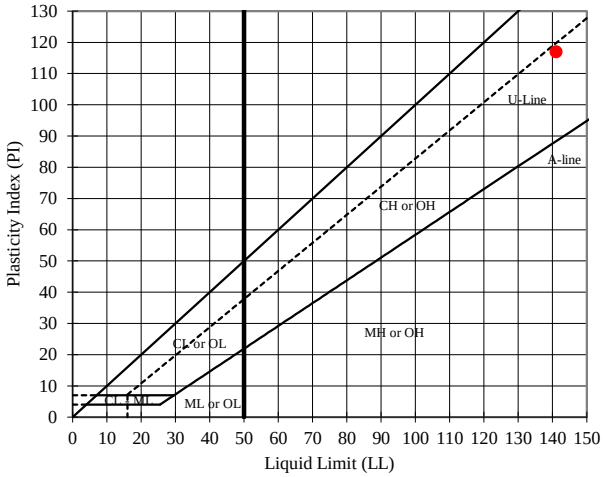
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **40.0 - 41.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.9**
#60	0.250	**99.9**
#100	0.150	**99.9**
#200	0.075	**99.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.07**
Fine Sand	**0.22**
Silt or Clay Fines	**99.71**



USCS Description (ASTM D 2487):

Fat clay, grayish brown, moist

LL	PL	PI
141	**24**	**117**

As-Received Moisture Content (%): **45.5**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	13-May-2019
REVIEW	MB

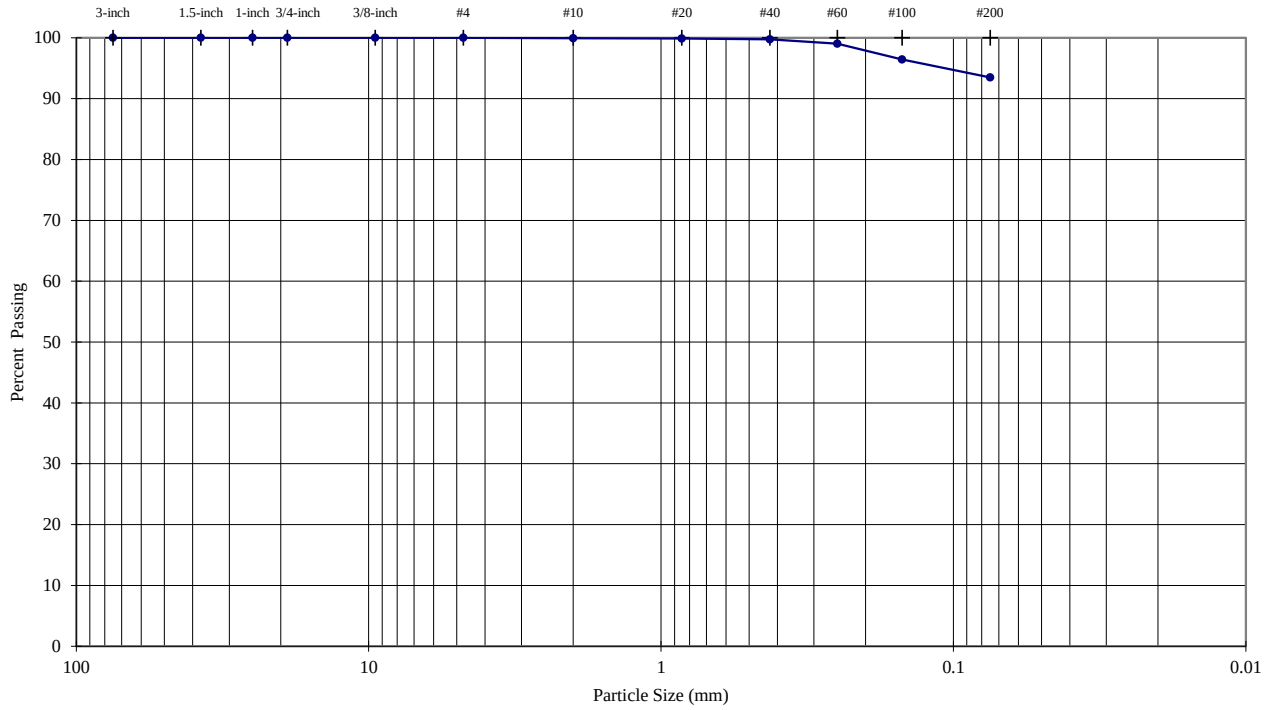
GOLDER

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

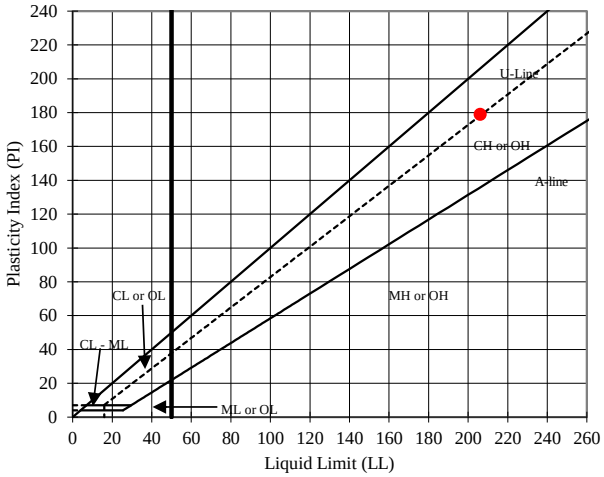
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **50 - 51.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.9**
#20	0.850	**99.9**
#40	0.425	**99.8**
#60	0.250	**99.0**
#100	0.150	**96.4**
#200	0.075	**93.5**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.06**
Medium Sand	**0.19**
Fine Sand	**6.26**
Silt or Clay Fines	**93.49**



USCS Description (ASTM D 2487):

Fat clay, olive yellow, moist

LL	PL	PI
206	**27**	**179**

As-Received Moisture Content (%): **42.2**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	13-May-2019
REVIEW	MB

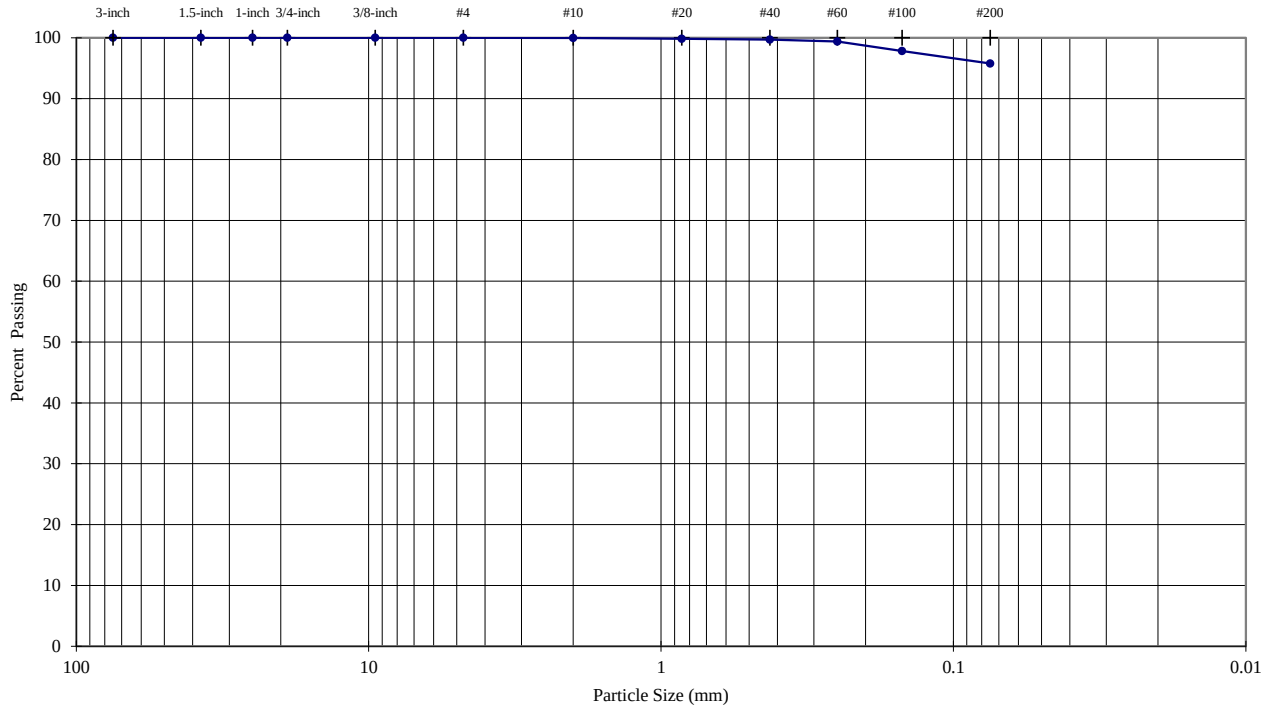
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

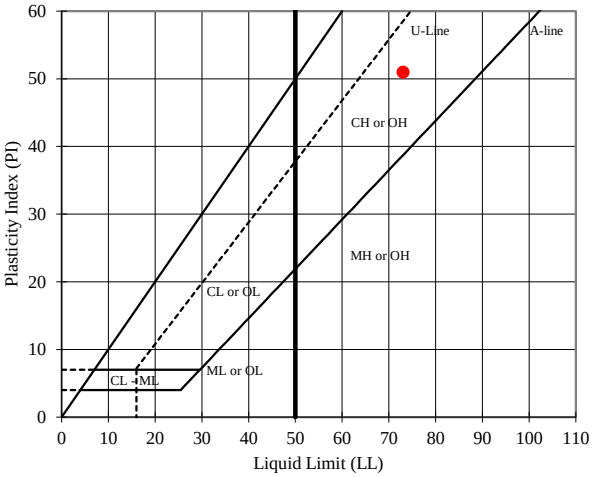
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **60 - 61.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.8**
#40	0.425	**99.7**
#60	0.250	**99.4**
#100	0.150	**97.8**
#200	0.075	**95.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.03**
Medium Sand	**0.28**
Fine Sand	**3.91**
Silt or Clay Fines	**95.78**



USCS Description (ASTM D 2487):

Fat clay, very dark gray, moist

LL	PL	PI
73	**22**	**51**

As-Received Moisture Content (%): **22.1**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	13-May-2019
REVIEW	MB

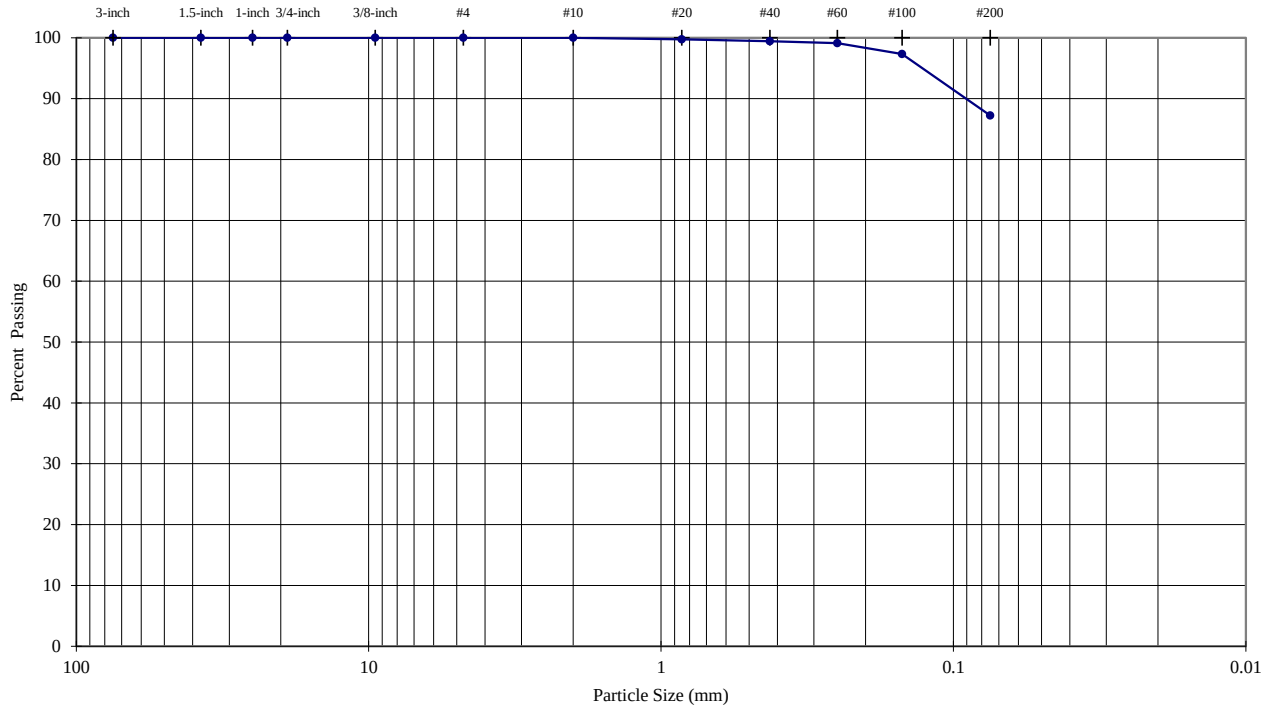
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

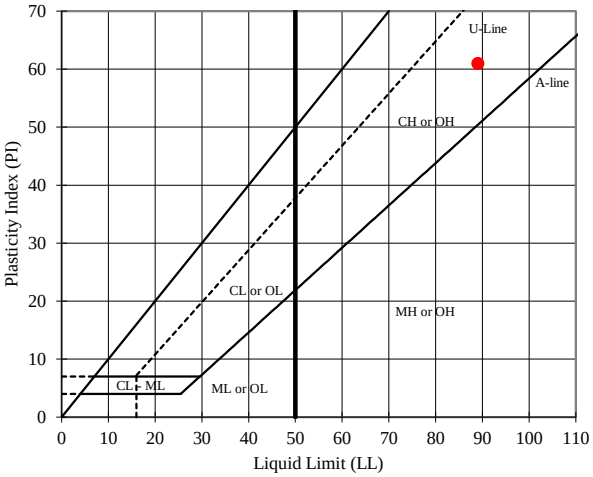
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **70 - 71.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.8**
#40	0.425	**99.4**
#60	0.250	**99.1**
#100	0.150	**97.3**
#200	0.075	**87.3**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.56**
Fine Sand	**12.19**
Silt or Clay Fines	**87.25**



USCS Description (ASTM D 2487):

Fat clay, bluish gray, moist

LL	PL	PI
89	**28**	**61**

As-Received Moisture Content (%): **30.3**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	13-May-2019
REVIEW	MB

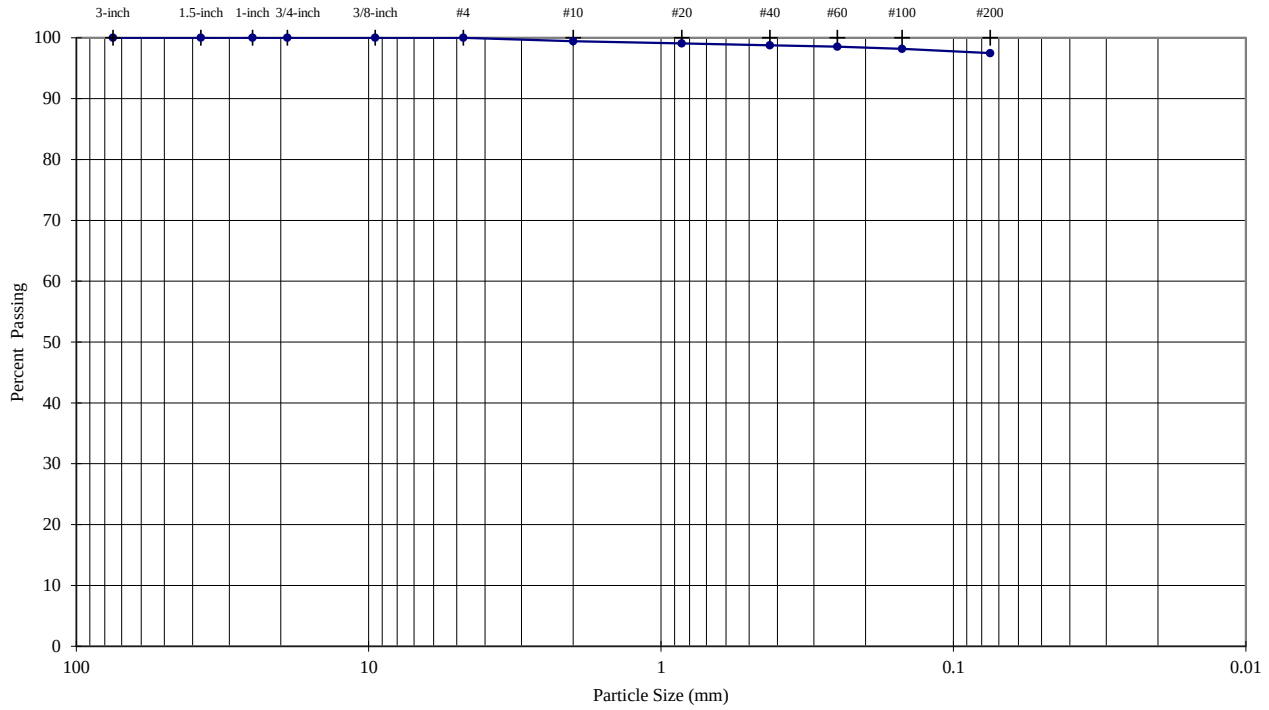
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

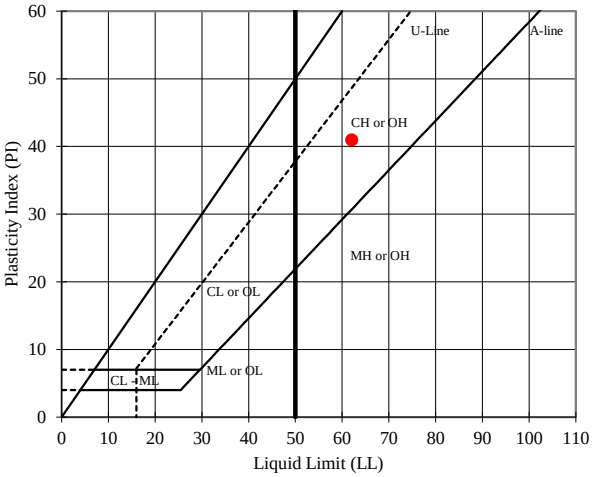
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **80 - 81.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.4**
#20	0.850	**99.1**
#40	0.425	**98.8**
#60	0.250	**98.6**
#100	0.150	**98.2**
#200	0.075	**97.5**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.56**
Medium Sand	**0.66**
Fine Sand	**1.29**
Silt or Clay Fines	**97.49**



USCS Description (ASTM D 2487):

Fat clay, bluish gray, moist

LL	PL	PI
62	**21**	**41**

As-Received Moisture Content (%): **20.9**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	26-Apr-2019
REVIEW	MB

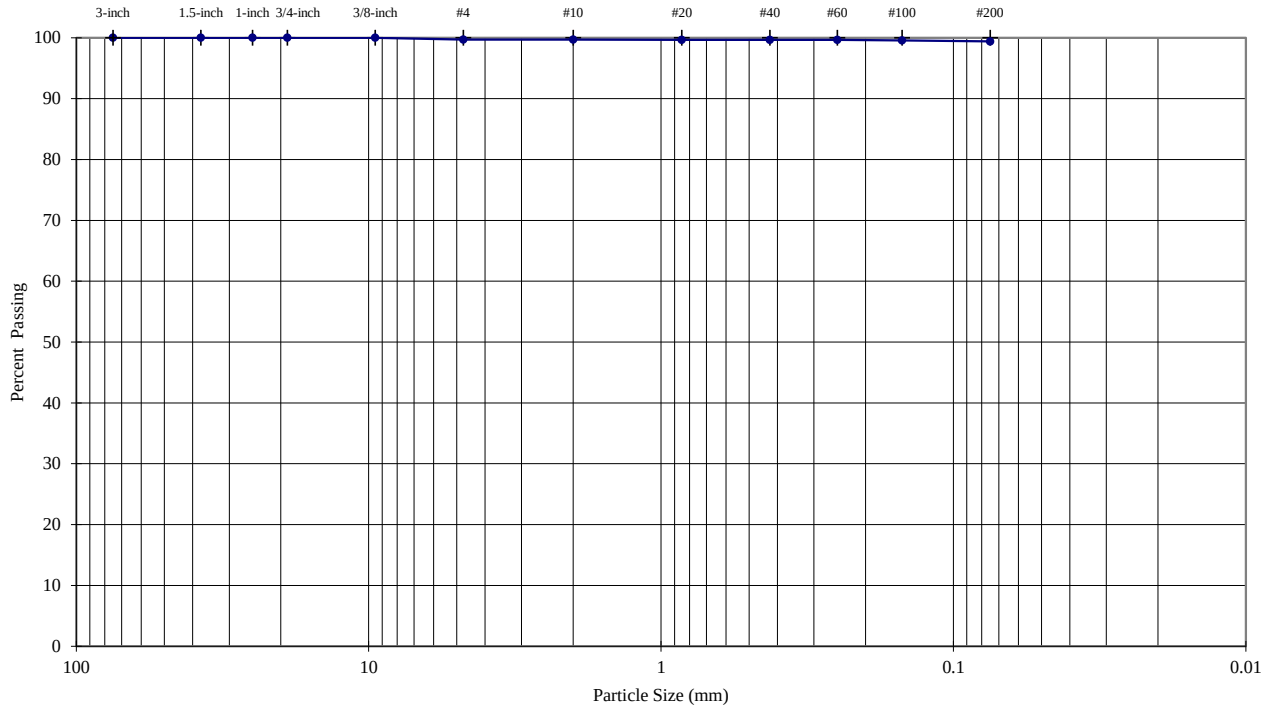
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

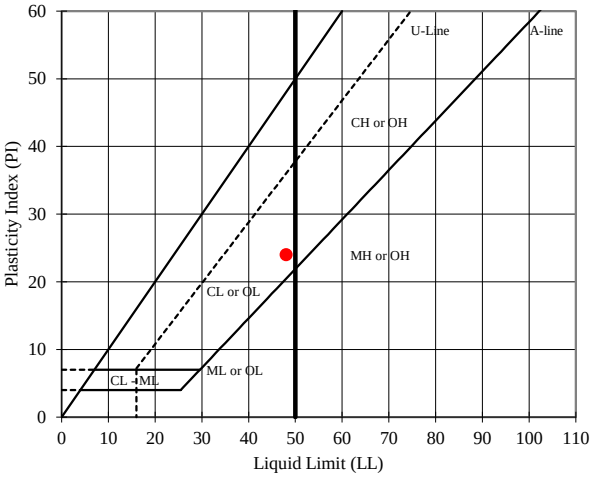
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **110.0 - 111.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**99.7**
#10	2.0	**99.7**
#20	0.850	**99.7**
#40	0.425	**99.7**
#60	0.250	**99.6**
#100	0.150	**99.6**
#200	0.075	**99.4**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.31**
Coarse Sand	**0.00**
Medium Sand	**0.03**
Fine Sand	**0.25**
Silt or Clay Fines	**99.41**



USCS Description (ASTM D 2487):

Lean clay, gray, moist

LL	PL	PI
48	**24**	**24**

As-Received Moisture Content (%): **17.8**

USCS Group Symbol: CL

Notes: 0 g of particles up to 9.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	13-May-2019
REVIEW	MB

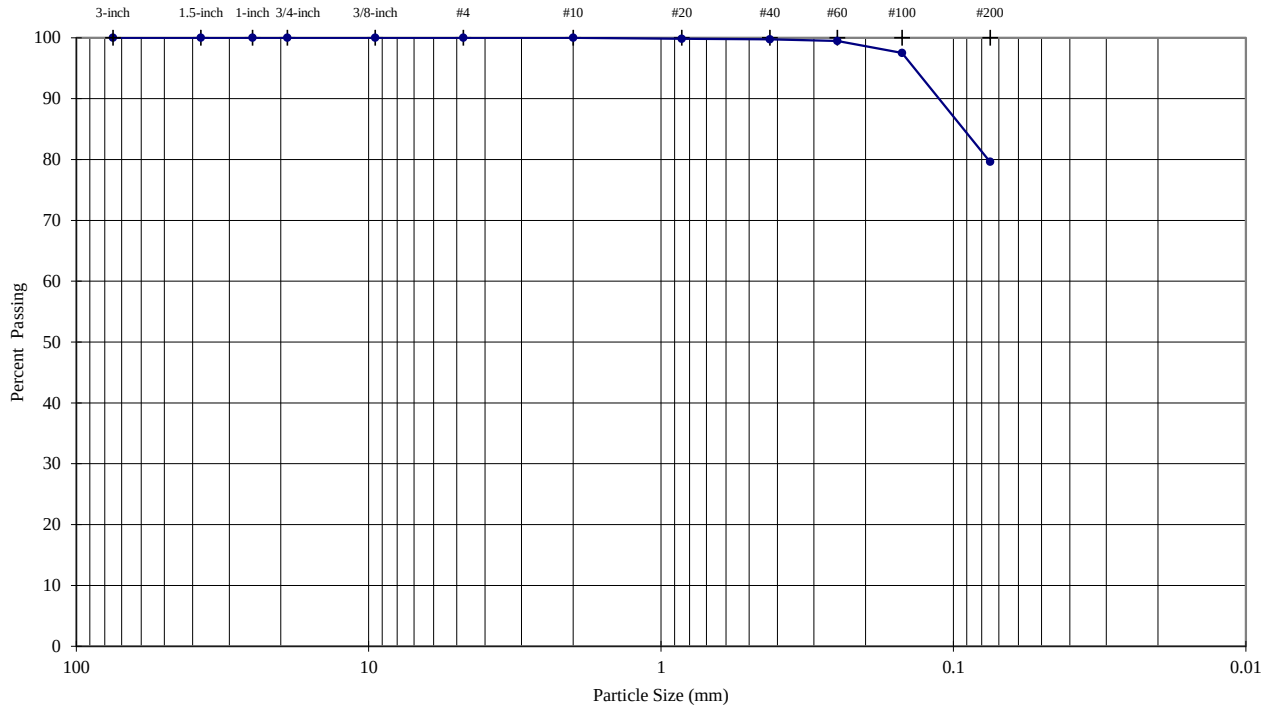
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

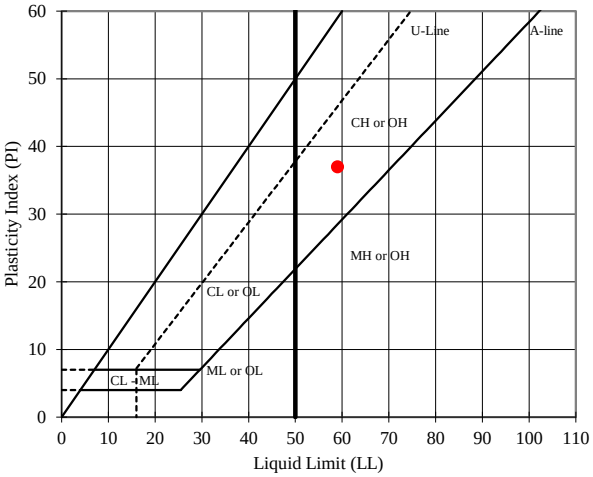
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-19** DEPTH (ft): **120 - 121.4**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.9**
#40	0.425	**99.7**
#60	0.250	**99.5**
#100	0.150	**97.5**
#200	0.075	**79.6**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.26**
Fine Sand	**20.12**
Silt or Clay Fines	**79.61**



USCS Description (ASTM D 2487):

Fat clay with sand, light gray, moist

LL	PL	PI
59	**22**	**37**

As-Received Moisture Content (%): **20.9**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	15-May-2019
REVIEW	MB

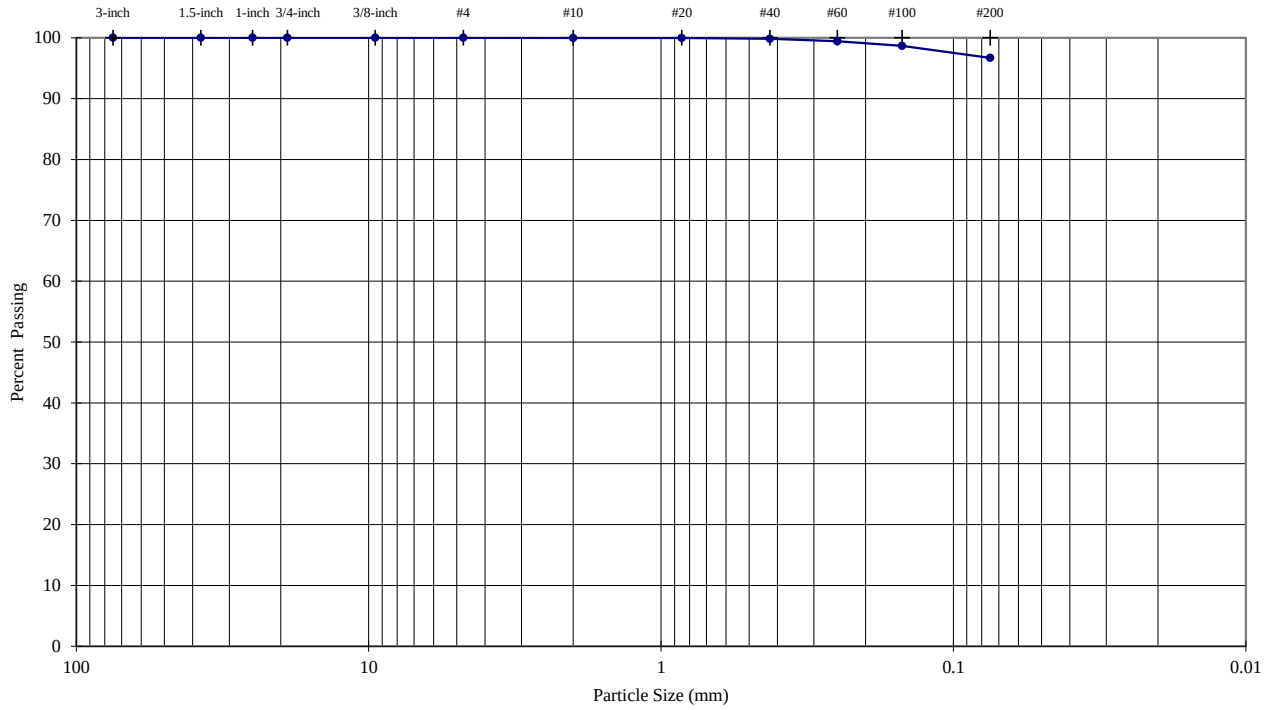
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

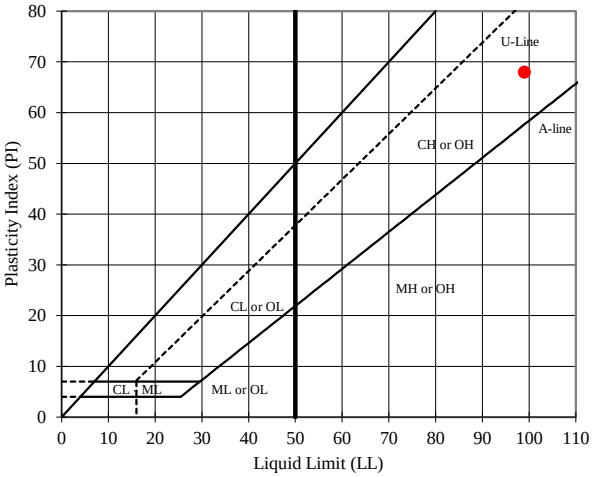
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **30-31.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.8**
#60	0.250	**99.4**
#100	0.150	**98.7**
#200	0.075	**96.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.01**
Medium Sand	**0.16**
Fine Sand	**3.13**
Silt or Clay Fines	**96.70**



USCS Description (ASTM D 2487):

Fat clay, olive brown, moist

LL	PL	PI
99	**31**	**68**

As-Received Moisture Content (%): **41.7**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	30-Apr-2019
REVIEW	PRH

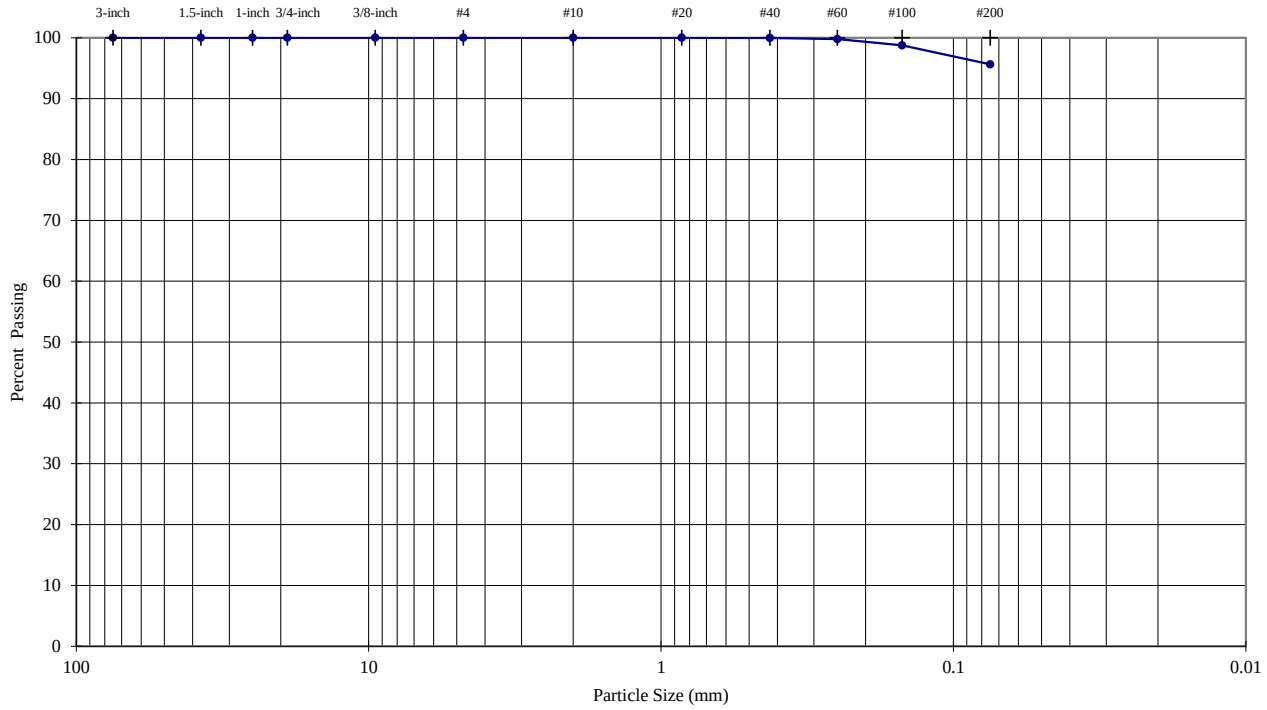
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

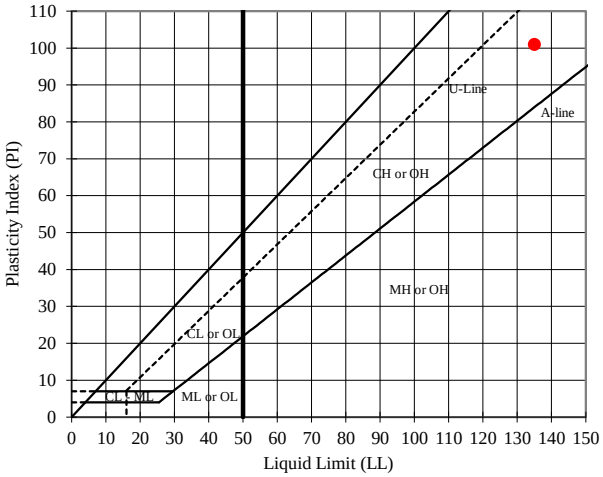
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **35 - 36.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**100.0**
#60	0.250	**99.8**
#100	0.150	**98.8**
#200	0.075	**95.6**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.02**
Fine Sand	**4.33**
Silt or Clay Fines	**95.65**



USCS Description (ASTM D 2487):

Fat clay, olive, moist

LL	PL	PI
135	**34**	**101**

As-Received Moisture Content (%): **41.7**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	30-Apr-2019
REVIEW	MB

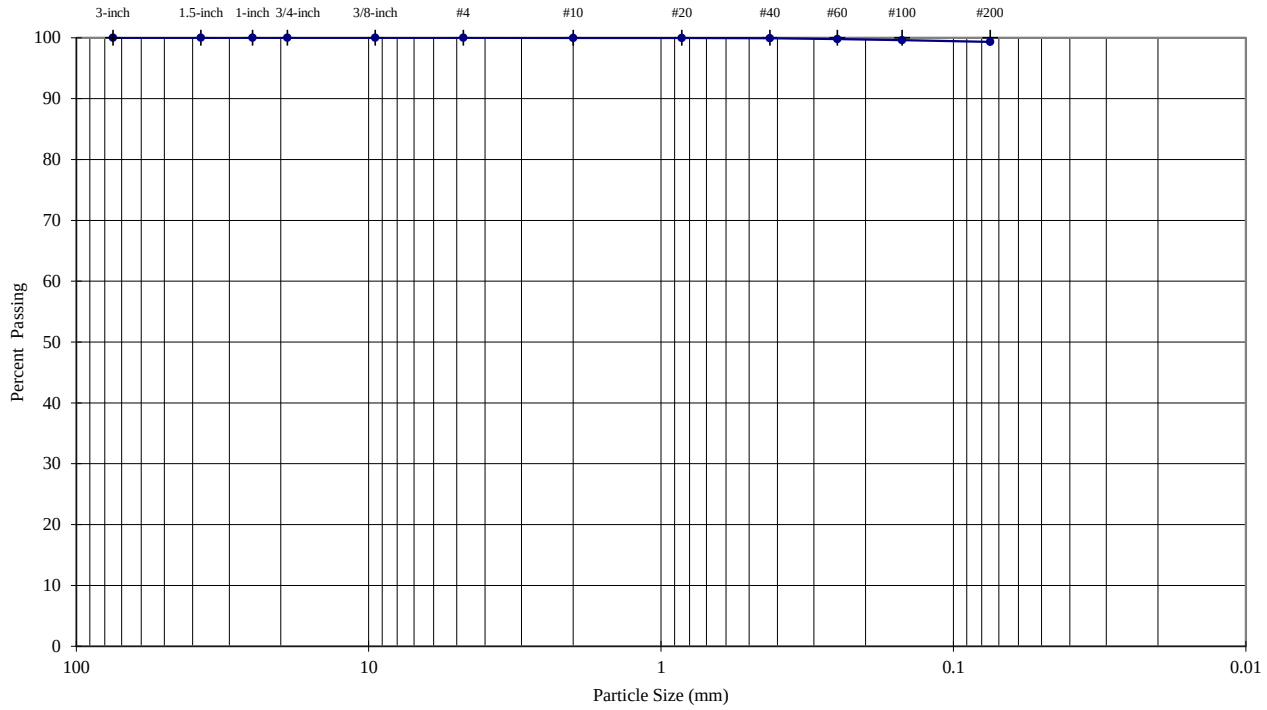
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

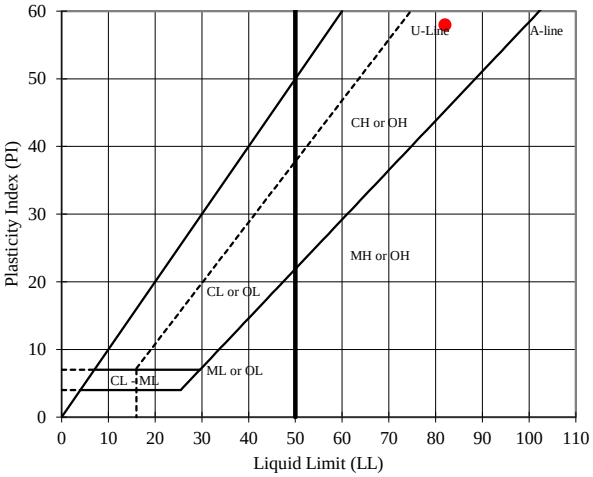
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **40 - 41.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.9**
#60	0.250	**99.8**
#100	0.150	**99.6**
#200	0.075	**99.3**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.01**
Medium Sand	**0.08**
Fine Sand	**0.58**
Silt or Clay Fines	**99.33**



USCS Description (ASTM D 2487):

Fat clay, pale brown, moist

LL	PL	PI
82	**24**	**58**

As-Received Moisture Content (%): **29.4**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	30-Apr-2019
REVIEW	MB

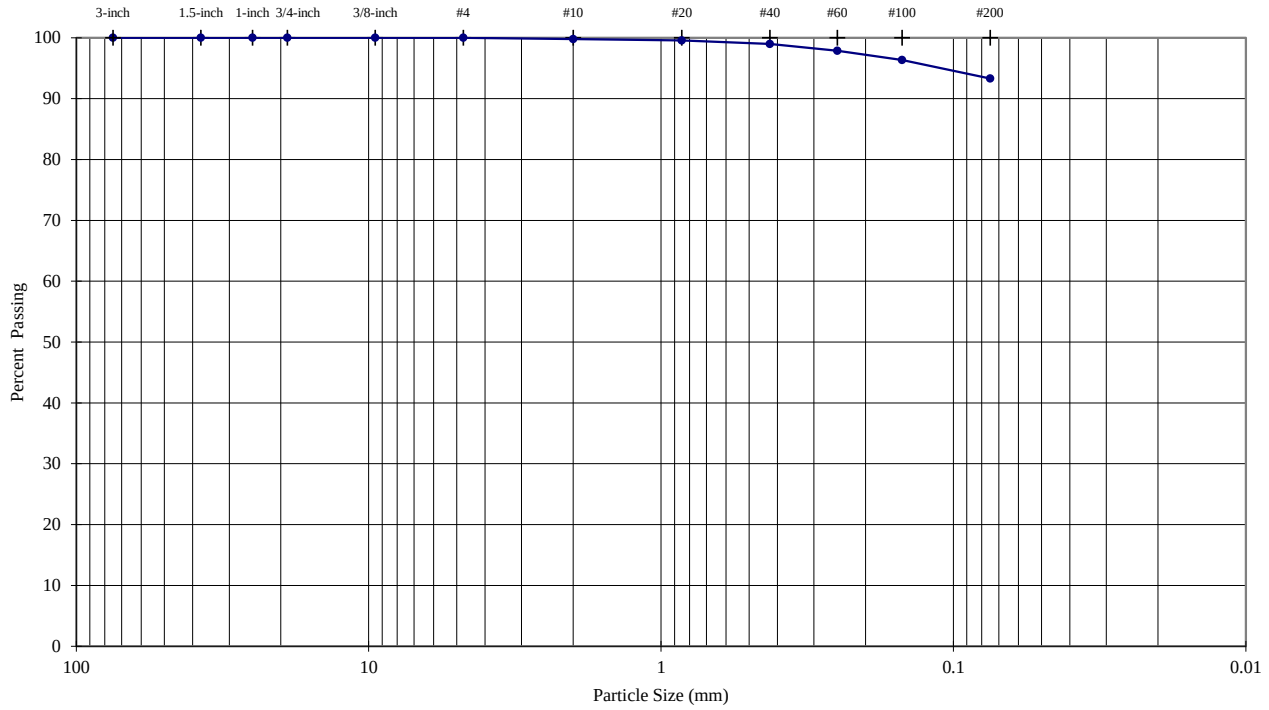
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

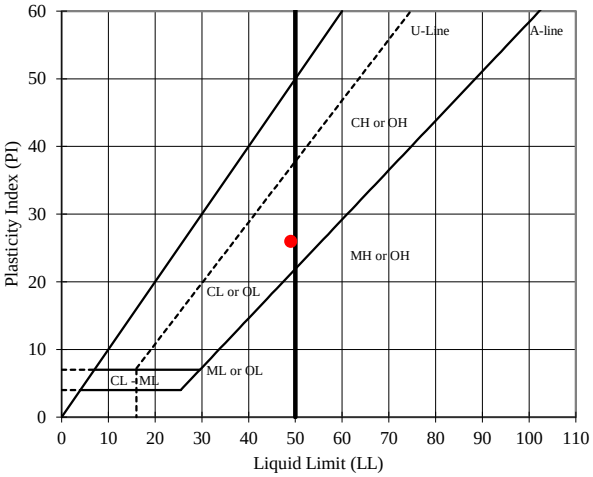
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **45-46.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.8**
#20	0.850	**99.6**
#40	0.425	**99.0**
#60	0.250	**97.9**
#100	0.150	**96.4**
#200	0.075	**93.3**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.21**
Medium Sand	**0.80**
Fine Sand	**5.68**
Silt or Clay Fines	**93.31**



USCS Description (ASTM D 2487):

Lean clay, pale brown, moist

LL	PL	PI
49	**23**	**26**

As-Received Moisture Content (%): **22.8**

USCS Group Symbol: CL

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	30-Apr-2019
REVIEW	PRH

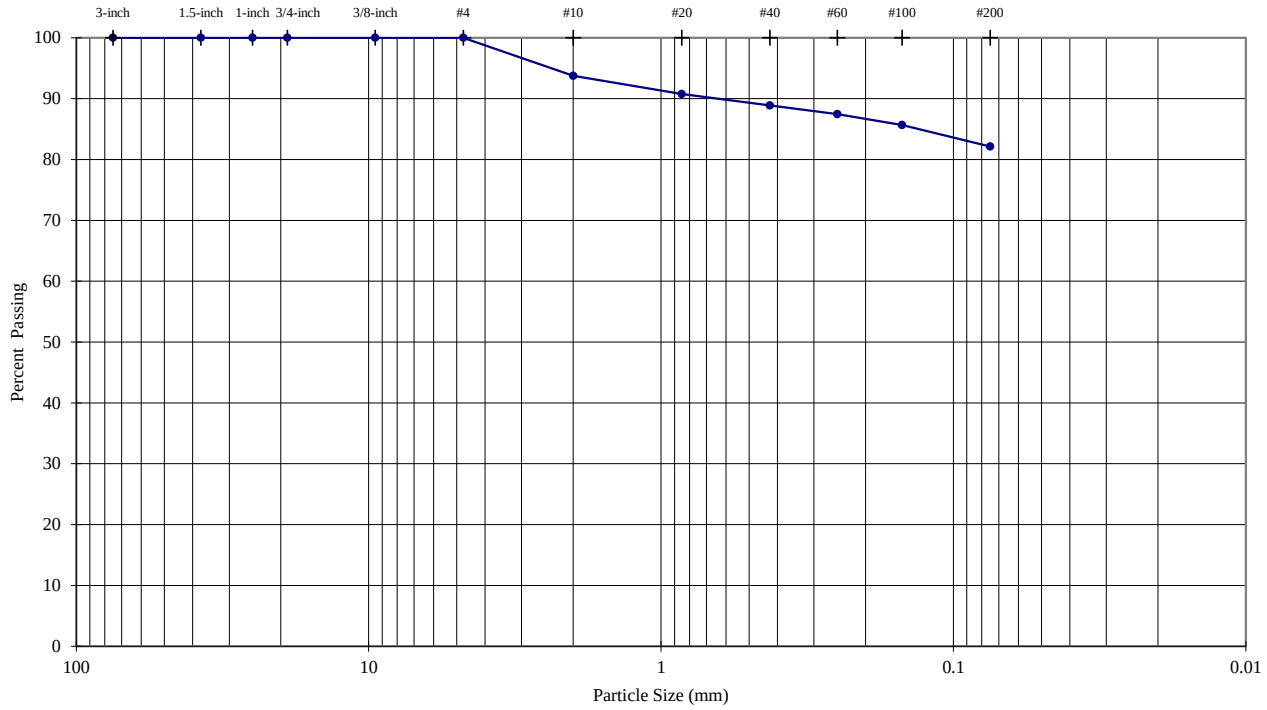
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

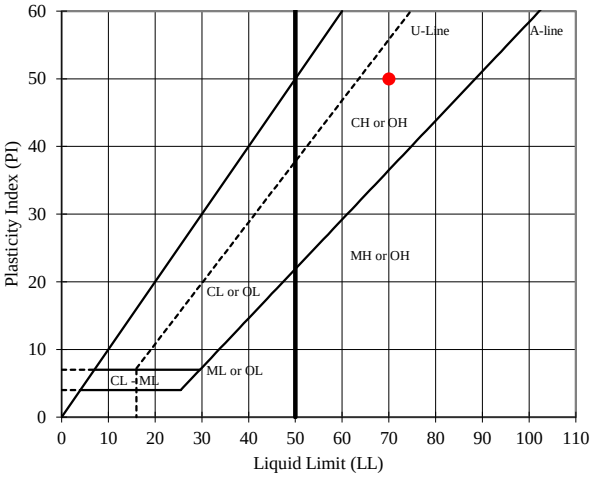
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **50 - 51.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**93.7**
#20	0.850	**90.7**
#40	0.425	**88.9**
#60	0.250	**87.5**
#100	0.150	**85.7**
#200	0.075	**82.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**6.26**
Medium Sand	**4.85**
Fine Sand	**6.76**
Silt or Clay Fines	**82.13**



USCS Description (ASTM D 2487):

Fat clay with sand, dark greenish gray, moist

LL	PL	PI
70	**20**	**50**

As-Received Moisture Content (%): **19.5**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	2-May-2019
REVIEW	MB

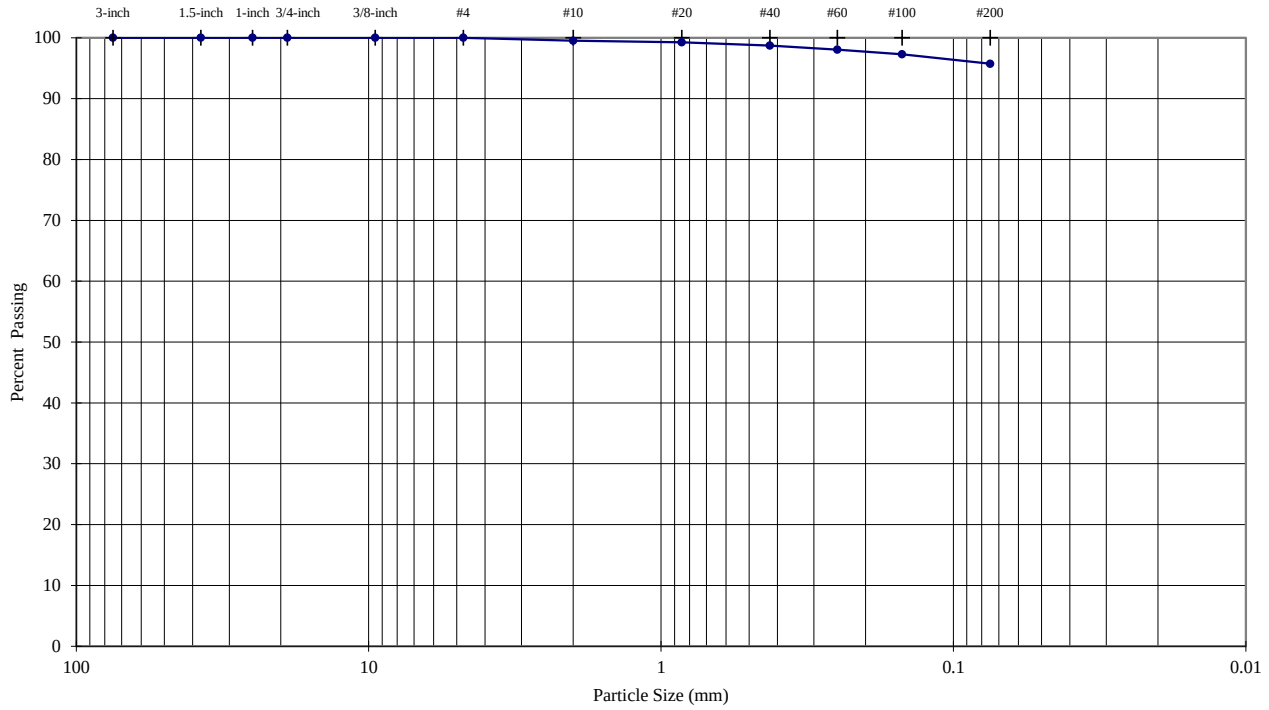
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

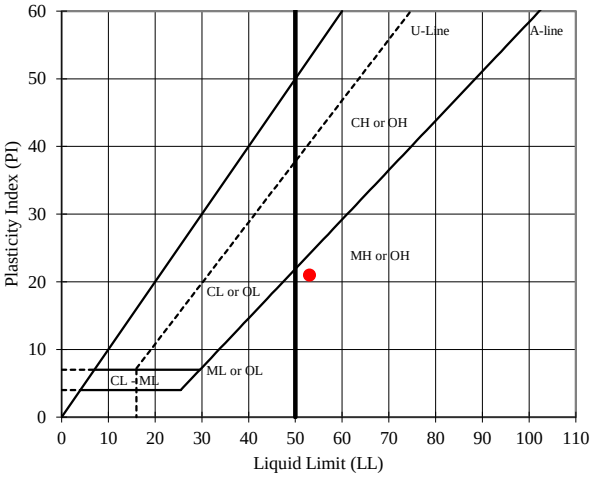
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **60-61.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.5**
#20	0.850	**99.3**
#40	0.425	**98.7**
#60	0.250	**98.1**
#100	0.150	**97.3**
#200	0.075	**95.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.45**
Medium Sand	**0.80**
Fine Sand	**3.00**
Silt or Clay Fines	**95.74**



USCS Description (ASTM D 2487):

Elastic silt, light yellowish brown, moist

LL	PL	PI
53	**32**	**21**

As-Received Moisture Content (%): **26.0**

USCS Group Symbol: MH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	1-May-2019
REVIEW	MB

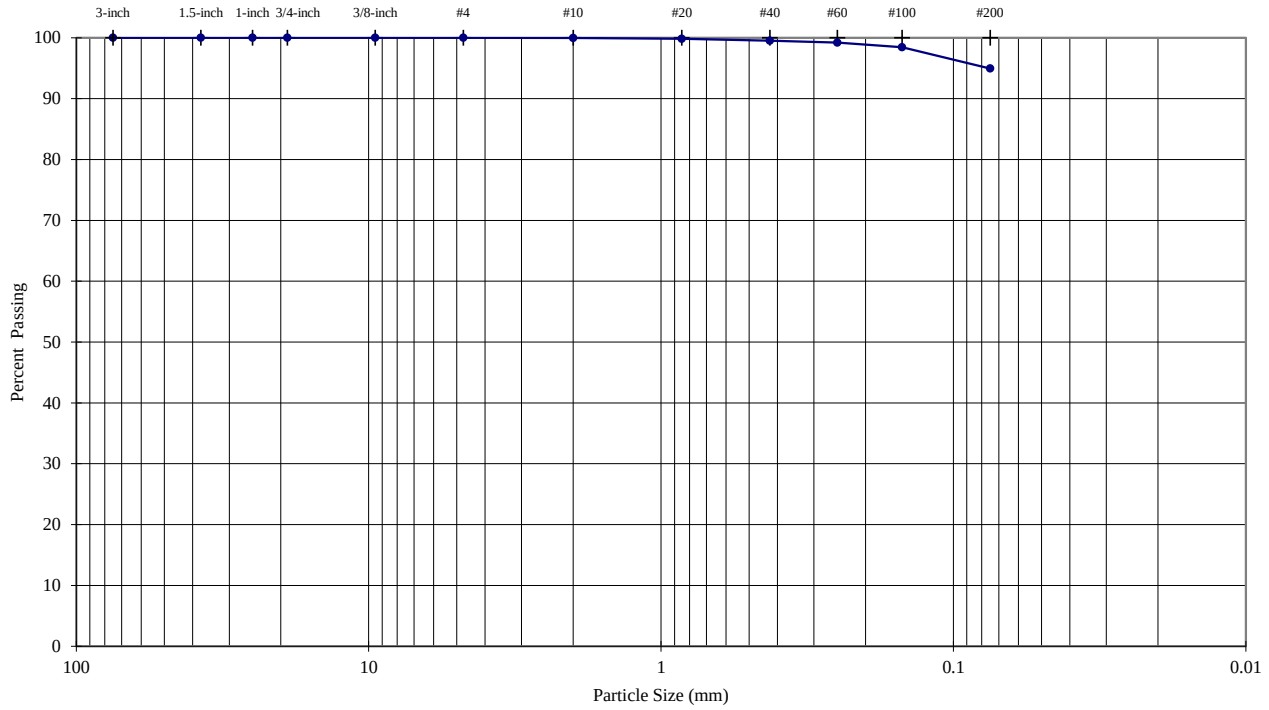
GOLDER

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

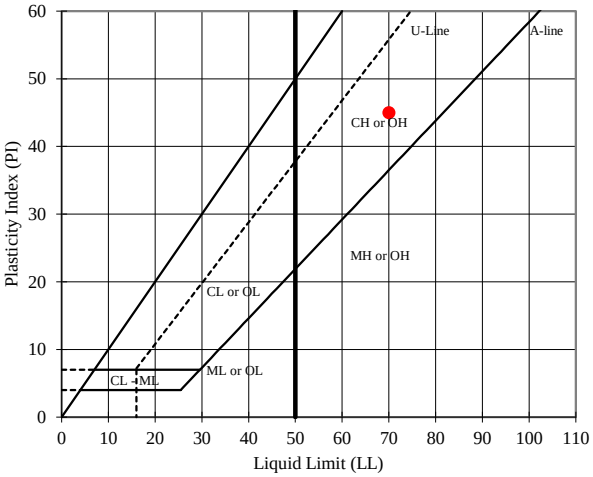
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **100 - 101.5**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.8**
#40	0.425	**99.5**
#60	0.250	**99.2**
#100	0.150	**98.4**
#200	0.075	**95.0**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.01**
Medium Sand	**0.45**
Fine Sand	**4.59**
Silt or Clay Fines	**94.95**



USCS Description (ASTM D 2487):

Fat clay, light gray and black, moist

LL	PL	PI
70	**25**	**45**

As-Received Moisture Content (%): **26.1**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	23-May-2019
REVIEW	MB

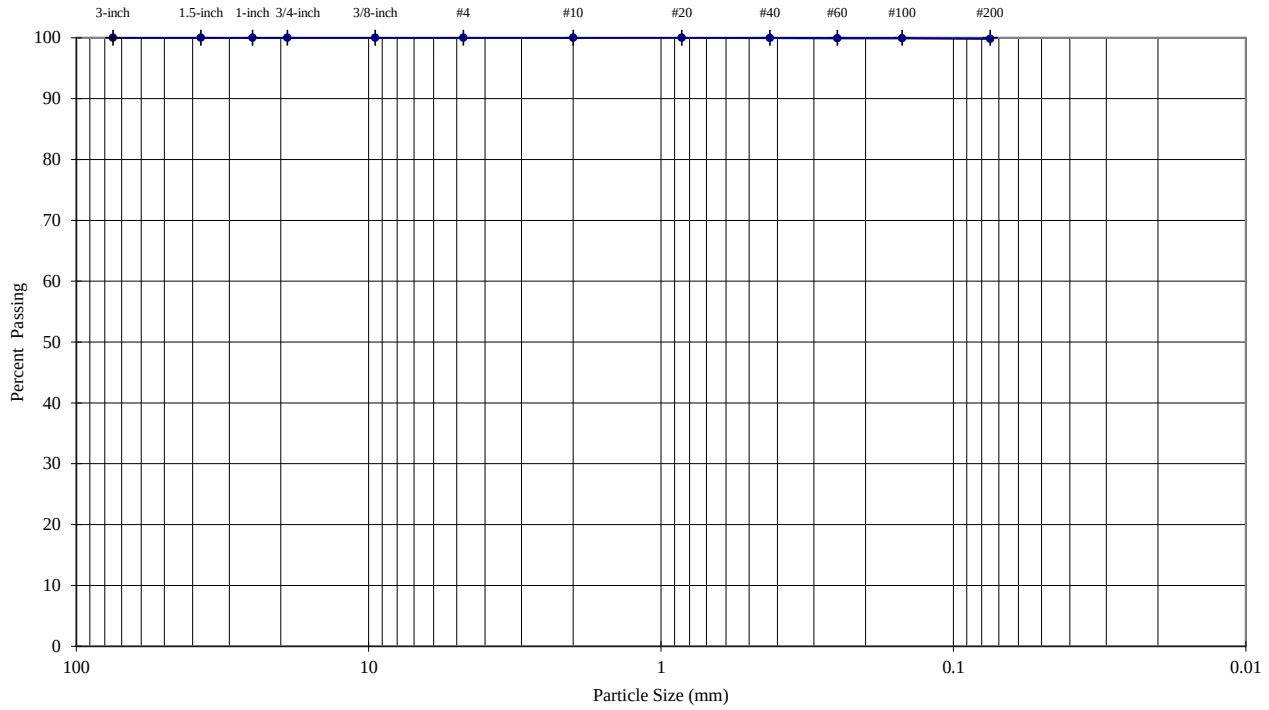
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

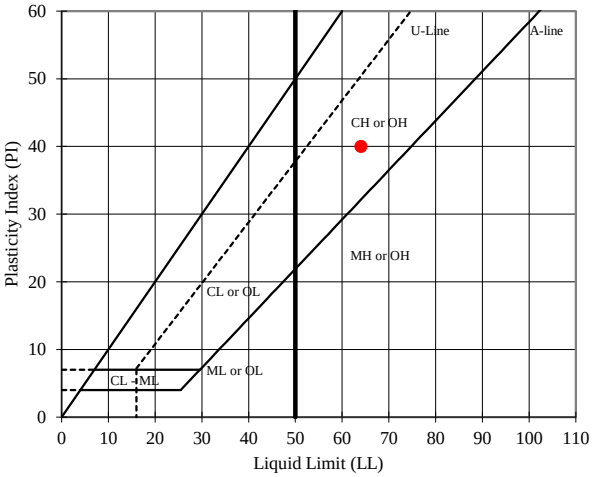
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-23** DEPTH (ft): **120 - 121.3**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**100.0**
#60	0.250	**99.9**
#100	0.150	**99.9**
#200	0.075	**99.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.04**
Fine Sand	**0.12**
Silt or Clay Fines	**99.84**



USCS Description (ASTM D 2487):

Fat clay, gray, moist

LL	PL	PI
64	**24**	**40**

As-Received Moisture Content (%): **25.1**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	17-May-2019
REVIEW	PRH

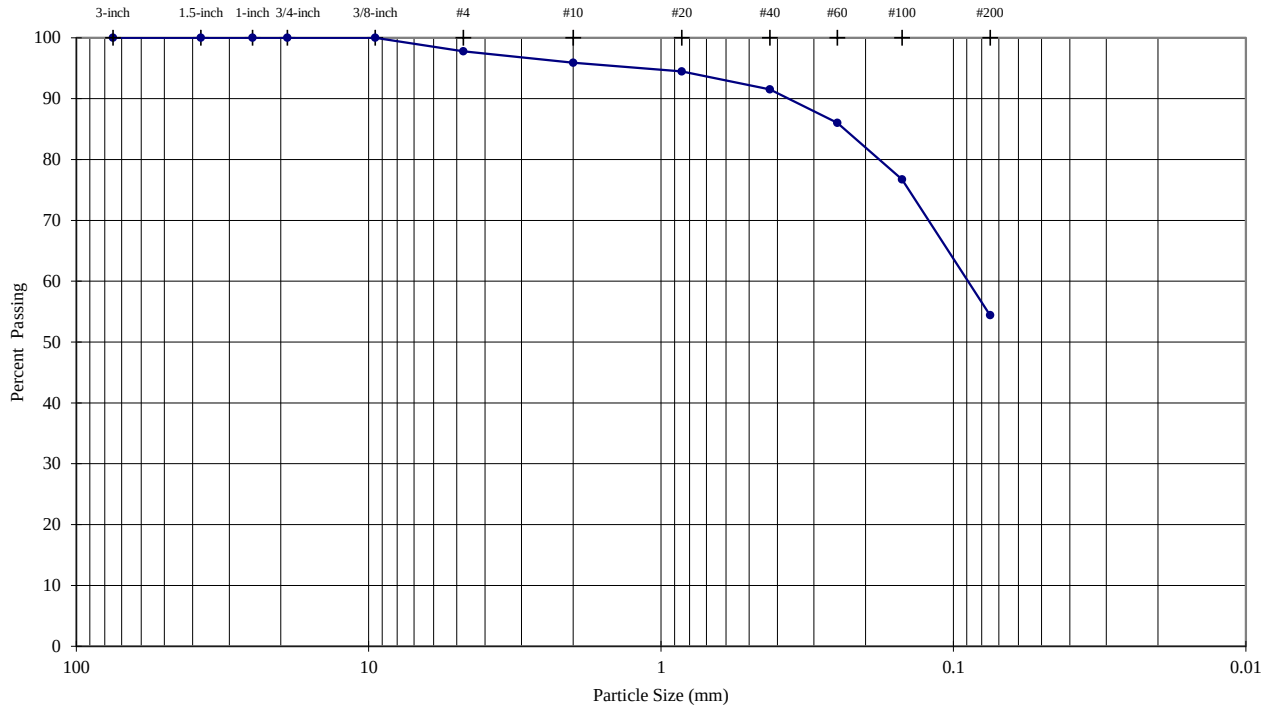
GOLDER

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

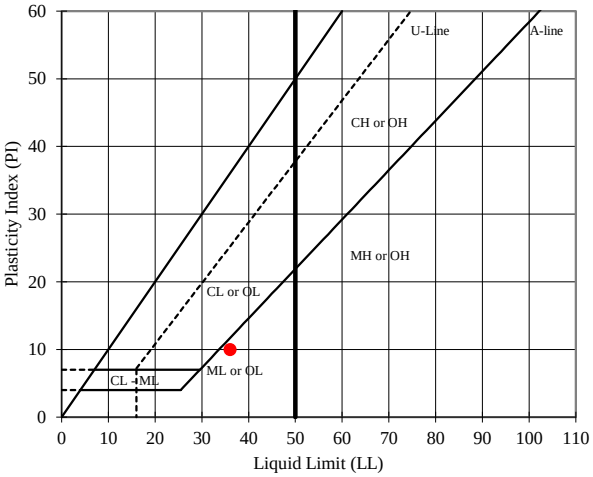
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-39** DEPTH (ft): **10.0-11.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**97.8**
#10	2.0	**95.9**
#20	0.850	**94.5**
#40	0.425	**91.5**
#60	0.250	**86.0**
#100	0.150	**76.7**
#200	0.075	**54.4**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**2.22**
Coarse Sand	**1.87**
Medium Sand	**4.40**
Fine Sand	**37.10**
Silt or Clay Fines	**54.41**



USCS Description (ASTM D 2487):

Sandy silt, light yellowish brown, moist

LL	PL	PI
36	**26**	**10**

As-Received Moisture Content (%): **16.0**

USCS Group Symbol: ML

Notes: 0 g of particles up to 9.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	6-May-2019
REVIEW	MB

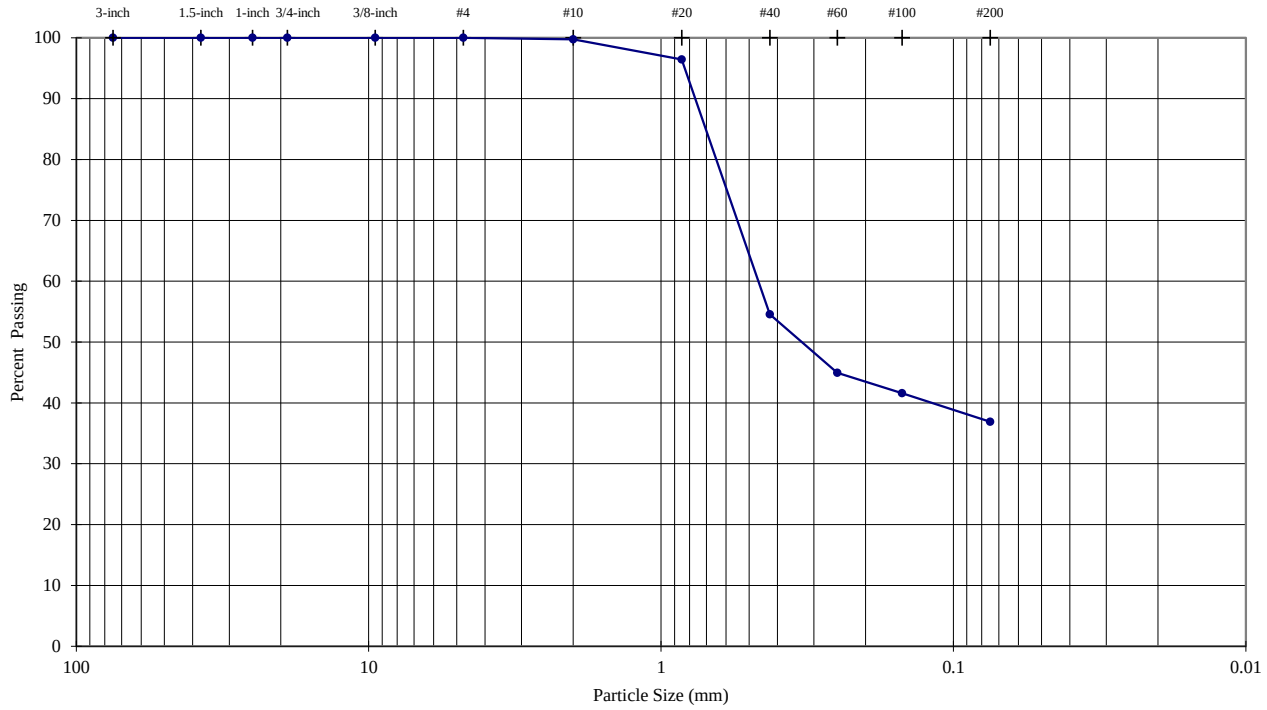
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

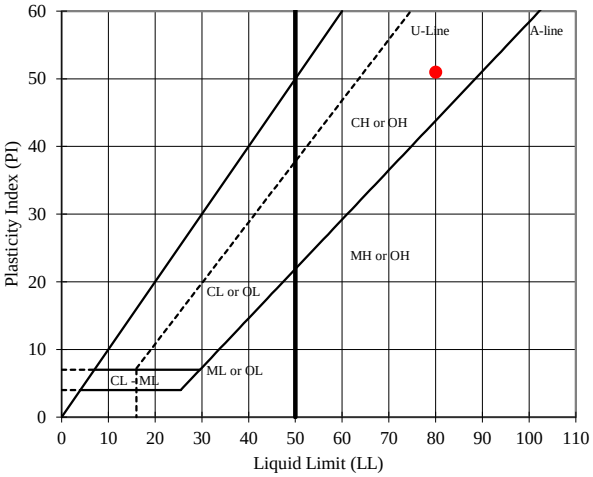
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-39** DEPTH (ft): **15.0-16.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**99.8**
#20	0.850	**96.5**
#40	0.425	**54.6**
#60	0.250	**44.9**
#100	0.150	**41.6**
#200	0.075	**36.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.25**
Medium Sand	**45.19**
Fine Sand	**17.66**
Silt or Clay Fines	**36.90**



USCS Description (ASTM D 2487):

Clayey sand, pale yellow, moist

LL	PL	PI
80	**29**	**51**

As-Received Moisture Content (%): **14.5**

USCS Group Symbol: SC

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	6-May-2019
REVIEW	MB

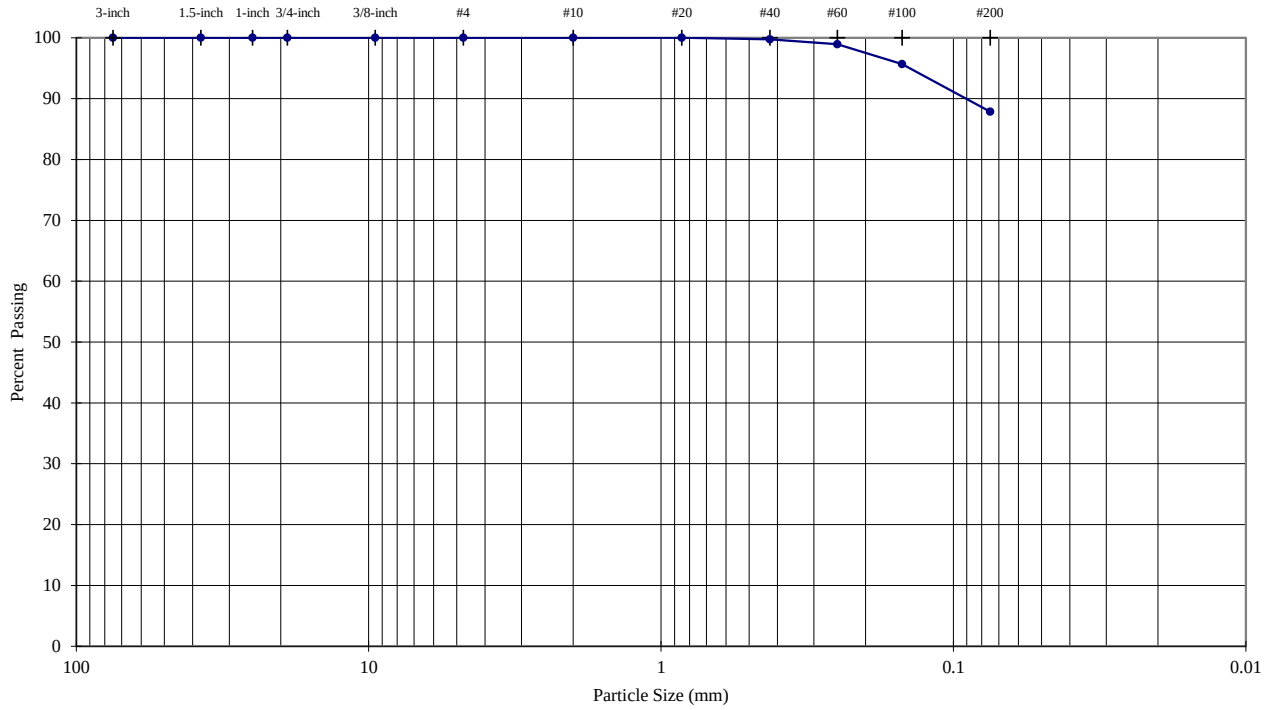
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

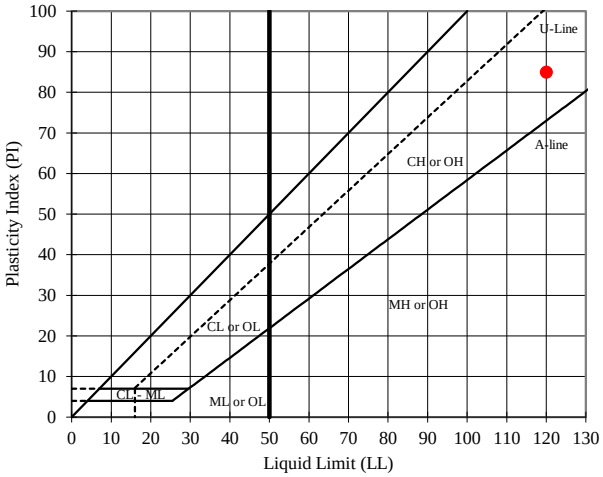
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-39** DEPTH (ft): **25 - 26.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.8**
#60	0.250	**99.0**
#100	0.150	**95.7**
#200	0.075	**87.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.23**
Fine Sand	**11.90**
Silt or Clay Fines	**87.87**



USCS Description (ASTM D 2487):

Fat clay, light greenish gray, moist

LL	PL	PI
120	**35**	**85**

As-Received Moisture Content (%): **39.3**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	6-May-2019
REVIEW	MB

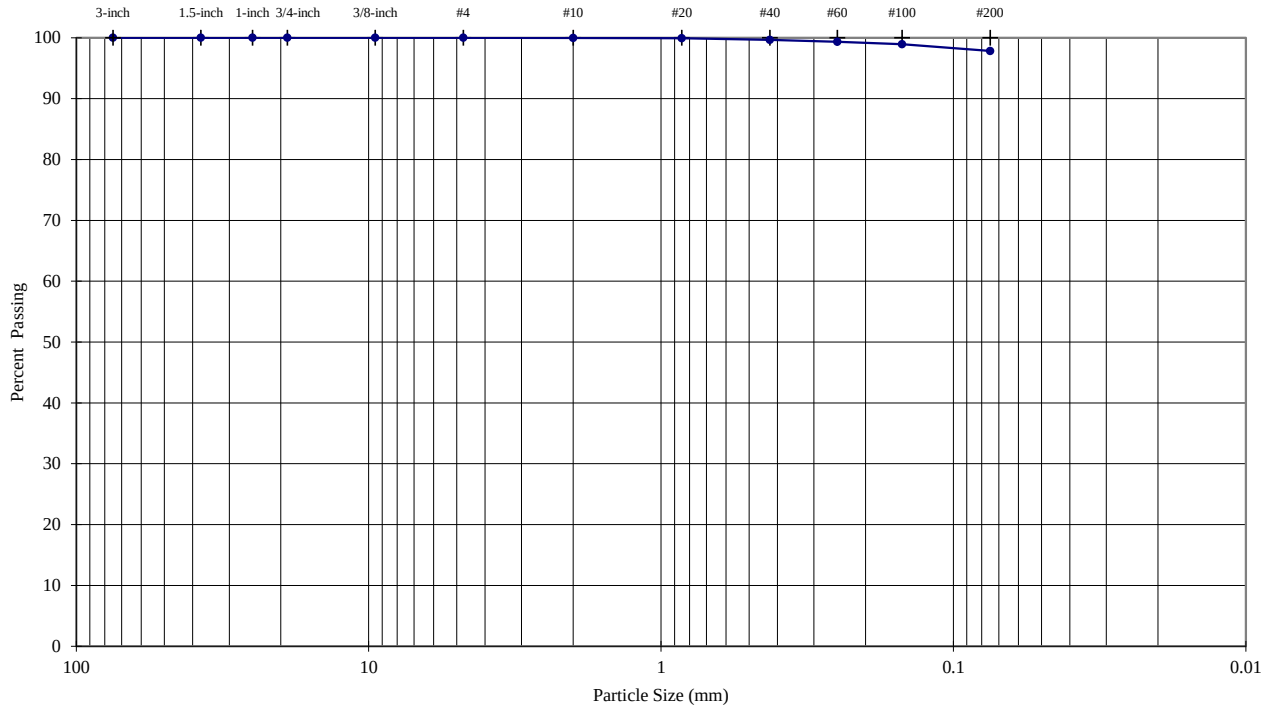
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

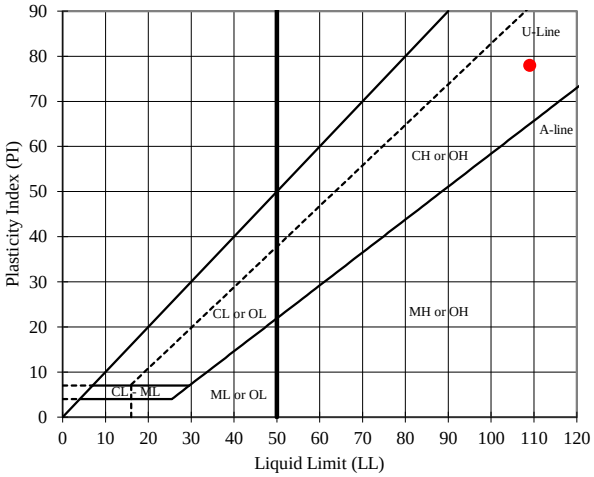
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-39** DEPTH (ft): **35 - 36.5**
TYPE: **Post Triaxial**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.9**
#40	0.425	**99.6**
#60	0.250	**99.3**
#100	0.150	**99.0**
#200	0.075	**97.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.03**
Medium Sand	**0.33**
Fine Sand	**1.80**
Silt or Clay Fines	**97.84**



USCS Description (ASTM D 2487):

Fat clay, olive yellow, dry

LL	PL	PI
109	**31**	**78**

As-Received Moisture Content (%): **38.8**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	5-Jun-2019
REVIEW	MB

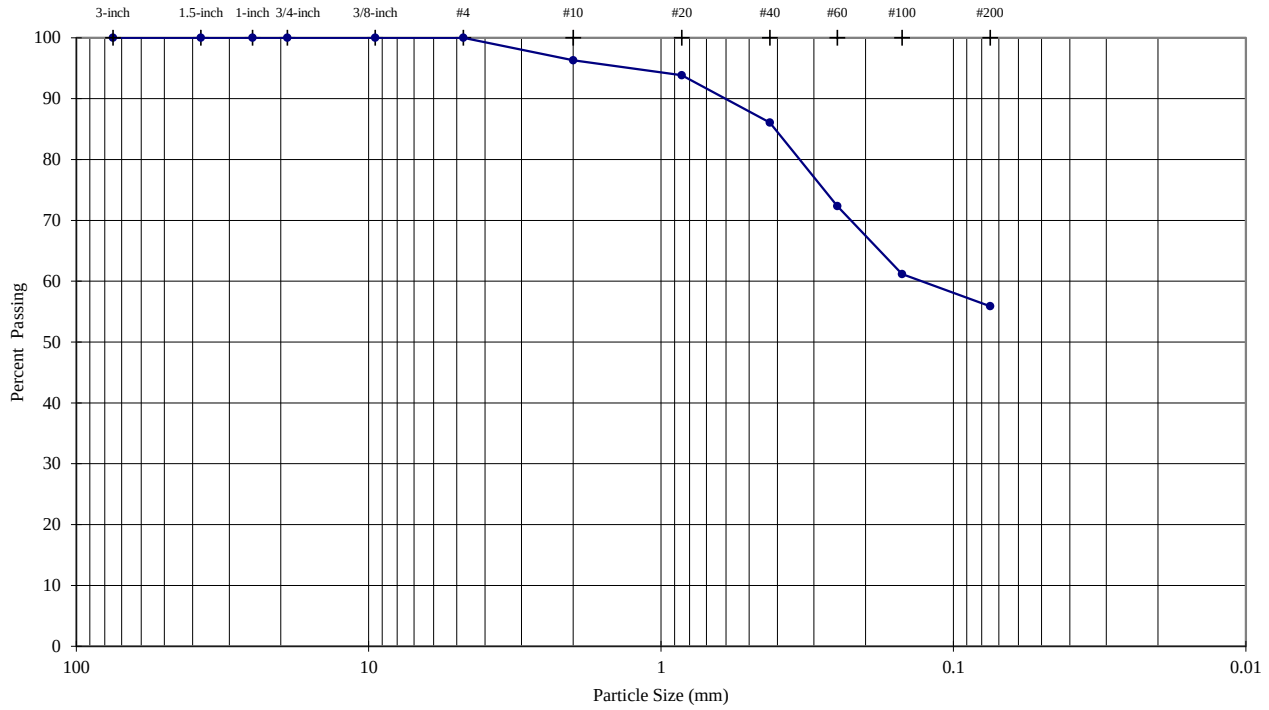
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

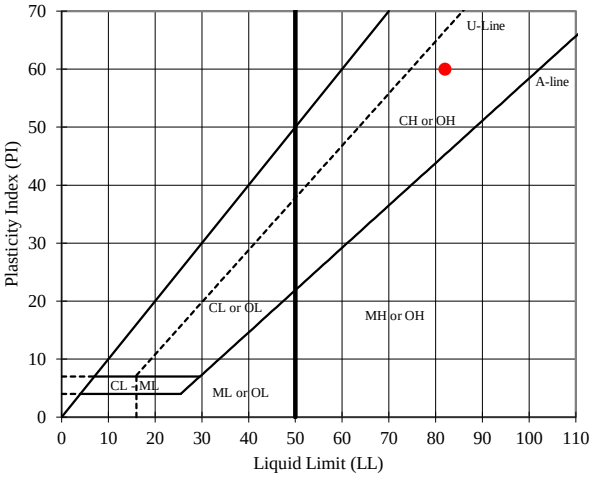
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **10 - 12**
TYPE: **Post Triaxial**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**96.3**
#20	0.850	**93.8**
#40	0.425	**86.1**
#60	0.250	**72.4**
#100	0.150	**61.2**
#200	0.075	**55.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**3.71**
Medium Sand	**10.23**
Fine Sand	**30.17**
Silt or Clay Fines	**55.89**



USCS Description (ASTM D 2487):

Fat clay, olive yellow, dry

LL	PL	PI	SpG
82	**22**	**60**	**2.75**

As-Received Moisture Content (%): **27.3**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	BC
DATE	5-Jun-2019
REVIEW	MB

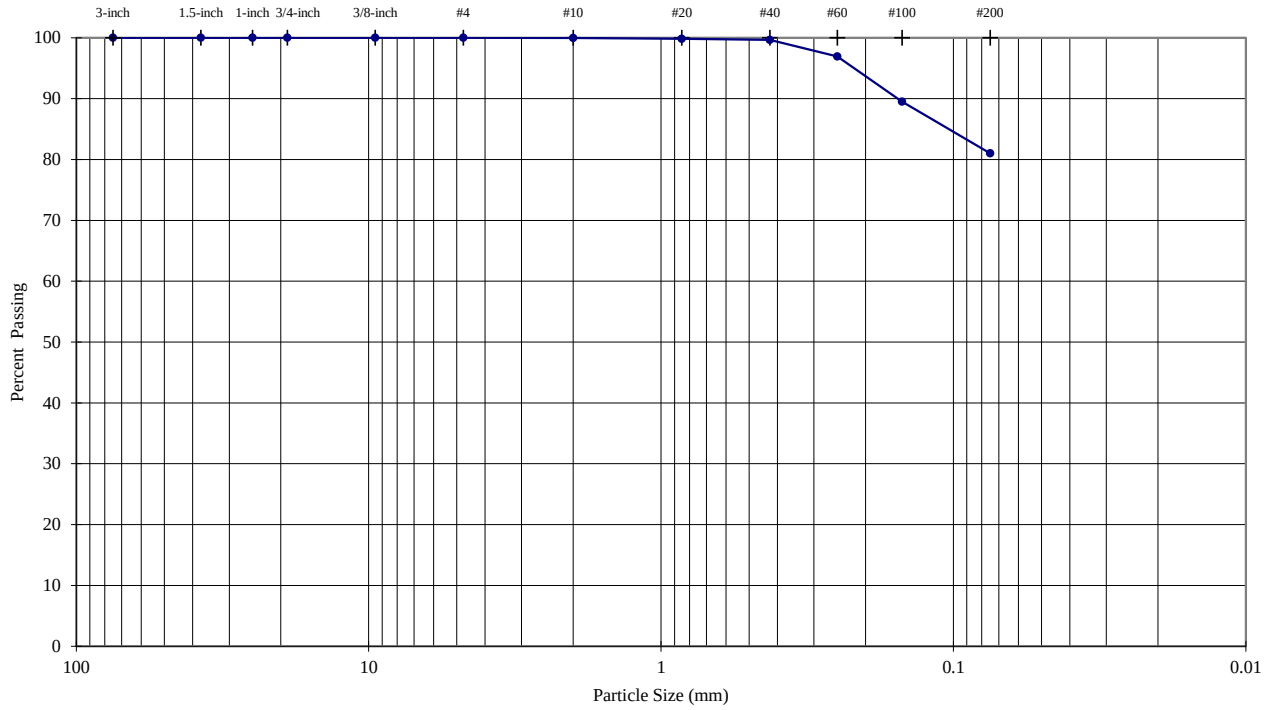
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

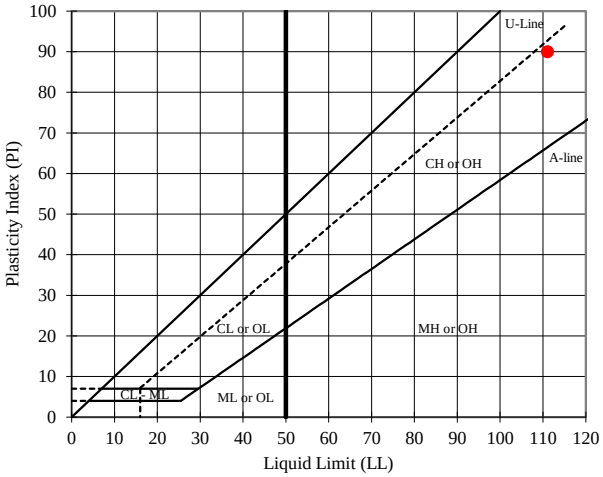
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **22 - 23.5**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.8**
#40	0.425	**99.7**
#60	0.250	**96.9**
#100	0.150	**89.5**
#200	0.075	**81.0**

Sieve Analysis (Initial Separation on No. 4 Sieve)

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.05**
Medium Sand	**0.28**
Fine Sand	**18.65**
Silt or Clay Fines	**81.02**



USCS Description (ASTM D 2487):

Fat clay with sand, light gray, moist

LL	PL	PI
111	**21**	**90**

As-Received Moisture Content (%): **35.5**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	29-May-2019
REVIEW	MB

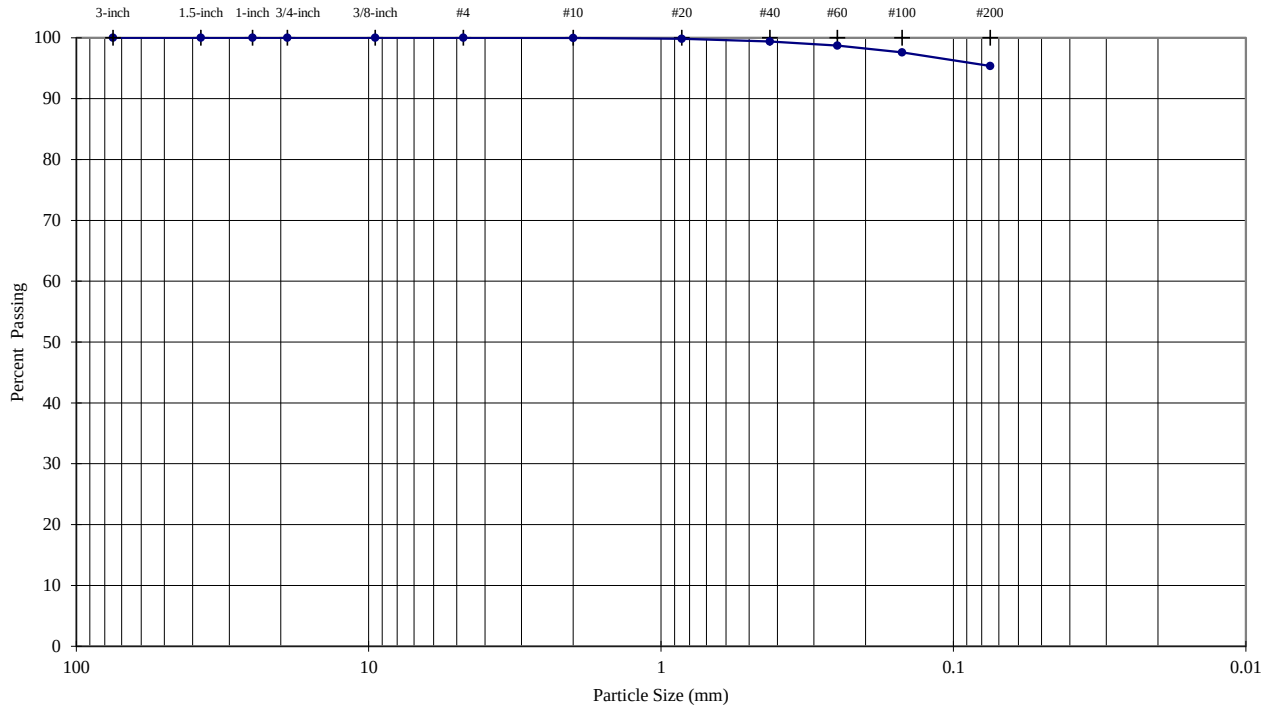
GOLDER

April-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

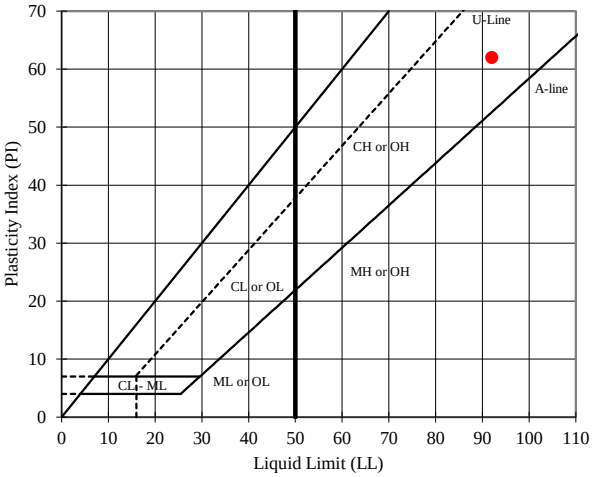
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **25 - 26.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.8**
#40	0.425	**99.4**
#60	0.250	**98.7**
#100	0.150	**97.6**
#200	0.075	**95.4**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.04**
Medium Sand	**0.58**
Fine Sand	**4.01**
Silt or Clay Fines	**95.37**



USCS Description (ASTM D 2487):

Fat clay, bluish gray, moist

LL	PL	PI
92	**30**	**62**

As-Received Moisture Content (%): **36.7**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	26-Apr-2019
REVIEW	MB

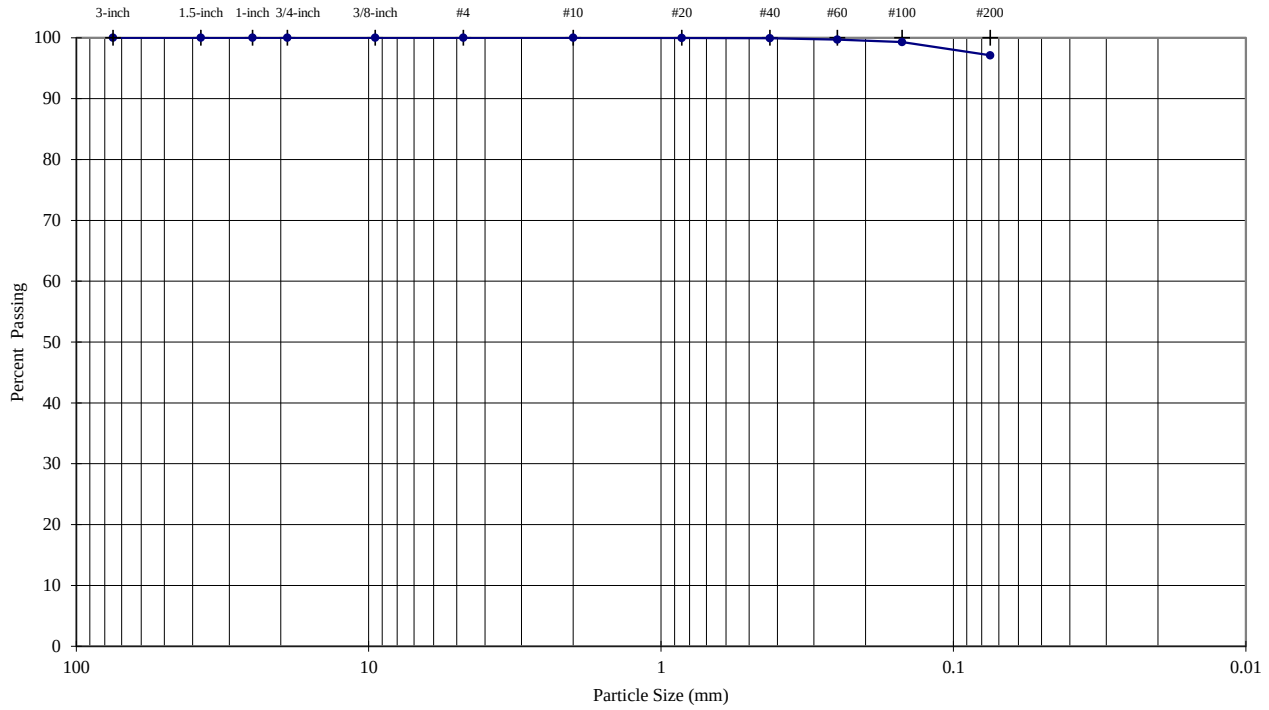
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

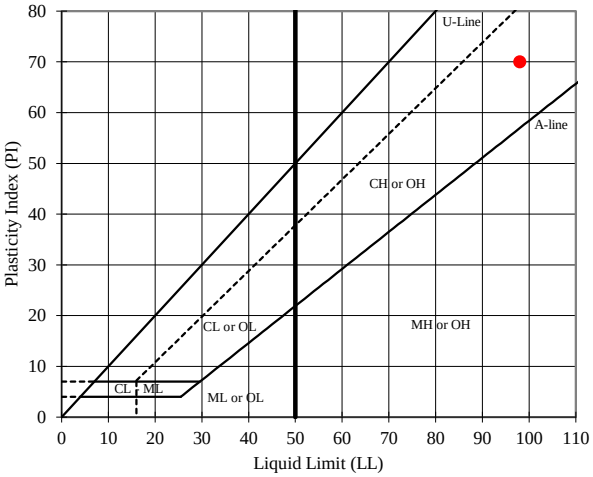
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **32 - 33.5**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.9**
#60	0.250	**99.7**
#100	0.150	**99.3**
#200	0.075	**97.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.08**
Fine Sand	**2.79**
Silt or Clay Fines	**97.13**



USCS Description (ASTM D 2487):

Fat clay, pale brown, moist

LL	PL	PI
98	**28**	**70**

As-Received Moisture Content (%): **40.3**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	29-May-2019
REVIEW	MB

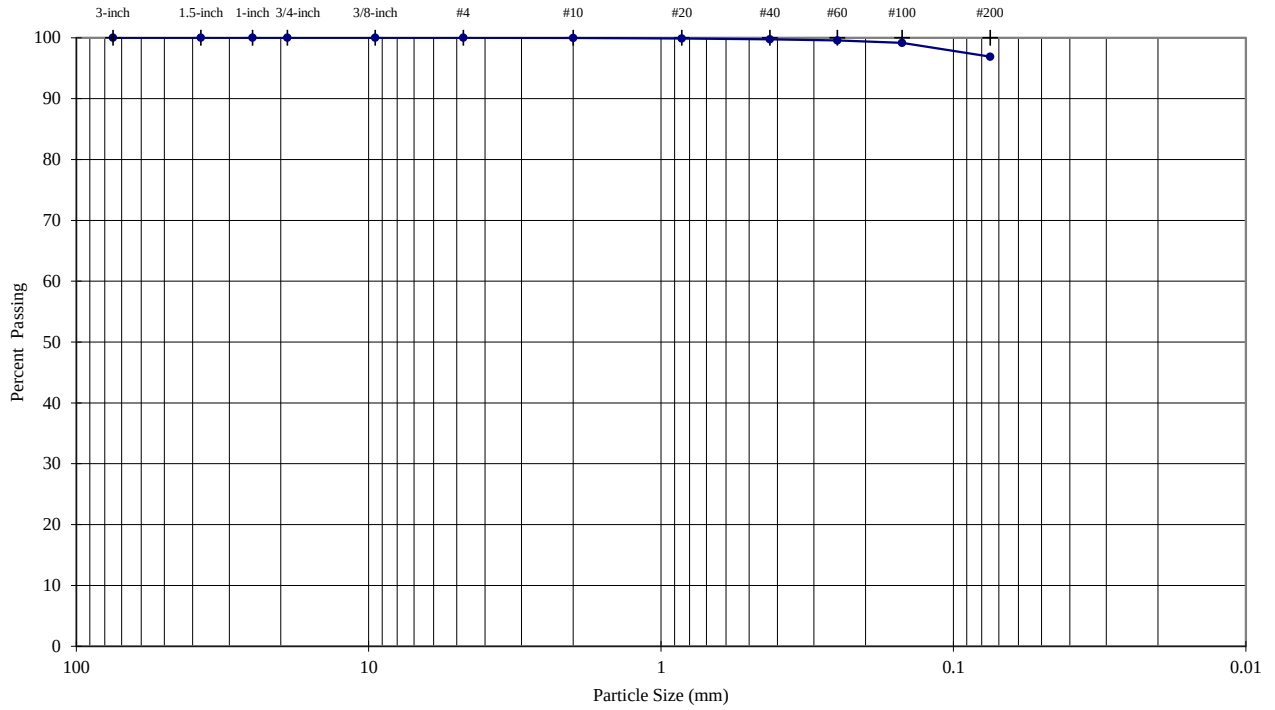
GOLDER

April-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

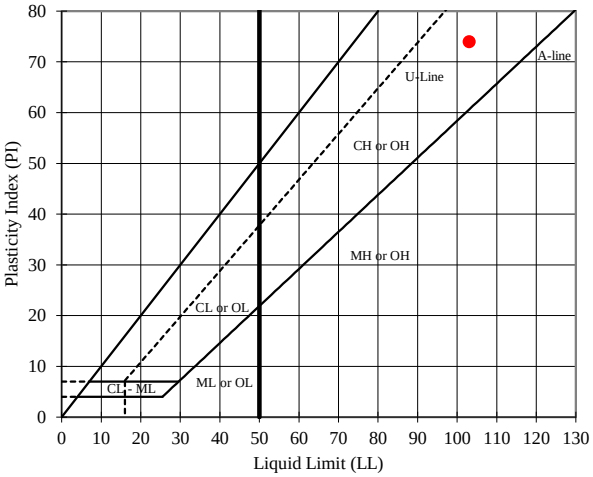
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **35 - 36.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**99.9**
#40	0.425	**99.7**
#60	0.250	**99.6**
#100	0.150	**99.2**
#200	0.075	**96.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.02**
Medium Sand	**0.24**
Fine Sand	**2.84**
Silt or Clay Fines	**96.91**



USCS Description (ASTM D 2487):

Fat clay, bluish gray, moist

LL	PL	PI
103	**29**	**74**

As-Received Moisture Content (%): **39.8**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	26-Apr-2019
REVIEW	MB

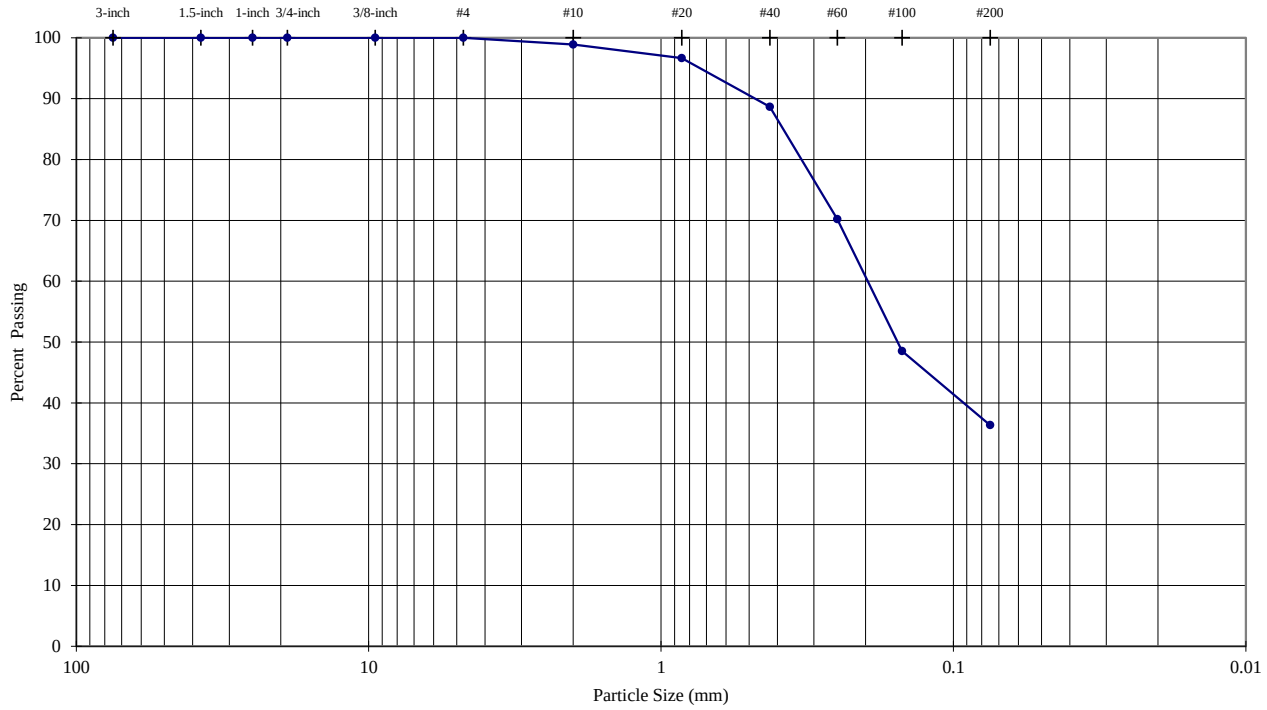
GOLDER

April-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

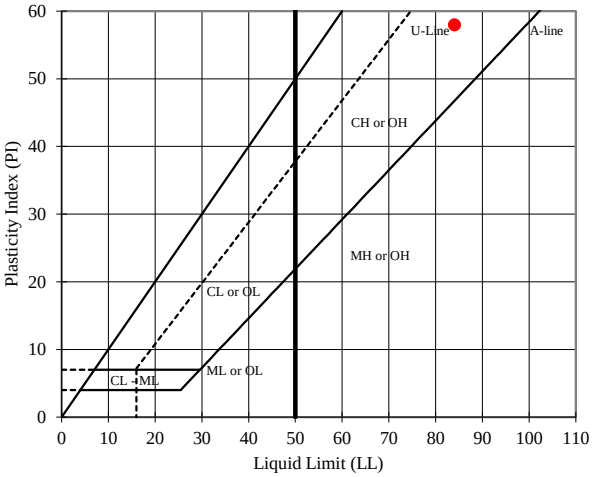
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **40 - 41.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**98.9**
#20	0.850	**96.7**
#40	0.425	**88.6**
#60	0.250	**70.2**
#100	0.150	**48.5**
#200	0.075	**36.3**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**1.08**
Medium Sand	**10.27**
Fine Sand	**52.30**
Silt or Clay Fines	**36.35**



USCS Description (ASTM D 2487):

Clayey sand, pale brown, moist

LL	PL	PI
84	**26**	**58**

As-Received Moisture Content (%): **28.0**

USCS Group Symbol: SC

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	26-Apr-2019
REVIEW	MB

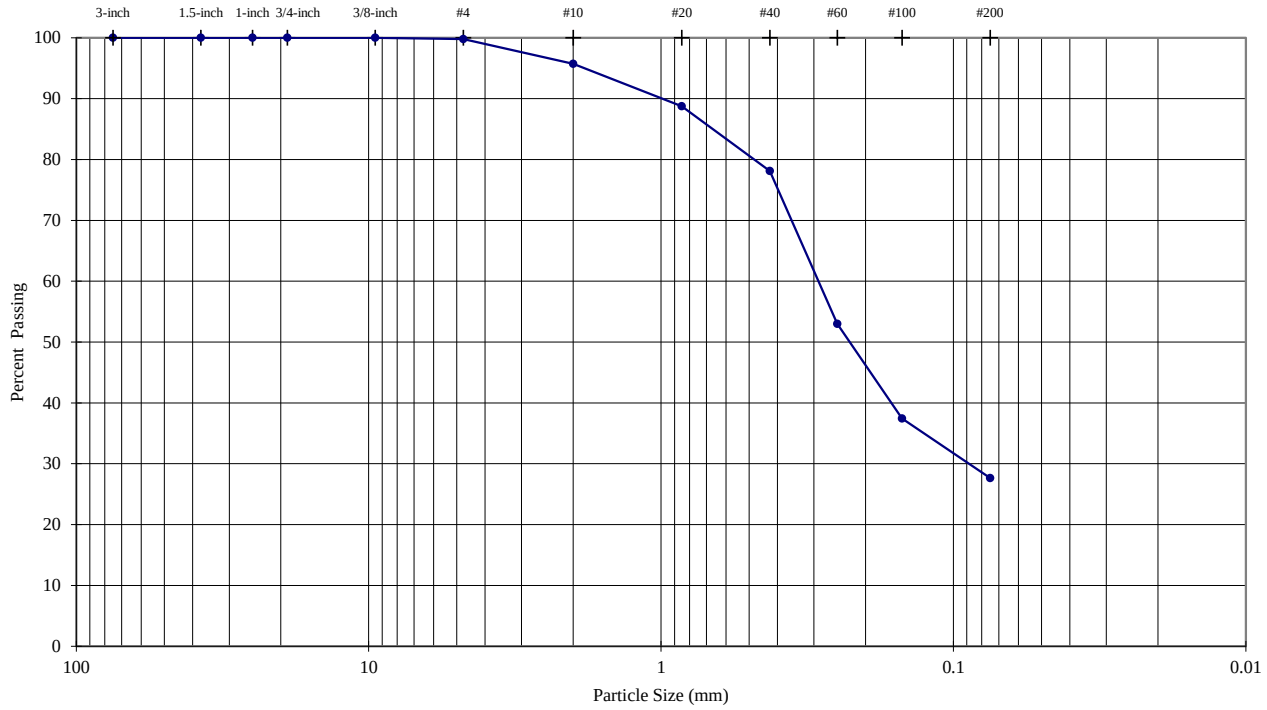
GOLDER

April-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

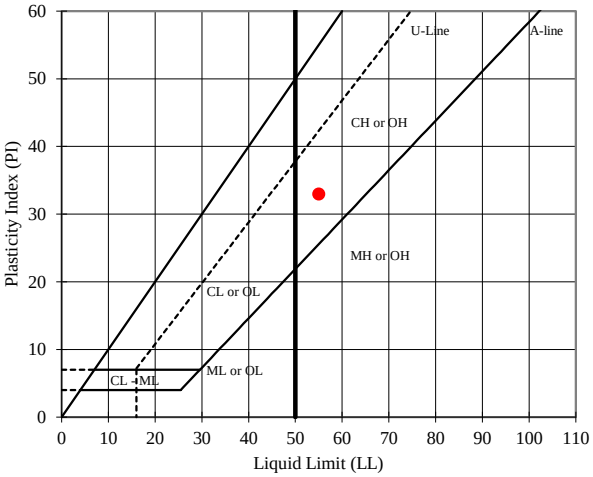
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **45 - 46.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**99.8**
#10	2.0	**95.7**
#20	0.850	**88.7**
#40	0.425	**78.1**
#60	0.250	**53.0**
#100	0.150	**37.4**
#200	0.075	**27.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.19**
Coarse Sand	**4.10**
Medium Sand	**17.58**
Fine Sand	**50.47**
Silt or Clay Fines	**27.67**



USCS Description (ASTM D 2487):

Clayey sand, light yellowish brown, moist

LL	PL	PI
55	**22**	**33**

As-Received Moisture Content (%): **17.8**

USCS Group Symbol: SC

Notes: 0 g of particles up to 9.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	26-Apr-2019
REVIEW	MB

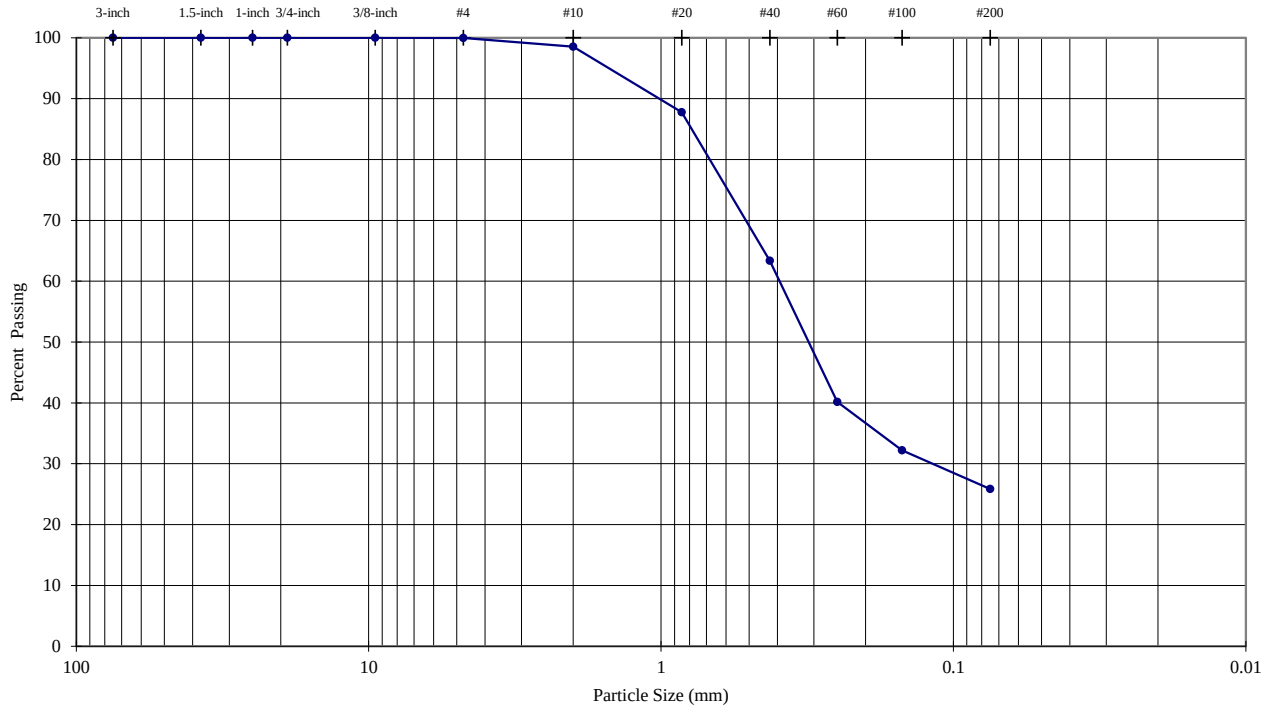
GOLDER

April-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

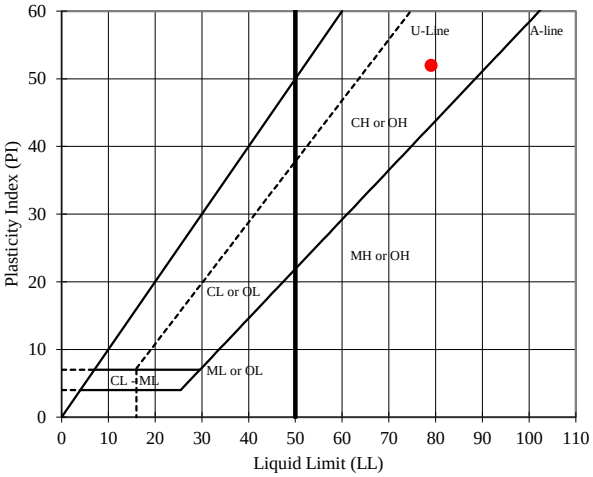
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **50 - 51.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**98.5**
#20	0.850	**87.8**
#40	0.425	**63.4**
#60	0.250	**40.2**
#100	0.150	**32.2**
#200	0.075	**25.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.05**
Coarse Sand	**1.40**
Medium Sand	**35.19**
Fine Sand	**37.50**
Silt or Clay Fines	**25.86**



USCS Description (ASTM D 2487):

Clayey sand, light yellowish brown, moist

LL	PL	PI
79	**27**	**52**

As-Received Moisture Content (%): **22.5**

USCS Group Symbol: SC

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	26-Apr-2019
REVIEW	MB

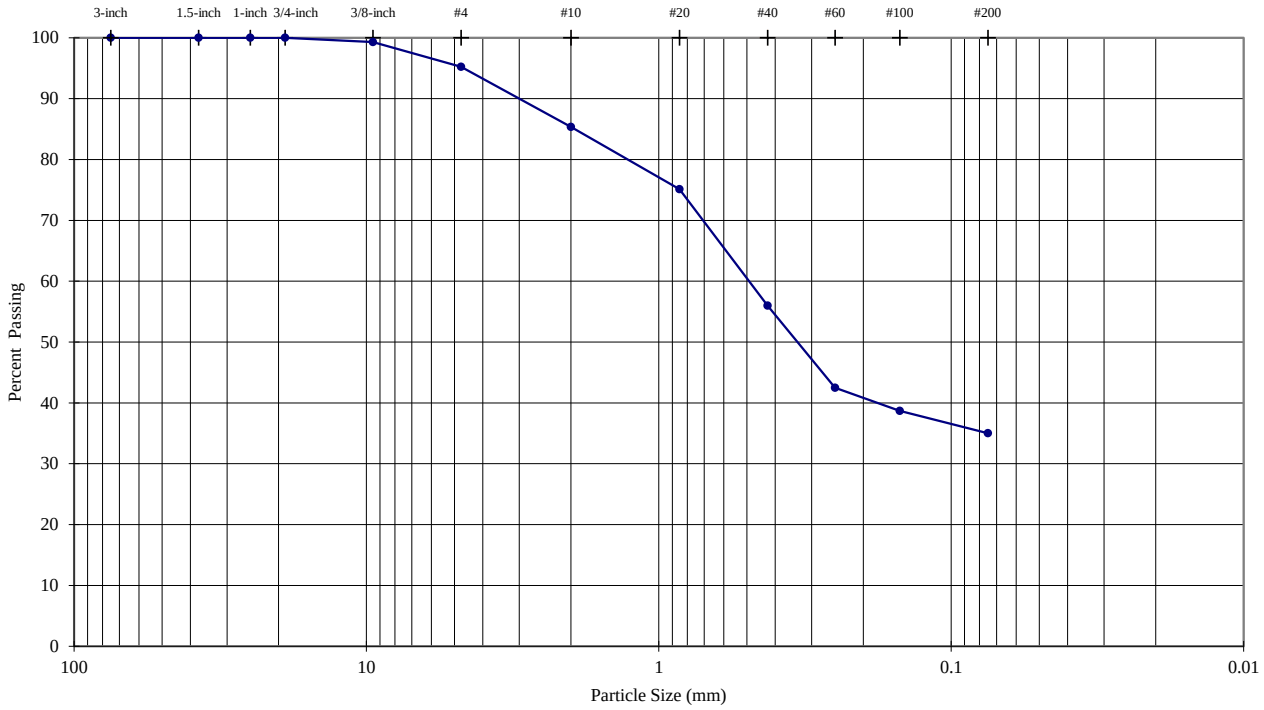
GOLDER

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

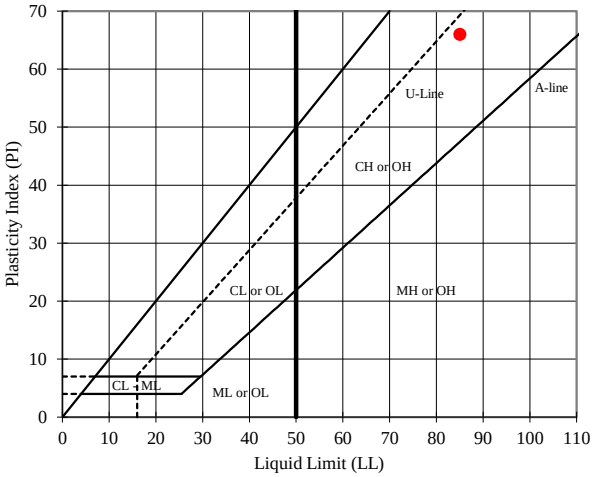
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **60 - 61.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.3**
#4	4.75	**95.2**
#10	2.0	**85.4**
#20	0.850	**75.1**
#40	0.425	**56.0**
#60	0.250	**42.5**
#100	0.150	**38.7**
#200	0.075	**35.0**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**4.78**
Coarse Sand	**9.87**
Medium Sand	**29.35**
Fine Sand	**20.99**
Silt or Clay Fines	**35.02**



USCS Description (ASTM D 2487):

Clayey sand, light olive gray, moist

LL	PL	PI
85	**19**	**66**

As-Received Moisture Content (%): **21.0**

USCS Group Symbol: SC

Notes: 0 g of particles up to 19.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	EH
DATE	29-Apr-2019
REVIEW	MB

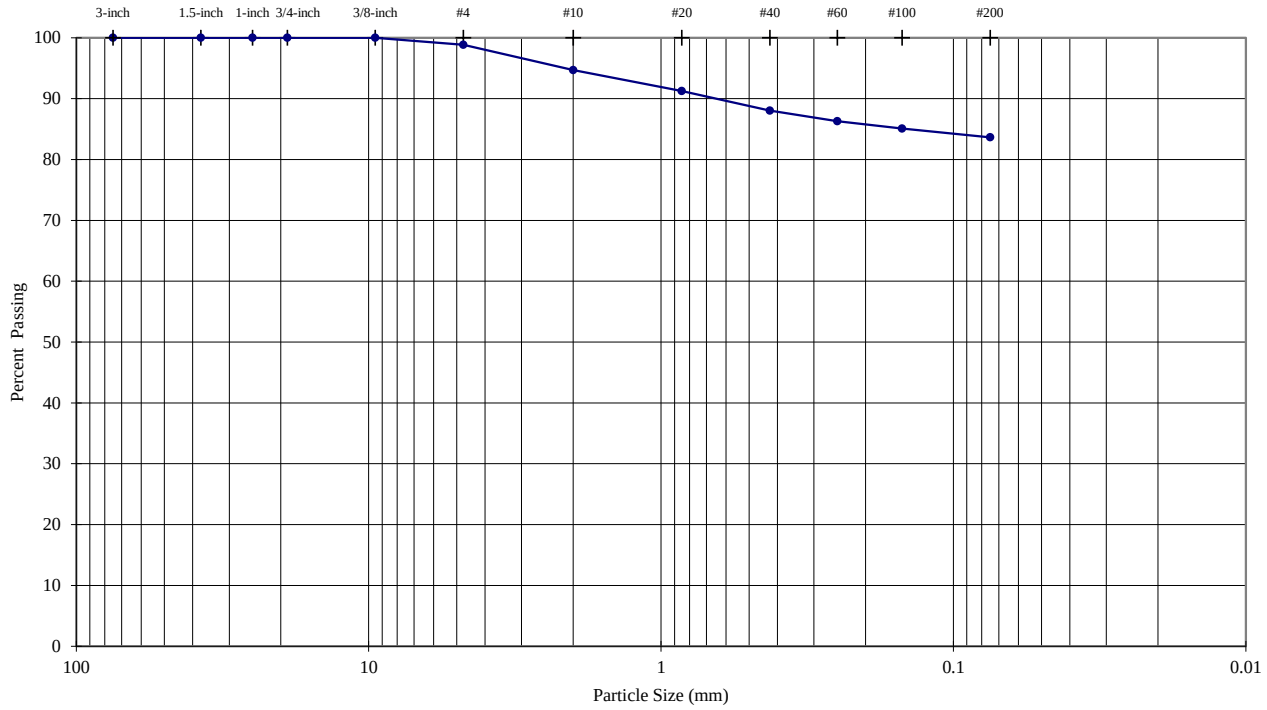
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

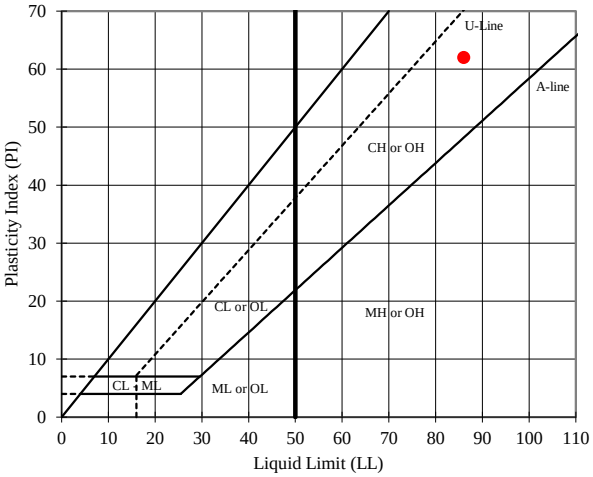
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **70 - 71.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**98.9**
#10	2.0	**94.7**
#20	0.850	**91.3**
#40	0.425	**88.1**
#60	0.250	**86.3**
#100	0.150	**85.1**
#200	0.075	**83.6**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**1.13**
Coarse Sand	**4.16**
Medium Sand	**6.65**
Fine Sand	**4.41**
Silt or Clay Fines	**83.64**



USCS Description (ASTM D 2487):

Fat clay with sand, brownish yellow, moist

LL	PL	PI
86	**24**	**62**

As-Received Moisture Content (%): **30.7**

USCS Group Symbol: CH

Notes: 0 g of particles up to 9.5 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	KWG
DATE	15-May-2019
REVIEW	PRH

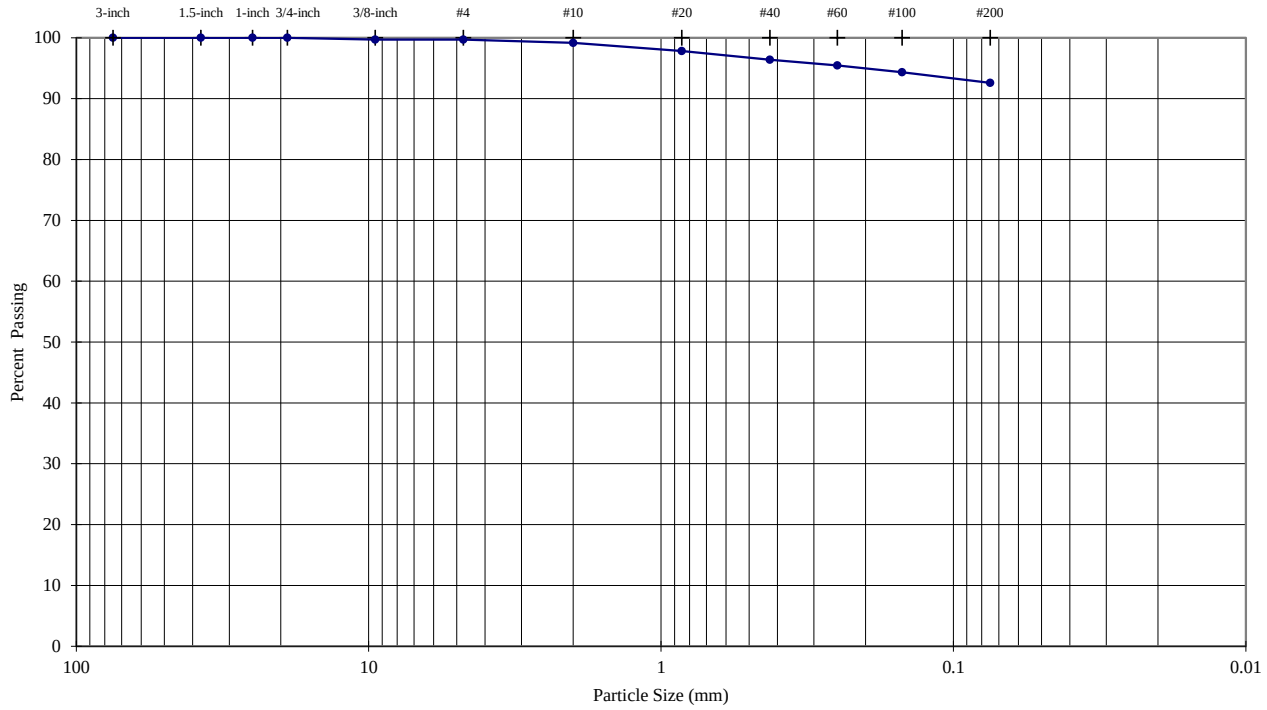
GOLDER

May-19 1663241.22000

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

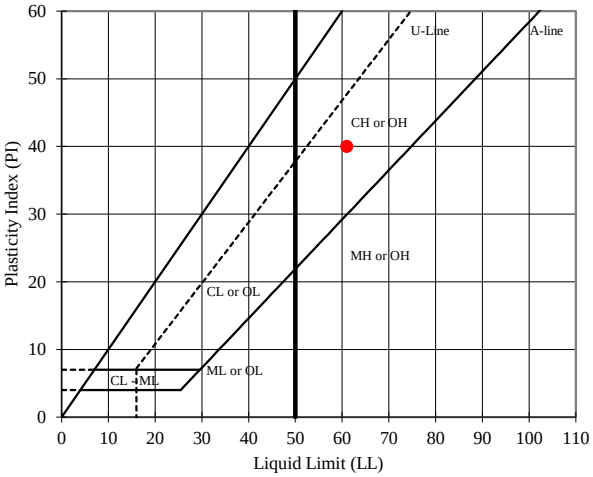
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **80 - 81.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.7**
#4	4.75	**99.7**
#10	2.0	**99.2**
#20	0.850	**97.8**
#40	0.425	**96.4**
#60	0.250	**95.4**
#100	0.150	**94.3**
#200	0.075	**92.6**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.28**
Coarse Sand	**0.53**
Medium Sand	**2.79**
Fine Sand	**3.80**
Silt or Clay Fines	**92.60**



USCS Description (ASTM D 2487):

Lean clay, dark gray, moist

LL	PL	PI
61	**21**	**40**

As-Received Moisture Content (%): **24.9**

USCS Group Symbol: CL

Notes: 0 g of particles up to 19.0 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	EH
DATE	30-Apr-2019
REVIEW	MB

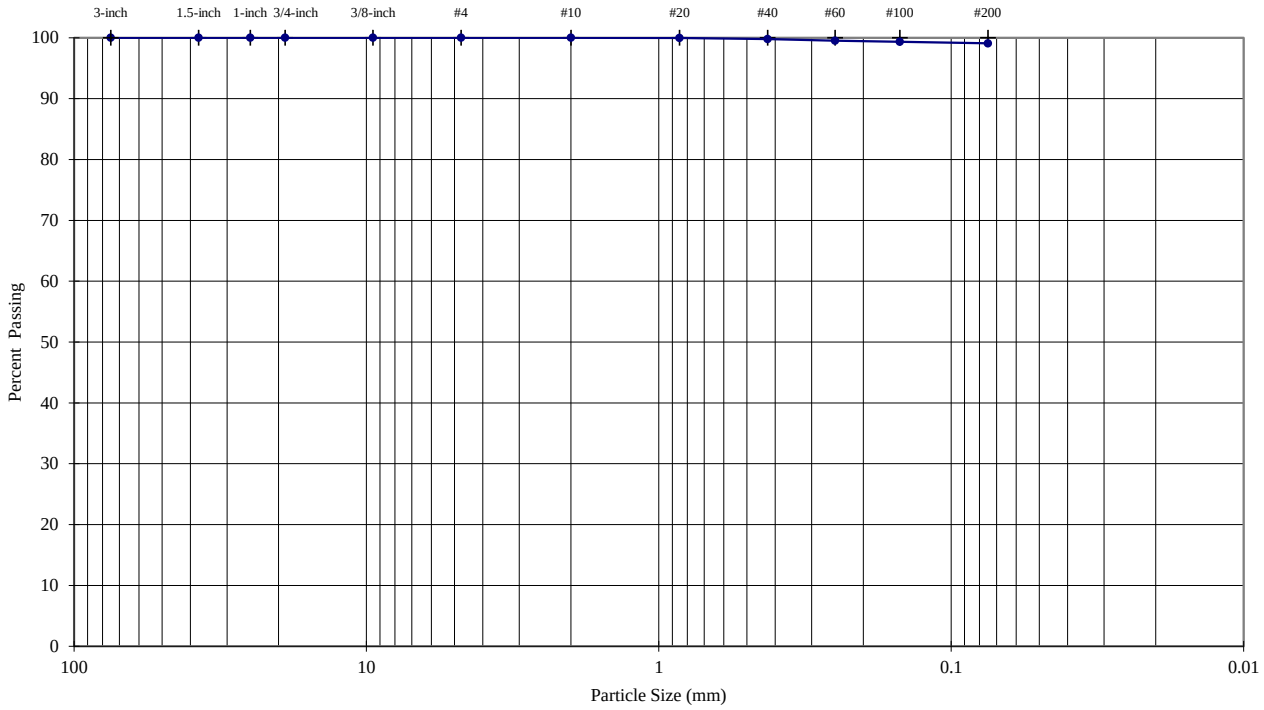
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

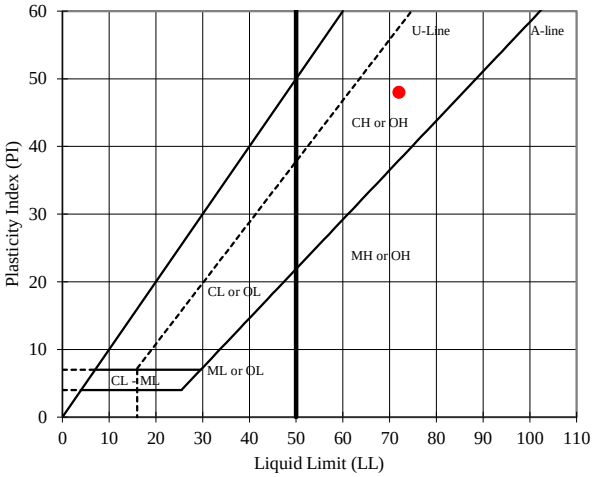
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **90 - 91.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.8**
#60	0.250	**99.5**
#100	0.150	**99.4**
#200	0.075	**99.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.00**
Medium Sand	**0.22**
Fine Sand	**0.68**
Silt or Clay Fines	**99.10**



USCS Description (ASTM D 2487):

Fat clay, very dark gray, moist

LL	PL	PI
72	**24**	**48**

As-Received Moisture Content (%): **26.3**

USCS Group Symbol: CH

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	EH
DATE	29-Apr-2019
REVIEW	MB

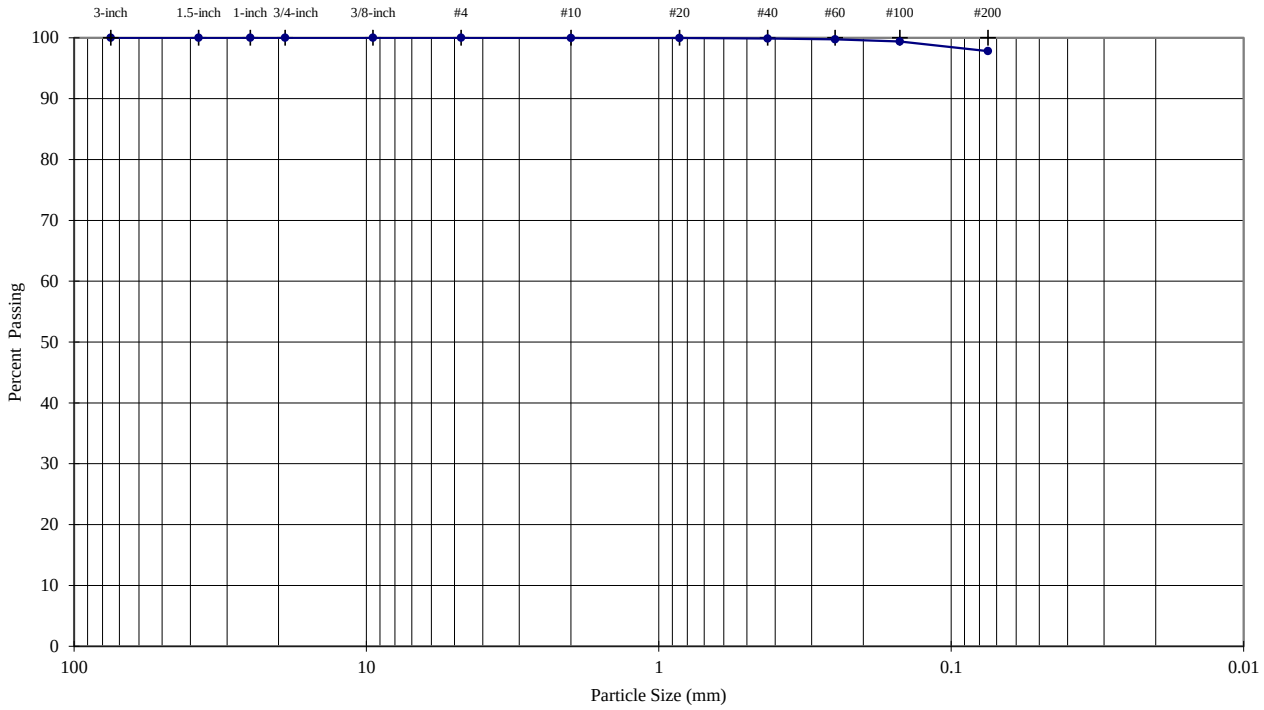
GOLDER

May-19 **1663241.22000**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

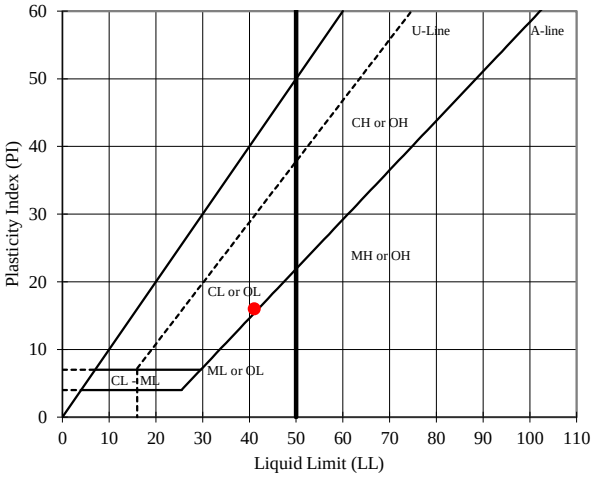
PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **BH19-TP-44** DEPTH (ft): **110.0 - 111.5**
TYPE: **Tube**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.75	**100.0**
#10	2.0	**100.0**
#20	0.850	**100.0**
#40	0.425	**99.9**
#60	0.250	**99.8**
#100	0.150	**99.4**
#200	0.075	**97.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.00**
Coarse Sand	**0.01**
Medium Sand	**0.09**
Fine Sand	**2.08**
Silt or Clay Fines	**97.81**



USCS Description (ASTM D 2487):

Lean clay, gray, moist

LL	PL	PI
41	**25**	**16**

As-Received Moisture Content (%): **17.9**

USCS Group Symbol: CL

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

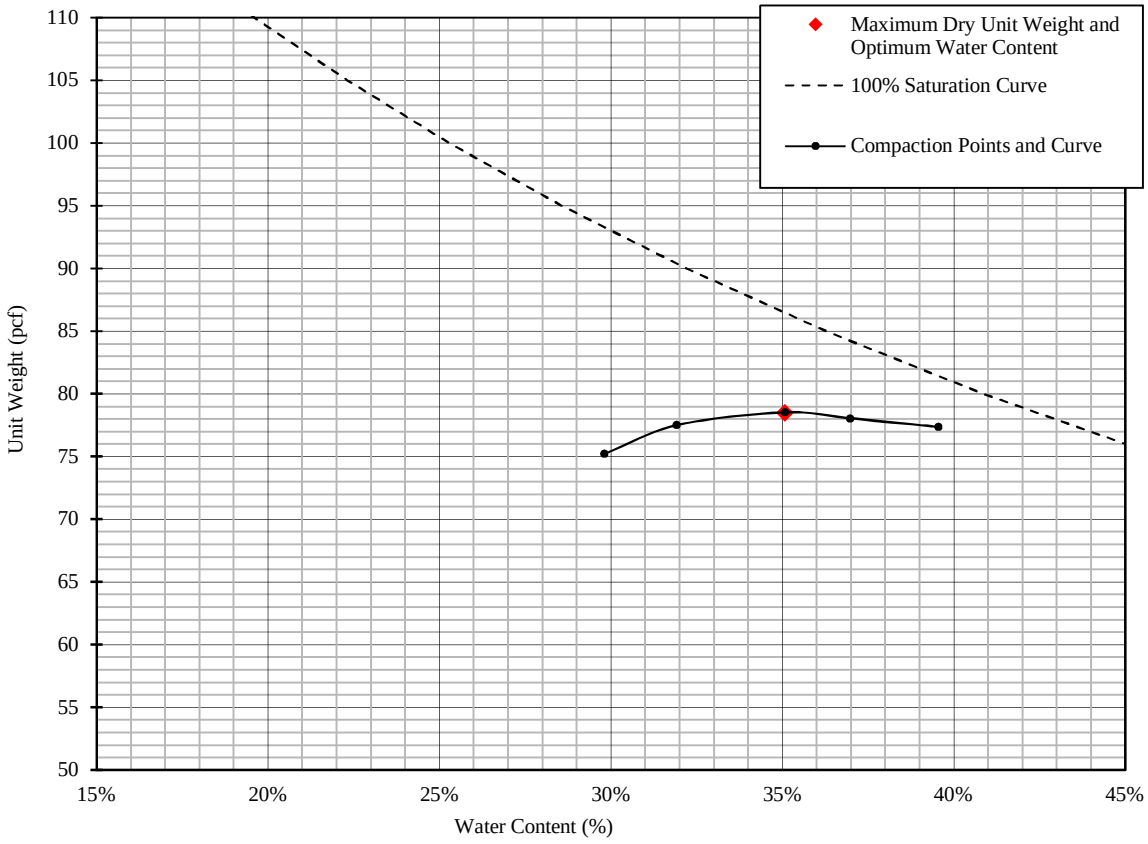
TECH	EH
DATE	29-Apr-2019
REVIEW	MB

March-18 1663241.11000

LABORATORY COMPACTION CHARACTERISTICS OF SOIL
ASTM D698 - Method A

Manual Rammer	Moist Preparation

PROJECT NAME: **MDA/Grassy Mtn PFS/OR**
SAMPLE ID: **TP-9** DEPTH (ft): **2-15**
TYPE: **Pail**



% Test Fraction Passing #4 Sieve	**100%**	Maximum Dry Unit Weight (pcf)	**78.5**
As-Received Moisture Content	**NA**	Optimum Water Content (%)	**35.1**
Specific Gravity (estimated)	**2.70**		

USCS Description (ASTM D 2487): Clay, pale olive, moist

USCS 0

TECH	JP
DATE	27-Mar-2018
REVIEW	MB

FLOW PUMP #1

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER
ASTM D5084
METHOD D, CONSTANT RATE OF FLOW

PROJECT TITLE	MDA/Grassy Mtn PFS/OR	BOARD #	7	COMMENTS	1. Specific gravity tested per ASTM D854.
PROJECT NUMBER	1663241.11	CELL #	CC		
SAMPLE ID	BH-6 / S-2 @ 10 - 11.5 ft.	Flow Pump Speed	12		
SAMPLE TYPE	Intact	Technician	BC		

Sample Data

	Initial	Final
Specific Gravity	2.74	
Height, cm	9.011	8.893
Diameter, cm	6.106	6.126
Area, m^2	0.002929	0.002947
Volume, m^3	0.0002639	0.0002621
Mass, g	419.59	421.42
Moisture Content	46.5%	53.0%
Dry Unit Weight, kN/m^3	10.65	10.31
Dry Unit Weight, lbf/ft^3	67.8	65.6
Saturation, %	83.5%	90.4%

Permeant	Water
Back Pressure, kPa	410
Effective Consolidation Stress, kPa	410
Length During Permeation, cm	8.893
Area During Permeation, m^2	0.002947

USCS Description (ASTM D 2487):
Fat clay, olive gray, moist

DATE/TIME		TEMP (°C)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
24-Apr-18	11:25	20.7	101	--	--	--
24-Apr-18	12:05	20.7	98	1.3E-08	11.19	1.67E-08
24-Apr-18	12:20	20.7	99	5.0E-09	11.08	1.68E-08
24-Apr-18	12:35	20.7	98	4.9E-09	11.08	1.68E-08
24-Apr-18	12:50	20.7	100	4.9E-09	11.13	1.68E-08

Average Corrected Hydraulic Conductivity (cm/s) 1.7E-08

DATE 4/30/2018
REVIEW MB

FLOW PUMP #1

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084

METHOD D, CONSTANT RATE OF FLOW

PROJECT TITLE	MDA/Grassy Mtn PFS/OR	BOARD #	3	COMMENTS	1. Specific gravity is assumed.
PROJECT NUMBER	1663241.11000	CELL #	AA		2. Specimen was remolded to 90.2% of the Maximum Dry Density and +0.6% of optimum moisture content (per ASTM D698)
SAMPLE ID	TP-9 @ 2 - 15 ft	Flow Pump Speed	12		
SAMPLE TYPE	Remold	Technician	BC		

Sample Data

	Initial	Final
Specific Gravity	2.70	
Height, cm	9.283	8.921
Diameter, cm	7.317	7.192
Area, m^2	0.004205	0.004062
Volume, m^3	0.0003904	0.0003624
Mass, g	600.82	622.13
Moisture Content	35.7%	39.5%
Dry Unit Weight, kN/m^3	11.12	12.07
Dry Unit Weight, lbf/ft^3	70.8	76.9
Saturation, %	69.8%	89.3%

Permeant	Water
Back Pressure, kPa	280
Effective Consolidation Stress, kPa	410
Length During Permeation, cm	8.921
Area During Permeation, m^2	0.004062

USCS Description (ASTM D 2487):

Fat clay, pale olive, moist

DATE/TIME		TEMP (°C)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
26-Apr-18	11:15	20.7	180	--	--	--
26-Apr-18	11:30	20.7	179	4.2E-09	20.12	5.72E-09
26-Apr-18	11:45	20.7	181	4.2E-09	20.18	5.70E-09
26-Apr-18	12:00	20.7	181	4.2E-09	20.29	5.67E-09
26-Apr-18	12:15	20.7	181	4.2E-09	20.29	5.67E-09

Average Corrected Hydraulic Conductivity (cm/s)	5.6E-09

DATE	4/27/2018
REVIEW	MB

GOLDER

FLOW PUMP #1

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084

METHOD D, CONSTANT RATE OF FLOW

PROJECT NAME	MDA/Grassy Mtn PFS/OR	BOARD #	7	COMMENTS	1. Specific gravity is assumed.
PROJECT NUMBER	1663241.22000	CELL #	No. 5		
SAMPLE ID	BH19-TP-01 @ 45 - 46.5 ft	Flow Pump Speed	10		
SAMPLE TYPE	Intact	Technician	BC		

Sample Data

	Initial	Final
Specific Gravity	2.80	
Height, cm	9.555	9.696
Diameter, cm	6.161	6.253
Area, m^2	0.002982	0.003071
Volume, m^3	0.0002849	0.0002977
Mass, g	534.04	550.91
Moisture Content	32.7%	34.7%
Dry Unit Weight, kN/m^3	13.86	13.48
Dry Unit Weight, lbf/ft^3	88.2	85.8
Saturation, %	93.2%	93.6%

Permeant	Water
Back Pressure, kPa	340
Effective Consolidation Stress, kPa	34
Length During Permeation, cm	9.696
Area During Permeation, m^2	0.003071

USCS Description (ASTM D 2487):

Fat clay with sand, gray, moist

DATE/TIME		TEMP (^oC)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
1-Jun-19	11:30	20.7	155	--	--	--
1-Jun-19	11:45	20.7	153	2.5E-08	15.88	5.74E-08
1-Jun-19	12:00	20.7	153	2.5E-08	15.78	5.78E-08
1-Jun-19	12:15	20.7	154	2.5E-08	15.83	5.76E-08
1-Jun-19	12:30	20.7	153	2.5E-08	15.83	5.76E-08

Average Corrected Hydraulic Conductivity (cm/s): 5.7E-08

DATE: 31-May-2019

REVIEW: MB

GOLDER

FLOW PUMP #2

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084

METHOD D, CONSTANT RATE OF FLOW

PROJECT NAME	MDA/Grassy Mtn PFS/OR	BOARD #	3	COMMENTS	1. Specific gravity is assumed.
PROJECT NUMBER	1663241.22000	CELL #	AA		
SAMPLE ID	BH19-TP-39 @ 25 - 26.5 ft	Flow Pump Speed	11		
SAMPLE TYPE	Intact	Technician	BC		

Sample Data

	Initial	Final
Specific Gravity	2.70	
Height, cm	8.991	9.140
Diameter, cm	6.134	6.273
Area, m^2	0.002955	0.003090
Volume, m^3	0.0002657	0.0002824
Mass, g	469.24	500.21
Moisture Content	22.1%	39.8%
Dry Unit Weight, kN/m^3	14.18	12.43
Dry Unit Weight, lbf/ft^3	90.3	79.1
Saturation, %	68.9%	95.0%

Permeant	Water
Back Pressure, kPa	280
Effective Consolidation Stress, kPa	34
Length During Permeation, cm	9.140
Area During Permeation, m^2	0.003090

USCS Description (ASTM D 2487):

Fat clay, light greenish gray, moist

DATE/TIME		TEMP (^oC)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
29-May-19	10:50	20.7	172	--	--	--
29-May-19	11:05	20.7	170	1.3E-08	18.71	2.42E-08
29-May-19	11:20	20.7	172	1.3E-08	18.71	2.42E-08
29-May-19	11:35	20.7	172	1.3E-08	18.82	2.41E-08
29-May-19	11:50	20.7	172	1.3E-08	18.82	2.41E-08

Average Corrected Hydraulic Conductivity (cm/s): 2.4E-08

DATE: 31-May-2019

REVIEW: MB

GOLDER

FLOW PUMP #2

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER

ASTM D5084

METHOD D, CONSTANT RATE OF FLOW

PROJECT NAME	MDA/Grassy Mtn PFS/OR	BOARD #	4	COMMENTS	1. Specific gravity is assumed.
PROJECT NUMBER	1663241.22000	CELL #	AA		
SAMPLE ID	BH19-TP-39 @ 35 - 36.5 ft	Flow Pump Speed	10		
SAMPLE TYPE	Intact	Technician	BC		

Sample Data

	Initial	Final
Specific Gravity	2.80	
Height, cm	9.745	10.060
Diameter, cm	6.131	6.301
Area, m^2	0.002952	0.003119
Volume, m^3	0.0002877	0.0003137
Mass, g	497.45	530.91
Moisture Content	38.8%	46.3%
Dry Unit Weight, kN/m^3	12.22	11.35
Dry Unit Weight, lbf/ft^3	77.8	72.2
Saturation, %	87.1%	91.3%

Permeant	Water
Back Pressure, kPa	280
Effective Consolidation Stress, kPa	34
Length During Permeation, cm	10.060
Area During Permeation, m^2	0.003119

USCS Description (ASTM D 2487):

Fat clay, olive brown, moist

DATE/TIME		TEMP (^oC)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
1-Jun-19	10:45	20.7	165	--	--	--
1-Jun-19	11:00	20.7	163	2.5E-08	16.30	5.51E-08
1-Jun-19	11:15	20.7	163	2.5E-08	16.20	5.54E-08
1-Jun-19	11:30	20.7	163	2.5E-08	16.20	5.54E-08
1-Jun-19	11:45	20.7	163	2.5E-08	16.20	5.54E-08

Average Corrected Hydraulic Conductivity (cm/s): 5.4E-08

DATE	31-May-2019
REVIEW	MB

Boring or Test Pit:	BH-6		Boring or Test Pit:	BH-6		Boring or Test Pit:	BH-6	
Sample:	S-4		Sample:	S-4		Sample:	S-4	
Depth:	20-21.5	ft	Depth:	20-21.5	ft	Depth:	20-21.5	ft
Point No.:	1		Point No.:	2		Point No.:	3	
	Initial			**Initial**			**Initial**	
Length =	5.196	in	Length =	5.589	in	Length =	5.773	in
Diameter =	2.404	in	Diameter =	2.414	in	Diameter =	2.413	in
Wet Mass =	1.306	lb	Wet Mass =	1.423	lb	Wet Mass =	1.535	lb
Area =	4.539	in^2	Area =	4.577	in^2	Area =	4.573	in^2
Volume =	23.58	in^3	Volume =	25.58	in^3	Volume =	26.40	in^3
Specific Gravity =	2.52	(ASTM D854)	Specific Gravity =	2.52	(ASTM D854)	Specific Gravity =	2.52	(ASTM D854)
Dry Mass of Solids =	1.025	lb	Dry Mass of Solids =	1.079	lb	Dry Mass of Solids =	1.098	lb
Water Content =	27.5%		Water Content =	31.9%		Water Content =	39.8%	
Wet Unit Weight =	95.7	pcf	Wet Unit Weight =	96.1	pcf	Wet Unit Weight =	100.5	pcf
Dry Unit Weight =	75.1	pcf	Dry Unit Weight =	72.9	pcf	Dry Unit Weight =	71.9	pcf
Void Ratio =	1.09		Void Ratio =	1.15		Void Ratio =	1.19	
Percent Saturation =	63%		Percent Saturation =	70%		Percent Saturation =	85%	
	After Consolidation			**After Consolidation**			**After Consolidation**	
Length =	4.980	in	Length =	5.341	in	Length =	5.604	in
Diameter =	2.340	in	Diameter =	2.371	in	Diameter =	2.378	in
Area =	4.301	in^2 (Method B)	Area =	4.414	in^2 (Method B)	Area =	4.443	in^2 (Method B)
Volume =	21.42	in^3	Volume =	23.57	in^3	Volume =	24.90	in^3
Water Content =	35.7%		Water Content =	39.1%		Water Content =	42.1%	
Wet Unit Weight =	112.2	pcf	Wet Unit Weight =	110.0	pcf	Wet Unit Weight =	108.3	pcf
Dry Unit Weight =	82.7	pcf	Dry Unit Weight =	79.1	pcf	Dry Unit Weight =	76.2	pcf
Void Ratio =	0.90		Void Ratio =	0.99		Void Ratio =	1.06	
Percent Saturation =	100%		Percent Saturation =	100%		Percent Saturation =	100%	
B Parameter =	0.98		B Parameter =	0.96		B Parameter =	0.96	
Shear Rate =	0.083%	/min.	Shear Rate =	0.083%	/min.	Shear Rate =	0.083%	/min.
t_{50} =	0.1	min.	t_{50} =	0.2	min.	t_{50} =	2.3	min.
Strain at Failure =	9.4%		Strain at Failure =	13.7%		Strain at Failure =	15.3%	
Cell Pressure =	95	psi	Cell Pressure =	145	psi	Cell Pressure =	200	psi
Back Pressure =	60	psi	Back Pressure =	70	psi	Back Pressure =	50	psi
Confining Pressure =	35	psi	Confining Pressure =	75	psi	Confining Pressure =	150	psi

Notes: USCS description (ASTM D2487): Sandy fat clay, olive yellow, moist

Atterberg limits: LL = 74 PL = 22 PI = 52 (ASTM D4318)

Percent finer: 3/4 in. = 100% No. 4 = 100% No. 200 = 65% (ASTM D422, refer to separate report for gradation curve)

Initial water content specimen obtained from cuttings.

Specimen type:	X	Intact		Reconstituted	
Saturation method:	X	Wet		Dry	
Failure criterion:	X	$(\sigma'_1/\sigma'_3)_{max}$		$(\sigma'_1-\sigma'_3)_{max}$	% strain
Membrane effect:	X	Corrected		Not Corrected	

Golder Associates Inc.

Title:

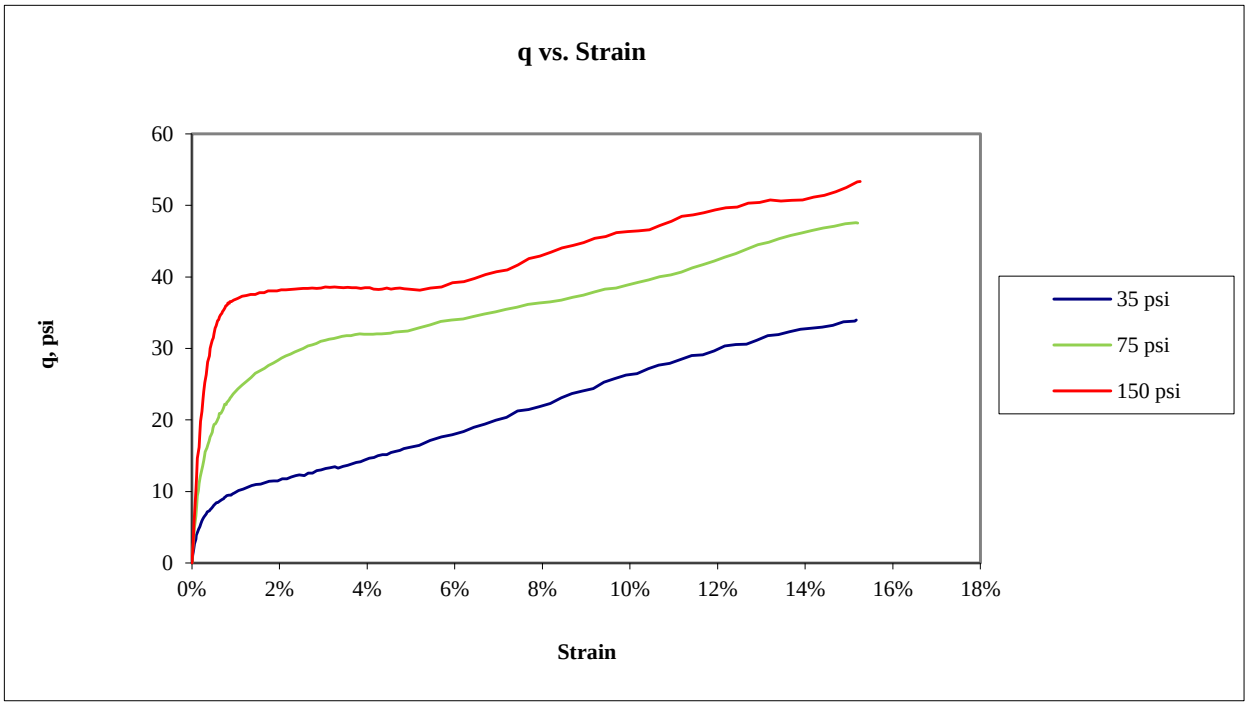
ASTM D4767

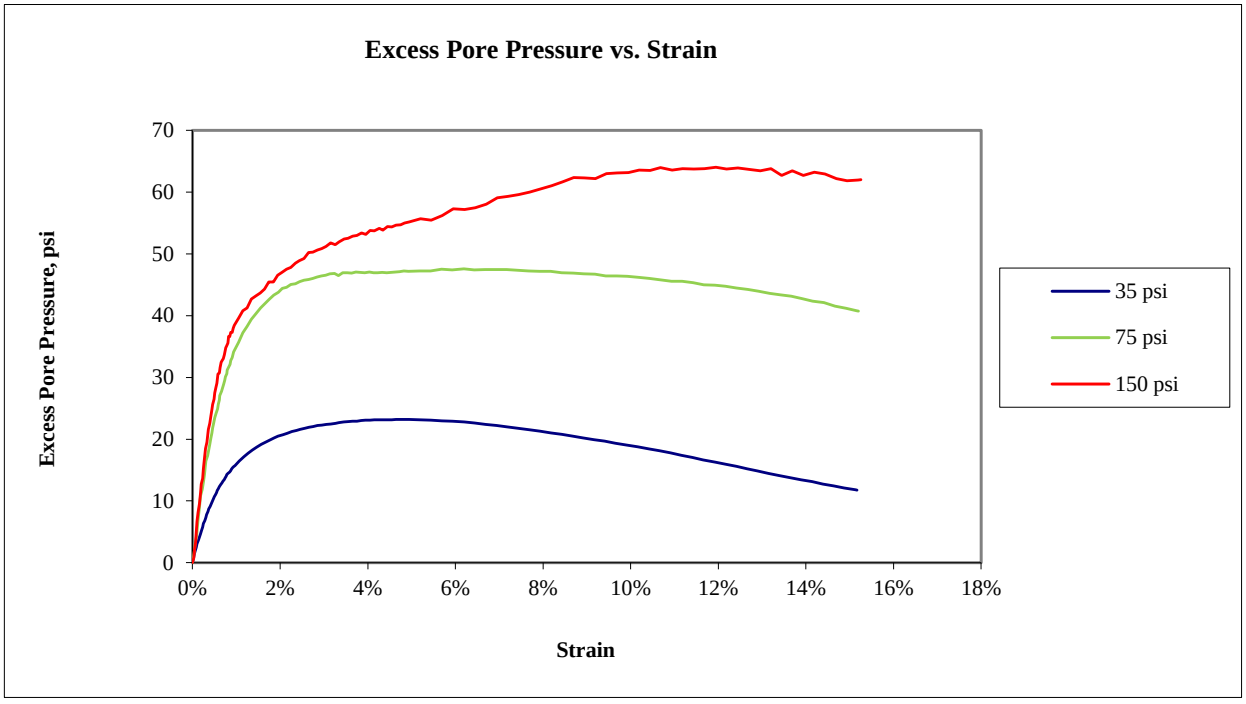
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT

SAMPLE AND TEST DATA

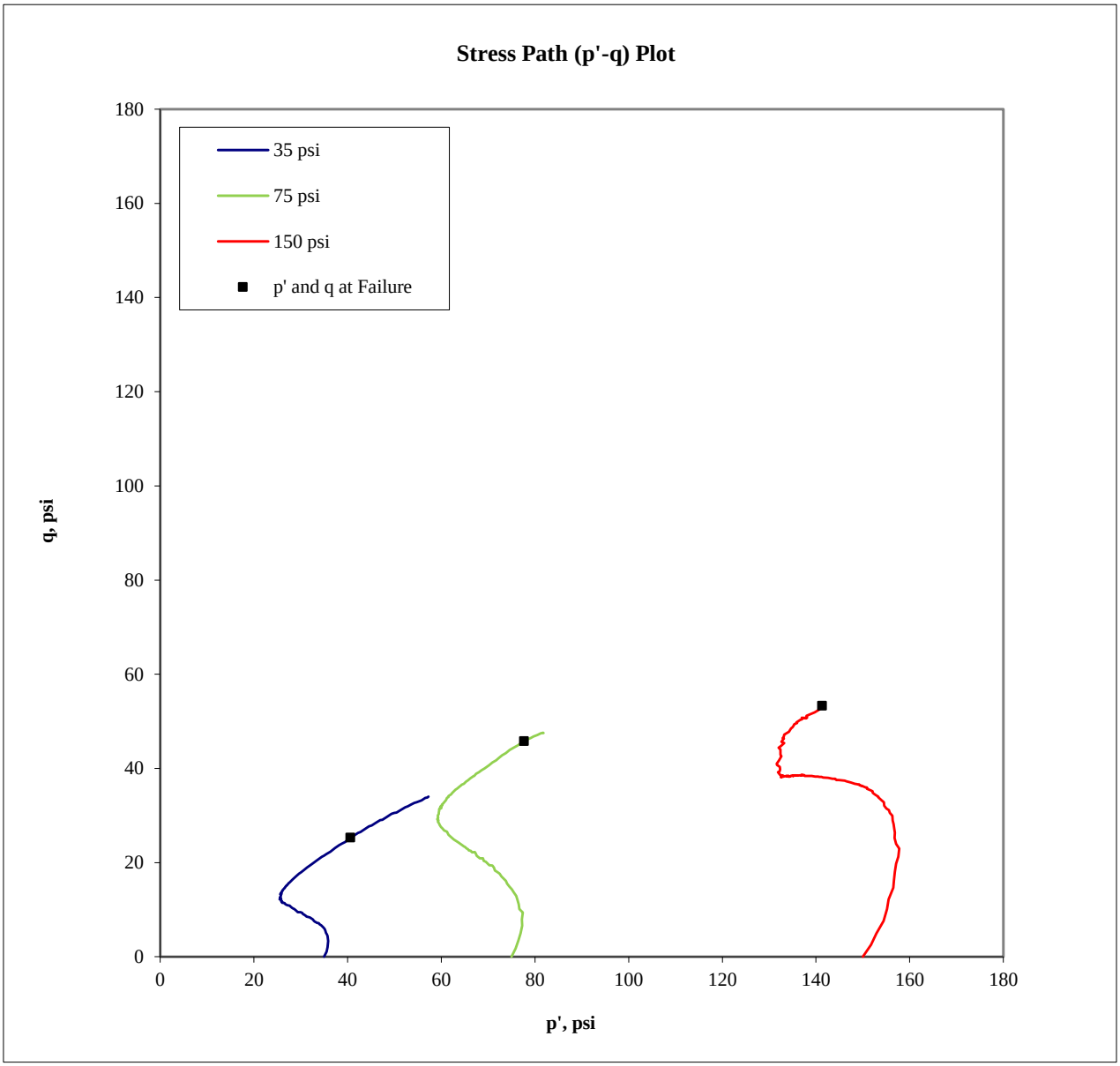
Job Short Title: MDA/Grassy Mtn PFS/OR

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
BH-6 / S4 @ 20 - 21.5 ft.	BC	RFS	1-May-2018	1663241.11000	1



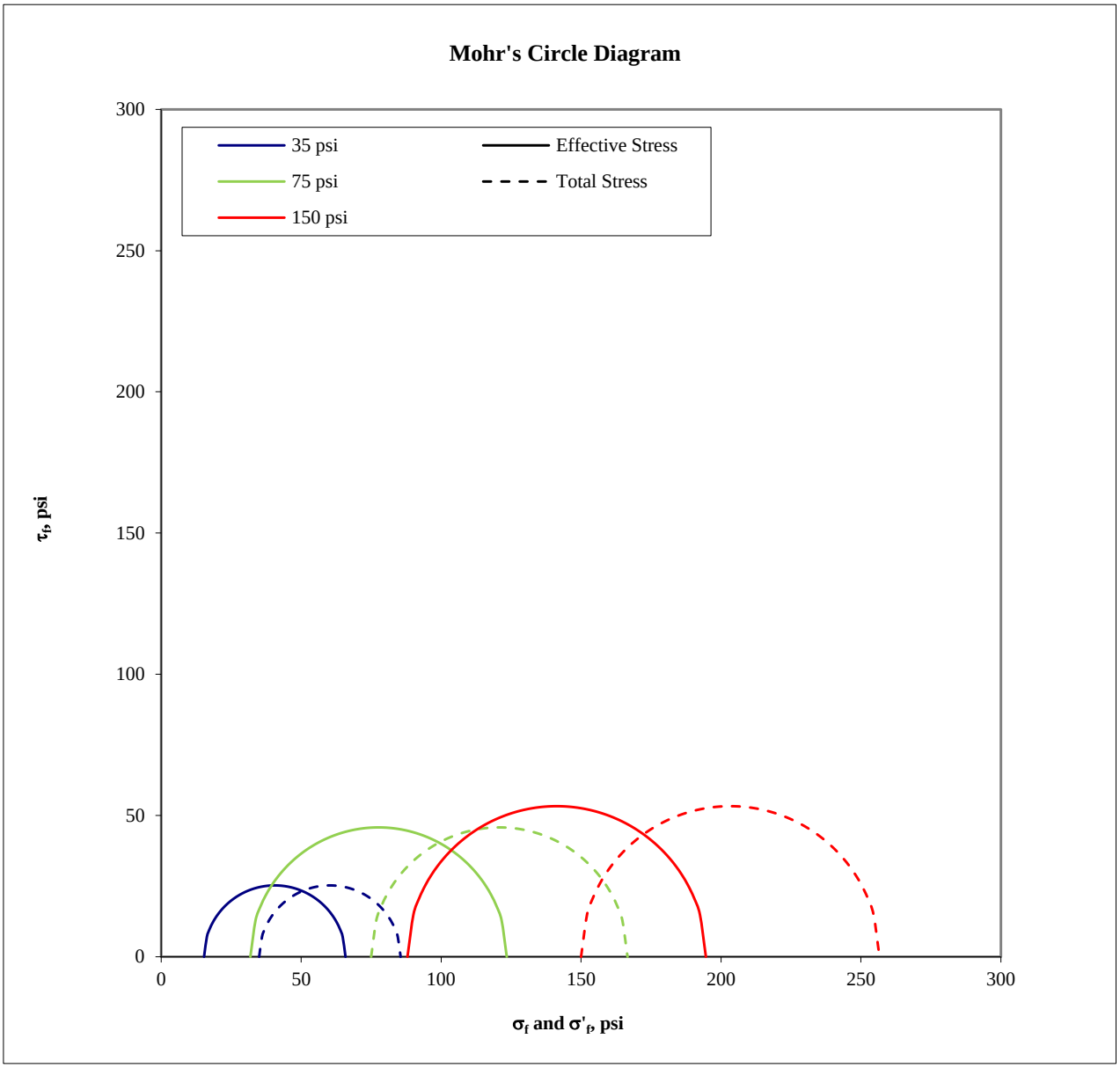


Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS					
Job Short Title: MDA/Grassy Mtn PFS/OR						
Sample: BH-6 / S4 @ 20 - 21.5 ft.	**Technician:** BC	**Reviewed:** RFS	**Date:** 1-May-2018	**Job Number:** 1663241.11000	**Figure:** 2	



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
35	60.3	40.6	25.3
75	120.8	77.7	45.8
150	203.3	141.3	53.3

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT STRESS PATH PLOT				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S4 @ 20 - 21.5 ft.	**Technician:** BC	**Reviewed:** RFS	**Date:** 1-May-2018	**Job Number:** 1663241.11000	**Figure:** 3



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
35	65.8	15.3	85.5	35.0
75	123.5	31.9	166.6	75.0
150	194.6	88.0	256.6	150.0

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT MOHR'S CIRCLE DIAGRAM				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S4 @ 20 - 21.5 ft.	**Technician:** BC	**Reviewed:** RFS	**Date:** 1-May-2018	**Job Number:** 1663241.11000	**Figure:** 4

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 35 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S4 @ 20 - 21.5 ft.	**Technician:** BC	**Reviewed:** RFS	**Date:** 1-May-2018	**Job Number:** 1663241.11000	**Figure:** 5

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 75 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S4 @ 20 - 21.5 ft.	**Technician:** BC	**Reviewed:** RFS	**Date:** 1-May-2018	**Job Number:** 1663241.11000	**Figure:** 6

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 150 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S4 @ 20 - 21.5 ft.	**Technician:** BC	**Reviewed:** RFS	**Date:** 1-May-2018	**Job Number:** 1663241.11000	**Figure:** 7

Boring or Test Pit:	BH-13		Boring or Test Pit:	BH-13		Boring or Test Pit:	BH-13	
Sample:	S6		Sample:	S6		Sample:	S6	
Depth:	30	ft	Depth:	30	ft	Depth:	30	ft
Point No.:	1		Point No.:	2		Point No.:	3	
	Initial			**Initial**			**Initial**	
Length =	5.661	in	Length =	5.628	in	Length =	5.663	in
Diameter =	2.407	in	Diameter =	2.414	in	Diameter =	2.411	in
Wet Mass =	1.701	lb	Wet Mass =	1.666	lb	Wet Mass =	1.597	lb
Area =	4.550	in^2	Area =	4.577	in^2	Area =	4.565	in^2
Volume =	25.76	in^3	Volume =	25.76	in^3	Volume =	25.85	in^3
Specific Gravity =	2.72	(ASTM D854)	Specific Gravity =	2.72	(ASTM D854)	Specific Gravity =	2.72	(ASTM D854)
Dry Mass of Solids =	1.278	lb	Dry Mass of Solids =	1.247	lb	Dry Mass of Solids =	1.202	lb
Water Content =	33.1%		Water Content =	33.6%		Water Content =	32.8%	
Wet Unit Weight =	114.1	pcf	Wet Unit Weight =	111.7	pcf	Wet Unit Weight =	106.7	pcf
Dry Unit Weight =	85.7	pcf	Dry Unit Weight =	83.6	pcf	Dry Unit Weight =	80.4	pcf
Void Ratio =	0.98		Void Ratio =	1.03		Void Ratio =	1.11	
Percent Saturation =	92%		Percent Saturation =	89%		Percent Saturation =	80%	
	After Consolidation			**After Consolidation**			**After Consolidation**	
Length =	5.709	in	Length =	5.521	in	Length =	5.359	in
Diameter =	2.444	in	Diameter =	2.438	in	Diameter =	2.374	in
Area =	4.691	in^2 (Method B)	Area =	4.669	in^2 (Method B)	Area =	4.428	in^2 (Method B)
Volume =	26.78	in^3	Volume =	25.78	in^3	Volume =	23.73	in^3
Water Content =	38.8%		Water Content =	37.8%		Water Content =	34.4%	
Wet Unit Weight =	114.5	pcf	Wet Unit Weight =	115.2	pcf	Wet Unit Weight =	117.7	pcf
Dry Unit Weight =	82.5	pcf	Dry Unit Weight =	83.6	pcf	Dry Unit Weight =	87.6	pcf
Void Ratio =	1.06		Void Ratio =	1.03		Void Ratio =	0.94	
Percent Saturation =	100%		Percent Saturation =	100%		Percent Saturation =	100%	
B Parameter =	0.95		B Parameter =	0.95		B Parameter =	0.95	
Shear Rate =	0.003%	/min.	Shear Rate =	0.019%	/min.	Shear Rate =	0.003%	/min.
t_{50} =	128.0	min.	t_{50} =	21.0	min.	t_{50} =	132.0	min.
Strain at Failure =	4.8%		Strain at Failure =	4.5%		Strain at Failure =	4.9%	
Cell Pressure =	85	psi	Cell Pressure =	145	psi	Cell Pressure =	230	psi
Back Pressure =	50	psi	Back Pressure =	70	psi	Back Pressure =	80	psi
Confining Pressure =	35	psi	Confining Pressure =	75	psi	Confining Pressure =	150	psi

Notes: Visual description: Fat clay, olive gray, moist

Atterberg limits: LL = -- PL = -- PI = -- (-- indicates test was not performed)

Percent finer: 3/4 in. = -- No. 4 = -- No. 200 = -- (-- indicates test was not performed)

Initial water content specimen obtained from cuttings.

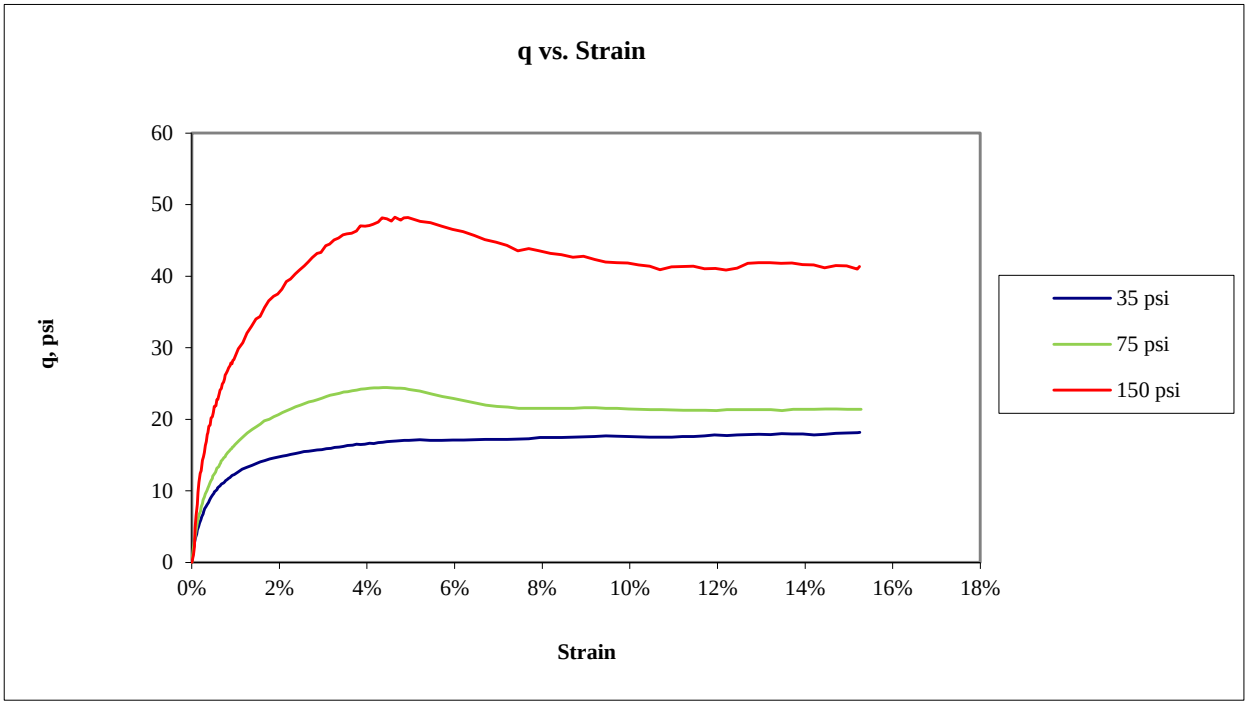
Specimen type:	X	Intact		Reconstituted	
Saturation method:	X	Wet		Dry	
Failure criterion:	X	$(\sigma'_1/\sigma'_3)_{max}$		$(\sigma'_1-\sigma'_3)_{max}$	% strain
Membrane effect:	X	Corrected		Not Corrected	

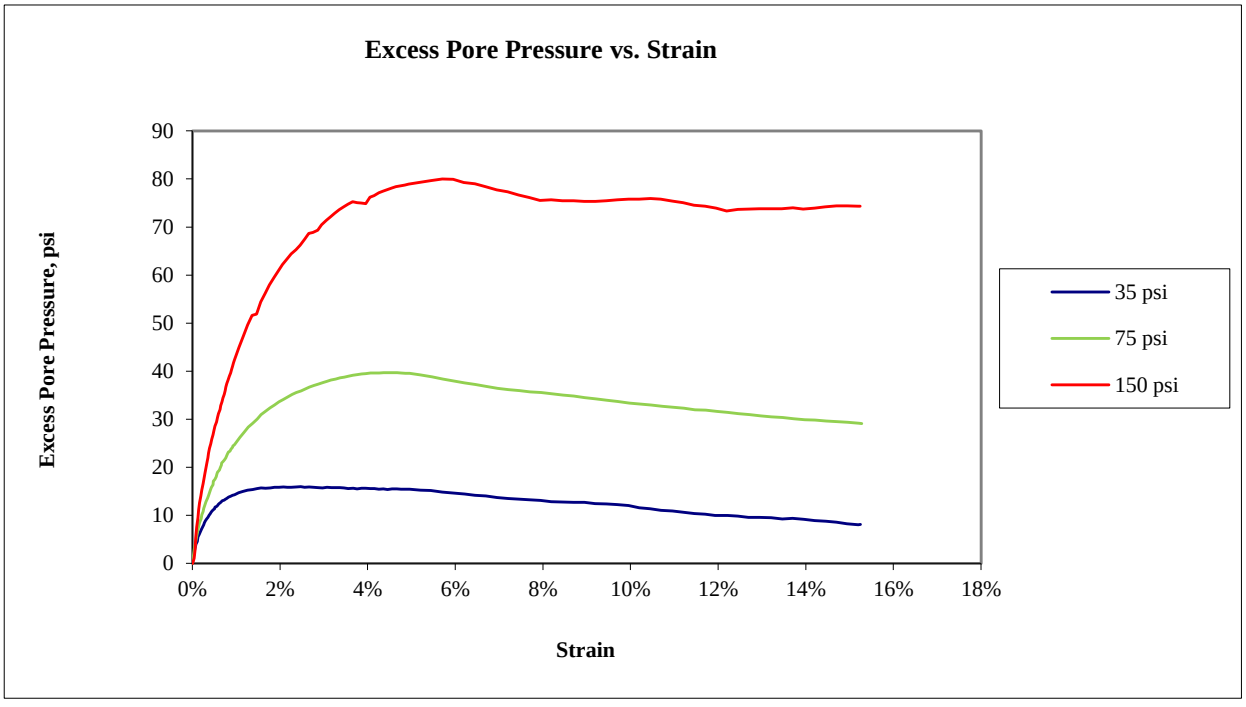
Golder Associates Inc.

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SAMPLE AND TEST DATA

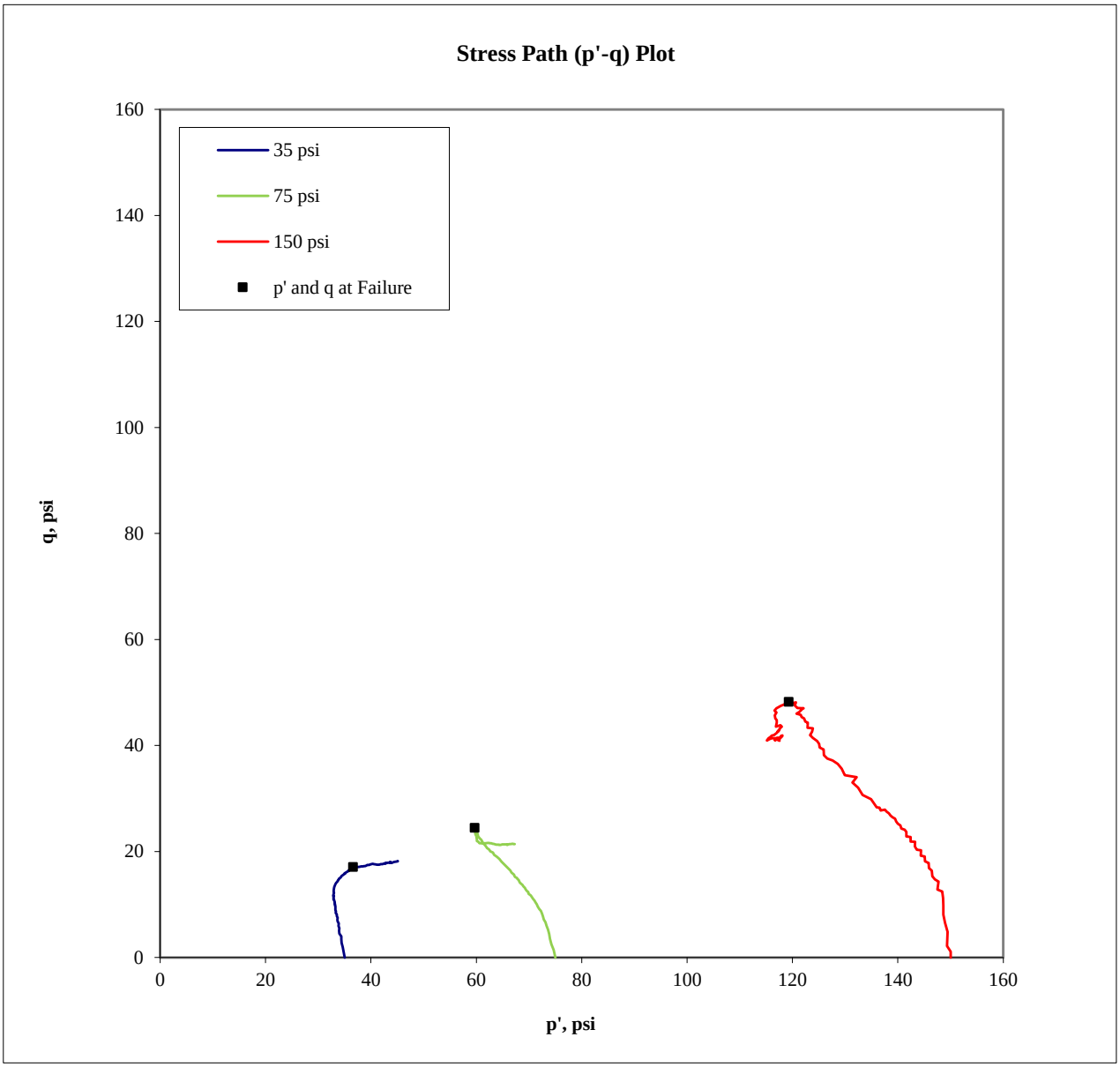
Job Short Title:
MDA/Grassy Mtn PFS/OR

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
BH-13 / S6 @ 30 ft	BC	MK	28-Mar-2018	1663241.11000	1





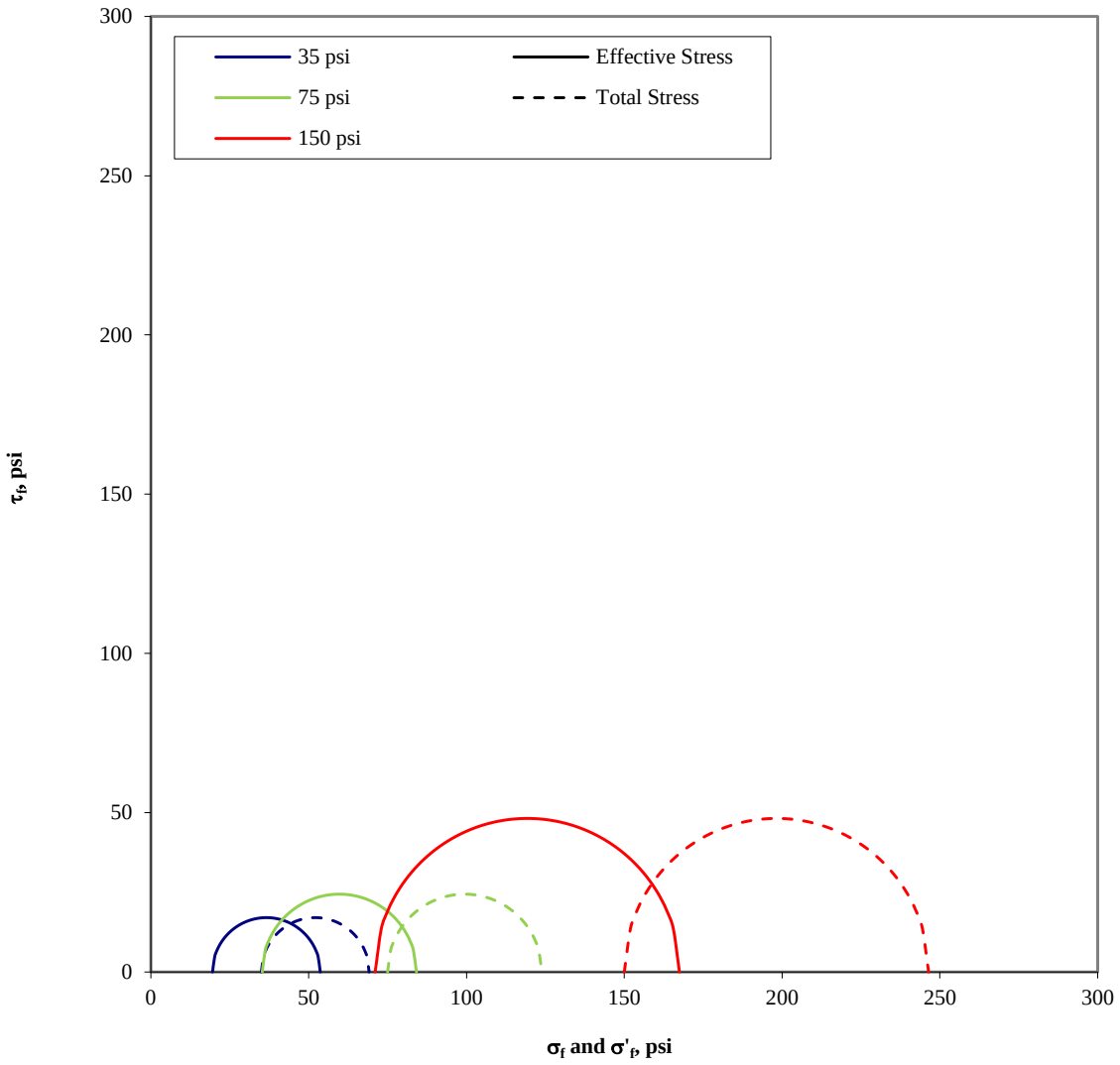
Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-13 / S6 @ 30 ft	**Technician:** BC	**Reviewed:** MK	**Date:** 28-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 2



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
35	52.1	36.6	17.1
75	99.4	59.7	24.4
150	198.2	119.3	48.2

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT STRESS PATH PLOT				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-13 / S6 @ 30 ft	**Technician:** BC	**Reviewed:** MK	**Date:** 28-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 3

Mohr's Circle Diagram



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
35	53.7	19.5	69.1	35.0
75	84.1	35.3	123.9	75.0
150	167.5	71.1	246.4	150.0

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT MOHR'S CIRCLE DIAGRAM				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-13 / S6 @ 30 ft	**Technician:** BC	**Reviewed:** MK	**Date:** 28-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 4

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 35 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-13 / S6 @ 30 ft	**Technician:** BC	**Reviewed:** MK	**Date:** 28-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 5

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 75 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-13 / S6 @ 30 ft	**Technician:** BC	**Reviewed:** MK	**Date:** 28-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 6

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 150 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-13 / S6 @ 30 ft	**Technician:** BC	**Reviewed:** MK	**Date:** 28-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 7

Boring or Test Pit:	BH-15		Boring or Test Pit:	BH-15	
Sample:	S2		Sample:	S2	
Depth:	25	ft	Depth:	25	ft
Point No.:	1		Point No.:	2	
	Initial			**Initial**	
Length =	5.168	in	Length =	5.699	in
Diameter =	2.427	in	Diameter =	2.382	in
Wet Mass =	1.283	lb	Wet Mass =	1.569	lb
Area =	4.626	in^2	Area =	4.456	in^2
Volume =	23.91	in^3	Volume =	25.40	in^3
Specific Gravity =	2.76	(ASTM D854)	Specific Gravity =	2.76	(ASTM D854)
Dry Mass of Solids =	0.929	lb	Dry Mass of Solids =	1.139	lb
Water Content =	38.2%		Water Content =	37.7%	
Wet Unit Weight =	92.8	pcf	Wet Unit Weight =	106.7	pcf
Dry Unit Weight =	67.1	pcf	Dry Unit Weight =	77.5	pcf
Void Ratio =	1.56		Void Ratio =	1.22	
Percent Saturation =	67%		Percent Saturation =	85%	
	After Consolidation			**After Consolidation**	
Length =	4.694	in	Length =	5.576	in
Diameter =	2.488	in	Diameter =	2.351	in
Area =	4.862	in^2 (Method B)	Area =	4.341	in^2 (Method B)
Volume =	22.82	in^3	Volume =	24.21	in^3
Water Content =	52.4%		Water Content =	40.4%	
Wet Unit Weight =	107.1	pcf	Wet Unit Weight =	114.2	pcf
Dry Unit Weight =	70.3	pcf	Dry Unit Weight =	81.3	pcf
Void Ratio =	1.45		Void Ratio =	1.12	
Percent Saturation =	100%		Percent Saturation =	100%	
B Parameter =	0.96		B Parameter =	0.98	
Shear Rate =	0.003%	/min.	Shear Rate =	0.003%	/min.
t_{50} =	120	min.	t_{50} =	130	min.
Strain at Failure =	6.0%		Strain at Failure =	3.3%	
Cell Pressure =	105	psi	Cell Pressure =	200	psi
Back Pressure =	70	psi	Back Pressure =	50	psi
Confining Pressure =	35	psi	Confining Pressure =	150	psi

Notes: USCS description (ASTM D2487): Fat clay, olive gray, moist

Atterberg limits: LL = 191 PL = 34 PI = 157 (ASTM D4318)

Percent finer: 3/4 in. = 100% No. 4 = 100% No. 200 = 98% (ASTM D422, refer to separate report for gradation curve)

Initial water content specimen obtained from cuttings.

Specimen type:	X	Intact		Reconstituted	
Saturation method:	X	Wet		Dry	
Failure criterion:	X	$(\sigma'_1/\sigma'_3)_{max}$		$(\sigma'_1-\sigma'_3)_{max}$	% strain
Membrane effect:	X	Corrected		Not Corrected	

Golder Associates Inc.

Title:

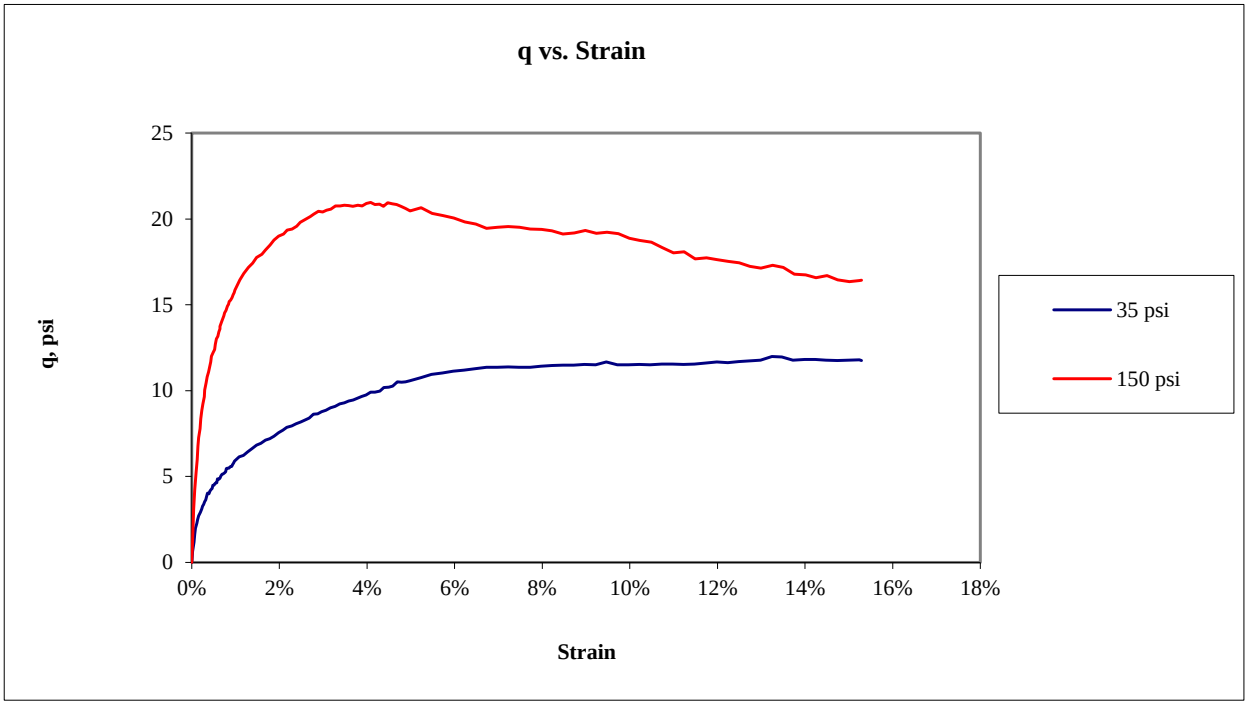
ASTM D4767

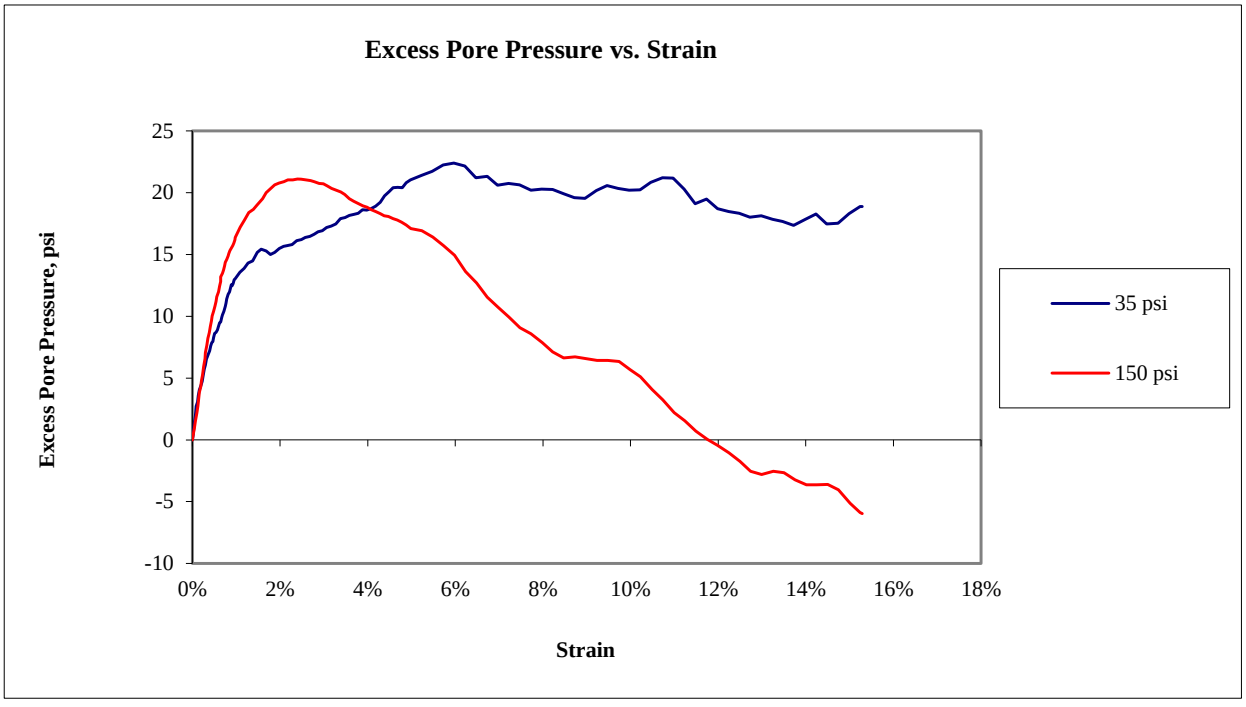
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT

SAMPLE AND TEST DATA

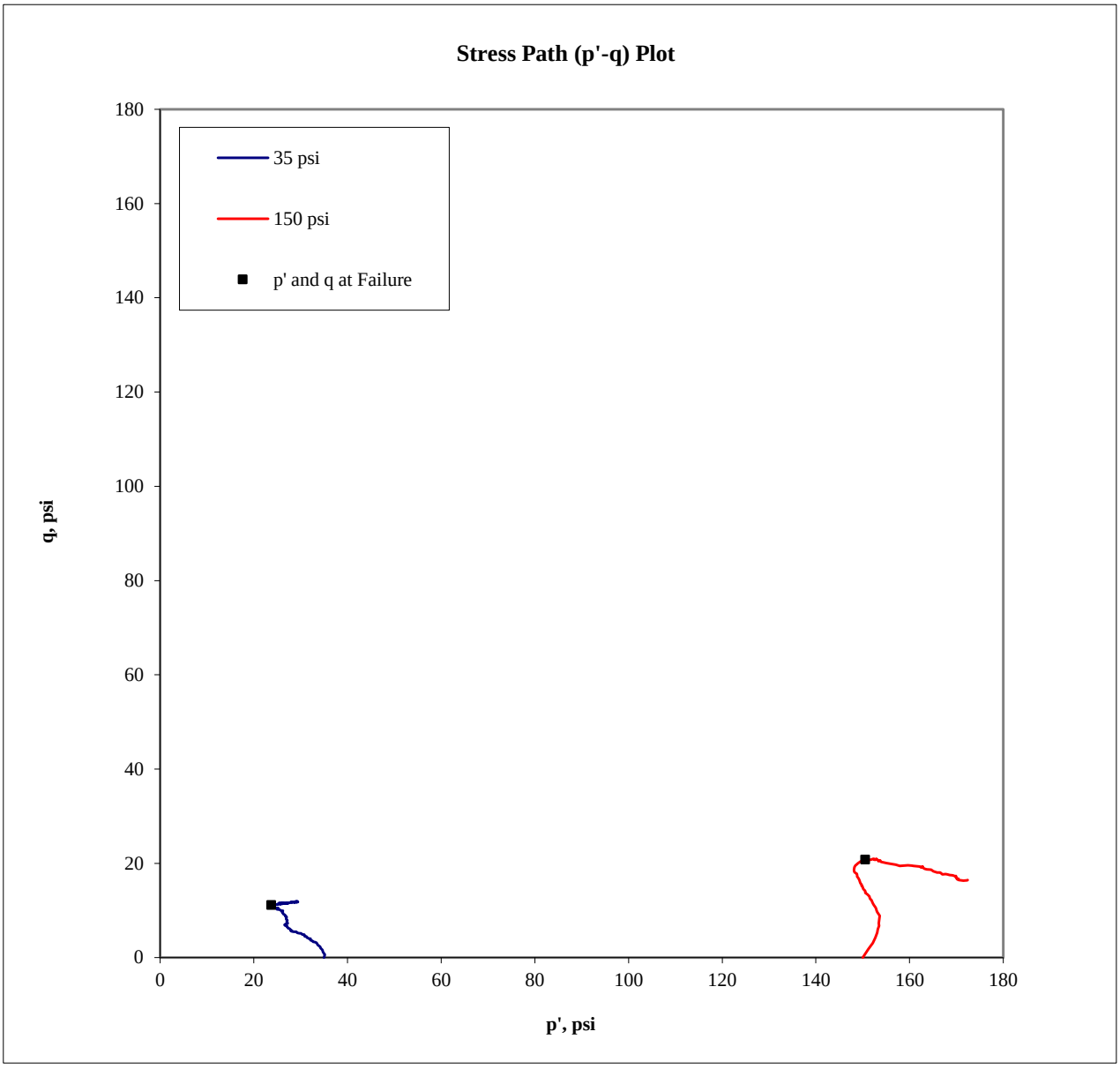
Job Short Title: MDA/Grassy Mtn PFS/OR

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
BH-15 / S2 @ 25 ft.	BC	MK	16-Mar-2018	1663241.11000	1



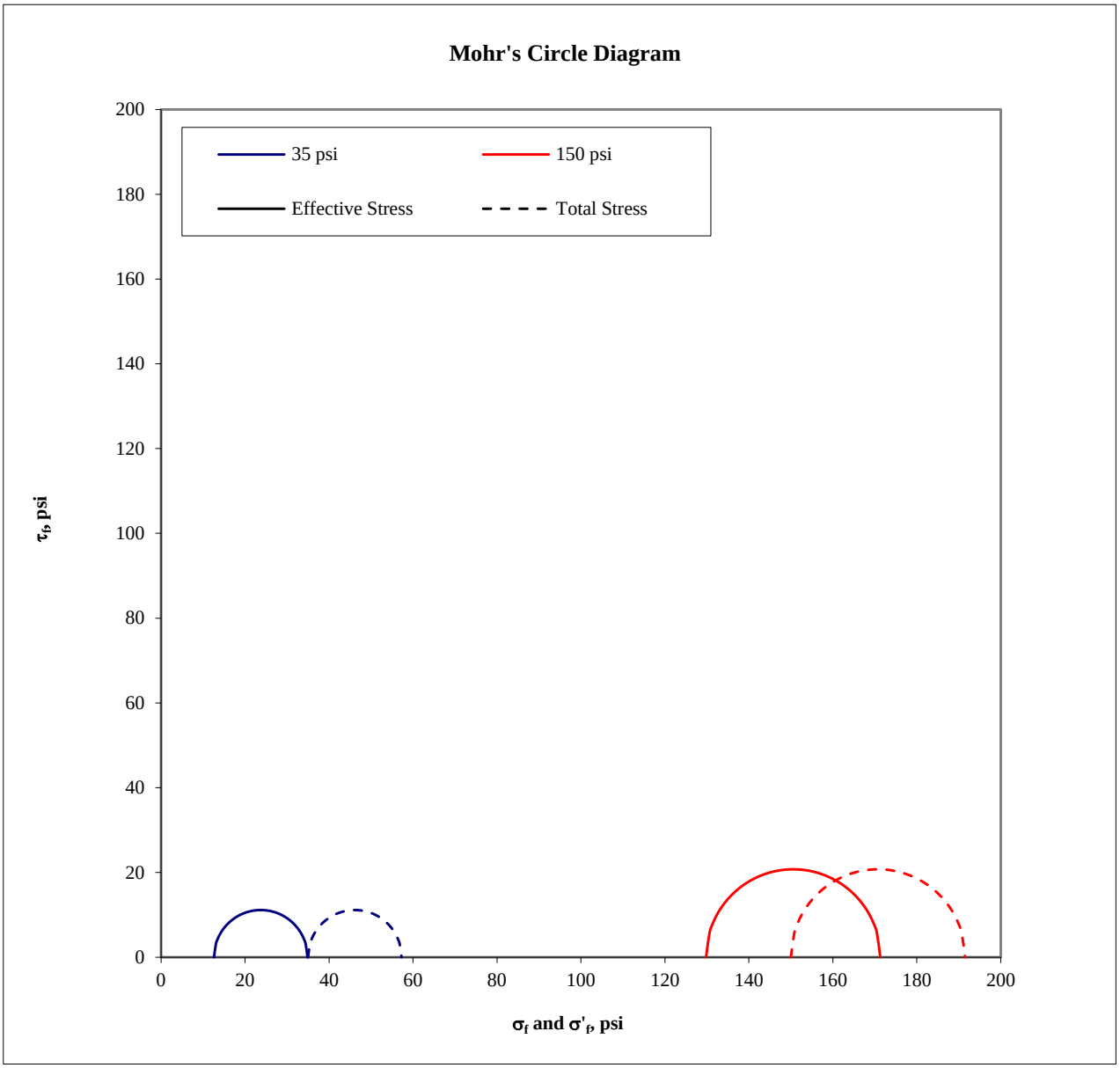


Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S2 @ 25 ft.	**Technician:** BC	**Reviewed:** MK	**Date:** 16-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 2



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
35	46.1	23.7	11.1
150	170.7	150.6	20.7

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT STRESS PATH PLOT				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S2 @ 25 ft.	**Technician:** BC	**Reviewed:** MK	**Date:** 16-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 3



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
35	34.9	12.6	57.3	35.0
150	171.3	129.8	191.5	150.0

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT MOHR'S CIRCLE DIAGRAM				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S2 @ 25 ft.	**Technician:** BC	**Reviewed:** MK	**Date:** 16-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 4

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 35 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S2 @ 25 ft.	**Technician:** BC	**Reviewed:** MK	**Date:** 16-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 5

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 150 psi				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S2 @ 25 ft.	**Technician:** BC	**Reviewed:** MK	**Date:** 16-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 6

GOLDER

Boring or Test Pit:	BH19-TP-23		Boring or Test Pit:	BH19-TP-23		Boring or Test Pit:	BH19-TP-23	
Sample ID:	--		Sample ID:	--		Sample ID:	--	
Depth:	15-17	ft	Depth:	15-17	ft	Depth:	15-17	ft
Point No.:	1		Point No.:	2		Point No.:	3	
	Initial			**Initial**			**Initial**	
Length =	6.021	in	Length =	6.021	in	Length =	5.976	in
Diameter =	2.876	in	Diameter =	2.869	in	Diameter =	2.874	in
Wet Mass =	2.285	lb	Wet Mass =	2.423	lb	Wet Mass =	2.480	lb
Area =	6.496	in^2	Area =	6.465	in^2	Area =	6.487	in^2
Volume =	39.11	in^3	Volume =	38.92	in^3	Volume =	38.77	in^3
Specific Gravity =	2.78	(ASTM D854)	Specific Gravity =	2.78	(ASTM D854)	Specific Gravity =	2.78	(ASTM D854)
Dry Mass of Solids =	1.698	lb	Dry Mass of Solids =	1.871	lb	Dry Mass of Solids =	1.861	lb
Water Content =	34.6%		Water Content =	29.5%		Water Content =	33.3%	
Wet Unit Weight =	100.9	pcf	Wet Unit Weight =	107.6	pcf	Wet Unit Weight =	110.6	pcf
Dry Unit Weight =	75.0	pcf	Dry Unit Weight =	83.0	pcf	Dry Unit Weight =	82.9	pcf
Void Ratio =	1.31		Void Ratio =	1.09		Void Ratio =	1.09	
Percent Saturation =	73%		Percent Saturation =	76%		Percent Saturation =	85%	
	After Consolidation			**After Consolidation**			**After Consolidation**	
Length =	5.898	in	Length =	6.041	in	Length =	5.976	in
Diameter =	2.884	in	Diameter =	2.778	in	Diameter =	2.817	in
Area =	6.534	in^2 (Method B)	Area =	6.060	in^2 (Method B)	Area =	6.231	in^2 (Method B)
Volume =	38.54	in^3	Volume =	36.61	in^3	Volume =	37.23	in^3
Water Content =	45.9%		Water Content =	34.6%		Water Content =	36.2%	
Wet Unit Weight =	111.1	pcf	Wet Unit Weight =	118.9	pcf	Wet Unit Weight =	117.6	pcf
Dry Unit Weight =	76.1	pcf	Dry Unit Weight =	88.3	pcf	Dry Unit Weight =	86.3	pcf
Void Ratio =	1.28		Void Ratio =	0.96		Void Ratio =	1.01	
Percent Saturation =	100%		Percent Saturation =	100%		Percent Saturation =	100%	
B Parameter =	0.99		B Parameter =	0.99		B Parameter =	0.95	
Shear Rate =	0.003%	/min.	Shear Rate =	0.007%	/min.	Shear Rate =	0.007%	/min.
t_{50} =	120	min.	t_{50} =	2,100	min.	t_{50} =	2,300	min.
Strain at Failure =	7.9%		Strain at Failure =	2.9%		Strain at Failure =	3.0%	
Cell Pressure =	85	psi	Cell Pressure =	125	psi	Cell Pressure =	200	psi
Back Pressure =	50	psi	Back Pressure =	50	psi	Back Pressure =	50	psi
Confining Pressure =	35	psi	Confining Pressure =	75	psi	Confining Pressure =	150	psi

Notes: Visual description: Fat clay, olive, moist

Atterberg limits: LL = -- PL = -- PI = -- (-- indicates test wast not performed)

Percent finer: 3/4 in. = -- No. 4 = -- No. 200 = --

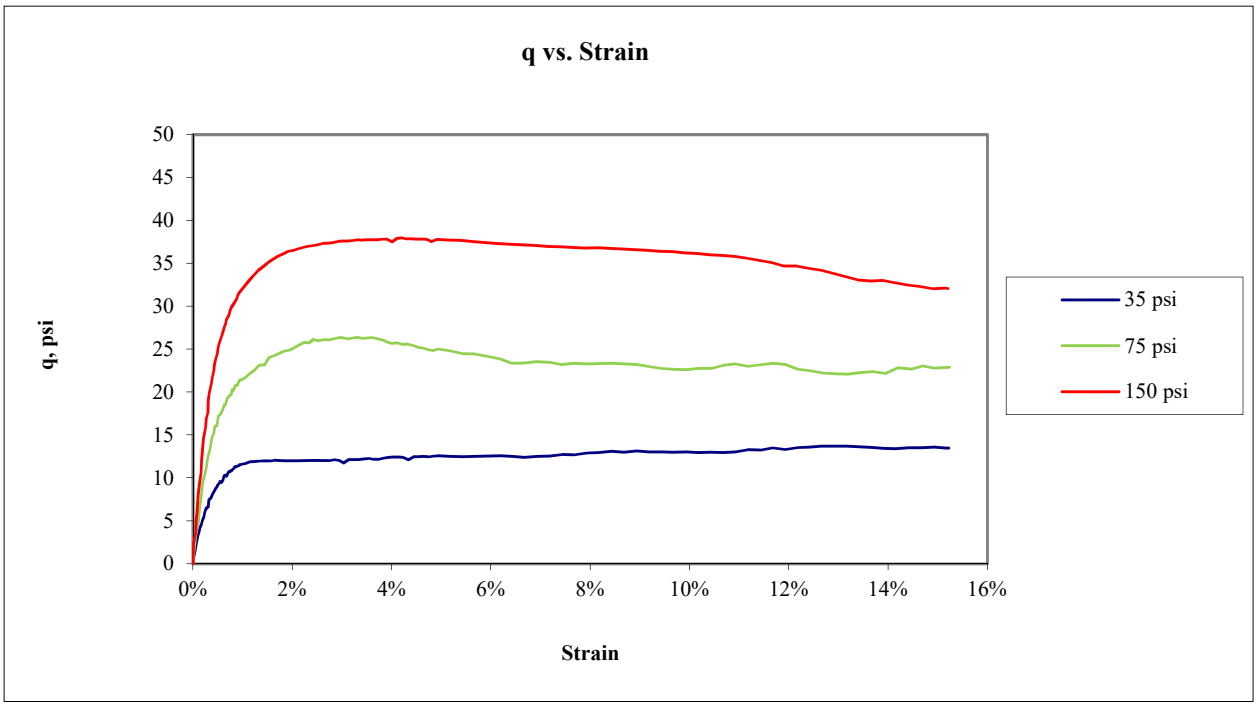
Initial water content obtained from entire sample.

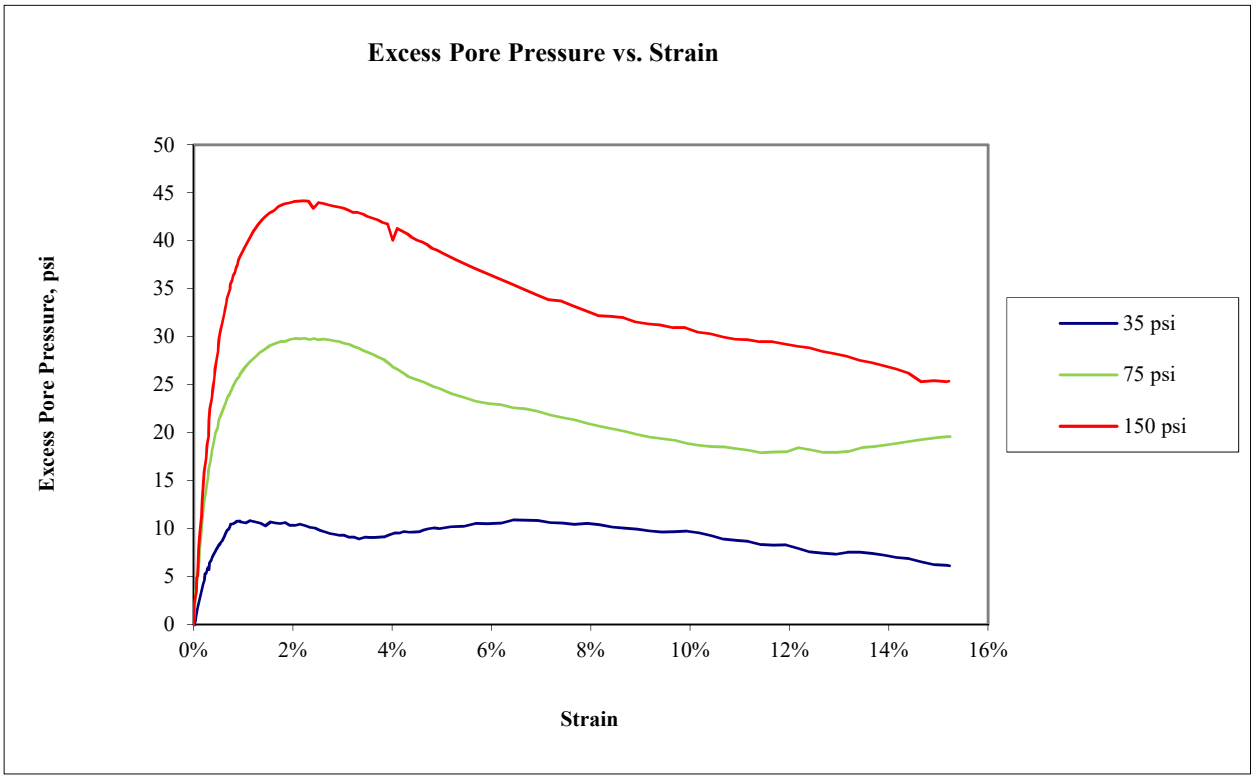
Specimen type:	X	Intact		Reconstituted	
Saturation method:	X	Wet		Dry	
Failure criterion:	X	$(\sigma'_1/\sigma'_3)_{max}$		$(\sigma'_1-\sigma'_3)_{max}$	% strain
Membrane effect:	X	Corrected		Not Corrected	

Shear rate for Point 2 and Point 3 assigned by client

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SAMPLE AND TEST DATA				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 15 - 17 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 1

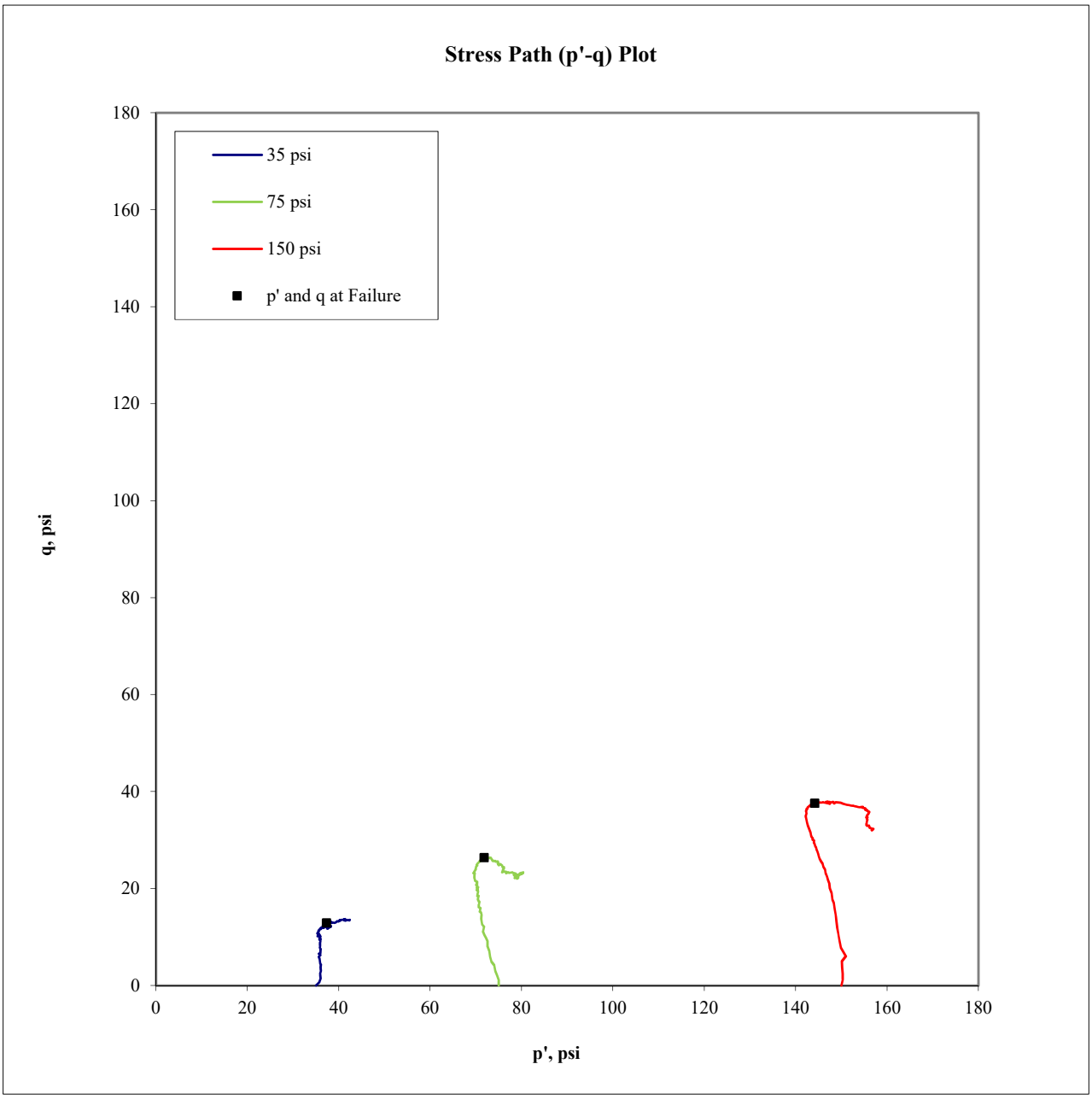
GOLDER





Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 15 - 17 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 2

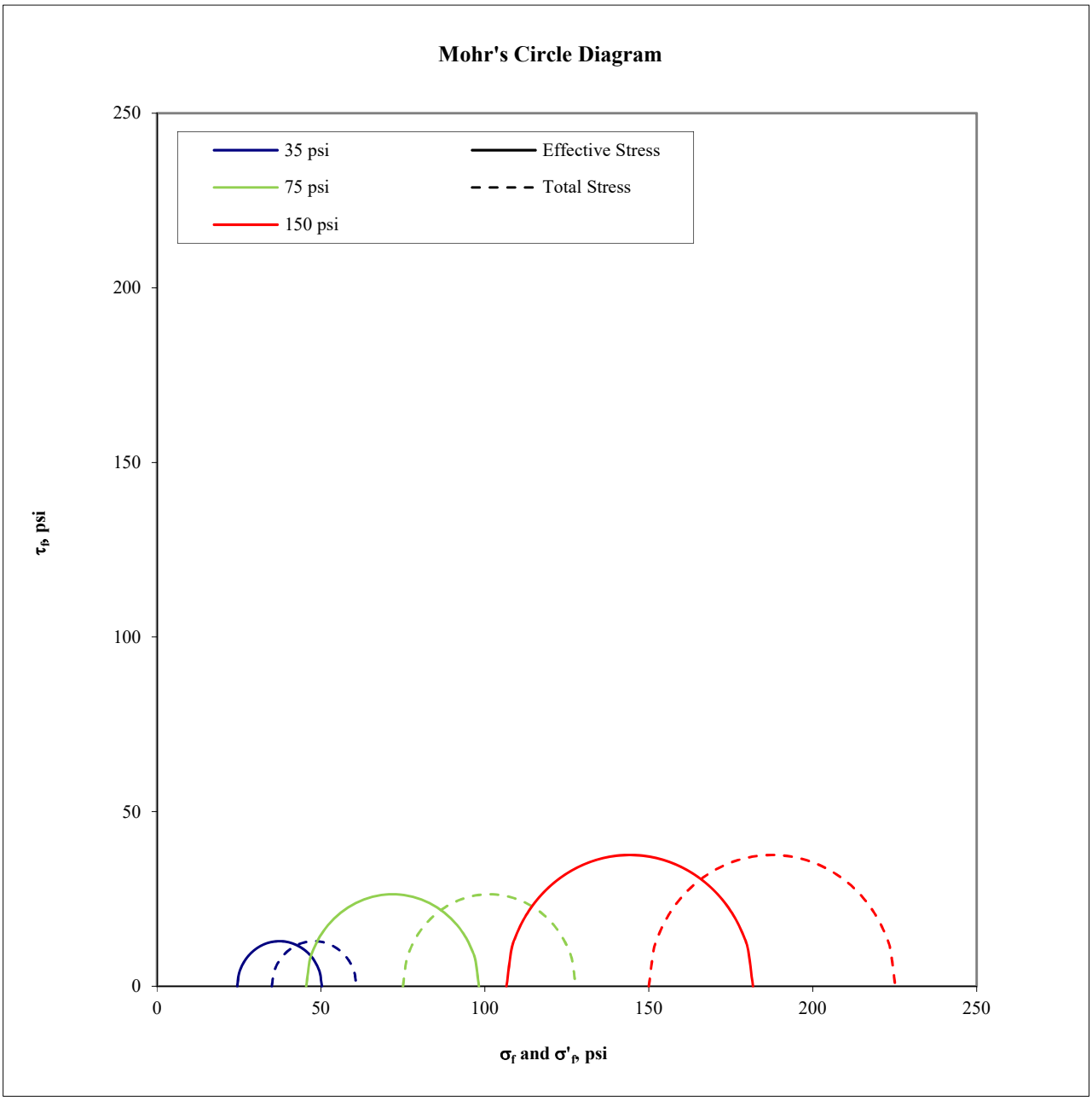
GOLDER



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
35.0	47.9	37.4	12.9
75.0	101.3	71.8	26.3
150.0	187.6	144.2	37.6

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT STRESS PATH PLOT				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 15 - 17 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 3

GOLDER



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
35.0	50.3	24.5	60.8	35.0
75.0	98.2	45.5	127.7	75.0
150.0	181.8	106.6	225.2	150.0

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT MOHR'S CIRCLE DIAGRAM				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 15 - 17 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 4

GOLDER

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767**				
Project Number: 1663241.22000	**CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **SPECIMEN PHOTOGRAPH - 35 psi**				
Sample ID: BH19-TP-23 @ 15 - 17 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 5

GOLDER

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767**				
Project Number: 1663241.22000	**CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **SPECIMEN PHOTOGRAPH - 75 psi**				
Sample ID: BH19-TP-23 @ 15 - 17 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 6

GOLDER

Project Name:		ASTM D4767				
MDA/Grassy Mtn PFS/OR		CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 150 psi				
Project Number:						
1663241.22000						
Sample ID:	Technician:	Checked:	Reviewed:	Date:	Figure:	
BH19-TP-23 @ 15 - 17 ft.	BC	PRH	CPA	7-Aug-2019	7	

GOLDER

Boring or Test Pit:	BH19-TP-23		Boring or Test Pit:	BH19-TP-23	
Sample ID:	--		Sample ID:	--	
Depth:	20-22	ft	Depth:	20 -22	ft
Point No.:	1		Point No.:	3	
	Initial			**Initial**	
Length =	5.971	in	Length =	5.812	in
Diameter =	2.848	in	Diameter =	2.838	in
Wet Mass =	2.255	lb	Wet Mass =	2.235	lb
Area =	6.370	in^2	Area =	6.326	in^2
Volume =	38.04	in^3	Volume =	36.77	in^3
Specific Gravity =	2.73	(ASTM D854)	Specific Gravity =	2.73	(ASTM D854)
Dry Mass of Solids =	1.601	lb	Dry Mass of Solids =	1.609	lb
Water Content =	40.8%		Water Content =	38.9%	
Wet Unit Weight =	102.5	pcf	Wet Unit Weight =	105.0	pcf
Dry Unit Weight =	72.8	pcf	Dry Unit Weight =	75.6	pcf
Void Ratio =	1.34		Void Ratio =	1.25	
Percent Saturation =	83%		Percent Saturation =	85%	
	After Consolidation			**After Consolidation**	
Length =	5.964	in	Length =	5.616	in
Diameter =	2.868	in	Diameter =	2.829	in
Area =	6.458	in^2 (Method B)	Area =	6.287	in^2 (Method B)
Volume =	38.52	in^3	Volume =	35.31	in^3
Water Content =	50.1%		Water Content =	42.5%	
Wet Unit Weight =	107.8	pcf	Wet Unit Weight =	112.2	pcf
Dry Unit Weight =	71.9	pcf	Dry Unit Weight =	78.8	pcf
Void Ratio =	1.37		Void Ratio =	1.16	
Percent Saturation =	100%		Percent Saturation =	100%	
B Parameter =	0.99		B Parameter =	0.98	
Shear Rate =	0.0036%	/min.	Shear Rate =	0.0026%	/min.
t_{50} =	545.0	min.	t_{50} =	4,300.0	min.
Strain at Failure =	2.0%		Strain at Failure =	4.5%	
Cell Pressure =	85	psi	Cell Pressure =	210	psi
Back Pressure =	50	psi	Back Pressure =	60	psi
Confining Pressure =	35	psi	Confining Pressure =	150	psi

Notes: Visual description: Fat clay, olive, moist

Atterberg limits: LL = -- PL = -- PI = -- (-- indicates test wast not performed)

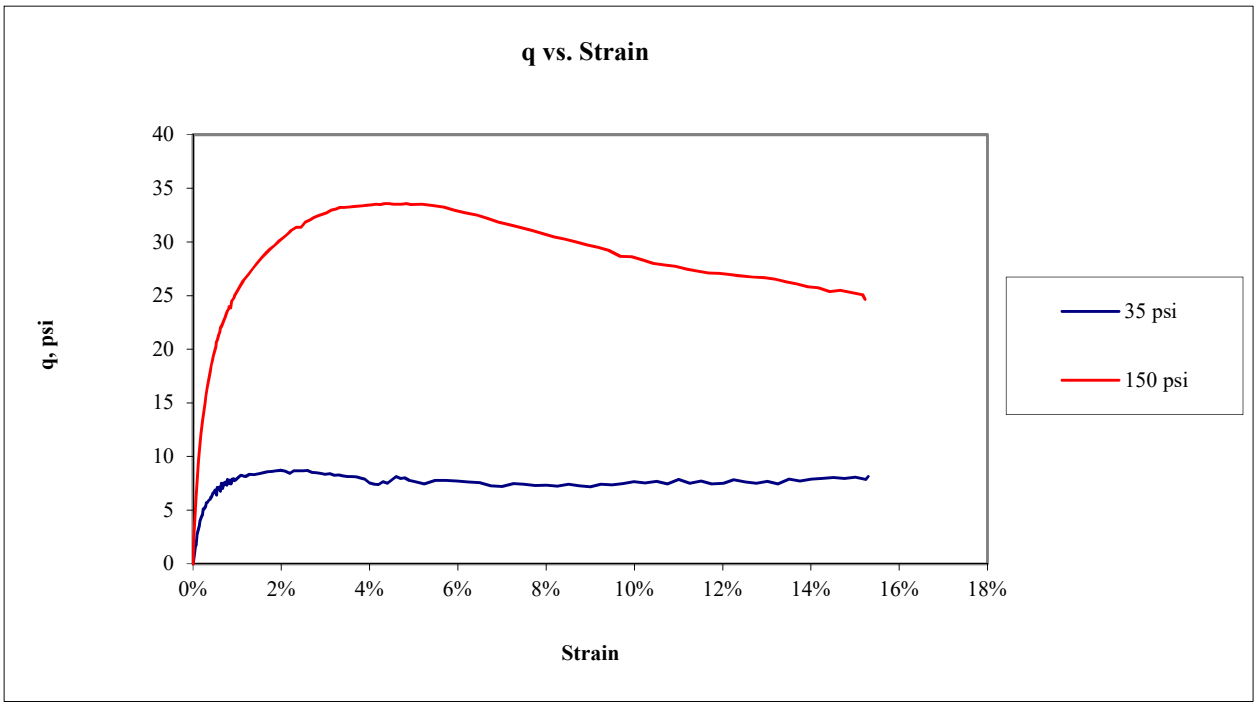
Percent finer: 3/4 in. = -- No. 4 = -- No. 200 = --

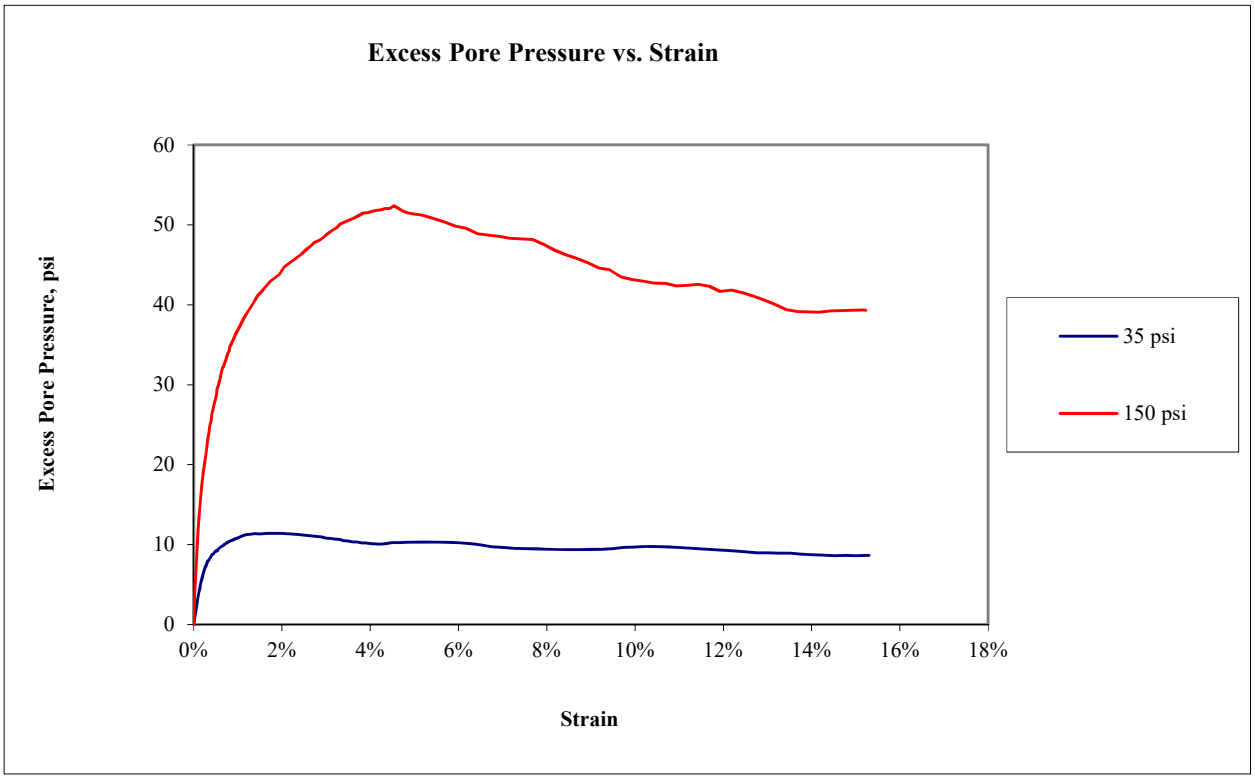
Initial water content obtained from entire sample.

Specimen type:	X	Intact		Reconstituted		
Saturation method:	X	Wet		Dry		
Failure criterion:	X	$(\sigma'_1/\sigma'_3)_{max}$		$(\sigma'_1-\sigma'_3)_{max}$		% strain
Membrane effect:	X	Corrected		Not Corrected		

Shear rates assigned by client.

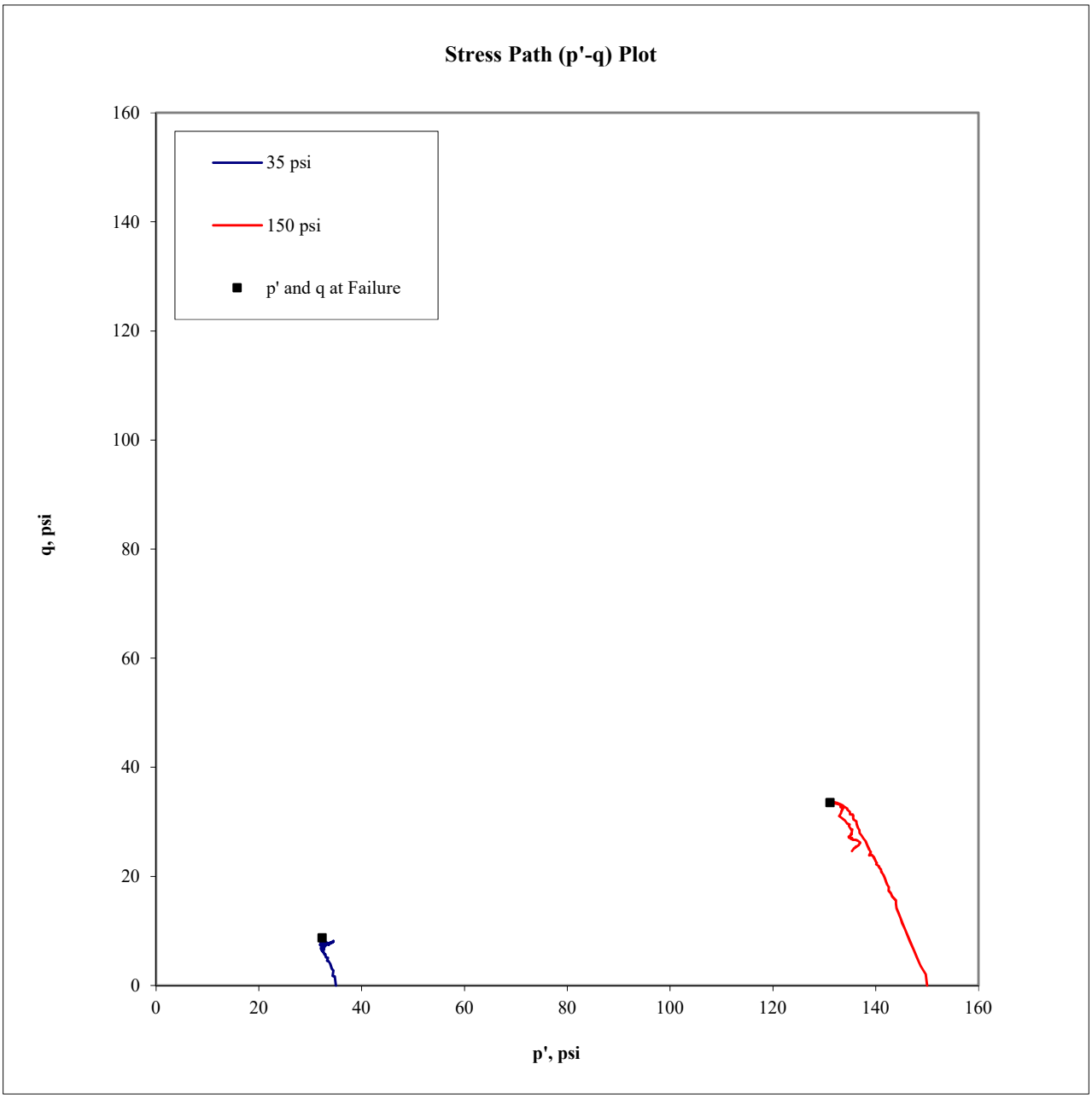
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SAMPLE AND TEST DATA				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 20 - 22 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 1





Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS					
Project Number: 1663241.22000						
Sample ID: BH19-TP-23 @ 20 - 22 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 2	

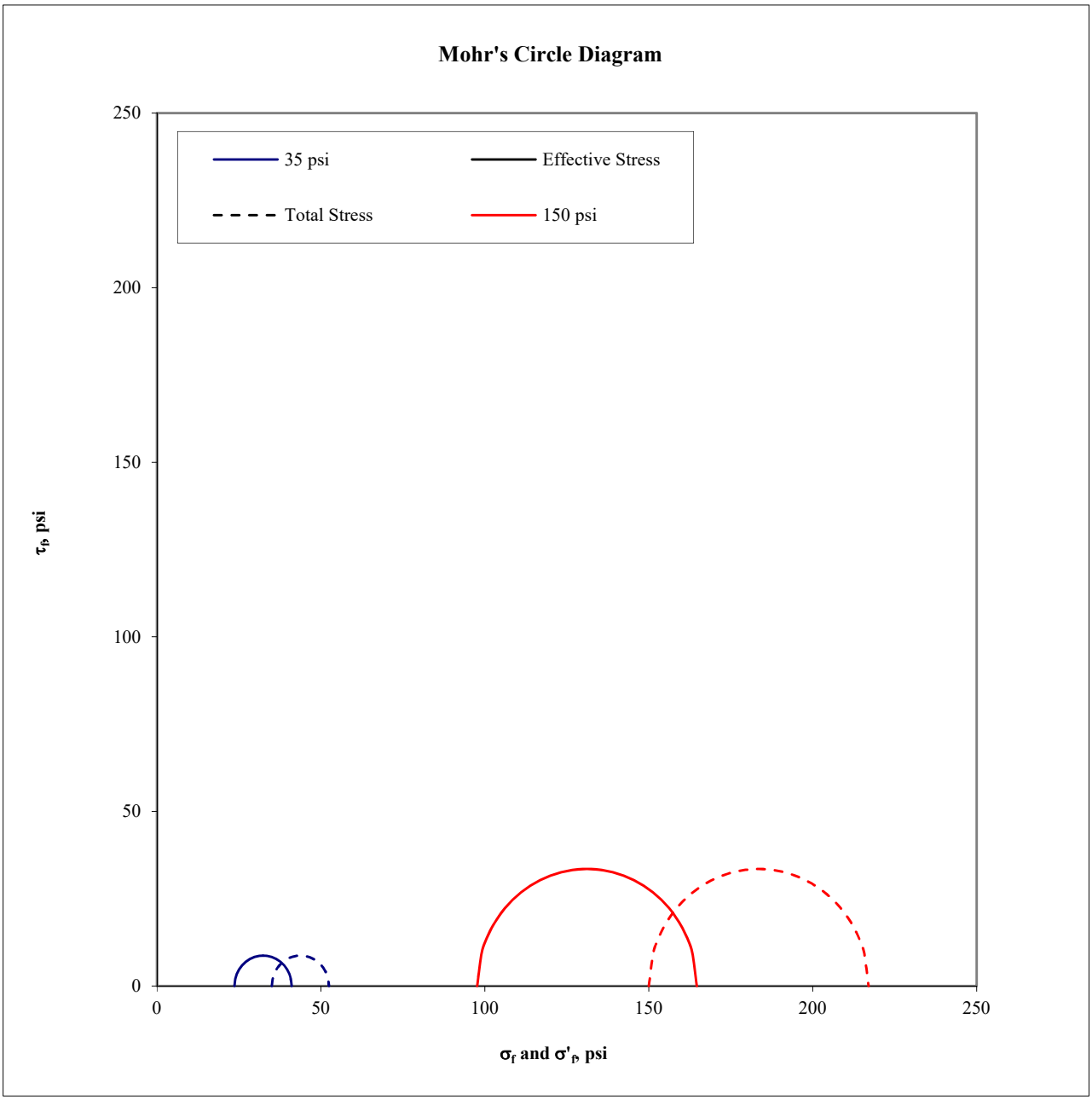
GOLDER



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
35.0	43.7	32.3	8.7
150.0	183.5	131.1	33.5

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT STRESS PATH PLOT				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 20 - 22 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 3

GOLDER



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
35.0	41.0	23.6	52.4	35.0
150.0	164.6	97.6	217.0	150.0

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT MOHR'S CIRCLE DIAGRAM				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 20 - 22 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 4

GOLDER

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767**					
Project Number: 1663241.22000	**CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **SPECIMEN PHOTOGRAPH - 35 psi**					
Sample ID: BH19-TP-23 @ 20 - 22 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 5	

GOLDER

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767**				
Project Number: 1663241.22000	**CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **SPECIMEN PHOTOGRAPH - 150 psi**				
Sample ID: BH19-TP-23 @ 20 - 22 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 7-Aug-2019	**Figure:** 6

GOLDER

Boring or Test Pit:	BH19-TP-44		Boring or Test Pit:	BH19-TP-44	
Sample:	--		Sample:	--	
Depth:	10-12	ft	Depth:	10-12	ft
Point No.:	1		Point No.:	2	
	Initial			**Initial**	
Length =	6.134	in	Length =	--	in
Diameter =	2.878	in	Diameter =	--	in
Wet Mass =	2.374	lb	Wet Mass =	--	lb
Area =	6.505	in^2	Area =	--	in^2
Volume =	39.90	in^3	Volume =	--	in^3
Specific Gravity =	2.75	(ASTM D854)	Specific Gravity =	2.75	(ASTM D854)
Dry Mass of Solids =	1.985	lb	Dry Mass of Solids =	1.985	lb
Water Content =	19.6%		Water Content =	--	
Wet Unit Weight =	102.8	pcf	Wet Unit Weight =	--	pcf
Dry Unit Weight =	86.0	pcf	Dry Unit Weight =	--	pcf
Void Ratio =	0.99		Void Ratio =	--	
Percent Saturation =	54%		Percent Saturation =	100%	
	After Consolidation			**After Consolidation**	
Length =	5.972	in	Length =	5.648	in
Diameter =	--	in	Diameter =	2.815	in
Area =	--	in^2 (Method B)	Area =	6.224	in^2 (Method B)
Volume =	--	in^3	Volume =	35.15	in^3
Water Content =	--		Water Content =	27.5%	
Wet Unit Weight =	--	pcf	Wet Unit Weight =	124.4	pcf
Dry Unit Weight =	--	pcf	Dry Unit Weight =	97.6	pcf
Void Ratio =	--		Void Ratio =	0.76	
Percent Saturation =	100%		Percent Saturation =	100%	
B Parameter =	0.97		B Parameter =	--	
Shear Rate =	0.010%	/min.	Shear Rate =	0.010%	/min.
t_{50} =	38.0	min.	t_{50} =	--	(not computed)
Strain at Failure =	4.7%		Strain at Failure =	5.6%	
Cell Pressure =	85.0	psi	Cell Pressure =	200.7	psi
Back Pressure =	50.0	psi	Back Pressure =	65.7	psi
Confining Pressure =	35.0	psi	Confining Pressure =	135.0	psi

Notes: USCS description (ASTM D2487): Fat clay, olive yellow, moist

Atterberg limits: LL = 82 PL = 22 PI = 60 (ASTM D4318)

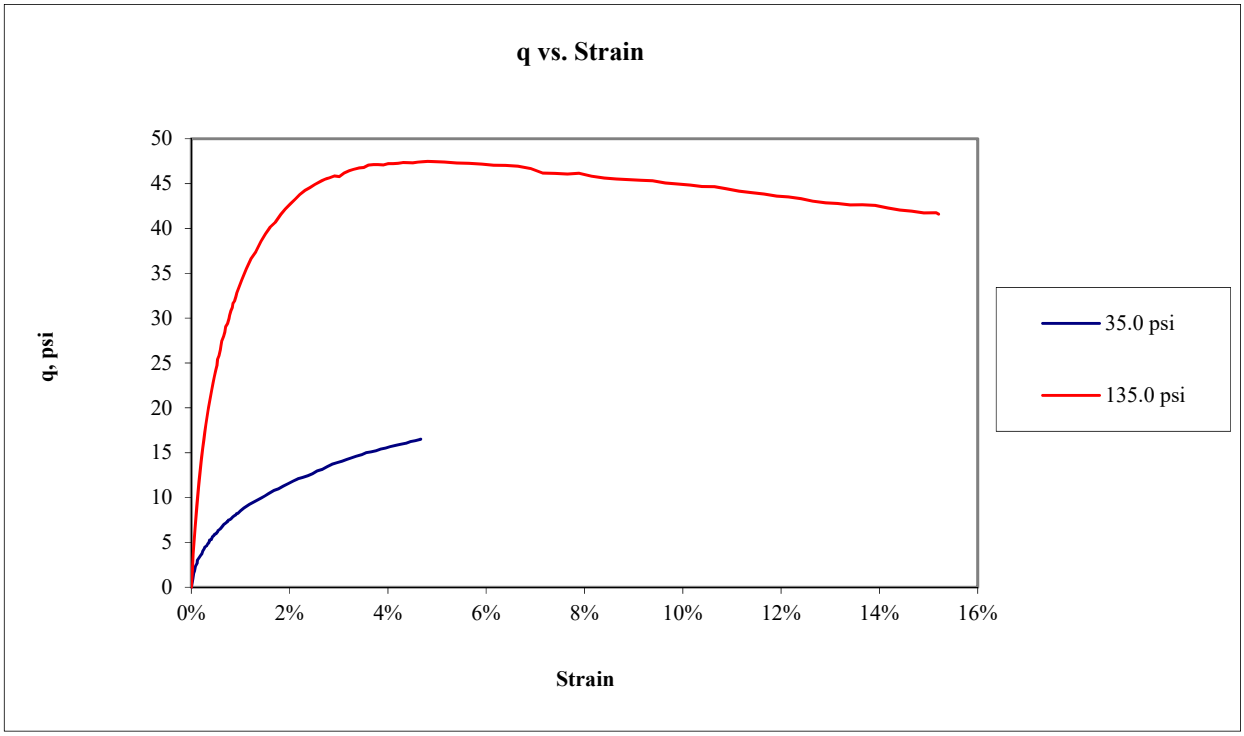
Percent finer: 3/4 in. = 100% No. 4 = 100% No. 200 = 56% (ASTM D422, refer to separate report for gradation curve)

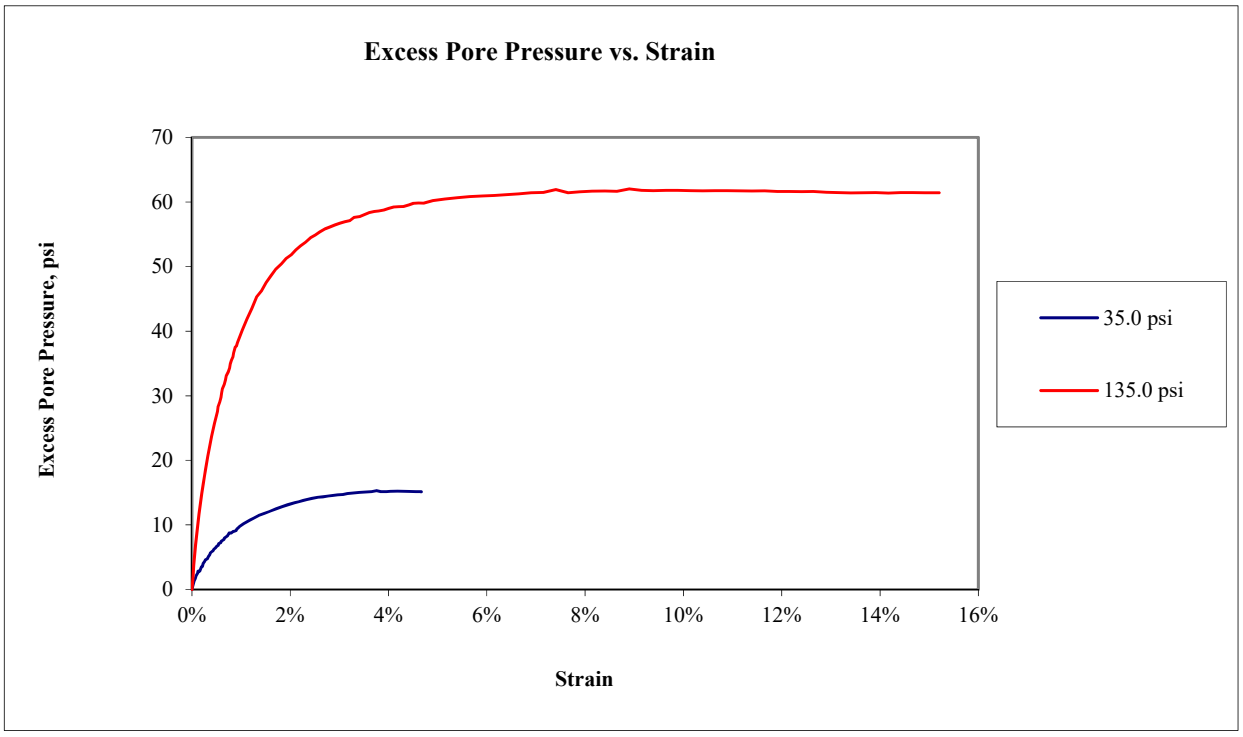
Initial water content obtained from entire sample.

Specimen type:	X	Intact		Reconstituted	
Saturation method:	X	Wet		Dry	
Failure criterion:	X	$(\sigma'_1/\sigma'_3)_{max}$		$(\sigma'_1-\sigma'_3)_{max}$	% strain
Membrane effect:	X	Corrected		Not Corrected	

Test was staged using a single specimen. Specimen was sheared to 5% for the first stage at which failure was defined. Intermediate specimen dimensions were not determined. Calculations are based on initial specimen dimensions and from corrected area calculations based on axial strain (deviation from ASTM D4767).

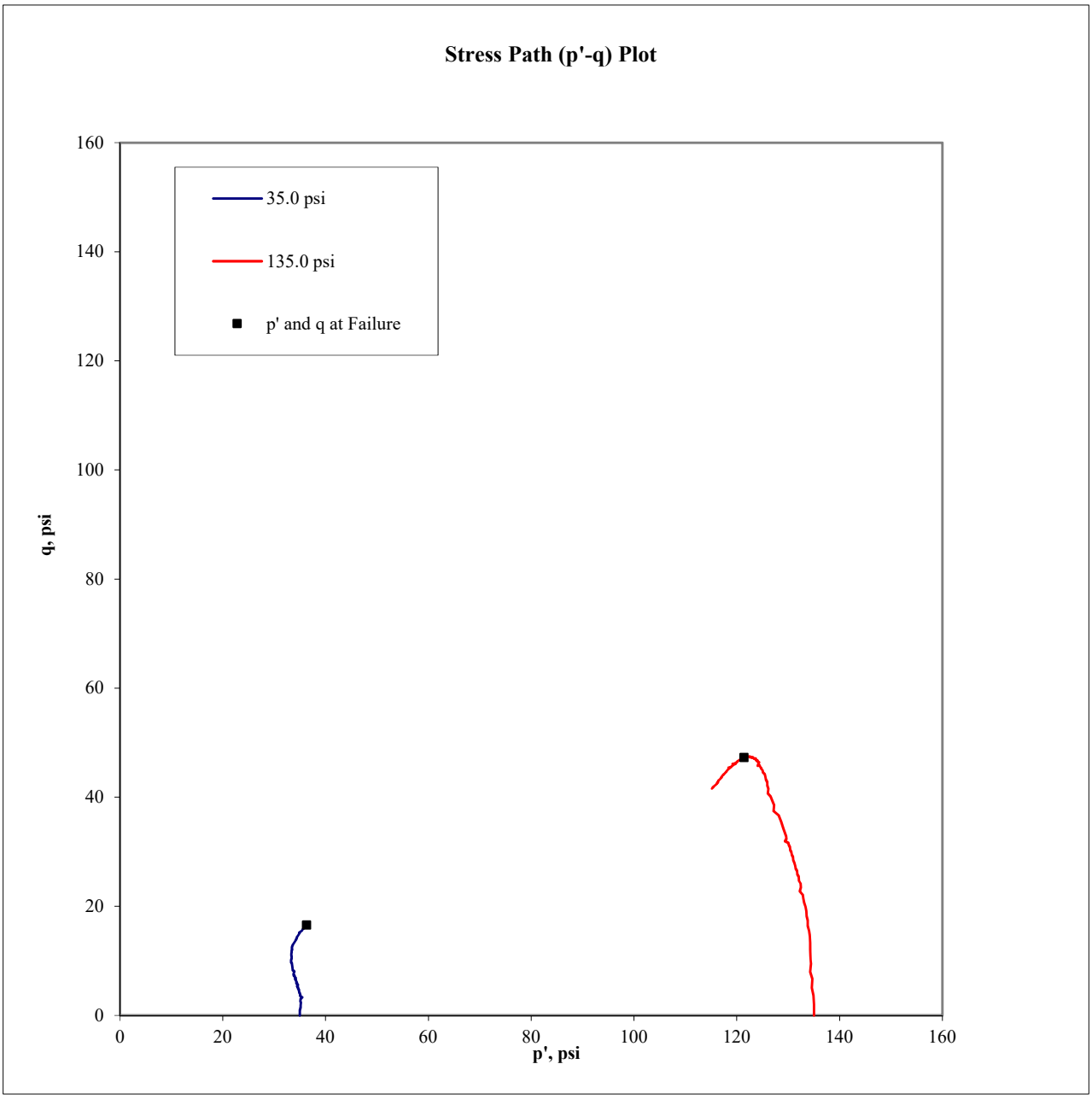
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SAMPLE AND TEST DATA				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 10 - 12 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Aug-2019	**Figure:** 1





Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS					
Project Number: 1663241.22000						
Sample ID: BH19-TP-44 @ 10 - 12 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Aug-2019	**Figure:** 2	

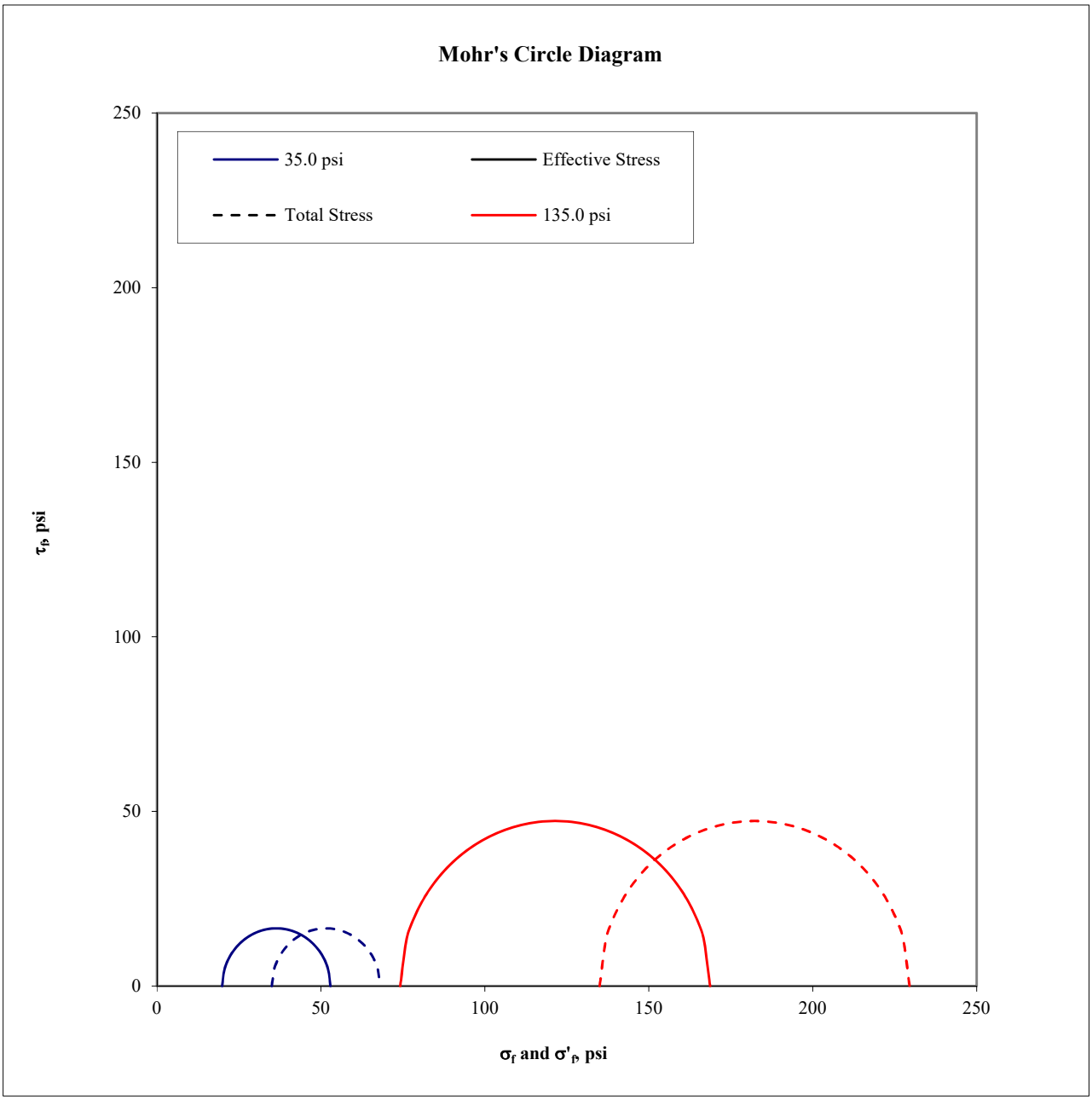
GOLDER



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
35.0	51.5	36.4	16.5
135.0	182.3	121.4	47.3

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT STRESS PATH PLOT				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 10 - 12 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Aug-2019	**Figure:** 3

GOLDER



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
35.0	52.9	19.9	68.0	35.0
135.0	168.7	74.2	229.5	135.0

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D4767** CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT MOHR'S CIRCLE DIAGRAM				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 10 - 12 ft.	**Technician:** BC	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Aug-2019	**Figure:** 4

GOLDER

Project Name: MDA/Grassy Mtn PFS/OR	ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT POST-TEST SPECIMEN PHOTOGRAPH				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 10 - 12 ft.	Technician: BC	Checked: PRH	Reviewed: CPA	Date: 3-Aug-2019	Figure: 5

	Initial		Final		Notes
Height =	1.077	in	1.091	in	USCS description (ASTM D2487): Fat clay, olive gray, moist
Diameter =	2.00	in	2.00	in	Atterberg Limits (ASTM D4318): LL = 121 PL = 36 PI = 85
Area =	3.14	in^2	3.14	in^2	Percent Finer (ASTM D422): 3/4 in. = 100% No. 4 = 100% No. 200 = 95%
Volume =	3.38	in^3	3.43	in^3	Specimen Type: [X] Intact [ ] Reconstituted
Water Content =	45.4%		49.1%		Remold Targets: Not applicable
Specific Gravity =	2.74	(Assumed)	2.74	(Assumed)	Water Content of Trimmings (ASTM D2216): 47.1%
Height of Solids =	0.4251	in	0.4251	in	Trimming Procedure: Specimen trimmed using a cylindrical cutting tool
Void Ratio =	1.533		1.566		Inundation: [ ] Not inundated [X] Inundated at 0.1 ksf
Degree of Saturation =	81.1%		85.9%		Test Method: [ ] A [X] B
Wet Mass =	0.192	lb	0.197	lb	Apparatus: GeoTac automated consolidometer
Dry Mass =	0.132	lb	0.132	lb	Final Water Content Specimen: [X] Entire [ ] Partial
Wet Unit Weight =	98.0	pcf	99.2	pcf	Final Differential Height: -0.0082 in
Dry Unit Weight =	67.4	pcf	66.5	pcf	Estimated Preconsolidation Stress: --

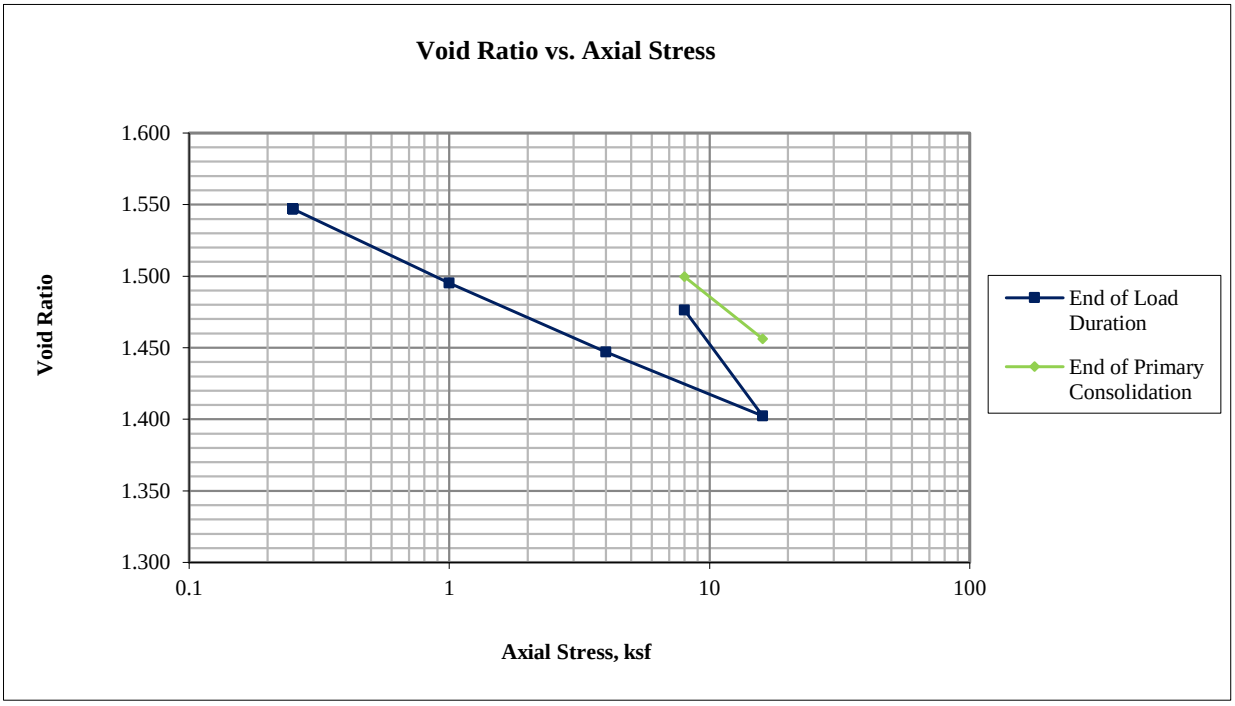
			At End of Primary Consolidation				At End of Load Duration							
	Axial Stress (ksf)	Load Duration (min)	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Time Deformation Method	Average Void Ratio	Coefficient of Consolidation (ft^2/day)	Time to 50% Consolidation (min)
Seating*	3.05	1482					0.0000	1.0711	0.00	1.519				
1	8.0	1717	0.0084	1.0627	0.78	1.500	0.0183	1.0528	1.70	1.476	2 (Root time)	1.509	4.924	0.1
2	16.0	4320	0.0269	1.0442	2.50	1.456	0.0498	1.0213	4.62	1.402	2 (Root time)	1.460	3.623	0.2
3	4.0	2810					0.0308	1.0403	2.86	1.447				
4	1.0	3198					0.0103	1.0608	0.96	1.495				
5	0.25	10000					-0.0117	1.0828	-1.09	1.547				

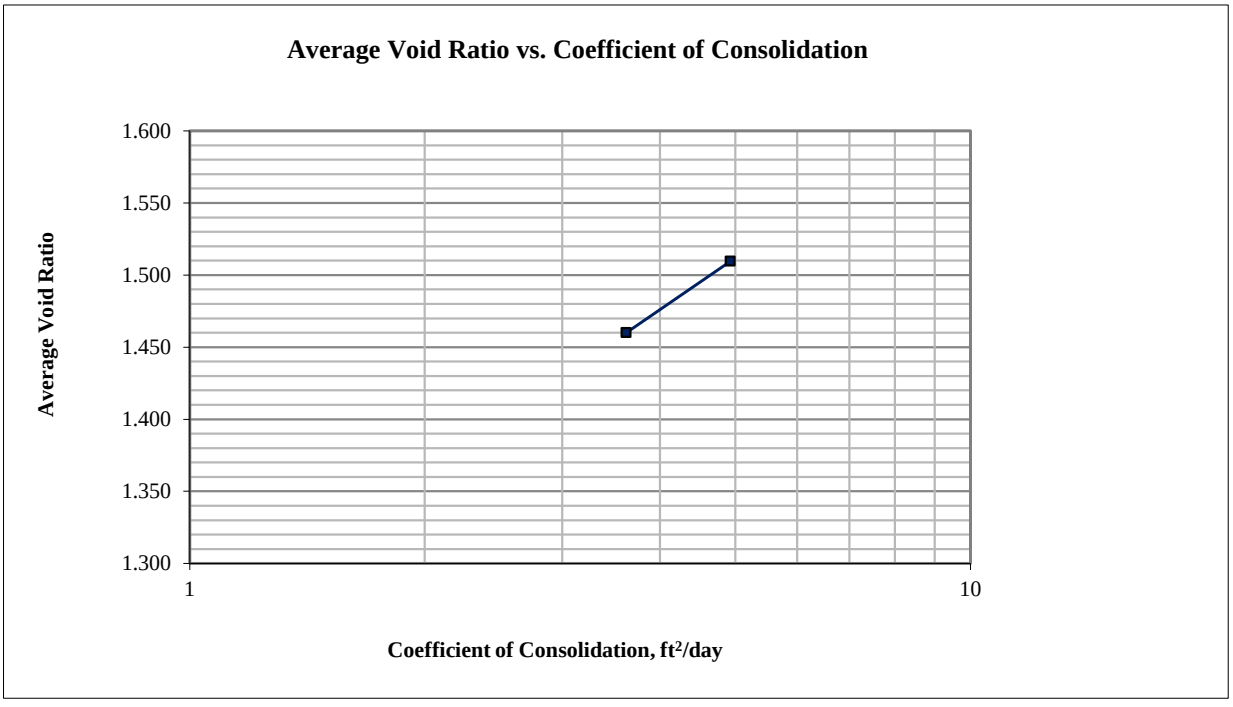
*Axial stress of 3.05 ksf was required to prevent swelling.

Golder Associates Inc.

Title:
ASTM D2435
ONE-DIMENSIONAL CONSOLIDATION TEST REPORT
SPECIMEN AND SUMMARY DATA

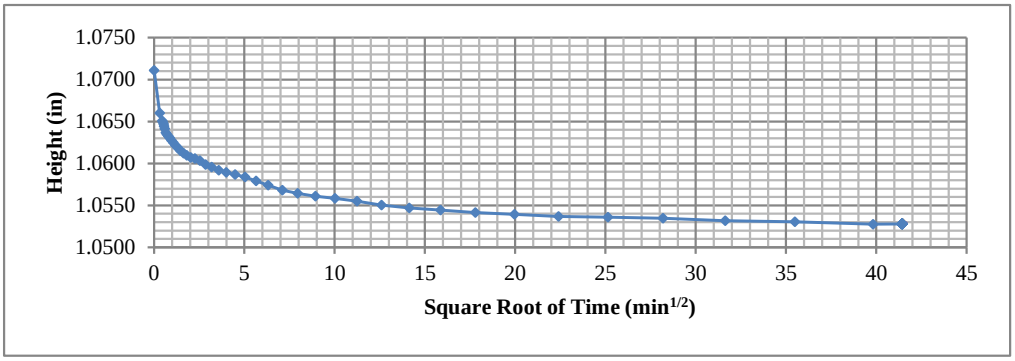
Job Short Title:					
MDA/Grassy Mtn PFS/OR					
Sample:	**Technician:**	**Reviewed:**	**Start Date:**	**Job Number:**	**Figure:**
BH-6 / S2 @ 10.0 - 11.5 ft.	PRH	MK	27-Mar-2018	1663241.11000	1



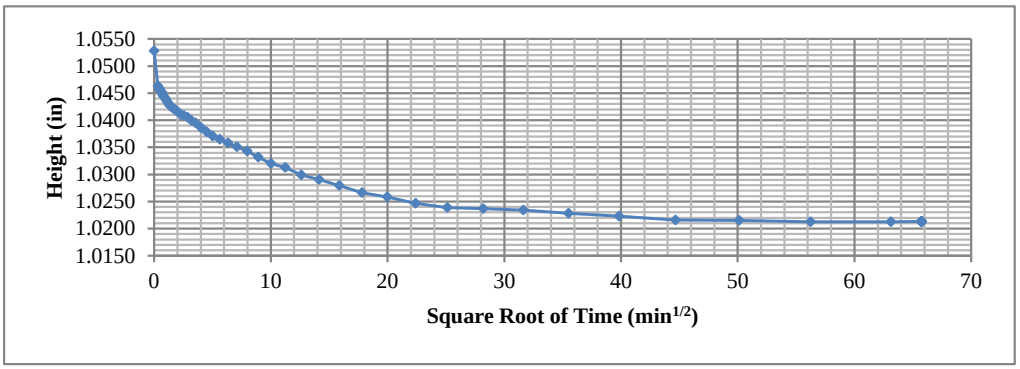


Golder Associates Inc.	**Title:** ASTM D2435 ONE-DIMENSIONAL CONSOLIDATION TEST REPORT CONSOLIDATION PLOTS				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S2 @ 10.0 - 11.5 ft.	**Technician:** PRH	**Reviewed:** MK	**Start Date:** 27-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 2

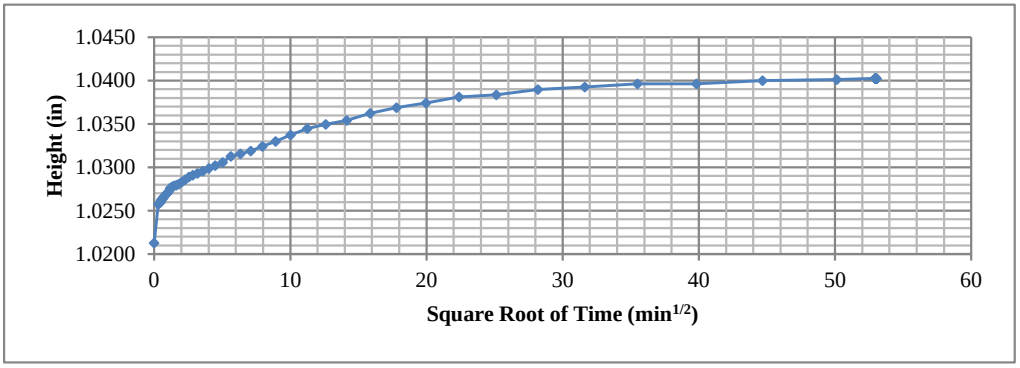
8.0 ksf



16.0 ksf

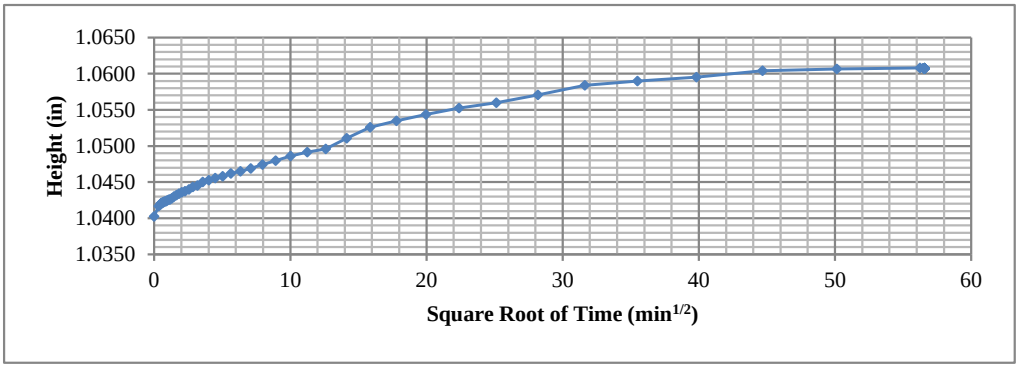


4.0 ksf - Rebound

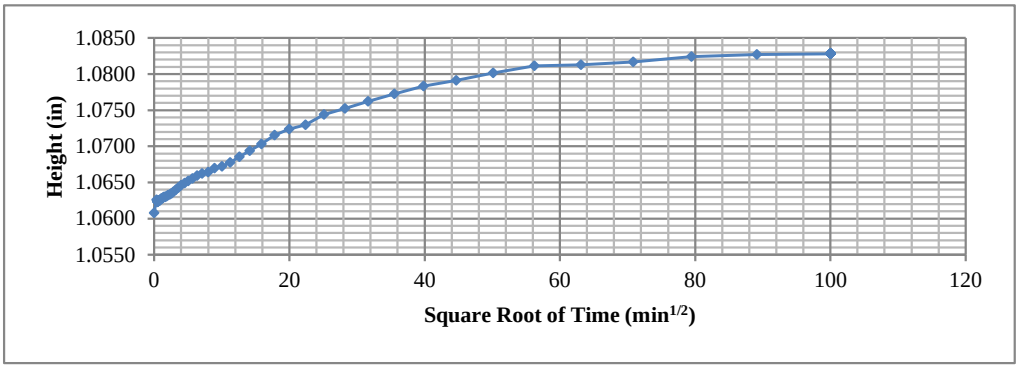


Golder Associates Inc.	**Title:** ASTM D2435 ONE-DIMENSIONAL CONSOLIDATION TEST REPORT TIME-DEFORMATION PLOTS (1)				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S2 @ 10.0 - 11.5 ft.	**Technician:** PRH	**Reviewed:** MK	**Start Date:** 27-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 3

1.0 ksf - Rebound



0.25 ksf - Rebound



Golder Associates Inc.	**Title:** ASTM D2435 ONE-DIMENSIONAL CONSOLIDATION TEST REPORT TIME-DEFORMATION PLOTS (2)				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-6 / S2 @ 10.0 - 11.5 ft.	**Technician:** PRH	**Reviewed:** MK	**Start Date:** 27-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 4

	Initial		Final		Notes					
Height =	1.074	in	1.072	in	USCS description (ASTM D2487):	Lean clay with sand, olive, moist				
Diameter =	2.00	in	2.00	in	Atterberg Limits (ASTM D4318):	LL = 134	PL = 40		PI = 94	
Area =	3.14	in^2	3.14	in^2	Percent Finer (ASTM D422):	3/4 in. = 100%	No. 4 = 100%		No. 200 = 81%	
Volume =	3.37	in^3	3.37	in^3	Specimen Type:	X	Intact		Reconstituted	
Water Content =	38.5%		56.3%		Remold Targets:	Not applicable				
Specific Gravity =	2.74	(Assumed)	2.74	(Assumed)	Water Content of Trimmings (ASTM D2216):	37.4%				
Height of Solids =	0.3868	in	0.3868	in	Trimming Procedure:	Specimen trimmed using a cylindrical cutting tool				
Void Ratio =	1.777		1.771		Inundation:		Not inundated	X	Inundated at	0.1 ksf
Degree of Saturation =	59.4%		87.1%		Test Method:		A	X	B	
Wet Mass =	0.166	lb	0.188	lb	Apparatus:	GeoTac automated consolidometer				
Dry Mass =	0.120	lb	0.120	lb	Final Water Content Specimen:	X	Entire		Partial	
Wet Unit Weight =	85.2	pcf	96.3	pcf	Final Differential Height:	-0.0084 in				
Dry Unit Weight =	61.5	pcf	61.6	pcf	Estimated Preconsolidation Stress:	--				

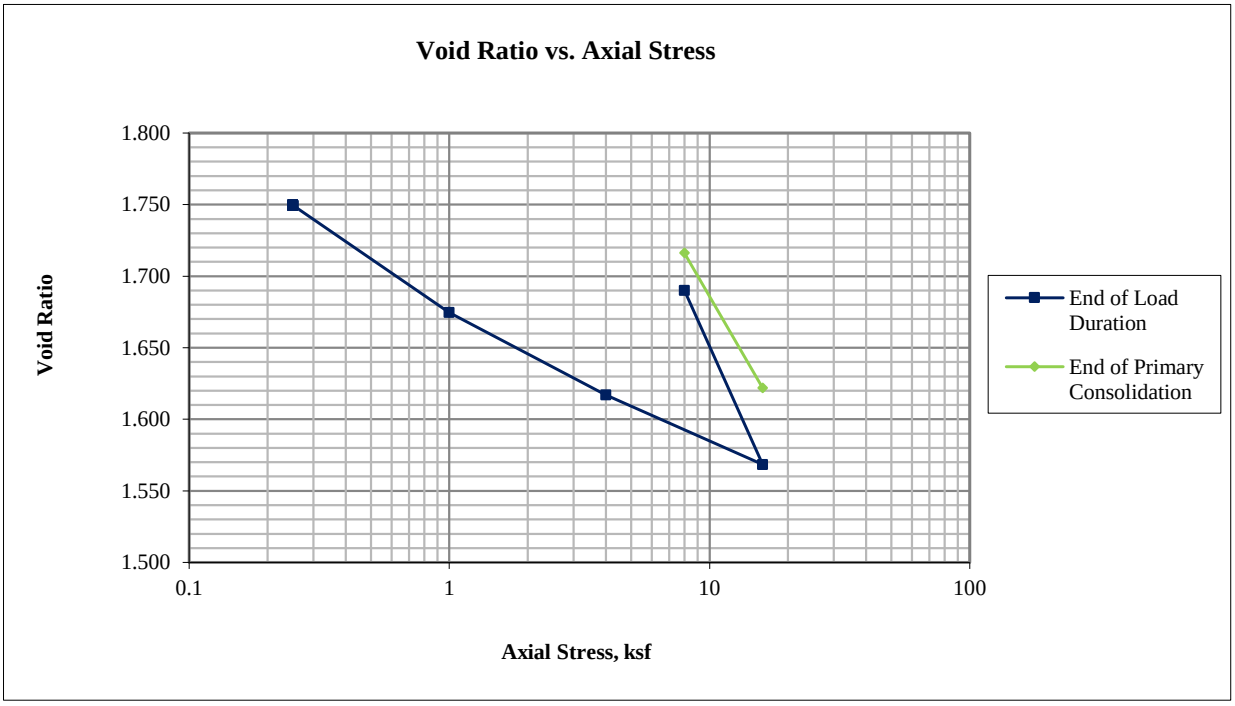
			At End of Primary Consolidation				At End of Load Duration							
	Axial Stress (ksf)	Load Duration (min)	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Time Deformation Method	Average Void Ratio	Coefficient of Consolidation (ft^2/day)	Time to 50% Consolidation (min)
Seating*	2.84	1451					0.0000	1.0740	0.00	1.777				
1	8.00	1636	0.0234	1.0507	2.18	1.716	0.0335	1.0405	3.12	1.690	2 (Root time)	1.746	8.205	0.05
2	16.00	2880	0.0599	1.0142	5.58	1.622	0.0805	0.9935	7.50	1.568	2 (Root time)	1.656	11.049	0.04
3	4.00	1440					0.0618	1.0123	5.75	1.617				
4	1.00	2880					0.0395	1.0346	3.67	1.675				
5	0.25	14400					0.0104	1.0636	0.97	1.750				

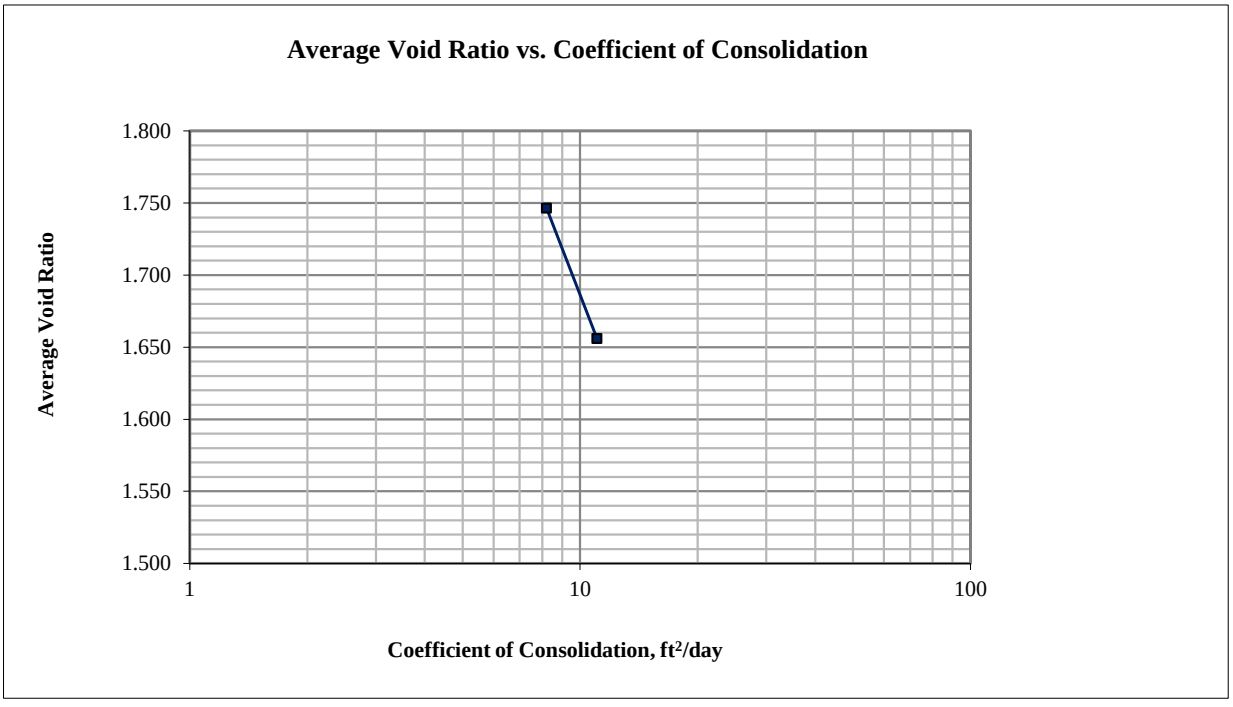
*Axial stress of 2.84 ksf was required to prevent swelling.

Golder Associates Inc.

Title:
ASTM D2435
ONE-DIMENSIONAL CONSOLIDATION TEST REPORT
SPECIMEN AND SUMMARY DATA

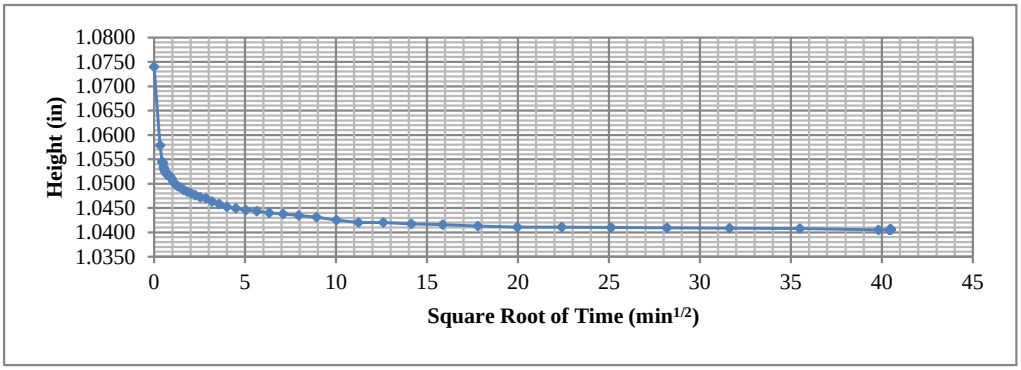
Job Short Title:					
MDA/Grassy Mtn PFS/OR					
Sample:	**Technician:**	**Reviewed:**	**Start Date:**	**Job Number:**	**Figure:**
BH-15 / S1 @ 15.0 - 16.5 ft.	PRH	MK	27-Mar-2018	1663241.11000	1



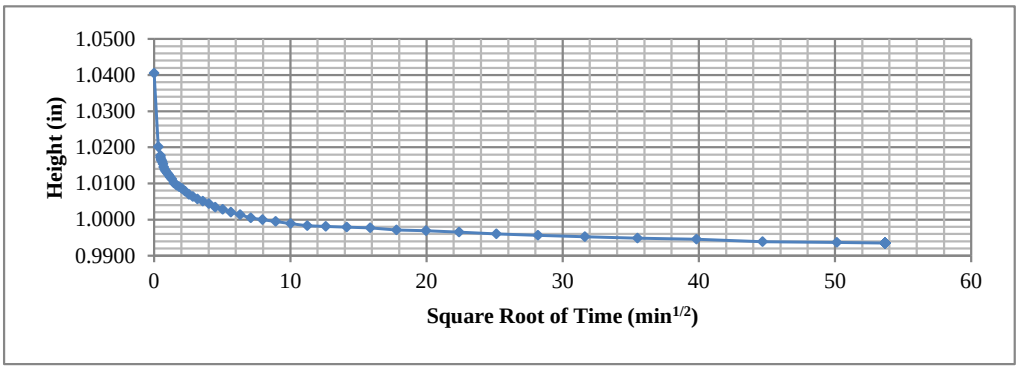


Golder Associates Inc.	**Title:** ASTM D2435 ONE-DIMENSIONAL CONSOLIDATION TEST REPORT CONSOLIDATION PLOTS				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S1 @ 15.0 - 16.5 ft.	**Technician:** PRH	**Reviewed:** MK	**Start Date:** 27-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 2

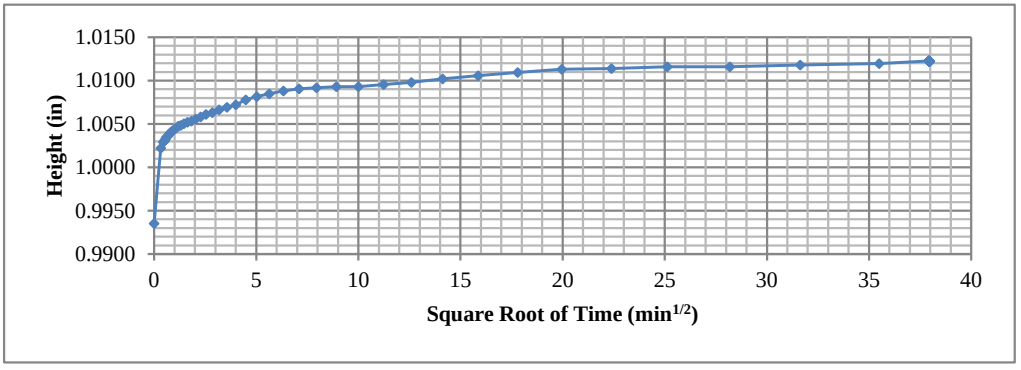
8.0 ksf



16.0 ksf

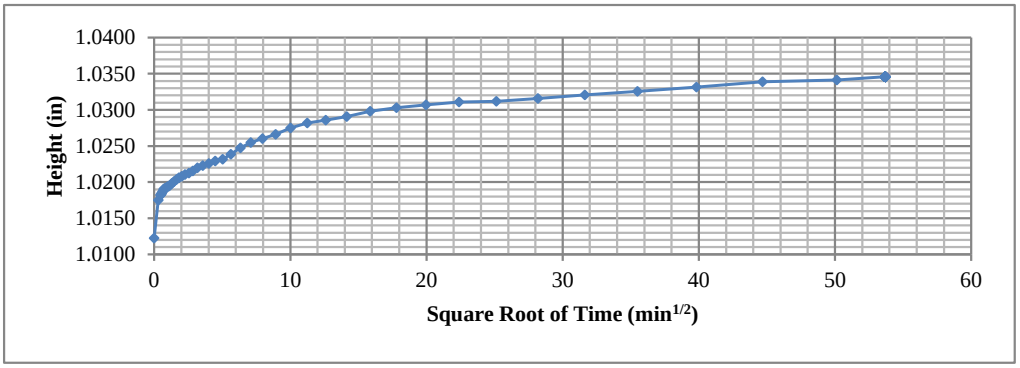


4.0 ksf - Rebound

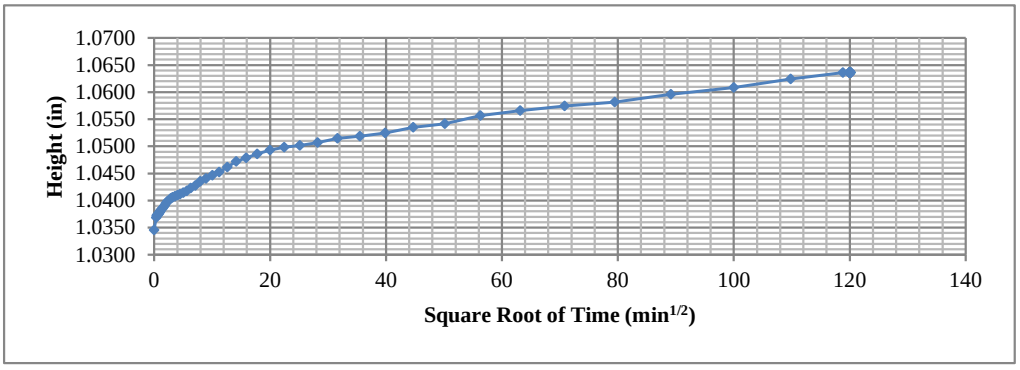


Golder Associates Inc.	**Title:** ASTM D2435 ONE-DIMENSIONAL CONSOLIDATION TEST REPORT TIME-DEFORMATION PLOTS (1)				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S1 @ 15.0 - 16.5 ft.	**Technician:** PRH	**Reviewed:** MK	**Start Date:** 27-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 3

1.0 ksf - Rebound



0.25 ksf - Rebound



Golder Associates Inc.	**Title:** ASTM D2435 ONE-DIMENSIONAL CONSOLIDATION TEST REPORT TIME-DEFORMATION PLOTS (2)				
Job Short Title: MDA/Grassy Mtn PFS/OR					
Sample: BH-15 / S1 @ 15.0 - 16.5 ft.	**Technician:** PRH	**Reviewed:** MK	**Start Date:** 27-Mar-2018	**Job Number:** 1663241.11000	**Figure:** 4

GOLDER

	Initial		Final		Notes
Height =	1.003	in	0.960	in	USCS description (ASTM D2487): Fat clay, olive brown, moist
Diameter =	2.42	in	2.42	in	Atterberg Limits (ASTM D4318): LL = 99 PL = 31 PI = 68
Area =	4.60	in^2	4.60	in^2	Percent Finer (ASTM D422): 3/4 in. = 100% No. 4 = 100% No. 200 = 97%
Volume =	4.61	in^3	4.42	in^3	Specimen Type: [X] Intact [ ] Reconstituted
Water Content =	51.5%		55.3%		Remold Targets: Not applicable
Specific Gravity =	2.69	(ASTM D854)	2.69	(ASTM D854)	Water Content of Trimmings (ASTM D2216): 45.1%
Height of Solids =	0.391	in	0.391	in	Trimming Procedure: Specimen trimmed using cylindrical trimming tool
Void Ratio =	1.567		1.457		Inundation: [ ] Not inundated [X] Inundated at 0.1 ksf
Degree of Saturation =	88.5%		102.1%		Test Method: [ ] A [X] B
Wet Mass =	0.264	lb	0.271	lb	Apparatus: Frame No. 5
Dry Mass =	0.174	lb	0.174	lb	Final Water Content Specimen: [X] Entire [ ] Partial
Wet Unit Weight =	99.0	pcf	106.0	pcf	Final Differential Height: 0.0018 in
Dry Unit Weight =	65.3	pcf	68.2	pcf	Estimated Preconsolidation Stress: -- ksf

			At End of Primary Consolidation				At End of Load Duration							
	Axial Stress (ksf)	Load Duration (min)	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Time Deformation Method	Average Void Ratio	Coefficient of Consolidation (ft^2/day)	Time to 50% Consolidation (min)
Seating*	2.14	1440					0.0000	1.0055	0.00	1.573				
1	4.0	1440	0.0109	0.9946	1.09	1.545	0.0116	0.9939	1.16	1.543	1 (Log time)	1.555	0.046	10.6
2	8.0	1440	0.0390	0.9665	3.89	1.473	0.0405	0.9650	4.04	1.469	1 (Log time)	1.495	0.054	8.6
3	16.0	1440	0.0750	0.9305	7.48	1.381	0.0760	0.9295	7.58	1.379	1 (Log time)	1.414	0.011	39.0
4	32.0	2880	0.1175	0.8880	11.71	1.272	0.1190	0.8865	11.86	1.268	1 (Log time)	1.318	0.003	160.0
5	64.0	2880	0.1646	0.8409	16.41	1.152	0.1671	0.8384	16.66	1.145	1 (Log time)	1.208	0.002	206.0
6	16.0	2940					0.1315	0.8740	13.11	1.237				
7	4.0	2880					0.0905	0.9150	9.02	1.341				
8	1.0	5400					0.0437	0.9618	4.36	1.461				

*Axial stress of 2.14 ksf was required to prevent swelling.

Project Name: MDA/Grassy Mtn PFS/OR

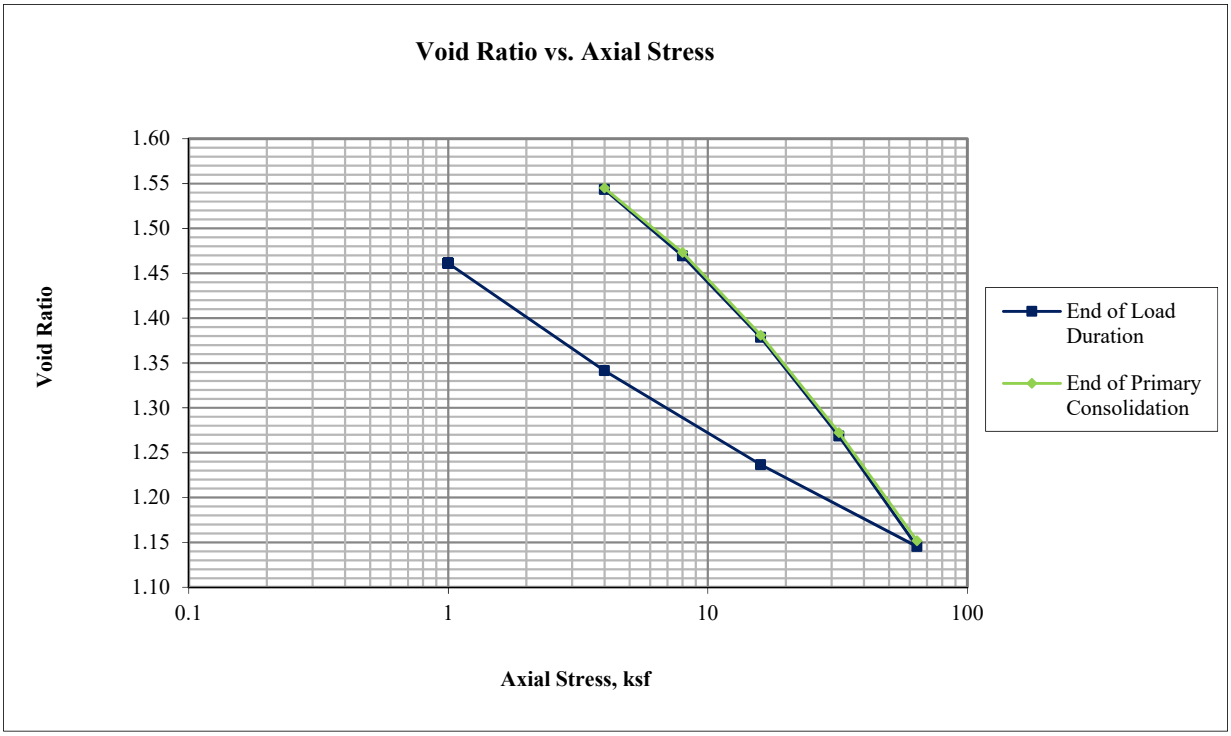
Project Number: 1663241.22000

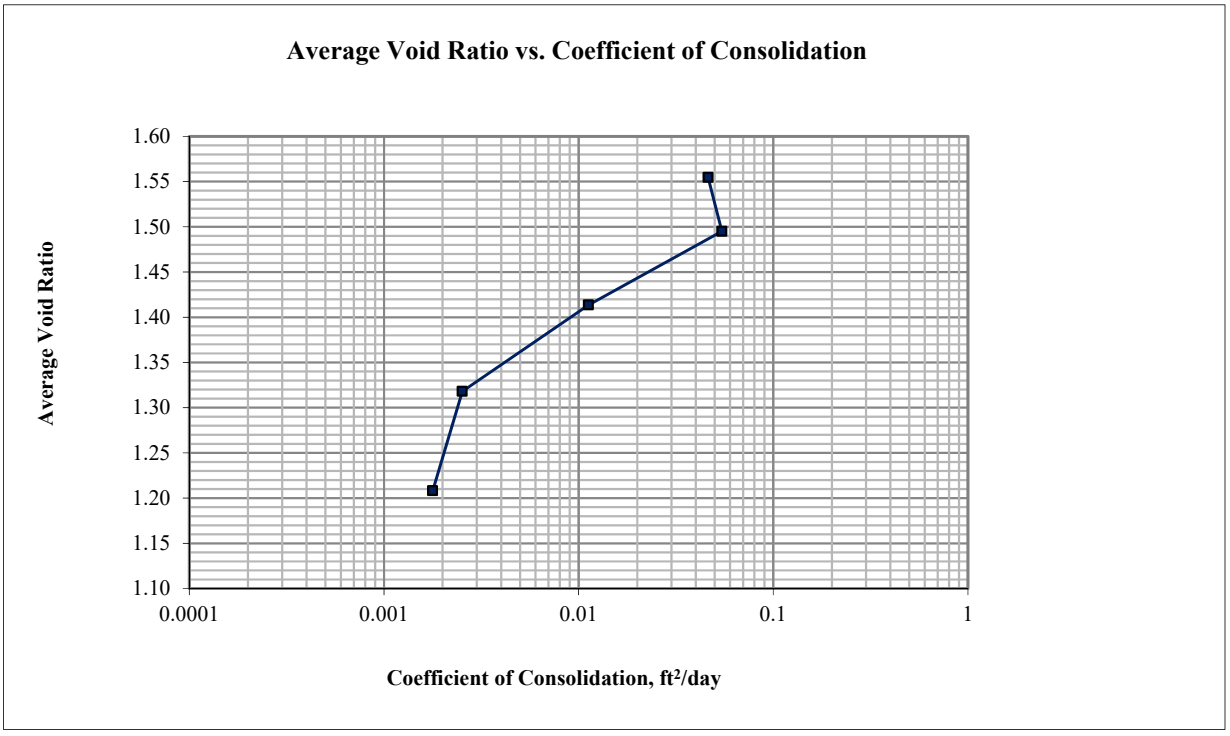
ASTM D2435

ONE-DIMENSIONAL CONSOLIDATION TEST REPORT SPECIMEN AND SUMMARY DATA

Sample ID:	Technician:	Checked:	Reviewed:	Date:	Figure:
BH19-TP-23 @ 30 - 30.5 ft.	PRH	PRH	CPA	13-Aug-2019	1

GOLDER

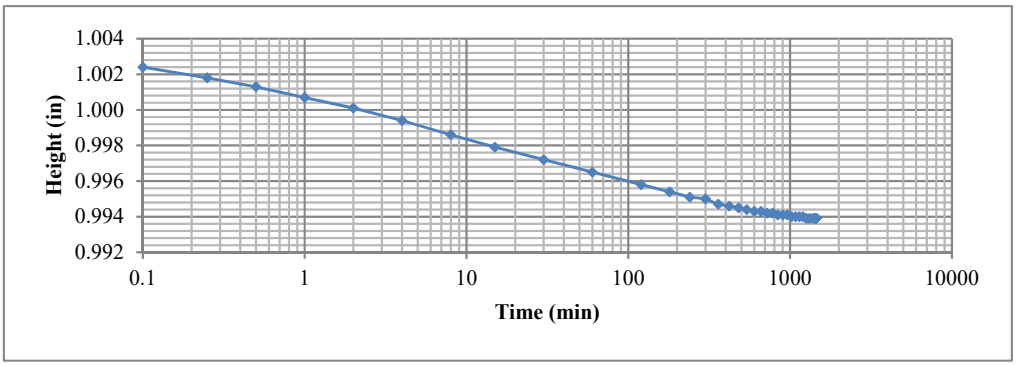




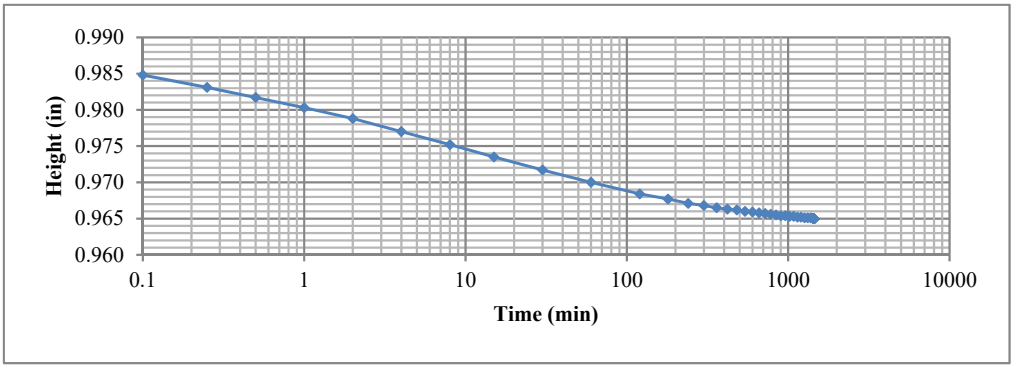
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION TEST REPORT CONSOLIDATION PLOTS				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 30 - 30.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 13-Aug-2019	**Figure:** 2

GOLDER

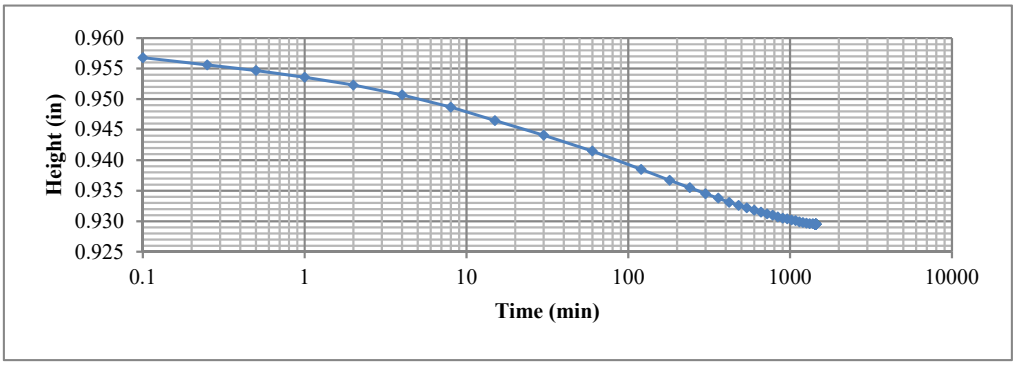
4.0 ksf



8.0 ksf



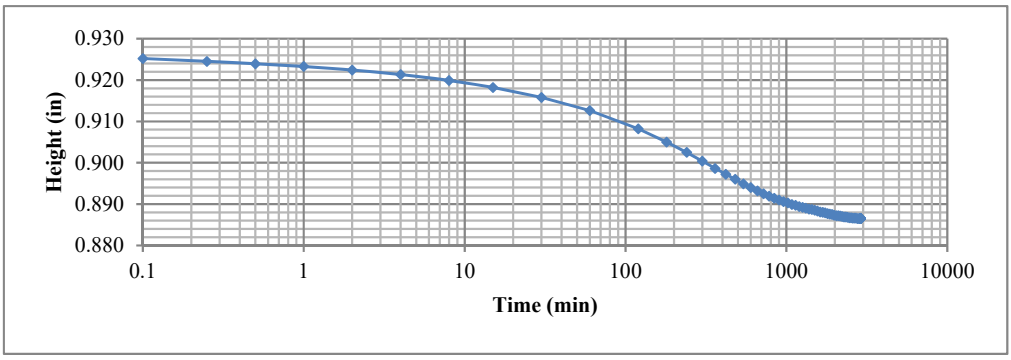
16.0 ksf



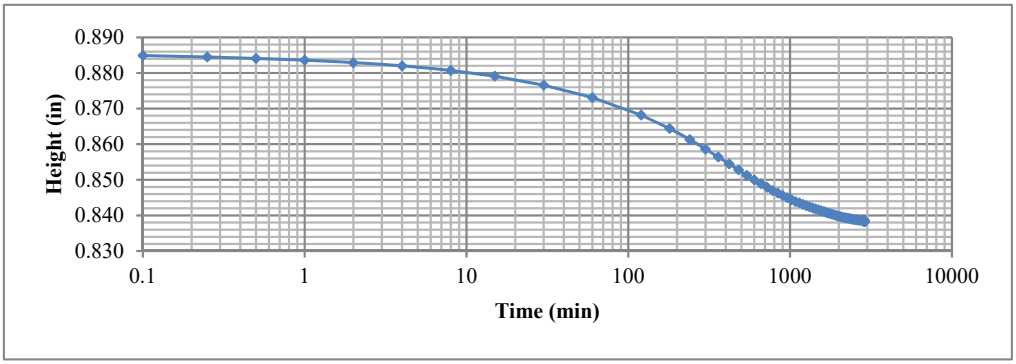
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (1)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 30 - 30.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 13-Aug-2019	**Figure:** 3

GOLDER

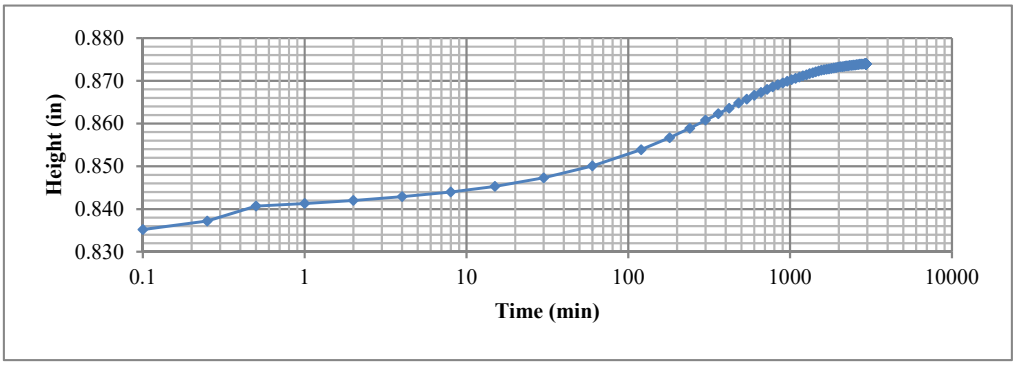
32.0 ksf



64.0 ksf

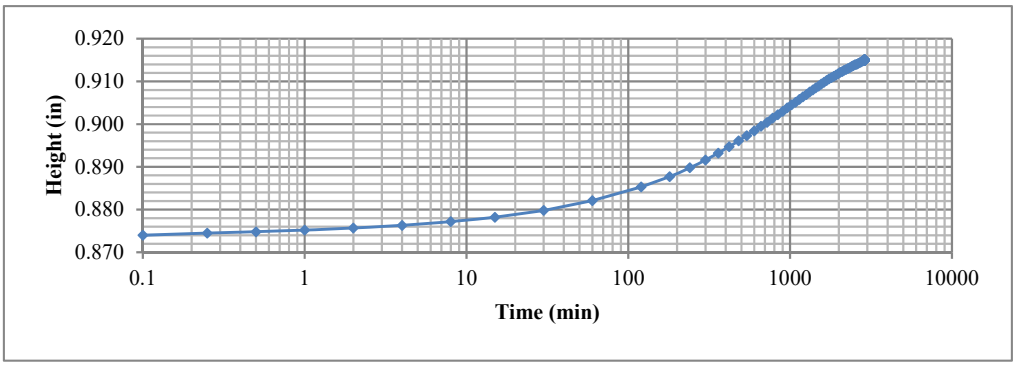


16.0 ksf - Unload

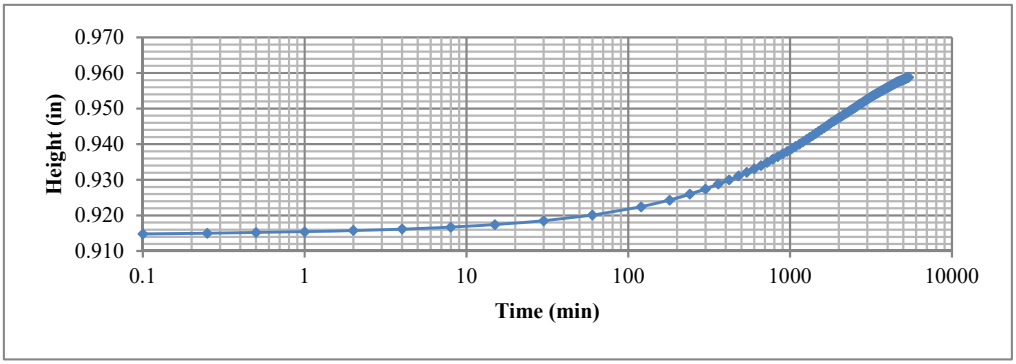


Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (2)					
Project Number: 1663241.22000						
Sample ID: BH19-TP-23 @ 30 - 30.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 13-Aug-2019	**Figure:** 4	

4.0 ksf - Unload



1.0 ksf - Unload



Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (3)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 30 - 30.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 13-Aug-2019	**Figure:** 5

GOLDER

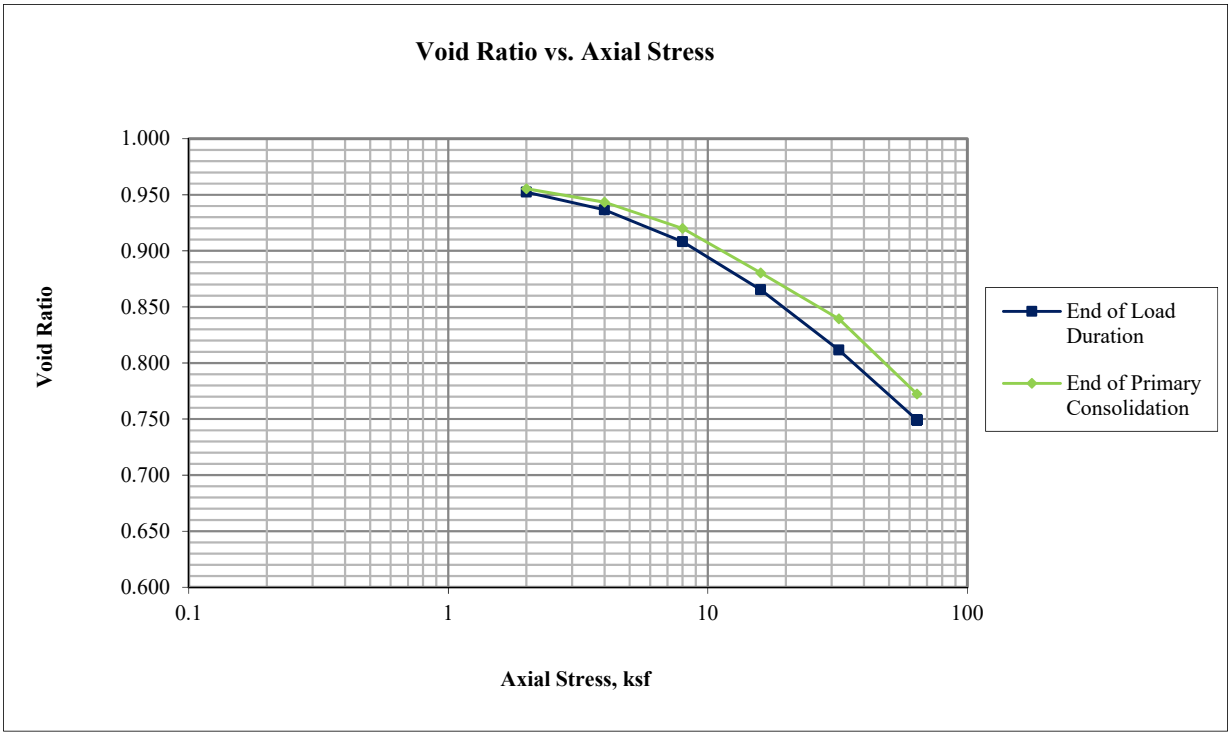
	Initial		Final		Notes
Height =	1.003	in	0.925	in	USCS description (ASTM D2487): Lean clay, pale brown, moist
Diameter =	2.420	in	2.420	in	Atterberg Limits (ASTM D4318): LL = 49 PL = 23 PI = 26
Area =	4.600	in^2	4.600	in^2	Percent Finer (ASTM D422): 3/4 in. = 100% No. 4 = 100% No. 200 = 93%
Volume =	4.613	in^3	4.255	in^3	Specimen Type: [X] Intact [ ] Reconstituted
Water Content =	31.0%		29.5%		Remold Targets: Not applicable
Specific Gravity =	2.66	(ASTM D854)	2.66	(ASTM D854)	Water Content of Trimmings (ASTM D2216): 29.6%
Height of Solids =	0.5133	in	0.5133	in	Trimming Procedure: Specimen trimmed using cylindrical cutting tool
Void Ratio =	0.954		0.802		Inundation: [ ] Not inundated [X] Inundated at 0.1 ksf
Degree of Saturation =	86.5%		97.8%		Test Method: [ ] A [X] B
Wet Mass =	0.297	lb	0.293	lb	Apparatus: Frame No. 5
Dry Mass =	0.226	lb	0.226	lb	Final Water Content Specimen: [X] Entire [ ] Partial
Wet Unit Weight =	111.2	pcf	119.1	pcf	Final Differential Height: -0.0271 in
Dry Unit Weight =	84.8	pcf	92.0	pcf	Estimated Preconsolidation Stress: 10.4 ksf

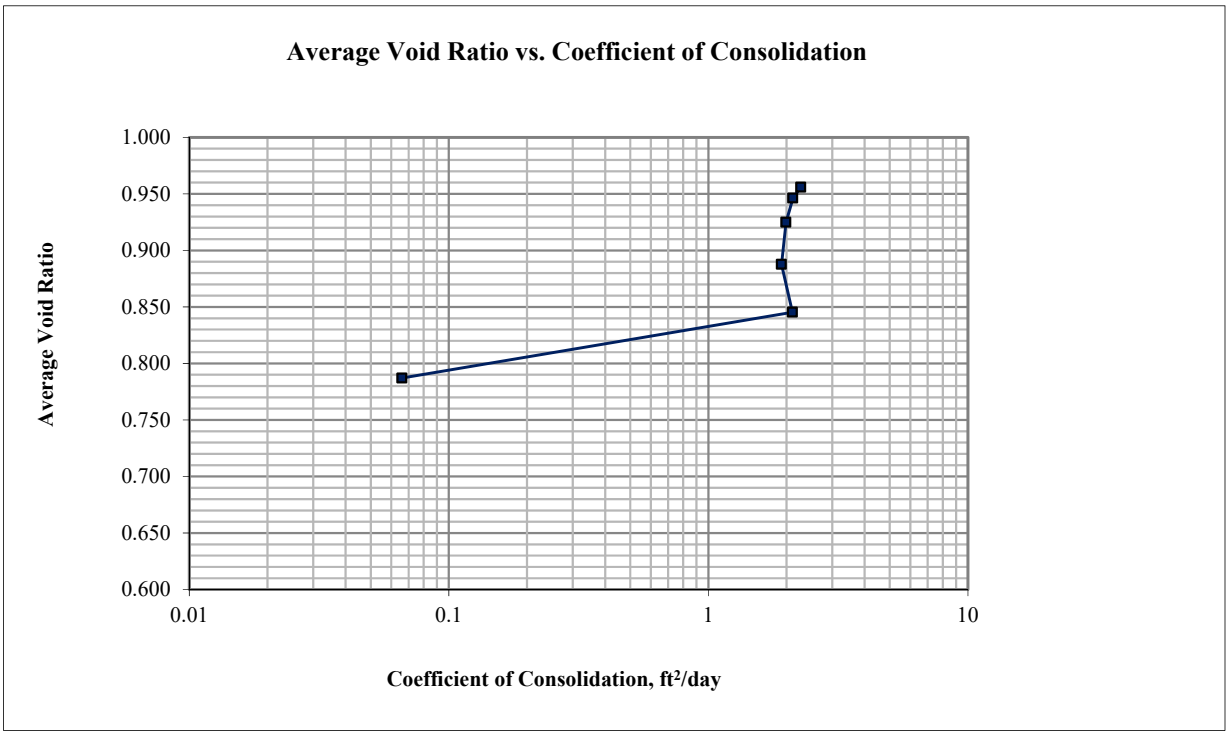
			At End of Primary Consolidation				At End of Load Duration							
	Axial Stress (ksf)	Load Duration (min)	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Time Deformation Method	Average Void Ratio	Coefficient of Consolidation (ft^2/day)	Time to 50% Consolidation (min)
Seating*	1.47	1380					0.0000	1.0045	0.00	0.957				
1	2.0	1440	0.0007	1.0038	0.07	0.955	0.0023	1.0022	0.23	0.952	2 (Root time)	0.956	2.271	0.2
2	4.0	1430	0.0069	0.9976	0.69	0.943	0.0104	0.9941	1.04	0.937	2 (Root time)	0.946	2.116	0.2
3	8.0	1440	0.0189	0.9856	1.88	0.920	0.0250	0.9795	2.49	0.908	2 (Root time)	0.925	1.989	0.2
4	16.0	1800	0.0392	0.9653	3.91	0.880	0.0470	0.9575	4.69	0.865	2 (Root time)	0.888	1.913	0.2
5	32.0	5400	0.0603	0.9442	6.01	0.839	0.0746	0.9299	7.44	0.812	2 (Root time)	0.845	2.108	0.2
6	64.0	1860	0.0947	0.9098	9.44	0.772	0.1066	0.8979	10.63	0.749	2 (Root time)	0.787	0.066	6.5

*Axial stress of 1.47 ksf was required to prevent swelling.

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION TEST REPORT SPECIMEN AND SUMMARY DATA				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 45.0 - 45.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 2-Sep-2019	**Figure:** 1

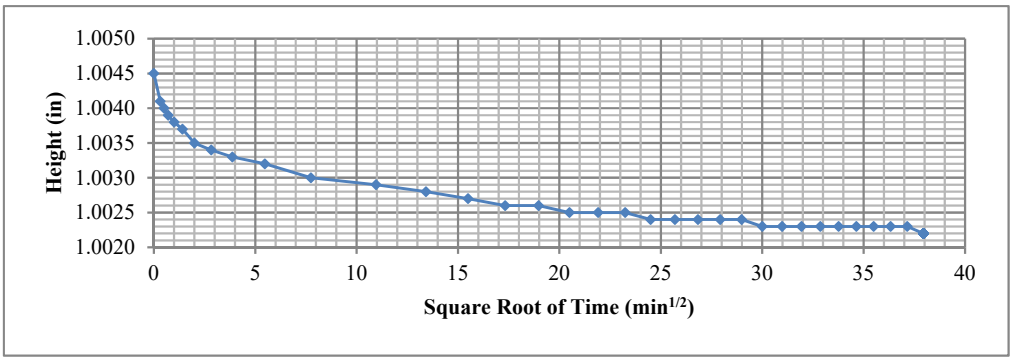
GOLDER



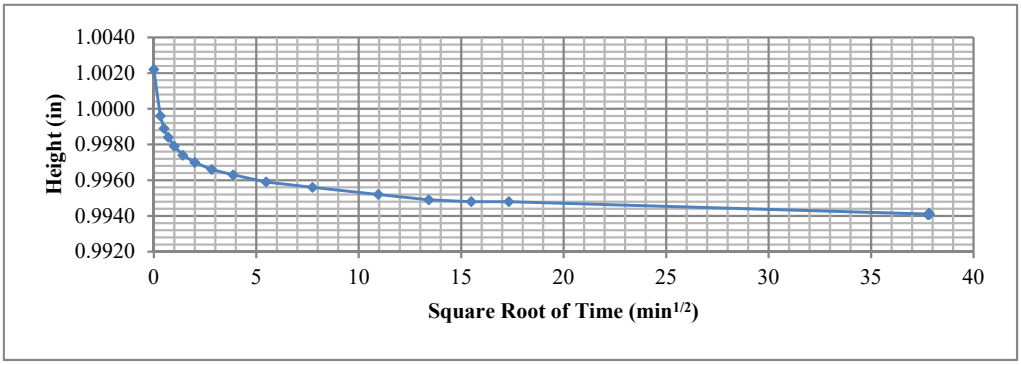


Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION TEST REPORT CONSOLIDATION PLOTS				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 45.0 - 45.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 2-Sep-2019	**Figure:** 2

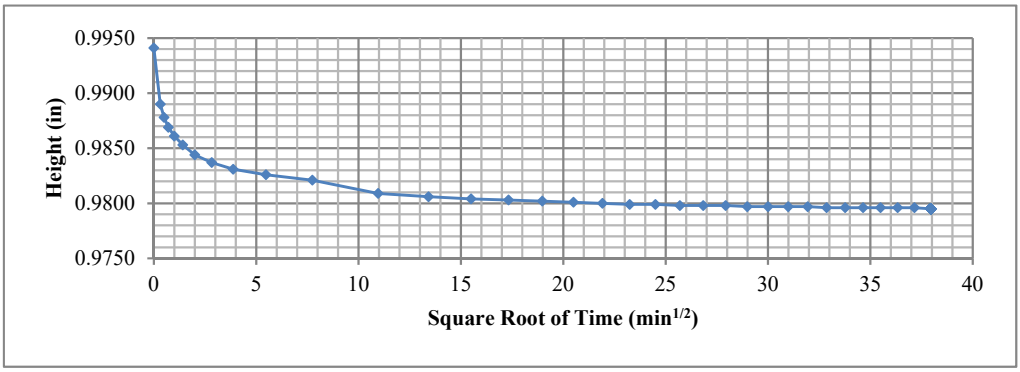
2.0 ksf



4.0 ksf



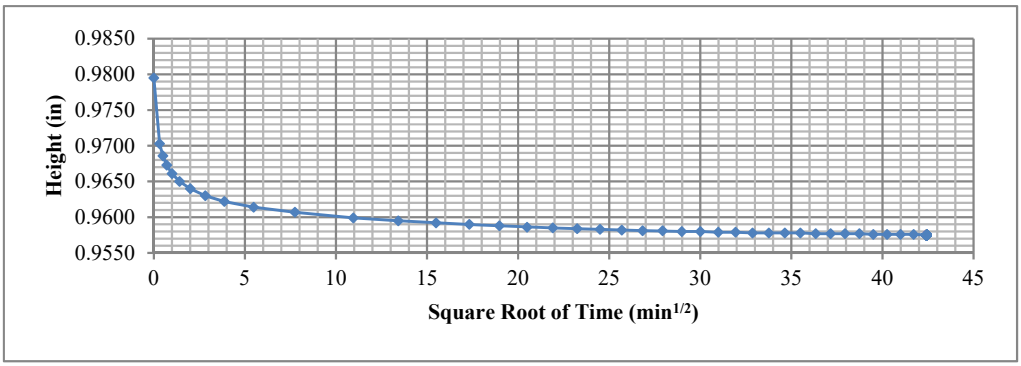
8.0 ksf



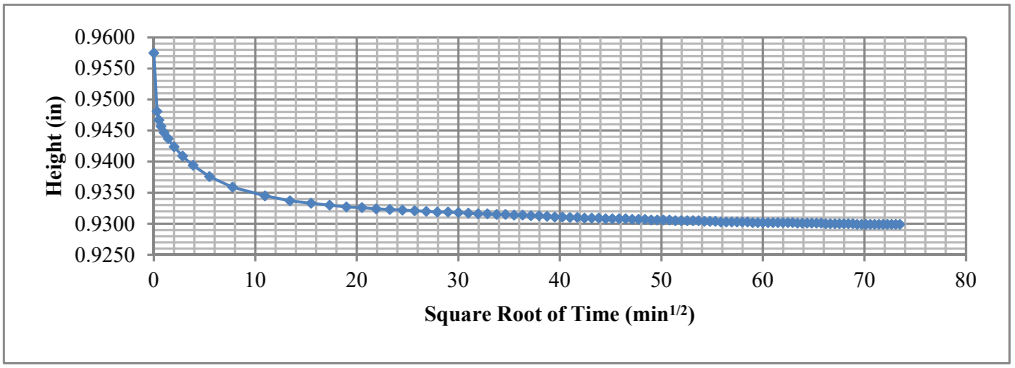
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (1)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 45.0 - 45.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 2-Sep-2019	**Figure:** 3

GOLDER

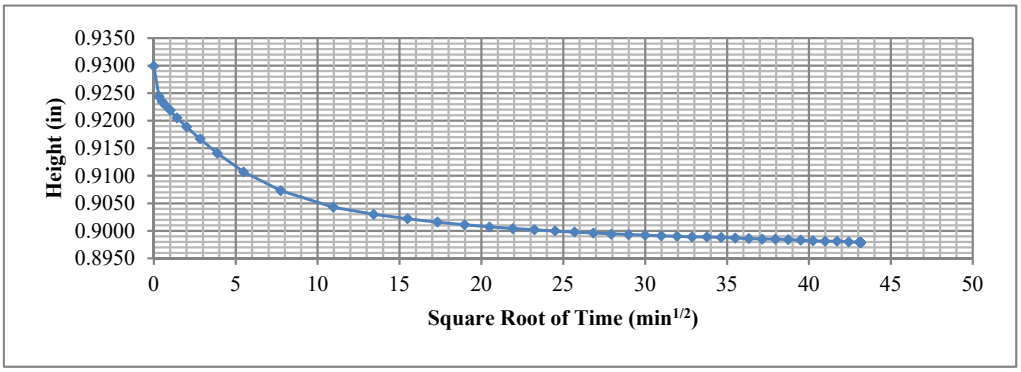
16.0 ksf



32.0 ksf



64.0 ksf



Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (2)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-23 @ 45.0 - 45.5 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 2-Sep-2019	**Figure:** 4

GOLDER

	Initial		Final		Notes
Height =	0.993	in	0.973	in	Visual description: Fat clay, some sand, light gray, moist
Diameter =	2.500	in	2.500	in	Atterberg Limits (ASTM D4318): LL = -- PL = -- PI = --
Area =	4.909	in^2	4.909	in^2	Percent Finer (ASTM D422): 3/4 in. = -- No. 4 = -- No. 200 = --
Volume =	4.874	in^3	4.776	in^3	Specimen Type: X Intact ___ Reconstituted
Water Content =	43.2%		45.7%		Remold Targets: Not applicable
Specific Gravity =	2.81	(ASTM D854)	2.81	(ASTM D854)	Water Content of Trimmings (ASTM D2216): 37.9%
Height of Solids =	0.419	in	0.419	in	Trimming Procedure: Specimen trimmed using cylindrical cutting tool
Void Ratio =	1.368		1.320		Inundation: ___ Not inundated X Inundated at 0.1 ksf
Degree of Saturation =	88.8%		97.3%		Test Method: ___ A X B
Wet Mass =	0.299	lb	0.304	lb	Apparatus: Frame No. 6
Dry Mass =	0.209	lb	0.209	lb	Final Water Content Specimen: X Entire ___ Partial
Wet Unit Weight =	105.9	pcf	110.0	pcf	Final Differential Height: -0.0081 in
Dry Unit Weight =	74.0	pcf	75.5	pcf	Estimated Preconsolidation Stress: -- ksf

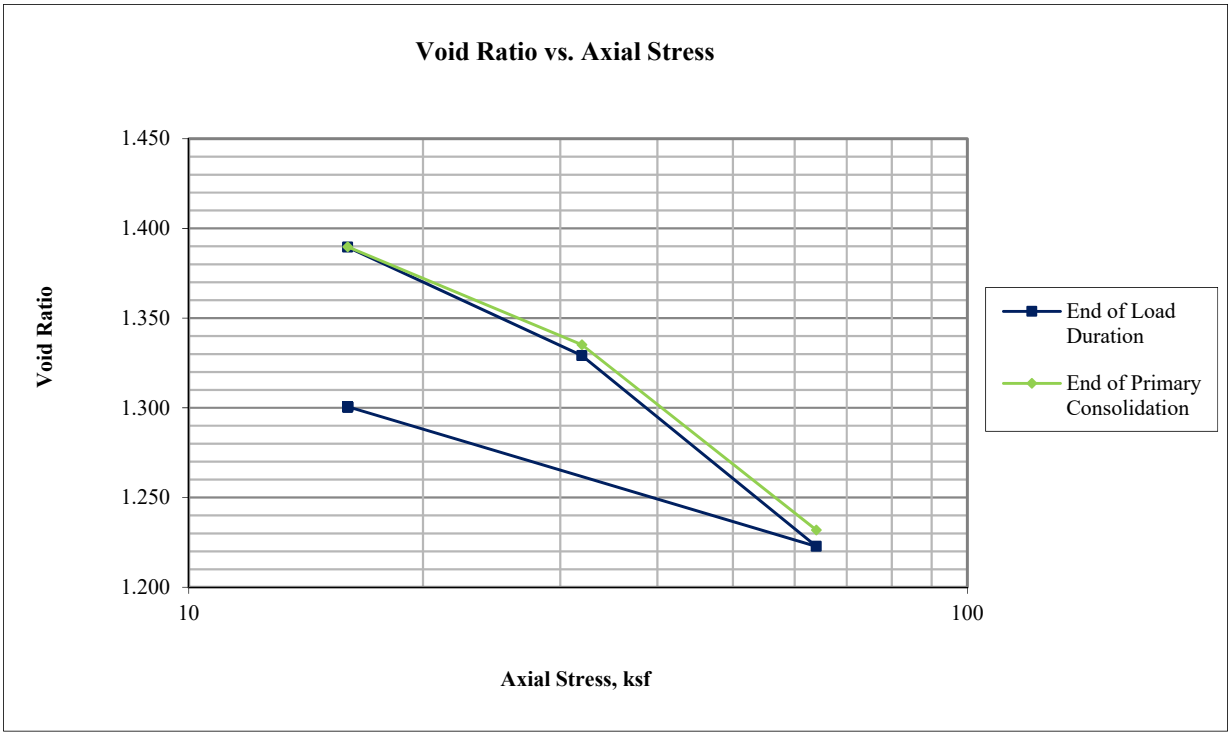
-- indicates test was not performed

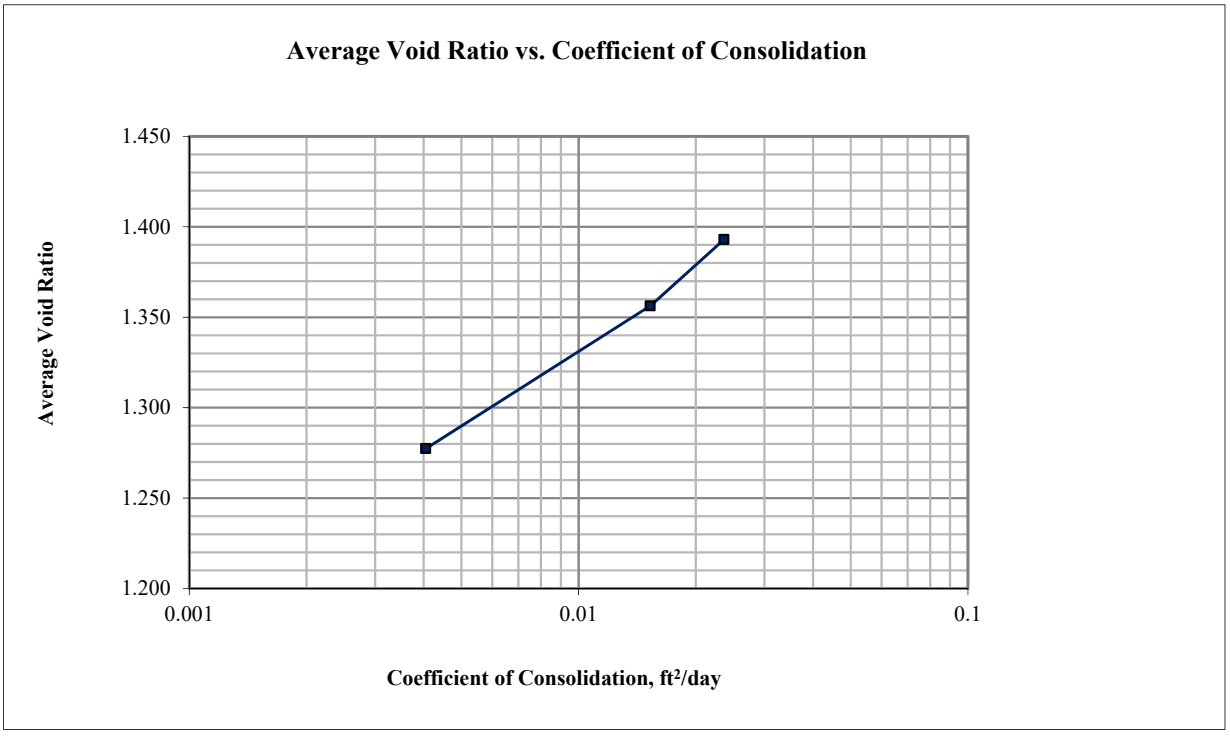
			At End of Primary Consolidation				At End of Load Duration							
	Axial Stress (ksf)	Load Duration (min)	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Time Deformation Method	Average Void Ratio	Coefficient of Consolidation (ft^2/day)	Time to 50% Consolidation (min)
Seating*	12.3	1425					0.0000	1.0049	0.00	1.396				
1	16.0	1320	0.0026	1.0023	0.26	1.390	0.0027	1.0022	0.27	1.390	1 (Log time)	1.393	0.024	21.0
2	32.0	4260	0.0255	0.9794	2.56	1.335	0.0280	0.9769	2.82	1.329	1 (Log time)	1.356	0.015	31.5
3	64.0	3000	0.0688	0.9361	6.92	1.232	0.0726	0.9323	7.31	1.223	1 (Log time)	1.277	0.004	111.0
4	16.0	1860					0.0400	0.9649	4.02	1.301				

*Axial stress of 12.3 ksf was required to prevent swelling.

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION TEST REPORT SPECIMEN AND SUMMARY DATA				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 20 - 22 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Sep-2019	**Figure:** 1

GOLDER

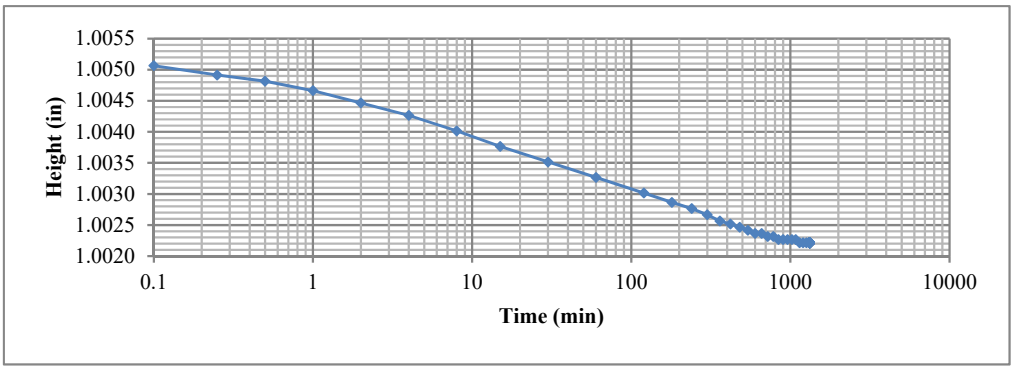




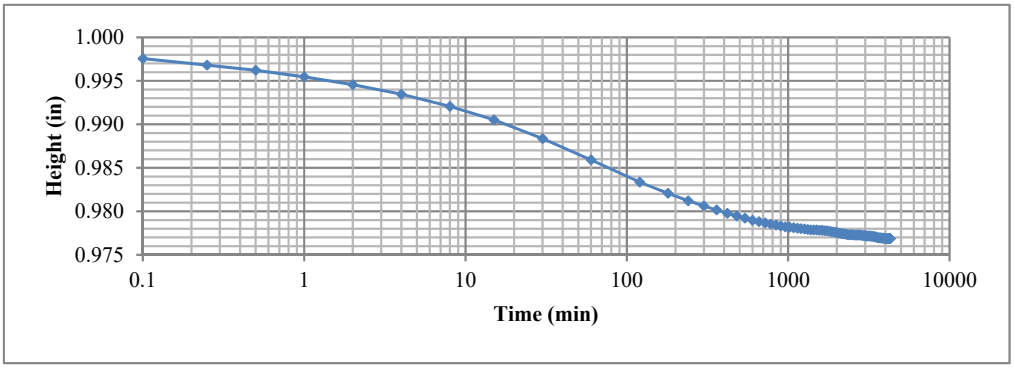
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION TEST REPORT CONSOLIDATION PLOTS				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 20 - 22 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Sep-2019	**Figure:** 2

GOLDER

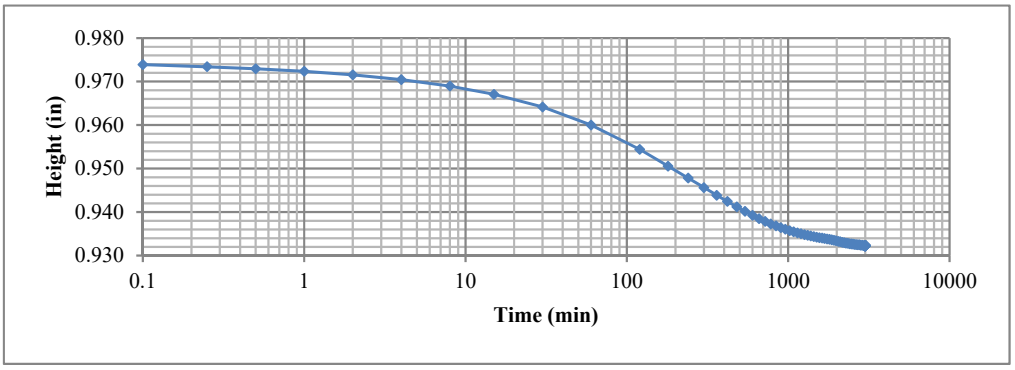
16.0 ksf



32.0 ksf

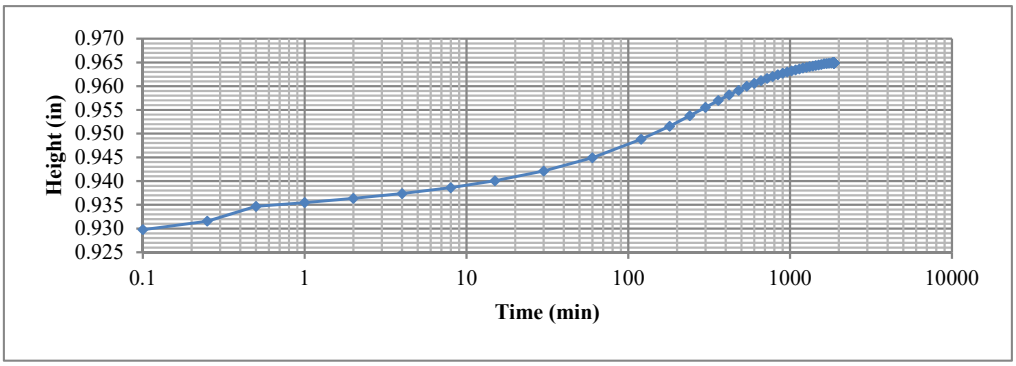


64.0 ksf



Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (1)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 20 - 22 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Sep-2019	**Figure:** 3

16.0 ksf - unload



Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (2)					
Project Number: 1663241.22000						
Sample ID: BH19-TP-44 @ 20 - 22 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 3-Sep-2019	**Figure:** 4	

GOLDER

	Initial		Final		Notes
Height =	0.995	in	0.951	in	Visual description: Fat clay, brown, moist
Diameter =	2.500	in	2.500	in	Atterberg Limits (ASTM D4318): LL = -- PL = -- PI = --
Area =	4.909	in^2	4.909	in^2	Percent Finer (ASTM D422): 3/4 in. = -- No. 4 = -- No. 200 = --
Volume =	4.884	in^3	4.668	in^3	Specimen Type: X Intact ___ Reconstituted
Water Content =	44.6%		43.0%		Remold Targets: Not applicable
Specific Gravity =	2.72	(ASTM D854)	2.72	(ASTM D854)	Water Content of Trimmings (ASTM D2216): 45.1%
Height of Solids =	0.4388	in	0.4388	in	Trimming Procedure: Specimen trimmed using cylindrical cutting tool
Void Ratio =	1.267		1.167		Inundation: ___ Not inundated X Inundated at 0.1 ksf
Degree of Saturation =	95.8%		100%		Test Method: ___ A X B
Wet Mass =	0.306	lb	0.302	lb	Apparatus: Frame No. 6
Dry Mass =	0.211	lb	0.211	lb	Final Water Content Specimen: X Entire ___ Partial
Wet Unit Weight =	108.1	pcf	111.8	pcf	Final Differential Height: -0.0056 in
Dry Unit Weight =	74.8	pcf	78.2	pcf	Estimated Preconsolidation Stress: 20.2 ksf

-- indicates test was not performed

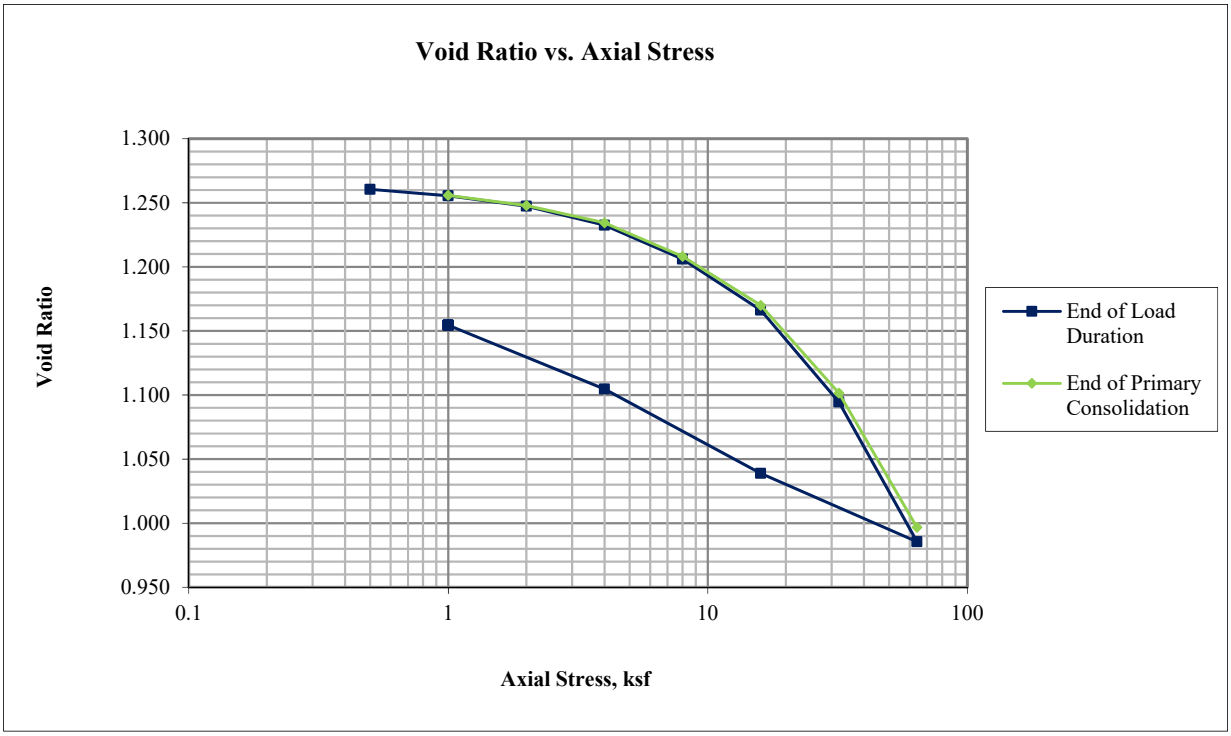
			At End of Primary Consolidation				At End of Load Duration							
	Axial Stress (ksf)	Load Duration (min)	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Time Deformation Method	Average Void Ratio	Coefficient of Consolidation (ft^2/day)	Time to 50% Consolidation (min)
Seating*	0.28	1380					0.0000	0.9932	0.00	1.263				
1	0.50	1440					0.0012	0.9920	0.12	1.260				
2	1.00	1440	0.0032	0.9899	0.33	1.256	0.0034	0.9898	0.34	1.255	1 (Log time)	1.258	0.045	10.8
3	2.00	1440	0.0067	0.9864	0.68	1.248	0.0070	0.9862	0.70	1.247	1 (Log time)	1.251	0.038	12.8
4	4.00	1440	0.0127	0.9805	1.27	1.234	0.0135	0.9797	1.36	1.232	1 (Log time)	1.239	0.030	15.7
5	8.00	1440	0.0242	0.9690	2.43	1.208	0.0251	0.9681	2.52	1.206	1 (Log time)	1.218	0.028	16.8
6	16.00	1440	0.0409	0.9522	4.11	1.170	0.0426	0.9506	4.28	1.166	1 (Log time)	1.185	0.032	14.3
7	32.00	2880	0.0710	0.9222	7.13	1.102	0.0740	0.9191	7.44	1.094	1 (Log time)	1.131	0.022	19.7
8	64.00	2940	0.1170	0.8762	11.75	0.997	0.1219	0.8713	12.25	0.986	1 (Log time)	1.043	0.006	63.0
9	16.00	1620					0.0984	0.8947	9.89	1.039				
10	4.00	2520					0.0696	0.9236	6.99	1.105				
11	1.00	2880					0.0478	0.9454	4.80	1.154				

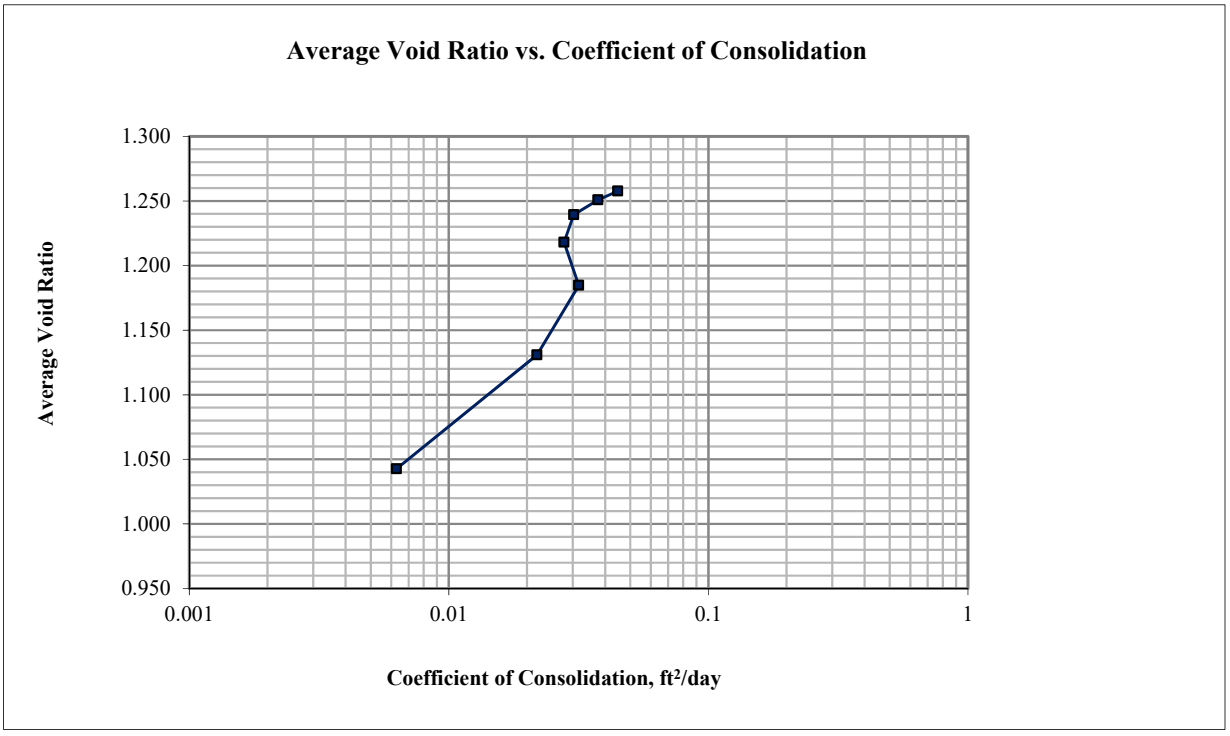
*Axial stress of 0.28 ksf was required to prevent swelling.

Specimen was initially set up for a CU triaxial test and partially saturated prior to being tested for one-dimensional consolidation properties.

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION TEST REPORT SPECIMEN AND SUMMARY DATA				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 30 - 32 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 16-Aug-2019	**Figure:** 1

GOLDER

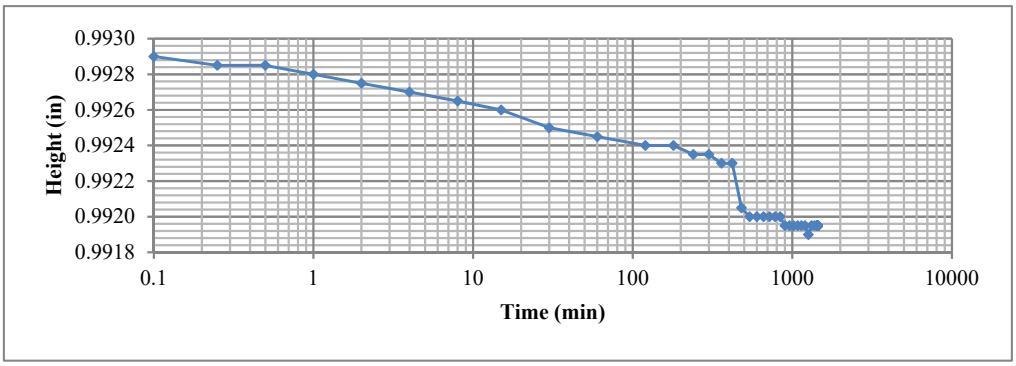




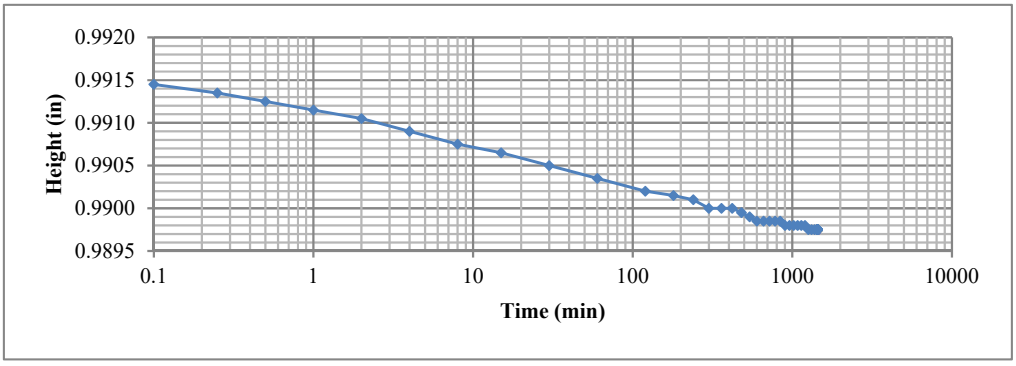
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION TEST REPORT CONSOLIDATION PLOTS				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 30 - 32 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 16-Aug-2019	**Figure:** 2

GOLDER

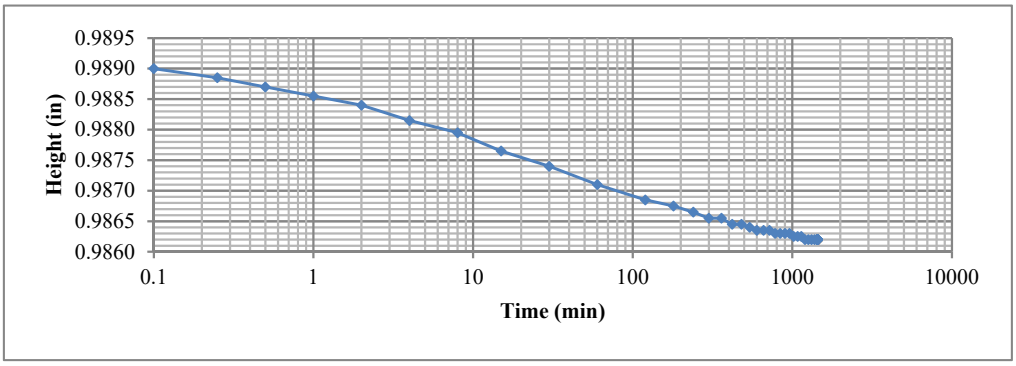
0.5 ksf



1.0 ksf



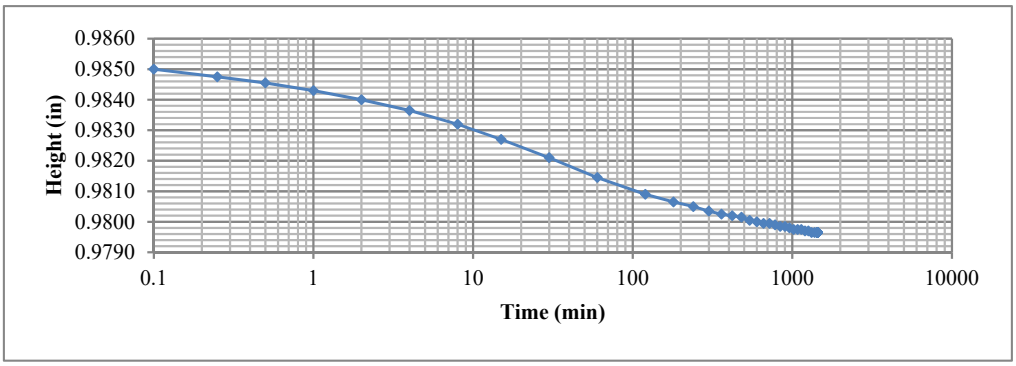
2.0 ksf



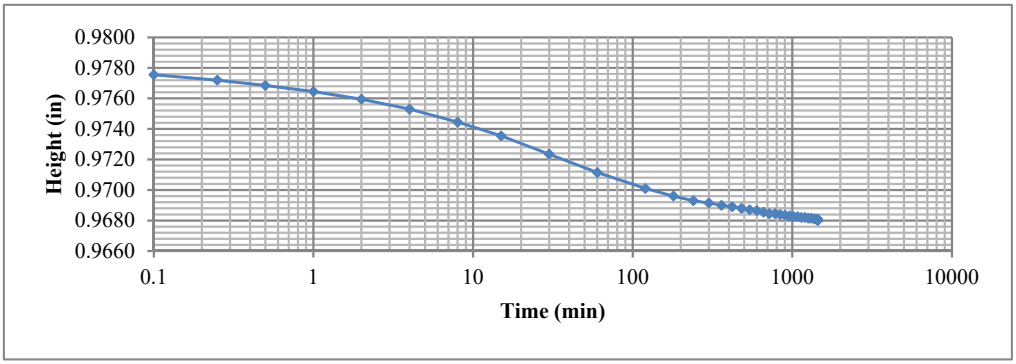
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (1)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 30 - 32 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 16-Aug-2019	**Figure:** 3

GOLDER

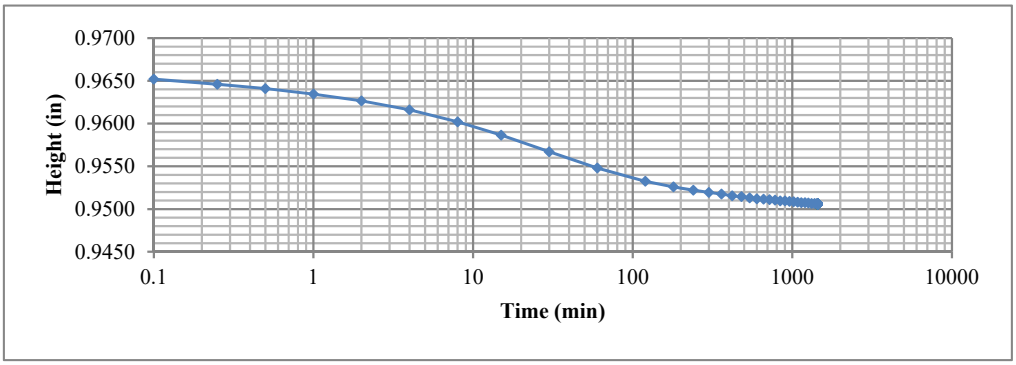
4.0 ksf



8.0 ksf



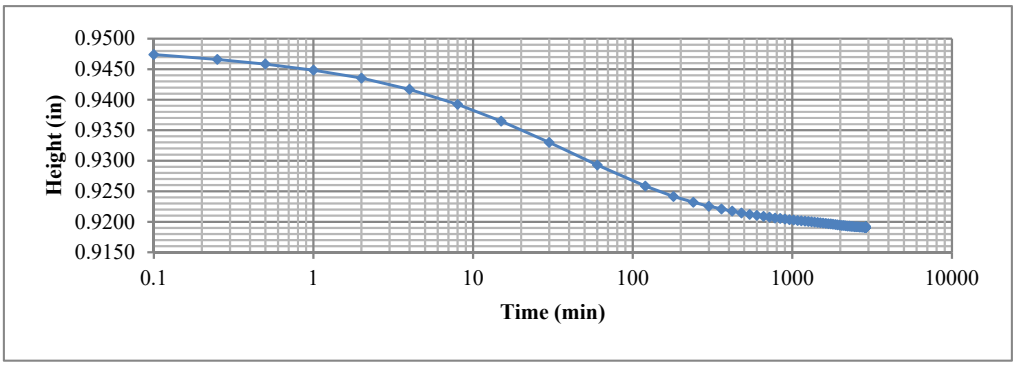
16.0 ksf



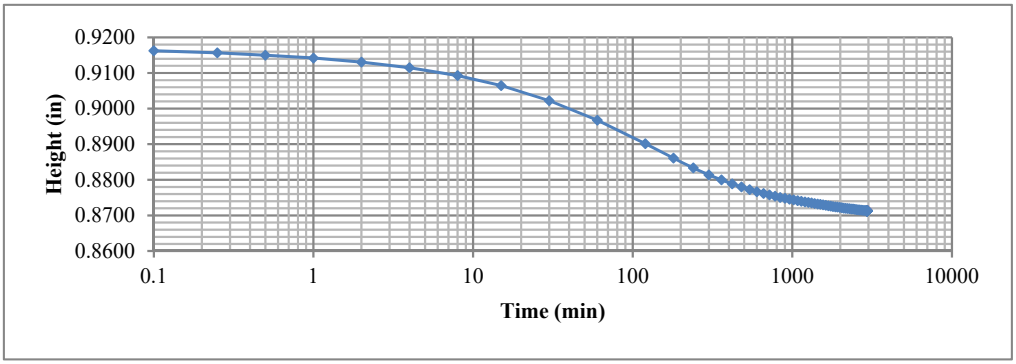
Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (2)					
Project Number: 1663241.22000						
Sample ID: BH19-TP-44 @ 30 - 32 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 16-Aug-2019	**Figure:** 4	

GOLDER

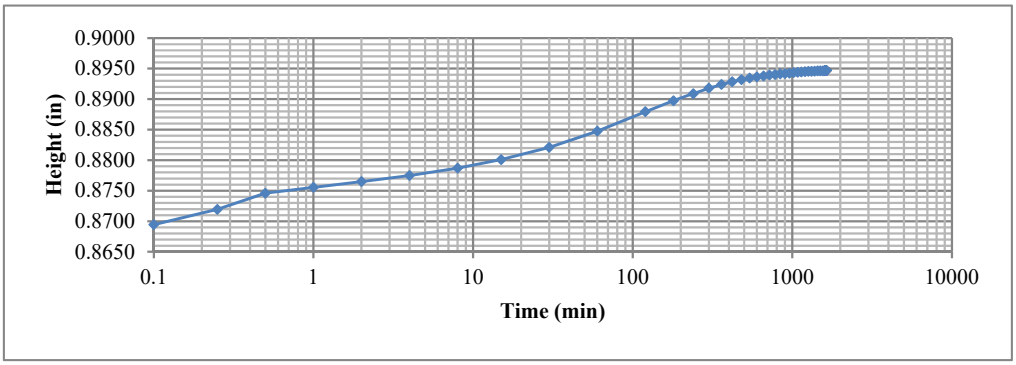
32.0 ksf



64.0 ksf

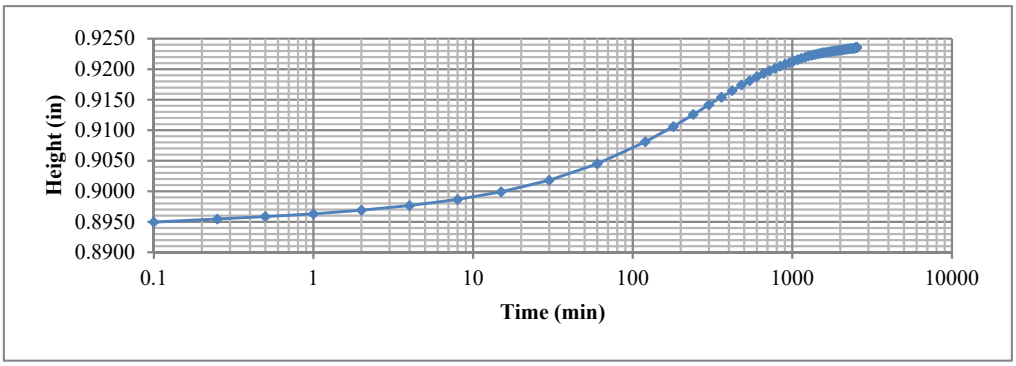


16.0 ksf - Unload



Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (3)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 30 - 32 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 16-Aug-2019	**Figure:** 5

4.0 ksf - Unload



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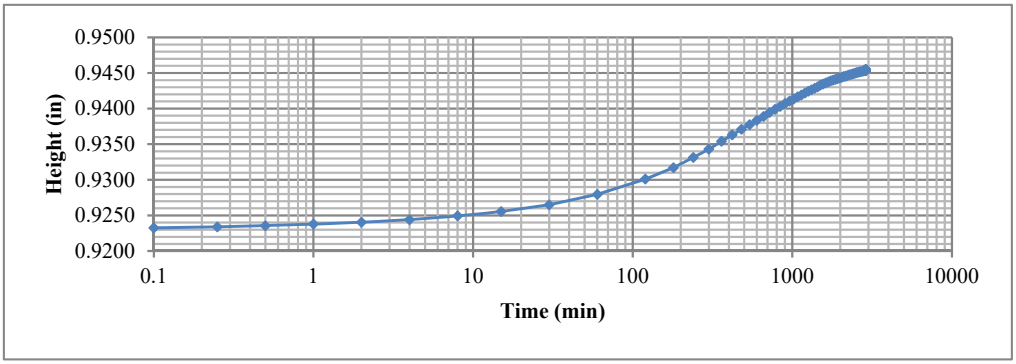

Project Name: MDA/Grassy Mtn PFS/OR	**ASTM D2435** ONE-DIMENSIONAL CONSOLIDATION REPORT TIME-DEFORMATION PLOTS (4)				
Project Number: 1663241.22000					
Sample ID: BH19-TP-44 @ 30 - 32 ft.	**Technician:** PRH	**Checked:** PRH	**Reviewed:** CPA	**Date:** 16-Aug-2019	**Figure:** 6

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April 23, 2018

Ms. Nancy Wolverson, Project Manager
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665 Anderson Street
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Tel: 775-625-3600
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nancy@paramountnevada.com
cheryl@paramountnevada.com

Re: X-ray Diffraction Analysis of 15 Grassy Mountain Bentonite Samples

Dear Paramount Gold Nevada Corp. and Ms. Wolverson:

Introduction: Your shipment of fifteen (15) Grassy Mountain Bentonite samples were received by MIMR on April 11, 2018. You requested that each core be evaluated by x-ray diffraction ("XRD") analysis for mineral composition, including montmorillonite. Each sample has been evaluated for montmorillonite and accessory mineral concentrations.

Bentonite characteristics: In the U.S.A., the active ingredient in bentonite is montmorillonite, a swelling smectite clay mineral. There are negative charge defects in the 3 layer structure of montmorillonite platelets that require cations between the platelets for charge neutralization. When monovalent cations such as sodium are dominant, these cations hydrate rapidly with exposure to water, expanding or swelling the bentonite typically 20 or more times its original dry volume. The hydrated sodium montmorillonite disperses to platelets with minimal shear to viscosify/thicken the water phase. When divalent cations such as calcium are dominant, montmorillonite expands to twice its dry volume with exposure to humid air and slightly more when placed in water, but does not expand further or disperse to platelets.

Market characteristics of sodium, and, calcium bentonites: In the U.S.A, sodium bentonite has 20 times greater market share than calcium bentonite does. Some calcium bentonite deposits can be altered to meet some commercial sodium bentonite market requirements. Major markets for sodium bentonite include clumping pet litter, drilling mud for oil and gas, foundry sand binder,

iron ore pelletizing, water proofing & sealing, and few other markets which are not major markets. Sodium bentonite from Wyoming and neighboring states produce the current major source available in the U.S.A. for present sodium bentonite markets. Commercial bentonite markets typically require approximately 70% or more montmorillonite as its active ingredient to meet functional acceptance. Both sodium bentonite, and, calcium bentonite may contain montmorillonite of variant quantity.

In the U.S.A., in 2016, commercial markets for bentonite used about 3.6 million metric tons. However, with changing competition and market demand, the major commercial markets may increase or decrease by up to 300,000 tons per year. In 2016, at the production facility, the average price per ton of processed bentonite was $73.76.

Summary of XRD Analysis of Submitted Samples*:* With regard to further testing of properties for current bentonite markets, only one (1) Grassy Mountain core sample contains sufficient montmorillonite; that is, contains more than approximately 70% active mineral. The remaining 14 core samples have 53% or less montmorillonite. In all 15 cores, divalent cations---such as calcium---are the dominant interlayer cations, further limiting the potential market for such 15 Grassy Mountain bentonite if mined. Calcium bentonite can be reacted with sodium carbonate to result in a quasi-sodium bentonite byproduct, and, a substantial calcium carbonate byproduct. Such conversion is typically not adequate for constituting the desired functional properties. This is because individual calcium montmorillonite platelets do not separate adequately for complete interlayer cation displacement.

X-Ray Diffraction Mineral Composition Analysis:

For XRD analysis, a Philips-Norelco Model 3000 x-ray diffractometer, containing a step-scanning goniometer, was used.

Each of the 15 samples was initially dried to constant weight at 50°C, then pulverized with a ceramic mortar and pestle to less than 200 mesh. In preparation for XRD analysis, the pulverized sample was back-loaded as a randomly oriented powder and compressed into a powder-sample-holder at 10 psi. For powder samples, the XRD range was from 4° to 65° 2theta.

For enhanced smectite detection and identification, a portion of each sample was slurried in distilled water, then the slurry was coated on the surface of a glass slide. As the slurry dried, dispersed smectite platelets oriented parallel to the glass surface, enhancing smectite XRD (0,0,x) layer peaks. After XRD evaluation of an oriented sample, it was exposed to ethylene glycol vapor for a minimum of 4 hours at 50°C, then after cooling to ambient temperature, re-analyzed by XRD.

The following is shown in Excel Table 1: With exposure to ethylene glycol vapor, 14 samples contained a smectite XRD (0,0,1) layer peak that expanded to 17 Angstroms, confirming that swelling smectite was present in each such sample. However, one (1) of the 15 total samples did not contain any smectite. Yet, each of the 14 samples which did contain such swelling smectite were further identified as montmorillonite by its (0,6,0) XRD peak at 1.50 Angstroms. With regard to all 15 samples, the XRD range for oriented samples was 2° to 18° 2theta.

Each mineral has been identified and semi-quantitatively estimated with respect to external standards:

- A refined Wyoming bentonite was prepared by slurrying in water, then centrifuged to less than 2µm to remove accessory minerals. This standard has 98.1% sodium montmorillonite and 1.9% opal-CT (an amorphous silica).
- Silver Bond B quartz was used to estimate quartz in the Grassy Mountain cores.

- Other external standards were used for illite/mica, kaolinite, gypsum, and feldspars, but with less accuracy than montmorillonite and quartz---this is because these minerals have more variable chemistry, particle size distribution, and crystallinity.

The Grassy Mountain cores have variable but significant concentrations of amorphous, or, poorly crystalline materials because the crystalline minerals identified above, by using such XRD standards, do not substantially represent the core samples as a whole.

The mineral compositions by XRD analyses are listed in the separate attachment, Excel Table 1.

Sincerely yours,

W. J. Miles, PhD

Table 1
Paramount Gold Nevada Corporation
XRD Mineral Composition

	Clay Minerals				Feldspars		Carbonate Minerals			Amorphous	
Core Sample	Montmorillonite	Illite	Kaolin	Quartz	Microcline	Albite	Calcite	Dolomite	Gypsum	Material	Total
BH-01 S5 25'	84	~1	2	10	2	0	0	0	0	3	100
BH-01 S9 60'	18	~1	0	23	2	0	0	0	0	58	100
BH-01 S12/13 90&10(	36	0	0	17	0	0	0	0	0	46	100
BH-02 S4 20'	43	~3	11	21	3	0	2	1	0	20	100
BH-02 S7 40'	27	2	0	24	2	0	1	0	0	45	100
BH-03 S6 30'	48	~1	0	13	0	2	0	0	0	36	100
BH-03 S9 60'	24	0	4	13	1	0	0	0	0	59	100
BH-03 S11 80'	7	3	18	32	2	0	0	2	0	36	100
BH-04 S2 10'	14	0	47	25	0	0	0	0	0	15	100
BH-05 S5 25'	23	0	0	1	2	0	0	0		73	100
BH-07 S5/6/7 25-35'	33	3	9	22	6	0	0	0	0	27	100
BH-08 S4 20'	29	0	0	1	0	12	1	0	0	58	100
BH-08 S10 50'	53	0	0	3	0	9	0	0	0	35	100
BH-09 S12 90'	19	0	3	0	0	0	0	0	0	78	100
BH-13 S14 15'	0	0	3	23	0	0	0	0	0	74	100
SCP Refined Bentonit(	98	0	0	0	0	0	0	0	0	2	100

The XRD concentrations of these minerals are estimated at plus or minus 5% by weight.
The detection and quantification limit for smectite clays is 0.3%.

APPENDIX B

Seismic Hazard Assessment

TECHNICAL MEMORANDUM

DATE October 30, 2019 **Project No.** 1663241.058.TM.Rev0

TO Christopher J. MacMahon, PE
Golder Associates Inc.

FROM Don Lowry, PG, CEG & Alan Hull, PG, CEG **EMAIL dlowry@golder.com**

UPDATED SEISMIC HAZARD ASSESSMENT, GRASSY MOUNTAIN TSF SITE, MALHEUR COUNTY, OREGON

Introduction

Golder Associates Inc. (Golder) completed an initial seismic hazard assessment (SHA) in 2017 (Golder 2017) as an appendix in Golder's pre-feasibility report (Golder 2018a) for the proposed Grassy Mountain Tailings Storage Facility (TSF) site (Site) located in Malheur County, Oregon (Figure 1).

At the time of the SHA preparation in 2017, subsurface information, including time-averaged shear wave velocity in the upper 100 feet (ft) (30 m) below the Site (i.e., $V_{S,30}$) was not available. Golder (2017) assumed a weak rock site [i.e., $V_{S,30}$ = 2,500 ft per second (ft/s) (760 meters per second (m/s)] or soil Site Class B/C per ASCE/SEI 7-10 for the initial assessment of earthquake ground motions at the TSF site.

Subsequent to preparation of the 2017 SHA, Golder has acquired new subsurface data that is presented in the main TSF Design Report to which this technical memorandum is appended. This technical memorandum updates the SHA for the proposed Grassy Mountain TSF based on logs from 21 boreholes,11 cone penetration test (CPT) soundings, and 59 seismic CPT tests. This data indicate that bedrock was not encountered in any of the boreholes that extended up to 120 ft beneath the proposed TSF Site.

The boreholes and CPT logs indicate that the proposed TSF Site is underlain by moist, stiff to very stiff clay. Direct measurements of the shear-wave velocity and laboratory testing indicate the presence of at least 100 ft (~30 m) of stiff to very stiff clay indicates that the initial assumption of a $V_{S,30}$ of 2,500 ft/s by Golder (2017) is no longer valid.

The SHA results reported in this technical memorandum update the earthquake ground motions presented in Golder (2017) with a deterministic seismic hazard analysis (DSHA) and probabilistic seismic hazard analysis (PSHA) for the proposed Grassy Mountain TSF site. This SHA provides earthquake ground motion values for a $V_{S,30}$ equivalent to the mid-point of a soil Site Class D sites as defined in ASCE/SEI 7-16. These values are considered appropriate for the seismic analysis and design of the proposed TSF structure given the known subsurface conditions.

Regulatory Framework

In August 2017, Golder presented Calico Resources USA Corp (Calico) with an initial conceptual design for the proposed TSF at the Grassy Mountain TSF site (Golder 2017b). Table 2 of Golder (2017b) notes that the proposed operational and closure design earthquake ground motions have 475- and 2,475-year return periods.

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Golder's current understanding is that the proposed TSF is a low-hazard dam under Oregon Administrative Rule (OAR) 690-020-0038, and the proposed operational and closure design earthquake ground motions exceed the requirements of OAR 690-020-0038.

Although the Oregon regulations do not require the application of deterministic maximum credible earthquake (MCE) ground motions for a low hazard dam classification, it is common practice in tailings dam seismic analysis to identify the MCE ground motions for comparison with the probabilistically derived earthquake ground motions. Accordingly, the minimum seismic criteria for stability analysis of the proposed TSF embankment are the 475-year return period and maximum credible earthquake (MCE) ground motions.

Work Scope

For this update, Golder used the fault location and characteristics information developed during the initial SHA (Golder 2017a) and performed the following additional tasks to define the earthquake ground motion estimates at the proposed TSF site.

- Evaluated the site soil conditions based on logs from 21 boreholes, 11 CPTs, 59 seismic CPTs that extended within the proposed TSF site footprint. Golder's evaluation concentrated on the Standard Penetration Test (SPT) results, soil moisture tests, and thickness of the clay deposits located within the proposed TSF footprint.
- Estimated the soil Site Class based on site classes defined in ASCE/SEI 7-16 Table 20.3-1 and the SPT and seismic CPT test results.
- Re-calculated the deterministic horizontal peak ground acceleration (PGA) for the MCE using a $V_{S,30}$ of 850 ft/s (259 m/s) that correspond to soil Site Class D. PGA values were calculated using 2014 NGA-West2 earthquake ground motion models (GMM) to estimate the source-to-site attenuation of earthquake accelerations.
- Re-calculated mean PGA for 475- and 2,475-year return periods based on the US Geological Survey National Seismic Hazard Maps (NSHM; USGS 2014).
- Estimated the return period of the deterministic MCE ground motions.
- Prepared this technical memorandum that describes of the inputs, results, and recommendations from Golder's SHA update.

The US Geological Survey NSHM was also de-aggregated at PGA to identify the dominant earthquake magnitude-distance pairs at 475 and 2,475-year return periods. This information can be used for any subsequent selection and development of earthquake acceleration time histories, if required.

Physiographic and Tectonic Setting

The proposed TSF Site (and surrounding region) is located within in the Columbia Plateau, a physiographic province of the United States that comprises thick sequences of basalt flows (Columbia River Basalt) erupted from about 17.5 to 6 million years ago (Ma) (e.g., Carson and Pogue 1996, Camp et al. 2003). The Columbia River Basalts are part of the long-lived volcanic activity related to the mantle "hot spot" that is now located below Yellowstone National Park (Madin 2009). The proposed TSF Site area is dissected by a number of rivers and their

tributaries that drain to the Snake River flood plain, including the Payette, Powder, Burnt, Malheur, and Owyhee rivers (Geology.com 2017a and 2017b). The relatively unaltered basalt flows in the Payette section range in elevation from about 3,800 to about 4,500 ft above sea level (asl).

The proposed TSF Site is located about 15 mi (24.5 km) southwest of the Snake River plain near Adrian, Oregon (Figure 1). At this location, some dissection of the basalt flow-dominated landscape has occurred, exposing the underlying sedimentary units of the Grassy Mountain Formation (Ferns and Ramp 1989). The TSF site is located within a north-flowing drainage at an elevation of about 3,700 ft asl northwest of Schweizer Reservoir (Figure 2).

Significant local features nearby include the Owyhee Dam (6.1 mi/9.8 km southeast), Owyhee Reservoir (4.6 mi/7.4 km south-southwest) within the Owyhee River drainage, and Sourdough Basin (1.9 mi/3.0 km west) located within a north–south trending tributary of the Owyhee River (Figure 1).

Site Geology

The geology of the region surrounding the proposed TSF site is a sequence of sedimentary and volcanic deposits within the Oregon-Idaho Graben (Ferns et al. 1993). Contemporaneous deposition of sandstone and conglomerate (Tgs), olivine basalt emplacement (Tbi), and repeated episodes of calc-alkaline lava eruption and flow (Tgb) occurred during middle to upper Miocene time (Figure 2). The volcanoes of west-central to southeastern Oregon range in age from 15 to 2 Ma (Madin 2009). The Payette section of the Columbia Plateau, where the TSF site is located, is a relatively uniform area of basalt flows that overlie and cap the underlying older sedimentary deposits (Fenneman 1946).

Grassy Mountain itself is mapped by Ferns et al. (1993) as underlain by calc-alkaline rich volcanic flow deposits (Tgb) and associated olivine basalt that crops out farther northeast. Ferns et al. (1993) geologic map (Figure 2) indicates that the proposed TSF site is located on a thick sequence of arkosic sandstones containing interbeds of conglomerate separated by the tuff of Kern Basin. Geologically, the site is within the upper arkosic (mid to upper Miocene) and the lower (mid-Miocene) arkosic units. Erosion over about the last 11 Ma has removed some of the volcanic deposits that overlie and cap the sedimentary units to expose the upper arkosic unit at the Site (Tgs, Figure 2).

Bedrock outcrops within the site expose siltstone, sandstone, and conglomerate of the late Miocene Grassy Mountain Formation. These units are also exposed in the northeast–southwest trending drainage that the proposed TSF will partially fill (Figure 2). Olivine-rich basalts are present immediately to the east and south (Figure 2). Igneous intrusions (Tbi) are mapped as isolated bodies surrounded by the sedimentary units (Tgs). The intrusive bodies are in places aligned along the mapped pre-Quaternary faults that may have controlled the locations and extent of these shallow intrusions.

Golder's subsurface investigation (Golder 2018a, 2018b) identified unconsolidated alluvium and colluvium overlying previously unmapped Miocene-aged lacustrine clays underlying most of the proposed TSF Site area. The lacustrine deposits are generally characterized as "fat clay" with variable quantities of dark tan to brown and occasionally blue-gray, fine- to medium-grained sand with lesser amounts of lean clay and poorly graded sand lenses. Moisture content, where measured, varies from 16% within lean clay deposits (BH-01 @ 10 ft) to 30 to 35% within fat clay deposits (BH-03 @ 10 ft, 40 ft and 50 ft). Uncorrected blow count (i.e., N-value) averages within the deep boreholes (BH-01, BH-03, BH-09 and BH-13) varied from 32.2 (BH-3) to 47.6 (BH-13). Laboratory

testing of the lacustrine clays indicates a range of plasticity index (PI) from 10 to 179, with several samples having PI values over 100. Similar deposits were mapped by Ferns et al. (1993) approximately 2 miles

(3 km) northeast of the proposed TSF site. Gray et al. (1989) considers that the clay was deposited during the Upper Miocene Epoch of the Neogene Period within alkaline lakes subjected to regular volcanic ash fall and/or hydrothermal activity.

The proposed mine is located on a 150 ft high, highly resistant, silicified and iron-stained knoll (43.670°N latitude, 117.359°W longitude). Bedding within the sandstone unit appears unaltered at the hilltop, dips at 10° to 25° toward the north-northeast on the northern and eastern flanks of the hill and steepens to 30° to 40° on the west side of the hill due to drag folding in the footwall along a fault striking about N20°W (Paramount 2017). Normal faulting of the Miocene-age units is common, with most faults striking either northwest–southeast or northeast–southwest (most common). Also, a number of mapped older faults strike approximately north–south, but these faults are generally located west of the proposed TSF site. These faults are not considered seismogenic (i.e., capable of generating earthquakes) in the present-day tectonic environment. The proposed TSF Site is located within the valley area to the west and north of the mine. The downstream extent of the TSF embankment is about 0.5 mi (less than 1 km) from the knoll presumed to be the center of the proposed mine workings (Figure 2).

Historical Earthquakes and Quaternary Faults

This section is a summary of information on the occurrence of historical earthquakes surrounding the TSF site. The section also includes descriptions of the activity of mapped Quaternary faults located within about 62 mi (100 km) of the proposed TSF site (Figure 1).

Historical Earthquakes

Figure 1 shows Quaternary-aged faults included in the United States Geological Survey (USGS) Quaternary Fault and Fold Database (USGS 2006) and located within 62 mi (100 km) of the proposed TSF site. Also shown in Figure 1 are historical earthquake epicenters located within a 125 mi (200 km) radius of the proposed TSF site. The earthquake records were obtained from a search within USGS (2016) and International Seismological Centre (2014) online earthquake catalogs. Any duplicate events were manually removed. The area surrounding the site shows a relatively low number of historical earthquakes.

Instrumental and reported historical records from the mid-20th century through April 2017 reveal that 81 earthquakes with magnitudes greater than magnitude 3.0 have been recorded within about 124 mi (200 km) of the proposed TSF site. Of these recorded earthquakes, six have exceeded moment magnitude (**M**)4.0—the most recent in October 1994. The largest earthquake recorded within 125 mi (200 km) of the TSF site in August 1965 had a reported **M**4.4 and was located about 20 mi (33 km) northwest of the site. The closest recorded earthquake with an **M**≥4.0 was an **M**4.0 event in October 1994. The epicenter was located about 81 mi (130 km) northeast of the proposed TSF site (Figure 1).

Quaternary Faults Mapped within 62 mi (100 km) of the Site

General

In the western USA, active faults are typically defined as those that have evidence for one or more displacements of Holocene-age soils and surfaces that range in age from about 10,000 to 11,000 years old or younger. This definition is typically used in seismically active, high average fault slip rate regions close to major tectonic plate

boundaries (e.g., California). Fault studies within regions away from the plate boundaries, such as the Basin and Range and Columbia Plateau of the western United States, however, indicate that recurrence intervals for surface fault rupture can be much longer than 10,000 years, and the use of a Holocene activity criterion may not be appropriate for the identification of potentially seismically active faults. For example, dePolo and Slemmons (1998) suggest that faults be considered as potentially seismically active in Nevada if they demonstrate surface fault rupture in the last 130,000 years (Late Pleistocene). The rationale for the selection of this longer time interval is because about 60% of historical earthquakes within the Basin and Range with magnitudes greater than or equal to **M**6.0 have been located on or near faults without a record of previous Holocene offset. In eastern Oregon, very few earthquakes have been recorded within Malheur County from the late 19th century through to the present day. Of those earthquakes, more than 50% are located more than 12 mi (20 km) from known seismogenic faults (State of Oregon 2003).

The most significant Quaternary faults, with respect to the development of earthquake ground motions, are generally those located closest to, and dip beneath the Site (i.e., the Site experiences more shaking from faults when located on the hanging wall of the fault). These faults are important because future large earthquakes on these faults can be expected to develop earthquake ground motions of engineering significance at the TSF site. Large earthquakes may occur on one or more of the faults further from the Site, but they not expected to generate high levels ground shaking at the Site.

The U.S. Geological Survey defines four classes of geological fault based on the physical evidence of Quaternary (i.e. last 2.6 million years) activity (https://earthquake.usgs.gov/hazards/qfaults/background.php).

- **Class A** faults have geologic evidence that demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed for mapping or inferred from liquefaction or other deformational features.
- **Class B** faults have geologic evidence that demonstrates the existence of a fault or suggests Quaternary deformation, but either: (1) the fault might not extend deeply enough to be a potential source of significant earthquakes; or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.
- **Class C** faults have geologic evidence that is insufficient to demonstrate: (1) the existence of tectonic fault; or (2) Quaternary slip or deformation associated with the feature.
- **Class D** faults have geologic evidence that demonstrates that the feature is not a tectonic fault or related feature (i.e., not a fault); this category includes features such as joints or joint zones, landslides, erosional or fluvial scarps, or landforms resembling fault scarps, but of demonstrable non-tectonic origin.

Generally, Class A faults are the only seismogenic sources considered in a SHA, and only Class A faults are considered here. By definition there is insufficient evidence that Class C and D faults are seismogenic sources that need to be considered for seismic analysis of mine facilities. Although there is a known Class B fault group mapped within 3.2 mi (5.2 km) of the site (i.e., Fault No. 808 - Faults near Owyhee Dam), there is insufficient evidence to consider them in the seismic hazard for the proposed Grassy Mountain TSF site. Detailed studies including subsurface investigations would be required to demonstrate Quaternary movement for Fault no. 808 and for its inclusion as a seismogenic source.

Significant Late Quaternary and Holocene Faults

The USGS (2006) and Petersen et al. (2008) recognize at least 11 faults or distinct fault segments with demonstrated Quaternary activity within about a 62 mi (100 km) radius of the proposed TSF site (Figure 1). Of these mapped faults:

- Six have demonstrated surface displacement during the Holocene Epoch (i.e., about the last 11,700 years).
- One has demonstrated surface displacement since the late Pleistocene Epoch (i.e., from about 130,000 to 11,700 years ago).
- Two have surface displacement since the early Pleistocene Epoch (i.e., from about 750,000 to 11,700 years ago).
- Two show surface displacement only in the early Quaternary Period (i.e., at some time in the last 2.6 million years).

The estimated average slip rates on these 11 faults are generally less than 0.2 mm/yr (USGS 2006). Table 1 lists selected fault parameters for each of the faults mapped within 62 mi (100 km) of the Site.

Table 1: Major Pleistocene- and Holocene-age Faults Mapped within about 62 mi (100 km) of the Grassy Mountain TSF Site, Malheur County, Oregon

Fault Number[1]	Fault (F) or Fault Zone (FZ)[2]	Estimated Age of Most Recent Surface Displacement[3]	Approximate Distance from Site (mi/km)[4]	Total Length (km)[5]	Fault Type[6]	Dip Angle, Direction[6]	Estimated Average Slip Rate (mm/yr)[7]	Estimated Recurrence Interval (years)[8]
806	Cottonwood Mountain	Holocene (<15 ka)	17/28	42	N, LLSS	60°±10°NE	<0.2	3,750-25,000[a]
636	Owyhee Mountain	Quaternary (<1.6 Ma)	17/28	206	N	65°-70°NE	<0.2 (0.12-0.18)	3,000-9,000 (5,200 average)[b]
635	Western Snake River Plain	Late Pleistocene (<130 ka) to *Quaternary* (<1.6 Ma)	24/38	74	N	55°-88°NE	<0.2	n/a
856a	Steens FZ, Crowley Section	Middle and late Quaternary (<750 ka)	30/49	43/197	N	60°SE	<0.2	n/a
805	Juniper Mountain	Holocene (<15 ka)	37/60	17	N	60°-70°NE	<0.2	n/a
1801	Warm Springs	Quaternary (<1.6 Ma)	46/74	9	N	*60°E	<0.2	n/a
632	Squaw Creek	Holocene (<15 ka)	50/80	47	N	60°E	<0.2	n/a
807	Faults near Unity Valley	Holocene (<15 ka)	50/80	46	N, RLSS	60°-70°N to E	<0.2	n/a
631	Big Flat	Holocene (<15 ka)	54/87	30	N	60°E	<0.2	n/a
630	Jakes Creek	Holocene (<15 ka)	55/88	16	N	60°W	<0.2	n/a

Fault Number[1]	Fault (F) or Fault Zone (FZ)[2]	Estimated Age of Most Recent Surface Displacement[3]	Approximate Distance from Site (mi/km)[4]	Total Length (km)[5]	Fault Type[6]	Dip Angle, Direction[6]	Estimated Average Slip Rate (mm/yr)[7]	Estimated Recurrence Interval (years)[8]
1802	Harney	Middle and late Quaternary (<750 ka)	61/98	30	N	*60°W	<0.2	n/a

Notes: ka = thousand years; Ma = million years; N = Normal Fault, RLSS = Right-Lateral Strike Slip, LLSS = Left-Lateral Strike Slip; n/a = not applicable; MCE = maximum credible earthquake.

1. Fault numbers from USGS (2006). References include:
   a. Personius (2002), Fault number 806
   b. Personius and Lewis (2003), Fault number 636
   c. Personius (2003), Fault number 635
   d. Personius (2002), Fault number 856a
   e. Personius (2002), Fault number 805
   f. Personius (2002), Fault number 1801
   g. Personius and Neier (2003), Fault number 632
   h. Personius (2002), Fault number 807
   i. Personius and Neier (2010), Fault number 631
   j. Personius and Lewis (2003), Fault number 630
   k. Personius (2002), Fault number 1802
2. Fault names, and zones were taken from Petersen et al. (2008).
3. Age of most recent pre-historic displacement taken from USGS (2006).
4. The distances are the closest approach of the mapped fault traces to the Grassy Mountain TSF site and were measured from the fault traces as plotted on Google Earth™ (from USGS 2006) for a location of 43.6728°N, 117.36437°W.
5. Length is based on the total lengths of the faults and fault segments as indicated in USGS (2006).
6. Fault dip and direction from USGS (2006). Dip determined from reference, where available. *Dip assumed to be 60º for normal faults where no other information is available.
7. Average fault slip rates taken from USGS (2006). Mid-range values assumed (i.e., for 0.2 to 1.0 mm/yr, 0.6 mm/yr) used for MCE calculation.
8. Recurrence interval as reported by:
   a. Knudsen et al. (1994)
   b. Beukelman (1997)

Cottonwood Mountain Fault

The closest mapped Quaternary fault to the proposed TSF site is the Holocene-aged Cottonwood Mountain fault located along the eastern slopes of Cottonwood Mountain (Personius 2002, fault 806) (Figure 1). The Cottonwood Mountain fault is a northwest-trending normal fault with a northeast dip, and with some evidence for left-lateral (sinistral) slip. The fault offsets pre-Quaternary ash-flow tuff and lacustrine deposits. The fault trace has scarps that offset alluvial fan deposits east of Cottonwood Mountain. Small scarps (1.5 to 3 ft [0.5 to 1 m]) on Holocene surfaces and larger scarps (6 to 43 ft [2 to 13 m]) on mid- to late-Pleistocene surfaces indicate repeated late-Quaternary surface rupture. The most recent surface rupture is estimated to have occurred in the late Holocene (Personius 2002, fault 806).

The Cottonwood Mountain fault is mapped by USGS (2006) as two well-defined lineaments about 1.2 to 1.6 mi (2 to 2.5 km) apart. The western lineament is about 11 mi (18 km) long, with the central portion mapped with the last surface displacement occurring in the Holocene. Other mapped portions of the fault show the last movement in middle and late Quaternary time (i.e., <750 ka). The eastern-most lineament is mapped as Holocene-active along its 26 mi (42 km) length. The combined length of mapped fault sections is about 43 mi (69 km), with an average strike at 331º (N29°W). The fault dips northeast at about 60º to 70º (USGS 2006).

Owyhee Mountains Fault System

The Owyhee Mountains Fault System is located about 17 mi (28 km) southeast of the proposed TSF site at its closest approach (Figure 1). This complex zone of faults forms the northwest-trending boundary between the Tertiary volcanic rocks of the Owyhee Mountains and the Neogene to Quaternary basalt flows of the Snake River Plain in southwestern Idaho. Most of the faults mapped in this fault system offset volcanic rocks of probable late Tertiary age, but many of these rock units are poorly dated. Some Quaternary rocks and surfaces may also be offset by these faults. A few faults offset Quaternary surficial deposits in the area between Shoofly Creek and Little Jacks Creek; these deposits are undated but are probably late Quaternary in age. Scarp profiling, trenching, and detailed soils analysis of faults and deposits in the Shoofly/Little Jacks Creek area suggest late Quaternary displacements on some of these faults (Personius and Lewis 2003, fault 636).

Western Snake River Plain Fault System

The Western Snake River Plain fault system is mapped as an east-propagating series of southwest-dipping normal faults that offsets Pliocene-Pleistocene fluvial deposits within the Snake River floodplain (Personius 2003, fault 635). Fault traces are mapped east of the Owyhee Mountains fault exposed within the hills just west of the Snake River floodplain. Tectonic linear and asymmetric ridges up to 100 ft (30 m) high are exposed within the fluvial deposits, including some that deform early Quaternary sediments (Ostenaa 1985; Othberg and Stanford 1992; Wood and Anderson 1981).

The fault system does not appear to extend into the rock units exposed to the southeast of the lower floodplain deposits. The longest fault structure mapped in the fault system extends about 38 mi (61 km) through the valley, about 7 mi (11 km) east of Lake Lowell. USGS (2006) maps the fault with an average strike azimuth of about 307º (N53°W). The fault system has a nominal width of about 23 mi (37 km).

Surface Fault Rupture Hazard

Faults mapped to have had surface rupture within the Quaternary Period (Figure 1) do not cut the footprint of the proposed TSF site. Considering the potential for surface fault rupture hazard, the current understanding of Quaternary faults suggests that the likelihood of surface fault rupture within the proposed TSF site is very low.

The Cottonwood Mountain fault that has a similar trend as the Owyhee Mountains fault system appear to be two independent faults and earthquake sources. Mapped faults are absent for about 29 mi (47 km) between the two fault systems based on current geological assessments. If future studies show there is continuity between these two fault structures, then a seismogenic fault could be located 5 to 10 mi (8 to 16 km) east of the proposed TSF site.

Evaluation of Seismic Hazard

This section presents the results of the DSHA and estimates of earthquake ground shaking from the NSHM (Petersen et al. 2008). Site-specific DSHA was undertaken using fault locations from USGS (2006). Fault-to-site distances and median MCE magnitudes were calculated for this study by measuring the distances to the fault traces as shown on Google Earth™. Probabilistic results are those based on the USGS NSHM and available hazard mapping tools (USGS 2017).

Deterministic Seismic Hazard Analysis

General

Deterministic Seismic Hazard Analysis uses available historical and instrumental seismic records and geologic data to generate discrete, single-valued estimates of earthquake ground motion for a site. These single-valued estimates are commonly used in the seismic analysis and design of major mining structures such as tailings dams and impoundments. Median (50th percentile) values of PGA are sometimes used for analysis and design of low failure consequence structures, while 84th percentile values are often used for high failure consequence structures.

Deterministic Seismic Hazard Analysis uses a concept of the MCE. The MCE is the largest possible earthquake that may reasonably occur along a recognized fault or within a geographically defined tectonic province, under the presently known or presumed tectonic framework. Little regard is given to the earthquake recurrence interval, which may vary from less than a hundred years to more than ten thousand years, depending on the geologic and tectonic environment under consideration.

Typically, in DSHA one or more MCEs are specified by magnitude and location with respect to the site of interest. In areas such as eastern Oregon, major earthquakes are assumed to be generated by movement along mapped active faults that have generated past surface rupture, and on that part of the mapped fault closest to the facility being evaluated. Site ground motions are usually estimated for displacement along a known fault, with a specified MCE magnitude, a source-to-site distance, and site soil conditions.

Review of Subsurface Data from Grassy Mountain TSF Site

For this update, we have reviewed the boring logs included in Golder (2018b) for the proposed TSF site. Boreholes BH-01, BH-03, BH -09 and BH-13 each extended to 100 ft below the ground surface. Average SPT blow counts (N_{avg}), measured shear wave velocity values in the upper 30 meters of soil, ($V_{S,30}$), plasticity index (PI) and moisture content can be used to classify the soil Site Class as defined in ASCE/SEI 7-16 Chapter 20.

$V_{s,30}$ Values (Seismic CPT Tests)

The National Earthquake Hazards Reduction Program (NEHRP 2009) and International Building Code (IBC 2018) define soil Site Class by the time-averages shear wave velocity in the upper 30 meters of the soil profile. Seismic shear wave velocity tests were conducted in twelve (12) CPT bores throughout the site. Shear wave velocities were directly measured at defined depths between 5 to 20 meters at each test and ranged between 200 and 800

meters per second (m/s), or approximately 650 to 2600 ft/s. In the CPT boreholes where direct measurement of shear wave velocities was not available, empirical models were used to estimate the shear wave velocity profiles. The empirical models such as Hegazy and Mayne (1995) for clayey soils, Mayne (2006), Mayne and Rix (1995), and Piratheepan (2002) use CPT tip resistance and sleeve friction measurements to estimate shear wave velocity. These models were used to develop a continuous log of shear wave velocity with depth and averaged over the depth of the hole ($V_{s,D}$).

CPT borings less than 5 ft deep were not considered for the determination of the site-wide shear wave velocity. For each CPT with a depth of hole less than 30 meters in which the $V_{s,30}$ value cannot be directly averaged, the method of Boore's (2004) was used to interpolate the $V_{s,30}$ value from the averaged shear wave velocity over the depth of the hole, $V_{s,D}$. Boore (2004) uses logarithmic regression coefficients based on the total depth of hole to estimate the $V_{s,30}$ value used in NEHRP soil Site Classifications. The calculated $V_{s,30}$ values for each hole ranged between 240 and 920 m/s (790 to 3020 ft/s) and averaged around 470 m/s (1540 ft/s). Golder classifies this site as a soil Site Class D or stiff soil profile based on ASCE/SEI 7-16.

N_{avg}-Values (SPT Blow Counts)

SPT blow counts were used to calculate N_{avg}-value (ASCE/SEI 7-16 20.4-2) for each borehole. N_{avg}-values are 44.9, 32.2, 47.6 and 43.8 for BH-01, BH-03, BH-09 and BH-13, respectively. From ASCE/SEI 7-16 Chapter 20 Table 20.3-1, soil Site Class C has a weighted N_{avg}-value >50 while soil Site Class D has N_{avg} SPT values from 15 to 50, and soil Site Class E weighted N_{avg}-values <15. N_{avg} values indicate that the ground conditions beneath TSF site are near the upper end of a soil Site Class D.

Plasticity Index

Where a soil does not meet the soil Site Class F requirements and there is a total thickness of soft clay greater than 10 ft (3 m) and the soft clay layer has an undrained shear strength (*su*) <500 psf (<25 kPa), moisture content (w) ≥40%, and a plasticity index (PI) >20, it is soil Site Class E. The PI values for all four deep boreholes were all PI >20. BH-01 had one sample tested at a depth of 10 ft with a PI of 25. BH-03 included data from three samples tested at depths of 10 ft (PI=55), 40 ft (PI=99) and 50 ft (PI=198). BH-09 included data from a sample tested at 25 ft (PI=62). BH-13 included data from four samples tested at depths of 5 ft (PI=63), 15 ft (PI=62), 25 ft (PI=35) and 30 ft (PI=62). These results meet some of the criteria for a soil Site Class E in ASCE/SEI 7-16 Chapter 20.

Moisture Content

Lean clay soils within borehole BH-01 had measured moisture content of 16% (BH-01 @ 10 ft). Moisture levels within fat clay soils measured in borehole BH-03 varied from about 30 to 35% (BH-03 @ 10 ft, 40 ft and 50 ft).

Site Soil Classification and Use in Seismic Hazard Analysis

The $V_{s,30}$ measurements calculated from the CPT seismic testing and SPT N_{avg} values from boreholes at the TSF site are generally consistent with a soil Site Class D site. Accordingly, Golder assigned a $V_{S,30}$ of 850 ft/s (259 m/s) for a soil Site Class D to estimate the earthquake ground motions at the site.

Table 2 lists the estimated MCE magnitude for Quaternary faults listed in Table 1. The earthquake magnitudes were calculated using empirical fault rupture versus earthquake magnitude relationships recommended by Stirling et al. (2013) for areas located away from plate boundaries and with low average fault slip rates such as Nevada. The regression developed by Stirling et al. (2008) was used to estimate MCE magnitudes for strike-slip/oblique-

slip faults, while the regression developed by Wesnousky (2008) was used to estimate the earthquake magnitudes for the normal-slip faults.

Individual fault geologic and geometric data were taken from USGS (2006). The MCE magnitude values are, in general, similar to those estimated by Petersen et al. (2008) for those faults included in the 2014 update of the NSHM.

Table 2: Estimated Maximum Credible Earthquake and Median Peak Ground Acceleration values from Faults Mapped within about 62 mi (100 km) of the Grassy Mountain Tailings Storage Facility Site, Malheur County, Oregon

Fault Number [1]	Significant Fault or Fault Zone [1]	Rrup[2]	Rjb[2]	Rx[2]	Ry0[2]	MCE[3]	Median (50th percentile) PGA (g)[4]
806	Cottonwood Mountain	28.78	28.78	17.50	22.85	7.2	**0.15**
636	Owyhee Mountain fault system	29.81	29.81	5.50	29.30	7.2	**0.15**
635	Western Snake River Plain fault system	38.19	38.19	34.37	16.65	7.0	**0.11**
856a	Steens fault zone, Crowley section	50.48	48.20	6.38	48.15	6.9	**0.08**
805	Juniper Mountain	60.31	60.31	41.00	44.23	6.7	**0.06**
1801	Warm Springs	66.53	64.82	73.25	5.47	6.6	**0.05**
632	Squaw Creek	80.46	80.46	63.74	49.10	6.9	**0.05**
807	Faults near Unity Valley	81.05	79.65	8.52	79.64	6.9	**0.05**
631	Big Flat	87.01	87.01	81.45	30.61	6.8	**0.04**
630	Jakes Creek	81.52	80.13	79.17	38.06	6.7	**0.04**
1802	Harney	97.55	97.55	97.55	0.00	6.8	**0.03**

Notes: Rrup = Closest distance to coseismic rupture (km); Rjb = Closest distance to surface projection of coseismic rupture (km); Rx =Horizontal distance from top of rupture measured perpendicular to fault strike (km); Ry0 = Horizontal distance off the end of the rupture measured parallel to strike (km); MCE = maximum credible earthquake

1. Fault numbers and names as defined within Table 1.
2. The distance parameters, in kilometers, are calculated based on the closest approach of the mapped fault traces to the sites, orientation and geometry with respect to the site as measured on Google Earth™ or GIS using the coordinates 43.669687° N, 117.359279° W.
3. MCE magnitudes were calculated based on regressions by Stirling et al. (2008) for strike-slip/oblique-slip and Wesnousky (2008) for normal faults.
4. Median PGA calculated assuming three soil Site Soil Class conditions: 1) Site Class B/C ($V_{S,30}$ = 760 m/s), 2) Middle Site Class D ($V_{S,30}$ = 259 m/s and using the following NGA-West2 GMMs with relative weighting in brackets: Abrahamson and Silva (2013) [0.25], Boore et al. (2013) [0.25], Campbell and Bozorgnia (2013) [0.25], Chiou and Youngs (2013) [0.25].

The median PGA was calculated at the TSF site using the geometric mean of four, equally weighted Next Generation Attenuation (NGA-West2) relations as developed by Abrahamson et al. (2013), Boore et al. (2013), Campbell and Bozorgnia (2013), and Chiou and Youngs (2013). The GMM estimate earthquake accelerations as

a function of earthquake magnitude, fault type, source-to-site distance, and site soil conditions. Table 2 lists the earthquake source-to-site distances (i.e., R_{rup}, R_{jb}, R_X, and R_{Y0}) used in the four NGA-West2 GMMs.

Conclusion from Deterministic Analysis at the Proposed Grassy Mountain TSF Site

Table 2 lists median (50th percentile) PGA values. Median values were calculated because the earthquakes originate on faults with average slip rates less than 0.3 mm/yr as recommended in Idriss et al. (2018). Soil Site Class D values range from 0.03 to 0.15 g based on $V_{S,30}$ of 2,500 ft/s (760 m/s). The soil Site Class D PGA values are about 35% higher than listed in Golder (2017) because the present values are for softer site conditions that generally amplify accelerations on rock conditions at the same site. The largest median PGA values result from an **M**7.2 earthquake occurring along the Cottonwood Mountain fault north of the proposed TSF site (Figure 1). Median PGAs of 0.15 g and 0.16 g indicate a relatively low level for the deterministic hazard at the proposed TSF site.

Probabilistic Seismic Hazard Analysis

General

Probabilistic seismic hazard analysis is commonly used to estimate earthquake ground motions for regions and for sites (e.g., McGuire 2004). The method provides a probabilistically based estimate (annual frequency of exceedance or its inverse of return period) for the specified earthquake ground motions. The earthquake ground motions can be PGA, as is often required for foundation and dam stability analyses, or spectral accelerations (accelerations at a specified frequency), as are commonly used in most modern building codes.

The USGS developed national probabilistic seismic hazard maps (NSHM) in 1996, 2002, 2008, and 2014. Each NSHM update incorporated the latest information on fault locations, fault characteristics, historical earthquakes, and the number and weighting of GMMs developed from earthquake records in the USA and around the world. Online tools based on the NSHM can be used to estimate PGA and spectral accelerations for any site in the conterminous United States (USGS 2017). Table 3 lists PGA and spectral accelerations for various return periods, based on the dynamic model (https://earthquake.usgs.gov/hazards/interactive) of the NSHM (USGS 2014). PGA values listed in Table 3 are for a stiff soil (soil Site Class D with $V_{S,30}$ = 850 ft/s [259 m/s]).

Table 3: PGA, 0.2- and 1.0-second Spectral Accelerations (Sa) for Selected Return Periods at the Grassy Mountain Tailings Storage Facility Site, Malheur County, Oregon

Probability of Exceedance (return period in years)[1]	Mean PGA (g)	0.2 second Sa (g)	1.0 second Sa (g)
10% in 50 years (475)	0.08	0.20	0.10
2% in 50 years (2,475)	0.20	0.50	0.23
1% in 50 years (4,975)	0.27	0.69	0.31

Notes: PGA = peak ground acceleration.

1. Values from the 2014 USGS national probabilistic model (Dynamic; Conterminous v.4.1.1) for a site location of 43.6728°N, 117.36437°W

Conclusion from Probabilistic Analysis for the Proposed Grassy Mountain TSF Site

Interpolation of the 2014 NSHM dynamic model indicates that the 2,475-year return period mean PGA is about 0.20 g for a soil Site Class D site (Table 3). Golder understands that a 2,475-year return period value is being considered for TSF seismic analysis and design. The 2,475-year return period ground motions indicate a low to moderate seismic hazard at the proposed TSF site.

Comparison between probabilistic and deterministic PGA ground motions indicate that the median PGA developed from an **M**7.2 earthquake on the Cottonwood Mountain fault (Table 2) has a return period estimated from the 2014 USGS NSHM at about 1,500 years for a soil Site Class D ground condition.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The Grassy Mountain proposed TSF Site is located in a region of relatively low historical earthquake activity within the Columbia Plateau physiographic province of the western USA. Since 1965, only 81 historical earthquakes with magnitudes greater than **M**3.0 have epicenters located within about a 125 mi (200 km) radius of the TSF site. Only six of the recorded earthquakes have exceeded **M**4.0.

Eleven Quaternary-active faults have been mapped within about 62 mi (100 km) of the proposed TSF site. Of the 11 mapped faults, seven have evidence for surface rupture in Holocene and Late Pleistocene time (i.e., <15 ka and 130 ka, respectively), two faults have had their most recent displacements in the mid- to early Quaternary (<750 ka), and two faults have had their most recent known displacement during the early Quaternary (<2.6 Ma).

The Deterministic Seismic Hazard Analysis indicates that the Cottonwood Mountain fault is the controlling MCE source for the proposed TSF site. The fault strikes at a 331° azimuth (N29°W) and dips 60º to 70º northeast. The trace of the Cottonwood Mountain fault is about 18 mi (28 km) north of the proposed TSF site at its closest approach and has an MCE magnitude estimated at **M**7.2. Using the geometric mean of four equally weighed GMMs, median PGA values for soil Site Class D ($V_{S,30}$ of 850 ft/s [259 m/s]) is 0.15 g. The median deterministic PGA has a return period estimated from the 2014 USGS NSHM at about 1,500 years.

Probabilistic analysis using the USGS 2014 National Seismic Hazard Map indicates that the 475-year and 2,475-year return period mean PGAs for a soil Site Class D site are 0.08 g and 0.20 g, respectively.

CLOSING

This office-based analysis of fault activity and seismic hazard is for use by Calico Resources Corp. The results of the assessment indicate a low to moderate seismic hazard based on the probabilistic analysis and a relatively low seismic hazard based the deterministic analysis. If you have any questions or concerns, please contact the undersigned.

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DJL/AGH/kt

https://golderassociates.sharepoint.com/sites/17031g/1663241 grassy mountain tsf/500_reporting/520_letters/526_seismic hazard/detailed design/final/1663241.058-tm-rev0-grassy mountain tsf-103019.docx

REFERENCES

American Society of Civil Engineers (ASCE). 2010. Minimum Design Loads for Buildings and Other Structures. ASCE Standard 7-10.

American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI). 2016. Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE/SEI 7-16). ASCE/SEI Standard 7-16.

Beukelman, G.S. 1997. Evidence of active faulting in the Halfway Gulch-Little Jacks Creek area of the western Snake River Plain, Idaho: Boise, Idaho, Boise State University, unpublished M.S. thesis, 170 p.

Boore, D.,2004. Estimating Vs(30) (or NEHRP Site Classes) from Shallow Velocity Models (Depths < 30 m). Seismological Society of America. Vol. 94. No. 2 pp. 591-597. April 2004.

Boore, D.M., Stewart, J.P., Seyhan, E. and Atkinson, G.M., 2013. NGA-West2 Equations for Predicting Response Spectral Accelerations for Shallow Crustal Earthquakes. Pacific Earthquake Engineering Research Center 2013/5, May 2013.Camp, V.E., M.E. Ross, and W.E. Hanson. 2003. Genesis of flood basalts and Basin and Range volcanic rocks from Steens Mountain to the Malheur River Gorge, Oregon. GSA Bulletin, 115(1):105–128.

Carson, R.J., and K.R. Pogue. 1996. Flood Basalts and Glacier Floods: Roadside Geology of Parts of Walla Walla, Franklin, and Columbia Counties, Washington. Washington State Department of Natural Resources, Information Circular 90, January.

dePolo, C.M.k and D.B. Slemmons. 1998. Age criteria for active faults in the Basin and Range Province, in Lund, W.R., ed., Proceedings Volume, Basin and Range Province Seismic-Hazard Summit: Utah Geological Survey Miscellaneous Publication 98-2:74-83.

Ferns, M.L. and L. Ramp. 1989. Geology and Mineral Resources Map of the Grassy Mountain Quadrangle, Malheur County, Oregon. State of Oregon, Department of Geology and Mineral Industries, GMS-57 1 plate.

Ferns, M.L., H.C. Brooks, J.G. Evans, and M.L. Cummings. 1993. Geologic Map of the Vale 30 x 60 Minute Quadrangle, Malheur County, Oregon, and Owyhee County, Idaho. State of Oregon, Department of Geology and Mineral Industries, GMS-77.

Fenneman, Nevin M. 1946. Physical Divisions of the United States: U.S. Geological Survey, scale 1:7,000,000.

Geology.com. 2017a. Oregon Lakes, Rivers and Water Resources, http://geology.com/lakes-rivers-water/oregon.shtml.

Geology.com. 2017b. Idaho Lakes, Rivers and Water Resources, http://geology.com/lakes-rivers-water/idaho.shtml.

Golder Associates Inc. (Golder). 2017a. Seismic Hazard Assessment, Grassy Mountain Mine Site, Malheur County, Oregon. Prepared for Calico Resources Corp., PN 1663524, Rev.0, dated July 14, 2017.

Golder. 2017b. Conceptual Design, Tailings Storage Facility, Grassy Mountain Project, Malheur County, Oregon. Prepared for Calico Resources USA Corp. Golder Doc. No. 1663241-Doc018-L-Rev0, August 22, 2017.

Golder 2018a. Pre-Feasibility Design Tailings Storage Facility, Grassy Mountain Project. Prepared for Calico Resources USA Corp., Golder Doc. No. 1663241-36-R-REV0, dated June 29, 2018.

Golder 2018b. Geotechnical Data Report, Grassy Mountain Project, Malheur County, Oregon. Prepared for Calico Resources Corp., PN 1663241, dated June 6, 2018.

Gray, J.J., Geitgey, R.P., and Baxter, G.L. 1989. Bentonite in Oregon: Occurrences, Analyses, and Economic Potential. State of Oregon Department of Geology and Mineral Resources, Special Paper 20.

Hegazy, Y.A. and Mayne, P.W., 1995. Statistical correlations between V30 and Cone Penetration Testing. Cpt 1995. Linkoping, Sweden, Vol. 2, 173-178.

Idriss, I.M., Abrahamson, N.A. and Archuleta, R.J. 2018. Chapter 13: Evaluation of Earthquake Ground Motions, Engineering Guidelines for the Evaluation of Hydropower Projects. Prepared for Division of Dam Safety and Inspections, Office of Energy Projects, Federal Energy Regulatory Commission (FERC).

International Code Council (IBC). 2018. *International Building Code.* Falls Church, Va.:International Code Council.

International Seismological Centre. 2014. On-line Bulletin, http://www.isc.ac.uk, Internatl. Seismol. Cent., Thatcham, United. Available at http://www.isc.ac.uk/iscbulletin/search/catalogue/ (accessed May 17, 2017).

Knudsen, K.L., I.G. Wong, J.D.J. Bott, G.E. Weber, W.J. Silva, and W.R. Lettis. 1994. Seismotectonic evaluation, Agency Valley and Bully Creek Dams, Vale Project, east-central Oregon: Draft Report prepared for U.S. Department of the Interior, Bureau of Reclamation, 171 pp., 4 pls.

Madin, I.P. 2009. Oregon: A Geologic History, 150 years of Statehood, 150 Million Years in the Making. Oregon Department of Geology and Mineral Industries, Interpretive Map 28.

Mayne, P.W. and Rix, R. J., 1995. Correlations between shear wave velocity and cone tip resistance in natural clays. Soils and Foundations, Vol. 35, No. 2, 193-194.

Mayne, P.W., 2006. A Global Statistical Correlation between Shear Wave Velocity and Cone Penetration Data. Conference Paper in Geotechnical Special Publication. May, 2006.

National Earthquake Hazards Reduction Program (NEHRP). 2009. *NEHRP Recommended Seismic Provisions for New Buildings and other Structures.* Prepared by the Building Seismic Safety Council of the National Institute of Building Sciences for the US Department of Homeland Security, Federal Emergency Management Agency. FEMA P-750.

Ostenaa, D. 1985. Memorandum to Chief, Division of Dam and Waterway Design, U.S. Bureau of Reclamation, Seismotectonic considerations for Modification Decision Analysis-Deer Flat Dams-Boise Project, Idaho, dated October 2, p. 10.

Othberg, K.L., and L.R. Stanford. 1992. Geologic map of the Boise Valley and adjoining areas, western Snake River Plain, Idaho: Idaho Geological Survey Geologic Map Series, scale 1:100,000.

Paramount Gold Nevada Corp. (Paramount). 2017. Grassy Mountain Gold Project. http://www.paramountnevada.com/projects/grassy-mountain-gold-project/.

Personius, S.F. and R.S. Lewis, compilers. 2003. Fault number 630, Jakes Creek fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 03:06 PM.

Personius, S.F. and R.S. Lewis, compilers. 2003. Fault number 636, Owyhee Mountains fault system, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:57 PM.

Personius, S.F. and R.S. Neier, compilers. 2003. Fault number 632, Squaw Creek fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:53 PM.

Personius, S.F. and R.S. Neier, compilers. 2010. Fault number 631, Big Flat fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 03:02 PM.

Personius, S.F., compiler. 2002. Fault number 1801, Warm Springs fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:55 PM.

Personius, S.F., compiler. 2002. Fault number 1802, Harney fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 03:08 PM.

Personius, S.F., compiler. 2002. Fault number 805, Juniper Mountain fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:54 PM.

Personius, S.F., compiler. 2002. Fault number 806, Cottonwood Mountain fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:18 PM.

Personius, S.F., compiler. 2002. Fault number 807, Faults near Unity Valley, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:59 PM.

Personius, S.F., compiler. 2002. Fault number 856a, Steens fault zone, Crowley section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:43 PM.

Personius, S.F., compiler. 2003. Fault number 635, Western Snake River Plain fault system, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 05/15/2017 02:56 PM.

Petersen, M.D., A.D. Frankel, S.C. Harmsen, C.S. Mueller, K.M. Haller, R.L. Wheeler, R.L. Wesson, Y. Zeng, O.S. Boyd, D.M. Perkins, N. Luco, E.H. Field, C.J. Wills, and K.S. Rukstales. 2008. Documentation for the 2008 Update of the United States National Seismic Hazard Maps: US Geological Survey Open-File Report 2008-1128.

Piratheepan, P. (2002). Estimating Shear-wave Velocity from SPT and CPT data. Dissertation. M.S. Clemenson University, 2002.

State of Oregon. 2003. Map of Selected Earthquakes for Oregon, 1841 through 2002. Department of Geology and Mineral Industries, Open-File Report 03-02.

Stirling, M. W., M. C. Gerstenberger, N. J. Litchfield, G. H. McVerry, W. D. Smith, J. Pettinga, and P. Barnes (2008). Seismic hazard of the Canterbury region, New Zealand: New earthquake source model and methodology, Bull. New Zeal. Natl. Soc. Earthq. Eng. 41, 51–67. USGS (US Geological Survey), 2006. Quaternary fault and fold database for the United States, accessed 05/15/2017, from USGS web site: https://earthquakes.usgs.gov/regional/qfaults/.

U.S. Geological Survey (USGS). 2014. Unified Hazard Tool. Accessed June 2019 at https://earthquake.usgs.gov/hazards/interactive/.

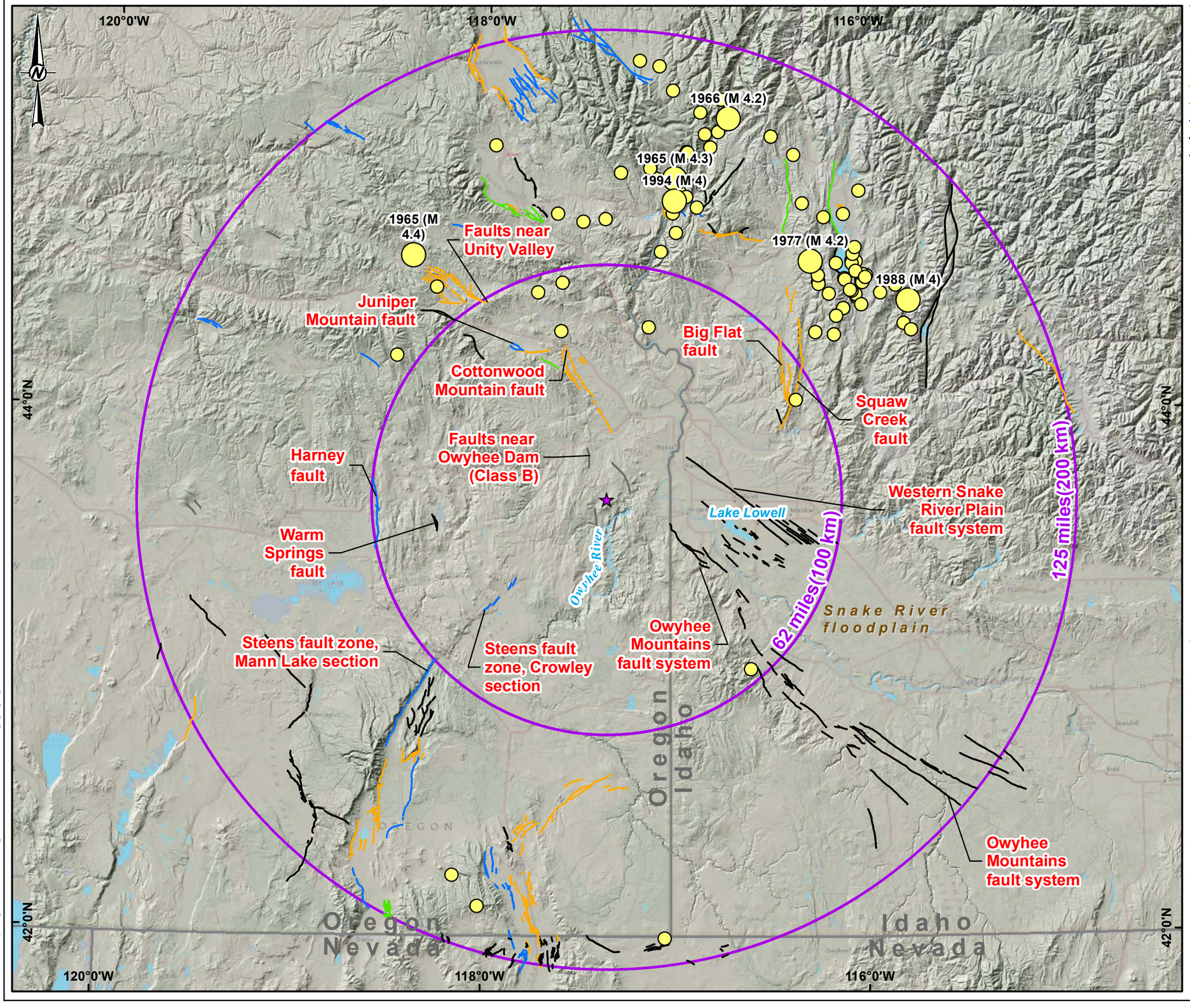
USGS .2016. Earthquake Hazards Program: Search Earthquake Catalogue. Available at http://earthquake.usgs.gov/earthquakes/search/, accessed May 17, 2017.

USGS . 2017. Design Ground Motions. https://earthquake.usgs.gov/hazards/designmaps/, accessed June 17, 2019.

Wesnousky, S.G. 2008. Displacement and geometrical characteristics of earthquake surface ruptures: Issues and implications for seismic hazard analysis and the process of earthquake rupture. Bulletin Seismological Society of America 98(4):1609-1632.

Wood, S.H., and J.E. Anderson. 1981. Chapter 2-Geology, in Mitchell, J.C., ed., Geological, hydrological, geochemical and geophysical investigations of the Nampa-Caldwell and adjacent areas, southwestern Idaho: Idaho Department of Water Resources Water Information Bulletin No. 30, Geothermal Investigations in Idaho, Part 11, p. 9-31.

Figure 1



LEGEND

Grassy Mountain TSF Site

Faults

Age of Most Recent Movement

- Latest Quaternary (<15,000 years)
- Late Quaternary (< 130,000 years)
- Middle and Late Quaternary (< 750,000 years)
- Quaternary (< 2.6 million years)
- Class B Faults

Historical Earthquake Epicenters

Magnitude

- 3.0 - 3.9
- ≥ 4.0

0 20 40

MILES

REFERENCE(S)

1. EARTHQUAKE EPICENTERS COMPILED BY GOLDER FROM MULTIPLE SOURCES, SEE REPORT REFERENCES SECTION
2. FAULTS: USGS (2018)
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N
4. SERVICE LAYER CREDITS: USGS,NGA,NASA,CGIAR,GEBCO,N ROBINSON,NCEAS,NLS,OS.NMA,GEODATASTYRELSEN AND THE GIS USER COMMUNITY CONTENT MAY NOT REFLECT NATIONAL GEOGRAPHIC'S CURRENT MAP POLICY. SOURCES: NATIONAL GEOGRAPHIC, ESRI, DELORME, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, INCREMENT P CORP.

CLIENT

CALICO RESOURCES USA CORPORATION/
PARAMOUNT GOLD NEVADA CORPORATION

PROJECT

SEISMIC HAZARD ASSESSMENT
GRASSY MOUNTAIN TSF SITE
MALHEUR COUNTY, OREGON

TITLE

HISTORICAL EARTHQUAKES AND POTENTIALLY SEISMOGENIC FAULTS IN REGION SURROUNDING THE PROPOSED GRASSY MOUNTAIN TSF SITE

CONSULTANT

GOLDER

YYYY-MM-DD	2019-06-18
DESIGNED	HJ/DL
PREPARED	HJ
REVIEWED	DL
APPROVED	AH

PROJECT NO.	PHASE	REV.	FIGURE
1663241	25000	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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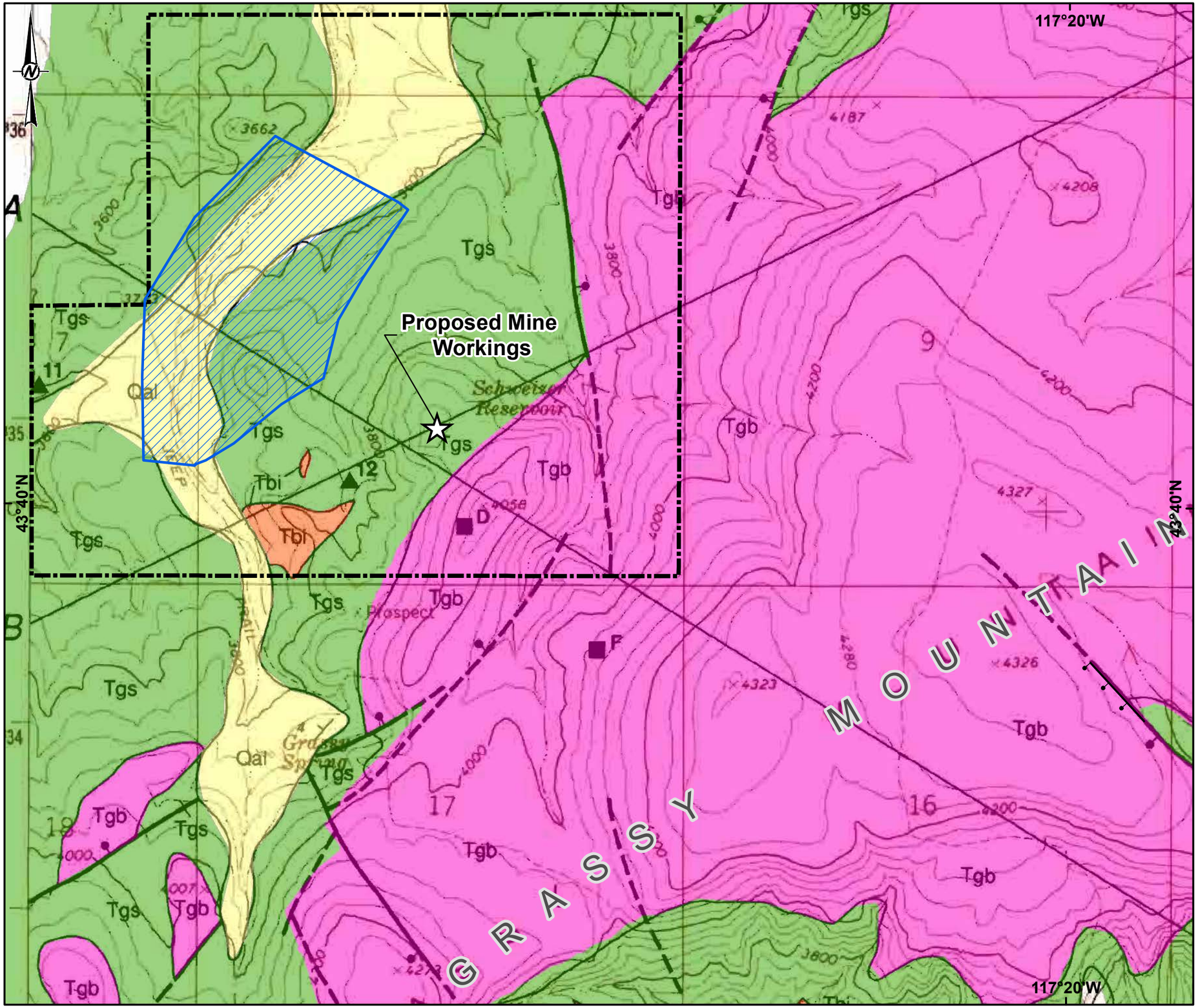
Figure 2



REFERENCE(S)

1. GEOLOGY: FERNS AND RAMP (1989)
2. COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N

CLIENT
CALICO RESOURCES USA CORPORATION/
PARAMOUNT GOLD NEVADA CORPORATION

PROJECT
SEISMIC HAZARD ASSESSMENT
GRASSY MOUNTAIN TSF SITE
MALHEUR COUNTY, OREGON

TITLE
MAPPED GEOLOGICAL UNITS SURROUNDING THE GRASSY MOUNTAIN TSF SITE

CONSULTANT
GOLDER

YYYY-MM-DD	2019-06-18
DESIGNED	HJ/DL
PREPARED	HJ
REVIEWED	DL
APPROVED	AH

PROJECT NO.	PHASE	REV.	FIGURE
1663241	25000	0	2

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APPENDIX C

Geotechnical Stability and Settlement Analyses

November 4, 2019 1663241.061.L.REV0

Mr. Christopher J. MacMahon, PE
Golder Associates Inc
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Suite 1000
Reno, Nevada 89521

GEOTECHNICAL STABILITY ANALYSIS AND SETTLEMENT CALCULATIONS
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
GRASSY MOUNTAIN PROJECT, MALHEUR COUNTY, OREGON

Dear Mr. MacMahon,

1.0 INTRODUCTION

This letter presents the geotechnical stability analysis and settlement calculations carried out for the proposed Tailings Storage Facility (TSF) and waste rock dump (WRD) for Calico Resources USA Corp's (Calico's) Grassy Mountain Project (Project) located in Malheur County in southeastern Oregon.

The proposed TSF is designed to be constructed in three stages (Stages1 to 3) using downstream construction methods. The TSF and WRD are designed to be fully geomembrane-lined with a continuous secondary geosynthetic clay liner (GCL) underlayment and leak collection and recovery system (LCRS) between the two primary and secondary containment layers.

Material properties were developed using data obtained during geotechnical investigations performed by Golder Associates Inc. (Golder) presented in Appendix A of the main TSF Design Report that this letter is appended to.

2.0 TSF OVERVIEW

Embankments will be required on the north and west sides of the TSF to impound tailings (Figure 1). The main North embankment will span the width of the valley, with a Stage 3 crest length of about 1,700 feet and maximum height of about 84 feet. The West embankment will be used to bridge saddles along the western ridge, with a Stage 3 crest length of about 1,000 feet and maximum height of about 30 feet. The TSF impoundment and upstream embankment slopes will be continuously-lined using 80 mil high density polyethylene (HDPE) geomembrane primary containment layer and an enhanced GCL secondary containment layer.

3.0 GENERAL GROUND CONDITIONS

3.1 Regional Geology

The proposed TSF and WRD site (and surrounding region) is located within in the Columbia Plateau, a physiographic province of the United States that comprises thick sequences of basalt flows (Columbia River

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Basalt) erupted from about 17.5 to 6 million years ago (Ma). The relatively unaltered basalt flows in the Payette section range in elevation from about 3,800 feet to about 4,500 feet above sea level (asl).

The TSF and WRD site is located about 15 miles southwest of the Snake River plain near Adrian, Oregon. At this location, some dissection of the basalt flow-dominated landscape has occurred, exposing the underlying sedimentary units of the Grassy Mountain Formation. The site is located within a north-flowing drainage area at an elevation of about 3,700 feet asl,

3.2 Site Geology

The geology of the region surrounding the TSF and WRD site is a sequence of sedimentary and volcanic deposits within the Oregon-Idaho Graben. Contemporaneous deposition of sandstone and conglomerate (Tgs), olivine basalt emplacement (Tbi), and repeated episodes of calc-alkaline lava eruption and flow (Tgb) occurred during middle to upper Miocene time. The Payette section of the Columbia Plateau, where the TSF and WRD site is located, is a relatively uniform area of basalt flows that overlie and cap the underlying older sedimentary deposits.

Grassy Mountain itself is mapped as underlain by calc-alkaline rich volcanic flow deposits (Tgb) and associated olivine basalt that crops out farther northeast. The TSF and WRD site is located on a thick sequence of arkosic sandstones containing interbeds of conglomerate separated by the tuff of Kern Basin. Geologically, the site is within the upper arkosic (mid- to upper Miocene) and the lower (mid-Miocene) arkosic units. Erosion over about the last 11 Ma has removed some of the volcanic deposits that overlie and cap the sedimentary units to expose the upper arkosic unit at the Site.

Bedrock outcrops within the site expose siltstone, sandstone, and conglomerate of the late Miocene Grassy Mountain Formation. These units are also exposed in the northeast–southwest trending drainage that the TSF will partially fill. Olivine-rich basalts are present immediately to the east and south. Igneous intrusions (Tbi) are mapped as isolated bodies surrounded by the sedimentary units (Tgs). The intrusive bodies are in places aligned along the mapped pre-Quaternary faults that may have controlled the locations and extent of these shallow intrusions.

The surficial soils at the TSF and WRD site area include unconsolidated alluvium and colluvium overlying previously unmapped Miocene-aged lacustrine clays. The lacustrine deposits are generally characterized as fat (high plastic) clay (with variable quantities of fine- to medium-grained sand, dark tan to brown with some blue-gray deposits) with lesser amounts of lean (low plastic) clay and poorly-graded sand lenses. Similar deposits were mapped by Ferns et al. (1993) approximately 2 miles (3 km) northeast of the proposed TSF site. Gray et al. (1989) considers that the clay was deposited during the Upper Miocene within alkaline lakes subjected to regular volcanic ash fall and/or hydrothermal alteration.

The Grassy Mountain Mine site is located on a 150-foot high, highly resistant, silicified and iron-stained knoll. Bedding within the sandstone unit appears unaltered at the hilltop, dips at 10° to 25° toward the north-northeast on the northern and eastern flanks of the hill and steepens to 30° to 40° on the west side of the hill due to drag folding in the footwall along a fault striking about N20°W (Paramount 2017). Normal faulting of the Miocene-age units is common, with most faults striking either northwest–southeast or northeast–southwest (most common).

Also, a number of mapped older faults strike approximately north–south, but these faults are generally located west of the TSF site and are not considered seismogenic under the current tectonic environment.

3.3 Seismic Hazard Assessment

Golder completed a preliminary seismic hazard analysis (SHA) for the Grassy Mountain Mine in 2017 (Golder, 2017). Subsequent to additional geotechnical field investigations in 2019, the preliminary SHA was updated to support the design of the TSF and WRD.

The SHA developed earthquake ground motions using both a deterministic seismic hazard analysis (DSHA) and probabilistic seismic hazard analysis (PSHA) for the proposed Grassy Mountain TSF and WRD site. The updated SHA is included in the main TSF Design Report this letter is appended to.

The proposed TSF and WRD site is classified as Class D based on the review of shear wave velocity measurements ($V_{S,30}$ of 850 ft/s). A probabilistic analysis using the USGS 2014 National Seismic Hazard Model indicates mean peak ground accelerations (PGA) for Site Soil Class D for return periods of 475 and 2,475 years. The following table presents PGA and spectral accelerations for the referenced return periods:

Table 1: Peak Ground Acceleration, 0.2- and 1.0-second Spectral Accelerations (Sa) for Selected Return Periods at the Grassy Mountain Tailings Storage Facility Site, Malheur County, Oregon

Probability of Exceedance (return period in years)[1]	**Mean PGA (g)**	**0.2 second Sa (g)**	**1.0 second Sa (g)**
Site Soil Class D ($V_{S,30}$[2] of 850 ft/s)			
10% in 50 years (475)	0.08	0.20	0.10
2% in 50 years (2,475)	0.20	0.50	0.23

Notes:

1. Values from the 2014 USGS national probabilistic model (Dynamic; Conterminous v.4.1.1) for a site location of 43.6728°N, 117.36437°W
2. $V_{S,30}$ is the shear wave velocity in the upper 100 feet (30 m) below the site

A deterministic analysis was used to estimate the maximum credible earthquake (MCE) that could be experienced at the Grassy Mountain Mine. The MCE is the largest possible earthquake that may reasonably occur along a recognized fault or within a geographically defined tectonic province, under the presently known or presumed tectonic framework. Little regard is given to the earthquake recurrence interval, which may vary from less than a hundred years to more than ten thousand years, depending on the geologic and tectonic environment under consideration.

Median (50th percentile) values of PGA created by an MCE are sometimes used for analysis and design of low failure consequence structures, while 84th percentile values are often used for high failure consequence structures.

Median (50th percentile) PGA values were calculated because the earthquakes originate on faults with average slip rates less than 0.3 mm/yr as recommended by Idriss et al. (2018). Soil Site Class D PGA values range from 0.03g to 0.15g. The largest median PGA values result from an **M**7.2 earthquake occurring along the Cottonwood Mountain fault north of the TSF site. The median PGA of 0.15g from the MCE indicates a relatively low level for the deterministic hazard at the TSF site. The median MCE was used for stability assessment of the TSF embankments and exceeds the minimum requirements of Oregon Administrative Rues (OAR) 690-020-0038 for Low Hazard dams.

The WRD is considered a temporary facility; therefore, a return period of 475 years with mean PGA of 0.0.08g was used for stability assessment of the WRD facility.

3.4 Geotechnical Investigation Data

The geotechnical investigations and laboratory testing programs pertinent to the development of geotechnical material property characteristics for the Grassy Mountain TSF and WRD site are briefly summarized below. Borehole locations from these investigations are shown on the Design Drawings in the main TSF Design Report this letter is appended to.

3.4.1 2017 Borehole Investigation

This investigation included advancing 14 boreholes to depths ranging between 25 feet to 100 feet below the ground surface (bgs) and excavating 45 test pits to depths of up to 20 feet bgs from November 30 to December 8, 2017. A geotechnical laboratory testing program on selected samples included index testing (grain size analysis, moisture, and Atterberg Limits), permeability (hydraulic conductivity) testing, consolidated undrained (CU) triaxial shear strength testing with porewater pressure measurement, oedometer (one-dimensional consolidation) testing and modified Proctor compaction testing.

3.4.2 2019 Borehole Investigation

This investigation included advancing six boreholes to depths ranging between 50 to 120 feet bgs from March 20 to 26, 2019. The investigation also included laboratory testing on selected samples including index testing (grain size analysis, moisture, and Atterberg Limits), triaxial tests and oedometer tests. Results from this investigation are presented in Appendix A of the main TSF Design Report.

3.4.3 2019 CPT Investigation

This investigation included pushing Cone Penetration Tests (CPTs) from August 16 to 20, 2019. A total of 12 CPTs (8 CPTs and 4 Seismic CPTs) were completed to depths ranging between 11 to 61 feet bgs. Pore water pressures induced during pushing of the cone tip were recorded during all CPTs, with pore pressure dissipation tests performed at selected intervals during the testing program. Results from this investigation are presented in Appendix A of the TSF Design Report. Shear wave velocities were recorded during seismic CPTs at four locations down to the depth of 60 feet bgs.

No groundwater table was detected during the CPT program.

3.5 Stratigraphy

Golder's subsurface 2017 and 2019 geotechnical investigations identified an unconsolidated surficial layer of alluvium (clayey/gravely/silty sand) overlying a thick layer of previously unmapped Miocene-aged lacustrine clays underlying most of the TSF and WRD site area. The lacustrine deposits were generally classified as CL to CH according to the Unified Soil Classification System (USCS), and characterized as high plastic, stiff to hard clay (with variable quantities of fine- to medium-grained sand, dark tan to brown with some blue-gray deposits) with lesser amounts of low plastic clay and poorly graded sand lenses.

The depth of the surficial alluvium and colluvium layer was up to 8 feet under the main North embankment and varied between 10 feet and 20 feet under the west dam embankment. The thickness of the clay layer is estimated to be more than 100 feet. Interbedded layers of sand and silt exist within the clay layer at some locations.

3.6 Groundwater Conditions

No groundwater was encountered during the field exploration with boreholes extending to a maximum depth of approximately 120 feet bgs. In the *Groundwater Resources Baseline Data Report* prepared by SPF Water Engineering, LLC (SPF 2019), it was reported that the groundwater depth beneath the southern portion of the TSF basin ranged between 155 feet at the BLM well located within the TSF footprint and 232 feet at the GW-3 well located just southwest of the TSF (SPF 2019). Inferred groundwater contours presented in the same report indicate groundwater beneath the reclaim pond area may be as shallow as 55 feet; however, no groundwater was encountered in any of the boreholes extending to a maximum depth of approximately 120 feet bgs. Groundwater depths in this area will be refined after the installation of proposed groundwater monitoring wells as presented in SPF (2019)'s report. In addition, no springs were observed in the TSF or mine facility areas during the field investigation.

4.0 MATERIAL PROPERTIES

Geotechnical material properties for use in stability analyses and settlement calculations are summarized in the following sections. Material units were assessed properties developed using information described in the TSF Design Report. Table 2 summarises the material properties selected for the following units:

- Tailings
- Embankment Fill
- Waste Rock
- Lining Interface
- Foundation Alluvium Layer
- Foundation Clay Layer

Table 2: Geotechnical Material Properties for Stability Analysis

Unit	Bulk Unit Weight (pcf)	Strength Model	Shear Strength Parameters					Bbar[1]
			Undrained Shear Strength, s_u (psi)	Effective Stress		Total Stress		
				Friction Angle, Φ' (deg)	Cohesion, c' (psi)	Friction Angle, Φ (deg)	Cohesion, c (psi)	
Tailings	95	Mohr-Coulomb	-	-	-	15	0	0
Lining System	120	Mohr-Coulomb	-	11	0	-	-	0
Embankment Fill	135	Mohr-Coulomb	-	40	0	-	-	0
Waste Rock	135	Mohr-Coulomb	-	35	0	-	-	0

Unit	Bulk Unit Weight (pcf)	Strength Model	Shear Strength Parameters					Bbar[1]
			Undrained Shear Strength, s_u (psi)	Effective Stress		Total Stress		
				Friction Angle, Φ' (deg)	Cohesion, c' (psi)	Friction Angle, Φ (deg)	Cohesion, c (psi)	
Foundation Alluvium	130	Mohr-Coulomb	-	30	0	-	-	0
Foundation Clay	120	Mohr-Coulomb	-	14	2 (315 psf)	-	-	0.15
		Undrained Mohr-Coulomb	20 (2851 psf)		-	-	-	-

Notes:

1. The porewater pressure parameter Bbar is defined as the ratio of load-induced excess porewater pressure to the applied loading expressed in terms of the increment of total vertical stress.

4.1 Tailings

Golder (2018) carried out laboratory testing on tailings samples prepared from bench-scale testing to assess their classification properties, settled density, compressibility and permeability characteristics. A bulk unit weight of 95 pcf was selected for tailings for the stability analyses. The strength parameters for tailings (total stress friction angle, ϕ = 15 degrees and cohesion, c = 0) were selected based on Golder's knowledge and experience with similar tailings facilities. Due to the embankments being constructed using downstream techniques, this unit is not a controlling unit in terms of the stability of the embankments; therefore, no advanced strength tests were carried out to characterize its frictional strength. The strength parameters selected for the tailings are conservatively low and will potentially be higher during operation and closure.

4.2 Embankment Fill

Quarried basalt rock will be used as mass fill material for the TSF embankment and Waste Rock Dump berms. The quarried material is expected to act as a competent and strong rockfill. The suitability of the basalt quarry source to be used as embankment fill material has been assessed by Golder (2019). A bulk unit weight of 135 pcf was selected for quarried basalt fill. The strength parameters for embankment fill material (ϕ'=40 degrees and c'=0) were selected based on review of data provided by Leps (1970) for similar material and range of applied vertical stresses. The maximum applied vertical stress of the embankment fill at the embankment foundation is about 80 psi, based on the maximum Stage 3 height of the embankment (84 feet). Figure 2 presents the supporting data from Leps (1970) and selected friction angle for embankment fill material.

4.3 Waste Rock

During mining, waste rock material will be temporarily stockpiled on the WRD pad. As mining progresses, the stockpiled waste will be rehandled and used as aggregate for cement rock backfill in the underground workings. Based on the current mine plan, the maximum anticipated volume of waste rock to be stockpiled is less than 200,000 tons. The proposed WRD is designed to contain a maximum volume of 200,000 tons of waste.

Generally, materials stockpiled will consist of coarse yet relatively weak run-of-mine waste rock. Waste rock will be placed in relatively thick and uncompacted lifts. However, due to the relatively low rate of dump development, the waste materials are expected to densify over time. A conservative material strength of ϕ'=35 degrees and c'=0 has bee selected.

4.4 Lining System

The proposed geosynthetic lining system to be used for the TSF and WRD consists of (from bottom to top) prepared subgrade, a geosynthetic liner (GCL), an 80-MIL HDPE geomembrane with single-sided texturing (textured side facing down), an 18-inch thick drainage layer, and a 6-inch thick filter fill layer. This lining system will be directly below the tailings in the TSF and the waste rock in the WRD.

Mohr-Coulomb strength parameters for the Lining System were estimated based on Golder's database of past interface direct shear testing between various types of geomembrane liner, soil and other geosynthetics. Golder reviewed strength parameters from this database from over 100 direct shear tests between GCL and soil and over 120 direct shear tests between textured geomembrane and GCL. In our review, Golder found that the interface direct shear tests between the GCL and textured geomembrane generally resulted in the lowest residual strength values. Therefore, average Mohr-Coulomb strength parameters of Φ' = 11° and c' = 0 psi for the GCL-geomembrane interface were conservatively assigned to be the modeled Lining System.

The strength of the lining system does not control the stability of the TSF but is an important factor for stability of WRD. Considering that WRD is a temporary structure which will be removed at closure, the long-term behaviour of the lining system was not assessed for WRD. If waste rock is intended to be stored on the WRD for durations longer than the current life of mine, stability of the WRD should be reconsidered for long-term conditions.

4.5 Alluvium Foundation Layer

These deposits were surficial in the TSF area and were generally characterized as compact to very dense sand to clayey gravelly or silty sand with up to 45% fines content, by weight. The thickness of the alluvium layer is up to 8 feet under the North embankment and varies between 10 feet and 20 feet under the West embankment. The uncorrected field Standard Penetration Testing (SPT) blow counts (N-value) recorded during 2017 and 2019 investigations for the near surface alluvium vary between 12 to 81 blows per foot of penetration.

This unit is not a controlling unit in terms of the stability of the embankments, therefore, no advanced strength tests were carried out to characterize its frictional strength. Considering that the high blow counts might be due to presence of gravel, an average friction angle of 30 degrees and cohesion of zero was conservatively assigned for alluvium layer.

4.6 Clay Foundation Layer

The Miocene-aged clay layer that underlies most of the TSF and WRD site were generally characterized as high plastic, stiff to hard clay (with variable quantities of fine- to medium-grained sand, dark tan to brown with some blue-gray deposits) with lesser amounts of low plastic clay and poorly graded sand lenses. The thickness of the clay layer was estimated to be over 100 feet (at the location of Boreholes TP-01, TP-02, TP-19 and TP-44, clay layer was observed at depth of 120 feet bgs). The measured water content for clay samples ranged between 2% to 73% with an average of 29% and standard deviation of 9%. The measured Plasticity Index for clay samples ranged between 10 to 198 with an average of 63 and standard deviation of 36.

Since this layer is a controlling unit for both stability analysis and settlement estimates, a comprehensive laboratory testing program and CPT program was developed to assist with understanding the geotechnical engineering characteristics of the layer. Figure 1A presents Golder's interpretation of the clay foundation layer's continuity below the North embankment. The following sections describe the material properties interpreted from the available investigations and laboratory testing programs on the foundation clays.

4.6.1 Pre-consolidation pressure

4.6.1.1 CPT Results

The estimated pre-consolidation pressure (using well-established published correlations) versus depth from all CPTs is presented on Figure 3. As shown, the likely pre-consolidation pressure increases with depth at a rate of about 3.3 psi/feet. A pre-consolidation pressure of about 90 psi was estimated for upper clay layers close to the ground surface. Since the anticipated maximum vertical stress caused from construction of the embankment is about 80 psi, it is concluded that the foundation clay will mostly remain over-consolidated (i.e., the stress imposed by the embankment will not make the clay become normally consolidation because the pre-consolidation pressure would not be exceeded).

4.6.1.2 Consolidation Test Results

The average estimated pre-consolidation pressure (p_c) from four laboratory Oedometer (1-dimensional consolidation) tests performed on selected samples of foundation clays is about 70 psi which is slightly lower than the estimated p_c from the CPT data (Section 4.6.1.1) and supports the strongly over-consolidated nature of the clays. The p_c from laboratory oedometer tests is likely to be underestimated due to the tested saturated conditions of the test specimens, while the in-situ condition of the foundation clay as identified by the field CPT tests is unsaturated. The results from the field CPT program are considered more representative of measuring the in-situ undrained shear strength and pre-consolidation pressure of the foundation clay and were therefore relied more heavily on in strength parameter selection. A pre-consolidation pressure p_c of 90 psi was selected for shear strength estimation of the clay layer.

4.6.2 Shear Strength Parameters

According to Mesri (1975), the undrained shear strength of clay (s_u) can be reliably estimated as 0.22 x p_c. This relationship has been demonstrated to be valid for a large number of clays and is commonly used in state-of-practice to estimate undrained shear strength.

A s_u of 19.8 psi (2,850 psf) was estimated for the foundation clay based on the selected p_c of 90 psi (as described on Section 4.6.1).

The measured peak effective friction angle on selected samples of the clay layer from triaxial shear strength tests completed for this study varies between 8 to 38 degrees for low confining (consolidation) stresses of about 35 psi. The effective friction angle of the clay decreases with increasing Plasticity Index. Based on data from Lo (1995) and Bjerrum (1968), the effective-stress friction angle of clay varies between 8° to 35° for PI of 10 to 198.

The failure surface normally passes through the weakest layer(s) (the layer with high plasticity index in clay deposits). Layering of the foundation clay deposit can create discontinuous areas of weaker and stronger materials. Based on laboratory strength and oedometer testing, variability in strength was observed. Due to this variability, clear delineation of these layers during typical geotechnical investigations.

Given these considerations, an average effective friction angle of 14 degrees was selected for the foundation clay. As shown in the geotechnical laboratory test results appended to the main Design Report, this effective friction angle is slightly lower than average strength measured.

Additionally, to account for the in situ unsaturated condition of the foundation clay and additional strength due to suction, an effective cohesion of approximately 2 psi (315 psf) was assigned.

4.6.3 Modulus of Elasticity

Golder estimated embankment settlements resulting from foundation compression using both consolidation theory and elastic settlement theory, the latter of which relies on the elastic moduli of the foundation geology.

The modulus of elasticity for the clay foundations can be estimated based on the large strain shear modulus of the soil, which in-turn is estimated using field data from the geotechnical investigations. The small strain (strain less than 10^{-4} %) shear modulus G_0 for the foundation clay was estimated from the shear wave velocity, V_s, measurements during the 2019 CPT program as:

$$G_0 = \rho V_s^2 \quad (1)$$

Where ρ is the in-situ density of the clay layer. Figure 4 presents the measured shear wave velocities and calculated G_0 versus depth from the four seismic CPTs carried out in Golder's 2019 CPT investigation. Vucetic and Dobry (1991) suggests that the large-scale shear modulus can be estimated using an average 80% reduction from the small-strain shear modulus for strain levels greater than 1% (i.e. $G/G_0=0.2$), as appropriate for strain level commonly experienced in engineering projects dealing with over-consolidated clay (OCR of up to 15) and PI of about 50. It is, therefore, estimated that the shear modulus (G) at engineering strain levels expected for the TSF is about $0.2xG_0$.

The undrained modulus of elasticity was calculated using the following equation of elastic theory:

$$E_{un} = 2(1+\nu)\mathrm{G} \quad (2)$$

where ν is the soil's Poisson's ratio. Figure 4 presents the calculated modulus of elasticity for clay layer versus depth assuming $\nu = 0.4$.

4.6.4 Compressibility Index and Swelling Index

The consolidation parameters: compressibility index, c_c, and swelling index, c_s, can be determined using the void ratio versus vertical stress in semi-log scale plot from oedometer tests. The slope of this plot at vertical stresses less than p_c is the swelling index, c_s, and at vertical stresses higher than p_c is the compressibility index, c_c. An average initial void ratio of 1, c_s of 0.04 and c_c of 0.4 was selected for the foundation clay layer based on the review of four oedometer tests results from the 2019 investigation provided in Appendix A of the main Design Report. These parameters were used for settlement calculations under the embankment due to primary consolidation of the foundation clay layer (Section 7.0).

5.0 MODEL GEOMETRY

Embankments will be constructed on the north and west sides of the TSF to impound tailings. A relatively short containment berm will be constructed around the perimeter of the WRD as shown on the Design Drawings appended to the main Design Report.

5.1 TSF Embankments

Both the North and West embankments will be constructed with an overall upstream slope of 3 horizontal to 1 vertical (3H:1V) or flatter (local slopes of 2.5H:1V separated by benches), and a downstream slope of 2.5H:1V. These slopes are selected during design to satisfy geotechnical stability of the embankment and foundation soils. The maximum height of the North embankment is about 84 feet, while the maximum height of the West embankment is about 30 feet. A minimum freeboard of 2 feet was considered for the embankments.

The phreatic surface was assumed to be at top of the Stage 3 tailings surface along the upstream side of the TSF with no phreatic surface within the embankment due to presence of the geosynthetic lining system.

No groundwater surface was included in the model as groundwater was not encountered in the geotechnical boreholes to depths of 120 feet below ground surface.

However, a pore pressure parameter, Bbar (defined as the ratio of load induced excess porewater pressure to the applied loading) of 0.15 was assumed for clay foundation to account for in-situ water content within foundation clay and excess porewater pressures built up during construction of the embankment. Bbar of 0.1 to 0.2 have been measured in similar foundation material during embankment construction in similar projects (Sherard 1963).

5.2 WRD Pad

Waste rock materials generated during mining will be stockpiled in a waste rock dump (WRD) near the TSF. Waste rock will be stored above a geomembrane lined pad located south of the TSF utilizing the same lining system as the TSF basin as discussed in Section 4.3. Generally, the WRD pad slopes from south to north at an approximate 2.5 percent grade. A perimeter berm with maximum height of about 12 feet, downstream slope of 2.5H:1V and upstream slope of 2H:1V was designed to support the placement of the waste rock material.

An underdrain collection system will be installed above the geomembrane liner for the WRD similar to the TSF underdrain collection system (perforated piping within a drainage layer above the geomembrane liner). Detailed design of the WRD pad, collection system, and cross sections are presented on the Design Drawings appended to the main Design Report.

No groundwater table was assumed in the foundation, however, as discussed in Section 5.1, Bbar of 0.15 was assumed for foundation clay.

6.0 STABILITY ANALYSIS

Golder designed the TSF embankments geometry based on deterministic stability analysis of both upstream and downstream of the of the main north and west TSF embankments and the WRD.

The analyses were performed using the 2-D limit equilibrium methods provided by the software package Slide 2018 (Rocscience 2018). The analyzed cross-sections were evaluated for both static and pseudo-static loading conditions using the Morgenstern-Price Method of slices to calculate the FOS against failure along the critical surface (i.e., the failure surface with the minimum calculated FOS) that was identified through an automated search algorithm.

Cross sections include the maximum embankment and/or dump heights of each facility, with additional sections being developed at the North embankment to refine the need for and/or extent of a downstream buttress. Figure 1 shows the location of the cross sections analysed for geotechnical stability assessment of the TSF and WRD.

Sections A, B and C are within the North embankment, Section D is within the West embankment, and Section E is within the WRD. Section D extends through the highest West embankment height of 30 feet.

As discussed in the main Design Report, no definitive factor of safety design criteria is presented the Oregon Administrative Rules (OAR), Division 20 – *Dam Safety*. The minimum factors of safety selected by Golder for static and pseudo-static loading conditions were selected based on Golder's expertise and industry best practice for tailings facilities in areas with arid climates and moderate seismicity.

Golder selected a minimum factor of safety of 1.5 for stability of the embankments and WRD under static loading and a factor of safety of 1.1 for pseudo-static loading conditions.

Both effective stress analysis (drained conditions) and total stress analysis (undrained conditions) were analysed using the material properties summarised in Table 1 for the foundation clay material**.** Considering the low permeability of the clay foundation and its in situ water content of up to 73 percent, by weight, (Section 4.6), it is likely that the clay foundation will shear in undrained conditions during construction of the embankment. Therefore, a total stress analysis was also conducted for analysed sections.

Pseudo-static analysis is one of the simplified approaches for analysing the seismic response of the embankments. This method is commonly used for facilities with low consequence of failure constructed at sites with low seismicity and for dam embankment and foundation soils that do not liquefy. For pseudo-static stability analysis, state-of-practice uses a horizontal seismic coefficient (k) that is half of the design PGA (Hynes-Griffin, Franklin, 1984) presented in Section 3.3. For the TSF site, the seismic coefficient used is 0.075 g (1/2 of the PGA of 0.15g). For the WRD, the seismic coefficient used is 0.04g (1/2 of the PGA of 0.08g).

6.1 Results

The results from the stability analysis are presented in Figures 5 to 18 for all three stages of the TSF embankment construction and WRD. A summary of the calculated factor of safeties for each section are presented in Table 3 and Table 4.

6.2 TSF Embankments

The foundation failure mode (i.e. failure through the foundation) using both effective stress analysis and total stress analysis were considered for stability analysis of TSF embankments. The internal failure mode (i.e. failure through the tailings and embankment fill material) was found not to be a controlling failure mode for TSF embankments. Stability analysis results for the TSF embankments are presented in Table 3 below.

All minimum calculated factors of safety for the Stage 1 (with downstream slope of 2.5H:1V) were higher than the minimum criterion for both static and pseudo-static analyses. Stages 2 and 3 require 15 feet high by 30 feet wide buttress constructed at the downstream toe to meet the required minimum calculated factor of safety under pseudo-static conditions.

It was found that the tailings' material properties are not controlling the failure surface as the failure surface with minimum factor of safety doesn't pass through the tailings.

It should be also noted that no groundwater was assumed for both effective stress and total stress analysis. If during construction or afterward, a shallow groundwater elevation was observed, the stability of the embankments should be reassessed.

Since the calculated factor of safeties for pseudo-static conditions under both effective stress and total stress analysis are sufficiently above the required factor of safety of 1.1, additional deformation analyses were not considered necessary.

Table 3: Summary of Critical Stability Analysis Results of TSF Embankments

Analysis Method	Stage of Construction	Static FOS (Target design minimum is 1.5)				Pseudo-static FOS (k = 0.075 g) (Target design minimum is 1.1)			
		North Embankment			West Embankment	North Embankment			West Embankment
		Section A	Section B	Section C	Section D	Section A	Section B	Section C	Section D
Effective Stress	1	1.5	1.7	1.6	1.9	1.2	-	-	1.4
	2	1.5	1.6	1.6	1.7	1.2	-	-	1.3
	3	1.5	1.5	1.5	1.5	1.2	-	-	1.2
Total Stress	1	2.1	-	-	-	1.7	-	-	-
	2	1.8	-	-	-	1.3	-	-	-
	3	1.5	-	-	-	1.1	-	-	-

6.3 Waste Rock Dump

The following two failure modes were considered for stability analysis of the WRD:

- Foundation failure mode (i.e. failure through the waste rock and foundation)
- Waste rock block sliding over the liner system

As shown on Figures 18 and 19 and summarised on Table 4 below, the minimum calculated factor of safety for Section E for the WRD was higher than the required minimum calculated factor of safety for both static and pseudo-static analyses.

The waste rock block sliding over the lining system (where the failure surface occurs at the weak interface between the liner and the waste rock) is the controlling mode of failure for WRD design (calculated FOS of 1.6). It was assumed that the drainage system designed for WRD will prevent a build up of pore water pressure within

the waste rock material such that it will not affect stability. It is recommended that the effectiveness of the drainage system in WRD being regularly assessed during waste rock placement in WRD.

It should be noted that the stability analysis for WRD was conducted for maximum stacking height of 35 feet and such that the waste rock is stacked against the geomembrane-lined perimeter containment berm with a maximum vertical separation of 2 feet from the crest of the berm to the toe waste rock dump slope as shown on the Design Drawings appended to the main Design Report. The stability of the WRD should be reassessed if higher waste rock heights are to be constructed.

Table 4: Summary of Critical Stability Analysis Results of Waste Rock Dump

Analysis Method	Static FOS (Target design minimum is 1.5)		Pseudo-static FOS (k = 0.04 g) (Target design minimum is 1.1)	
Effective Stress	Circular Failure through Foundation	Waste Rock Block Sliding over the Liner System	Circular Failure through Foundation	Waste Rock Block Sliding over the Liner System
	1.8	1.6	1.5	1.3

7.0 TSF EMBANKMENT FOUNDATION SETTLEMENT ANALYSIS

The objective of the settlement calculations was to estimate the settlement profile, caused by the weight of the embankment, of the underdrain collection piping system within the North embankment of the TSF for flow capacity evaluation of the pipes after settlement. These estimated settlements were used to determine the profile of the underdrain collection piping system after settlement takes place. Settlement grades along the underdrain collection piping after settlement must allow for positive solution flow from the TSF basin to the reclaim pond. To maintain this flow, underdrain collection pipes were designed to have a minimum post-settlement slope of one percent.

Settlement analysis was performed using Settle3D 4.0 (Rocscience 2019) software for a 150-foot thick clay foundation with material properties summarised in Table 5. The foundation clay has been observed at some boreholes down to the depth of about 120 feet. The actual thickness of the clay is not clear. However, since the induced stresses, and consequently the settlements within the foundation caused by placement of the embankment fill material, tends to decrease with depth and the soil at depth is much stiffer, assigning a clay foundation thickness of 150 feet was considered to be sufficient for settlement estimations. Both elastic compression and primary consolidation of the foundation clay were included in the settlement analysis. Settlements were estimated along the pipe for Section A (with maximum embankment height) of the North embankment of TSF as shown in Figure 1. No groundwater was assumed within analyzed top 150 feet clay layer for settlement calculations.

Table 5: Foundation Material Properties for Settlement Calculations

Unit	Layer Thickness	Bulk Unit Weight	Pre-consolidation Pressure, p_c	Increase in p_c with depth	Undrained Modulus of Elasticity	Consolidation Parameters		
	feet	pcf	psi	psi	psi	c_c	c_r	e_0
Foundation Clay	150	120	90	3.3[1]	10,000	0.4	0.04	1

Notes:

1. The increase in pre-consolidation pressure with depth at a rate of 3.3 psi/feet is assumed based on data from CPT results as shown on Figure 1 and described in Section 4.6.1.1.

A maximum settlement of about 3 feet was estimated in the embankment foundation under the crest of the embankment. Figure 19 presents the section and stationing used to compute the settlement profile along Section A.

As designed, grades of the underdrain pipe will be about 2.5 percent from the downstream crest of Stage 3 to the toe. With a maximum foundation settlement of about 3 feet over 250 feet of pipe length, the underdrain pipes are expected to flatten to about 1.1 percent near the downstream toe of Stage 3.

As presented in the main Design Report, the underdrain outlet pipes are designed to provide redundant capacity and are individually sized for a minimum one percent grade. At a one percent grade, each underdrain pipe can convey approximately 2.5 times the maximum anticipated underdrain flow rate during steady state drainage from the tailings. All calculated post-settlement grades meet the minimum required values for positive flow of the underdrain collection piping.

8.0 TSF EMBANKMENT CREST SETTLEMENT

As staged construction progresses, primary settlements within the foundation and embankment will occur. Placement of subsequent construction fill lifts will be performed up to the final Stage 3 design crest elevation as shown on the Design Drawings appended to the main Design Report. The consolidation of the foundation due to the additional lift at each stage of construction will take place after the immediate settlement and continue at a decreasing rate.

The minimum design freeboard of 2 feet from the maximum tailings surface to the dam crest will be large enough so that long-term settlement of the embankment and foundation after tailings deposition is compete will not reduce the dam crest elevation such that it encroaches on the final tailings surface.

Upon completion of tailings deposition and during the active water management closure period, free water on the tailings surface will be evaporated and settlement of the dam crest as a result of embankment and foundation settlement is expected to be less than settlement due to the foundation and tailings consolidation.

During long-term closure, once the tailings have consolidated and the proposed closure cover installed (discussed in the main Design Report), precipitation falling on the tailings surface will be routed through a closure spillway at the eastern abutment of the North embankment. After installation of the closure cover, the impoundment surface and dam crest will be at the same relative elevation. The final closed TSF will not provide any water retention capacity above the closure cover.

9.0 RECOMMENDATIONS

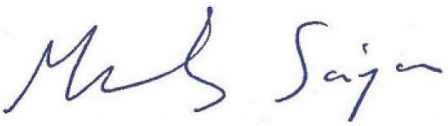
Golder's proposed design of the TSF and WRD have been based on industry-accepted engineering practices, extensive geotechnical investigation and laboratory testing programs, and technical resources. The following are recommended to be monitored during construction and operation. Findings should be compared to those used in this analysis.

- Groundwater conditions below the TSF embankments and WRD pad through installing and monitoring a series of open standpipes at controlling locations along the embankment toe
- Piezometric responses within the dam foundation during construction through installing and monitoring a series of vibrating wire piezometers at controlling locations within the embankment and foundation under the downstream crest and toe of the embankments
- TSF dam crest settlement and lateral movements during staged construction and tailings deposition through installing and monitoring a series of slope inclinometers and monuments at controlling locations within and along the embankment
- Embankment and waste rock drainage conditions
- TSF embankment and waste rock dump construction geometries

10.0 CLOSING

This letter describes the geotechnical stability analysis and settlement calculations for both TSF and WRD, as well as the geotechnical material properties estimated for these analyses. Golder trusts that this document addresses your current requirements. Please do not hesitate to contact the undersigned should you need additional information or clarification.

Golder Associates Ltd.



Masoumeh Saiyar, PhD
Senior Geotechnical Engineer

Dennis E. Becker, PhD
Principal, Senior Geotechnical Specialist

MS/DEB/kg

FIGURES

Figure 1 Stability Analysis, Section Locations
Figure 1A Stability Analysis, Embankment Foundation Cross Sections
Figure 2 Leps (1970) Rock Fill Strength
Figure 3 Pre-consolidation Pressure Versus Depth
Figure 4 Shear Wave Velocity and Modulus of Elasticity for Clay Layers Versus Depth
Figures 5 to 16 TSF Stability Analysis Results
Figures 17 and 18 WRD Stability Analysis Results
Figure 19 TSF Foundation Settlement Analysis

11.0 REFERENCES

Ferns, M.L., H.C. Brooks, J.G. Evans, and M.L. Cummings. 1993. Geologic Map of the Vale 30 x 60 Minute

Quadrangle, Malheur County, Oregon, and Owyhee County, Idaho. State of Oregon, Department of Geology and Mineral Industries, GMS-77.

Golder 2018. *Pre-Feasibility Design Tailings Storage Facility, Grassy Mountain Project*. Prepared for Calico Resources USA Corp., Golder Doc. No. 1663241-36-R-REV0, dated June 29, 2018.

Golder 2019. *Material Suitability and Slope Stability Assessment – Grassy Mountain Basalt Borrow Quarry, Malheur county, Oregon*. Dated April 4, 2019.

Gray, J.J., Geitgey, R.P., and Baxter, G.L. 1989. *Bentonite in Oregon: Occurrences, Analyses, and Economic Potential*. State of Oregon Department of Geology and Mineral Resources, Special Paper 20.

Hynes-Griffin, M.E., and Franklin, A. G. (1984). “Rationalizing the seismic coefficient method.” *Miscellaneous Paper GL-84-13,* Geotechnical Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Idriss, I.M., Abrahamson, N.A. and Archuleta, R.J. 2018. Chapter 13: Evaluation of Earthquake Ground Motions, Engineering Guidelines for the Evaluation of Hydropower Projects. Prepared for Division of Dam Safety and Inspections, Office of Energy Projects, Federal Energy Regulatory Commission (FERC).

Leps T. M. 1970. *Review of Shearing Strength of Rockfill*. Journal of the Soil Mechanics and Foundations Division, 1970, Vol. 96, Issue 4, Pg. 1159-1170

Mesri, G. (1975) ‘New design procedure for stability of soft clays’, in Proceedings of the international conference on soil mechanics and foundation engineering. Cambridge, pp. 409–412

Rocscience 2018. Slide2 2018, build 8.027. Rocscience Inc. August 2, 2019.

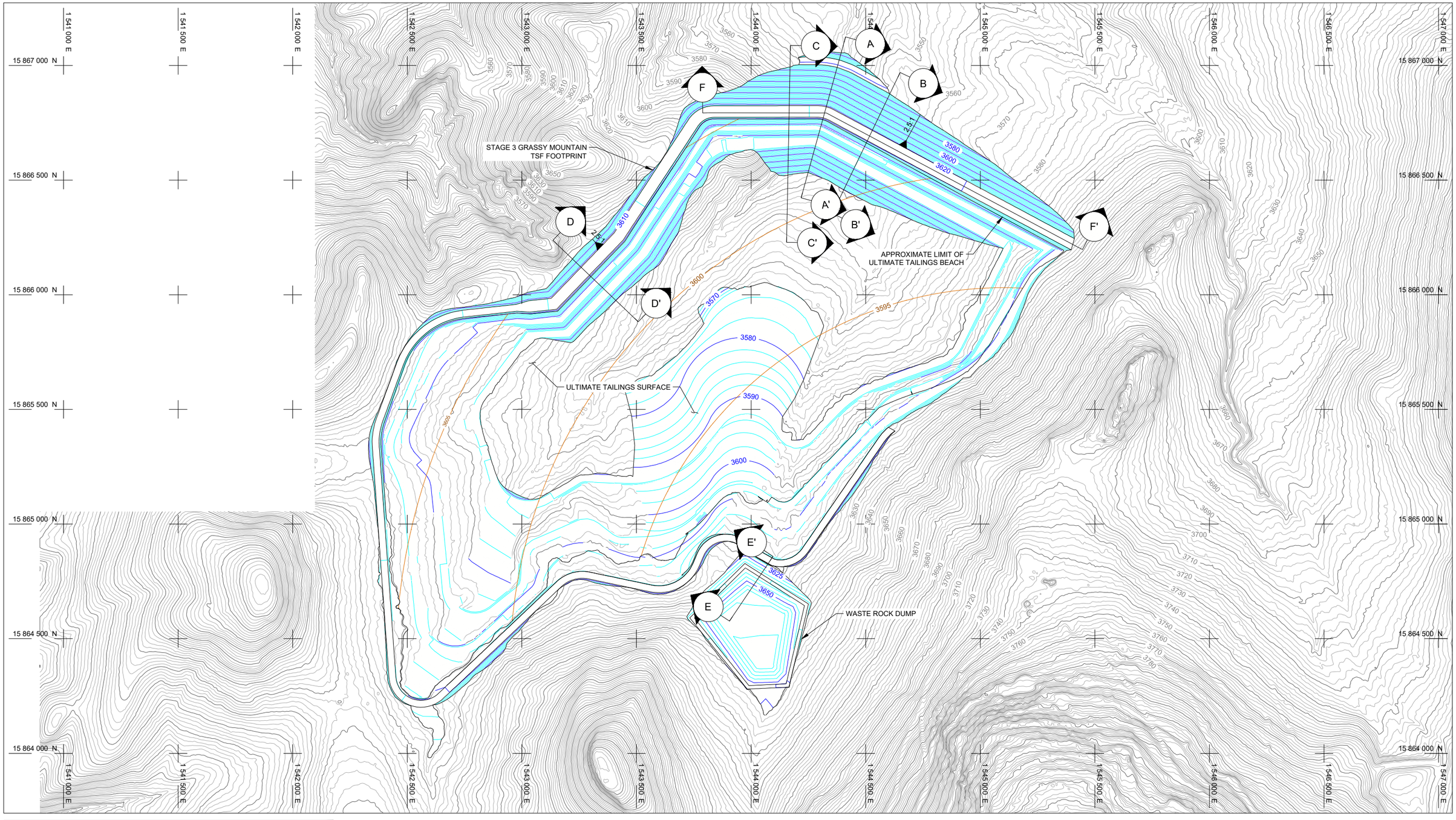
Rocscience 2019. Settle v4.0, build v4.023. Rocscience Inc. April 12, 2019.

Sherard J.L. 1963. Earth and Earth-rock Dams: Engineering Problems of Design and Construction. John Wiley & Sons Inc.

SPF 2019. *Grassy Mountain Gold Project Groundwater Vol. II, Groundwater Characterization Report.* Prepared for Calico Resources USA Corp. by SPF Water Engineering, LLC. August 13, 2019.

Vucetic, M., and R. Dobry. 1991. *Effect of Soil Plasticity on Cyclic Response*. Journal of Geotechnical Engineering. v. 117(1): pp. 89-107.

FIGURES



LEGEND

- 3600 — EXISTING GROUND (2 FT CONTOURS)
- 3600 — PROPOSED GRADING (2 FT CONTOURS)
- 3600 — ULTIMATE TAILINGS SURFACE (5 FT CONTOURS)

0 200 400 600
1" = 200' FEET

CLIENT
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	MJS
REVIEWED	MS
APPROVED	CJM

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
STABILITY ANALYSIS
SECTION LOCATIONS

PROJECT NO.	REV.	FIGURE
1663241	0	1

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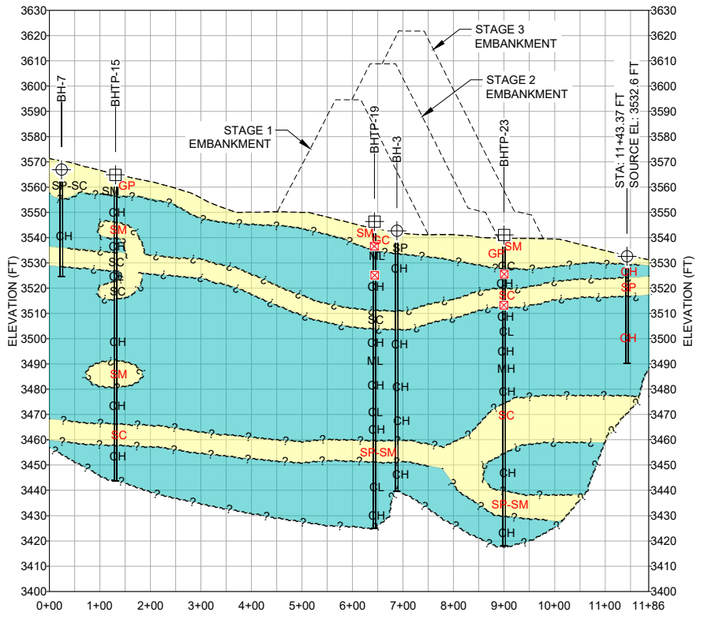

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VERT. SCALE 1"=30'

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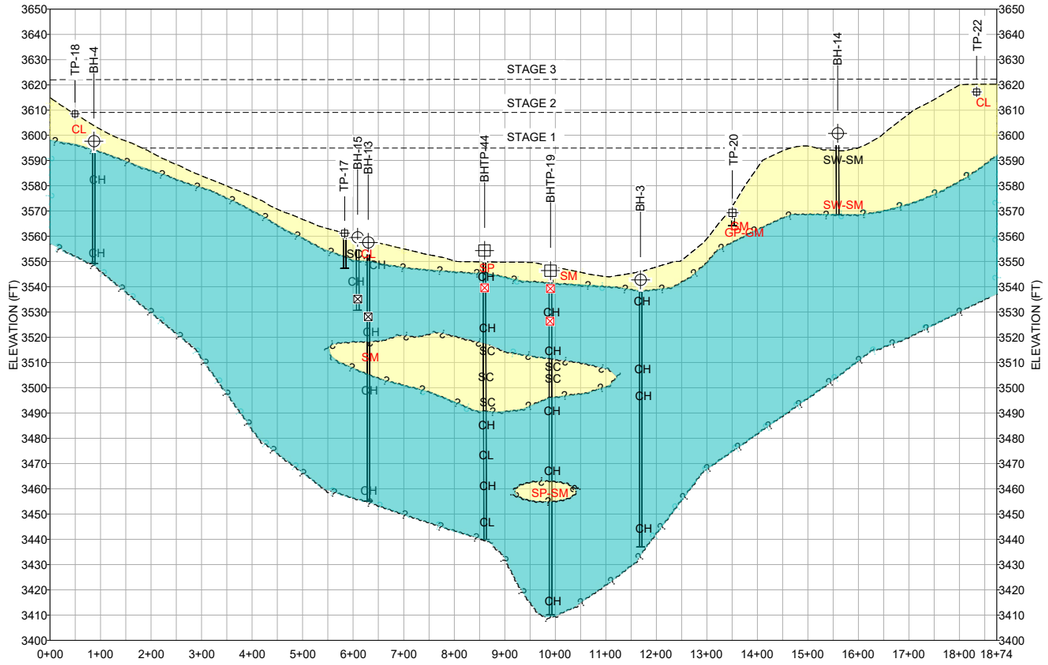

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USCS CLASSIFACTION PROFILE F-F'

LEGEND

FINE GRAINED SOIL

COARSE GRAINED SOIL

0 150 300 450
1" = 150' FEET

0 30 60 90
1" = 30' FEET

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TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
STABILITY ANALYSIS
EMBANKMENT FOUNDATION CROSS SECTIONS

PROJECT NO.	REV.	FIGURE
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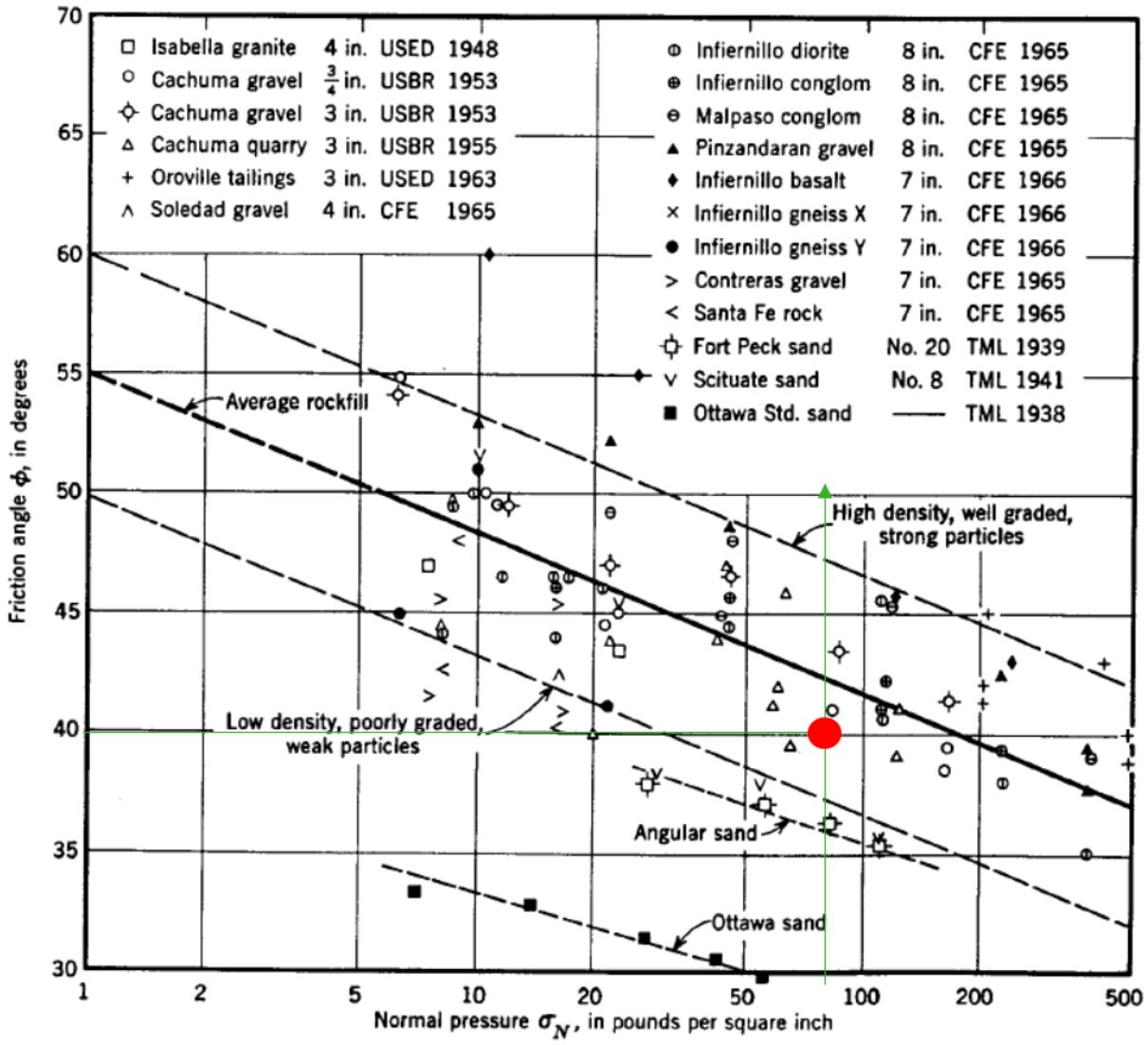

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APPROVED	CJM

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TITLE
LEPS (1970) ROCK FILL STRENGTH

PROJECT No.
1663241

FIGURE
2

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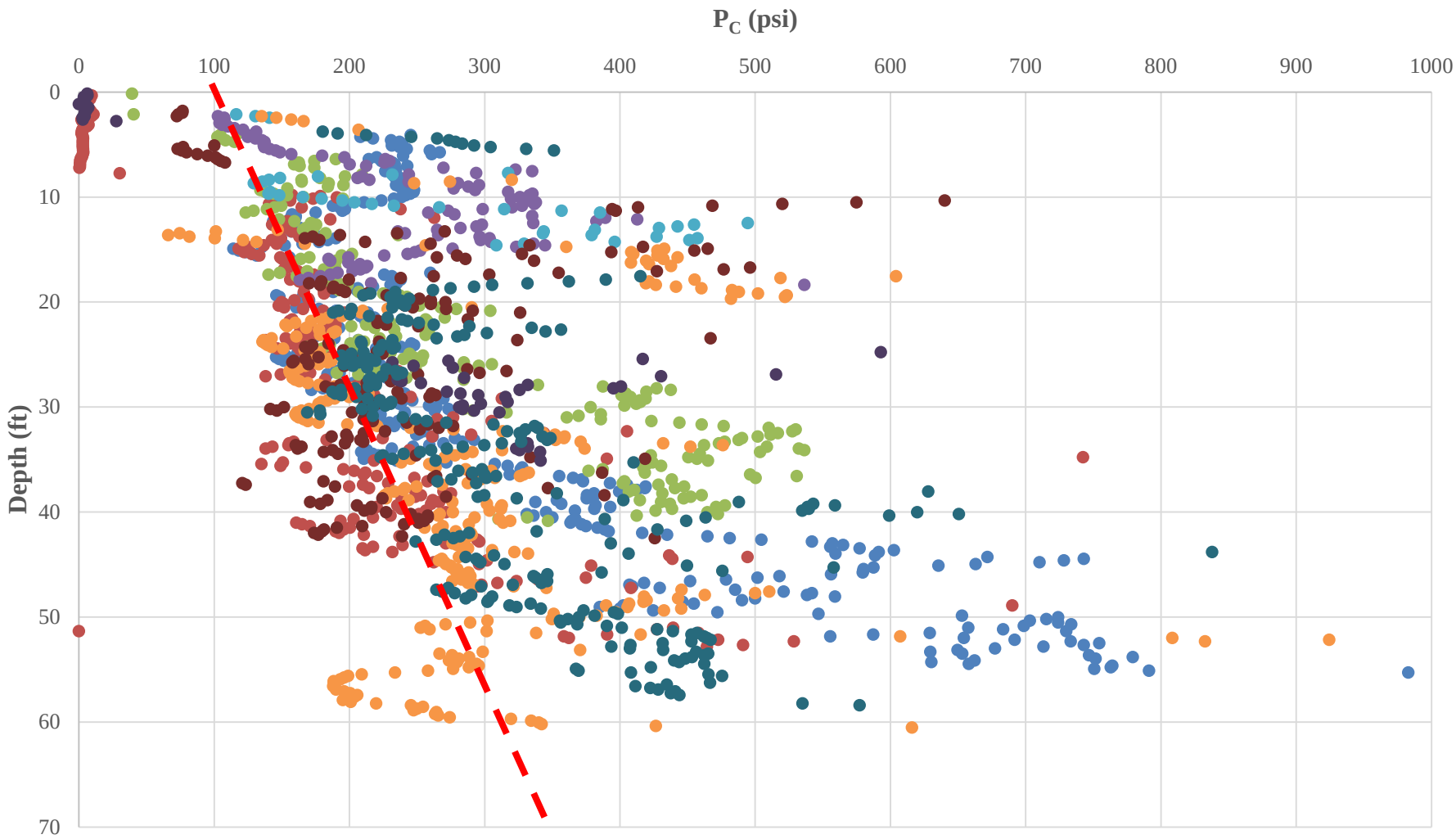

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TITLE
PRECONSOLIDATION PRESSURE VERSUS DEPTH

PROJECT No.
1663241

FIGURE
3

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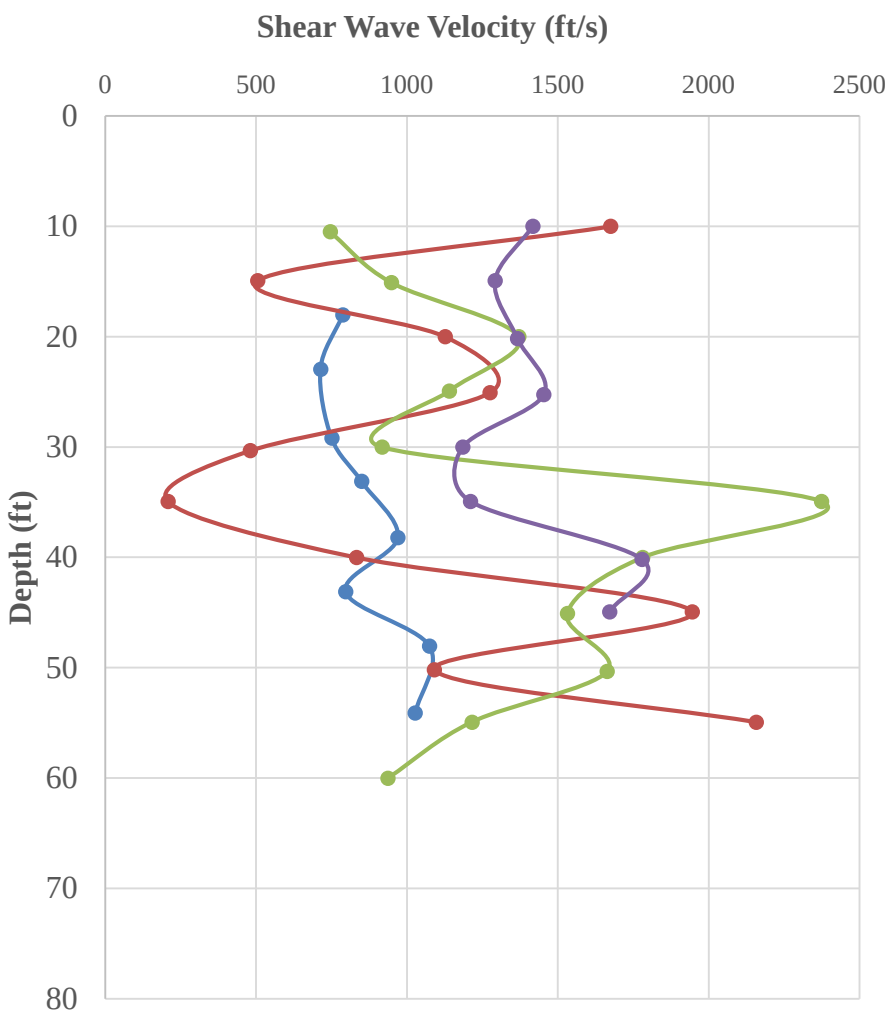

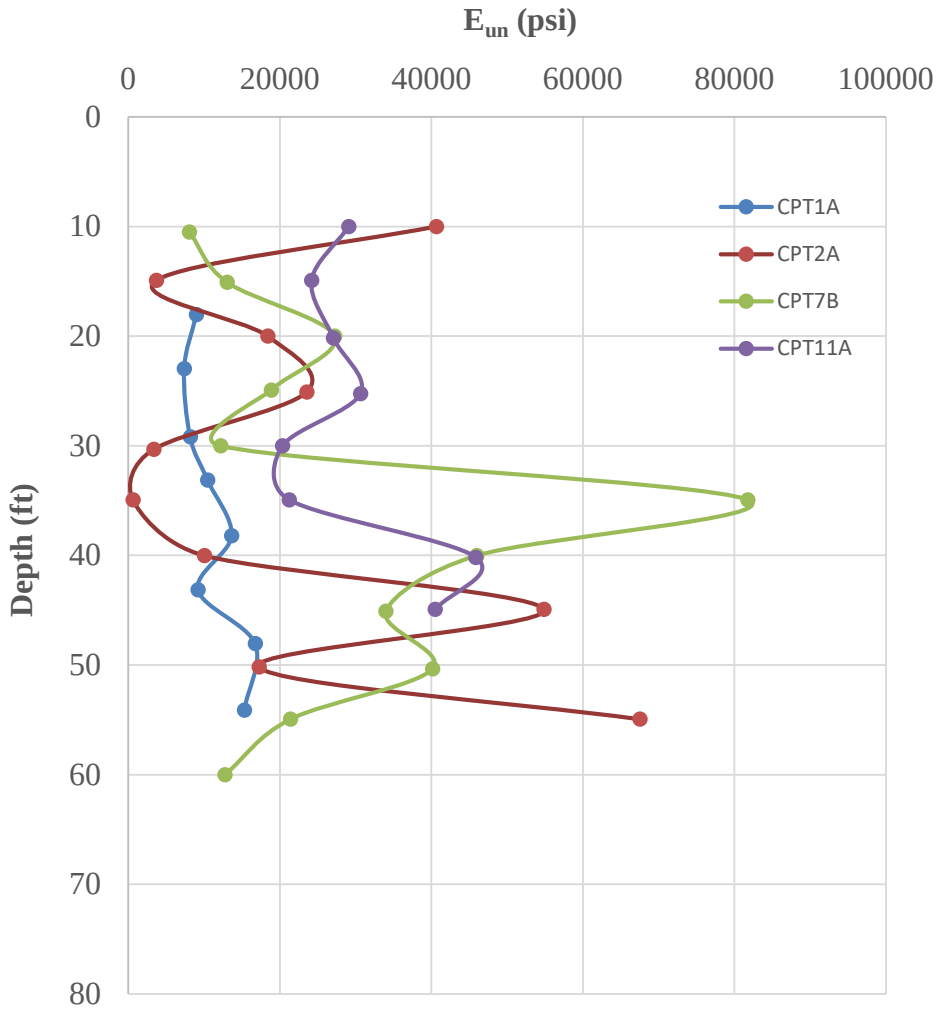

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TITLE
SHEAR WAVE VELOCITY AND MODULUS OF ELASTICITY FOR CLAY LAYERS VERSUS DEPTH

PROJECT No.
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FIGURE
4

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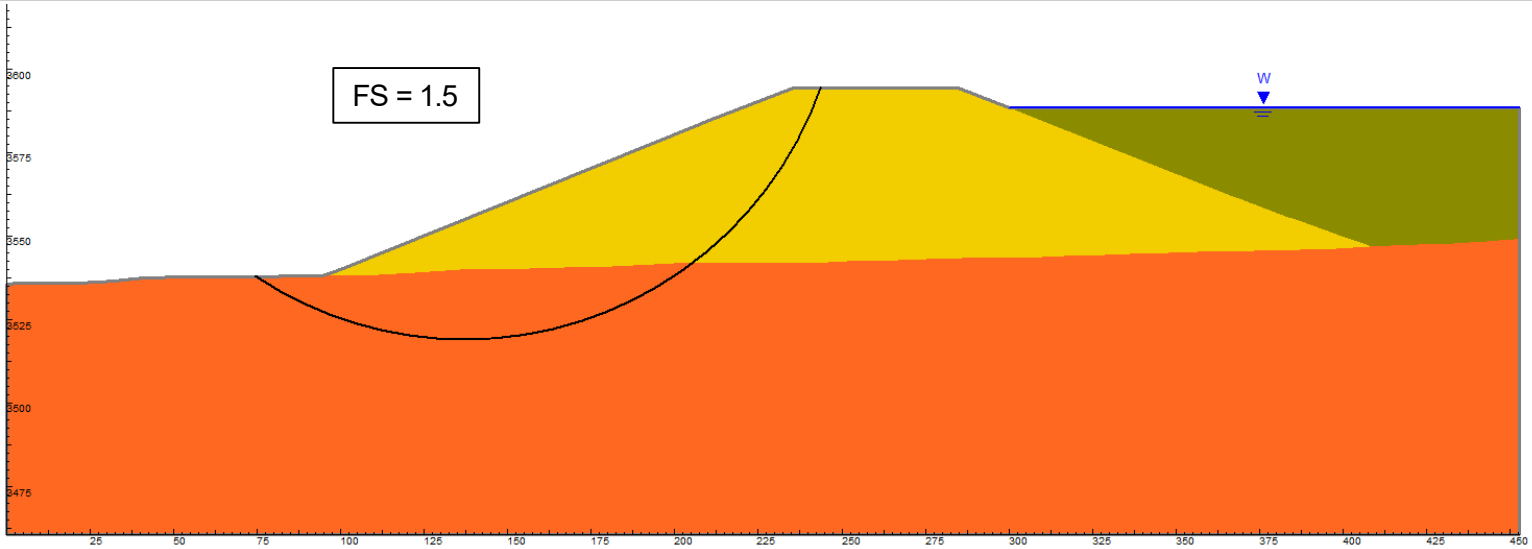
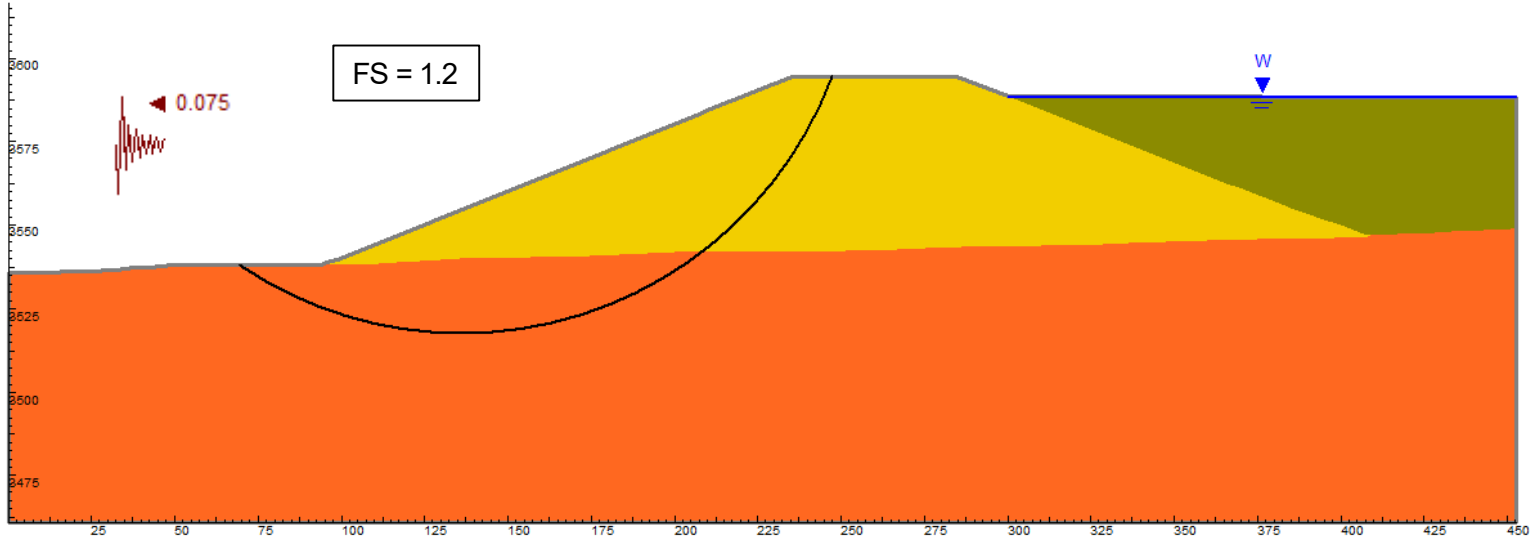


STAGE 1 SECTION A – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 1 SECTION A – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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REVIEW	MS
APPROVED	CJM

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TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TSF STABILITY ANALYSIS RESULTS – EFFECTIVE STRESS ANALYSIS
GLOBAL CIRCULAR FAILURE – STAGE 1 - SECTION A

PROJECT No.
1663241

FIGURE
5

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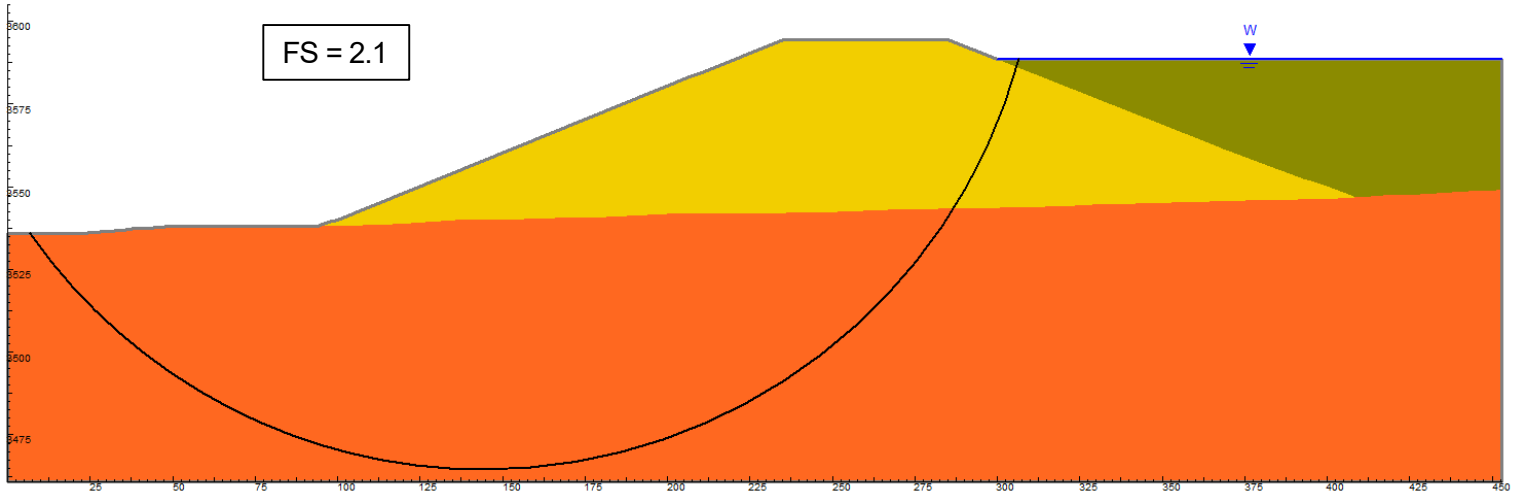
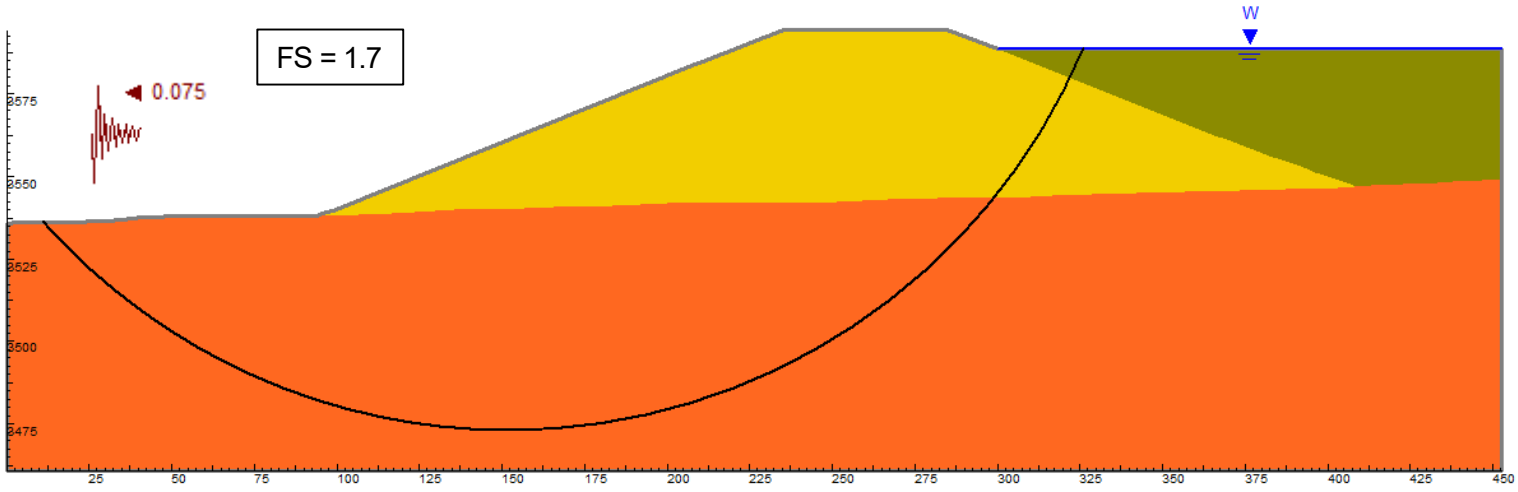


STAGE 1 SECTION A – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 1 SECTION A – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Clay		120	Undrained	2851	
Tailings		95	Mohr-Coulomb	0	15

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REVIEW	MS
APPROVED	CJM

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GRASSY MOUNTAIN
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TSF STABILITY ANALYSIS RESULTS – TOTAL STRESS ANALYSIS
GLOBAL CIRCULAR FAILURE – STAGE 1 - SECTION A

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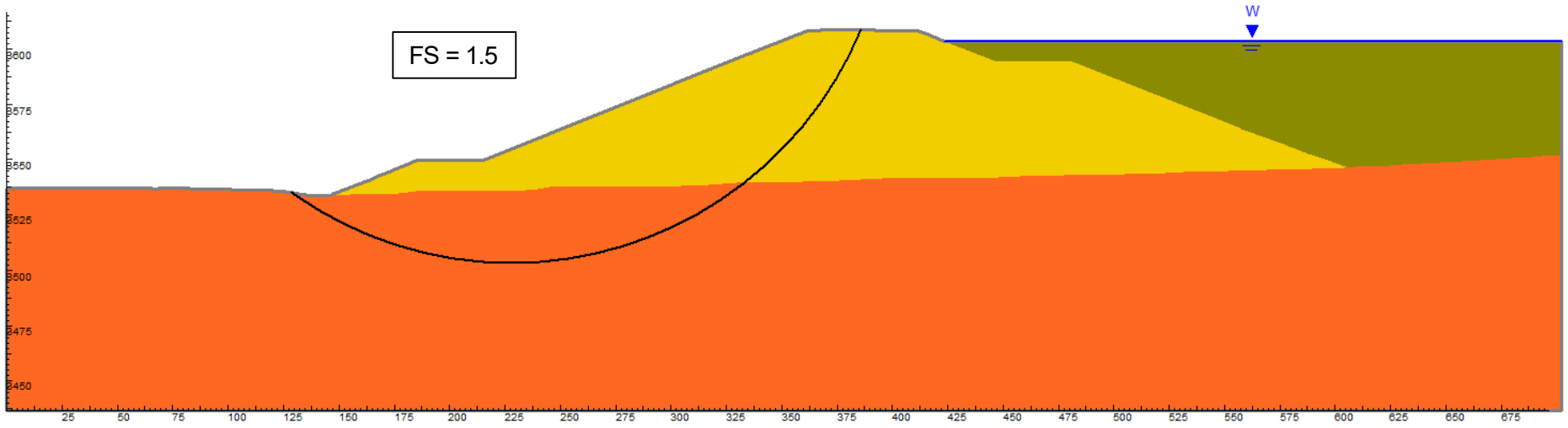
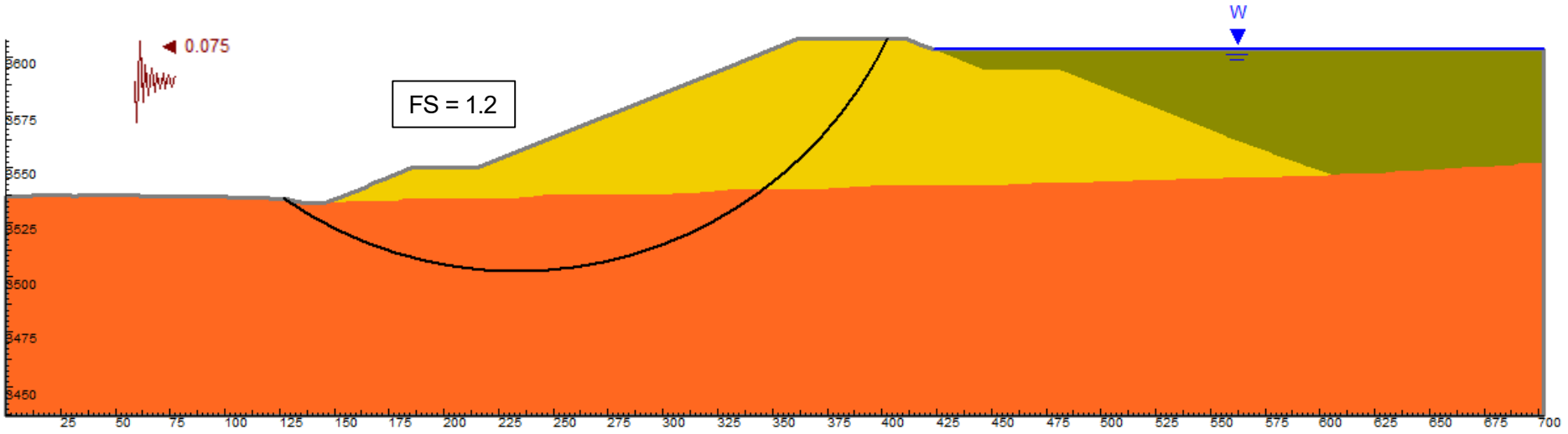
1663241

FIGURE
6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 2 SECTION A – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 2 SECTION A – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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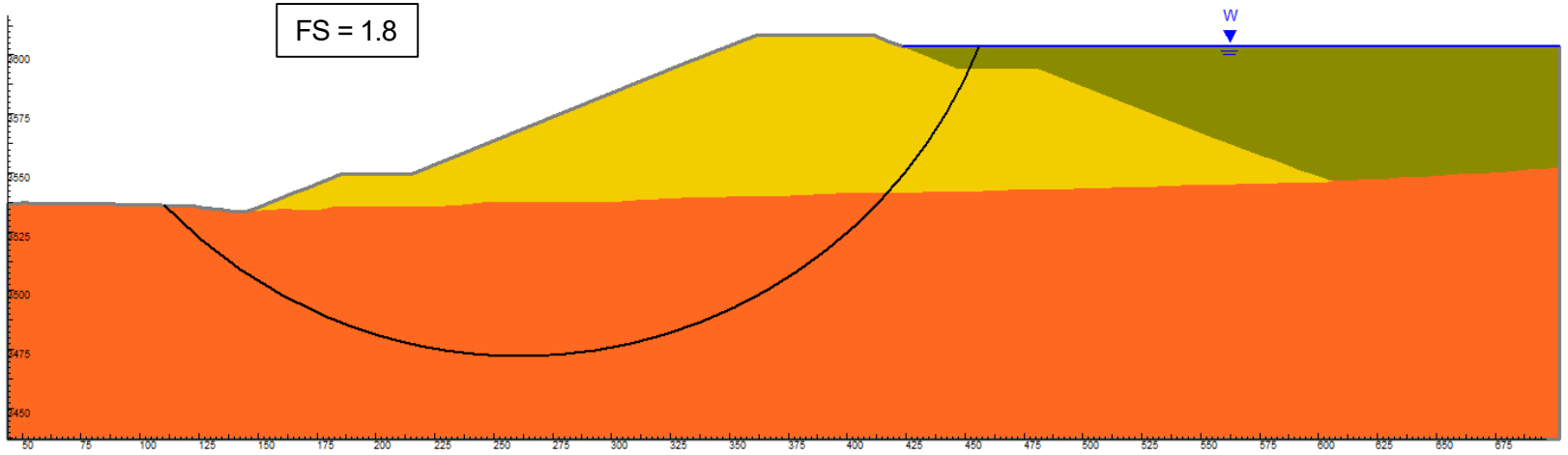
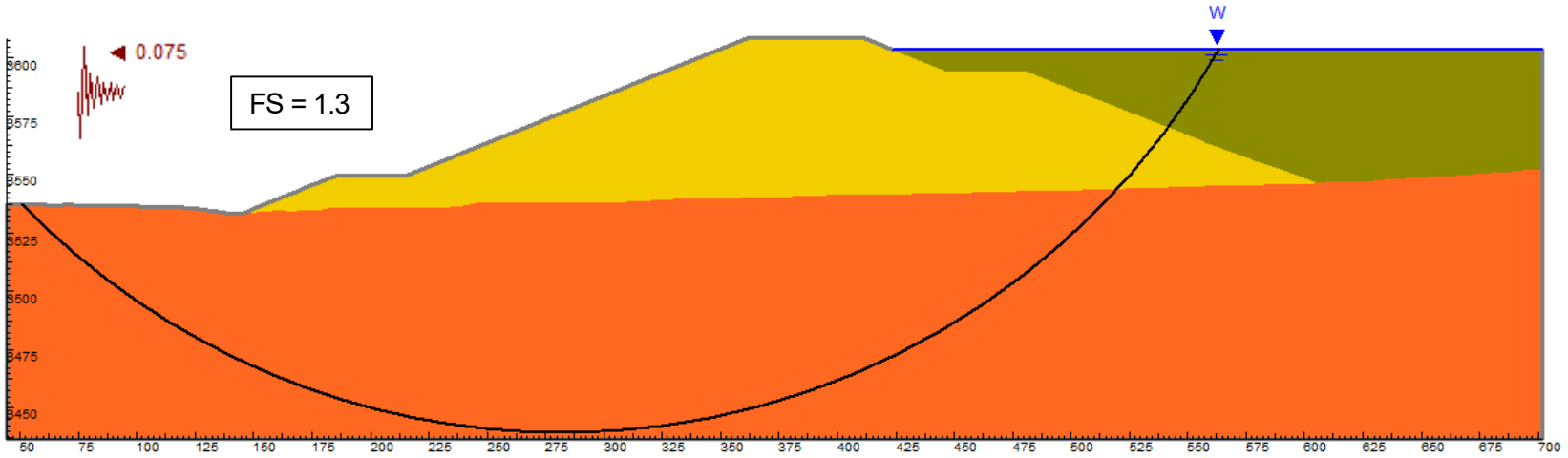
FIGURE
7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 2 SECTION A – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 2 SECTION A – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Clay		120	Undrained	2851	
Tailings		95	Mohr-Coulomb	0	15

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GLOBAL CIRCULAR FAILURE – STAGE 2 - SECTION A

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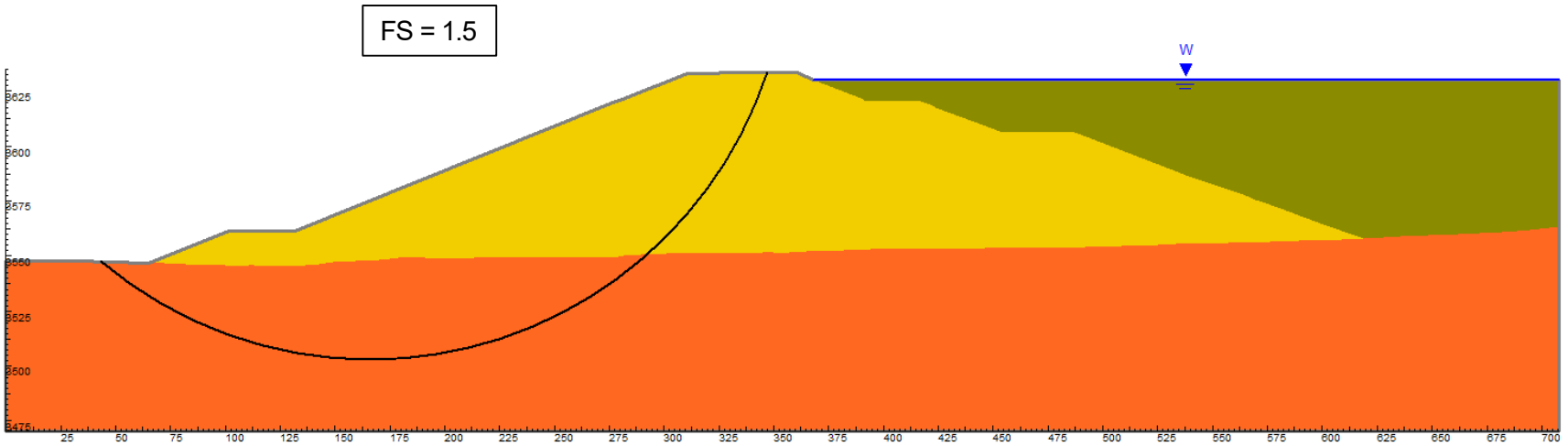
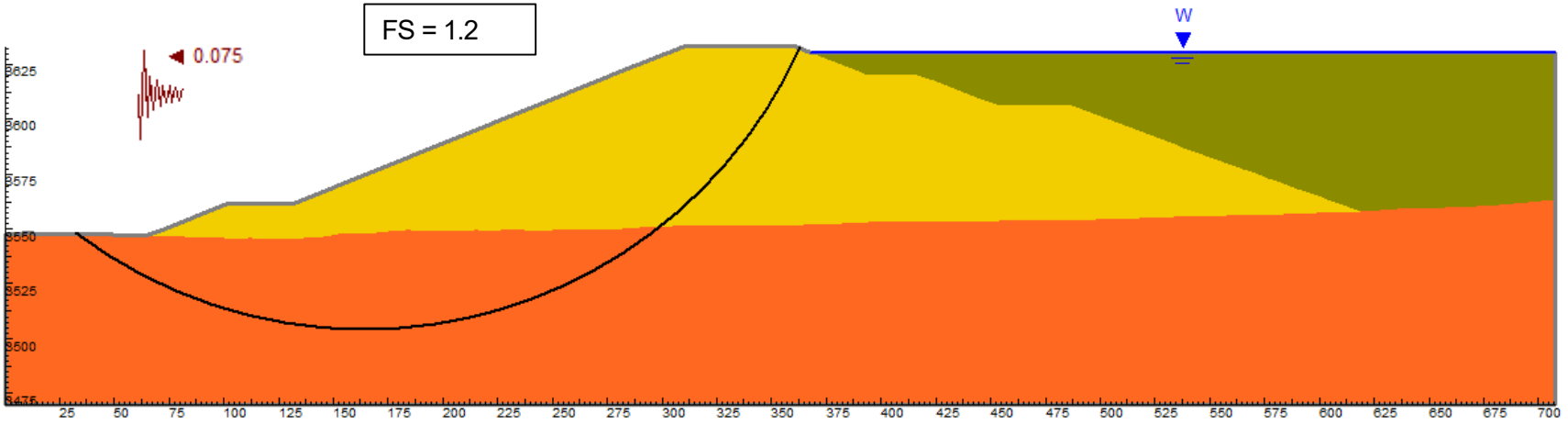
FIGURE
8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 3 SECTION A – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 3 SECTION A – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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TSF STABILITY ANALYSIS RESULTS – EFFECTIVE STRESS ANALYSIS
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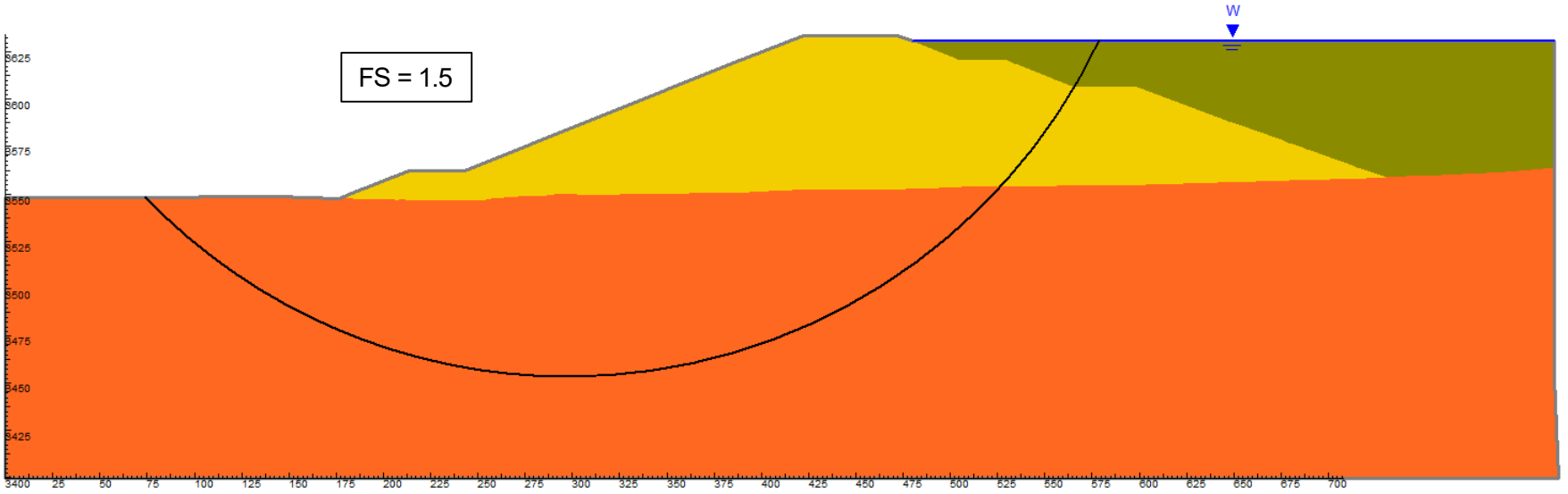
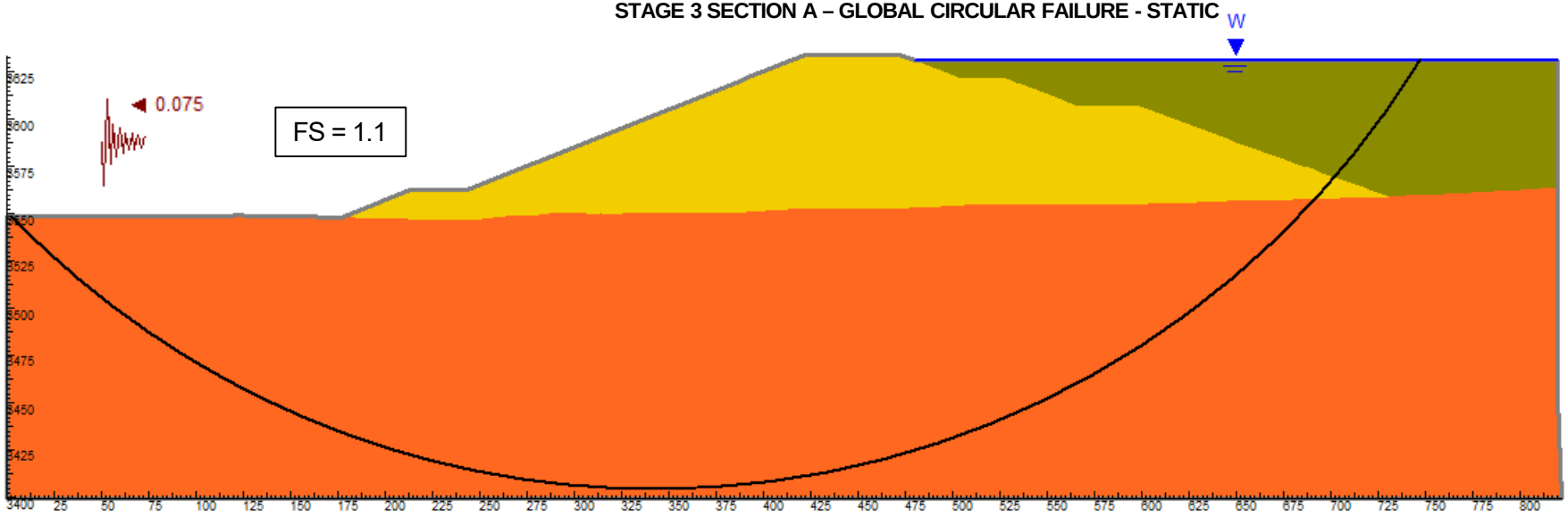
FIGURE
9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 3 SECTION A – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 3 SECTION A – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Clay		120	Undrained	2851	
Tailings		95	Mohr-Coulomb	0	15

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TSF STABILITY ANALYSIS RESULTS – TOTAL STRESS ANALYSIS
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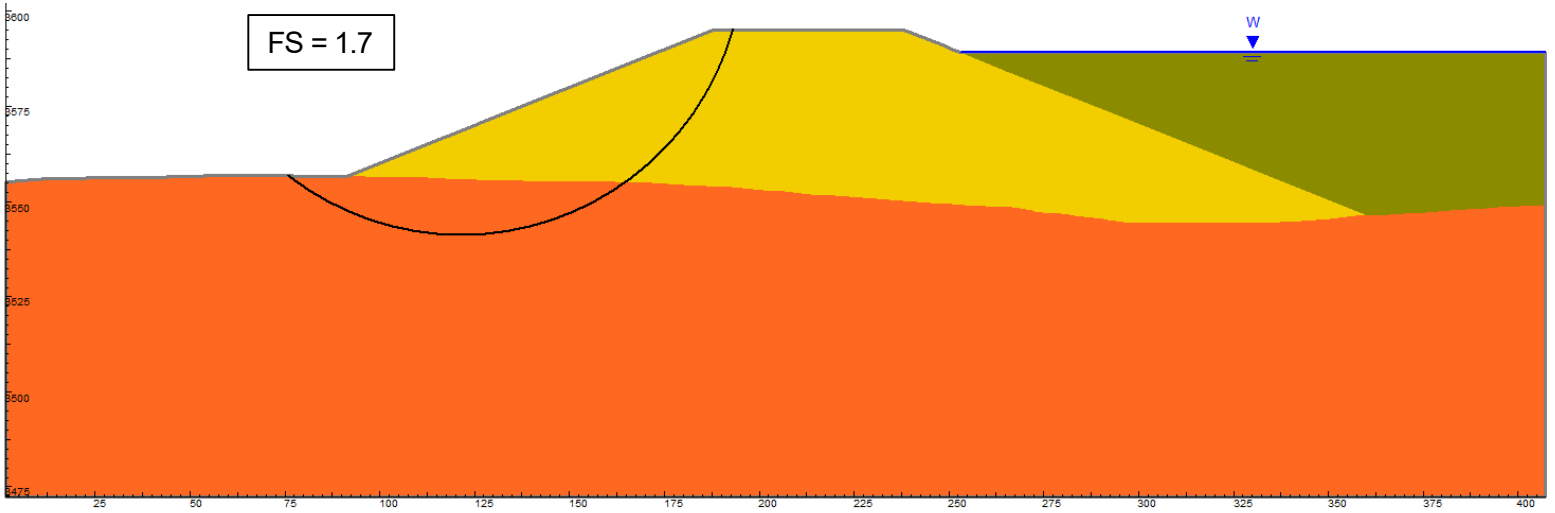
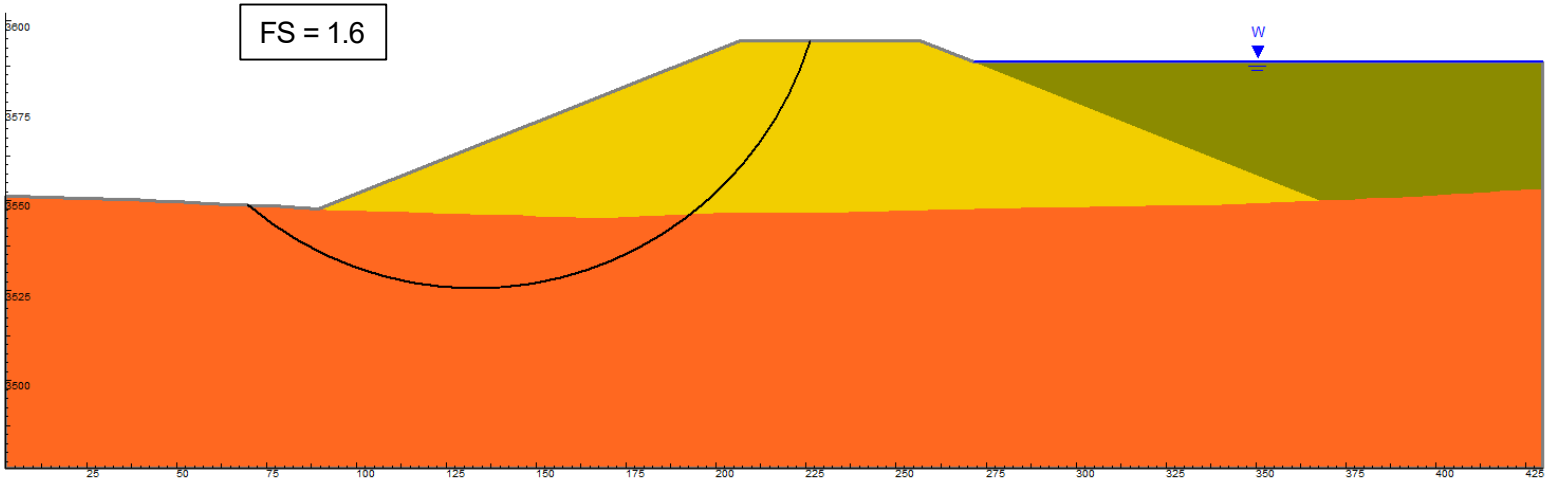
FIGURE
10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 1 SECTION B – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 1 SECTION C – GLOBAL CIRCULAR FAILURE - STATIC

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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TSF STABILITY ANALYSIS RESULTS –EFFECTIVE STRESS ANALYSIS
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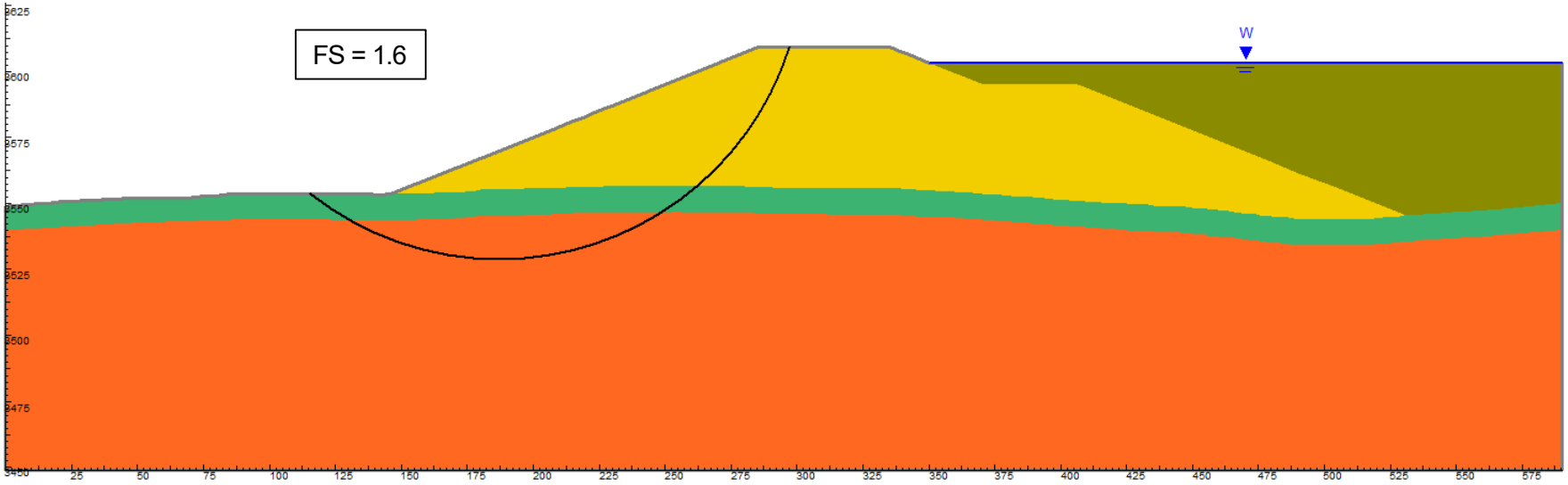
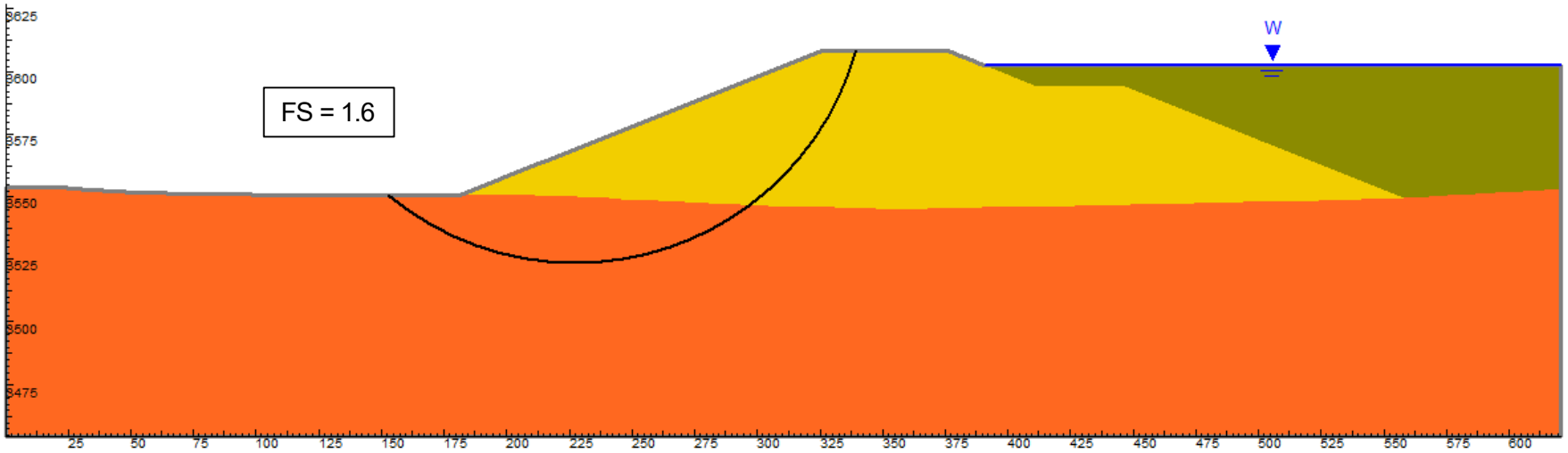
FIGURE
11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 2 SECTION B – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 2 SECTION C – GLOBAL CIRCULAR FAILURE - STATIC

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		130	Mohr-Coulomb	0	30
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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TSF STABILITY ANALYSIS RESULTS – EFFECTIVE STRESS ANALYSIS
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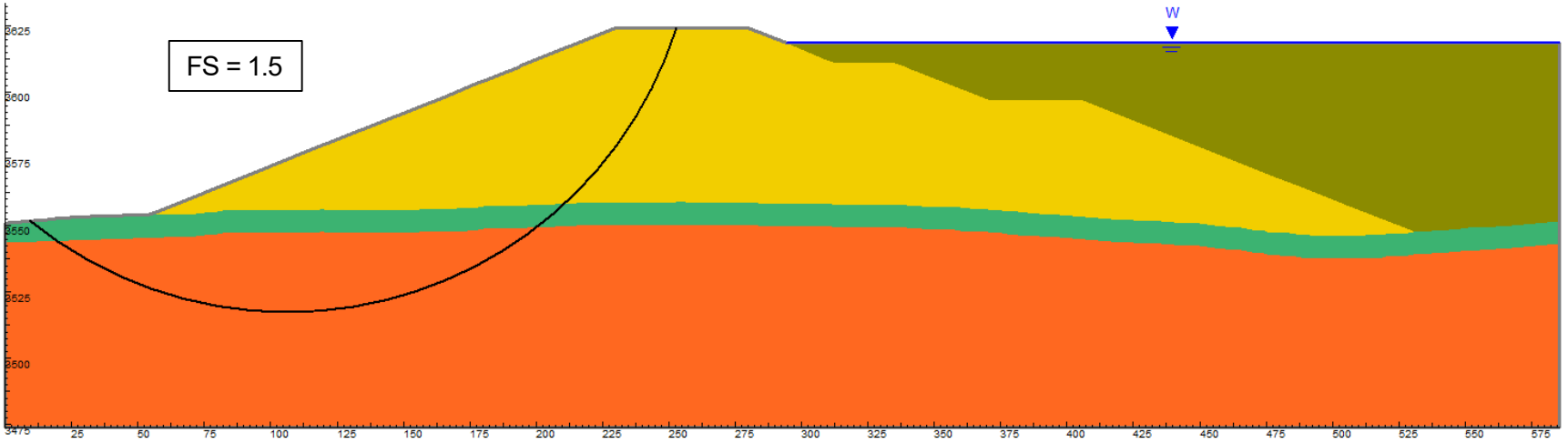
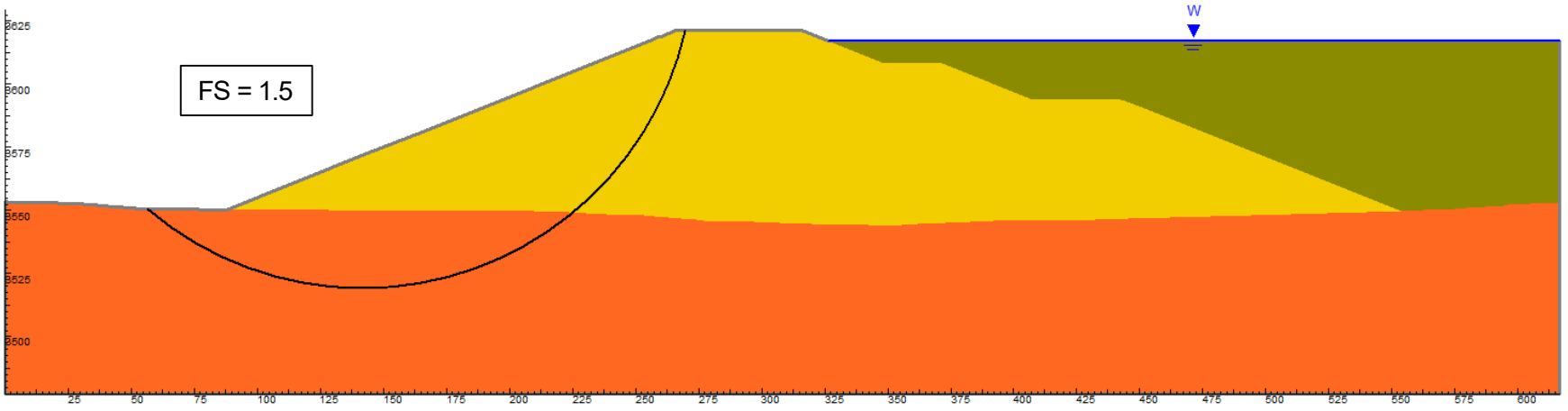
FIGURE
12

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 3 SECTION B – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 3 SECTION C – GLOBAL CIRCULAR FAILURE - STATIC

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		130	Mohr-Coulomb	0	30
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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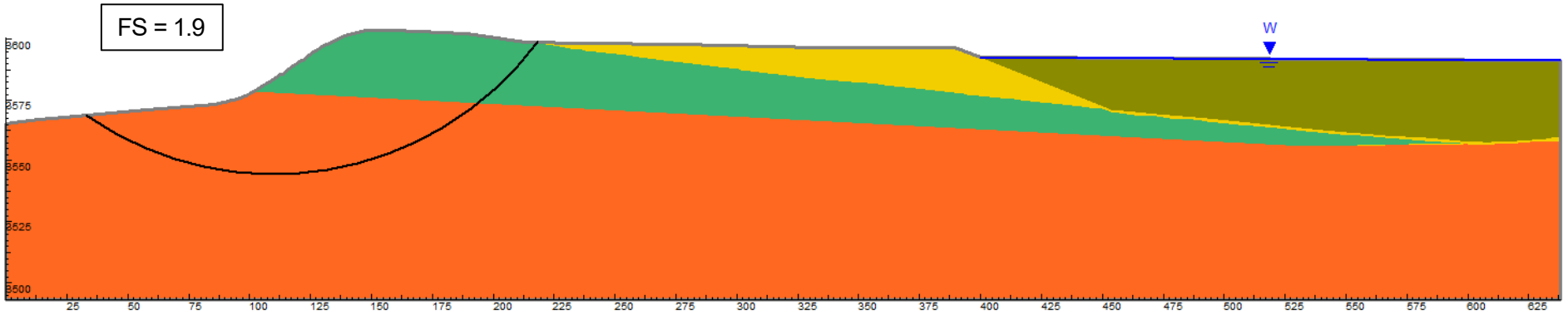
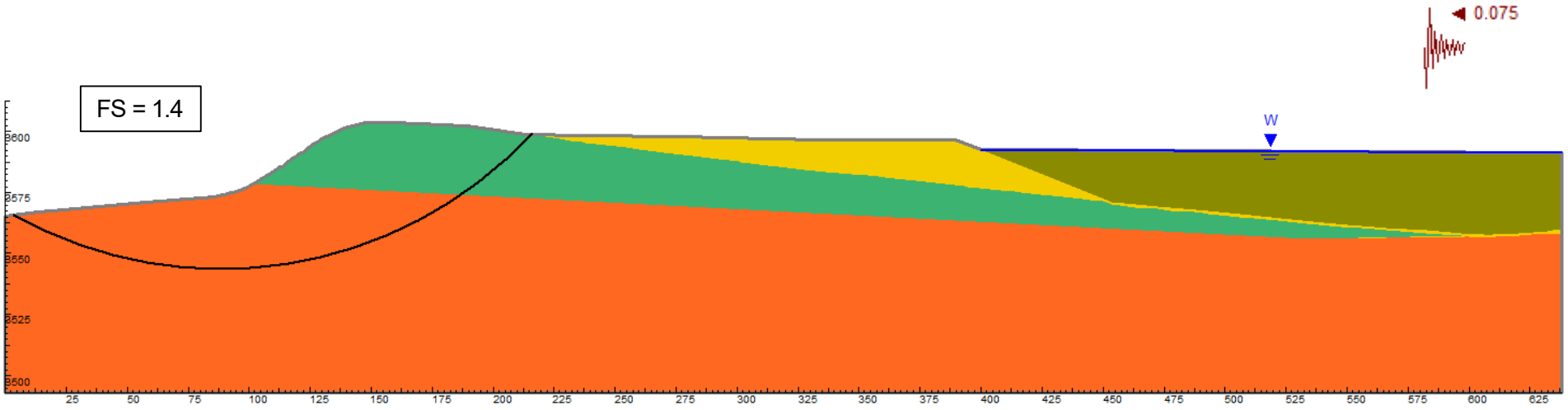
FIGURE
13

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 1 SECTION D – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 1 SECTION D – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		130	Mohr-Coulomb	0	30
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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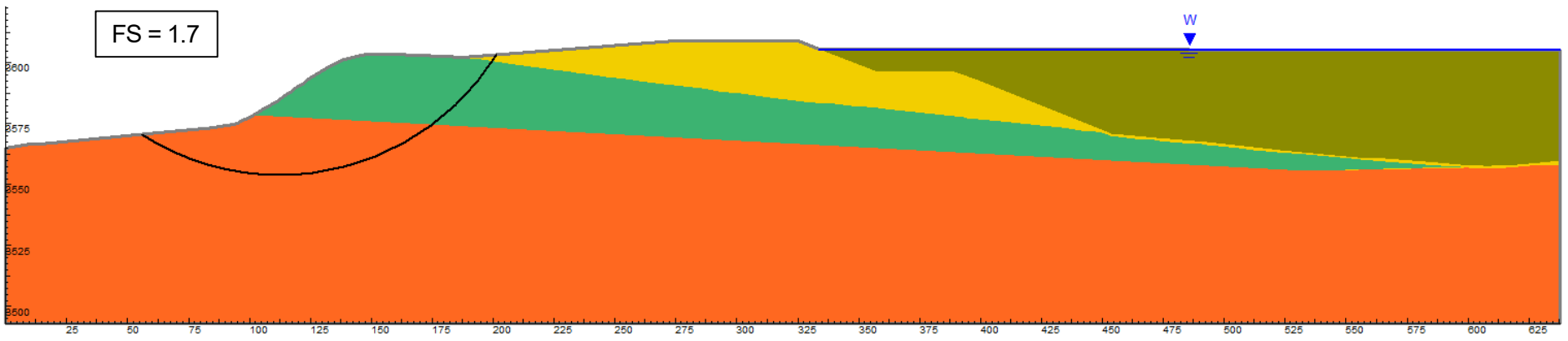
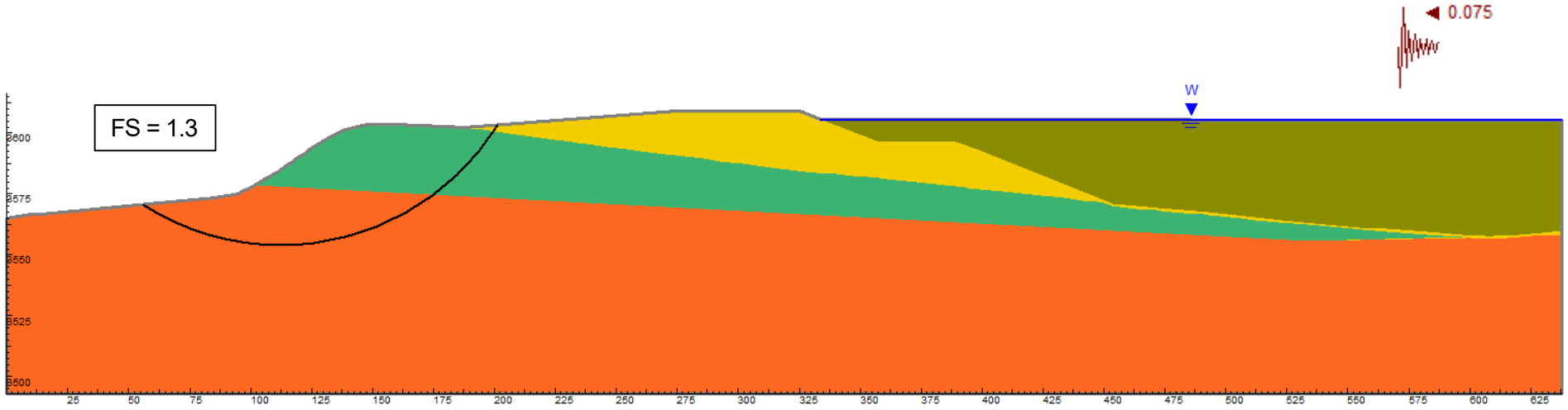
FIGURE
14

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0



STAGE 2 SECTION D – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 2 SECTION D – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		130	Mohr-Coulomb	0	30
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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GLOBAL CIRCULAR FAILURE – STAGE 2 -- SECTION D

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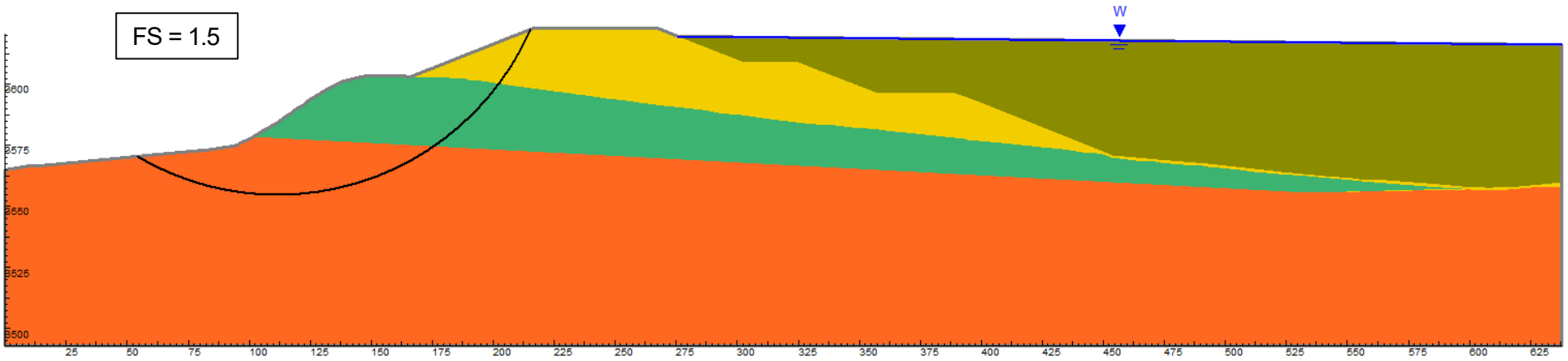
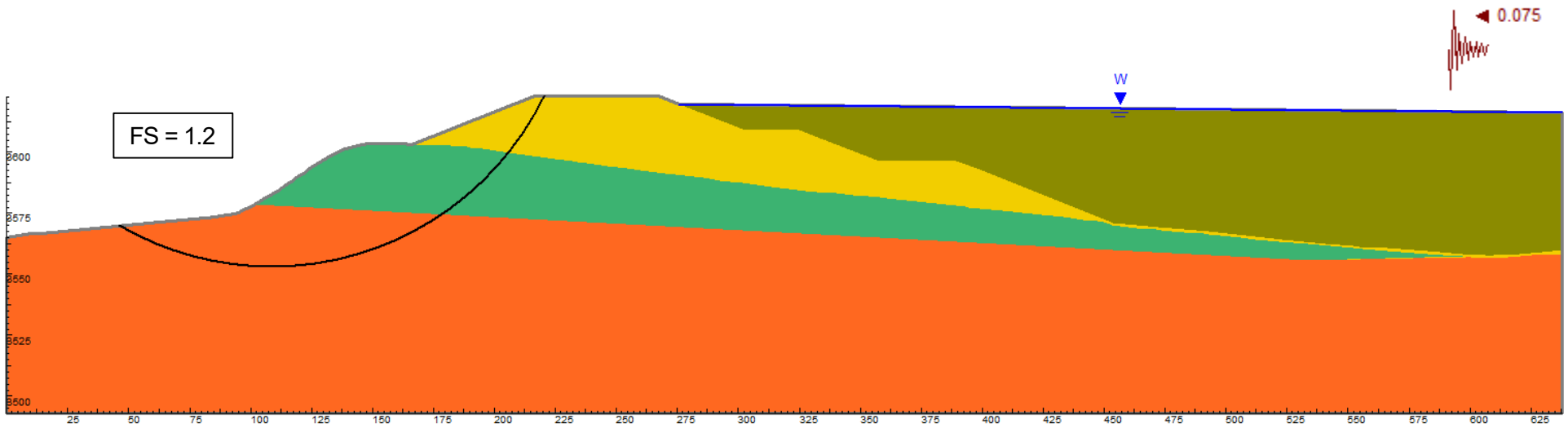
FIGURE
15

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



STAGE 2 SECTION D – GLOBAL CIRCULAR FAILURE - STATIC



STAGE 2 SECTION D – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.075 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		130	Mohr-Coulomb	0	30
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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TSF STABILITY ANALYSIS RESULTS – EFFECTIVE STRESS ANALYSIS
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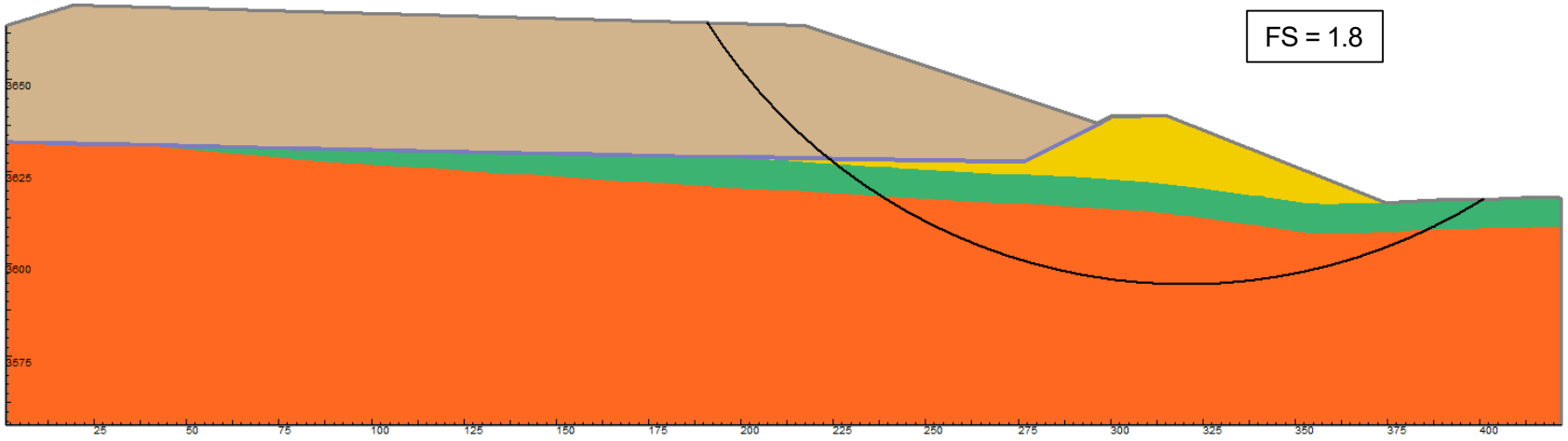
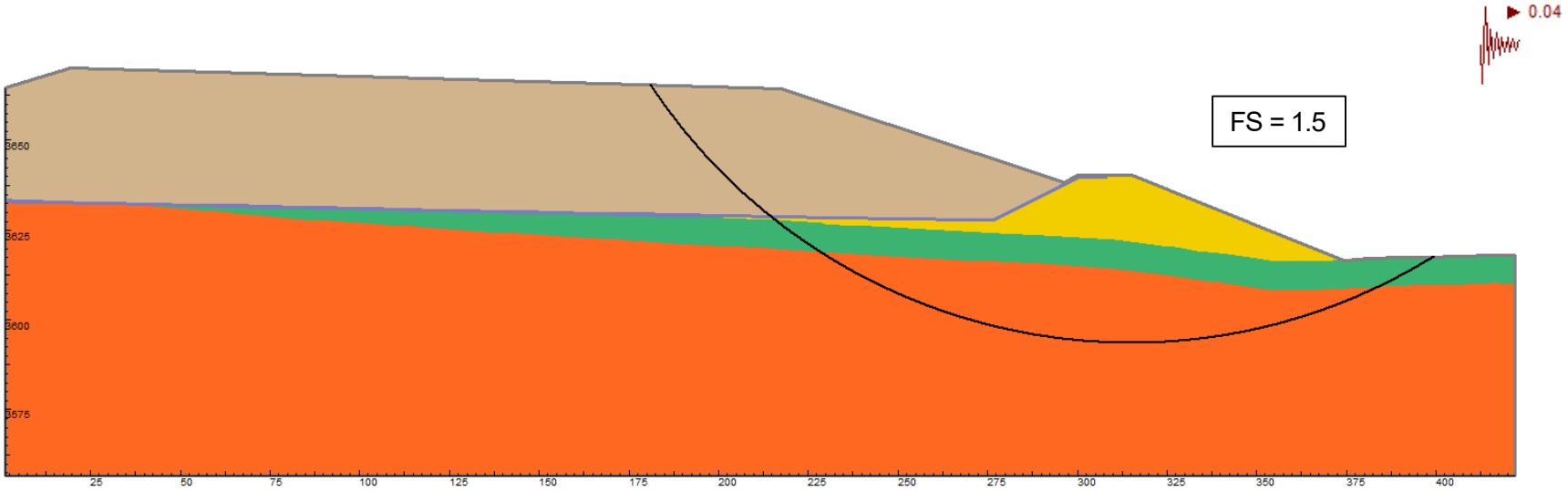
FIGURE
16

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



WASTE ROCK DUMP – SECTION E – GLOBAL CIRCULAR FAILURE - STATIC



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		130	Mohr-Coulomb	0	30
Clay		120	Mohr-Coulomb	315	14
Liner Interface		120	Mohr-Coulomb	0	11
Waste Rock		135	Mohr-Coulomb	0	35

WASTE ROCK DUMP – SECTION E – GLOBAL CIRCULAR FAILURE - PSEUDO-STATIC (k = 0.04 g)

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WRD STABILITY ANALYSIS RESULTS – EFFECTIVE STRESS ANALYSIS
GLOBAL CIRCULAR FAILURE – WASTE ROCK DUMP- SECTION E

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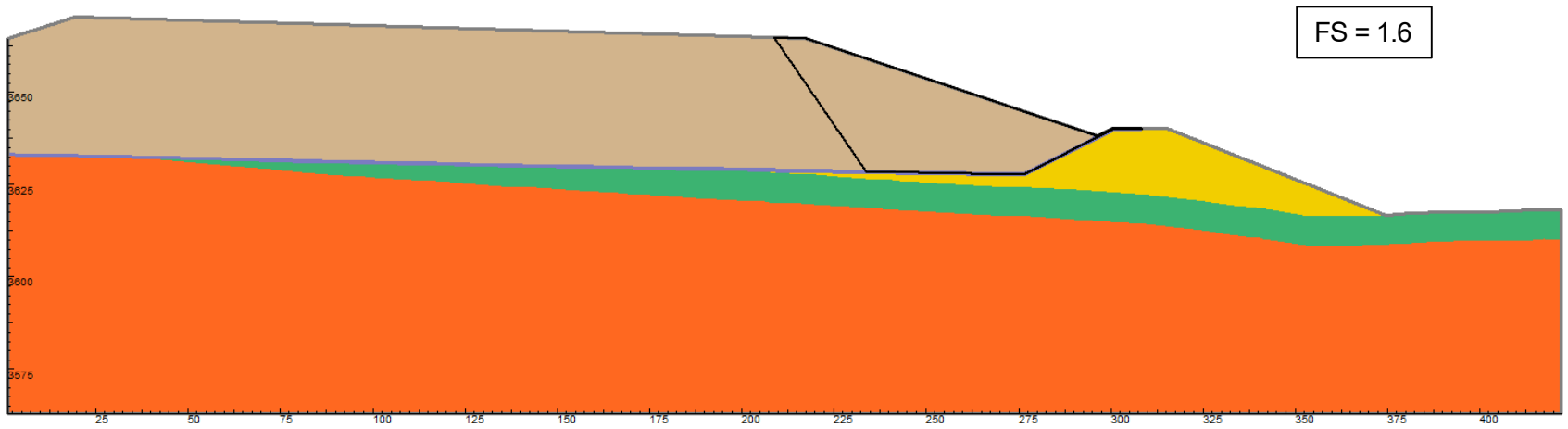
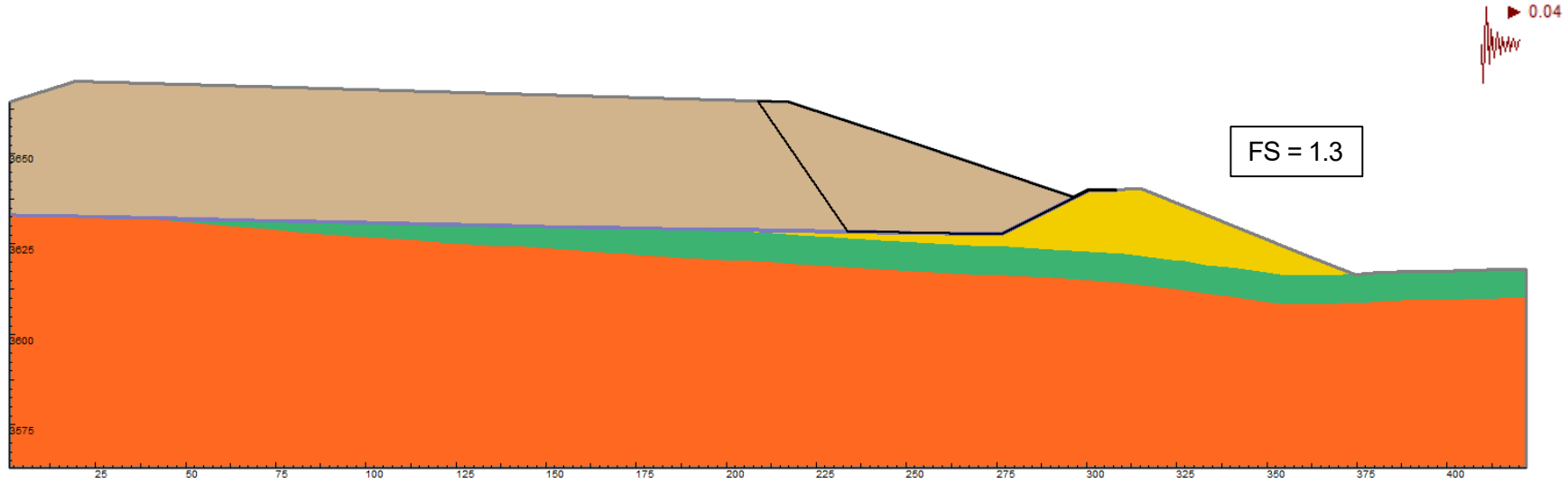
1663241

FIGURE
17

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



WASTE ROCK DUMP – SECTION E – BLOCK FAILURE - STATIC



WASTE ROCK DUMP – SECTION E – BLOCK FAILURE- PSEUDO-STATIC (k = 0.04 g)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		130	Mohr-Coulomb	0	30
Clay		120	Mohr-Coulomb	315	14
Liner Interface		120	Mohr-Coulomb	0	11
Waste Rock		135	Mohr-Coulomb	0	35

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DETAILED DESIGN

TITLE
WRD STABILITY ANALYSIS RESULTS – EFFECTIVE STRESS ANALYSIS
GLOBAL BLOCK FAILURE – WASTE ROCK DUMP - SECTION E

PROJECT No.
1663241

FIGURE
18

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
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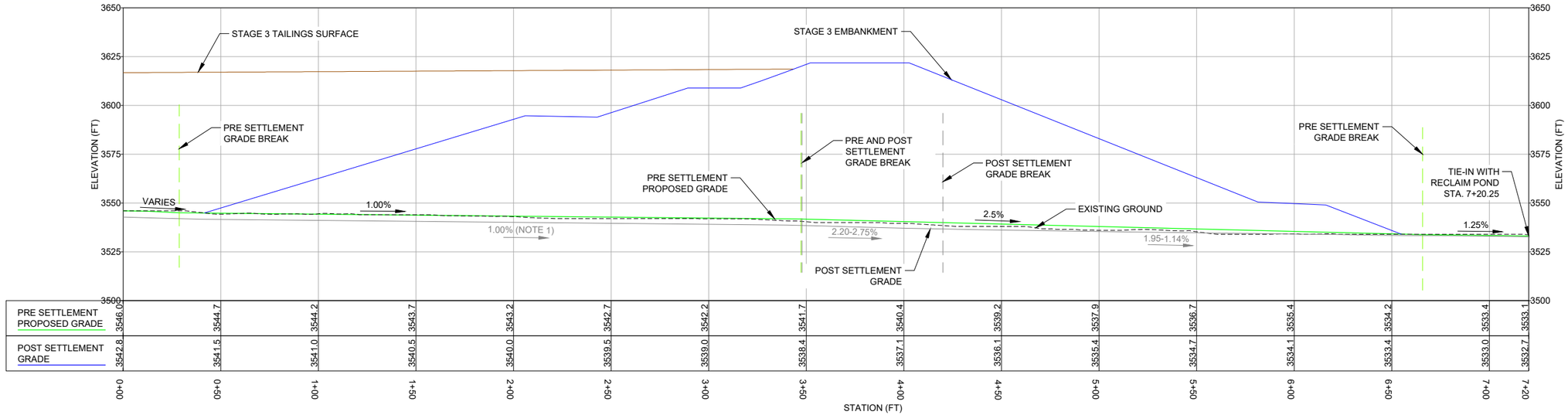

SCALE 1"=15' A - SETTLEMENT SECTION

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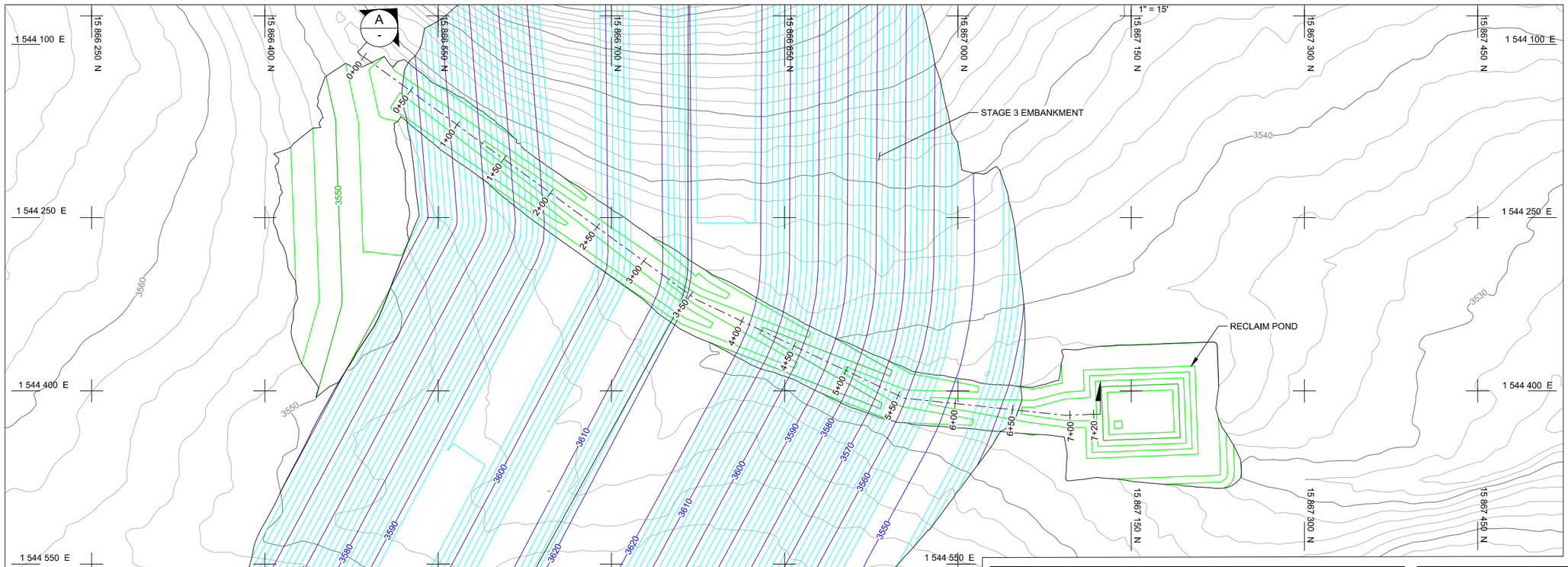

LEGEND

- 3600 — EXISTING GROUND CONTOURS (2 FT)
- 3600 — PROPOSED EMBANKMENT CONTOURS (2 FT)
- 0+00 — SETTLEMENT ALIGNMENT (A -)
- 3600 — PROPOSED CHANNEL AND POND GRADING (2 FT)
- 2.5% — PRE SETTLEMENT PROPOSED GRADE
- 1.4% — POST SETTLEMENT GRADE

NOTE

1. POST SETTLEMENT GRADE MAY BE GREATER THAN 1.0% DEPENDING ON TAILINGS ELEVATION.

0 50 100 150
1" = 50' FEET

CLIENT
CALICO RESOURCES USA CORP.
PARAMOUNT GOLD NEVADA CORP.

CALICO RESOURCES

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN PROJECT
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
SETTLEMENT ANALYSIS

PROJECT NO. 1663241 | REV. 0 | FIGURE 19

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APPENDIX D

Tailings Testing and Consolidation Modeling

TECHNICAL MEMORANDUM

DATE October 18, 2019 **Reference No. 1663241.060.TM.REV0**

TO Chris MacMahon
Golder Associates Inc.

FROM Gordan Gjerapic **EMAIL ggjerapic@golder.com**

GRASSY MOUNTAIN PROJECT – CONSOLIDATION AND THIN-LIFT MODELING

1.0 INTRODUCTION

Golder Associates Inc., (Golder) has prepared this technical memorandum to describe the consolidation and thin-lift modeling results for the Tailings Storage Facility (TSF), proposed to be constructed as a part of the Grassy Mountain Project, Oregon. The main goal of the modeling effort was to evaluate the storage capacity and drainage rates from the tailings impoundment. The consolidation analyses were conducted by using properties for the GMTC-1 and GMTC-2 samples delivered to Golder's Soil Laboratory in Lakewood, Colorado in April 2019. The thin-lift calculations were conducted using parameters for the GMTC-1 and GMTC-2 composite sample. All analyses utilized the tailings production rate of 680 tons per day.

2.0 MODELING APPROACH, INPUTS AND ASSUMPTIONS

2.1 Consolidation Modeling

The TSF consolidation model is commonly used to: 1) predict average dry densities; 2) develop staged settled dry density estimates; and 3) develop predictions for the volume of water extracted from the top and the bottom of the tailings during the consolidation process. Due to uncertainties in boundary conditions associated with the thin-lift deposition process, the consolidation results were compared to results from the thin-lift analyses. Consolidation analyses presented in this memorandum were conducted using the one-dimensional and the simplified three-dimensional column accretion models (see Section 2.1.1). The assumptions and input parameters used to perform consolidation analyses are:

- Production rate of 680 tons per day
- Compressibility and hydraulic conductivity (permeability) parameters for GMTC-1 and GMTC-2 samples (Attachment 1)
- Stage filling curve relationships (see Figure 1) developed from the design drawings (Golder 2019a)
- Perform analyses assuming that water collected by the underdrain system is conveyed from the bottom of the tailings into a reclaim pond
- Assume tailings deposition at 46 percent solids
- Assume tailings solids content between 54 and 56 percent at the end of the sedimentation process based on the available laboratory data (Attachment 1)

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2.1.1 Model Codes

Consolidation modeling was performed using CONDES (Yao and Znidarcic 1997) and FSConsol (GWP 2014) model codes. Model codes are discussed in more detail in Sections 2.1.1.1 and 2.1.1.2.

2.1.1.1 CONDES Model Code

To account for the non-linearity of material properties, the computer program CONDES (Yao and Znidarcic 1997) was used. CONDES is a computer program used to model impoundment filling and one-dimensional consolidation based on the large-strain consolidation theory (Gibson et al. 1967). The program solves a non-linear second order partial differential equation formulated for one-dimensional compression. CONDES results provide time-dependent solutions of void ratio distribution (solid content distribution), and layer thickness. To account for three-dimensional effects, results from multiple CONDES models were combined based on the approach proposed by Gjerapic et al. (2008). The governing equations are listed below:

Velocity function:

$$v_u = \frac{k\cdot(G_s-1)}{1+e} + \frac{k\cdot(1+e_o)}{\gamma_w(1+e)}\frac{d\sigma'}{de}\frac{\partial e}{\partial a} \quad (1)$$

Conservation of mass:

$$\frac{\partial v_u}{\partial a} = \frac{-1}{1+e_0}\frac{\partial e}{\partial t} \quad (2)$$

Where: t = time
a = Lagrangian Coordinate Systems
k = hydraulic conductivity
e_0 = void ratio at zero effective stress
G_s = specific gravity of soil particles
v_u = velocity function
γ_w = unit weight of water

CONDES uses an iterative numerical procedure to solve Equations (1) and (2) and to predict void ratio profiles based on the following constitutive properties (see e.g., Abu-Hejleh and Znidarcic 1994, 1996):

$$e = A(\sigma' + Z)^B \quad (3)$$

and

$$k = Ce^D \quad (4)$$

Where: e denotes the void ratio
σ′ stands for the effective stress and
k is hydraulic conductivity functionally dependent on void ratio.

In the above equations *A, B, Z, C* and *D* are material parameters for the GMTC-1 and GMTC-2 tailings samples.

2.1.1.2 FSConsol Model Code

FSConsol V3.48, is a commercially available software for large strain consolidation modeling based on Gibson et al. (1967) methodology. The program can calculate the pore pressure distribution and the void ratio profile (solids

content distribution) as a function of time. The program inputs include: TSF geometry, tailings production rates, boundary conditions, and tailings consolidation properties.

The following relationships are used in FSConsol to define tailings consolidation properties (GWP 2014):

$$e = A(\sigma')^B + M \quad (5)$$

and

$$k = Ce^D \quad (4 \text{ ibid})$$

Parameters *A, B, M, C* and *D* are determined by fitting constitutive relationships defined by Equations (4) and (5) to laboratory data.

2.2 Thin-Lift Modeling

The thin-lift deposition assumes that the tailings are deposited in a controlled manner allowing for the fresh tailings to desiccate in a climate characterized by relatively high net evaporation losses. As the tailings' densities increase, a large amount of water from the porous matrix is lost to the atmosphere. Consequently, water inflows to the tailings pool are significantly reduced as compared to conventional deposition practices. A successful thin-lift deposition design requires consideration of the water balance needs, tailings' transport and geotechnical properties, climate conditions, TSF geometry, production rates, as well as the management practices throughout the life of the facility. The benefits of the thin-lift deposition considered in the design typically include reduced infiltration, higher tailings densities (lower embankment height, i.e., reduced construction costs), lower permeability (simpler and more efficient water management) and higher strength (increased stability and reduced liquefaction susceptibility). The focus of the modeling effort presented in this memorandum was to evaluate the feasibility of the thin-lift approach and to estimate seepage rates (vertical percolation rates) during the thin-lift deposition process.

The thin-lift deposition is based on the laboratory testing results for the GMTC composite tailings sample (Attachment 1), the proposed TSF geometry (Golder 2019a) and the anticipated climate conditions (Golder 2019b).

2.2.1 Model Approach

To evaluate the feasibility of the thin-lift deposition management, one can apply the simplified model based on the input tailings parameters and the net evaporation potential (see Figure 2). To evaluate impacts of the seasonal effects, however, the thin-lift model needs to account for the continuous deposition (tailings accretion) and the tailings interaction with the atmosphere (see Figure 3). The thin-lift accretion model used in this study allows for the interaction of the deposited tailings with the atmosphere utilizing the numerical approach that was originally implemented by Fayer (2000). The accretion model geometry is updated in daily increments and is accompanied with adjustments of the soil-water characteristic curve (SWCC) determined from laboratory measurements (Attachment 1). The outputs from the accretion model include evaporation and drainage losses reported in daily increments. The simplified and the accretion models were developed for two case scenarios:

- Case 1 – assume that all tailings water entering the TSF is initially contained within the soil matrix.
- Case 2 – assume that a portion of the tailings discharge water is lost during the sedimentation process and reports directly to the tailings pool. Consequently, the initial amount of porous water, at the onset of the thin-

lift modeling process, is reduced by the estimated initial bleed. The initial bleed estimates used for the thin-lift analyses were selected based on the settling column test results (Attachment 1).

2.2.2 Thin-Lift Model Inputs

The following inputs were used in the thin-lift deposition model simulations:

- The annual tailings production rate of 680 tons per day.
- Tailings are deposited over the period of 14 years.
- The stage-storage relationships for thin-lift modeling are based on the design geometry (Golder 2019a) as illustrated in Figure 1.
- The tailings are subjected to semi-arid climate conditions with a relatively low annual precipitation (9.7 inches) and high annual potential evaporation (45.0 inches) resulting in an average net annual evaporation potential of 35.3 inches (Golder 2019b).
- The tailings are discharged at the solids content of 46 percent.
- At the end of the sedimentation process, the average solids content is approximately 56 percent.
- The specific gravity of tailings is 2.63. This value is based on the laboratory results for the GMTC-1 and GMTC-2 composite sample (Attachment 1).
- The tailings shrinkage limit is 38.8% based on desiccation test results (Attachment 1).
- Assume that the tailings are fully saturated from the moment of deposition and throughout the desiccation process until reaching the shrinkage limit.

Results from the settling column tests used to estimate the amount of water released to the tailings pool due to initial bleed and to adjust SWCC parameters (based on the calculated volumetric moisture content/porosity values) are summarized in Table 1.

Table 1: Settling Column Test Results – Summary

Sample ID	Initial Solids Content (%)	Initial Void Ratio (-)	Initial Porosity (%)	Final Void Ratio	Final Porosity (%)
GMTC-1	46%	3.088	75.5%	2.159	68.3%
GMTC-2	46%	3.087	75.5%	1.972	66.4%

Based on the results in Table 1, the initial volumetric moisture content of 67 percent (with the corresponding void ratio of 2.03) was adopted for the Case 2 thin-lift model simulations. I.e., the thin-lift simulations accounting for the initial bleed were conducted assuming the average settled dry density of approximately 54 pcf (solids content of approximately 56 percent) at the end of the sedimentation process.

The SWCC parameters at low suctions (see Attachment 1) were adopted to develop the thin-lift model predictions. The selected van Genuchten model parameters are summarized in Table 2.

Table 2: SWCC Parameters for Thin-Lift Modeling

Sample	θ_{sat} (-)	θ_r (-)	α (1/kPa)	n (cm/sec)
GMTC composite – low suction	0.51 to 0.76	0.00	0.05	1.50

The SWCC relationships used for the thin-lift analyses are shown in Figure 4.

2.3 Staged Filling

The TSF filling process was modeled by starting the tailings deposition from the impoundment bottom and ending at the TSF maximum height according to the stage-storage curve (height-area-volume relationship) developed from the TSF design drawings (Golder 2019a). A simplified stage-storage curve used for both the consolidation and the thin-lift accretion modeling is presented in Table 3:

Table 3: Stage Filling Curve Used for Consolidation and Thin-Lift Analyses

Stage	Top of Tailings Elevation (ft)	Tailings Area (acres)	Cumulative Tailings Storage Volume (MCY)
Initial	3,545	0.0	0.0
1	3,592	37.00	0.93
2	3,605	59.43	1.92
3	3,617	83.43	3.38

The stage-storage curve used for the consolidation and the thin-lift analyses is shown in Figure 1.

3.0 RESULTS

3.1 Consolidation Model Results

The consolidation analyses were conducted assuming flexible TSF side boundaries (FSConsol calculations) and rigid side boundaries (CONDES calculations) for the TSF areas above the impoundment bottom. Dry densities calculated at the end of each stage of the proposed TSF development, for both FSConsol and CONDES calculations, are shown in Table 4.

Table 4: Average Dry Density Estimates

Stage	Top of Tailings Elevation (ft)	Model Column Height (ft)	Average Dry Density (pcf)	
			FSConsol[1]	CONDES[2]
1	3,592	46	80.62	81.0 – 82.2
2	3,605	60	81.98	79.4 – 80.4
3	3,617	>63	>82.26	79.8 – 80.8

Notes:
1) Modeling results for pervious bottom boundary using FSConsol Model.
2) Density range based on GMTC-1 and GMTC-2 parameters.

Average dry densities as a function of the maximum tailings elevation are shown in Figure 5.

3.2 Thin-Lift Model Results

To estimate the minimum TSF area required for the thin-lift deposition approach, one can utilize the simplified model based on the net evaporation requirements illustrated in Figure 2. Based on the assumption that all water (in excess of the amount contained in the pores of a fully saturated tailings deposit) is expelled by evaporation until reaching tailings' shrinkage limit, one can determine the minimum required TSF area using the average annual net evaporation rate of 35.3 inch/year. The simplified thin-lift deposition model results are summarized in Table 5.

Table 5: Minimum TSF Area for Thin-Lift Management

Scenario	Production Rate (t/day)	Solids Volume Rate (yd^3/day)	Evaporation Demand (yd^3/day)	Minimum TSF Management Area (acre)	Dry Density[1] (pcf)
Case 1	680	307	635	49	81.2
Case 2	680	307	322	25	81.2

Note:
1) Dry density corresponding to the shrinkage limit of 38.8% for GMTC-1/GMTC-2 composite sample.

The minimum TSF areas determined from the simplified thin-lift model (see Table 5) are compared to the design TSF area at different stages of development in Figure 6.

The simplified thin-lift model is based on the average annual net evaporation values. In addition, Figure 1 demonstrates that the success of the thin-lift deposition process in Stage 1 is likely to depend on the deposition practices and the associated tailings behavior affecting the desiccation rate. Considering the net evaporation values presented in Table 6, active water management may be required throughout the TSF operation, at least during the winter months. Table 6 demonstrates that the simplified model predictions based on the annual tailings production and the average annual net evaporation may be underpredicting the minimum TSF area requirements for six months out of the year from approximately October through March.

Table 6: Net Evaporation

Month	Precipitation (in/month)	Precipitation (in/year)	Evaporation (inch/month)	Evaporation (inch/yr)	Evaporation (% of Annual Average)	Net Evaporation (inch/yr)	Net Evaporation (% of Annual Average)
1	0.91	10.9	0.85	10.2	22.7%	-0.7	-2.0%
2	0.63	7.6	1.31	15.7	35.0%	8.2	23.1%
3	1.00	12.0	2.69	32.3	71.8%	20.3	57.5%
4	1.14	13.7	3.81	45.7	101.7%	32.0	90.9%
5	1.39	16.7	5.28	63.4	141.0%	46.7	132.4%
6	0.89	10.7	6.37	76.4	170.1%	65.8	186.6%
7	0.51	6.1	8.16	97.9	217.8%	91.8	260.4%
8	0.31	3.7	7.04	84.5	187.9%	80.8	229.1%
9	0.47	5.6	4.39	52.7	117.2%	47.0	133.4%
10	0.83	10.0	2.95	35.4	78.8%	25.4	72.2%
11	0.73	8.8	1.31	15.7	35.0%	7.0	19.7%
12	0.89	10.7	0.79	9.5	21.1%	-1.2	-3.4%

A more detailed assessment of the TSF area with respect to the thin-lift deposition management can be determined by accounting for the accretion process and for the soil-atmosphere interaction at the tailings' boundary. The thin-lift accretion model schematics and assumptions are presented in Figure 3. The accretion model was evaluated using the climate data for the period from 1999 to 2012 (Golder 2019b). The thin-lift accretion model results are summarized in Table 7 in terms of drainage rates.

Table 7: Drainage Rates

Year	Case 1 – Drainage Rate (gpm)			Case 2 – Drainage Rate (gpm)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
1	5.0	122.6	31.7	2.3	99.3	13.5
2	11.1	78.1	34.0	3.3	30.3	12.5
3	8.2	82.8	43.2	5.1	72.1	20.7
4	6.8	82.8	40.0	4.3	52.4	16.6
5	10.3	110.4	45.5	4.9	73.5	19.5
6	12.2	105.4	48.1	5.7	46.3	18.3
7	17.9	115.0	56.1	6.5	57.8	24.6
8	16.6	116.3	52.0	7.9	47.0	20.3
9	16.3	165.3	57.6	8.0	91.4	25.0
10	16.8	133.5	58.2	8.6	58.4	21.7
11	22.6	134.7	64.6	9.1	65.7	26.4
12	21.7	127.4	62.6	10.9	58.8	25.3
13	23.4	122.9	61.3	12.6	64.7	27.0
14	25.1	128.6	64.2	13.7	63.1	28.8

The calculated drainage rates for Case 1 (w/out initial bleed) and Case 2 (with initial bleed) model scenarios are shown in Figures 7 and 8.

4.0 CONCLUSIONS

Presented consolidation analyses demonstrate that the tailings dry densities range from 79 to more than 82 pcf at the end of the staged-filling deposition. Approximately 50 percent or more of the consolidation water is expected to be intercepted by the underdrain system at the beginning of impoundment filling. Within first couple of years, the amount of water conveyed by the underdrain system is expected to decrease to approximately 30 to 40 percent of the total consolidation water with the potential for further reduction as the tailings height in the impoundment increases. The employed consolidation models do not account for the soil-atmosphere interaction during the TSF filling period. Hence, the drainage predictions determined from the thin-lift simulations are likely to be more reliable assuming that the tailings are deposited using the thin-lift management practices.

The settling column tests on GMTC-1 and GMTC-2 samples, using the initial solids content of 46 percent, indicate that the tailings segregation potential is not likely to have a significant impact on settled tailings densities. This finding was confirmed by flume testing.

The thin-lift deposition assessment indicates that the TSF operation may require active water management during the winter months, especially during periods characterized by larger than average precipitation. The TSF is expected to exhibit seasonal variation in drainage rates. The drainage rates ranging from 5.0 to 165 gpm and from 2.3 to 100 gpm were determined for the Case 1 and Case 2 model scenarios, respectively. Median drainage rates of approximately 47 gpm (Case 1) and 19 gpm (Case 2) were determined for the thin-lift simulation period of 14 years. The reported drainage rates are based on the one-dimensional tailings accretion model that does not account for the presence of the tailings pool, i.e., the actual seepage from the TSF will be affected by the employed management practices affecting the extent of the tailings pool area.

5.0 REFERENCES

Abu-Hejleh, A.N., and D. Znidarcic. 1994. “Estimation of the Consolidation Constitutive Relations,” Computer Methods and Advances in Geomechanics, Siriwardane & Zaman (eds) Balkema, Rotterdam, pp. 499-504.

Abu-Hejleh, A.N., and D. Znidarcic. 1996. “Consolidation Characteristics of Phosphatic Clays,” Journal of Geotechnical Engineering, ASCE, New-York, Vol. 122, No. 4. pp. 295-301.

Fayer, M. 2000. “UNSAT-H Version 3.0: Unsaturated Soil Water and Heat Flow Model – Theory, User Manual, and examples,” Report No. PNNL-13249, Pacific Northwest National Laboratory, Richland, WA, USA.

GWP Geo Software Inc. (GWP). 2014. FSConsol V3.48, Edmonton, AB, T6C 4R4, Canada.

Gibson, R.E., G.L. England, and M.H.L. Hussey. 1967. “The theory of one-dimensional consolidation of saturated clays, I. finite non-linear consolidation of thin homogeneous layers.” Geotechnique, 17(3), 261-273.

Gjerapic, G., J. Johnson, J. Coffin, and D. Znidarcic. 2008. “Determination of Tailings Impoundment Capacity via Finite-Strain Consolidation Models.” GeoCongress 2008: Characterization, Monitoring, and Modeling of GeoSystems (GSP179) conference proceedings. New Orleans, LA, pp 798-805.

Golder Associates Inc. (Golder). 2019a. “Grassy Mountain Project – Tailings Storage Facility,” draft design drawings prepared for Calico Resources USA Corp., Golder Project No. 166-3241. April 19.

Golder Associates Inc. (Golder). 2019b. Grassy Mountain Climate Data – Detailed Design Revision, technical memorandum, project number 181-11356. June 17.

Liu, J.C., and D. Znidarcic. 1991. “Modeling One-Dimensional Compression Characteristics of Soils,” Journal of Geotechnical Engineering, ASCE, New-York, Vol. 117, No. 1. pp. 162-169.

Yao, D.T.C., and D. Znidarcic. 1997. “Crust Formation and Desiccation Characteristics for Phosphatic Clays – User’s manual for computer program CONDES0”. The Florida institute of Phosphate Research, Publication No. 04-055-134.

Yao, D.T.C., W.L. Oliveira-Filho, X.C. Cai, and D. Znidarcic. 2002. “Numerical solution for consolidation and desiccation of soft soils,” International Journal for Numerical and Analytical Methods in Geomechanics, Vol. 26, pp. 1-23.

Figures

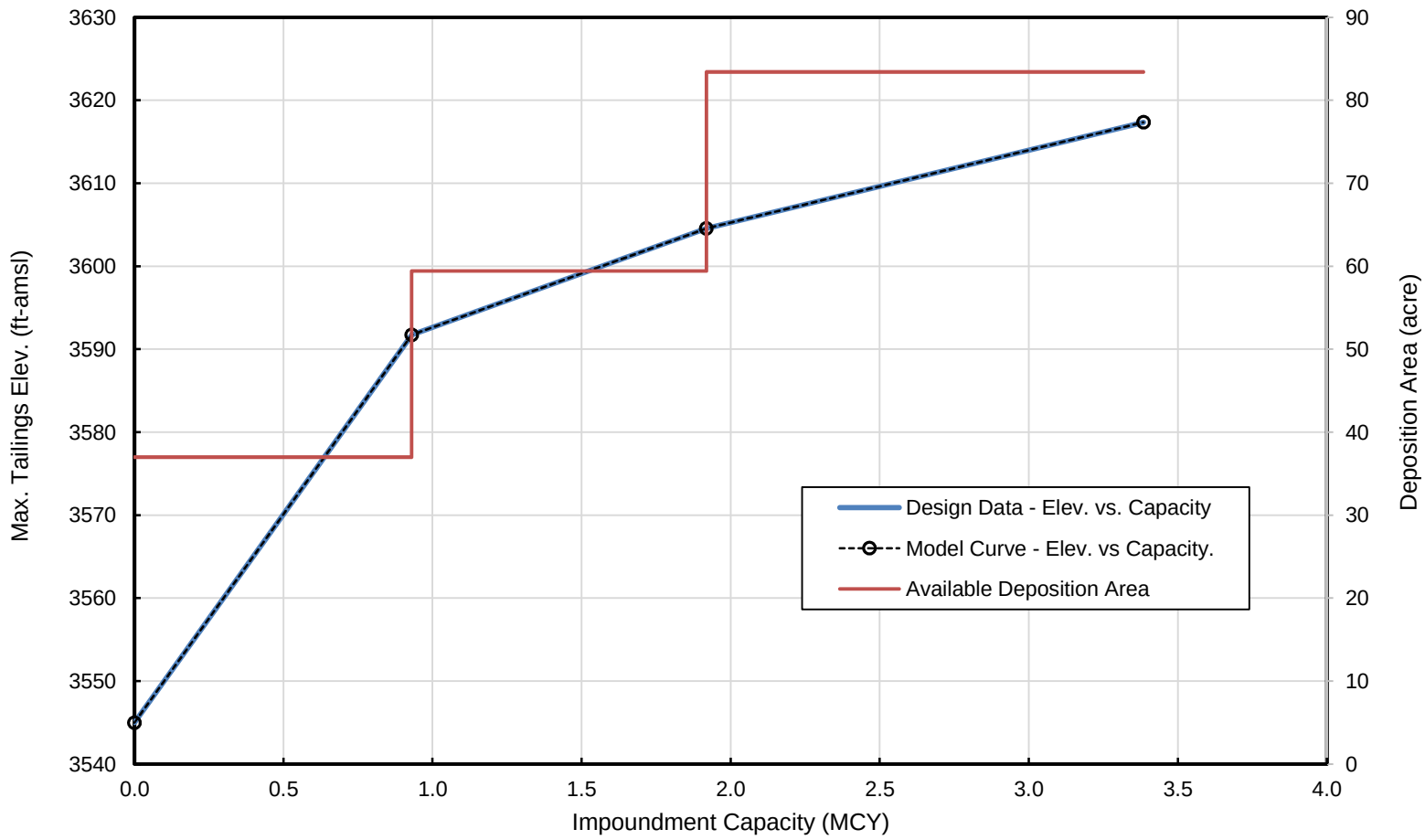

Figure 1

Thin-Lift Model Stage Storage Relationships

Grassy Mountain

Consolidation and Thin Lift Modeling

Denver

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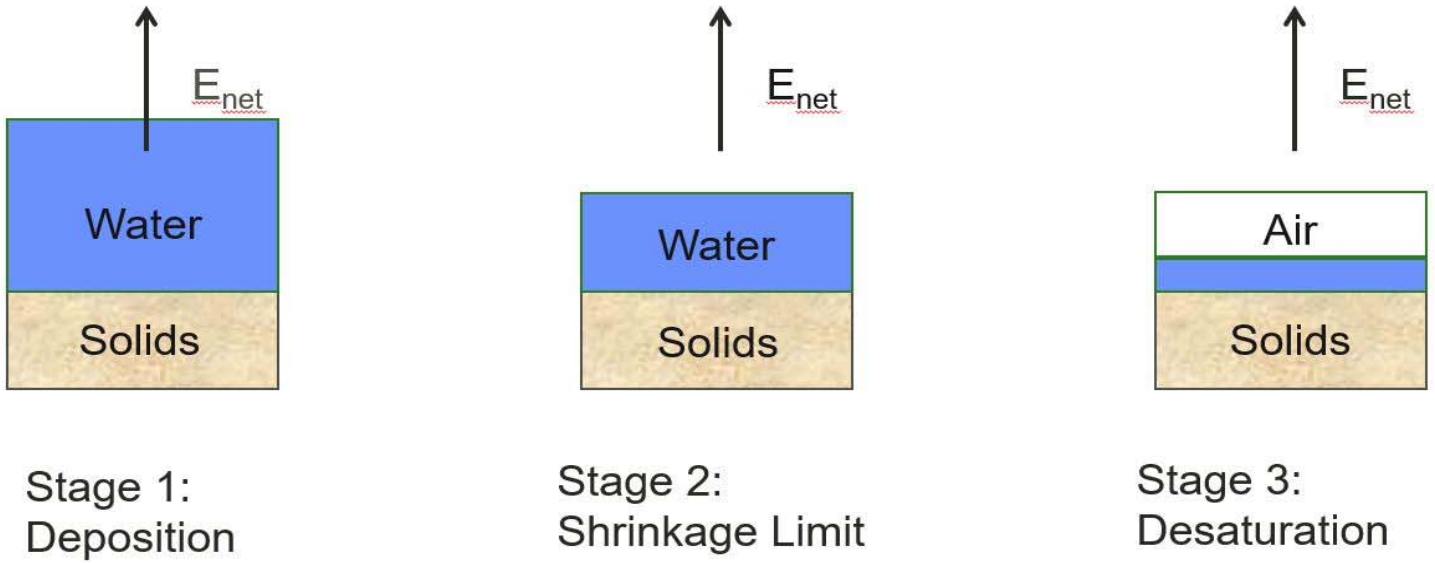
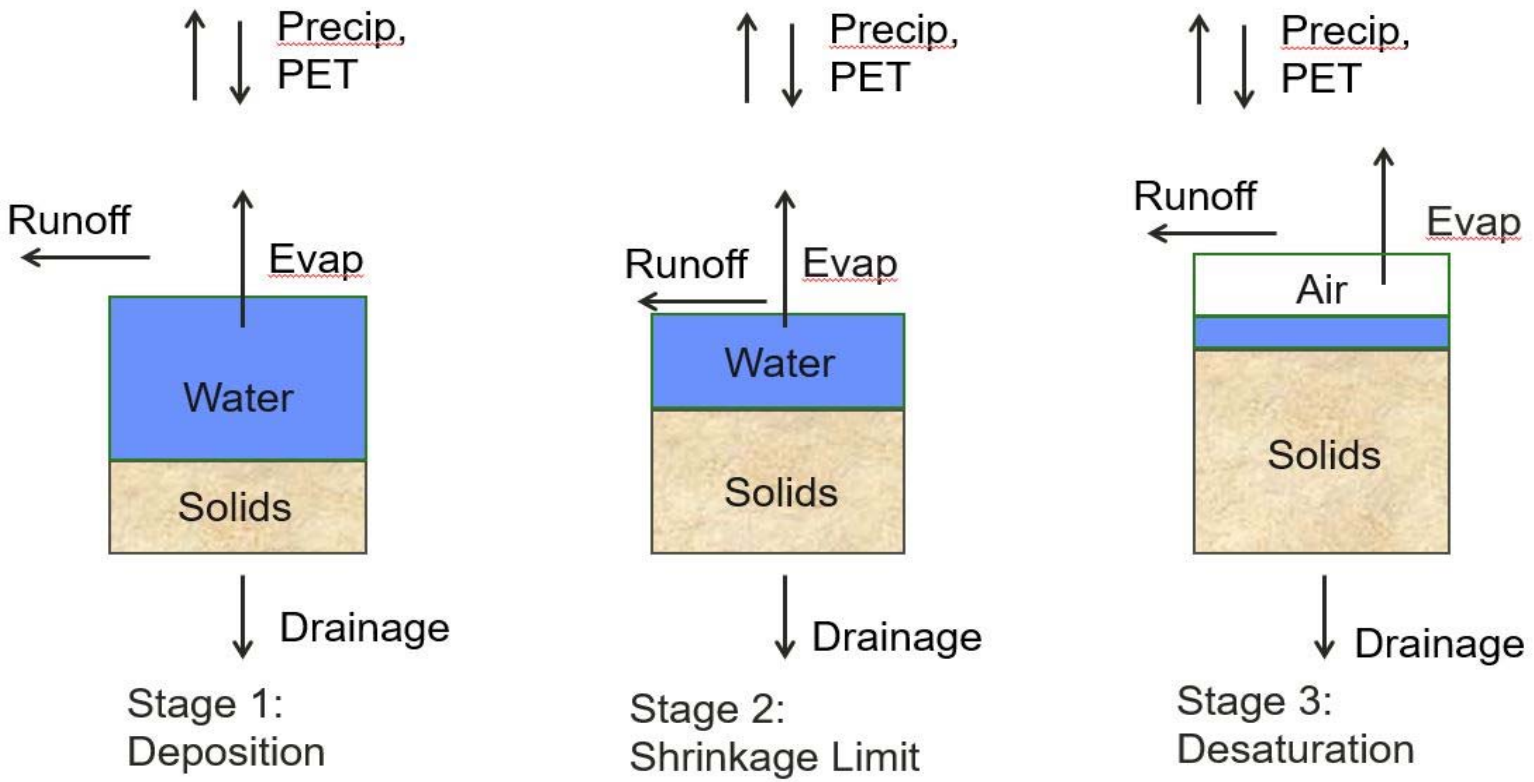


Simplified Model Assumptions
- No runoff (one-dimensional model)
- No seepage (assume impervious bottom)
- Precipitation is readily absorbed (use net evaporation)
- Fully saturated until shrinkage limit

Figure 2
Thin-Lift Deposition - Simplified Model
Grassy Mountain
Consolidation and Thin Lift Modeling



Accretion Model Assumptions

- Account for runoff (no run-on => one-dimensional model)
- Account for seepage looses (assume unit gradient bottom boundary)
- Calculate evaporation losses based on physical conditions at the soil-atmosphere boundary
- Allow for accretion of tailings and gradual change in height/desaturation (increase in tailings mass)
- Fully saturated until shrinkage limit

Figure 3

Thin-Lift Deposition - Accretion Model

Grassy Mountain

Consolidation and Thin Lift Modeling

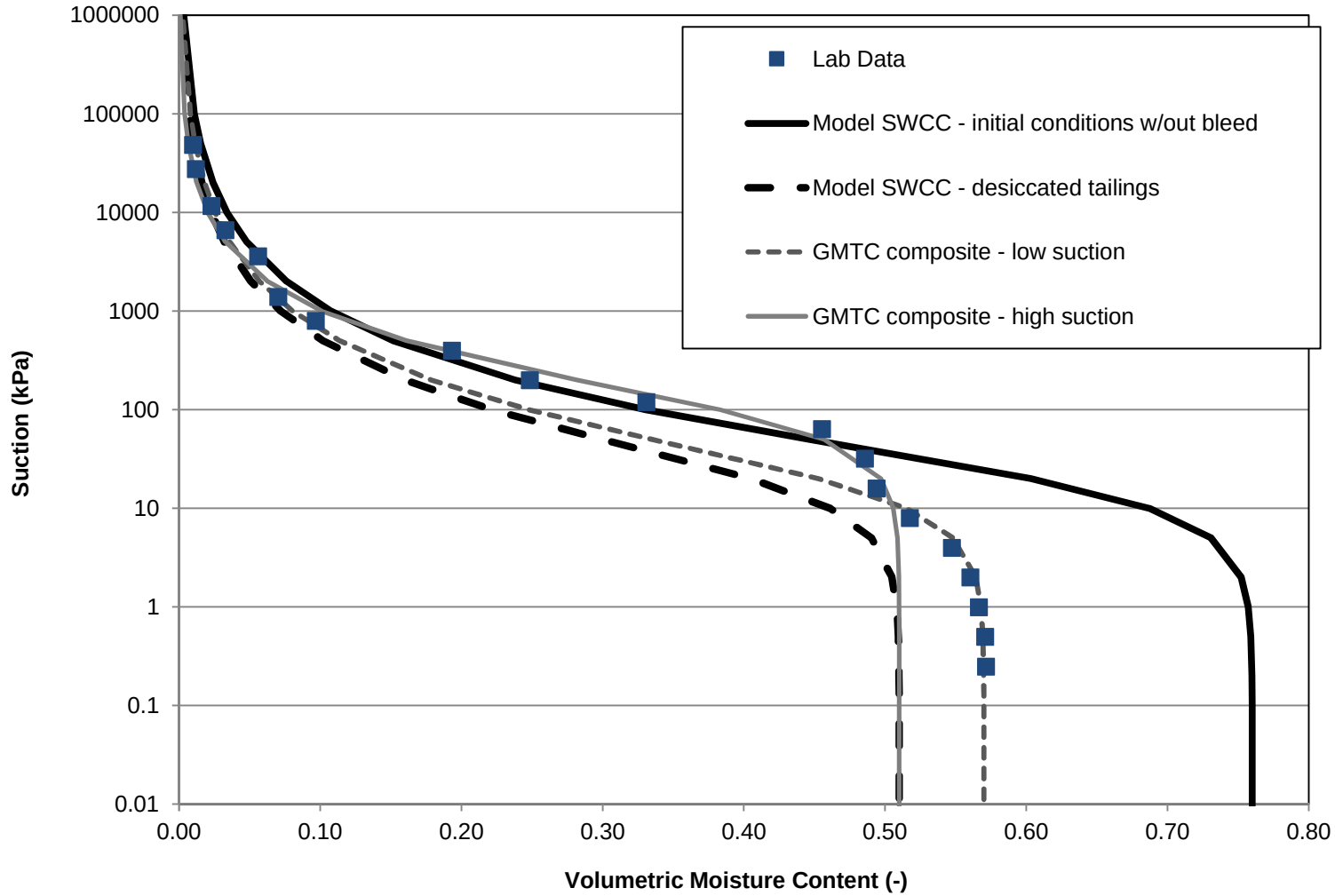


Figure 4

Model SWCCs

Grassy Mountain

Consolidation and Thin Lift Modeling

Denver

GOLDER

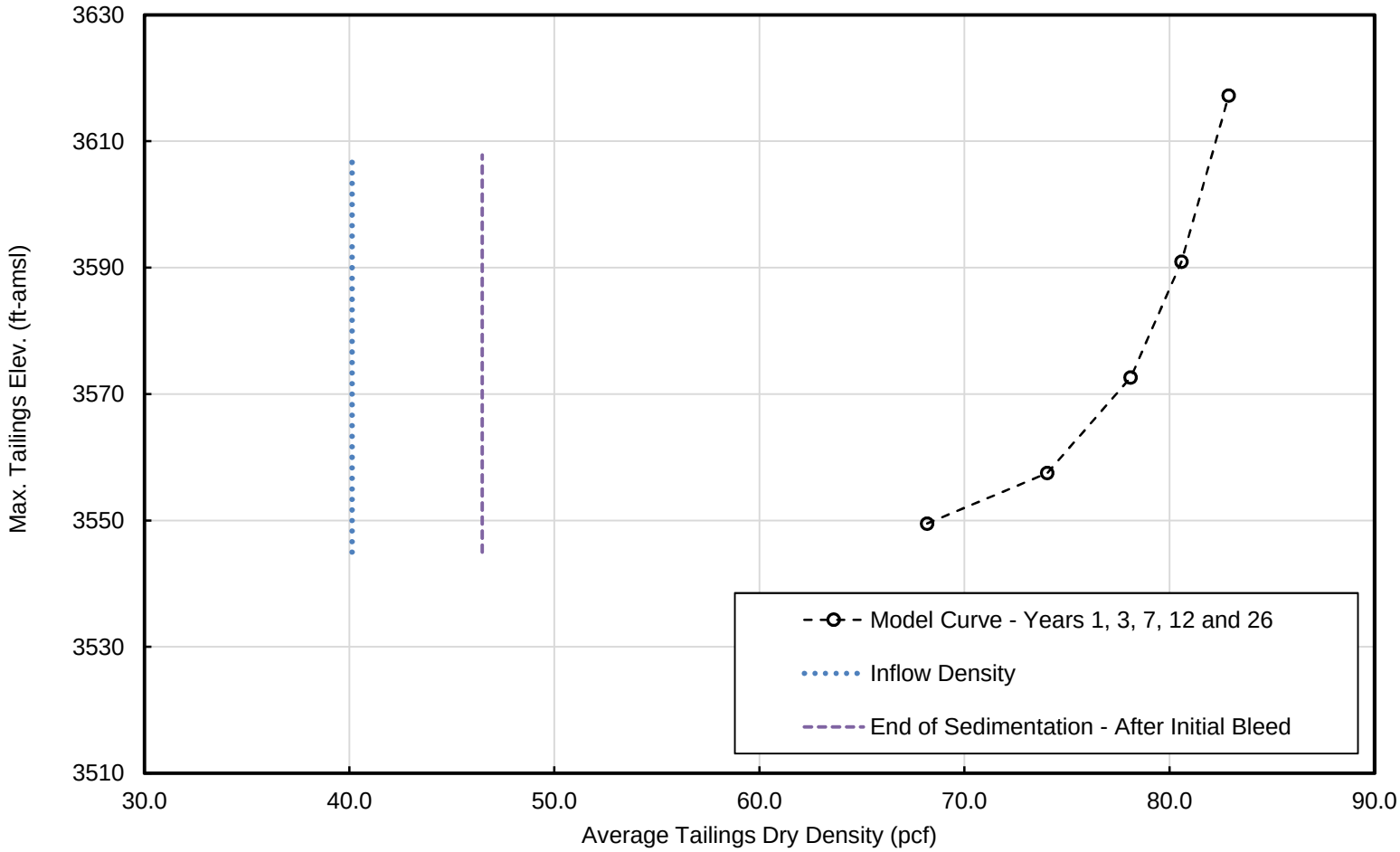


Figure 5

Density Profile - FSConsol Model Results

Grassy Mountain

Consolidation and Thin Lift Modeling

Denver

GOLDER

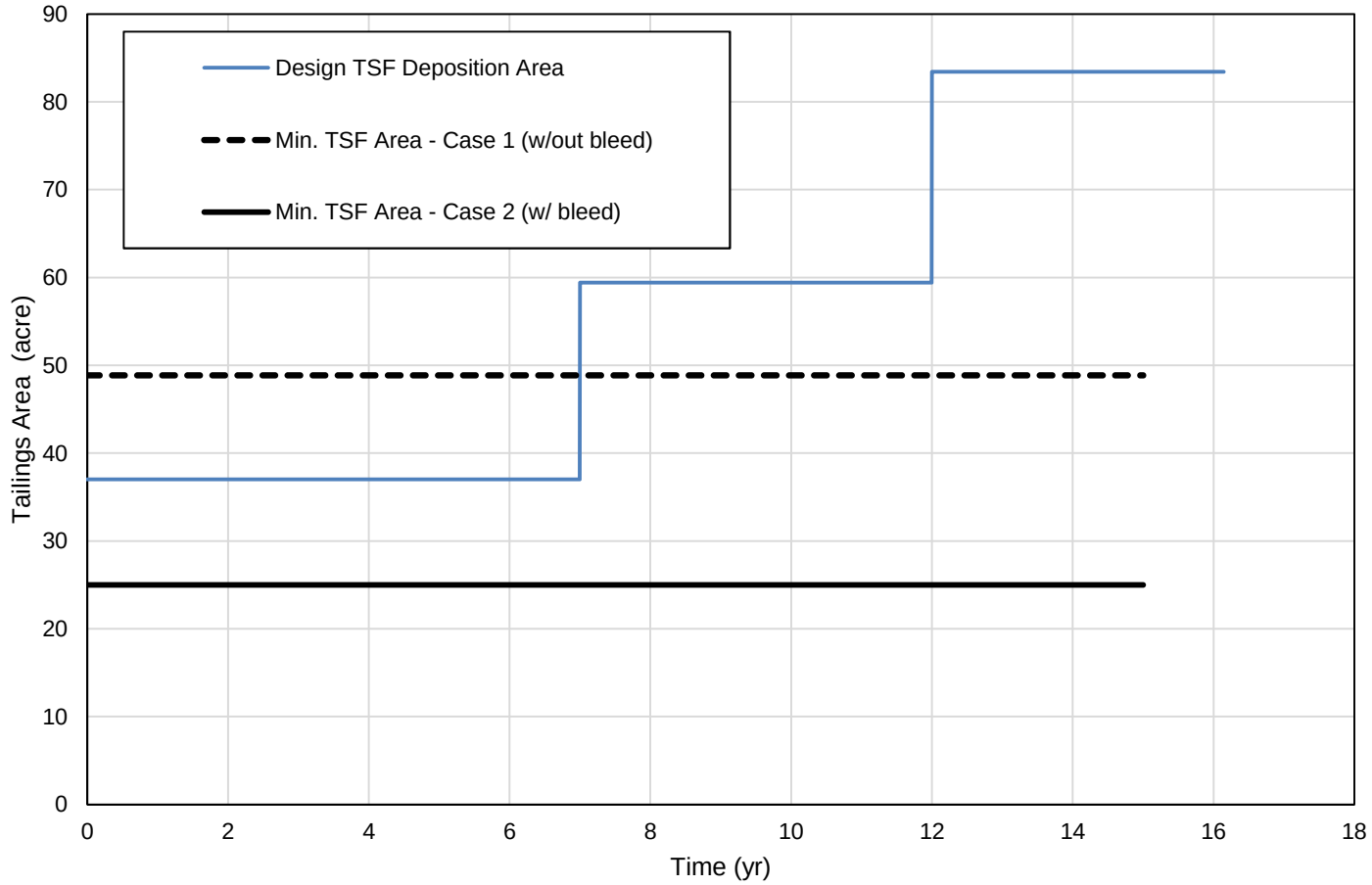


Figure 6

Thin-Lift Simplified Model Results

Grassy Mountain

Consolidation and Thin Lift Modeling

Denver

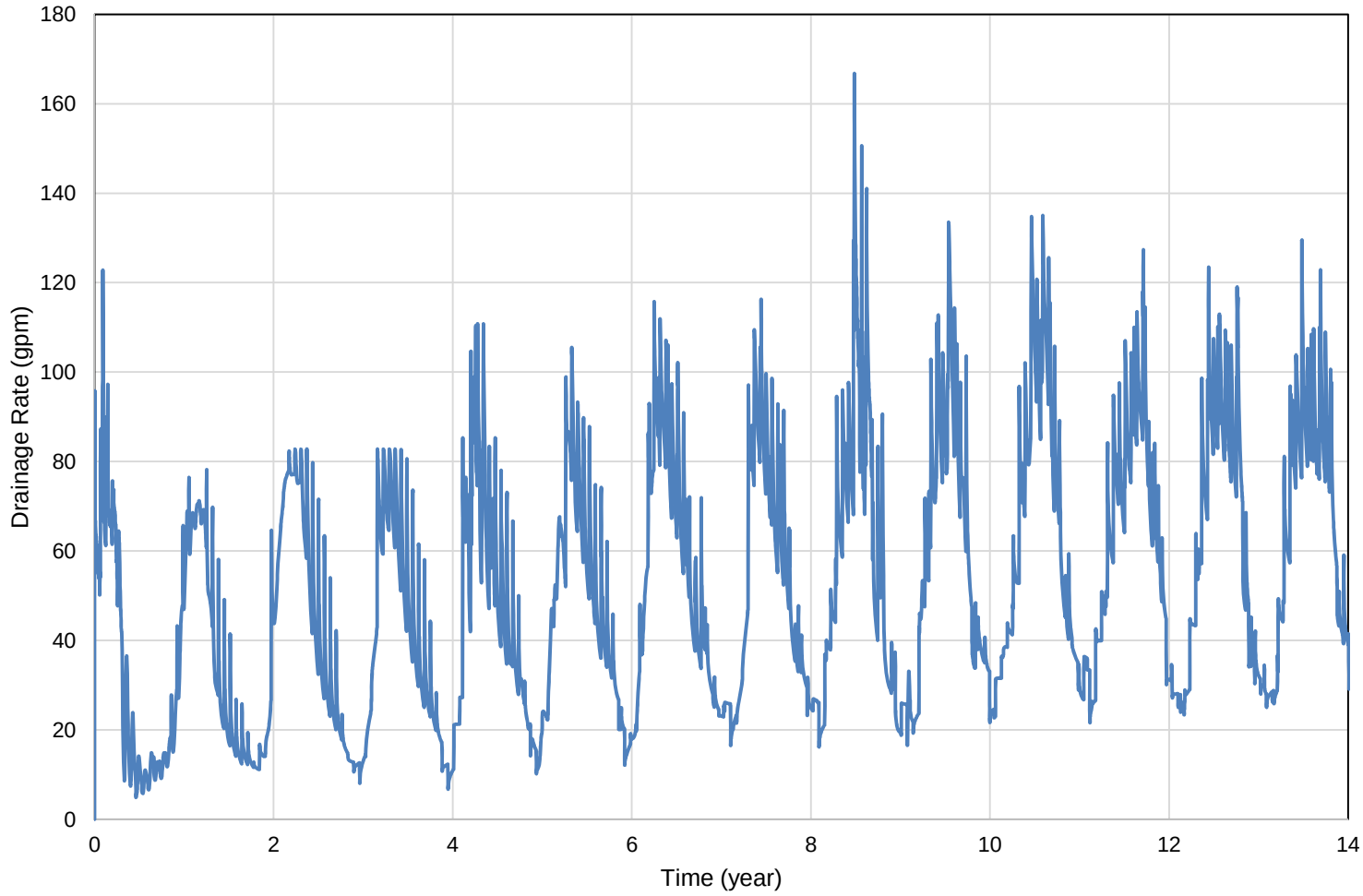


Figure 7

Case 1 - Accretion Model Drainage Rates

Grassy Mountain

Consolidation and Thin Lift Modeling

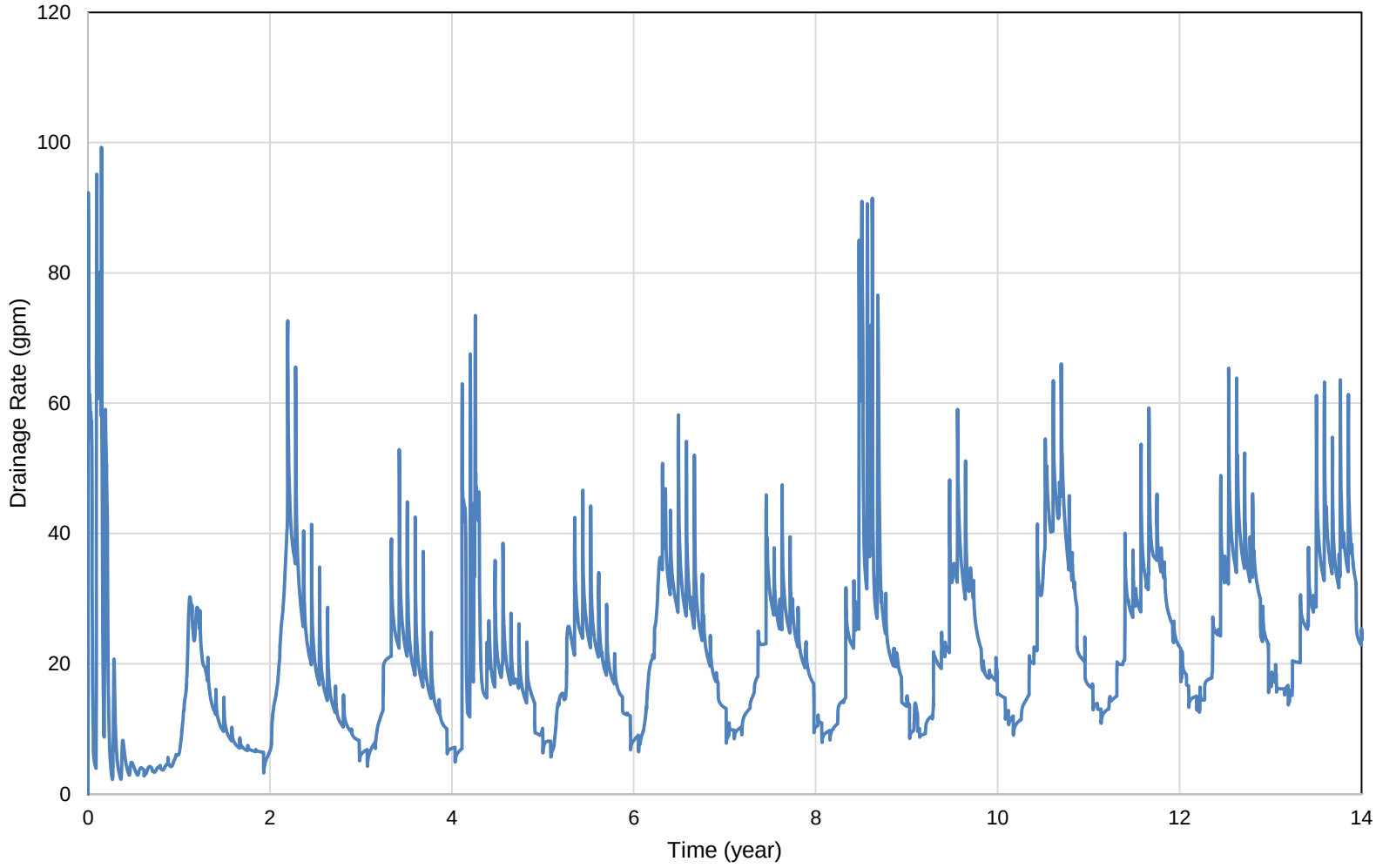


Figure 8

Case 2 - Accretion Model Drainage Rates

Grassy Mountain

Consolidation and Thin Lift Modeling

Denver

ATTACHMENT 1

Laboratory Testing on Tailings Samples

TECHNICAL MEMORANDUM

DATE October 8, 2019 **Reference No.** 1663241-9000-9005-TM-A

TO Chris MacMahon
Golder Associates Inc. – Reno, NV

FROM Gordan Gjerapic, Matt Barrett **EMAIL GGjerapic@Golder.com**

LABORATORY TESTING ON TAILINGS SAMPLES, GRASSY MOUNTAIN PROJECT

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has completed a series of laboratory tests on tailings samples provided to Golder by SGS Canada Inc. (SGS) on behalf of Calico Resources USA Corp. (Calico) to assess the tailings' consolidation properties, settled density, hydraulic conductivity, water retention characteristics, desiccation properties, segregation potential and deposition properties. The laboratory testing was completed in accordance with the ASTM International (ASTM) standards and Golder's internal laboratory procedures for non-standardized tests on tailings slurries. The testing was conducted at Golder's Geotechnical Testing Laboratory at 9197 West 6th Ave, Building C Init 100, Lakewood, Colorado 80215.

This report summarizes results of the laboratory testing program on the GMTC-1 and GMTC-2 samples and the representative mixture of these two samples.

2.0 TAILINGS SAMPLES AND ASSIGNED TESTING

Golder received twelve (12) five-gallon buckets, six buckets of GMTC-1 and six buckets of GMTC-2 tailings, on April 22, 2019. After visual classification, Golder created a composite of the GMTC-1 and GMTC-2 samples. The as-delivered GMTC-1 composite sample had the gravimetric moisture content of 128.9 percent and the solids content of 43.7 percent. The as-delivered GMTC-2 composite sample had the gravimetric moisture content of 148.0 percent and the solids content of 40.3 percent.

The laboratory testing on GMTC-1 and GMTC-2 samples was conducted in two phases. The Phase 1 testing program was conducted to determine classification properties, settled density, compressibility and permeability characteristics and to evaluate the potential for tailings to segregate. The Phase 1 testing included the following:

- Particle size distribution (PSD) – ASTM D422 (hist.)
- Atterberg limits – ASTM D4318
- Specific gravity – ASTM D854
- Settling column testing – Golder procedure
- Slurry consolidation testing – Golder procedure

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The Phase 2 testing was conducted to determine parameters required for the thin-lift deposition modeling, and to determine beach angles and the segregation potential during the deposition process. The Phase 2 testing included the following:

- Soil water characteristic curves (SWCC) determination – ASTM D6836
- Shrinkage curve – Golder procedure
- Flume test – Golder procedure

Conducted laboratory tests are summarized in Table 1.

Table 1: Summary of Laboratory Testing

Test	Procedure	Tailings Sample		
		GMTC-1	GMTC-2	GMTC Composite
Particle Size Distribution	ASTM D422	1 (4)	1 (4)	1
Atterberg Limits	ASTM D4318	1	1	n/a
Specific Gravity	ASTM D854	1	1	n/a
Settling Column	Golder procedure	2	2	n/a
Slurry Consolidation	Golder procedure	1	1	1
SWCC	ASTM D6836	n/a	n/a	1
Shrinkage Curve	Golder procedure	n/a	n/a	1
Flume Test	Golder procedure	n/a	n/a	1

Notes:
1) Numbers in parentheses denote number of PSD tests on settling column samples

3.0 TEST RESULTS

This report summarizes Phase 1 and Phase 2 laboratory data on GMTC-1 and GMTC-2 tailings samples and the GMTC composite. More information is provided in the attachments:

- Attachment 1.1 – Classification Testing on As-Delivered Samples
- Attachment 1.2 – Settling Column Tests
- Attachment 1.3 – Consolidation Tests
- Attachment 1.4 – SWCC Testing
- Attachment 1.5 – Desiccation Tests
- Attachment 1.6 – Flume Testing

3.1 Classification Testing on As-Delivered Samples

Classification testing results for GMTC-1 and GMTC-2 tailings samples are summarized in Table 2.

Table 2: Classification Testing on As-Delivered Samples

Sample	As-Delivered Moisture Content (%)	Solids Content (%)	Specific Gravity (-)	% Fines (< #200)	Liquid Limit	Plastic Limit	Plasticity Index	USCS Symbol
GMTC-1	128.9	43.7	2.62	66.5	NP	NP	NP	ML
GMTC-2	148.0	40.3	2.64	63.3	NP	NP	NP	ML

Particle size distribution (PSD) curves for GMTC-1 and GMTC-2 samples are shown in Figure 1-1. Phase 1 classification testing results are presented in Attachment 1.1.

3.2 Settling Column Tests

The settling column test results are summarized in Table 3.

Table 3: Settling Column Testing Results

Sample/Test[1]	Initial Solids Content (%)	%Fines – Initial Sample	%Fines – Sample Top	%Fines – Sample Bottom	Settled Dry Density (pcf)
GMTC-1/DD	45.9	66.5	65.7	65.5	57.3
GMTC-1/ SD	45.9		66.5	65.7	51.0
GMTC-2/DD	45.8	63.3	63.2	62.9	62.6
GMTC-2/SD	46.1		63.1	62.9	54.2

Notes:
1) DD = double drained settling column tests, SD = single drained settling column test.

The settling column test results are presented in Figure 1-2 in terms of the (final) settled dry density. Settled dry densities of 51 and 54 pcf were recorded for tests conducted with the impervious bottom boundary, i.e., the single drained or SD tests (see Table 3). For tests with the pervious/drained bottom boundary, i.e., the double drained or DD tests, settled dry densities of 57 and 63 pcf were recorded at the end of the test. In both cases, using either SD or DD conditions, lower settled dry density values were recorded for the GMTC-1 sample.

Figures 1-2.1 to 1-2.4 display the PSD for the tailings “feed” material, i.e., tailings poured into the settling column at the initial solids content of 46 percent, and the PSDs for the material sampled at the top and the bottom of the settling column at the end of the test. Results in Figures 1-2.1 to 1-2.4 display very little change in the PSDs recorded for the top and the bottom samples supporting the conclusion that the tailings deposited at 46 percent are not likely to exhibit significant segregation. Similarly, results in Table 3 indicate very low segregation potential based on the difference in the recorded percentage of fines (the difference of less than one percent) between the top and the bottom tailings samples.

Results from the settling column testing are presented in more detail in Attachment 1.2.

3.3 Consolidation Testing

Consolidation parameters for GMTC-1 and GMTC-2 samples were determined from the slurry consolidation test data using the following constitutive relationships (see e.g., Liu and Znidarcic 1991, and Abu-Hejleh and Znidarcic, 1994, 1996):

$$e = A(\sigma' + Z)^B \quad (1)$$

and

$$k = Ce^D \quad (2)$$

Where e denotes the void ratio, σ′ stands for the effective stress, and *k* is the hydraulic conductivity functionally dependent on void ratio. In the above equations *A, B, Z, C* and *D* are material parameters determined by fitting analytical relationships, defined by Equations (1) and (2), to laboratory data. Consolidation parameters determined from the slurry consolidation measurements on GMTC-1 and GMTC-2 tailings samples are summarized in Table 4.

Table 4: Consolidation Parameters Based on Slurry Consolidation Measurements

Sample	A (1/psf)^B	B (-)	Z (psf)	C (cm/sec)	D (-)
GMTC-1	2.1204	-0.1091	1.0097	5.737 x 10^{-6}	10.668
GMTC-2	2.2853	-0.1223	2.0878	8.308 x 10^{-6}	6.2795

Results from the slurry consolidation measurements and the analytical compressibility and permeability relationships for GMTC-1 and GMTC-2 samples are presented graphically in Figures 1-3.1 and 1-3.2. A comparison between the GMTC-1 and GMTC-2 consolidation data is illustrated in Figure 1-3.3. Results in Figure 1-3.3 demonstrate that GMTC-1 and GMTC-2 exhibit similar geomechanical properties.

Detailed consolidation test results on GMTC-1 and GMTC-2 tailings samples are presented in Attachment 1.3.

3.4 SWCC Testing

The SWCC testing was conducted to determine water retention parameters required for the thin-lift deposition modeling, i.e., data to define the tailings' water retention capacity at different values of matric suction. The following suction-saturation relationship was adopted to fit experimental measurements (see van Genuchten 1978, 1980):

$$\theta = \theta_r + (\theta_{sat} - \theta_r)[1 + (\alpha \cdot h_c)^n]^{-m} \quad (3)$$

Where:
- θ = volumetric moisture content
- h_c = matric suction
- θ_r = residual volumetric moisture content
- θ_{sat} = saturated volumetric moisture content (porosity)
- α = van Genuchten "alpha" parameter
- n = van Genuchten "n" parameter
- m = van Genuchten "m" parameter, $m = 1 - 1/n$.

The van Genuchten parameters were determined by fitting the relationship defined by Equation (3) to SWCC laboratory data determined by testing the GMTC composite sample. The adopted SWCC parameters are summarized in Table 5.

Table 5: SWCC Parameters

Sample	θ_{sat} (-)	θ_r (-)	α (1/kPa)	n (cm/sec)
GMTC composite – low suction	0.57	0.00	0.05	1.50
GMTC composite – high suction	0.51	0.00	0.01	1.70

Based on the laboratory SWCC measurements, two closed-form relationships are recommended to describe the GMTC composite retention capacity (see Table 5). For suctions below 10 kPa, the GMTC composite sample exhibits relatively significant changes in volume during the desiccation process. The saturated moisture content of 0.51 is recommended to be applied for capillary pressures in excess of 10 kPa as the soil approaches the shrinkage limit. Laboratory SWCC measurements and the fitted van Genuchten relationships are displayed in Figure 1-4.

Detailed SWCC test results on the GMTC composite sample are provided in Attachment 1.4.

3.5 Desiccation Testing

The purpose of the desiccation test is to determine tailings parameters that are governing soil behavior during the drying/desiccation process. One of the most important parameters describing the desiccation process is the soil's shrinkage limit. The shrinkage limit is defined as a moisture content at which soil ceases to exhibit significant changes in volume when subjected to the continuous increases in suction. I.e., after reaching the shrinkage limit, the soil will continue to desaturate while the pore volume remains approximately the same. Based on the shrinkage limit test results, the following parameters are recommended for the thin-lift deposition analyses:

Table 6: Desiccation Parameters

Sample	Specific Gravity (-)	Shrinkage Limit (%)	Void Ratio at Shrinkage Limit	Dry Density at Shrinkage Limit (pcf)
GMTC composite	2.63	38.8	1.02	81.3

The measured range of dry densities at the end of the shrinkage test is shown in Figure 1-5. The shrinkage test results are presented in more detail in Attachment 1.5.

3.6 Flume Testing

The flume test can be used to determine the following:

- Segregation potential of deposited tailings
- Estimate the range of beach slopes for deposition modeling
- Confirm rheological properties of tailings deposited at relatively low discharge velocities

- Estimate/confirm density, strength and consolidation properties and estimate potential variability of these properties within the impoundment

3.6.1 Segregation Potential

The GMTC composite deposited at the solids content of 46 percent is not likely to exhibit significant segregation during the deposition process. Based on the PSDs on samples collected at the discharge point (beach sample) and at the end of the flume (slimes sample), the difference in the fines content between the beach and the slimes samples is likely to be less than 10 percent. However, results in Figure 1-6.1 demonstrate that a measurable fraction of fines smaller than 10 microns may remain in suspension after the initial settling process is completed. These smaller particles suspended in the bleed water are likely to be transported towards the pool and be responsible for the presence of finer, lower permeability layers in the tailings deposited within the TSF pool area due to the continuous sedimentation process. I.e., flume results indicate that the fines smaller than approximately 10 microns may contribute to reducing the overall hydraulic permeability of tailings within the pool area and affect the turbidity of water returned to the mill.

3.6.2 Beach Slopes

Beach slopes are relatively difficult to predict as they depend on the flow/deposition rate, rate of rise, initial slopes governed by the depositional practices and the TSF geometry, tailings segregation potential, conditions at the deposition surface, etc. Consequently, beach angles are expected to vary as a function of the location of tailings within the impoundment and throughout the life of the facility. To investigate possible range of beach angles under different scenarios, the flume testing program was conducted by depositing tailings in a 12-inch wide and 24-ft long flume. The measured beach angles are summarized in Table 7.

Table 7: Beach Angles

Sample	Average Slope (%)	Slope at Mid-Point (%)	End Slope (%)
GMTC composite	0.63	0.94	1.38

3.6.3 Rheological Properties

Flume results can be used to evaluate rheological properties at relatively low shearing rates associated with the movement of the deposited tailings through the flume and utilizing the recorded tailings profile.

Table 8: Yield Stress

Sample	Minimum Yield Stress (Pa)	Maximum Yield Stress (Pa)	Average Yield Stress (Pa)
GMTC composite	4.4	4.9	4.7

The yield stress estimates in Table 8 were determined using the tailings profile at the end of the flume test. The tailings were discharged at the solids content of 46 percent. At the end of the test, the measured tailings solids content along the flume ranged from 49 to 52 percent.

3.6.4 Density and Consolidation Properties

Samples collected along the flume were used to evaluate the expected range of densities and consolidation properties for the deposited tailings. If required for stability analyses, the variability of tailings strength may be evaluated for the range of densities determined from consolidation analyses using the representative flume samples. The strength testing on tailings samples was not considered in this study. The range of tailings densities at low effective stresses were determined by collecting samples along the flume at the end of the test. Results for the settled dry density, solids content and void ratio, determined for the average flume deposit thickness of less than 2 inches and the initial (discharge) solids content of 46 percent, are summarized in Table 9

Table 9: Flume Test – Settled Dry Density, Solids Content and Void Ratio

	Dry Density (pcf)	Solids Content (%)	Void Ratio (-)
Minimum	43.9	48.8%	2.46
Maximum	47.7	51.7%	2.76
Median	46.7	51.0%	2.53
Average	46.4	50.7%	2.55

Two samples collected at the discharge point (beach sample) and at the end of the flume (slimes sample) were used to evaluate potential variability of the tailings consolidation parameters, i.e., to evaluate the range of consolidation properties in the simulated depositional environment. The consolidation test results on the beach and slimes samples are presented in Figures 1-6.2.1 and 1-6.2.2 with the consolidation parameters summarized in Table 10.

Table 10: Flume Test – Consolidation Parameters on Beach and Slimes Samples

Sample	A $(1/psf)^B$	B (-)	Z (psf)	C (cm/sec)	D (-)
GMTC Composite – Beach	2.4438	-0.1241	0.5637	1.593×10^{-5}	4.1248
GMTC Composite – Slimes	2.2421	-0.1143	0.2505	8.274×10^{-6}	2.9008

Consolidation parameters for the GMTC composite (beach and slimes) samples are compared to GMTC-1 and GTMC-2 samples in Figure 1-6.2.3. The flume test results are presented in Attachment 1.6.

4.0 REFERENCES

Abu-Hejleh, A.N., and D. Znidarcic. 1994. “Estimation of the Consolidation Constitutive Relations,” Computer Methods and Advances in Geomechanics, Siriwardane & Zaman (eds) Balkema, Rotterdam, pp. 499-504.

Abu-Hejleh, A.N., and D. Znidarcic. 1996. “Consolidation Characteristics of Phosphatic Clays,” Journal of Geotechnical Engineering, ASCE, New-York, Vol. 122, No. 4. pp. 295-301.

Liu, J.C., and D. Znidarcic. 1991. “Modeling One-Dimensional Compression Characteristics of Soils,” Journal of Geotechnical Engineering, ASCE, New-York, Vol. 117, No. 1. pp. 162-169.

van Genuchten, R. 1978. *Calculating the unsaturated hydraulic conductivity with a new closed-form analytical model.* Water Resources Program, Department of Civil Engineering, Princeton University, Princeton, New Jersey.

van Genuchten, M.T. 1980. "*A closed-form equation for predicting the hydraulic conductivity of unsaturated soils*," Soil Sci. Soc. Am. J., 44: 892-898.

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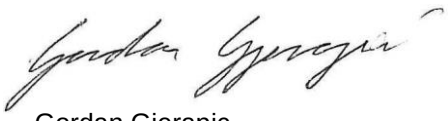

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Figures

Figure 1-1: PSD – As-Delivered Tailings Samples

Figure 1-2: Settled Dry Density – Settling Column Testing on GMTC-1 and GMTC-2 Samples

Figure 1-2.1: Tailings Gradation and Segregation Potential – GMTC-1 – Double Drained Settling Column Test

Figure 1-2.2: Tailings Gradation and Segregation Potential – GMTC-1 – Single Drained Settling Column Test

Figure 1-2.3: Tailings Gradation and Segregation Potential – GMTC-2 – Double Drained Settling Column Test

Figure 1-2.4: Tailings Gradation and Segregation Potential – GMTC-2 – Single Drained Settling Column Test

Figure 1-3.1: Consolidation Properties – GMTC-1 Sample

Figure 1-3.2: Consolidation Properties – GMTC-2 Sample

Figure 1-3.3: Consolidation Properties – GMTC-1 and GMTC-2 Samples – Comparison

Figure 1-4: SWCC Test – GMTC Composite Sample

Figure 1-5: Shrinkage Curve Test – Dry Density at Shrinkage Limit

Figure 1-6.1: Flume Test – PSD for Beach and Slimes Samples

Figure 1-6.2.1: Consolidation Properties – GMTC Composite – Beach Sample

Figure 1-6.2.2: Consolidation Properties – GMTC Composite – Slimes Sample

Figure 1-6.2.3: Consol. Properties – GMTC Composite vs. GMTC-1/2 Samples – Comparison

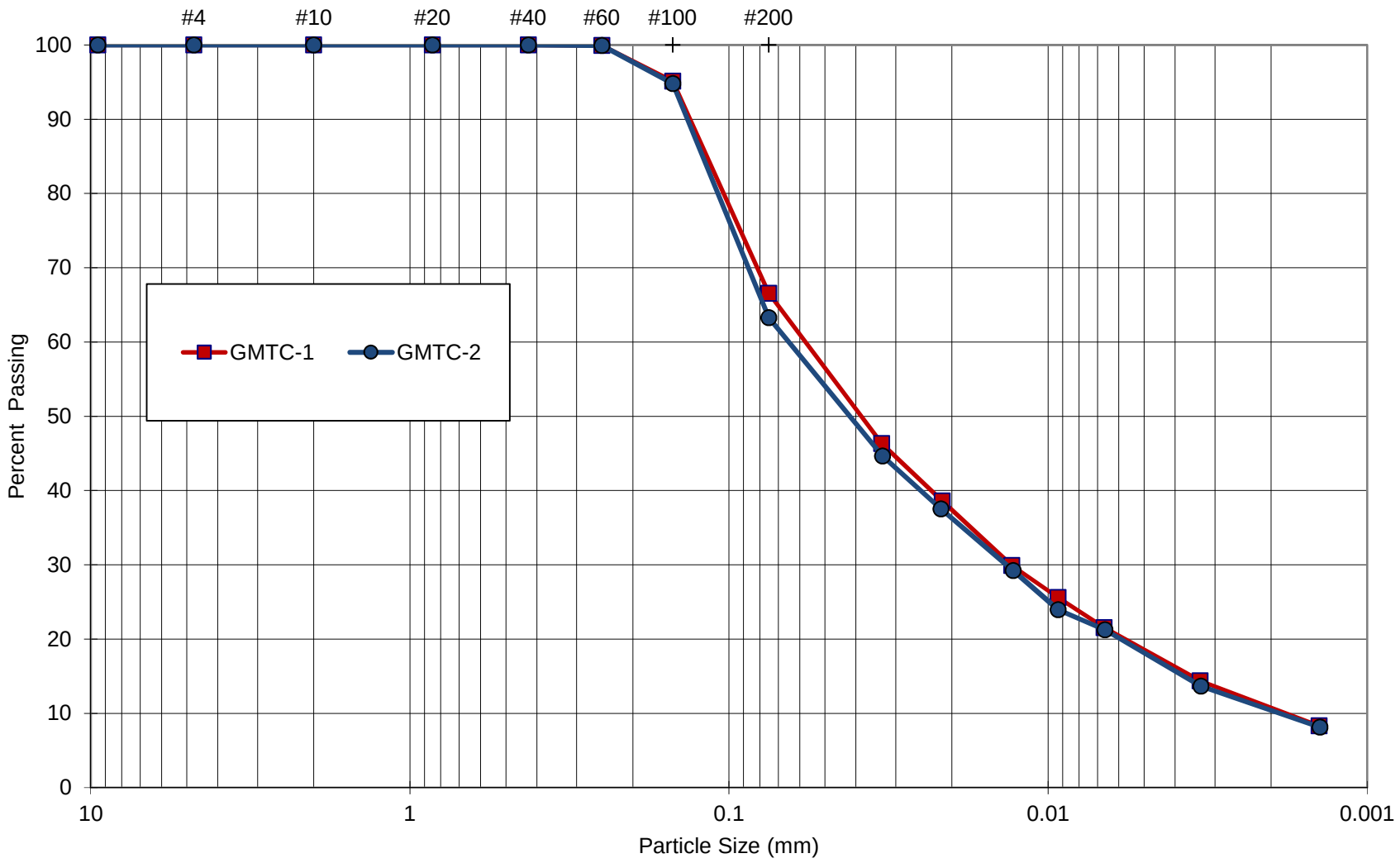

Figure 1-1

PSD - As-Delivered Tailings Samples

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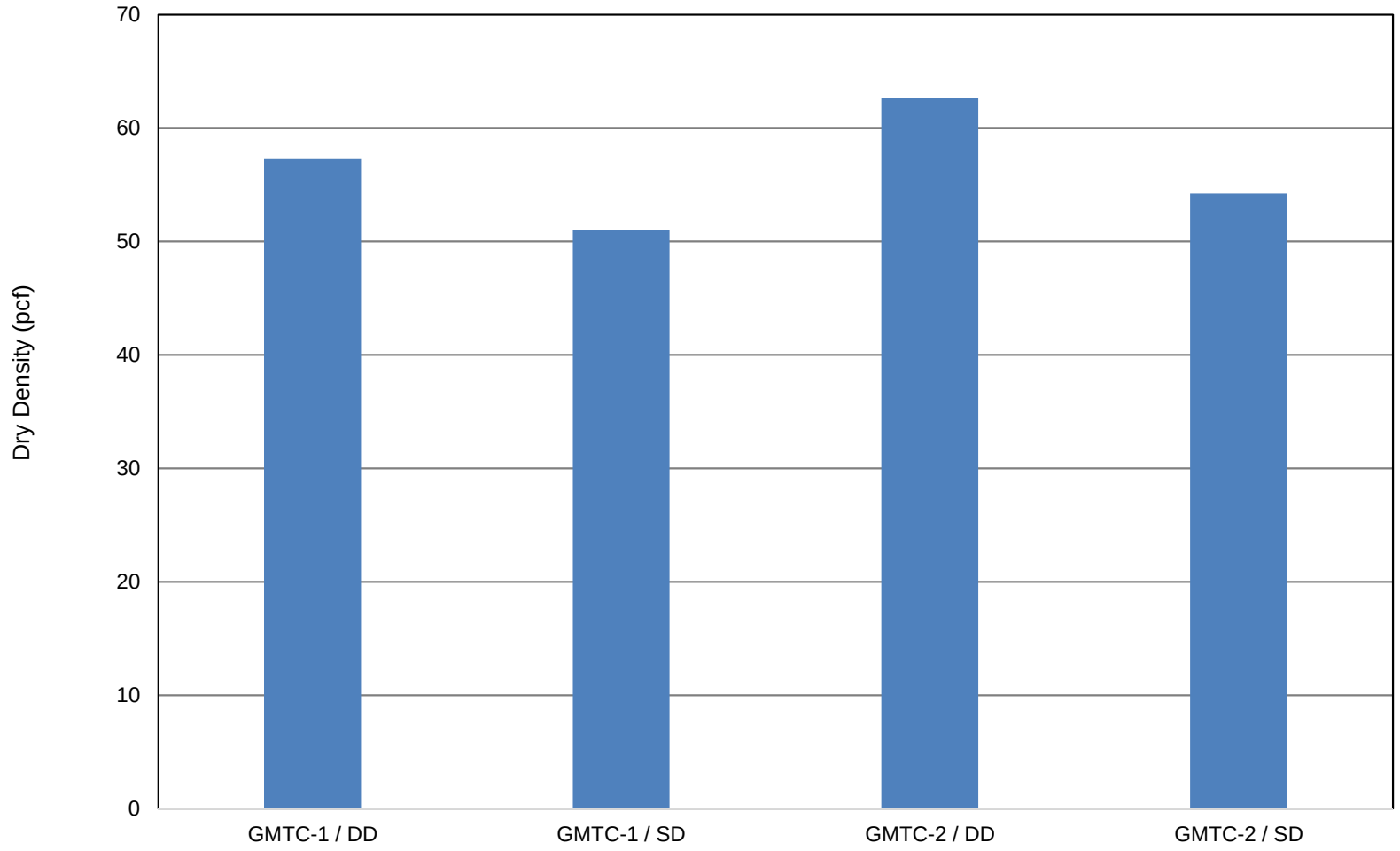


Figure 1-2

Settled Dry Density - Settling Column Testing on GMTC-1 and GMTC-2 Samples

Grassy Mountain, OR

Tailings Laboratory Testing

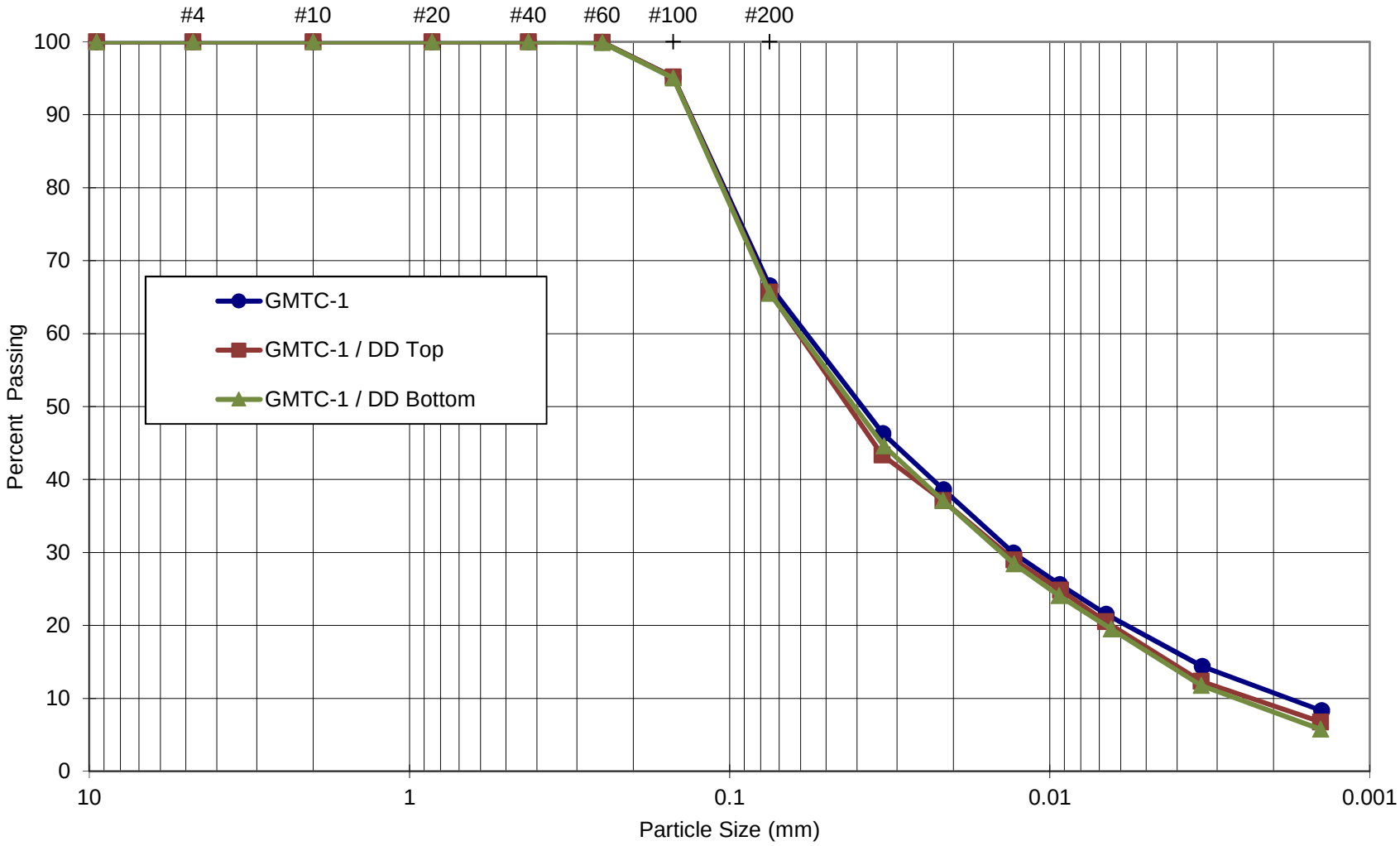


Figure 1-2.1

Tailings Gradation and Segregation Potential - GMTC-1 - Double Drained Settling Column Test

Grassy Mountain, OR

Tailings Laboratory Testing

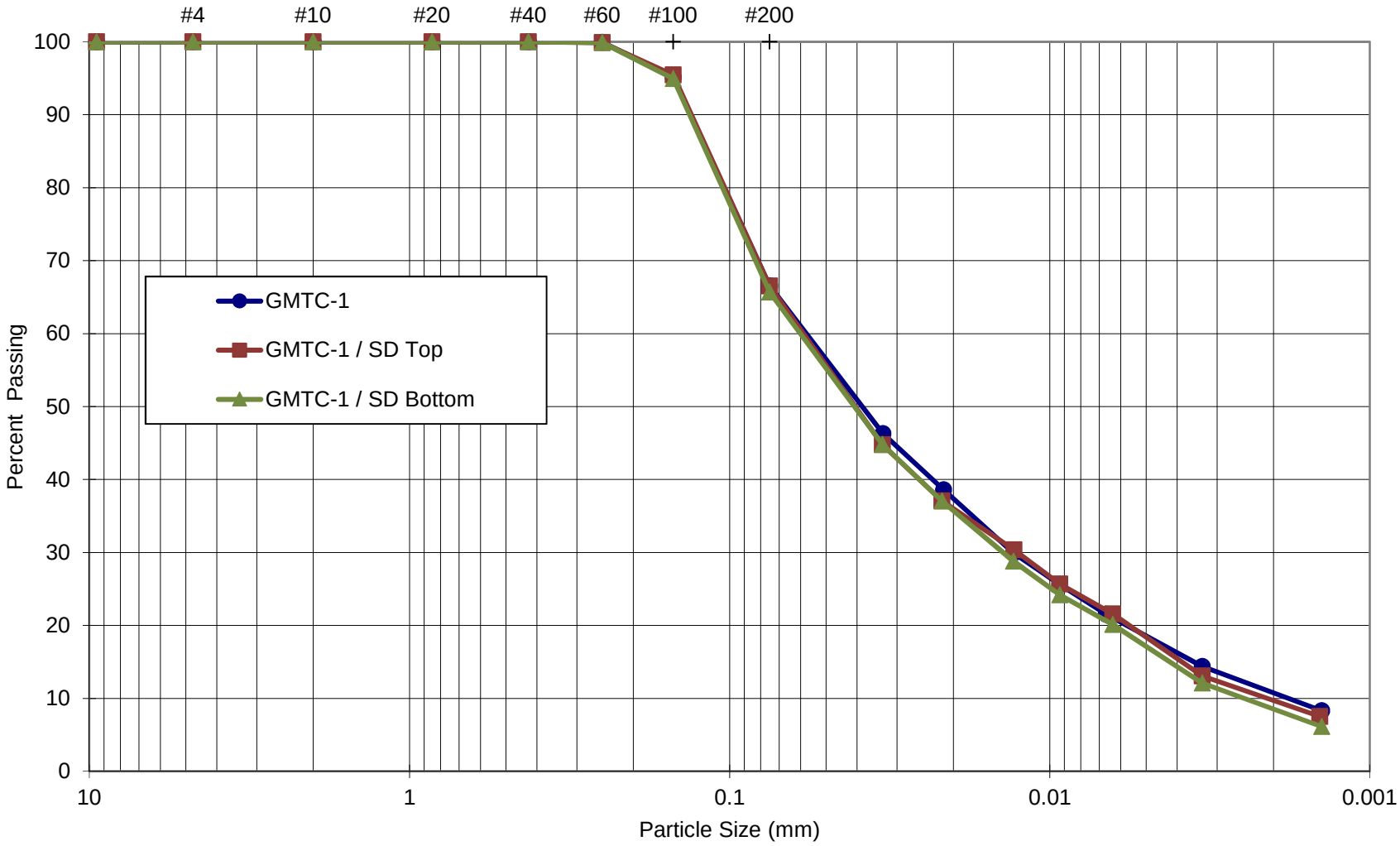


Figure 1-2.2

Tailings Gradation and Segregation Potential - GMTC-1 - Single Drained Settling Column Test

Grassy Mountain, OR

Tailings Laboratory Testing

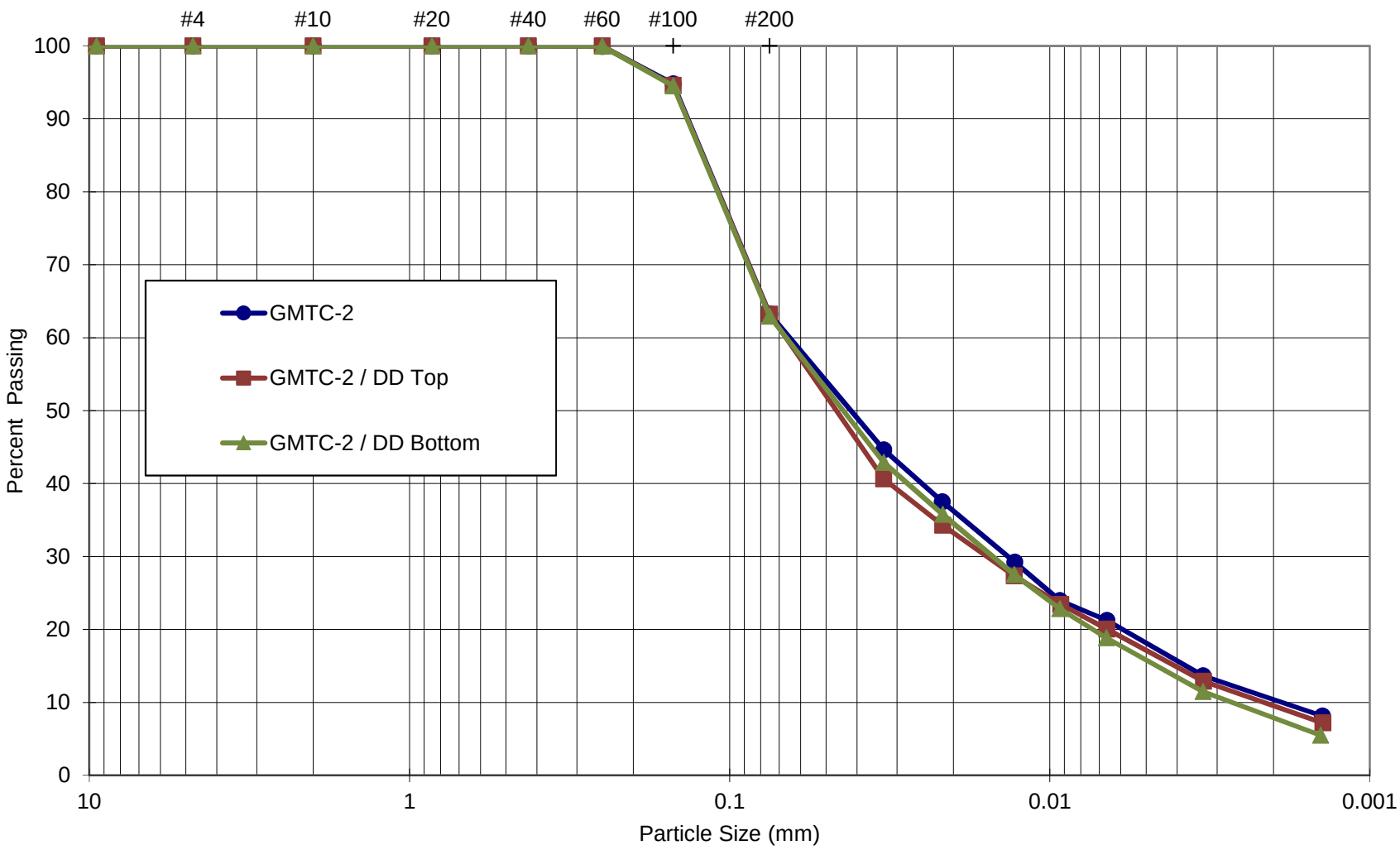


Figure 1-2.3

Tailings Gradation and Segregation Potential - GMTC-2 - Double Drained Settling Column Test

Grassy Mountain, OR

Tailings Laboratory Testing

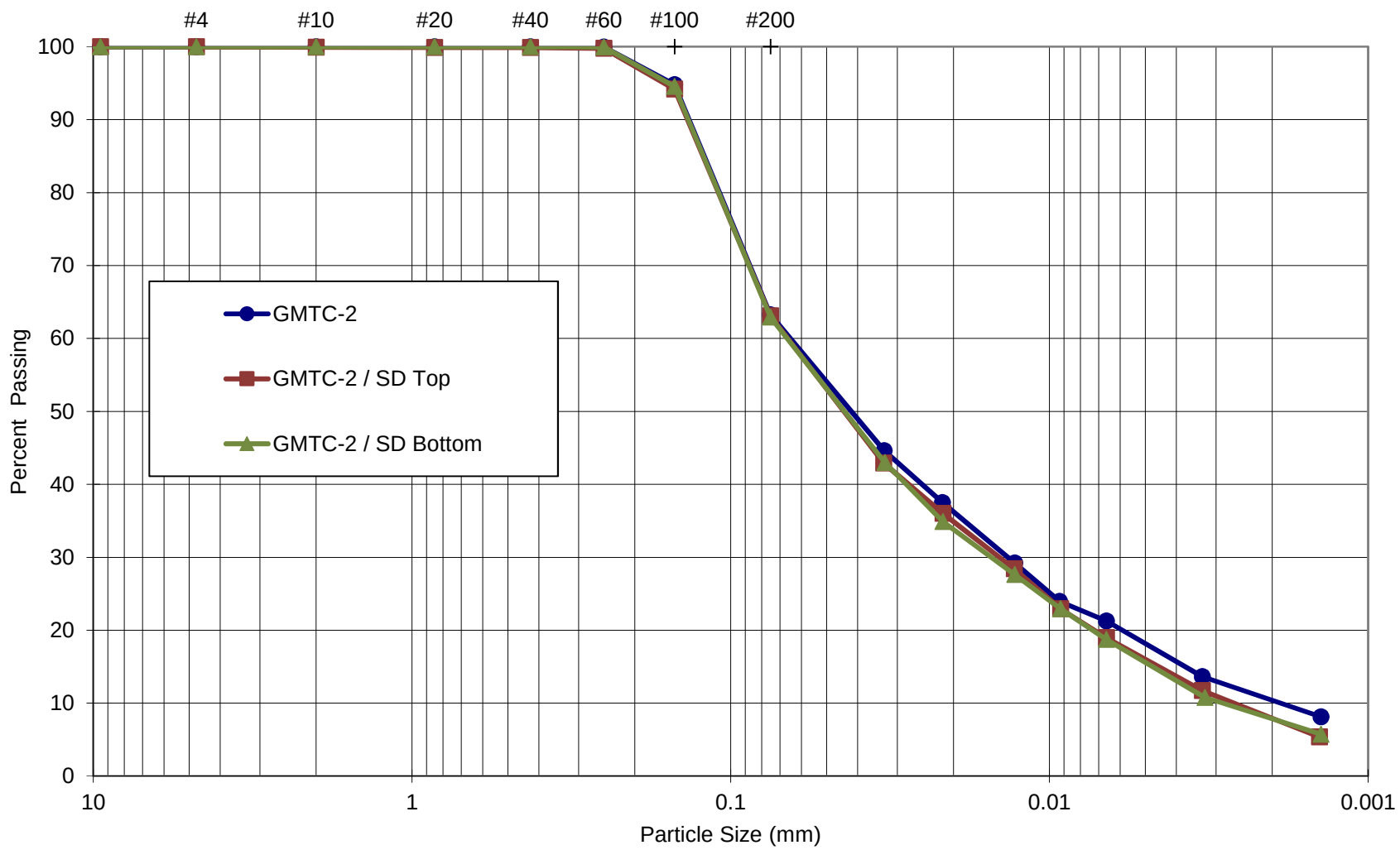
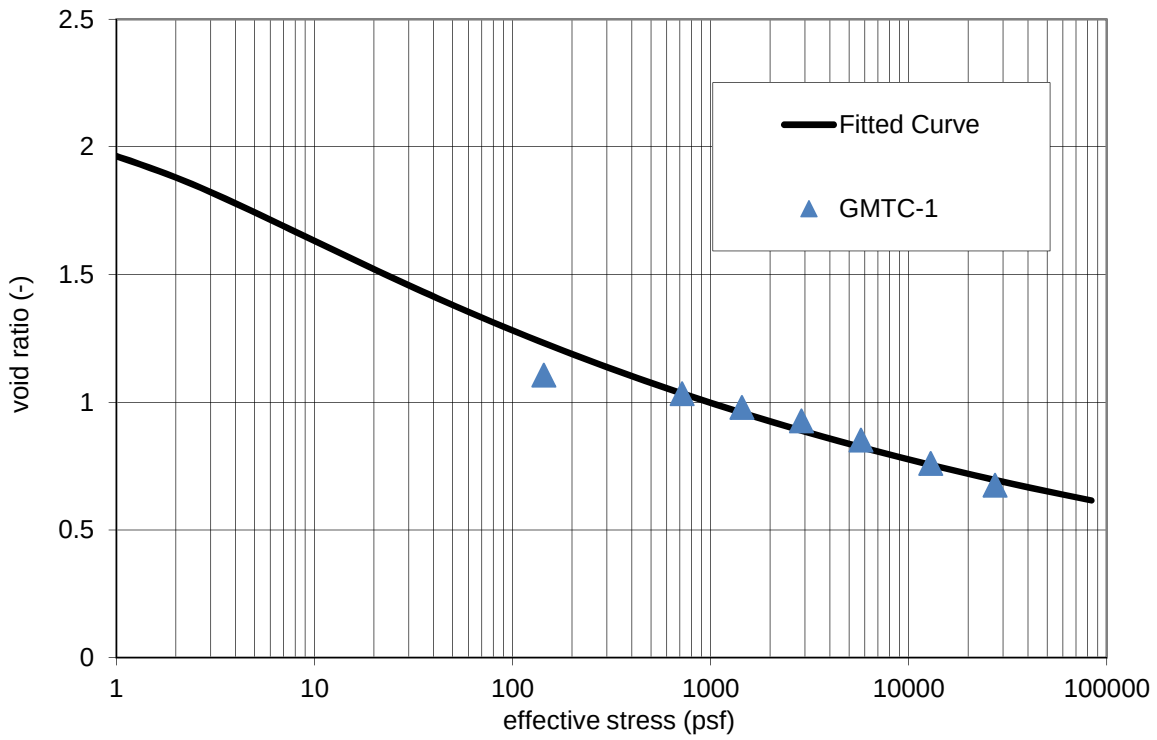


Figure 1-2.4

Tailings Gradation and Segregation Potential - GMTC-2 - Single Drained Settling Column Test

Grassy Mountain, OR

Tailings Laboratory Testing



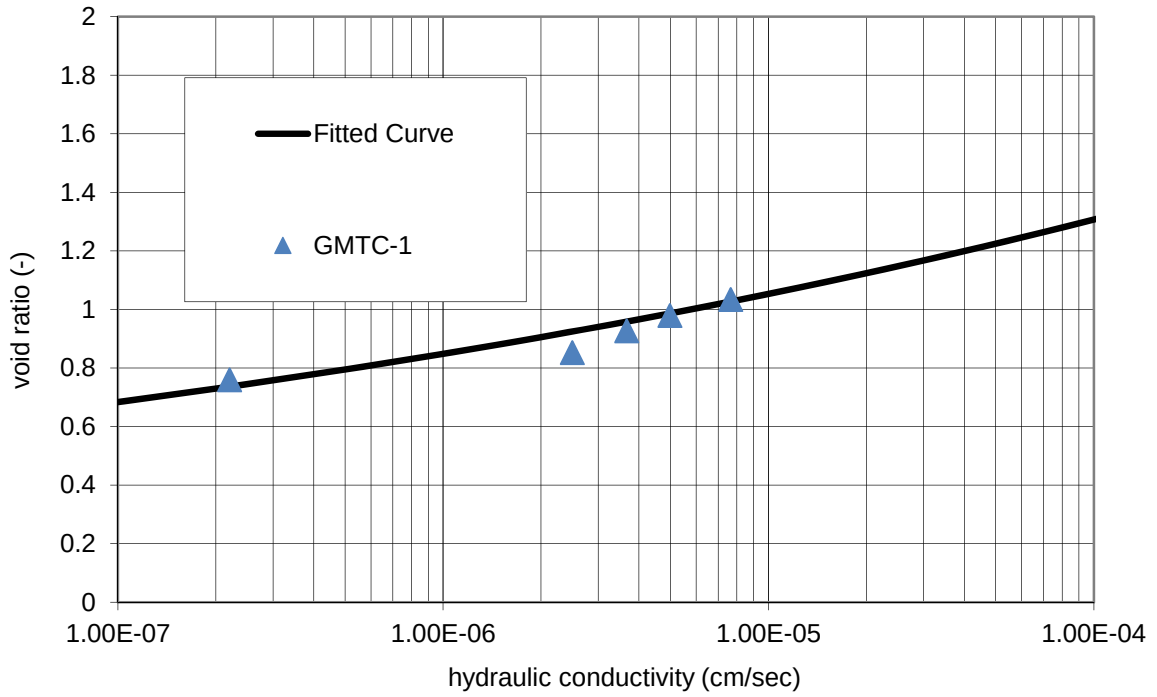
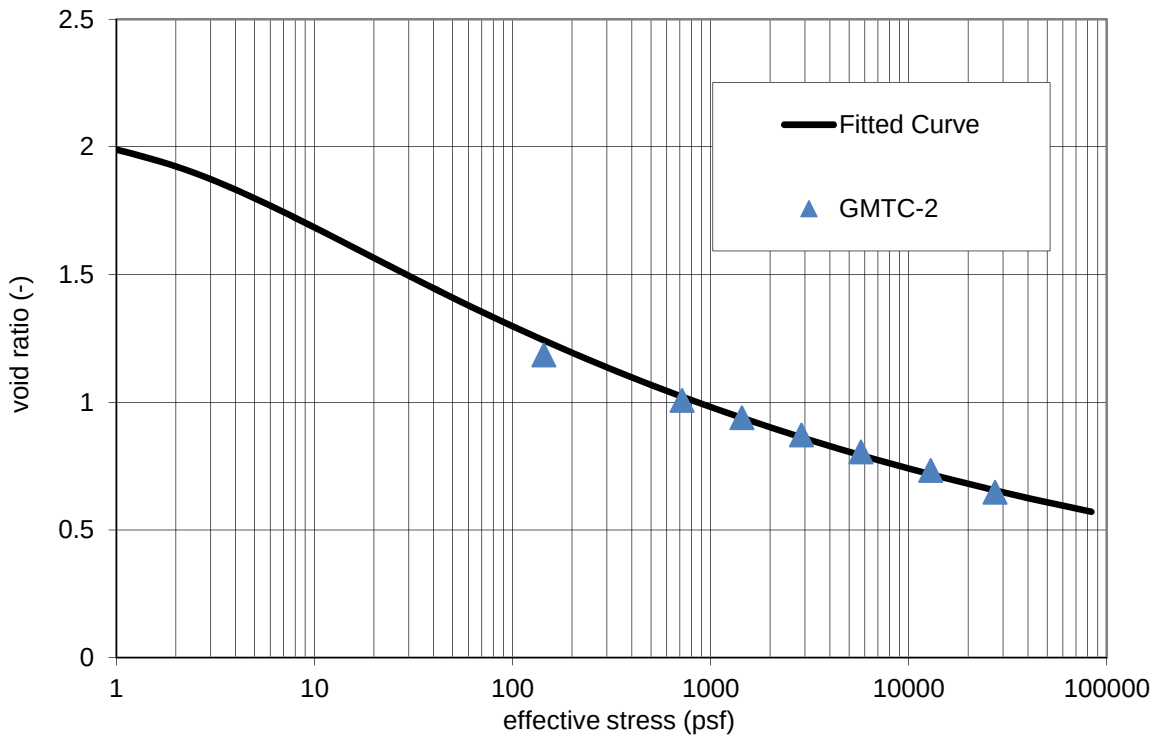


Figure 1-3.1

Consolidation Properties - GMTC-1 Sample

Grassy Mountain, OR

Tailings Laboratory Testing



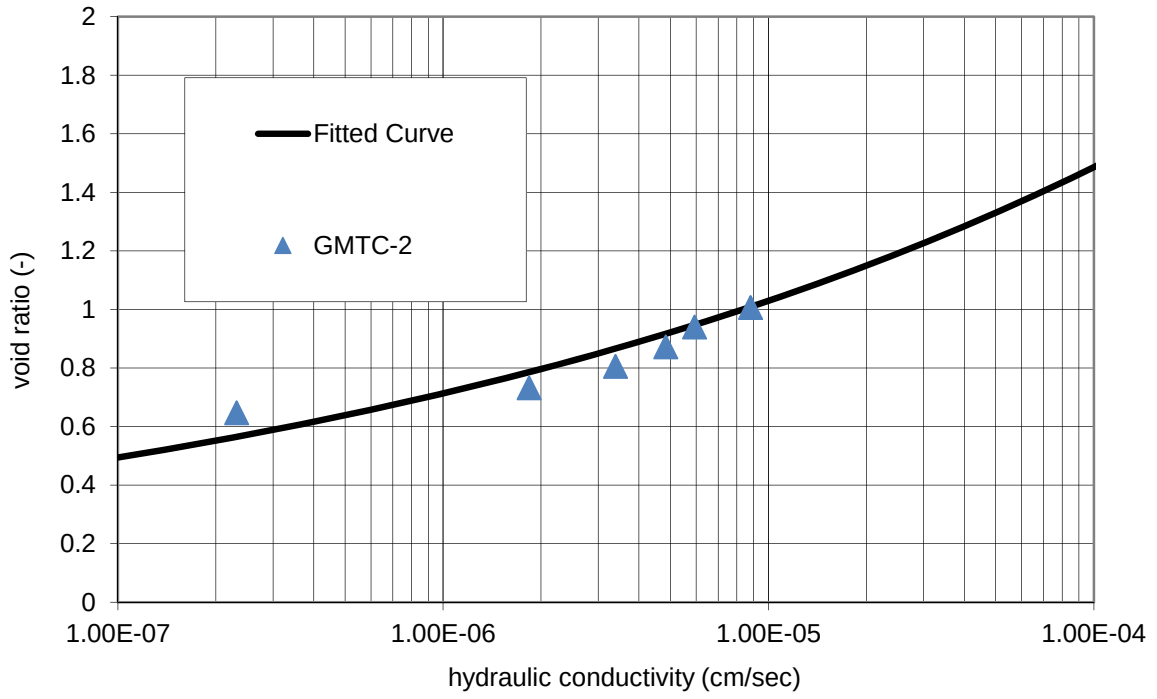


Figure 1-3.2

Consolidation Properties - GMTC-2 Sample

Grassy Mountain, OR

Tailings Laboratory Testing

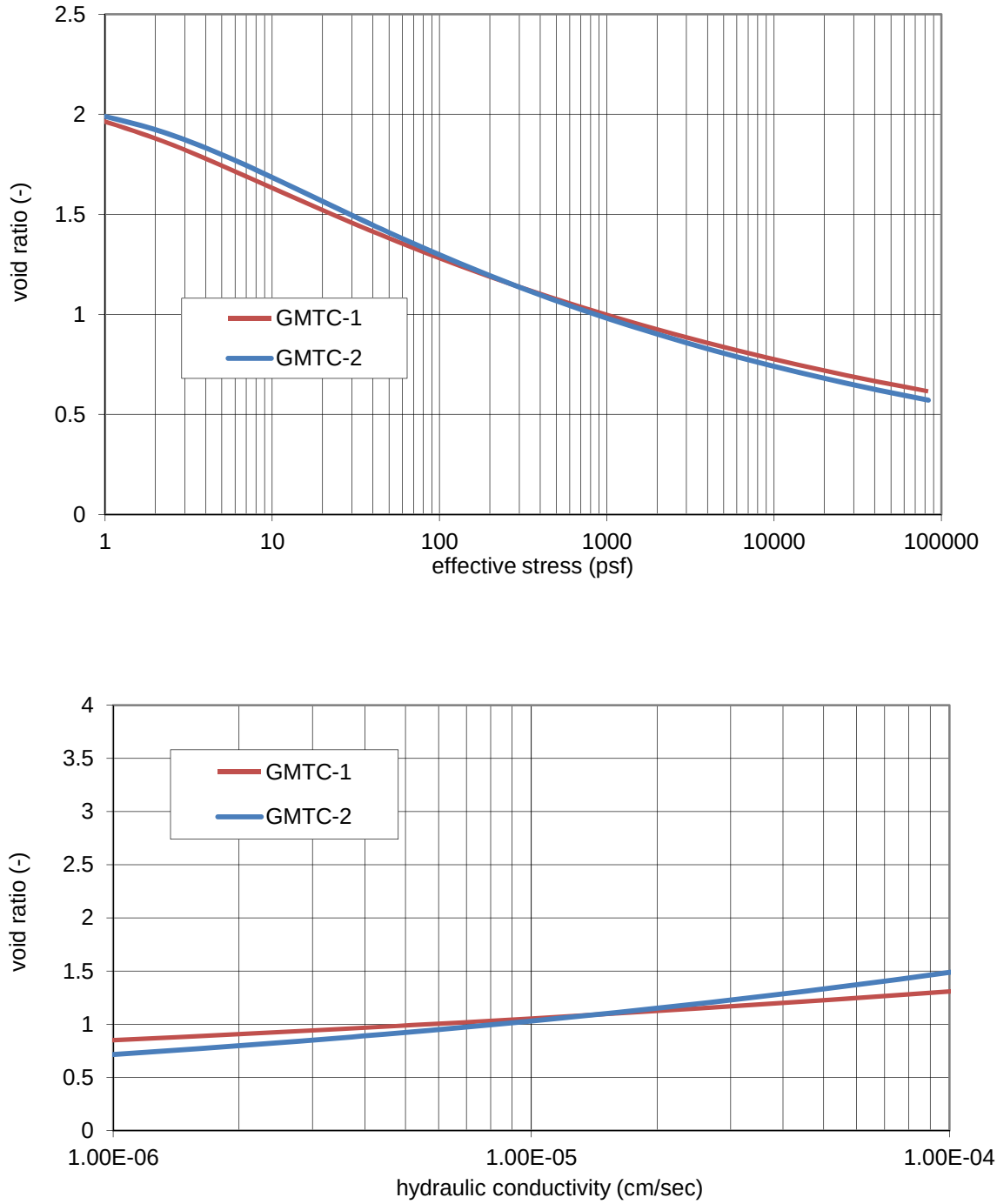


Figure 1-3.3

Consolidation Properties - GMTC-1 and GMTC-2 Samples - Comparison

Grassy Mountain, OR

Tailings Laboratory Testing

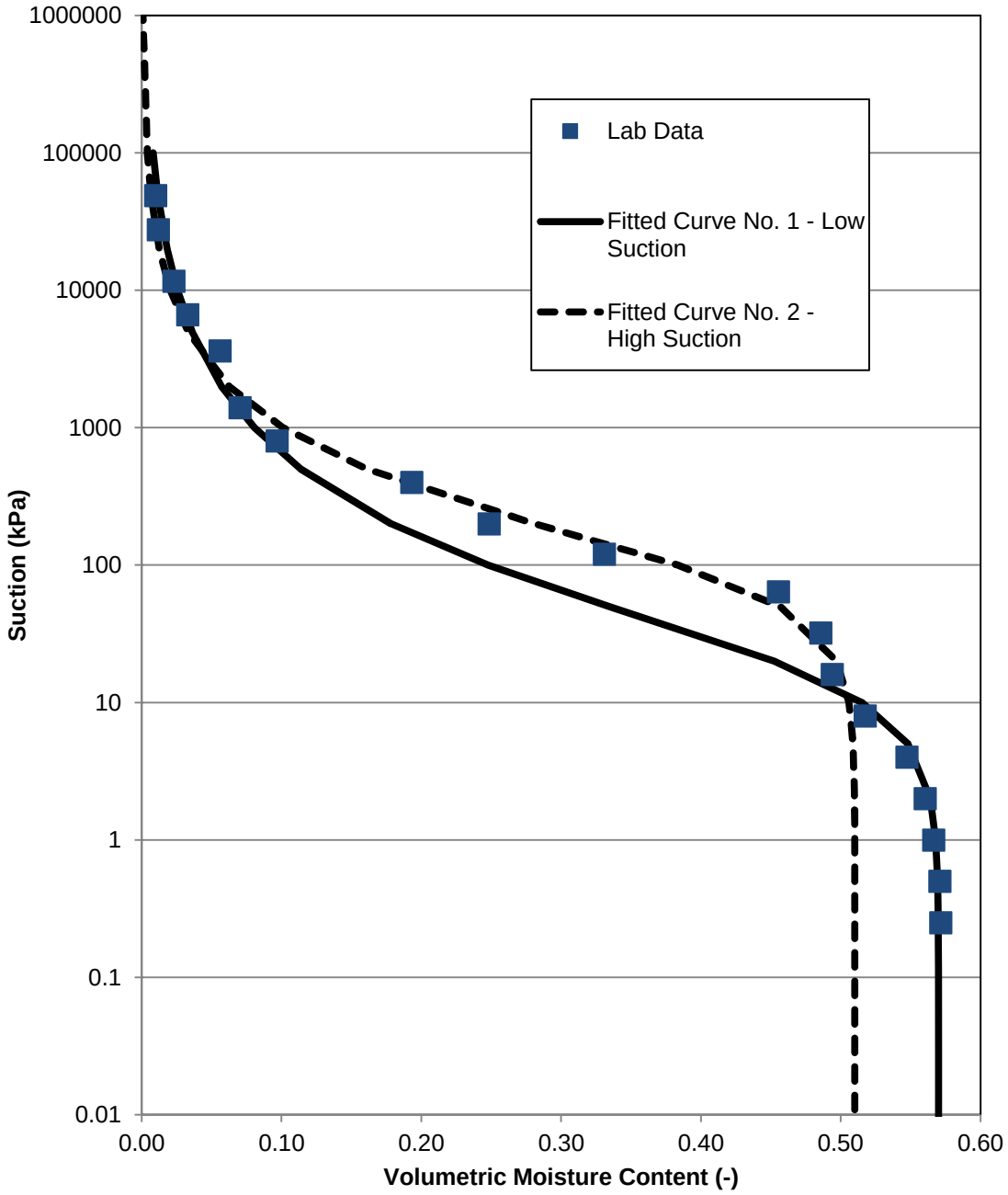


Figure 1-4

SWCC Test - GMTC Composite Sample

Grassy Mountain, OR

Tailings Laboratory Testing

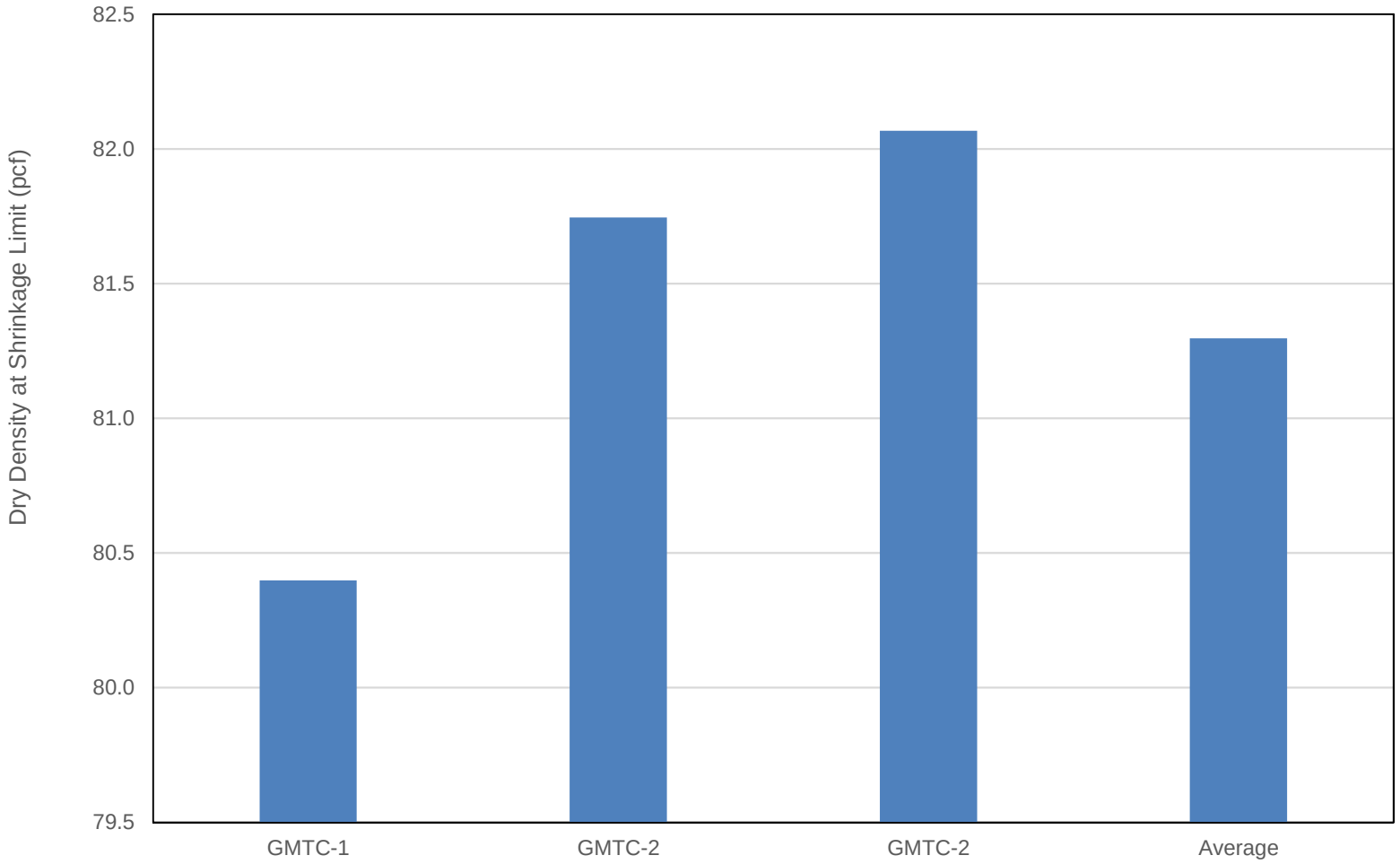


Figure 1-5

Shrinkage Curve Test - Dry Density at Shrinkage Limit

Grassy Mountain, OR

Tailings Laboratory Testing

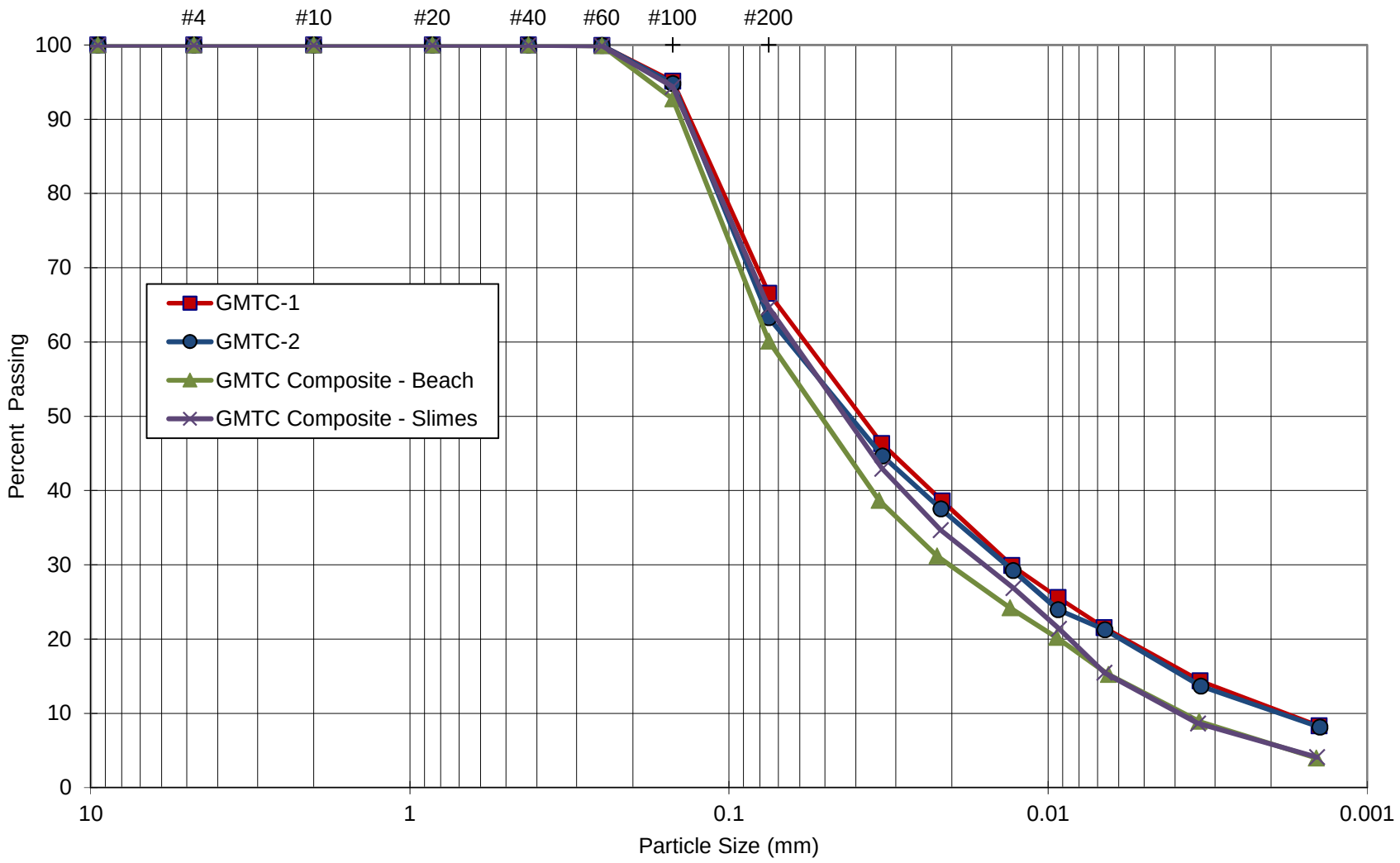
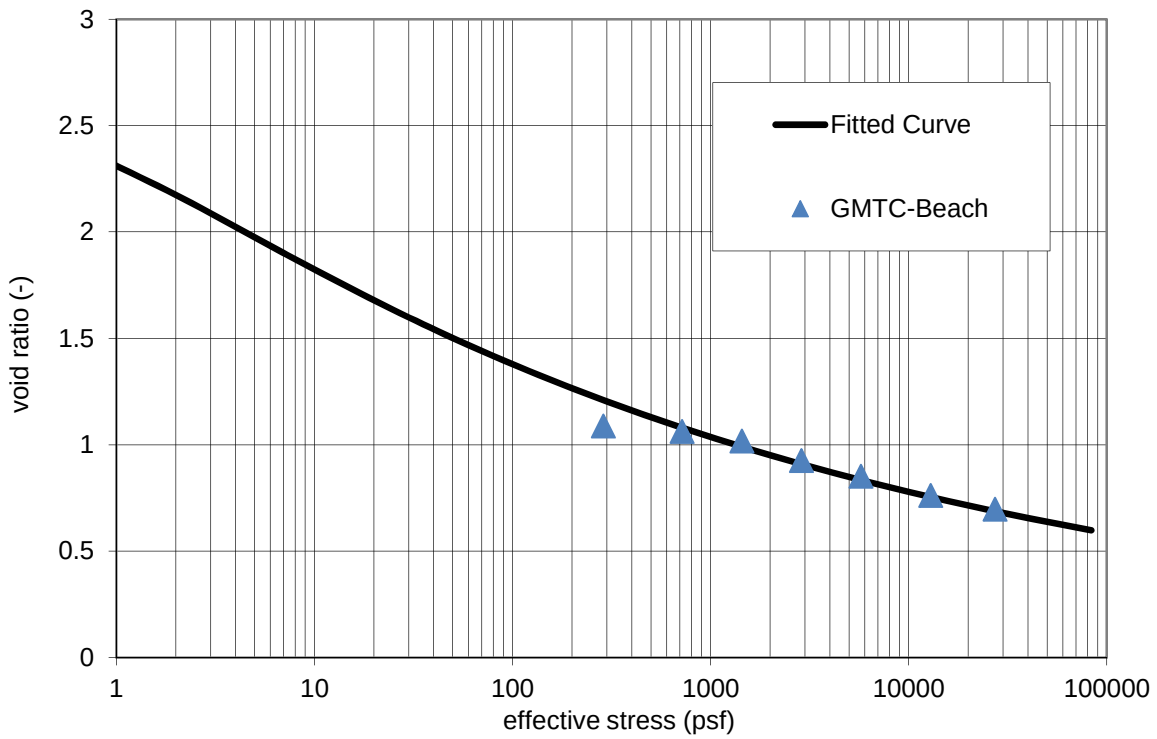


Figure 1-6.1

Flume Test - PSD for Beach and Slimes Samples

Grassy Mountain, OR

Tailings Laboratory Testing



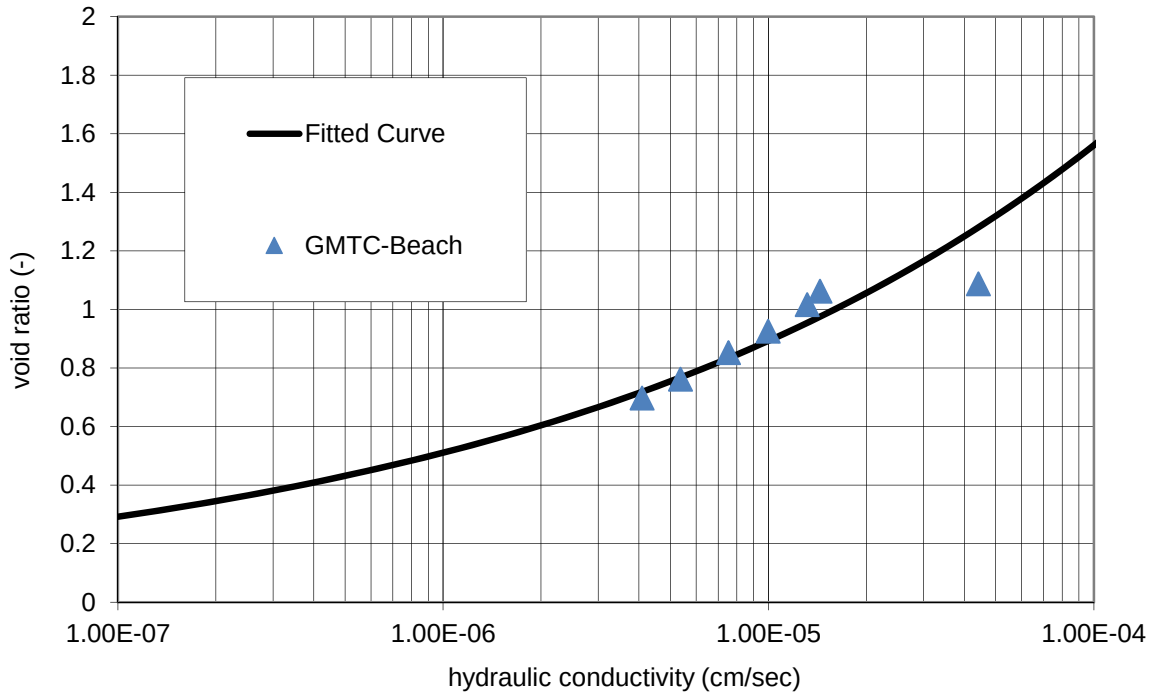
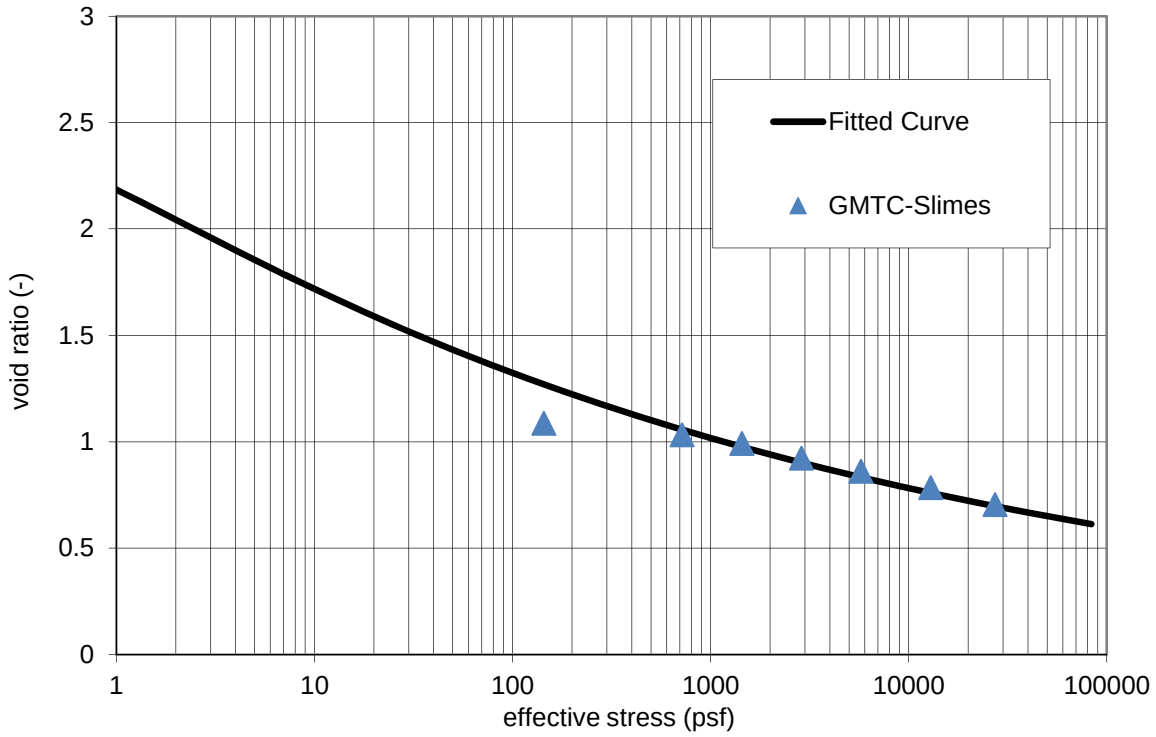


Figure 1-6.2.1

Consolidation Properties - GMTC Composite - Beach Sample

Grassy Mountain, OR

Tailings Laboratory Testing



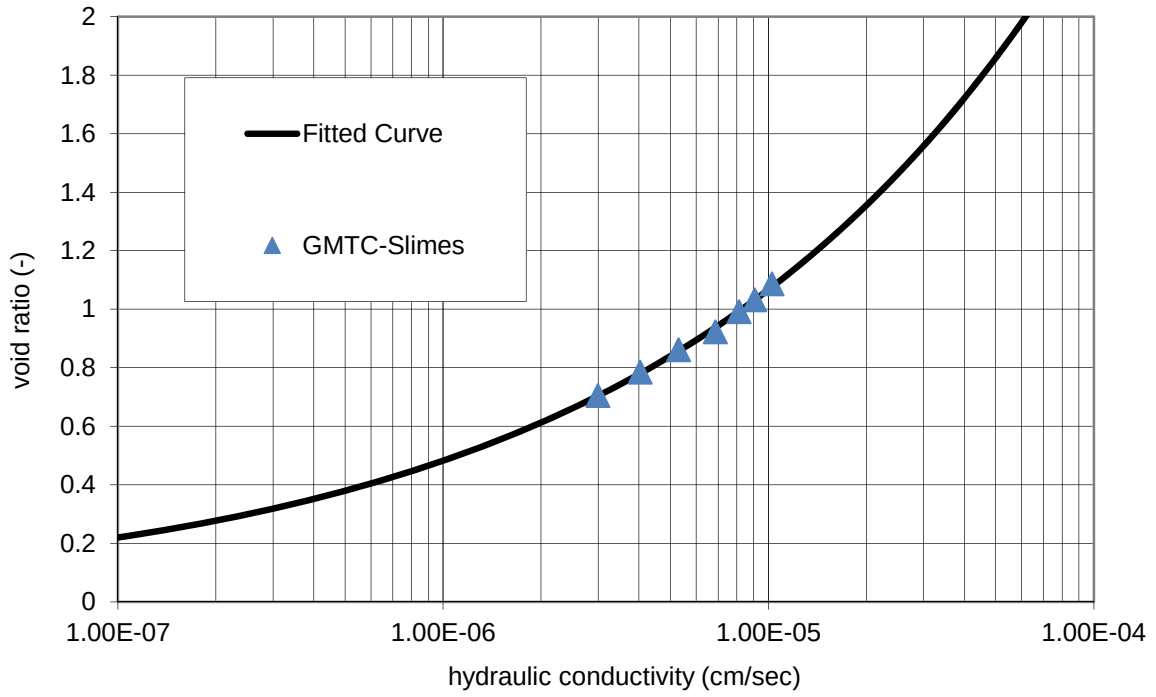
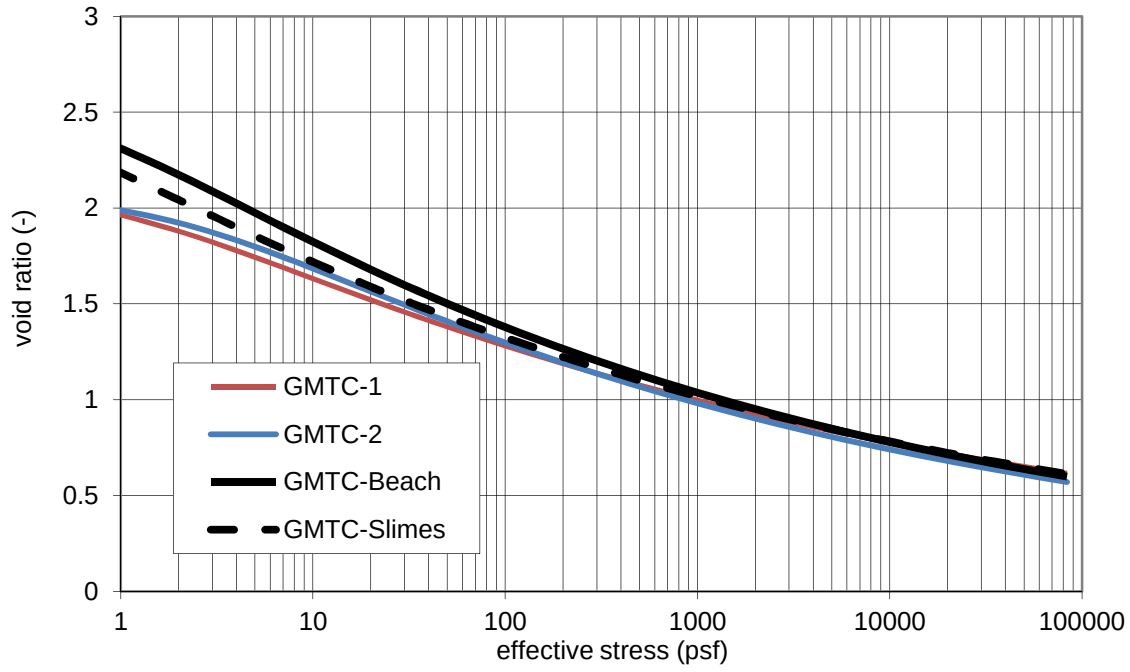


Figure 1-6.2.2

Consolidation Properties - GMTC Composite - Slimes Sample

Grassy Mountain, OR

Tailings Laboratory Testing



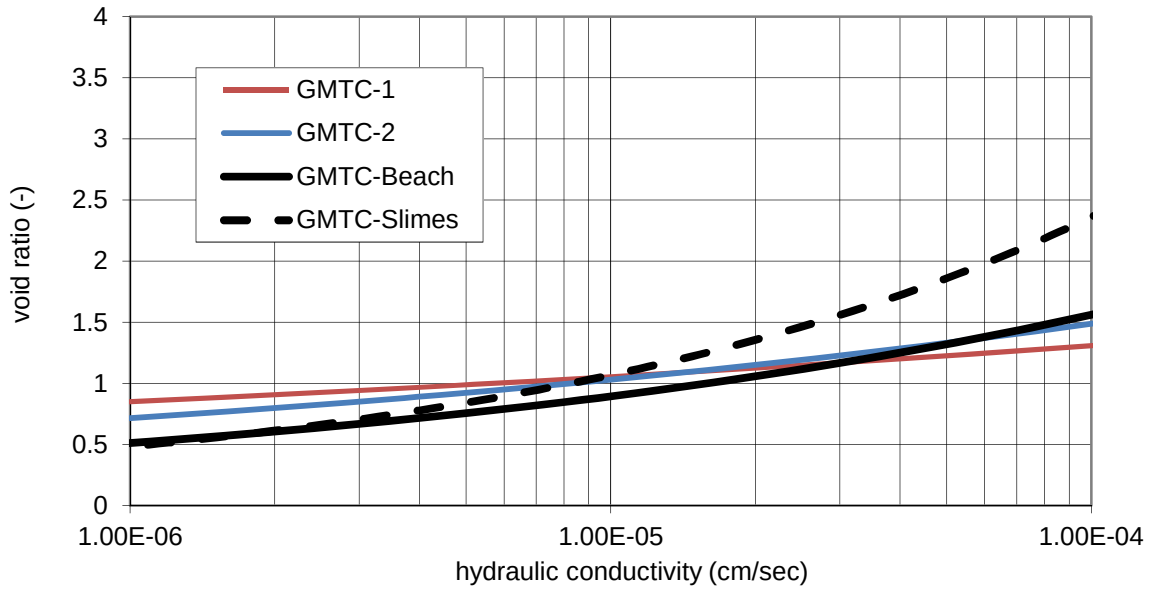


Figure 1-6.2.3

Consol. Properties - GMTC Composite vs. GMTC-1 / 2 Samples - Comparison

Grassy Mountain, OR

Tailings Laboratory Testing

ATTACHMENT 1.1

Classification Testing on As-Delivered Samples

TABLE 1
MDA/GRASSY MTN PFS/OR
SUMMARY OF SOIL DATA

Sample Type	Sample Identification	Sample Depth (ft.)	USCS Soil Classification	Delivered Moisture (%)	Atterberg Limits			Grain Size Distribution			Specific Gravity	Moisture/Density Relationship Standard Proctor		Additional Tests Comments (See Notes)
					LL	PL	PI	% Finer 3/4"	% Finer #4	% Finer #200		Dry Density (pcf)	Moisture (%)	
Bulk	GMTC-1	--	ML	128.9	NP	NP	NP	100	100	67	2.62	--	--	Slurry Consolidation, Column Settling
Bulk	GMTC-1 @ 46% Solids (Single Drain Top 1/3)	--	--	--	--	--	--	100	100	66	--	--	--	
Bulk	GMTC-1 @ 46% Solids (Single Drain Bottom 1/3)	--	--	--	--	--	--	100	100	66	--	--	--	
Bulk	GMTC-1 @ 46% Solids (Double Drain Top 1/3)	--	--	--	--	--	--	100	100	66	--	--	--	
Bulk	GMTC-1 @ 46% Solids (Double Drain Bottom 1/3)	--	--	--	--	--	--	100	100	66	--	--	--	
Bulk	GMTC-2	--	ML	148.1	NP	NP	NP	100	100	63	2.64	--	--	Slurry Consolidation, Column Settling
Bulk	GMTC-2 @ 46% Solids (Single Drain Top 1/3)	--	--	--	--	--	--	100	100	63	--	--	--	
Bulk	GMTC-2 @ 46% Solids (Single Drain Bottom 1/3)	--	--	--	--	--	--	100	100	63	--	--	--	
Bulk	GMTC-2 @ 46% Solids (Double Drain Top 1/3)	--	--	--	--	--	--	100	100	63	--	--	--	
Bulk	GMTC-2 @ 46% Solids (Double Drain Bottom 1/3)	--	--	--	--	--	--	100	100	63	--	--	--	

NOTES:

LL= LIQUID LIMIT
PL= PLASTIC LIMIT
PI= PLASTIC INDEX
SL= SHRINKAGE LIMIT
UW= UNIT WEIGHT
P or Red Indicates Pending test result(s)
* Over size corrected value per ASTM D4718

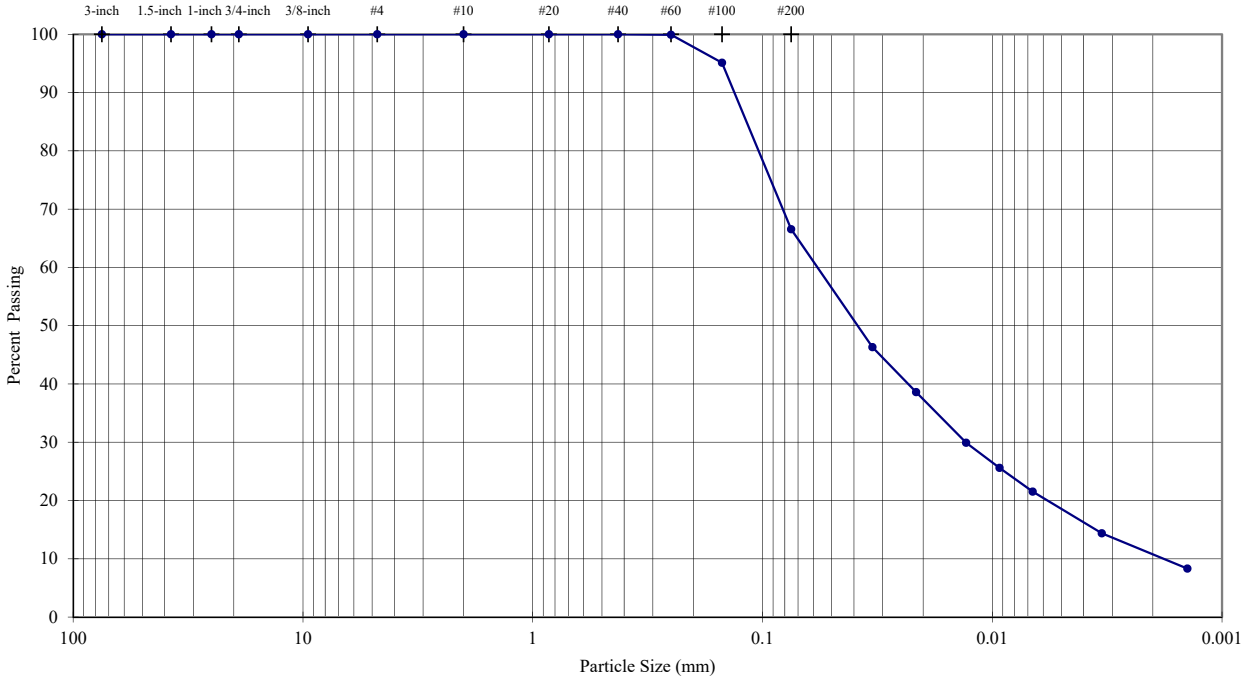
T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
DS = DIRECT SHEAR TEST
PERM = PERMEABILITY

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

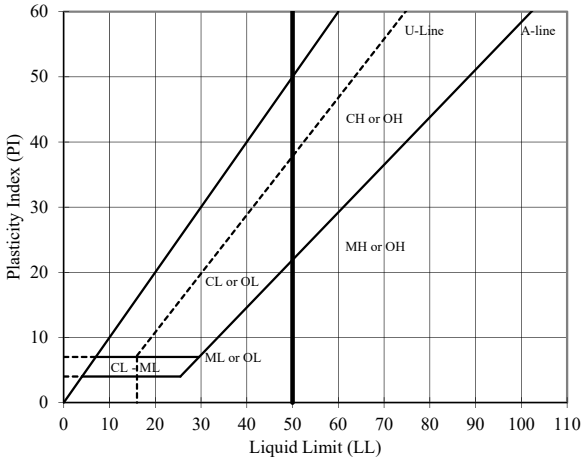
ASTM D421, D422, D4318

PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-1** DEPTH (ft): **--**
TYPE: **Bulk**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.00**
#40	0.425	**100.0**		
#60	0.250	**99.9**		
#100	0.150	**95.1**	Fine Sand	**33.46**
#200	0.075	**66.5**		
	0.033	**46.3**		
	0.021	**38.6**		
	0.013	**29.9**		
	0.009	**25.6**	Silt or Clay Fines	**66.54**
	0.007	**21.5**		
	0.003	**14.4**		
	0.001	**8.3**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



USCS Description (ASTM D 2487):

Sandy silt, grayish brown, wet

LL	PL	PI	SpG
NP	**NP**	**NP**	**2.62**

As-Received Moisture Content (%): --

USCS Group Symbol: ML

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

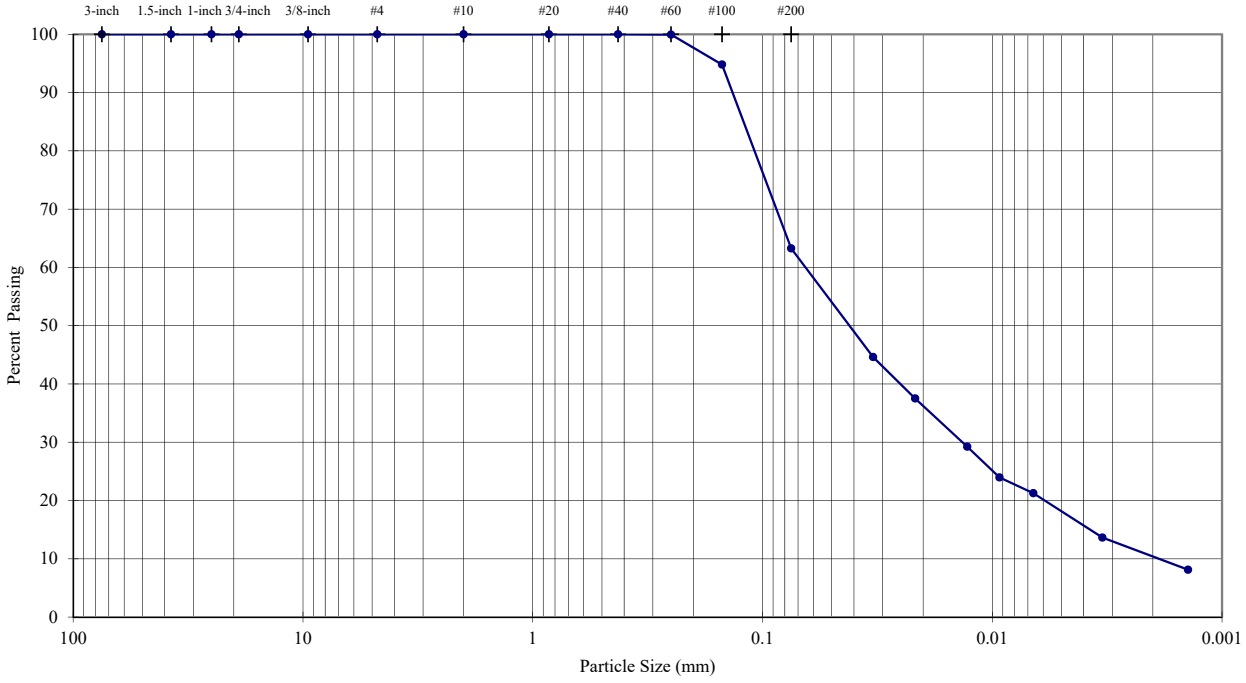
TECH	EH/MGC
DATE	9-May-2019
REVIEW	MB

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

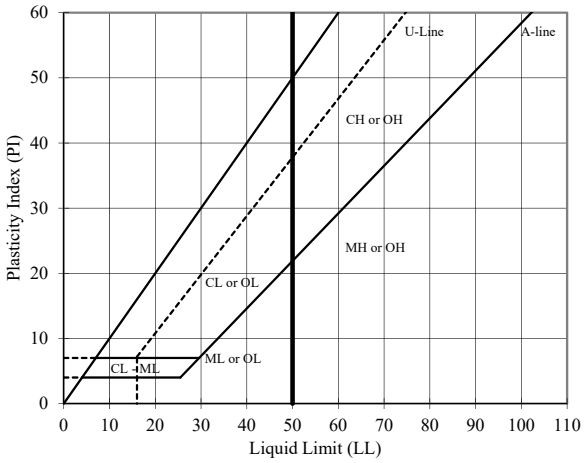
ASTM D421, D422, D4318

PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-2** DEPTH (ft): **--**
TYPE: **Bulk**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.00**
#40	0.425	**100.0**		
#60	0.250	**99.9**		
#100	0.150	**94.8**	Fine Sand	**36.74**
#200	0.075	**63.3**		
	0.033	**44.6**		
	0.022	**37.5**		
	0.013	**29.2**		
	0.009	**24.0**	Silt or Clay Fines	**63.26**
	0.007	**21.3**		
	0.003	**13.6**		
	0.001	**8.1**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



USCS Description (ASTM D 2487):

Sandy silt, grayish brown, wet

LL	PL	PI	SpG
NP	**NP**	**NP**	**2.64**

As-Received Moisture Content (%): **148.1**

USCS Group Symbol: ML

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	EH/MGC
DATE	9-May-2019
REVIEW	MB

ATTACHMENT 1.2

Settling Column Tests

Double Drain

GMTC-1 46%	
Initial Moisture Content (%) =	117.9%
Mass of Slurry + Cylinder (g) =	5970
Mass of Cylinder (g) =	5049
Total mass of Slurry (g) =	921.0
Mass of Water Initial (g) =	498.28
Total Mass of Solids (g) =	422.72
Slurry % Solids =	45.9%

Cylinder diameter (cm) =	6.336

INITIAL MOISTURE:	
Wet Weight (g) =	452.7
Dry Weight (g) =	355.37
Tare (g) =	272.8

Reading Number	Reading Date and Time (mm/dd/yyyy hh:mm)	Elapsed Time (min)	Height of Soil (cm)	Height of Water (cm)	Vol of Water Drained (ml)	Undrained Water (ml)	Pore Water (ml)	Volume of Soil (cm^3)	Moisture Content %	Dry Density of Slurry g/cc	Dry Density of Slurry lbs/ft^3	Wet Density of Slurry lbs/ft^3
1	5/9/2019 9:26	0.0	21.45	21.45	0.0	498.3	498.3	676.3	117.9%	0.63	39.0	85.0
2	5/9/2019 9:28	2.0	21.25	21.35	3.2	495.1	492.0	670.0	116.4%	0.63	39.4	85.2
3	5/9/2019 9:28	2.5	21.05	21.15	9.5	488.8	485.7	663.7	114.9%	0.64	39.7	85.4
4	5/9/2019 9:30	4.0	20.85	21.00	14.2	484.1	479.4	657.4	113.4%	0.64	40.1	85.6
5	5/9/2019 9:31	5.0	20.70	20.85	18.9	479.4	474.6	652.7	112.3%	0.65	40.4	85.8
6	5/9/2019 9:33	7.0	20.50	20.70	23.6	474.6	468.3	646.4	110.8%	0.65	40.8	86.0
7	5/9/2019 9:35	9.0	20.40	20.60	26.8	471.5	465.2	643.2	110.0%	0.66	41.0	86.1
8	5/9/2019 9:37	11.0	20.20	20.50	30.0	468.3	458.9	636.9	108.6%	0.66	41.4	86.4
9	5/9/2019 9:39	13.5	20.05	20.35	34.7	463.6	454.1	632.2	107.4%	0.67	41.7	86.6
10	5/9/2019 9:43	17.0	19.85	20.20	39.4	458.9	447.8	625.9	105.9%	0.68	42.1	86.8
11	5/9/2019 9:47	21.0	19.65	20.05	44.1	454.1	441.5	619.6	104.4%	0.68	42.6	87.0
12	5/9/2019 9:50	24.0	19.45	19.95	47.3	451.0	435.2	613.3	103.0%	0.69	43.0	87.3
13	5/9/2019 9:53	27.0	19.30	19.80	52.0	446.3	430.5	608.5	101.8%	0.69	43.3	87.5
14	5/9/2019 9:59	33.0	19.10	19.60	58.3	440.0	424.2	602.2	100.3%	0.70	43.8	87.8
15	5/9/2019 10:03	37.0	18.90	19.45	63.1	435.2	417.9	595.9	98.9%	0.71	44.3	88.0
16	5/9/2019 10:07	41.0	18.70	19.40	64.6	433.6	411.6	589.6	97.4%	0.72	44.7	88.3
17	5/9/2019 10:11	45.0	18.55	19.25	69.4	428.9	406.8	584.9	96.2%	0.72	45.1	88.5
18	5/9/2019 10:15	49.0	18.45	19.15	72.5	425.8	403.7	581.7	95.5%	0.73	45.3	88.6
19	5/9/2019 10:23	57.0	18.15	19.00	77.2	421.0	394.2	572.3	93.3%	0.74	46.1	89.1
20	5/9/2019 10:28	62.0	17.95	18.90	80.4	417.9	387.9	566.0	91.8%	0.75	46.6	89.4
21	5/9/2019 10:33	67.0	17.80	18.75	85.1	413.2	383.2	561.2	90.7%	0.75	47.0	89.6
22	5/9/2019 10:38	72.0	17.60	18.65	88.3	410.0	376.9	554.9	89.2%	0.76	47.5	89.9
23	5/9/2019 10:44	78.0	17.40	18.55	91.4	406.8	370.6	548.6	87.7%	0.77	48.1	90.2
24	5/9/2019 10:52	86.0	17.20	18.45	94.6	403.7	364.3	542.3	86.2%	0.78	48.6	90.6
25	5/9/2019 10:58	92.0	17.05	18.35	97.7	400.5	359.6	537.6	85.1%	0.79	49.1	90.8
26	5/9/2019 11:02	96.0	16.85	18.25	100.9	397.4	353.2	531.3	83.6%	0.80	49.6	91.1
27	5/9/2019 11:08	102.0	16.70	18.15	104.0	394.2	348.5	526.5	82.4%	0.80	50.1	91.4
28	5/9/2019 11:27	121.0	16.20	17.85	113.5	384.8	332.8	510.8	78.7%	0.83	51.6	92.3
29	5/9/2019 11:36	130.0	16.00	17.75	116.7	381.6	326.4	504.5	77.2%	0.84	52.3	92.7
30	5/9/2019 11:43	137.0	15.85	17.75	116.7	381.6	321.7	499.7	76.1%	0.85	52.8	93.0
31	5/9/2019 11:52	146.0	15.65	17.55	123.0	375.3	315.4	493.4	74.6%	0.86	53.5	93.3
32	5/9/2019 12:01	155.0	15.50	17.45	126.1	372.2	310.7	488.7	73.5%	0.86	54.0	93.6
33	5/9/2019 12:11	165.0	15.30	17.25	132.4	365.9	304.4	482.4	72.0%	0.88	54.7	94.1
34	5/9/2019 12:22	176.0	15.05	17.25	132.4	365.9	296.5	474.5	70.1%	0.89	55.6	94.6
35	5/9/2019 12:32	186.0	14.80	17.05	138.7	359.6	288.6	466.6	68.3%	0.91	56.5	95.1
36	5/9/2019 12:47	201.0	14.60	16.95	141.9	356.4	282.3	460.3	66.8%	0.92	57.3	95.6

Double Drain

GMTC-1 46%	
Initial Moisture Content (%) =	117.9%
Mass of Slurry + Cylinder (g) =	5970
Mass of Cylinder (g) =	5049
Total mass of Slurry (g) =	921.0
Mass of Water Initial (g) =	498.28
Total Mass of Solids (g) =	422.72
Slurry % Solids =	45.9%

Cylinder diameter (cm) =	6.336

INITIAL MOISTURE:	
Wet Weight (g) =	452.7
Dry Weight (g) =	355.37
Tare (g) =	272.8

Reading Number	Reading Date and Time (mm/dd/yyyy hh:mm)	Elapsed Time (min)	Height of Soil (cm)	Height of Water (cm)	Vol of Water Drained (ml)	Undrained Water (ml)	Pore Water (ml)	Volume of Soil (cm^3)	Moisture Content %	Dry Density of Slurry g/cc	Dry Density of Slurry lbs/ft^3	Wet Density of Slurry lbs/ft^3
37	5/9/2019 13:00	214.0	14.45	16.80	146.6	351.7	277.6	455.6	65.7%	0.93	57.9	95.9
38	5/9/2019 13:17	231.0	14.35	16.65	151.3	346.9	274.4	452.5	64.9%	0.93	58.3	96.1

Double Drain

GMTC-1 46%	
Initial Moisture Content (%) =	117.9%
Mass of Slurry + Cylinder (g) =	5970
Mass of Cylinder (g) =	5049
Total mass of Slurry (g) =	921.0
Mass of Water Initial (g) =	498.28
Total Mass of Solids (g) =	422.72
Slurry % Solids =	45.9%

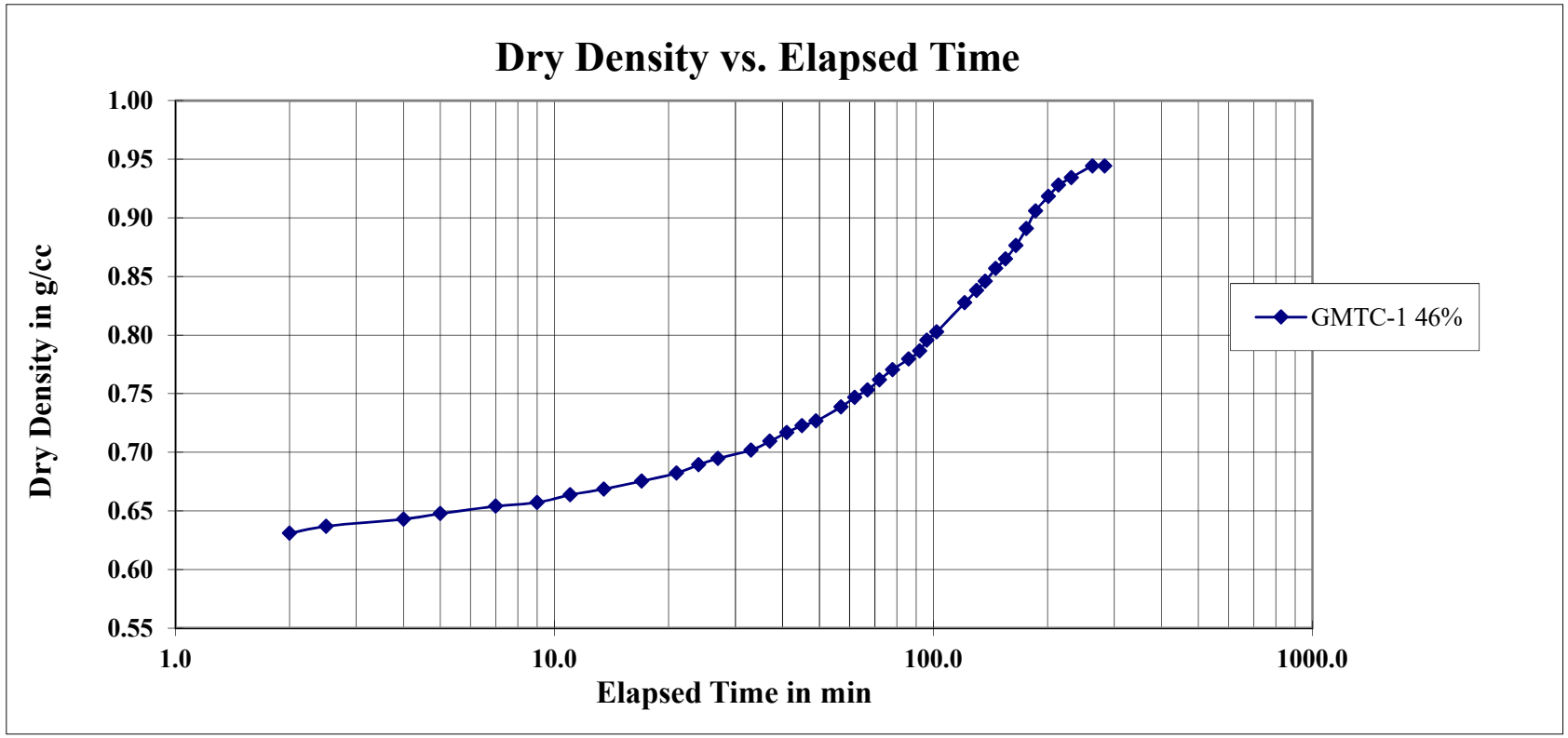
Cylinder diameter (cm) =	6.336

INITIAL MOISTURE:	
Wet Weight (g) =	452.7
Dry Weight (g) =	355.37
Tare (g) =	272.8

Reading Number	Reading Date and Time (mm/dd/yyyy hh:mm)	Elapsed Time (min)	Height of Soil (cm)	Height of Water (cm)	Vol of Water Drained (ml)	Undrained Water (ml)	Pore Water (ml)	Volume of Soil (cm^3)	Moisture Content %	Dry Density of Slurry g/cc	Dry Density of Slurry lbs/ft^3	Wet Density of Slurry lbs/ft^3
39	5/9/2019 13:49	263.0	14.20	16.35	160.8	337.5	269.7	447.7	63.8%	0.94	58.9	96.5
40	5/9/2019 14:09	283.0	14.20	16.15	167.1	331.2	269.7	447.7	63.8%	0.94	58.9	96.5

Note: The expected error is +/- 2.5% based on the calcutations of the volume of soil.

Golder Associates, Inc. Denver, Colorado			**Title:** **SEDIMENTATION TESTING SAMPLE DATA AND CALCULATIONS**		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification: GMTC-1 46%	**System:** Double Drain	**Reviewed:** MB	**Date:** 09-May-19	**Job Number:** 1663241.9000.9005	**Figure:** 1



Golder Associates, Inc. Denver, Colorado			Title: SEDIMENTATION TESTING GRAPHICAL DATA		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification: GMTC-1 46%	**System:** Double Drain	**Reviewed:** MB	**Date:** 09-May-19	**Job Number:** 1663241.9000.9005	**Figure:** 2

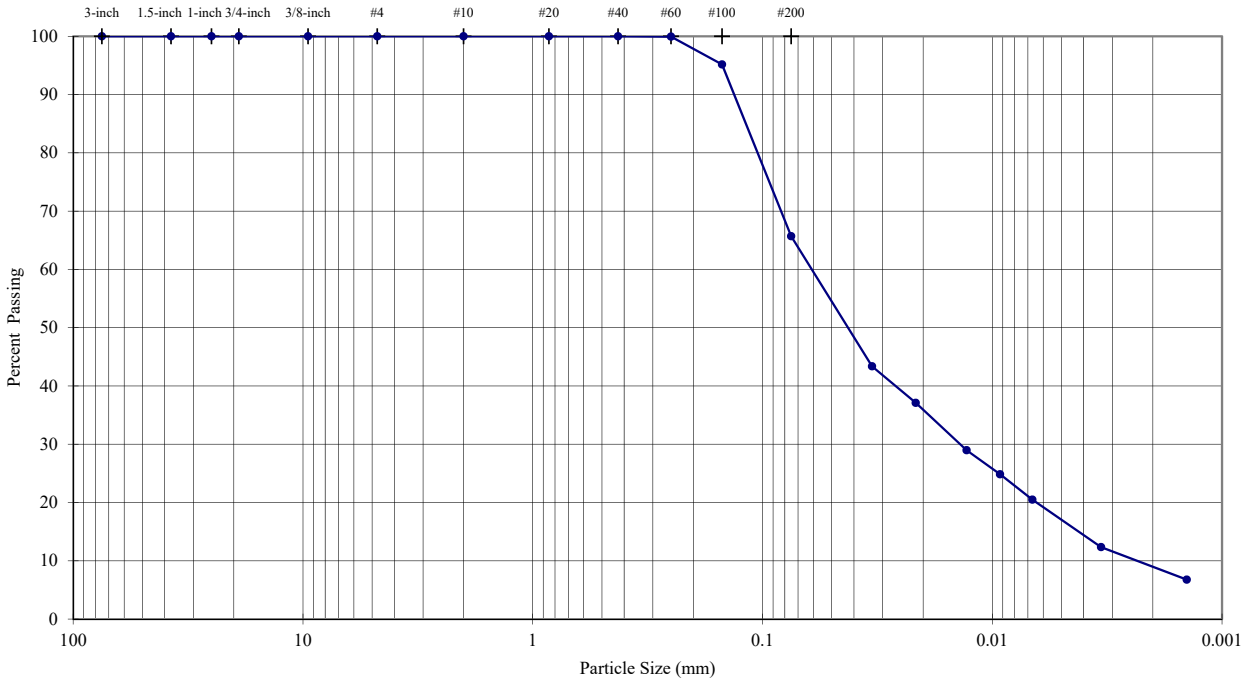
GOLDER

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

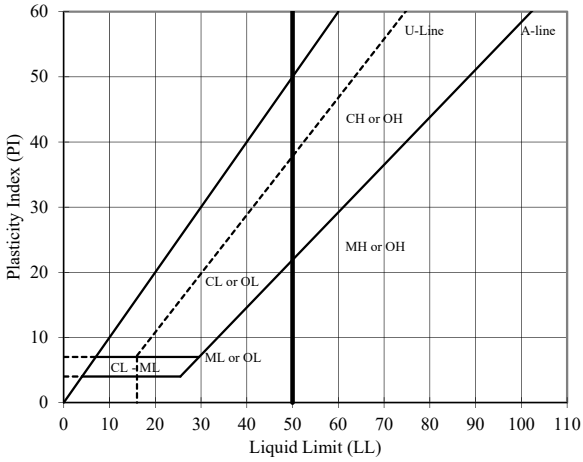
ASTM D421, D422, D4318

PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-1 @ 46% Solids** DEPTH (ft): **--**
TYPE: **Post Double Drain Column Settling Top 1/3**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.00**
#40	0.425	**100.0**		
#60	0.250	**99.9**		
#100	0.150	**95.2**	Fine Sand	**34.31**
#200	0.075	**65.7**		
	0.033	**43.4**		
	0.022	**37.1**		
	0.013	**29.0**		
	0.009	**24.8**	Silt or Clay Fines	**65.69**
	0.007	**20.5**		
	0.003	**12.3**		
	0.001	**6.8**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



USCS Description (ASTM D 2487):

SILT, white, dry

LL	PL	PI	SpG
--	--	--	**2.62**

As-Received Moisture Content (%): --

USCS Group Symbol: --

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute

TECH	KWG/MGC
DATE	14-May-2019
REVIEW	MB

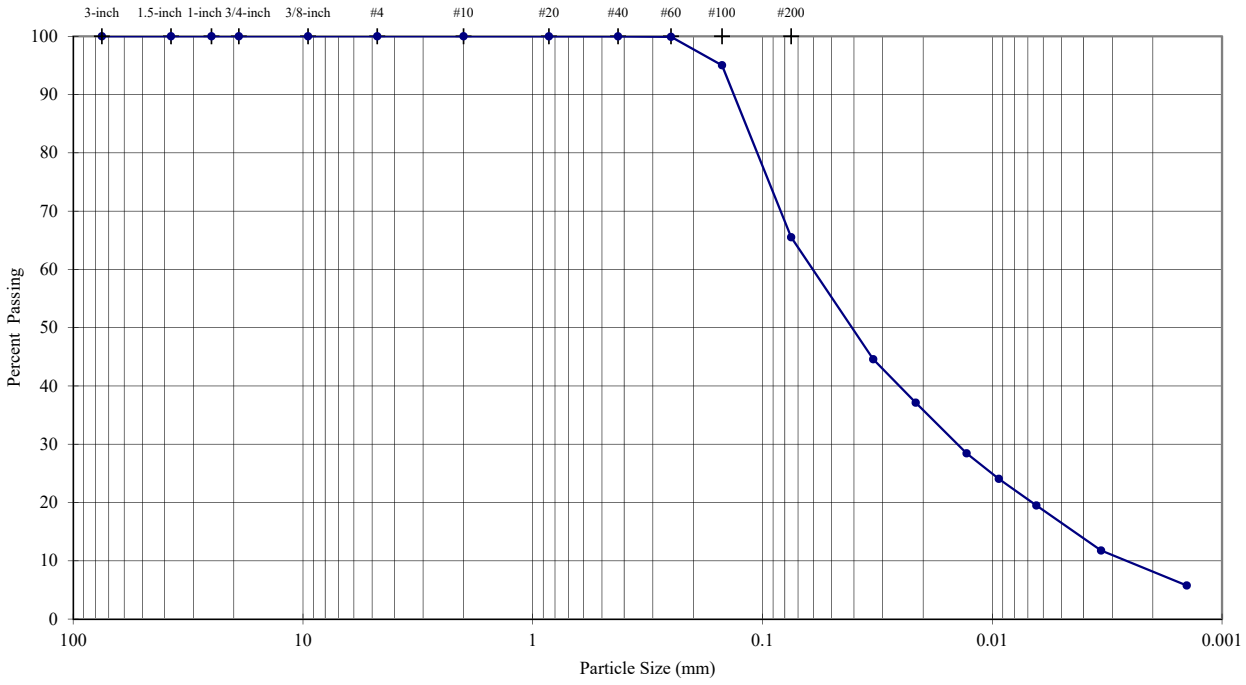
GOLDER

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

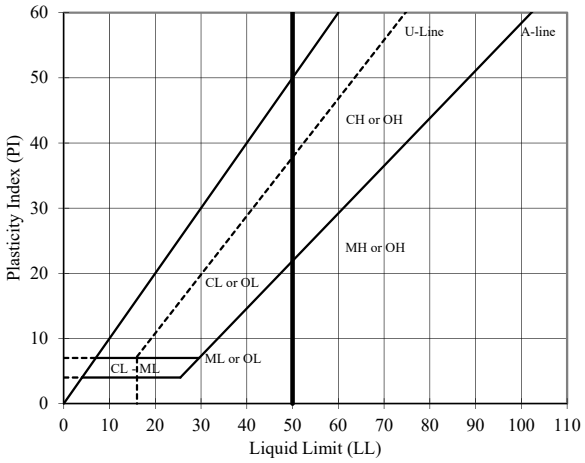
ASTM D421, D422, D4318

PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-1 @ 46% Solids** DEPTH (ft): **--**
TYPE: **Post Double Drain Column Settling Bottom 1/3**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.02**
#40	0.425	**100.0**		
#60	0.250	**99.9**		
#100	0.150	**95.0**	Fine Sand	**34.47**
#200	0.075	**65.5**		
Hydrometer Analysis	0.033	**44.6**		
	0.022	**37.1**		
	0.013	**28.4**		
	0.009	**24.1**	Silt or Clay Fines	**65.51**
	0.006	**19.5**		
	0.003	**11.8**		
	0.001	**5.8**		

Sieve Analysis (Initial Separation on No. 4 Sieve)



USCS Description (ASTM D 2487):

SILT, white, dry

LL	PL	PI	SpG
--	--	--	**2.62**

As-Received Moisture Content (%): --

USCS Group Symbol: --

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute

TECH	KWG/MGC
DATE	14-May-2019
REVIEW	MB

Single Drain

GMTC-1 46%	
Initial Moisture Content (%) =	117.7%
Mass of Slurry + Cylinder (g) =	6100
Mass of Cylinder (g) =	5042
Total mass of Slurry (g) =	1058.0
Mass of Water Initial (g) =	571.94
Total Mass of Solids (g) =	486.06
Slurry % Solids =	45.9%

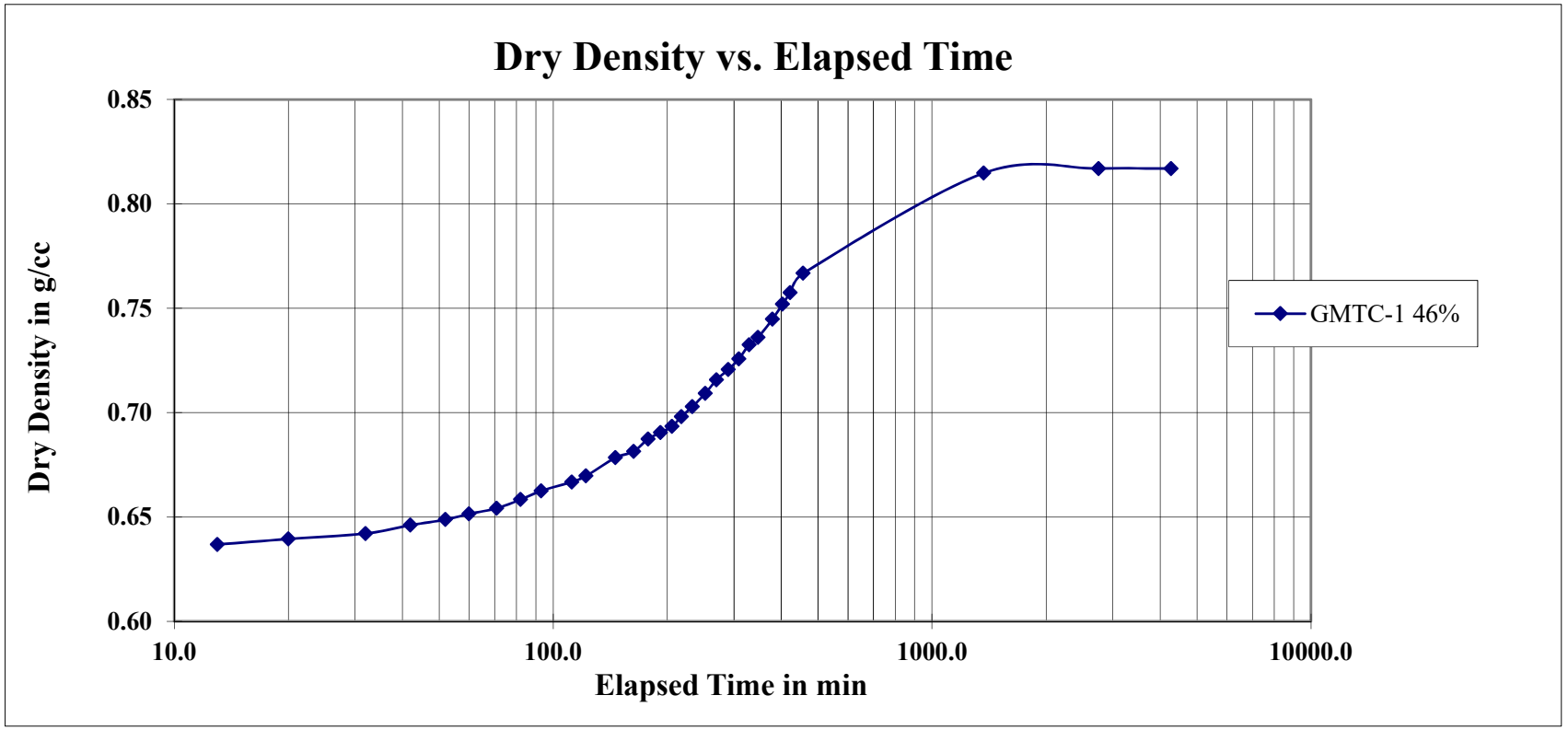
Cylinder diameter (cm) =	6.298

INITIAL MOISTURE:	
Wet Weight (g) =	452.81
Dry Weight (g) =	349.91
Tare (g) =	262.46

Reading Number	Reading Date and Time (mm/dd/yyyy hh:mm)	Elapsed Time (min)	Height of Soil (cm)	Height of Water (cm)	Vol of Water Drained (ml)	Undrained Water (ml)	Pore Water (ml)	Volume of Soil (cm^3)	Moisture Content %	Dry Density of Slurry g/cc	Dry Density of Slurry lbs/ft^3	Wet Density of Slurry lbs/ft^3
1	5/9/2019 9:00	0.0	24.60	24.60	0.0	571.9	571.9	766.4	117.7%	0.63	39.6	86.1
2	5/9/2019 9:13	13.0	24.50	24.60	0.0	571.9	568.8	763.2	117.0%	0.64	39.7	86.2
3	5/9/2019 9:20	20.0	24.40	24.60	0.0	571.9	565.7	760.1	116.4%	0.64	39.9	86.3
4	5/9/2019 9:32	32.0	24.30	24.60	0.0	571.9	562.6	757.0	115.7%	0.64	40.1	86.4
5	5/9/2019 9:42	42.0	24.15	24.60	0.0	571.9	557.9	752.3	114.8%	0.65	40.3	86.6
6	5/9/2019 9:52	52.0	24.05	24.60	0.0	571.9	554.8	749.2	114.1%	0.65	40.5	86.7
7	5/9/2019 10:00	60.0	23.95	24.60	0.0	571.9	551.7	746.1	113.5%	0.65	40.7	86.8
8	5/9/2019 10:11	71.0	23.85	24.60	0.0	571.9	548.6	743.0	112.9%	0.65	40.8	86.9
9	5/9/2019 10:22	82.0	23.70	24.60	0.0	571.9	543.9	738.3	111.9%	0.66	41.1	87.0
10	5/9/2019 10:33	93.0	23.55	24.60	0.0	571.9	539.2	733.6	110.9%	0.66	41.3	87.2
11	5/9/2019 10:52	112.0	23.40	24.60	0.0	571.9	534.6	729.0	110.0%	0.67	41.6	87.4
12	5/9/2019 11:02	122.0	23.30	24.60	0.0	571.9	531.4	725.9	109.3%	0.67	41.8	87.5
13	5/9/2019 11:26	146.0	23.00	24.60	0.0	571.9	522.1	716.5	107.4%	0.68	42.3	87.8
14	5/9/2019 11:43	163.0	22.90	24.60	0.0	571.9	519.0	713.4	106.8%	0.68	42.5	87.9
15	5/9/2019 11:58	178.0	22.70	24.60	0.0	571.9	512.7	707.2	105.5%	0.69	42.9	88.1
16	5/9/2019 12:12	192.0	22.60	24.60	0.0	571.9	509.6	704.1	104.8%	0.69	43.1	88.2
17	5/9/2019 12:26	206.0	22.50	24.60	0.0	571.9	506.5	700.9	104.2%	0.69	43.3	88.4
18	5/9/2019 12:38	218.0	22.35	24.60	0.0	571.9	501.8	696.3	103.2%	0.70	43.6	88.5
19	5/9/2019 12:53	233.0	22.20	24.60	0.0	571.9	497.2	691.6	102.3%	0.70	43.9	88.7
20	5/9/2019 13:12	252.0	22.00	24.60	0.0	571.9	490.9	685.4	101.0%	0.71	44.3	89.0
21	5/9/2019 13:30	270.0	21.80	24.60	0.0	571.9	484.7	679.1	99.7%	0.72	44.7	89.2
22	5/9/2019 13:50	290.0	21.65	24.60	0.0	571.9	480.0	674.5	98.8%	0.72	45.0	89.4
23	5/9/2019 14:09	309.0	21.50	24.60	0.0	571.9	475.4	669.8	97.8%	0.73	45.3	89.6
24	5/9/2019 14:29	329.0	21.30	24.60	0.0	571.9	469.1	663.6	96.5%	0.73	45.7	89.8
25	5/9/2019 14:47	347.0	21.20	24.60	0.0	571.9	466.0	660.4	95.9%	0.74	45.9	90.0
26	5/9/2019 15:19	379.0	20.95	24.60	0.0	571.9	458.2	652.6	94.3%	0.74	46.5	90.3
27	5/9/2019 15:43	403.0	20.75	24.60	0.0	571.9	452.0	646.4	93.0%	0.75	46.9	90.6
28	5/9/2019 16:02	422.0	20.60	24.60	0.0	571.9	447.3	641.7	92.0%	0.76	47.3	90.8
29	5/9/2019 16:37	457.0	20.35	24.60	0.0	571.9	439.5	634.0	90.4%	0.77	47.8	91.1
30	5/10/2019 7:49	1369.0	19.15	24.60	0.0	571.9	402.2	596.6	82.7%	0.81	50.8	92.9
31	5/11/2019 6:52	2752.0	19.10	24.60	0.0	571.9	400.6	595.0	82.4%	0.82	51.0	93.0
32	5/12/2019 8:10	4270.0	19.10	24.60	0.0	571.9	400.6	595.0	82.4%	0.82	51.0	93.0

Note: The expected error is +/- 1.5% based on the calcutations of the volume of soil.

Golder Associates, Inc. **Denver, Colorado**			**Title:** **SEDIMENTATION TESTING** **SAMPLE DATA AND CALCULATIONS**		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification: GMTC-1 46%	**System:** Single Drain	**Reviewed:** MB	**Date:** 09-May-19	**Job Number:** 1663241.9000.9005	**Figure:** 1



Golder Associates, Inc. Denver, Colorado			Title: SEDIMENTATION TESTING GRAPHICAL DATA		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification: GMTC-1 46%	**System:** Single Drain	**Reviewed:** MB	**Date:** 09-May-19	**Job Number:** 1663241.9000.9005	**Figure:** 2

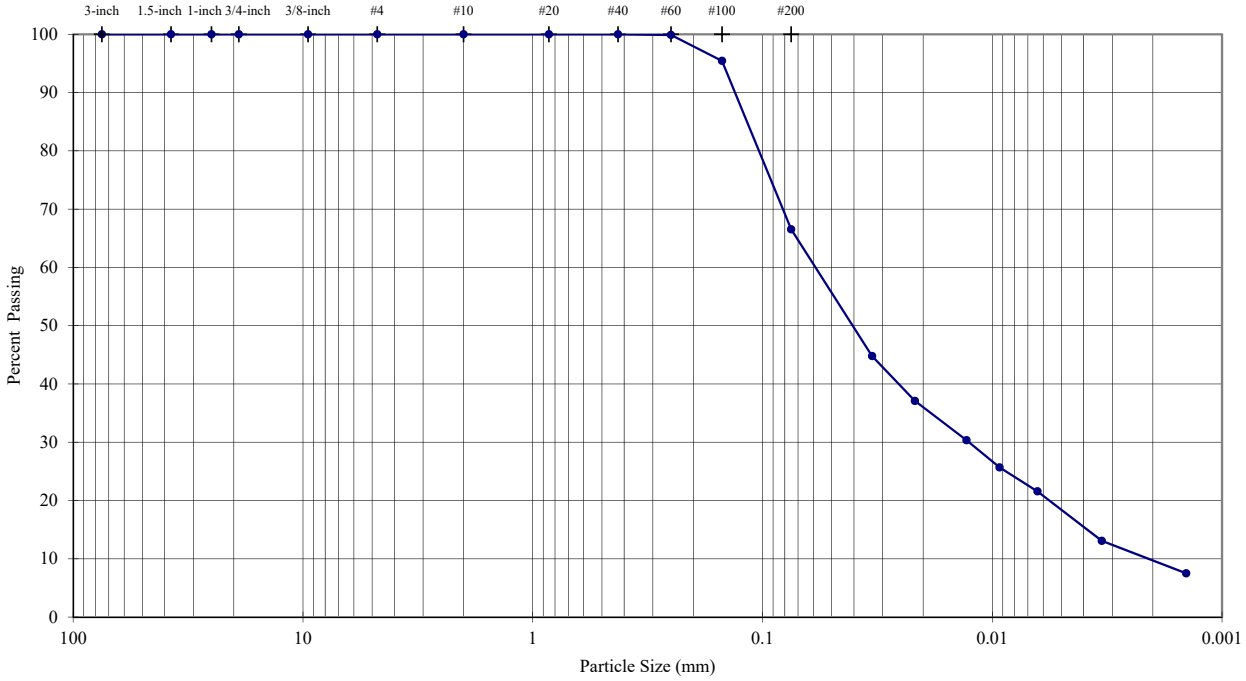
GOLDER

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

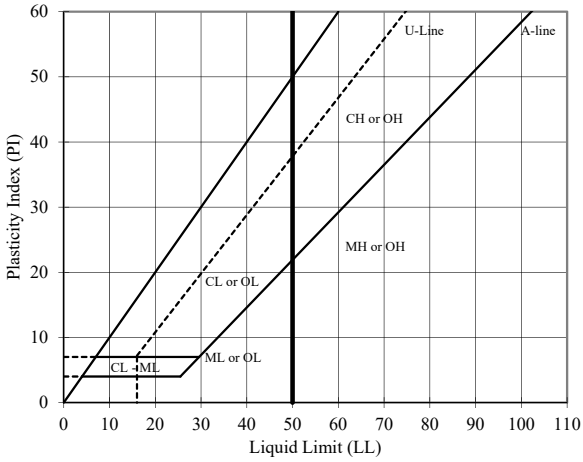
ASTM D421, D422, D4318

PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-1 @ 46% Solids** DEPTH (ft): **--**
TYPE: **Post Single Drain Column Settling Top 1/3**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.00**
#40	0.425	**100.0**		
#60	0.250	**99.9**	Fine Sand	**33.47**
#100	0.150	**95.4**		
#200	0.075	**66.5**		
	0.033	**44.8**	Silt or Clay Fines	**66.53**
	0.022	**37.1**		
	0.013	**30.3**		
	0.009	**25.7**		
	0.006	**21.6**		
	0.003	**13.1**		
	0.001	**7.5**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



USCS Description (ASTM D 2487):

SILT, light gray, dry

LL	PL	PI	SpG
--	--	--	**2.62**

As-Received Moisture Content (%): --

USCS Group Symbol: --

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute

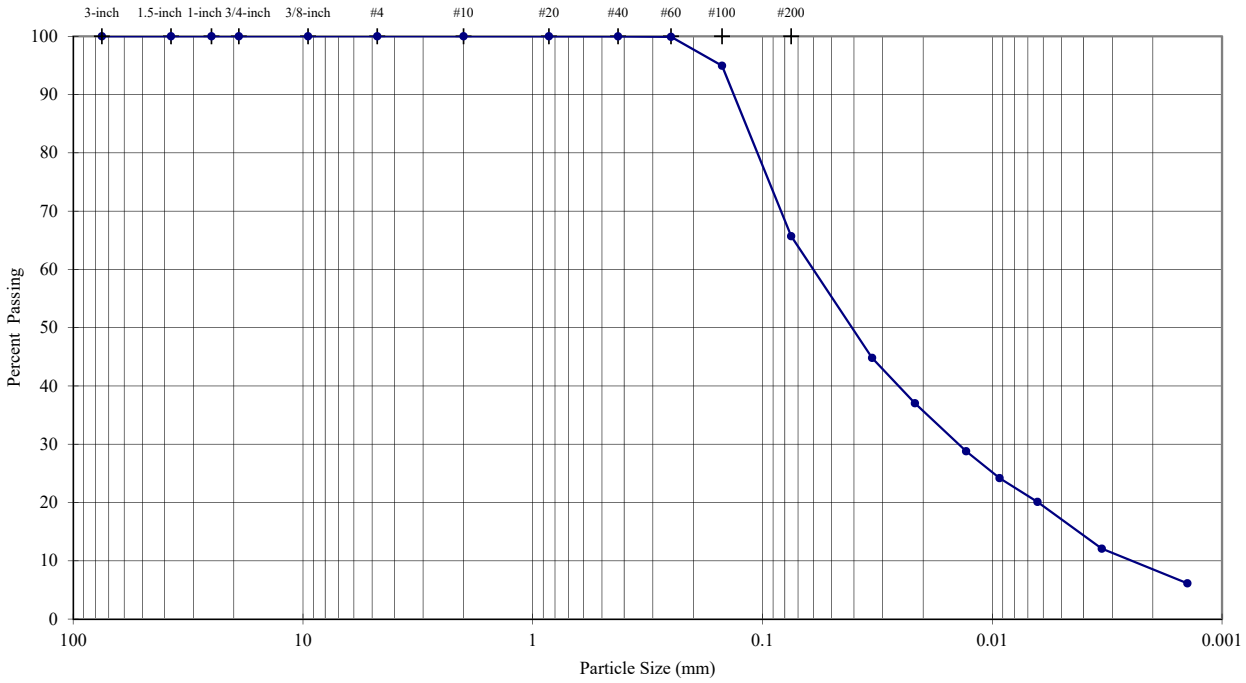
TECH	KWG/MGC
DATE	18-May-2019
REVIEW	MB

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

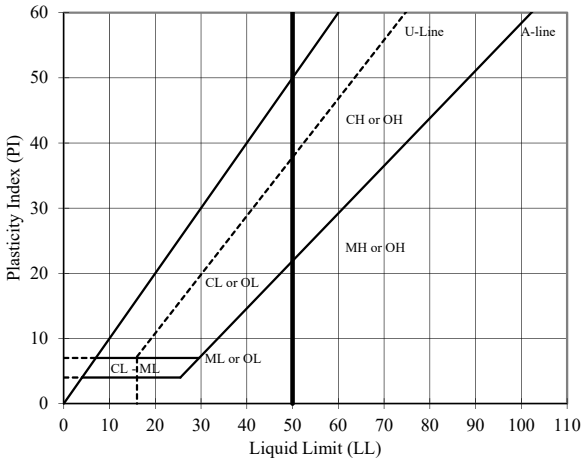
ASTM D421, D422, D4318

PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-1 @ 46% Solids** DEPTH (ft): **--**
TYPE: **Post Single Drain Column Settling Bottom 1/3**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.02**
#40	0.425	**100.0**		
#60	0.250	**99.9**		
#100	0.150	**94.9**	Fine Sand	**34.28**
#200	0.075	**65.7**		
	0.033	**44.8**		
	0.022	**37.0**		
	0.013	**28.8**		
	0.009	**24.2**	Silt or Clay Fines	**65.70**
	0.006	**20.1**		
	0.003	**12.1**		
	0.001	**6.1**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



USCS Description (ASTM D 2487):

SILT, light gray, dry

LL	PL	PI	SpG
--	--	--	**2.62**

As-Received Moisture Content (%): --

USCS Group Symbol: --

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute

TECH	KWG/MGC
DATE	18-May-2019
REVIEW	MB

Double Drain

GMTC-2 @ 46% Solids

Initial Moisture Content (%) =	118.3%
Mass of Slurry + Cylinder (g) =	5834
Mass of Cylinder (g) =	4564
Total mass of Slurry (g) =	1270.0
Mass of Water Initial (g) =	688.27
Total Mass of Solids (g) =	581.73
Slurry % Solids =	45.8%

Cylinder diameter (cm) =	6.327

INITIAL MOISTURE:	
Wet Weight (g) =	606.22
Dry Weight (g) =	417.44
Tare (g) =	257.88

Reading Number	Reading Date and Time (mm/dd/yyyy hh:mm)	Elapsed Time (min)	Height of Soil (cm)	Height of Water (cm)	Vol of Water Drained (ml)	Undrained Water (ml)	Pore Water (ml)	Volume of Soil (cm^3)	Moisture Content %	Dry Density of Slurry g/cc	Dry Density of Slurry lbs/ft^3	Wet Density of Slurry lbs/ft^3
1	5/17/2019 8:09	0.0	29.35	29.35	0.0	688.3	688.3	922.8	118.3%	0.63	39.3	85.9
2	5/17/2019 8:11	2.5	29.10	29.20	4.7	683.6	680.4	914.9	117.0%	0.64	39.7	86.1
3	5/17/2019 8:12	3.5	28.90	29.10	7.9	680.4	674.1	908.6	115.9%	0.64	40.0	86.2
4	5/17/2019 8:13	4.5	28.70	28.95	12.6	675.7	667.8	902.3	114.8%	0.64	40.2	86.4
5	5/17/2019 8:14	5.5	28.55	28.85	15.7	672.5	663.1	897.6	114.0%	0.65	40.4	86.5
6	5/17/2019 8:16	7.0	28.40	28.70	20.4	667.8	658.4	892.9	113.2%	0.65	40.7	86.7
7	5/17/2019 8:18	9.0	28.25	28.65	22.0	666.3	653.7	888.2	112.4%	0.65	40.9	86.8
8	5/17/2019 8:20	11.0	28.05	28.50	26.7	661.5	647.4	881.9	111.3%	0.66	41.2	87.0
9	5/17/2019 8:22	13.0	27.90	28.40	29.9	658.4	642.7	877.2	110.5%	0.66	41.4	87.1
10	5/17/2019 8:24	15.0	27.75	28.30	33.0	655.3	638.0	872.5	109.7%	0.67	41.6	87.2
11	5/17/2019 8:26	17.0	27.60	28.20	36.2	652.1	633.2	867.8	108.9%	0.67	41.8	87.4
12	5/17/2019 8:29	20.0	27.40	28.10	39.3	649.0	627.0	861.5	107.8%	0.68	42.1	87.6
13	5/17/2019 8:32	23.0	27.20	28.00	42.4	645.8	620.7	855.2	106.7%	0.68	42.4	87.7
14	5/17/2019 8:36	27.0	27.00	27.85	47.2	641.1	614.4	848.9	105.6%	0.69	42.8	87.9
15	5/17/2019 8:39	30.0	26.80	27.75	50.3	638.0	608.1	842.6	104.5%	0.69	43.1	88.1
16	5/17/2019 8:43	34.0	26.60	27.60	55.0	633.2	601.8	836.3	103.5%	0.70	43.4	88.3
17	5/17/2019 8:47	38.0	26.40	27.60	55.0	633.2	595.5	830.0	102.4%	0.70	43.7	88.5
18	5/17/2019 8:52	43.0	26.15	27.45	59.7	628.5	587.7	822.2	101.0%	0.71	44.2	88.8
19	5/17/2019 8:56	47.0	25.95	27.30	64.5	623.8	581.4	815.9	99.9%	0.71	44.5	89.0
20	5/17/2019 9:01	52.0	25.65	27.20	67.6	620.7	571.9	806.4	98.3%	0.72	45.0	89.3
21	5/17/2019 9:07	58.0	25.35	27.20	67.6	620.7	562.5	797.0	96.7%	0.73	45.5	89.6
22	5/17/2019 9:12	63.0	25.05	26.90	77.0	611.2	553.1	787.6	95.1%	0.74	46.1	89.9
23	5/17/2019 9:18	69.0	24.80	26.90	77.0	611.2	545.2	779.7	93.7%	0.75	46.6	90.2
24	5/17/2019 9:24	75.0	24.50	26.75	81.7	606.5	535.8	770.3	92.1%	0.76	47.1	90.5
25	5/17/2019 9:30	81.0	24.25	26.75	81.7	606.5	527.9	762.4	90.7%	0.76	47.6	90.8
26	5/17/2019 9:36	87.0	24.00	26.55	88.0	600.2	520.1	754.6	89.4%	0.77	48.1	91.1
27	5/17/2019 9:46	97.0	23.60	26.40	92.7	595.5	507.5	742.0	87.2%	0.78	48.9	91.6
28	5/17/2019 9:55	106.0	23.25	26.40	92.7	595.5	496.5	731.0	85.3%	0.80	49.7	92.0
29	5/17/2019 10:03	114.0	23.00	26.20	99.0	589.2	488.6	723.1	84.0%	0.80	50.2	92.4
30	5/17/2019 10:08	119.0	22.85	26.20	99.0	589.2	483.9	718.4	83.2%	0.81	50.5	92.6
31	5/17/2019 10:16	127.0	22.55	25.90	108.5	579.8	474.5	709.0	81.6%	0.82	51.2	93.0
32	5/17/2019 10:24	135.0	22.30	25.90	108.5	579.8	466.6	701.1	80.2%	0.83	51.8	93.3
33	5/17/2019 10:31	142.0	22.10	25.85	110.0	578.2	460.3	694.8	79.1%	0.84	52.2	93.6
34	5/17/2019 10:39	150.0	21.90	25.70	114.8	573.5	454.0	688.5	78.0%	0.84	52.7	93.9
35	5/17/2019 10:54	165.0	21.50	25.55	119.5	568.8	441.5	676.0	75.9%	0.86	53.7	94.5
36	5/17/2019 11:01	172.0	21.35	25.55	119.5	568.8	436.7	671.2	75.1%	0.87	54.1	94.7

Double Drain

GMTC-2 @ 46% Solids	
Initial Moisture Content (%) =	118.3%
Mass of Slurry + Cylinder (g) =	5834
Mass of Cylinder (g) =	4564
Total mass of Slurry (g) =	1270.0
Mass of Water Initial (g) =	688.27
Total Mass of Solids (g) =	581.73
Slurry % Solids =	45.8%

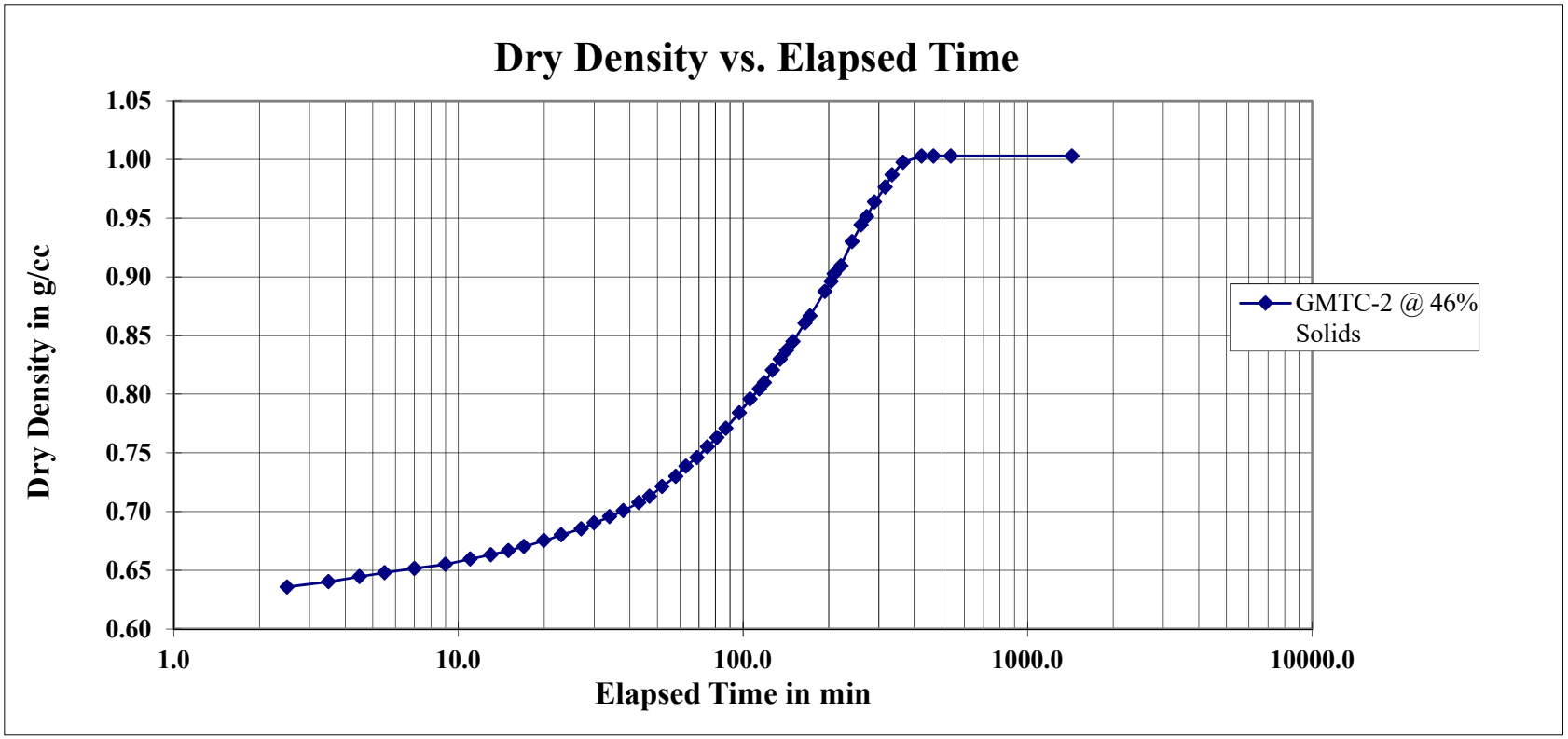
Cylinder diameter (cm) =	6.327

INITIAL MOISTURE:	
Wet Weight (g) =	606.22
Dry Weight (g) =	417.44
Tare (g) =	257.88

Reading Number	Reading Date and Time (mm/dd/yyyy hh:mm)	Elapsed Time (min)	Height of Soil (cm)	Height of Water (cm)	Vol of Water Drained (ml)	Undrained Water (ml)	Pore Water (ml)	Volume of Soil (cm^3)	Moisture Content %	Dry Density of Slurry g/cc	Dry Density of Slurry lbs/ft^3	Wet Density of Slurry lbs/ft^3
37	5/17/2019 11:23	194.0	20.85	25.20	130.5	557.8	421.0	655.5	72.4%	0.89	55.4	95.5
38	5/17/2019 11:33	204.0	20.65	25.10	133.6	554.6	414.7	649.2	71.3%	0.90	55.9	95.8
39	5/17/2019 11:38	209.0	20.50	25.10	133.6	554.6	410.0	644.5	70.5%	0.90	56.3	96.0
40	5/17/2019 11:50	221.0	20.35	25.10	133.6	554.6	405.3	639.8	69.7%	0.91	56.7	96.3
41	5/17/2019 12:11	242.0	19.90	24.90	139.9	548.4	391.2	625.7	67.2%	0.93	58.0	97.0
42	5/17/2019 12:29	260.0	19.60	24.75	144.6	543.6	381.7	616.2	65.6%	0.94	58.9	97.6
43	5/17/2019 12:41	272.0	19.45	24.75	144.6	543.6	377.0	611.5	64.8%	0.95	59.4	97.8
44	5/17/2019 12:59	290.0	19.20	24.60	149.3	538.9	369.1	603.7	63.5%	0.96	60.1	98.3
45	5/17/2019 13:25	316.0	18.95	24.40	155.6	532.6	361.3	595.8	62.1%	0.98	60.9	98.8
46	5/17/2019 13:43	334.0	18.75	24.40	155.6	532.6	355.0	589.5	61.0%	0.99	61.6	99.2
47	5/17/2019 14:14	365.0	18.55	24.15	163.5	524.8	348.7	583.2	59.9%	1.00	62.2	99.6
48	5/17/2019 15:13	424.0	18.45	23.90	171.3	516.9	345.6	580.1	59.4%	1.00	62.6	99.8
49	5/17/2019 15:56	467.0	18.45	23.65	179.2	509.1	345.6	580.1	59.4%	1.00	62.6	99.8
50	5/17/2019 17:07	538.0	18.45	23.30	190.2	498.1	345.6	580.1	59.4%	1.00	62.6	99.8
51	5/18/2019 8:00	1431.0	18.45	19.55	308.1	380.2	345.6	580.1	59.4%	1.00	62.6	99.8

Note: The expected error is +/- 1.5% based on the calcutations of the volume of soil.

Golder Associates, Inc. **Denver, Colorado**			**Title:** **SEDIMENTATION TESTING** **SAMPLE DATA AND CALCULATIONS**		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification: GMTC-2 @ 46% Solids	**System:** Double Drain	**Reviewed:** MB	**Date:** 17-May-19	**Job Number:** 1663241.9000.9005	**Figure:** 1



Golder Associates, Inc. **Denver, Colorado**			**Title:** **SEDIMENTATION TESTING** **GRAPHICAL DATA**		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification: GMTC-2 @ 46% Solids	**System:** Double Drain	**Reviewed:** MB	**Date:** 17-May-19	**Job Number:** 1663241.9000.9005	**Figure:** 2

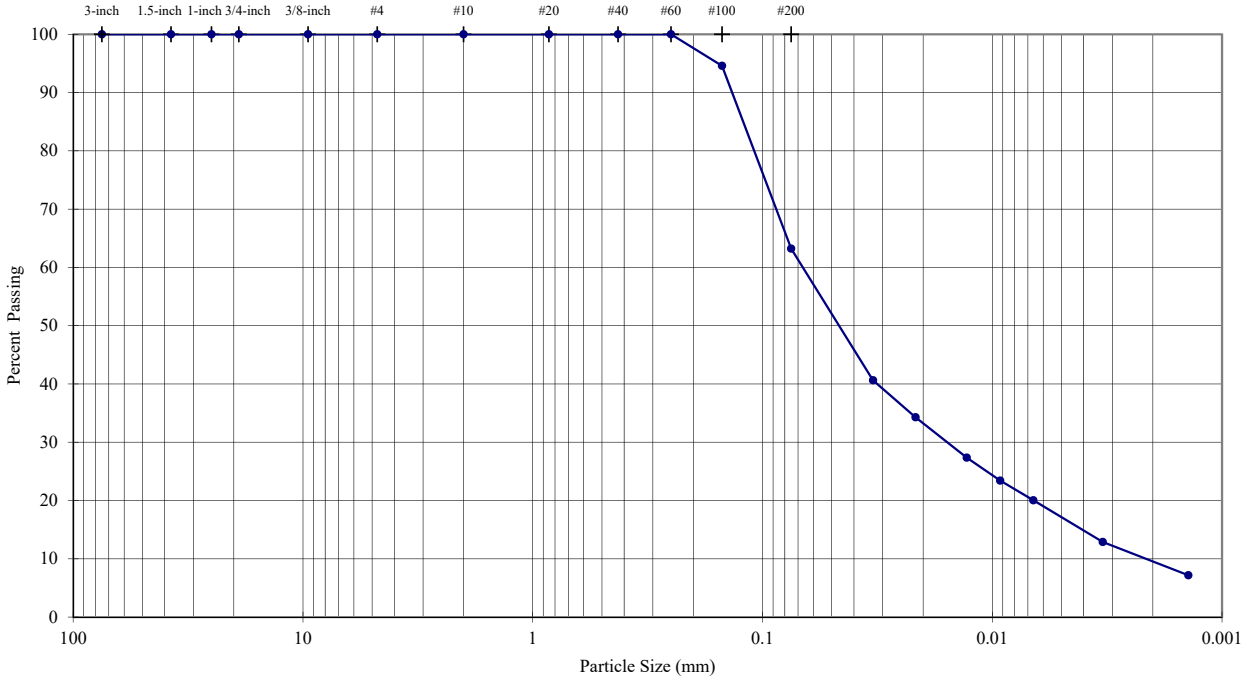
GOLDER

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

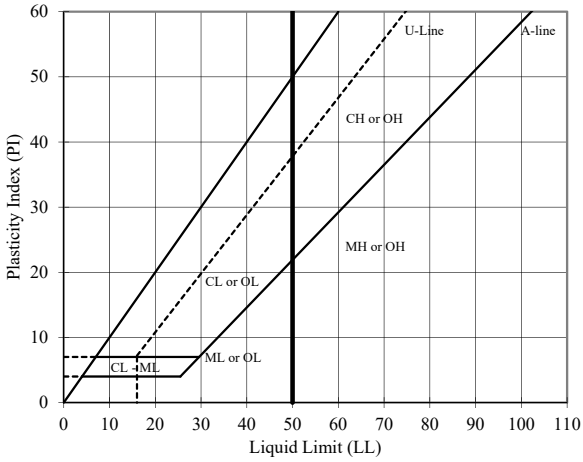
ASTM D421, D422, D4318

PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-2 @ 46% Solids** DEPTH (ft): **--**
TYPE: **Post Double Drain Column Settling Top 1/3**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.00**
#40	0.425	**100.0**		
#60	0.250	**100.0**		
#100	0.150	**94.6**	Fine Sand	**36.78**
#200	0.075	**63.2**		
	0.033	**40.6**		
	0.022	**34.3**		
	0.013	**27.4**		
	0.009	**23.4**	Silt or Clay Fines	**63.22**
	0.007	**20.0**		
	0.003	**12.9**		
	0.001	**7.2**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



Visual Description (Golder Procedure):

Sandy silt, white, dry

LL	PL	PI	SpG
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As-Received Moisture Content (%): --

USCS Group Symbol: --

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute

TECH	MGC
DATE	23-May-2019
REVIEW	MB

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

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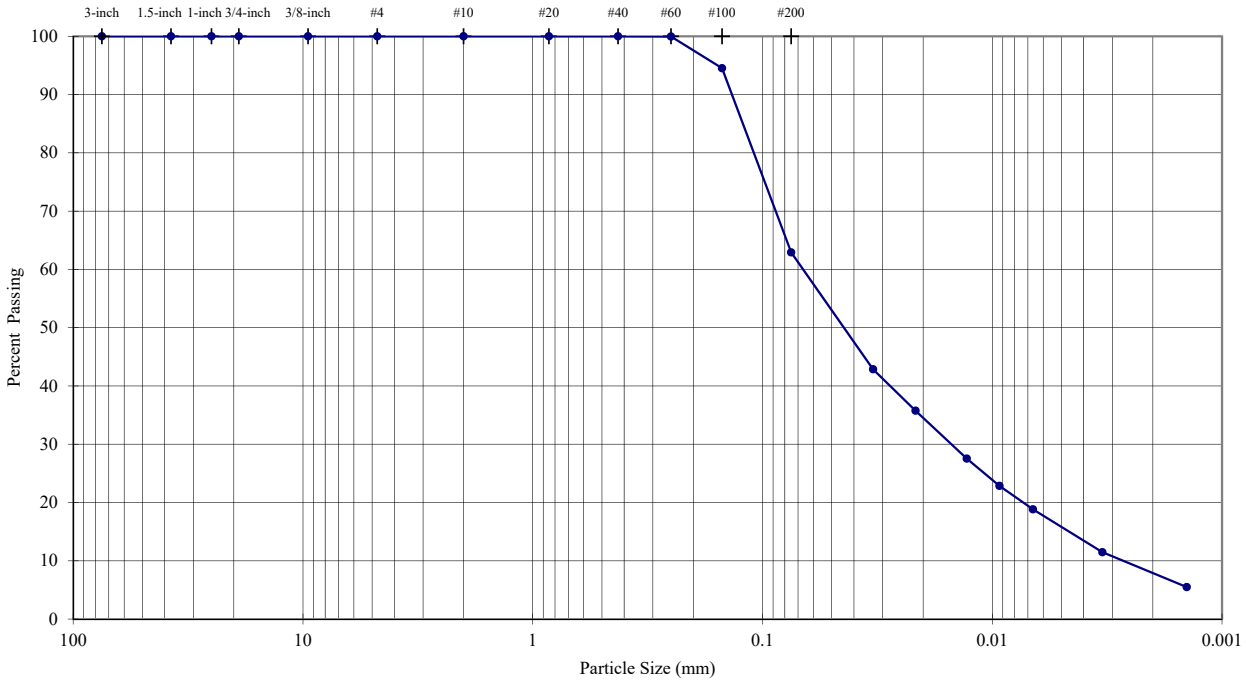
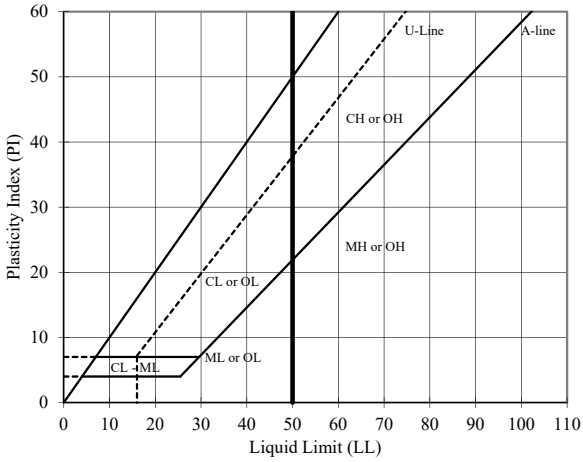


Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.00**
#40	0.425	**100.0**		
#60	0.250	**100.0**		
#100	0.150	**94.5**	Fine Sand	**37.08**
#200	0.075	**62.9**		
	0.033	**42.9**		
	0.022	**35.7**		
	0.013	**27.5**		
	0.009	**22.9**	Silt or Clay Fines	**62.92**
	0.007	**18.8**		
	0.003	**11.5**		
	0.001	**5.5**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



Visual Description (Golder Procedure):

Sandy silt, white, dry

LL	PL	PI	SpG
--	--	--	--

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USCS Group Symbol: --

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute

TECH	MGC
DATE	23-May-2019
REVIEW	MB

Single Drain

GMTC-2 @ 46% Solids	
Initial Moisture Content (%) =	117.0%
Mass of Slurry + Cylinder (g) =	5775
Mass of Cylinder (g) =	4547
Total mass of Slurry (g) =	1228.0
Mass of Water Initial (g) =	662.18
Total Mass of Solids (g) =	565.82
Slurry % Solids =	46.1%

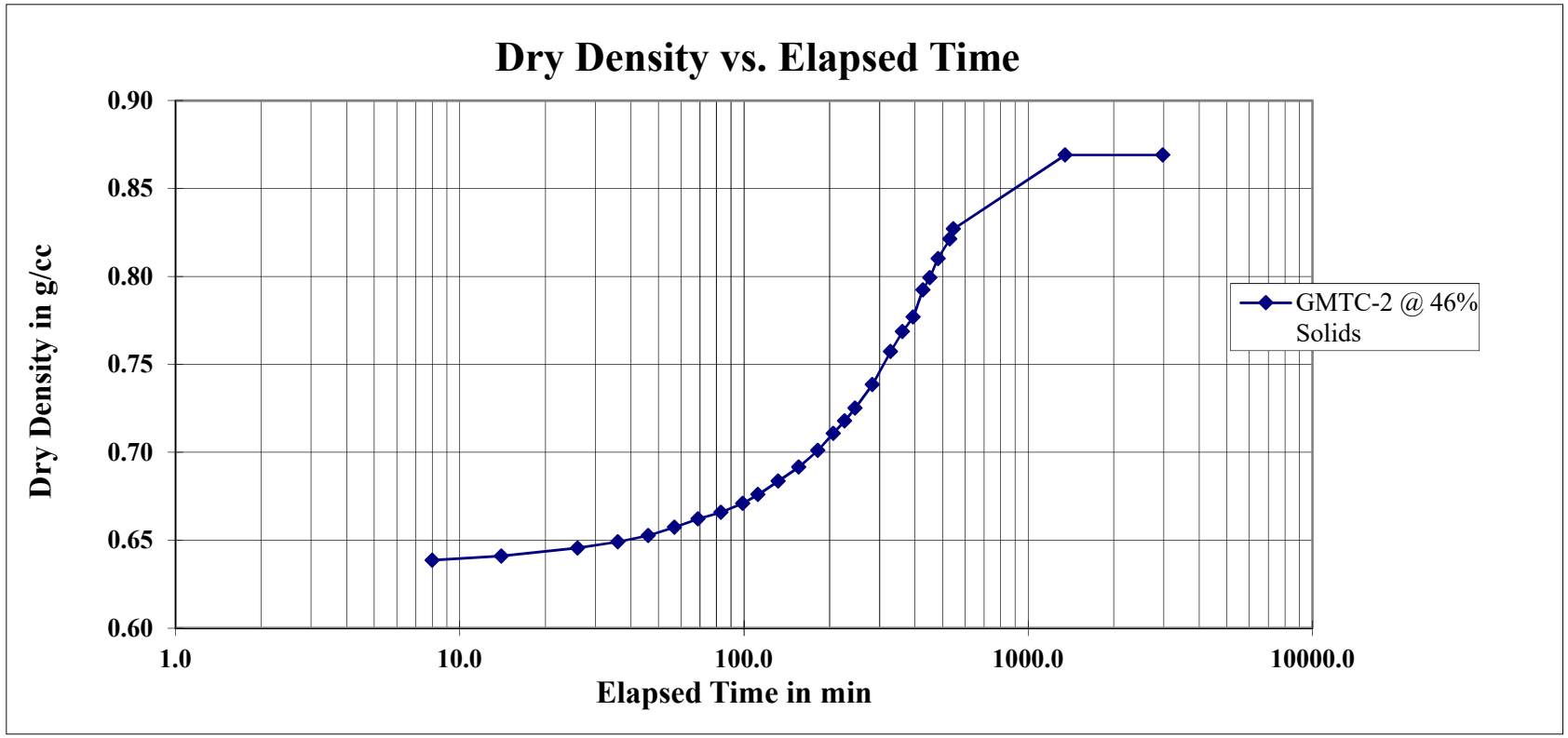
Cylinder diameter (cm) =	6.336

INITIAL MOISTURE:	
Wet Weight (g) =	447.01
Dry Weight (g) =	344.54
Tare (g) =	256.98

Reading Number	Reading Date and Time (mm/dd/yyyy hh:mm)	Elapsed Time (min)	Height of Soil (cm)	Height of Water (cm)	Vol of Water Drained (ml)	Undrained Water (ml)	Pore Water (ml)	Volume of Soil (cm^3)	Moisture Content %	Dry Density of Slurry g/cc	Dry Density of Slurry lbs/ft^3	Wet Density of Slurry lbs/ft^3
1	5/14/2019 8:16	0.0	28.25	28.25	0.0	662.2	662.2	890.7	117.0%	0.64	39.6	86.0
2	5/14/2019 8:24	8.0	28.10	28.25	0.0	662.2	657.4	886.0	116.2%	0.64	39.9	86.2
3	5/14/2019 8:30	14.0	28.00	28.25	0.0	662.2	654.3	882.8	115.6%	0.64	40.0	86.2
4	5/14/2019 8:42	26.0	27.80	28.25	0.0	662.2	648.0	876.5	114.5%	0.65	40.3	86.4
5	5/14/2019 8:52	36.0	27.65	28.25	0.0	662.2	643.3	871.8	113.7%	0.65	40.5	86.5
6	5/14/2019 9:02	46.0	27.50	28.25	0.0	662.2	638.5	867.1	112.8%	0.65	40.7	86.7
7	5/14/2019 9:13	57.0	27.30	28.25	0.0	662.2	632.2	860.8	111.7%	0.66	41.0	86.9
8	5/14/2019 9:25	69.0	27.10	28.25	0.0	662.2	625.9	854.5	110.6%	0.66	41.3	87.0
9	5/14/2019 9:39	83.0	26.95	28.25	0.0	662.2	621.2	849.7	109.8%	0.67	41.6	87.2
10	5/14/2019 9:55	99.0	26.75	28.25	0.0	662.2	614.9	843.4	108.7%	0.67	41.9	87.4
11	5/14/2019 10:08	112.0	26.55	28.25	0.0	662.2	608.6	837.1	107.6%	0.68	42.2	87.5
12	5/14/2019 10:28	132.0	26.25	28.25	0.0	662.2	599.1	827.7	105.9%	0.68	42.7	87.8
13	5/14/2019 10:52	156.0	25.95	28.25	0.0	662.2	589.7	818.2	104.2%	0.69	43.2	88.1
14	5/14/2019 11:18	182.0	25.60	28.25	0.0	662.2	578.6	807.2	102.3%	0.70	43.7	88.5
15	5/14/2019 11:42	206.0	25.25	28.25	0.0	662.2	567.6	796.1	100.3%	0.71	44.3	88.8
16	5/14/2019 12:02	226.0	25.00	28.25	0.0	662.2	559.7	788.2	98.9%	0.72	44.8	89.1
17	5/14/2019 12:22	246.0	24.75	28.25	0.0	662.2	551.8	780.4	97.5%	0.73	45.2	89.4
18	5/14/2019 12:59	283.0	24.30	28.25	0.0	662.2	537.6	766.2	95.0%	0.74	46.1	89.9
19	5/14/2019 13:44	328.0	23.70	28.25	0.0	662.2	518.7	747.3	91.7%	0.76	47.2	90.6
20	5/14/2019 14:17	361.0	23.35	28.25	0.0	662.2	507.7	736.2	89.7%	0.77	48.0	91.0
21	5/14/2019 14:50	394.0	23.10	28.25	0.0	662.2	499.8	728.3	88.3%	0.78	48.5	91.3
22	5/14/2019 15:22	426.0	22.65	28.25	0.0	662.2	485.6	714.1	85.8%	0.79	49.4	91.9
23	5/14/2019 15:47	451.0	22.45	28.25	0.0	662.2	479.3	707.8	84.7%	0.80	49.9	92.1
24	5/14/2019 16:18	482.0	22.15	28.25	0.0	662.2	469.8	698.4	83.0%	0.81	50.6	92.5
25	5/14/2019 17:06	530.0	21.85	28.25	0.0	662.2	460.4	688.9	81.4%	0.82	51.3	92.9
26	5/14/2019 17:22	546.0	21.70	28.25	0.0	662.2	455.7	684.2	80.5%	0.83	51.6	93.2
27	5/15/2019 6:45	1349.0	20.65	28.25	0.0	662.2	422.5	651.1	74.7%	0.87	54.2	94.7
28	5/16/2019 9:51	2975.0	20.65	28.25	0.0	662.2	422.5	651.1	74.7%	0.87	54.2	94.7

Note: The expected error is +/- 3% based on the calcutations of the volume of soil.

Golder Associates, Inc. **Denver, Colorado**			**Title:** **SEDIMENTATION TESTING** **SAMPLE DATA AND CALCULATIONS**		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification: GMTC-2 @ 46% Solids	**System:** Single Drain	**Reviewed:** MB	**Date:** 14-May-19	**Job Number:** 1663241.9000.9005	**Figure:** 1



Golder Associates, Inc. Denver, Colorado			Title: SEDIMENTATION TESTING GRAPHICAL DATA		
Job Short Title: MDA/GRASSY MTN PFS/OR					
Sample Identification:	**System:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
GMTC-2 @ 46% Solids	Single Drain	MB	14-May-19	1663241.9000.9005	2

GOLDER

May-19 1663241.9000.9005

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

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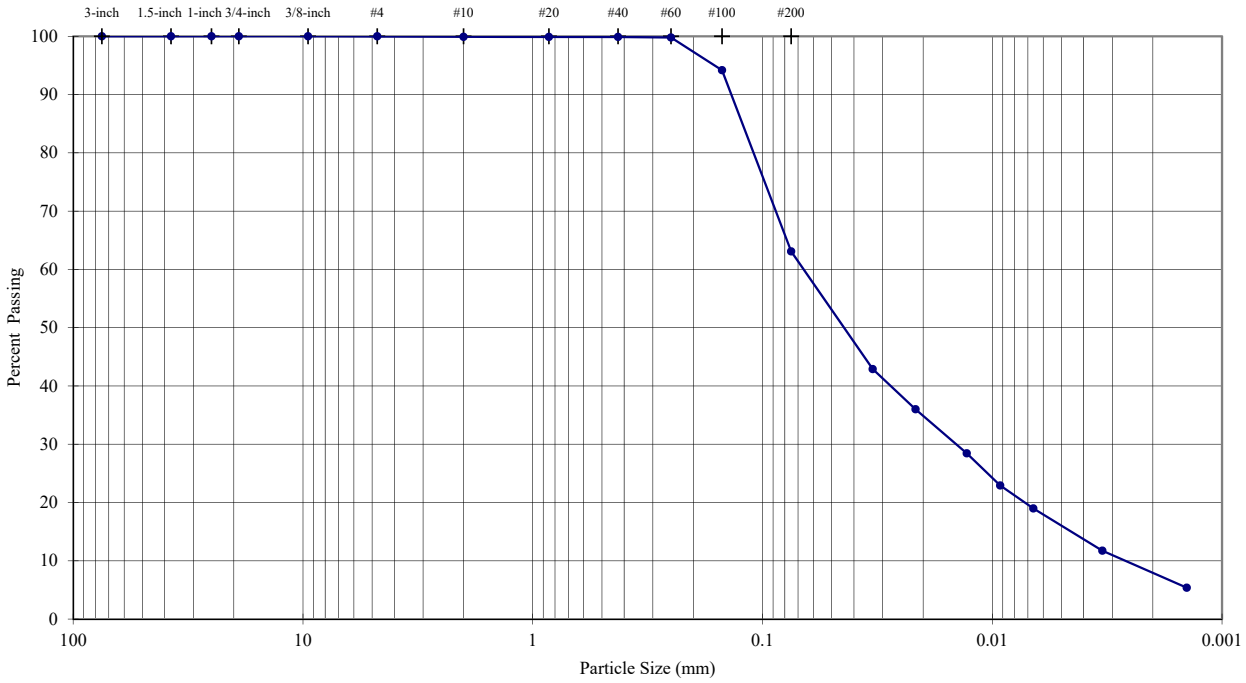

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3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**99.9**	Coarse Sand	**0.10**
#20	0.850	**99.9**	Medium Sand	**0.02**
#40	0.425	**99.9**		
#60	0.250	**99.8**		
#100	0.150	**94.2**	Fine Sand	**36.80**
#200	0.075	**63.1**		
	0.033	**42.9**		
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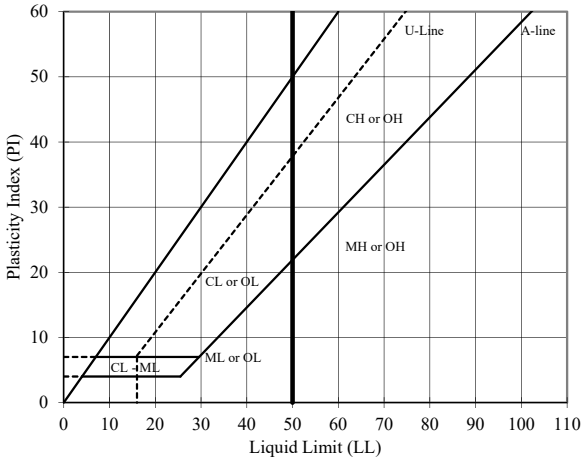
	0.001	**5.4**		

Sieve Analysis (Initial Separation on No. 4 Sieve)
Hydrometer Analysis



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LL	PL	PI	SpG
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USCS Group Symbol: --

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Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute

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DATE	23-May-2019
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May-19 1663241.9000.9005

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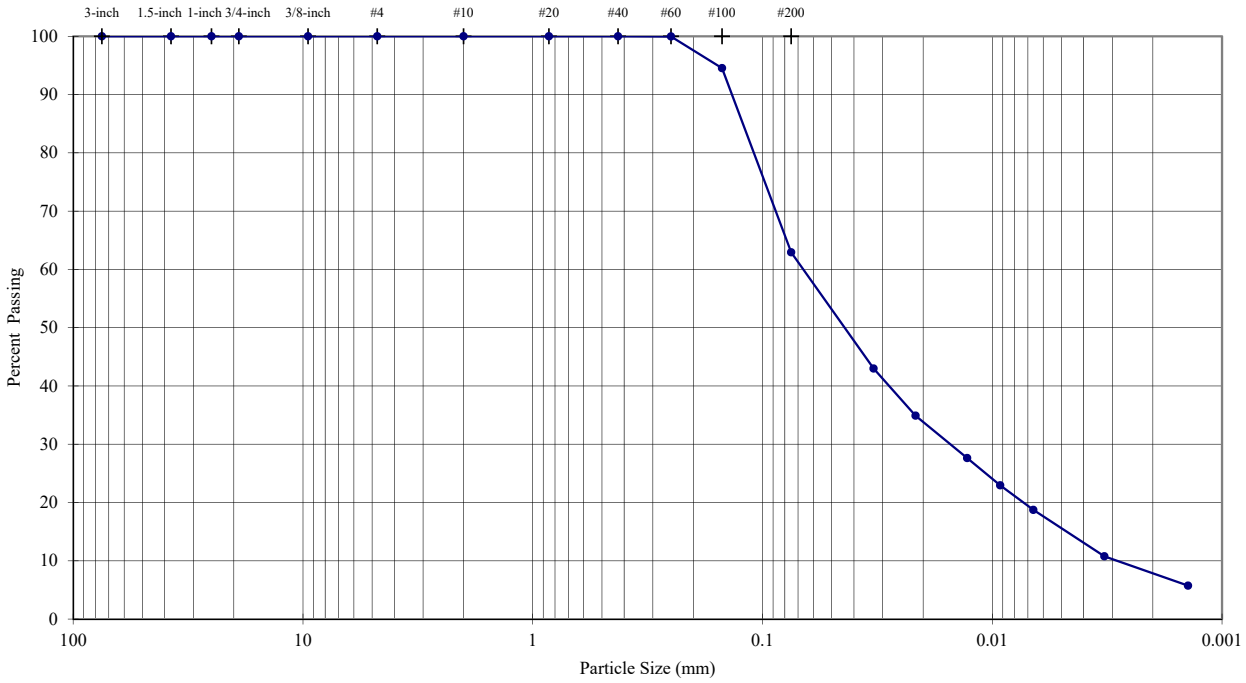

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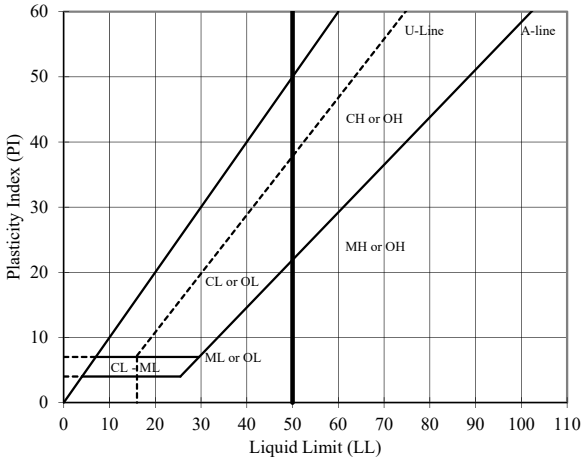
Hydrometer Analysis



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TECH	MGC
DATE	23-May-2019
REVIEW	MB

ATTACHMENT 1.3

Consolidation Tests

	Initial	Final	
Length =	4.069	2.194	cm
Diameter =	7.100	7.100	cm
Wet Mass =	263.44	166.44	g
Area =	39.59	39.59	cm^2
Volume =	161.10	86.86	cm^3
Moisture Content =	103.0%	28.5%	
Specific Gravity =	2.62	2.62	(ASTM D854)
Dry Mass of Solids =	129.77	129.53	g
Density =	1.64	1.92	g/cm^3
Dry Density =	0.81	1.49	g/cm^3
Unit Weight =	102.1	119.6	lb/ft^3
Dry Unit Weight =	50.3	93.1	lb/ft^3
Solids Content =	49.3%	77.8%	

Sample initially prepared at approximately 46% solids and allowed to settle. Some supernatant water was then decanted and the sample was mixed and poured into the slurry consolidation device and allowed to settle overnight. Prior to beginning the test, the sample was again decanted.

Piston Pressure:	6.0 psi	421.8 g/cm^2	Piston Pressure:	10.0 psi	703.1 g/cm^2	Piston Pressure:	15.0 psi	1,054.6 g/cm^2	Piston Pressure:	25.0 psi	1,757.7 g/cm^2	Piston Pressure:	50.0 psi	3,515.4 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	10.0 psi	703.1 g/cm^2
Consolidation pressure:	**1.0 psi**	70.3 g/cm^2	Consolidation Pressure:	**5.0 psi**	351.5 g/cm^2	Consolidation Pressure:	**10.0 psi**	703.1 g/cm^2	Consolidation Pressure:	**20.0 psi**	1,406.2 g/cm^2	Consolidation Pressure:	**40.0 psi**	2,812.3 g/cm^2
Before Consolidation			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**		
Initial Sample Height:	4.069	cm	Initial Sample Height:	2.634	cm	Initial Sample Height:	2.543	cm	Initial Sample Height:	2.475	cm	Initial Sample Height:	2.410	cm
Initial Dry Unit Weight:	0.81	g/cm^3	Initial Dry Unit Weight:	1.24	g/cm^3	Initial Dry Unit Weight:	1.29	g/cm^3	Initial Dry Unit Weight:	1.32	g/cm^3	Initial Dry Unit Weight:	1.36	g/cm^3
Initial Void Ratio:	2.25		Initial Void Ratio:	1.11		Initial Void Ratio:	1.04		Initial Void Ratio:	0.98		Initial Void Ratio:	0.93	
After Consolidation			**After Consolidation**			**After Consolidation**			**After Consolidation**			**After Consolidation**		
Final Sample Height:	2.634	cm	Final Sample Height:	2.543	cm	Final Sample Height:	2.475	cm	Final Sample Height:	2.410	cm	Final Sample Height:	2.316	cm
Final Dry Unit Weight:	1.24	g/cm^3	Final Dry Unit Weight:	1.29	g/cm^3	Final Dry Unit Weight:	1.32	g/cm^3	Final Dry Unit Weight:	1.36	g/cm^3	Final Dry Unit Weight:	1.41	g/cm^3
Final Void Ratio:	1.11		Final Void Ratio:	1.04		Final Void Ratio:	0.98		Final Void Ratio:	0.93		Final Void Ratio:	0.85	
Calculations			**Calculations**			**Calculations**			**Calculations**			**Calculations**		
Coefficient of Compressibility, a_v	1.63E-02	cm^2/g	Coefficient of Compressibility, a_v	2.59E-04	cm^2/g	Coefficient of Compressibility, a_v	1.55E-04	cm^2/g	Coefficient of Compressibility, a_v	7.40E-05	cm^2/g	Coefficient of Compressibility, a_v	5.35E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	5.00E-03	cm^2/g	Coefficient of Volume Compressibility, m_v	1.23E-04	cm^2/g	Coefficient of Volume Compressibility, m_v	7.61E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	3.74E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	2.77E-05	cm^2/g
Compression Index, C_c	-		Compression Index, C_c	0.10		Compression Index, C_c	0.18		Compression Index, C_c	0.17		Compression Index, C_c	0.25	

Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
3.6	1.3E-05	2.57E-03	4.7	9.5E-06	7.74E-02	7.0	6.2E-06	8.11E-02	8.9	4.8E-06	1.28E-01	12.7	3.2E-06	1.15E-01
6.8	1.1E-05	2.23E-03	8.6	8.5E-06	6.91E-02	12.4	5.7E-06	7.50E-02	15.9	4.4E-06	1.17E-01	22.6	2.9E-06	1.06E-01
10.4	1.1E-05	2.14E-03	13.2	8.2E-06	6.65E-02	19.3	5.4E-06	7.14E-02	24.8	4.1E-06	1.10E-01	35.0	2.8E-06	1.01E-01
15.2	1.0E-05	2.07E-03	19.3	7.9E-06	6.44E-02	28.0	5.3E-06	6.96E-02	36.2	4.0E-06	1.07E-01	51.3	2.7E-06	9.75E-02
22.1	1.0E-05	2.02E-03	27.8	7.8E-06	6.32E-02	33.5	5.2E-06	6.89E-02	43.6	3.9E-06	1.05E-01	62.0	2.7E-06	9.57E-02
27.1	1.0E-05	2.00E-03	42.4	7.6E-06	6.23E-02	40.6	5.2E-06	6.78E-02	53.0	3.9E-06	1.03E-01	75.5	2.6E-06	9.38E-02
34.3	9.8E-06	1.96E-03	49.8	7.7E-06	6.23E-02	49.8	5.1E-06	6.69E-02	65.0	3.8E-06	1.02E-01	93.0	2.6E-06	9.20E-02
41.9	9.4E-06	1.89E-03	56.8	7.7E-06	6.25E-02	62.7	5.0E-06	6.63E-02	82.0	3.8E-06	1.00E-01	117.2	2.5E-06	9.10E-02
49.2	9.2E-06	1.84E-03				74.7	5.0E-06	6.54E-02	98.8	3.7E-06	9.79E-02	140.1	2.5E-06	8.94E-02
						86.4	4.9E-06	6.45E-02	114.9	3.6E-06	9.62E-02	160.4	2.5E-06	8.92E-02
Average (of final 3 values)	9.47E-06	1.89E-03	Average (of final 3 values)	7.66E-06	6.24E-02	Average (of final 3 values)	4.97E-06	6.54E-02	Average (of final 3 values)	3.67E-06	9.82E-02	Average (of final 3 values)	2.49E-06	8.99E-02

Golder Associates Inc.
Denver, Colorado

Project Name:
MDA/Grassy Mtn PFS/OR

Title:
SLURRY CONSOLIDATION TEST
SAMPLE DATA AND CALCULATIONS

Project Number:	Reviewed:	Date:	Sample ID:	Figure:
1663241.9000.9005	GG	8-Jun-2019	GMTC-1	1A

	Initial	Final	
Length =	4.069	2.194	cm
Diameter =	7.100	7.100	cm
Wet Mass =	263.44	166.44	g
Area =	39.59	39.59	cm^2
Volume =	161.10	86.86	cm^3
Moisture Content =	103.0%	28.5%	
Specific Gravity =	2.62	2.62	(ASTM D854)
Dry Mass of Solids =	129.77	129.53	g
Density =	1.64	1.92	g/cm^3
Dry Density =	0.81	1.49	g/cm^3
Unit Weight =	102.1	119.6	lb/ft^3
Dry Unit Weight =	50.3	93.1	lb/ft^3
Solids Content =	49.3%	77.8%	

Piston Pressure:	100.0 psi	7,030.8 g/cm^2
Sample Pressure:	10.0 psi	703.1 g/cm^2
Consolidation pressure:	**90.0 psi**	6,327.7 g/cm^2
Before Consolidation		
Initial Sample Height:	2.316	cm
Initial Dry Unit Weight:	1.41	g/cm^3
Initial Void Ratio:	0.85	
After Consolidation		
Final Sample Height:	2.201	cm
Final Dry Unit Weight:	1.49	g/cm^3
Final Void Ratio:	0.76	
Calculations		
Coefficient of Compressibility, a_v	2.62E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	1.41E-05	cm^2/g
Compression Index, C_c	0.26	

Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
46.9	8.2E-07	5.83E-02
99.6	6.3E-07	4.48E-02
170.5	5.5E-07	3.86E-02
308.0	4.3E-07	3.03E-02
418.2	3.7E-07	2.65E-02
583.4	3.2E-07	2.26E-02
844.7	2.7E-07	1.89E-02
1,074.4	2.4E-07	1.69E-02
1,257.8	2.2E-07	1.58E-02
1,648.5	2.0E-07	1.42E-02
Average (of final 3 values)	2.21E-07	1.56E-02

Piston Pressure:	200.0 psi	14,061.5 g/cm^2
Sample Pressure:	10.0 psi	703.1 g/cm^2
Consolidation pressure:	**190.0 psi**	13,358.5 g/cm^2
Before Consolidation		
Initial Sample Height:	2.201	cm
Initial Dry Unit Weight:	1.49	g/cm^3
Initial Void Ratio:	0.76	
After Consolidation		
Final Sample Height:	2.095	cm
Final Dry Unit Weight:	1.56	g/cm^3
Final Void Ratio:	0.68	
Calculations		
Coefficient of Compressibility, a_v	1.21E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	6.85E-06	cm^2/g
Compression Index, C_c	0.26	

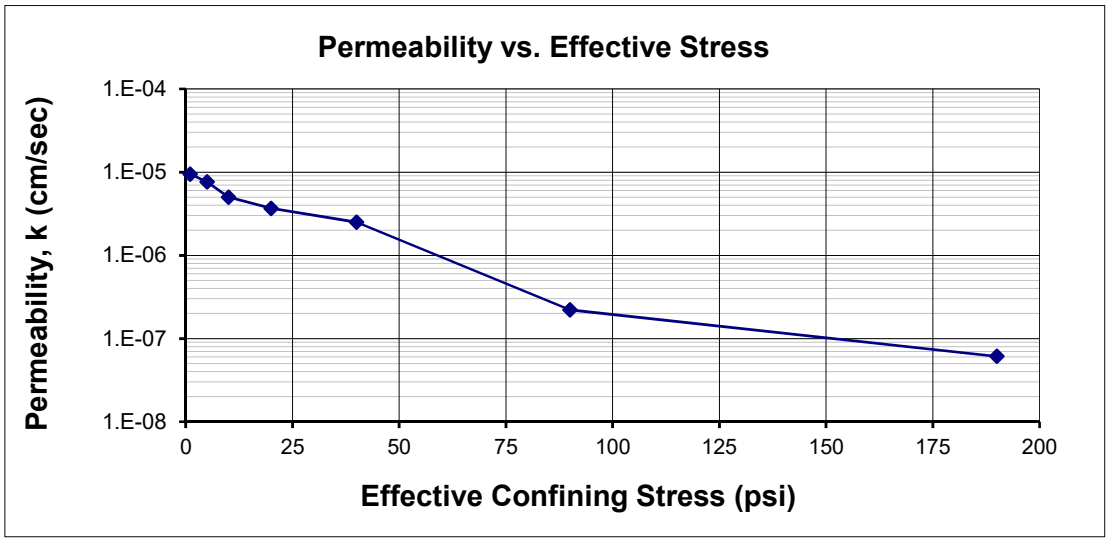
Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
239.0	1.5E-07	2.24E-02
610.0	1.0E-07	1.50E-02
903.0	9.1E-08	1.33E-02
1,229.0	8.3E-08	1.21E-02
2,813.0	6.3E-08	9.21E-03
3,248.0	6.1E-08	8.92E-03
3,670.0	6.1E-08	8.90E-03
4,191.0	6.1E-08	8.88E-03
Average (of final 3 values)	6.10E-08	8.90E-03

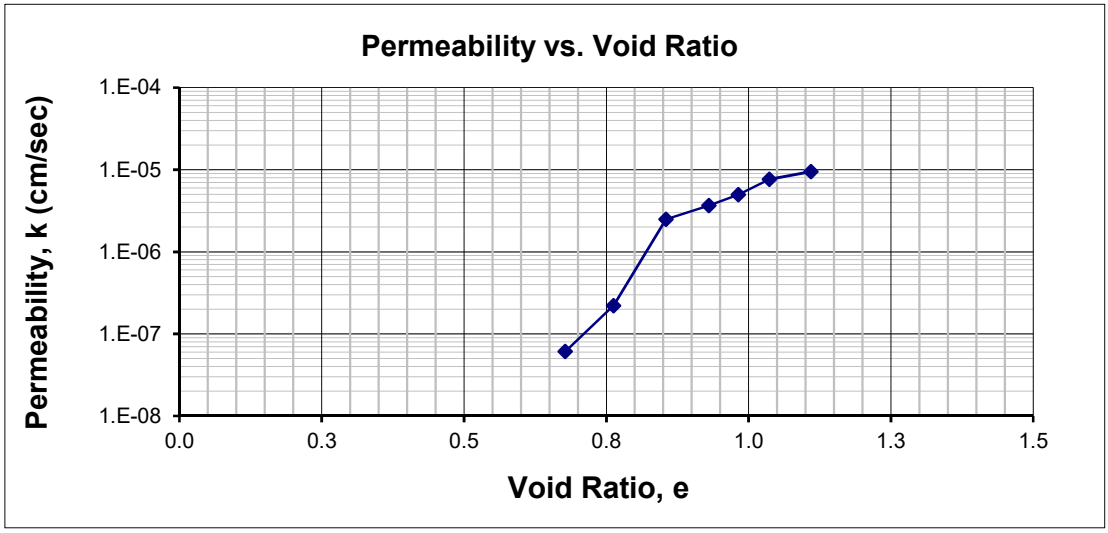
Golder Associates Inc.
Denver, Colorado

Project Name: MDA/Grassy Mtn PFS/OR

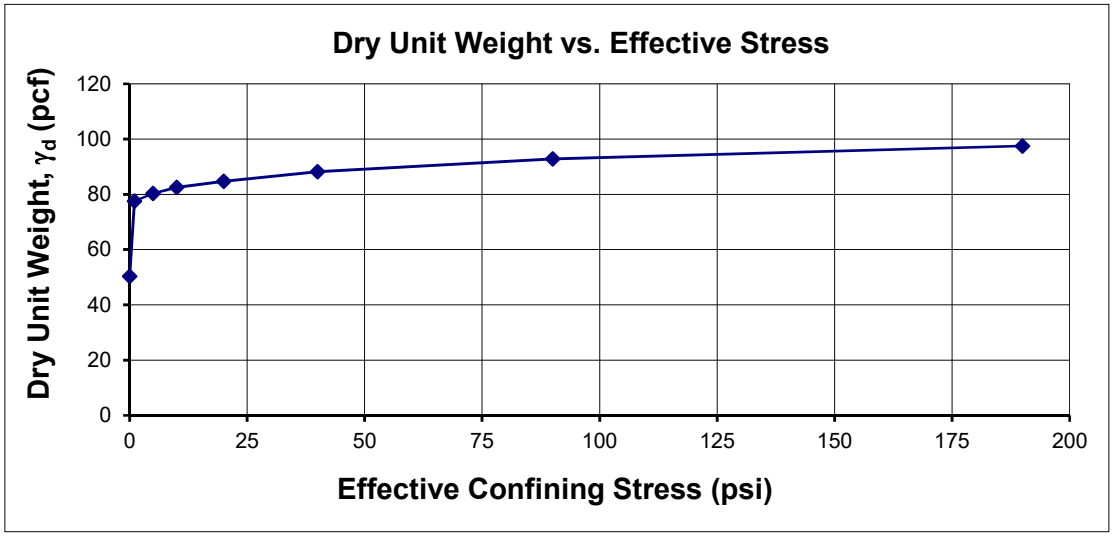
Title:
SLURRY CONSOLIDATION TEST
SAMPLE DATA AND CALCULATIONS

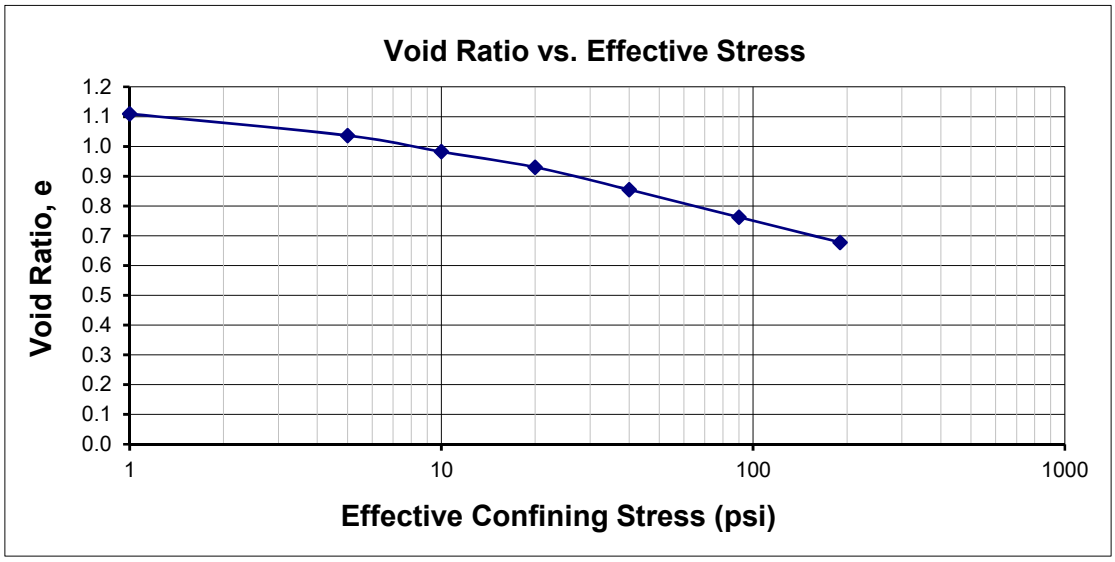
Project Number:	Reviewed:	Date:	Sample ID:	Figure:
1663241.9000.9005	GG	8-Jun-2019	GMTC-1	1B



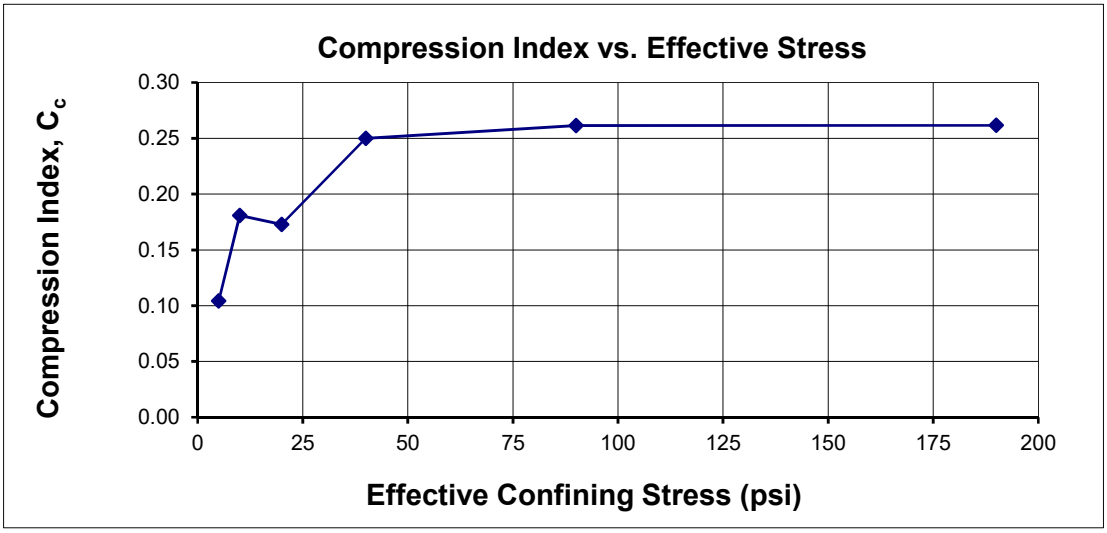


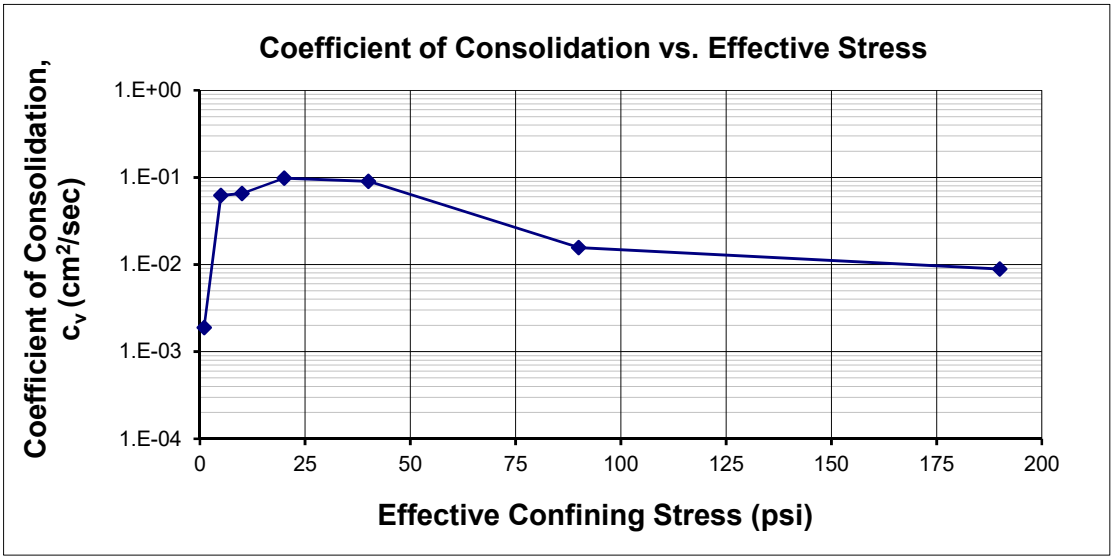
Golder Associates Inc. Denver, Colorado			**Title:** **SLURRY CONSOLIDATION TEST RESULTS PERMEABILITY DATA**	
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-1	**Figure:** 2





Golder Associates Inc. **Denver, Colorado**			**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **DENSITY DATA**	
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-1	**Figure:** 3





Golder Associates Inc. Denver, Colorado		**Title:** **SLURRY CONSOLIDATION TEST RESULTS COMPRESSION DATA**		
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-1	**Figure:** 4

	Initial	Final	
Length =	3.961	2.289	cm
Diameter =	7.10	7.10	cm
Wet Mass =	271.57	176.51	g
Area =	39.59	39.59	cm^2
Volume =	156.82	90.63	cm^3
Moisture Content =	94.9%	26.6%	
Specific Gravity =	2.64	2.64	(ASTM D854)
Dry Mass of Solids =	139.34	139.42	g
Density =	1.73	1.95	g/cm^3
Dry Density =	0.89	1.54	g/cm^3
Unit Weight =	108.1	121.6	lb/ft^3
Dry Unit Weight =	55.5	96.0	lb/ft^3
Solids Content =	51.3%	79.0%	

Sample initially prepared at approximately 46% solids and allowed to settle. Some supernatant water was then decanted and the sample was mixed and poured into the slurry consolidation device and allowed to settle overnight. Prior to beginning the test, the sample was again decanted.

Piston Pressure:	6.0 psi	421.8 g/cm^2	Piston Pressure:	10.0 psi	703.1 g/cm^2	Piston Pressure:	15.0 psi	1,054.6 g/cm^2	Piston Pressure:	25.0 psi	1,757.7 g/cm^2	Piston Pressure:	45.0 psi	3,163.8 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**1.0 psi**	70.3 g/cm^2	Consolidation Pressure:	**5.0 psi**	351.5 g/cm^2	Consolidation Pressure:	**10.0 psi**	703.1 g/cm^2	Consolidation Pressure:	**20.0 psi**	1,406.2 g/cm^2	Consolidation Pressure:	**40.0 psi**	2,812.3 g/cm^2
Before Consolidation			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**		
Initial Sample Height:	3.961	cm	Initial Sample Height:	2.915	cm	Initial Sample Height:	2.677	cm	Initial Sample Height:	2.587	cm	Initial Sample Height:	2.497	cm
Initial Dry Unit Weight:	0.89	g/cm^3	Initial Dry Unit Weight:	1.21	g/cm^3	Initial Dry Unit Weight:	1.32	g/cm^3	Initial Dry Unit Weight:	1.36	g/cm^3	Initial Dry Unit Weight:	1.41	g/cm^3
Initial Void Ratio:	1.97		Initial Void Ratio:	1.19		Initial Void Ratio:	1.01		Initial Void Ratio:	0.94		Initial Void Ratio:	0.87	
After Consolidation			**After Consolidation**			**After Consolidation**			**After Consolidation**			**After Consolidation**		
Final Sample Height:	2.915	cm	Final Sample Height:	2.677	cm	Final Sample Height:	2.587	cm	Final Sample Height:	2.497	cm	Final Sample Height:	2.408	cm
Final Dry Unit Weight:	1.21	g/cm^3	Final Dry Unit Weight:	1.32	g/cm^3	Final Dry Unit Weight:	1.36	g/cm^3	Final Dry Unit Weight:	1.41	g/cm^3	Final Dry Unit Weight:	1.46	g/cm^3
Final Void Ratio:	1.19		Final Void Ratio:	1.01		Final Void Ratio:	0.94		Final Void Ratio:	0.87		Final Void Ratio:	0.81	
Calculations			**Calculations**			**Calculations**			**Calculations**			**Calculations**		
Coefficient of Compressibility, a_v	1.12E-02	cm^2/g	Coefficient of Compressibility, a_v	6.34E-04	cm^2/g	Coefficient of Compressibility, a_v	1.92E-04	cm^2/g	Coefficient of Compressibility, a_v	9.60E-05	cm^2/g	Coefficient of Compressibility, a_v	4.74E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	3.76E-03	cm^2/g	Coefficient of Volume Compressibility, m_v	2.90E-04	cm^2/g	Coefficient of Volume Compressibility, m_v	9.56E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	4.95E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	2.53E-05	cm^2/g
Compression Index, C_c	-		Compression Index, C_c	0.26		Compression Index, C_c	0.22		Compression Index, C_c	0.22		Compression Index, C_c	0.22	

Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
0.9	5.7E-05	1.51E-02	3.2	1.5E-05	5.00E-02	5.0	9.1E-06	9.46E-02	6.3	6.9E-06	1.40E-01	8.2	5.1E-06	2.03E-01
5.6	2.2E-05	5.88E-03	11.4	9.9E-06	3.41E-02	10.2	7.3E-06	7.60E-02	12.4	5.8E-06	1.17E-01	16.4	4.2E-06	1.66E-01
9.5	1.8E-05	4.88E-03	17.1	9.4E-06	3.22E-02	16.4	6.7E-06	6.98E-02	19.8	5.3E-06	1.08E-01	26.4	3.9E-06	1.52E-01
14.9	1.7E-05	4.42E-03	25.2	9.0E-06	3.10E-02	20.1	6.5E-06	6.79E-02	24.4	5.2E-06	1.04E-01	32.6	3.7E-06	1.47E-01
18.9	1.6E-05	4.21E-03	30.8	8.9E-06	3.06E-02	24.6	6.3E-06	6.59E-02	29.5	5.1E-06	1.02E-01	39.7	3.6E-06	1.43E-01
23.9	1.6E-05	4.13E-03	38.8	8.8E-06	3.03E-02	29.6	6.2E-06	6.49E-02	35.5	5.0E-06	1.01E-01	48.1	3.6E-06	1.40E-01
28.8	1.5E-05	4.04E-03	45.6	8.8E-06	3.04E-02	35.7	6.1E-06	6.42E-02	43.0	4.9E-06	9.96E-02	58.4	3.5E-06	1.38E-01
33.5	1.5E-05	3.96E-03	52.1	8.8E-06	3.03E-02	40.4	6.1E-06	6.34E-02	48.6	4.9E-06	9.84E-02	66.5	3.4E-06	1.35E-01
						43.8	6.1E-06	6.33E-02	52.6	4.9E-06	9.83E-02	72.0	3.4E-06	1.35E-01
						50.5	6.0E-06	6.23E-02	60.1	4.8E-06	9.76E-02	82.7	3.4E-06	1.34E-01
						55.4	6.0E-06	6.23E-02	66.1	4.8E-06	9.75E-02	90.4	3.4E-06	1.34E-01
						66.1	5.9E-06	6.14E-02				106.7	3.4E-06	1.34E-01
Average (of final 3 values)	1.52E-05	4.04E-03	Average (of final 3 values)	8.80E-06	3.03E-02	Average (of final 3 values)	5.93E-06	6.20E-02	Average (of final 3 values)	4.84E-06	9.78E-02	Average (of final 3 values)	3.39E-06	1.34E-01

Golder Associates Inc. Denver, Colorado	**Title:** SLURRY CONSOLIDATION TEST SAMPLE DATA AND CALCULATIONS			
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-2	**Figure:** 1A

	Initial	Final	
Length =	3.961	2.289	cm
Diameter =	7.10	7.10	cm
Wet Mass =	271.57	176.51	g
Area =	39.59	39.59	cm^2
Volume =	156.82	90.63	cm^3
Moisture Content =	94.9%	26.6%	
Specific Gravity =	2.64	2.64	(ASTM D854)
Dry Mass of Solids =	139.34	139.42	g
Density =	1.73	1.95	g/cm^3
Dry Density =	0.89	1.54	g/cm^3
Unit Weight =	108.1	121.6	lb/ft^3
Dry Unit Weight =	55.5	96.0	lb/ft^3
Solids Content =	51.3%	79.0%	

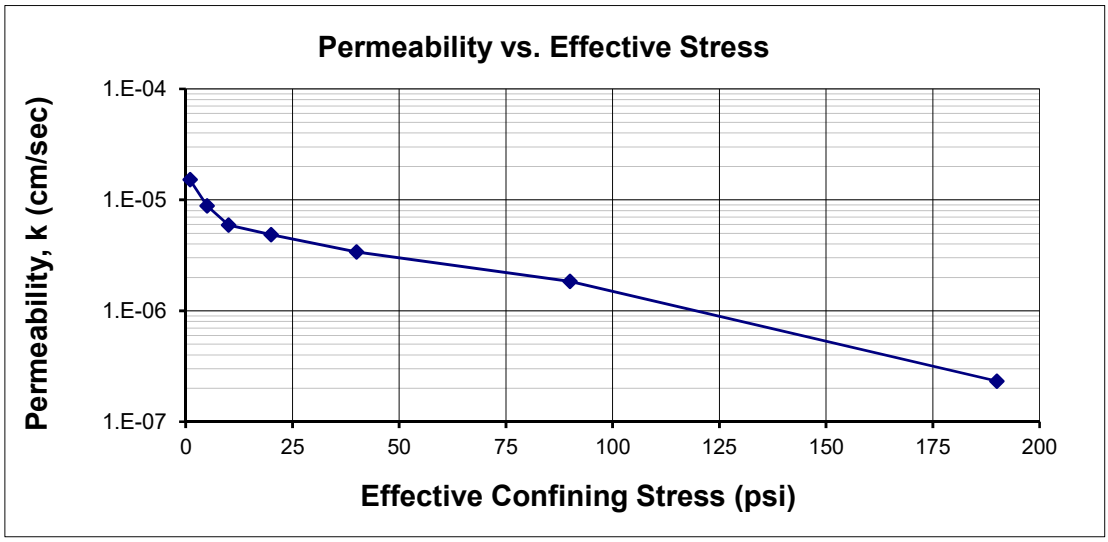
Piston Pressure:	95.0 psi	6,679.2 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**90.0 psi**	6,327.7 g/cm^2
Before Consolidation		
Initial Sample Height:	2.408	cm
Initial Dry Unit Weight:	1.46	g/cm^3
Initial Void Ratio:	0.81	
After Consolidation		
Final Sample Height:	2.310	cm
Final Dry Unit Weight:	1.52	g/cm^3
Final Void Ratio:	0.73	
Calculations		
Coefficient of Compressibility, a_v	2.09E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	1.16E-05	cm^2/g
Compression Index, C_c	0.21	

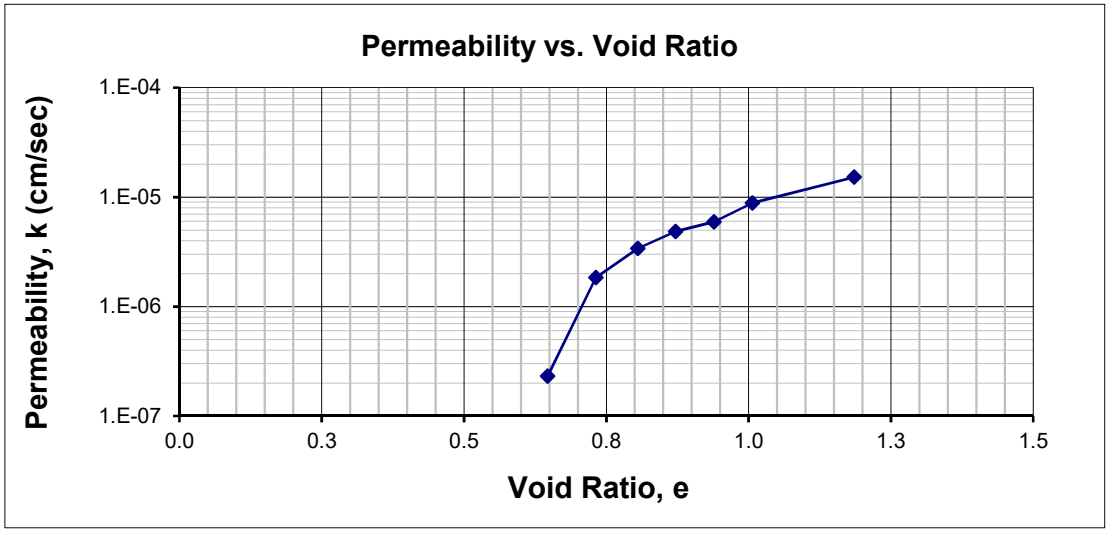
Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
15.4	2.6E-06	2.28E-01
30.2	2.2E-06	1.89E-01
48.8	2.0E-06	1.73E-01
60.3	1.9E-06	1.67E-01
73.6	1.9E-06	1.62E-01
88.9	1.8E-06	1.59E-01
106.6	1.8E-06	1.59E-01
119.6	1.8E-06	1.58E-01
128.4	1.8E-06	1.59E-01
Average (of final 3 values)	1.84E-06	1.59E-01

Piston Pressure:	195.0 psi	13,710.0 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**190.0 psi**	13,358.5 g/cm^2
Before Consolidation		
Initial Sample Height:	2.310	cm
Initial Dry Unit Weight:	1.52	g/cm^3
Initial Void Ratio:	0.73	
After Consolidation		
Final Sample Height:	2.197	cm
Final Dry Unit Weight:	1.60	g/cm^3
Final Void Ratio:	0.65	
Calculations		
Coefficient of Compressibility, a_v	1.20E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	6.96E-06	cm^2/g
Compression Index, C_c	0.26	

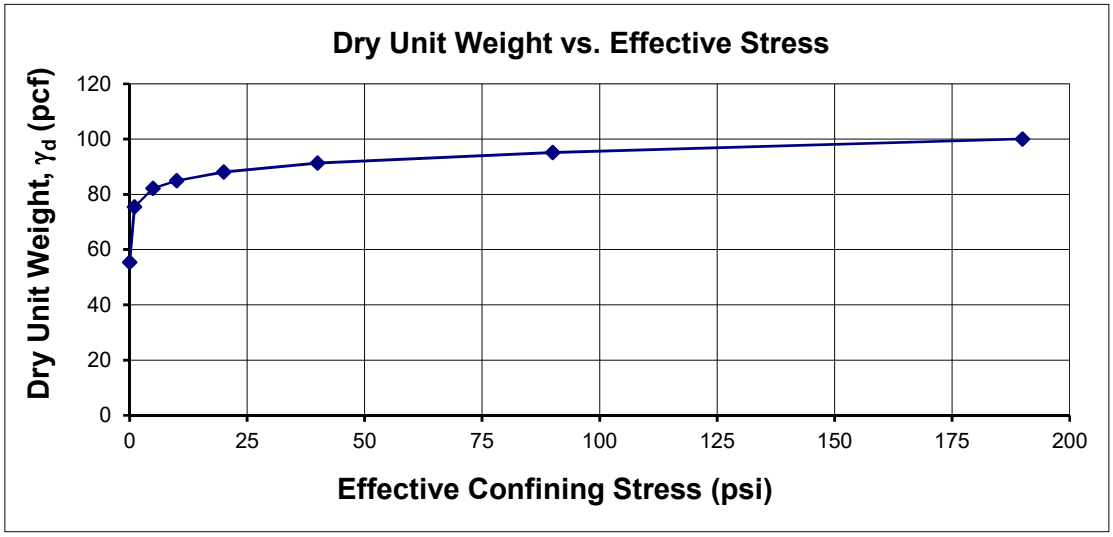
Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
	2.3E-07	3.33E-02
	2.32E-07	3.33E-02

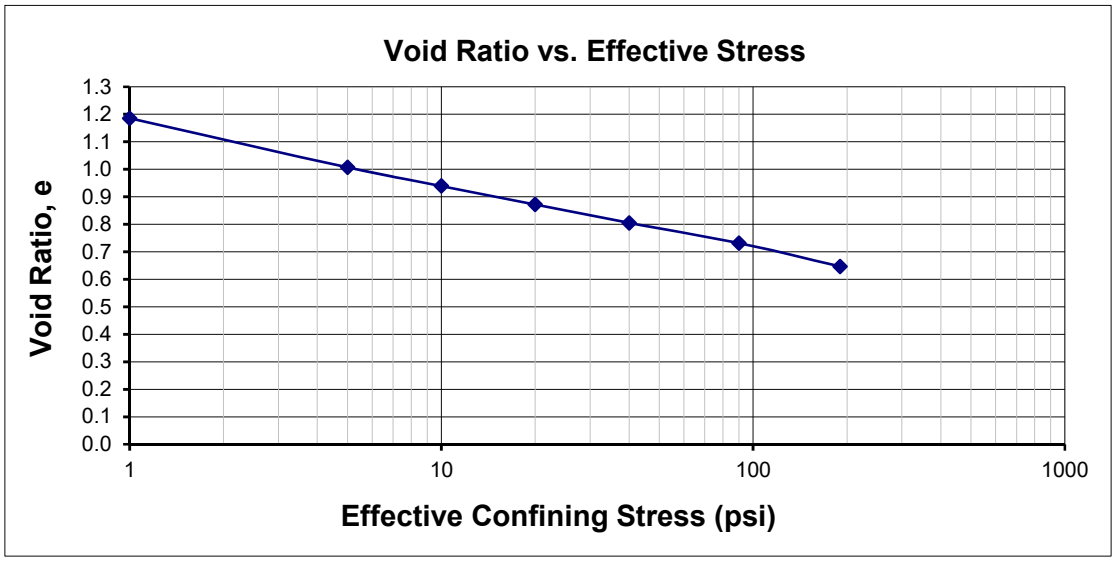
Golder Associates Inc. Denver, Colorado	**Title:** **SLURRY CONSOLIDATION TEST SAMPLE DATA AND CALCULATIONS**			
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-2	**Figure:** 1B



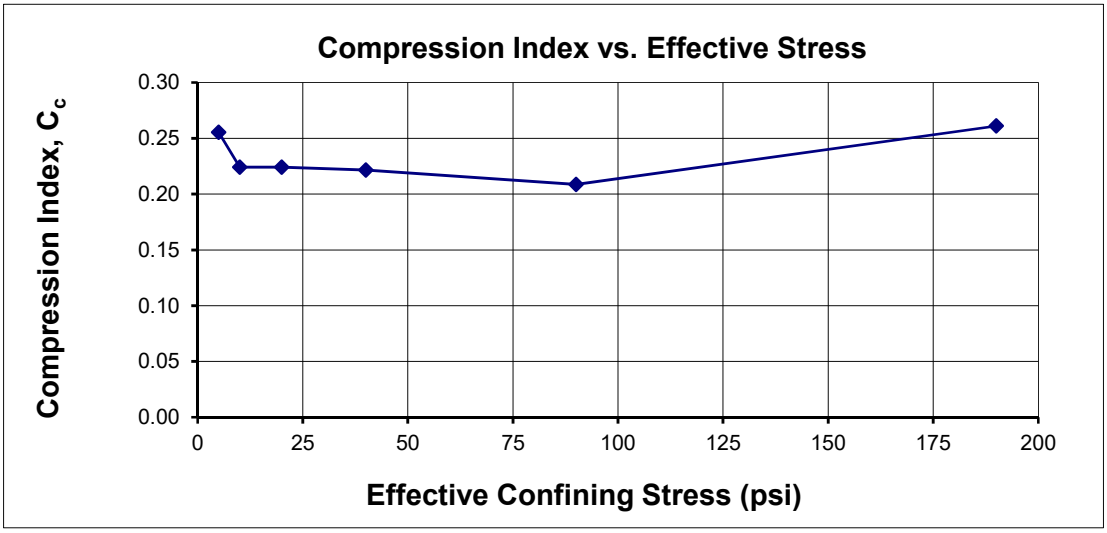


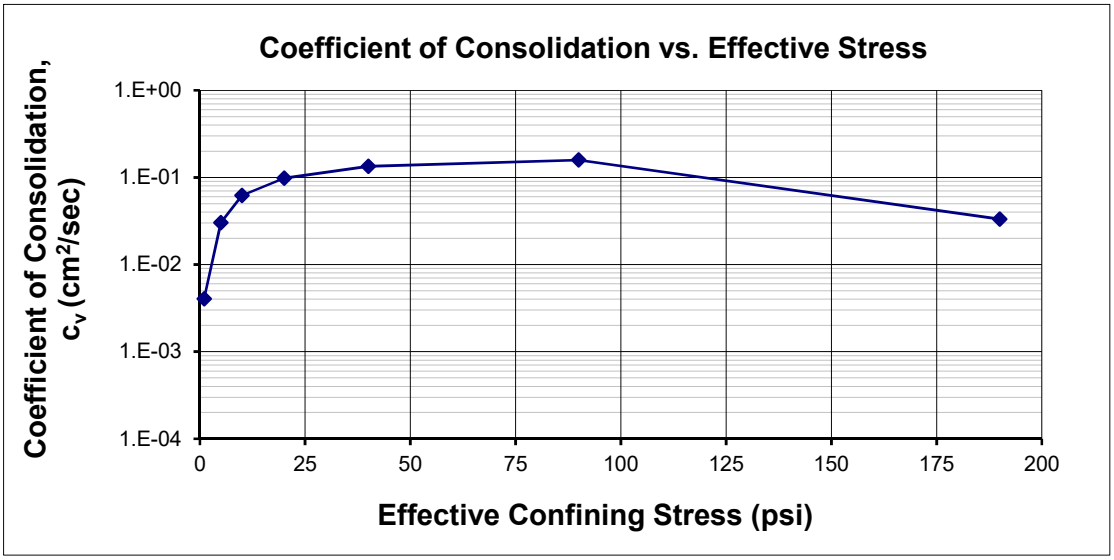
Golder Associates Inc. **Denver, Colorado**			**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **PERMEABILITY DATA**	
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-2	**Figure:** 2





Golder Associates Inc. **Denver, Colorado**			**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **DENSITY DATA**	
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-2	**Figure:** 3





Golder Associates Inc. **Denver, Colorado**			**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **COMPRESSION DATA**	
Project Name: MDA/Grassy Mtn PFS/OR				
Project Number: 1663241.9000.9005	**Reviewed:** GG	**Date:** 8-Jun-2019	**Sample ID:** GMTC-2	**Figure:** 4

ATTACHMENT 1.4

SWCC Testing

SOIL-WATER CHARACTERISTIC CURVE
ASTM D6836

Short Title:	Grassy Mtn PFS/OR			Project #:	1663241.9000.9005
Sample :	GMTC Composite			Reviewed By:	CPA
Tested By:	MGC	Start Date:	8/9/2019	Completion Date:	9/20/2019

Visual Description (Golder Procedure): SILT, olive gray, wet

Test Results:

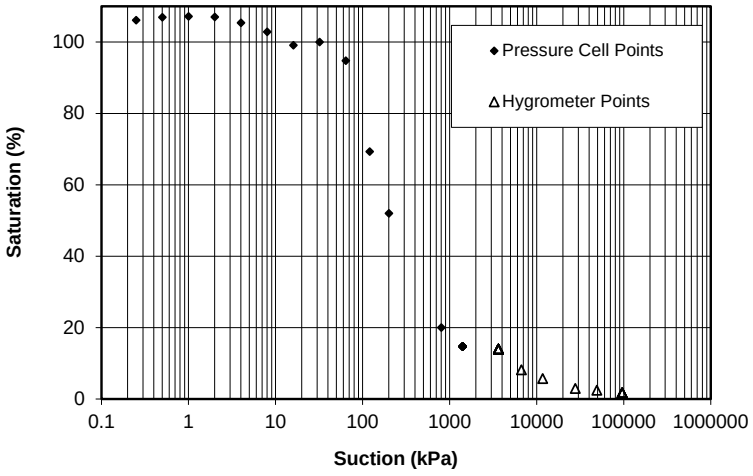
Suction	Water Content (%)	
(kPa)	Gravimetric	Volumetric
0.25	47.1	57.1
0.5	46.6	57.1
1	45.7	56.6
2	44.8	56.0
4	43.3	54.7
8	39.6	51.8
16	37.4	49.4
32	35.9	48.6
64	33.3	45.5
120	24.1	33.1
200	18.1	24.8
800	7.1	9.7
1400	5.1	7.0
3620	3.6	5.6
6650	2.1	3.3
11670	1.5	2.3
27620	0.7	1.2
48770	0.6	1.0
95520	0.4	0.7

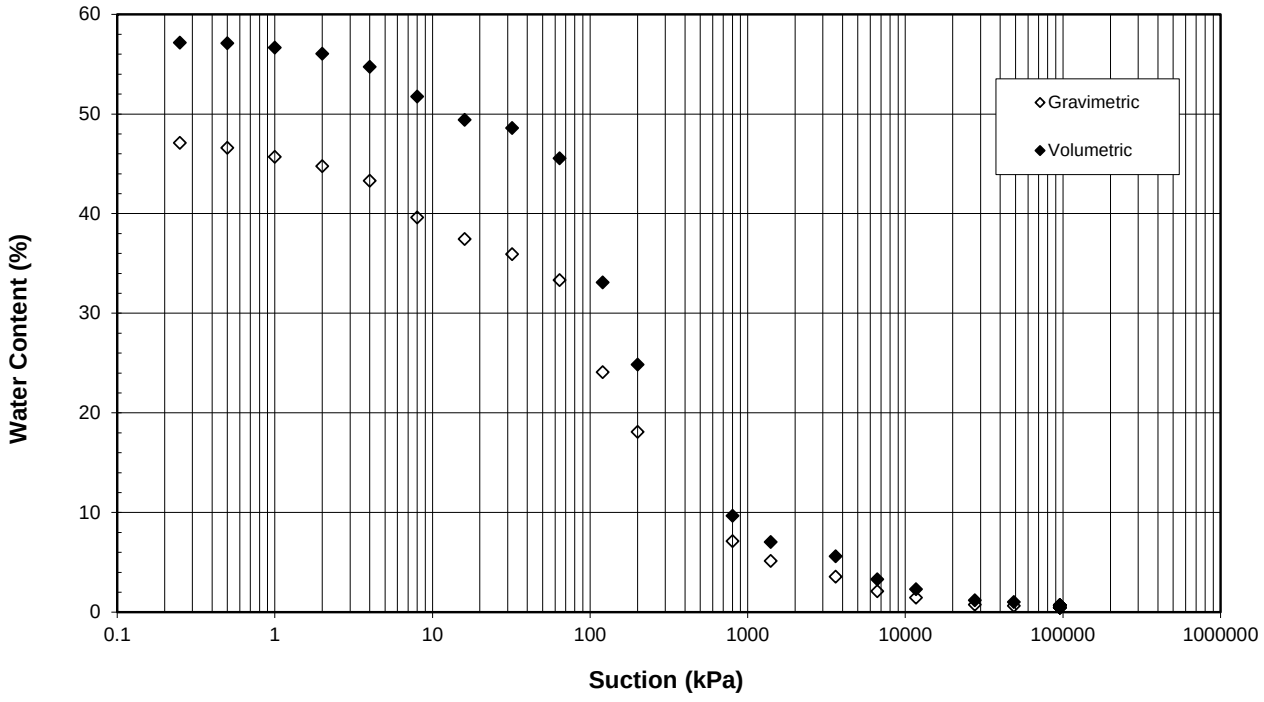
Sample Data:

Diameter:	63.04	mm (initial)	Compactive Method:	
Height:	31.68	mm (initial)	Trimmed from shrinkage curve sample	
Initial Water Content:	47.2	% (gravimetric)	75.1	pcf (initial)
Dry Density:	1203	kg/m^3 (initia	Specific Gravity (ASTM D854):	2.63
Material used passing:	#4	sieve		

Methods used:
Method A: 5 bar plate
Method C: 5 bar and 15 bar plates
Method D: Decagon WP4C Hygrometer

Type of Water used to Saturate:
De-aired
Method of Saturation:
Sample fully saturated before setup





The testing services reported herein have been performed in accordance with the indicated recognized standard, or in accordance with local industry practice. This report is for the sole use of the designated client. This report constitutes a testing service only and does not represent any results interpretation or opinion regarding specification compliance or material suitability. Engineering interpretation can be provided by Golder Associates Inc. upon request.

GOLDER

Golder Associates Inc.	Title: ASTM D6836 SOIL WATER CHARACTERISTIC CURVE SPECIMEN PHOTOGRAPH				
Job Short Title: Grassy Mtn PFS/OR					
Sample: GMTC Composite	Technician: MGC	Reviewed: CPA	Date: 9/20/2019	Job Number: 1663241.9000.9005	Figure: 1

ATTACHMENT 1.5

Desiccation Testing

GOLDER

SHRINKAGE CURVE TEST REPORT

PROJECT NAME: MDA/Grassy Mtn PFS/OR
PROJECT NUMBER: 1663241.9000.9005
SAMPLE ID: GMTC-1 **Depth (ft.):** --

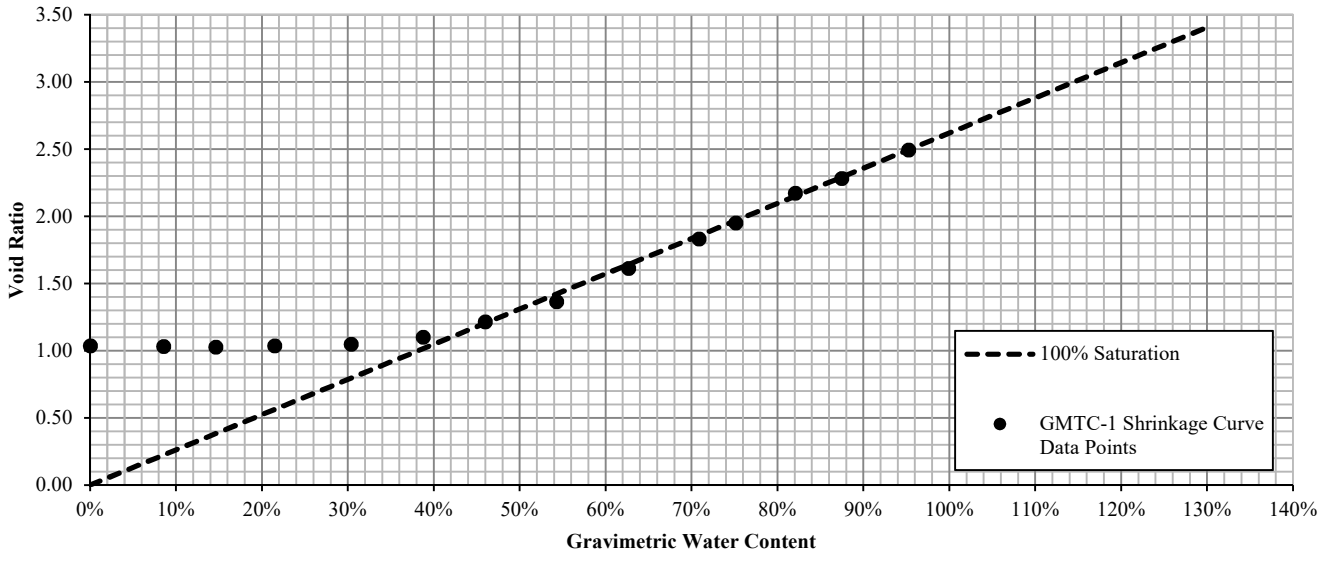
Technician: MGC
Checked: MB
Reviewed: MB
Date: 10-Jul-2019

Description: Sandy silt, grayish brown, wet
Method: USCS Description (ASTM D 2487)

Initial Sample Conditions

Initial Moisture Content: 118.5% Specific Gravity: 2.62 ASTM D854
Initial Dry Density (pcf): 46.8
Initial Saturation %: 124.4%

Date and Time	Temperature °C	Diameter (cm)	Height (cm)	Sample Volume (cc)	Wet Mass Soil (g)	Gravimetric Water Content %	Void Ratio	Saturation %
6/26/2019 16:20	21.4	6.332	2.842	89.485	130.98	95.3%	2.495	100.0%
6/27/2019 7:25	21.4	6.332	2.670	84.054	125.76	87.5%	2.283	100.4%
6/27/2019 16:28	21.4	6.332	2.580	81.225	122.12	82.1%	2.172	99.0%
6/28/2019 7:56	21.4	6.332	2.399	75.542	117.49	75.1%	1.950	100.9%
6/28/2019 16:21	21.4	6.332	2.303	72.519	114.61	70.9%	1.832	101.3%
6/29/2019 10:42	21.4	6.245	2.183	66.875	109.10	62.6%	1.612	101.8%
6/30/2019 9:03	21.4	6.005	2.139	60.581	103.49	54.3%	1.366	104.1%
7/1/2019 10:27	21.4	5.859	2.104	56.733	97.93	46.0%	1.216	99.1%
7/2/2019 8:25	21.4	5.740	2.080	53.809	93.08	38.8%	1.102	92.2%
7/3/2019 9:37	21.4	5.691	2.061	52.425	87.46	30.4%	1.048	76.0%
7/4/2019 9:49	21.4	5.687	2.053	52.136	81.48	21.5%	1.036	54.3%
1/0/1900 0:00	21.4	5.675	2.053	51.933	76.88	14.6%	1.028	37.2%
7/6/2019 8:12	21.4	5.680	2.053	52.019	72.82	8.6%	1.032	21.7%
7/8/2019 8:37	21.4	5.676	2.062	52.179	67.08	0.0%	1.038	0.0%



Notes: The sample was placed in an oven set to approximately 60° C prior to recording the final mass and volume measurements.
The sample began to separate from the ring between the reading on 6/28/2019 at 16:21 and 6/29/2019 at 10:42.

GOLDER

SHRINKAGE CURVE TEST REPORT

PROJECT NAME: MDA/Grassy Mtn PFS/OR
PROJECT NUMBER: 1663241.9000.9005
SAMPLE ID: GMTC-2 **Depth (ft.): --**

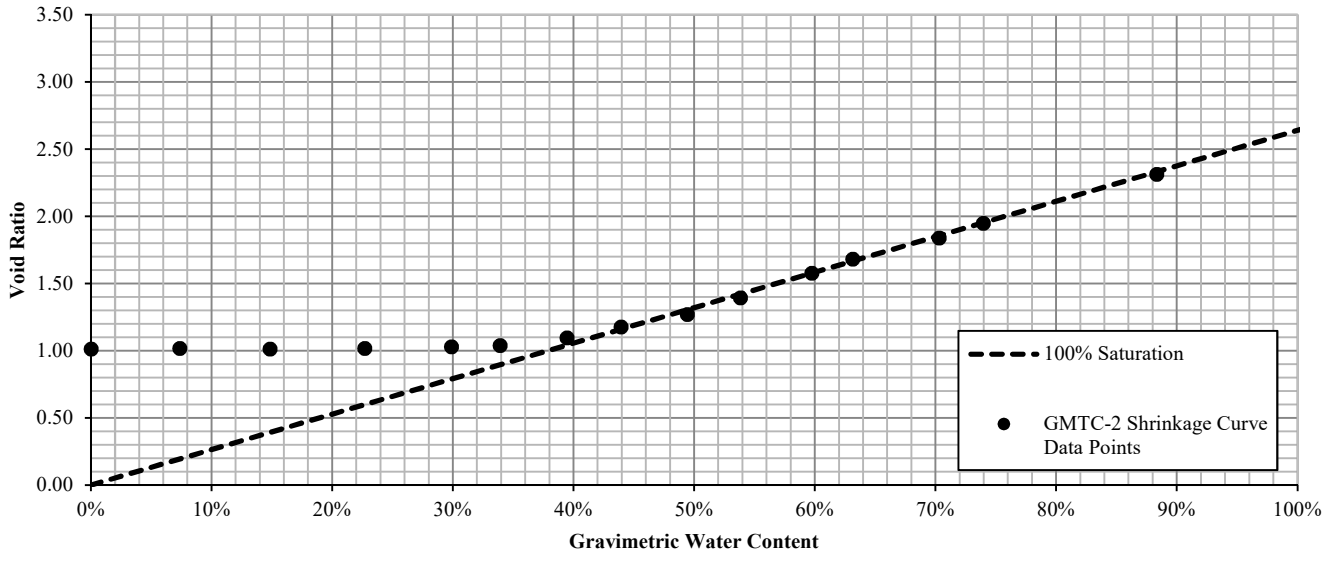
Technician: MGC
Checked: MB
Reviewed: MB
Date: 9-Jul-2019

Description: Sandy silt, grayish brown, wet
Method: USCS Description (ASTM D 2487)

Initial Sample Conditions

Initial Moisture Content: 119.5%
Initial Dry Density (pcf): 49.7
Initial Saturation %: 136.3%
Specific Gravity: 2.64 ASTM D854

Date and Time	Temperature °C	Diameter (cm)	Height (cm)	Sample Volume (cc)	Wet Mass Soil (g)	Gravimetric Water Content %	Void Ratio	Saturation %
6/23/2019 9:25	21.4	6.324	2.648	83.181	124.83	88.3%	2.313	100.8%
6/24/2019 9:48	21.4	6.324	2.357	74.041	115.29	73.9%	1.949	100.2%
6/24/2019 16:15	21.4	6.324	2.270	71.282	112.87	70.3%	1.839	100.9%
6/25/2019 9:27	21.4	6.324	2.144	67.335	108.13	63.1%	1.682	99.1%
6/25/2019 16:05	21.4	6.324	2.060	64.686	105.88	59.7%	1.577	100.0%
6/26/2019 7:18	21.4	6.176	2.007	60.110	101.95	53.8%	1.394	101.9%
6/26/2019 16:21	21.4	6.063	1.974	56.979	99.03	49.4%	1.270	102.8%
6/27/2019 7:21	21.4	5.928	1.982	54.683	95.40	43.9%	1.178	98.5%
6/27/2019 16:33	21.4	5.849	1.958	52.625	92.43	39.5%	1.096	95.0%
6/28/2019 7:46	21.4	5.795	1.941	51.191	88.75	33.9%	1.039	86.1%
6/28/2019 16:13	21.4	5.795	1.932	50.964	86.07	29.9%	1.030	76.5%
6/29/2019 10:27	21.4	5.782	1.929	50.662	81.32	22.7%	1.018	58.9%
6/30/2019 8:54	21.4	5.774	1.929	50.513	76.11	14.8%	1.012	38.7%
7/1/2019 10:04	21.4	5.792	1.923	50.650	71.15	7.3%	1.017	19.1%
7/2/2019 7:55	21.4	5.785	1.924	50.559	66.28	0.0%	1.014	0.0%



Notes: The sample was placed in an oven set to approximately 60° C prior to recording the final mass and volume measurements.
The sample began to separate from the ring between the reading on 6/25/2019 at 16:05 and 6/26/2019 at 7:18.

GOLDER

SHRINKAGE CURVE TEST REPORT

PROJECT NAME: MDA/Grassy Mtn PFS/OR
PROJECT NUMBER: 1663241.9000.9005
SAMPLE ID: GMTC-2 **Depth (ft.):** --

Technician: MGC
Checked: MB
Reviewed: MB
Date: 10-Jul-2019

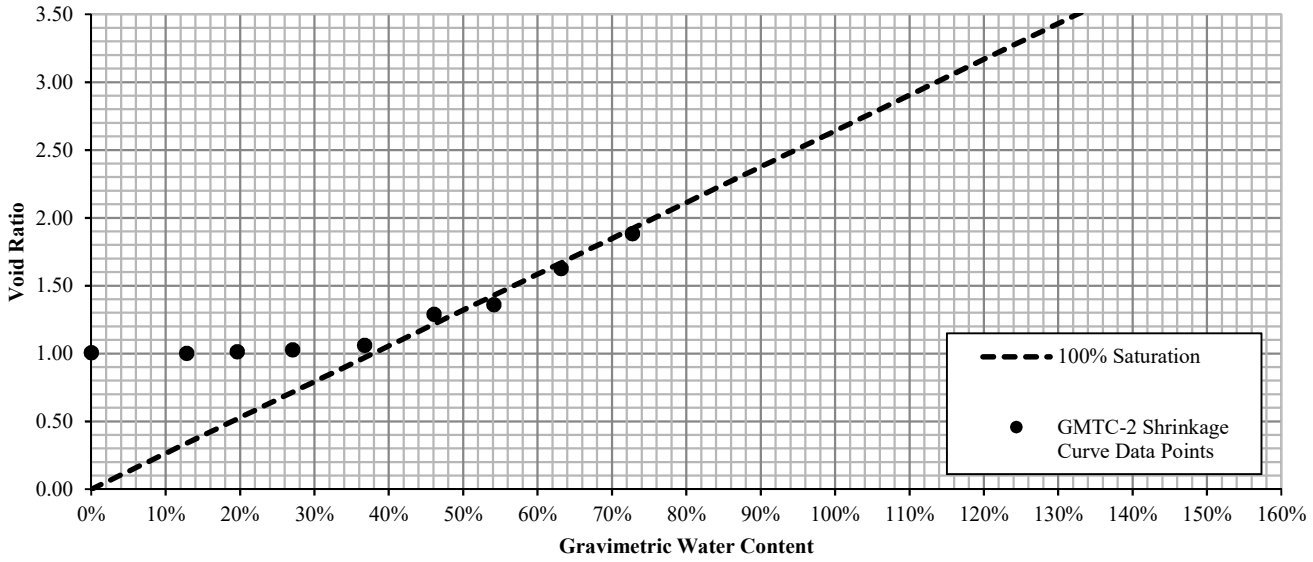
Description: Sandy silt, grayish brown, wet
Method: USCS Description (ASTM D 2487)

Initial Sample Conditions

Initial Moisture Content: 120.7%
Initial Dry Density (pcf): 57.2
Initial Saturation %: 169.3%

Specific Gravity: 2.64 ASTM D854

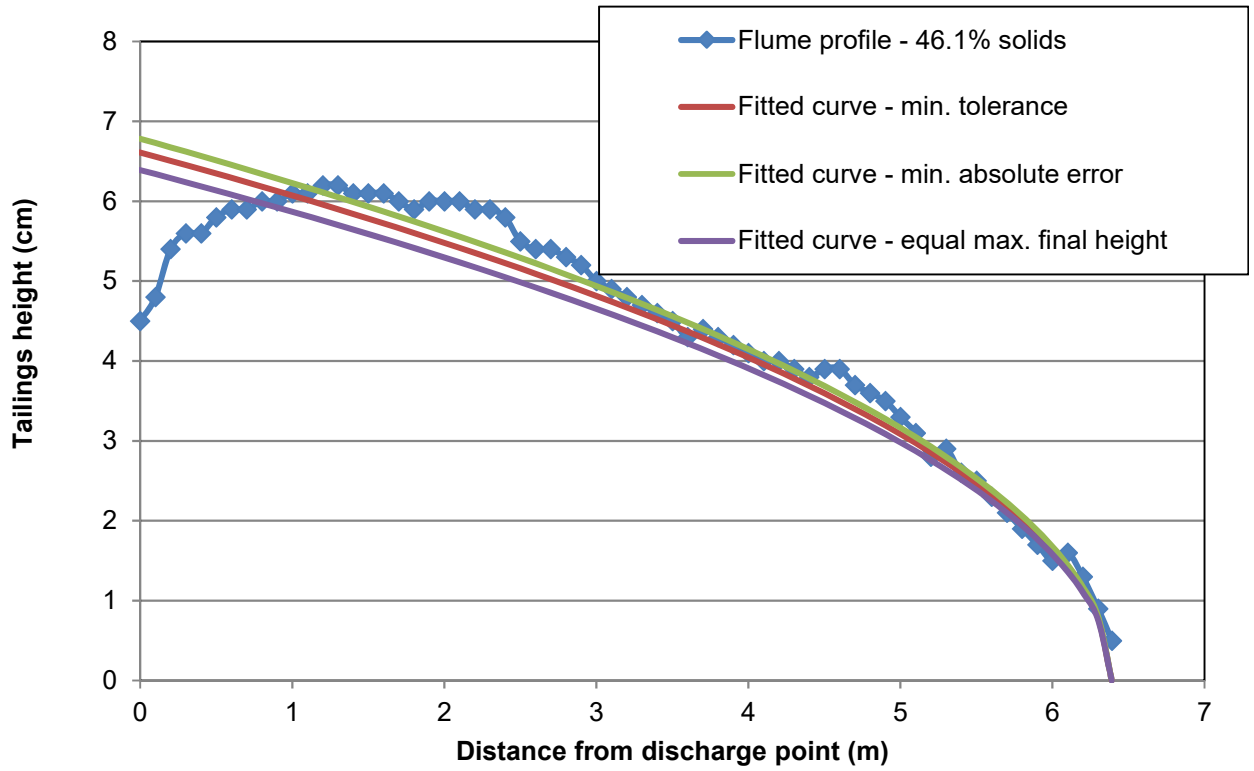
Date and Time	Temperature °C	Diameter (cm)	Height (cm)	Sample Volume (cc)	Wet Mass Soil (g)	Gravimetric Water Content %	Void Ratio	Saturation %
6/29/2019 10:30	21.4	6.280	2.217	68.682	108.68	72.8%	1.883	102.1%
6/30/2019 8:58	21.4	6.280	2.020	62.564	102.64	63.2%	1.626	102.6%
7/1/2019 10:16	21.4	6.139	1.900	56.237	96.96	54.1%	1.360	105.1%
7/2/2019 8:04	21.4	6.007	1.925	54.552	91.90	46.1%	1.290	94.4%
7/3/2019 9:32	21.4	5.798	1.859	49.085	86.02	36.8%	1.060	91.5%
7/4/2019 9:46	21.4	5.772	1.847	48.316	79.93	27.1%	1.028	69.5%
7/5/2019 9:01	21.4	5.755	1.845	47.983	75.26	19.7%	1.014	51.2%
7/6/2019 8:09	21.4	5.738	1.845	47.704	70.96	12.8%	1.002	33.8%
7/8/2019 8:39	21.4	5.743	1.845	47.803	62.90	0.0%	1.006	0.0%



Notes: The sample was placed in an oven set to approximately 60° C prior to recording the final mass and volume measurements.
The sample began to separate from the ring between the reading on 6/30/2019 at 8:58 and 7/1/2019 at 10:16.

ATTACHMENT 1.6

Flume Testing



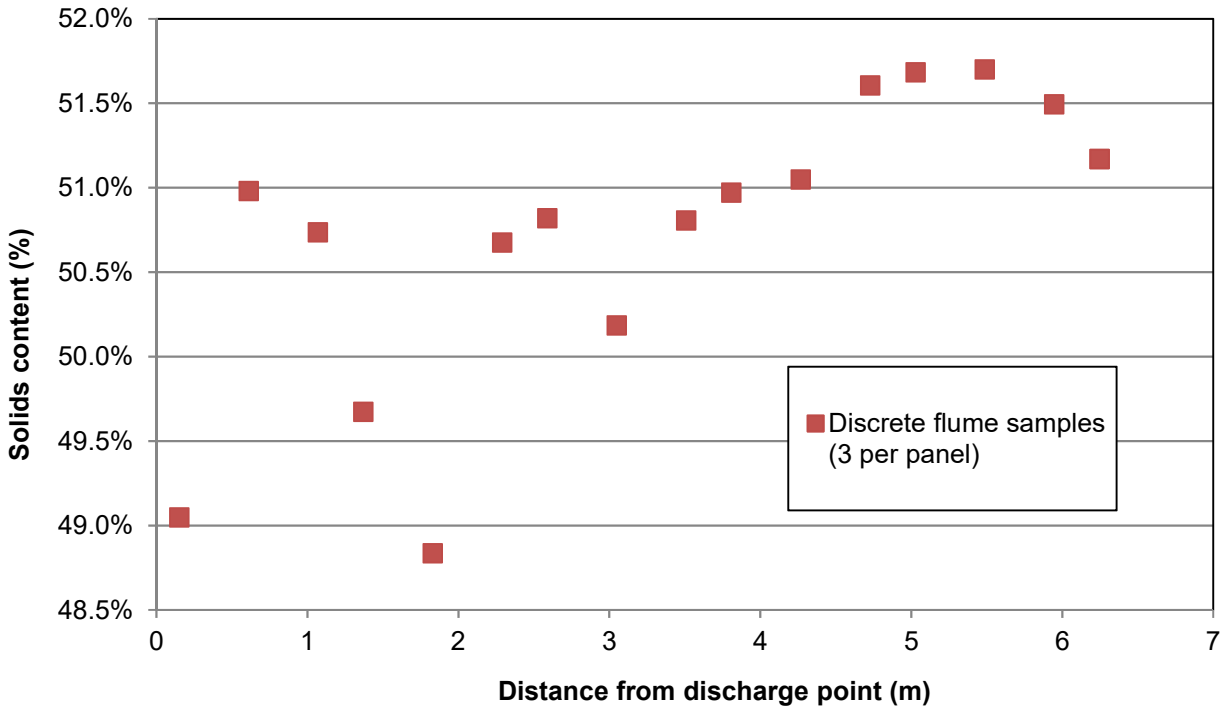


Figure 1-6-1

Flume Test Results

Grassy Mountain, Oregon

Tailings Laboratory Testing

Golder Associates

FINAL

9/17/2019

Denver

166-3241

D:\2019\166-3241-Grassy\Mntl\LAB-DATA-08-30-2019\Flume\[FlumeTestLong-46Percent.xlsm]F-1

Project Number	1663241.9000.9005					Start index	16
Name (flume type - perc. solids)	Flume profile - 46.1% solids					End index	80
Date	23-Aug-2019						
Start time	8:26		Flume Width	12	inch		
End time	8:52		Moisture content	116.92%			
Average flow rate	1	gpm	Void ratio	3.07			
Solids content	46%		Density	1.40	g/cm^3		
Gs	2.63	Assumed					
Yield stress (min. profile error)	4.7	Pa					
Yield stress (min. abs tolerance)	4.9	Pa					
Yield Stress (min. start height)	4.4	Pa					
Max. tails height (end of test)	6.2	cm					
End of flume, L	6.39	m					

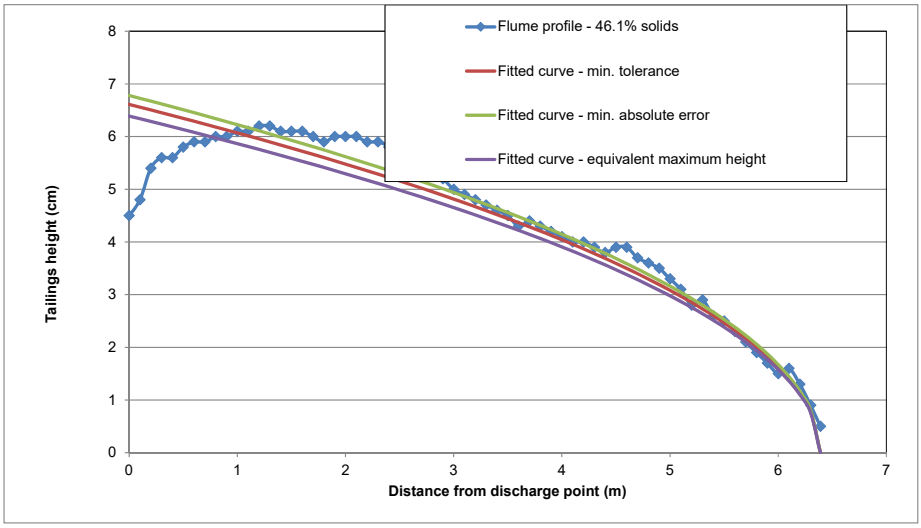
	Slope (%)
Average	0.63
Mid	0.94
Start 1/2	#N/A
End 1/2	1.38

Location	Distance (m)	Index	Height (cm)
x=0	0.00	1	4.50
x=1/3*L	2.13	22	5.97
x=1/2*L	3.20	32	4.90
x=2/3*L	4.26	43	3.97
Hfinal	6.39	65	0.50

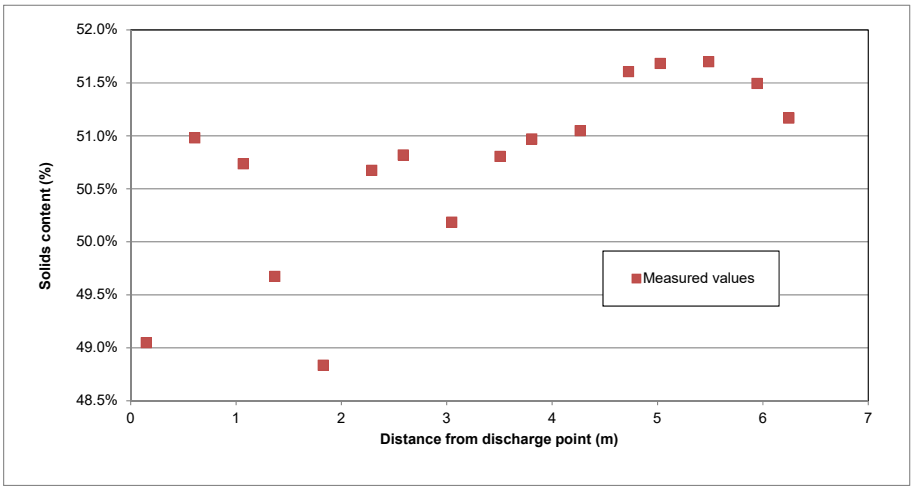
							Cum Error	4.30E-07	1.52E+01
Distance (m)	H (cm)	Volume (cm^3)	x=L-Distance	h1 (cm)	h2 (cm)	h3 (cm)	h-h1	Abs (h-h2)	
0	4.5	0	6.39	6.61	6.78	6.39	-2.11	2.28	
0.1	4.8	1,417	6.29	6.56	6.73	6.34	-1.76	1.93	
0.2	5.4	2,972	6.19	6.51	6.67	6.29	-1.11	1.27	
0.3	5.6	4,648	6.09	6.45	6.62	6.24	-0.85	1.02	
0.4	5.6	6,355	5.99	6.40	6.57	6.19	-0.80	0.97	
0.5	5.8	8,092	5.89	6.35	6.51	6.13	-0.55	0.71	
0.6	5.9	9,876	5.79	6.29	6.46	6.08	-0.39	0.56	
0.7	5.9	11,674	5.69	6.24	6.40	6.03	-0.34	0.50	
0.8	6.0	13,487	5.59	6.18	6.34	5.98	-0.18	0.34	
0.9	6.0	15,316	5.49	6.13	6.29	5.92	-0.13	0.29	
1.0	6.1	17,160	5.39	6.07	6.23	5.87	0.03	0.13	
1.1	6.1	19,020	5.29	6.02	6.17	5.81	0.08	0.07	
1.2	6.2	20,894	5.19	5.96	6.11	5.76	0.24	0.09	
1.3	6.2	22,784	5.09	5.90	6.05	5.70	0.30	0.15	
1.4	6.1	24,658	4.99	5.84	5.99	5.65	0.26	0.11	
1.5	6.1	26,518	4.89	5.78	5.93	5.59	0.32	0.17	
1.6	6.1	28,377	4.79	5.72	5.87	5.53	0.38	0.23	
1.7	6.0	30,221	4.69	5.66	5.81	5.47	0.34	0.19	
1.8	5.9	32,034	4.59	5.60	5.75	5.42	0.30	0.15	
1.9	6.0	33,848	4.49	5.54	5.68	5.36	0.46	0.32	
2.0	6.0	35,677	4.39	5.48	5.62	5.30	0.52	0.38	
2.1	6.0	37,506	4.29	5.42	5.56	5.24	0.58	0.44	
2.2	5.9	39,319	4.19	5.35	5.49	5.17	0.55	0.41	
2.3	5.9	41,118	4.09	5.29	5.43	5.11	0.61	0.47	
2.4	5.8	42,901	3.99	5.22	5.36	5.05	0.58	0.44	
2.5	5.5	44,623	3.89	5.16	5.29	4.99	0.34	0.21	
2.6	5.4	46,284	3.79	5.09	5.22	4.92	0.31	0.18	
2.7	5.4	47,930	3.69	5.02	5.15	4.86	0.38	0.25	
2.8	5.3	49,560	3.59	4.96	5.08	4.79	0.34	0.22	
2.9	5.2	51,161	3.49	4.89	5.01	4.72	0.31	0.19	
3.0	5.0	52,715	3.39	4.82	4.94	4.65	0.18	0.06	
3.1	4.9	54,224	3.29	4.74	4.87	4.59	0.16	0.03	
3.2	4.8	55,702	3.19	4.67	4.79	4.51	0.13	0.01	
3.3	4.7	57,150	3.09	4.60	4.72	4.44	0.10	0.02	
3.4	4.6	58,567	2.99	4.52	4.64	4.37	0.08	0.04	
3.5	4.5	59,954	2.89	4.45	4.56	4.30	0.05	0.06	
3.6	4.3	61,295	2.79	4.37	4.48	4.22	-0.07	0.18	
3.7	4.4	62,621	2.69	4.29	4.40	4.15	0.11	0.00	
3.8	4.3	63,947	2.59	4.21	4.32	4.07	0.09	0.02	
3.9	4.2	65,242	2.49	4.13	4.23	3.99	0.07	0.03	
4.0	4.1	66,507	2.39	4.04	4.15	3.91	0.06	0.05	
4.1	4.0	67,742	2.29	3.96	4.06	3.83	0.04	0.06	
4.2	4.0	68,961	2.19	3.87	3.97	3.74	0.13	0.03	
4.3	3.9	70,165	2.09	3.78	3.88	3.65	0.12	0.02	
4.4	3.8	71,338	1.99	3.69	3.78	3.57	0.11	0.02	
4.5	3.9	72,512	1.89	3.60	3.69	3.48	0.30	0.21	
4.6	3.9	73,701	1.79	3.50	3.59	3.38	0.40	0.31	
4.7	3.7	74,859	1.69	3.40	3.49	3.29	0.30	0.21	
4.8	3.6	75,971	1.59	3.30	3.38	3.19	0.30	0.22	
4.9	3.5	77,053	1.49	3.19	3.27	3.09	0.31	0.23	
5.0	3.3	78,090	1.39	3.08	3.16	2.98	0.22	0.14	
5.1	3.1	79,065	1.29	2.97	3.05	2.87	0.13	0.05	
5.2	2.8	79,964	1.19	2.85	2.93	2.76	-0.05	0.13	
5.3	2.9	80,833	1.09	2.73	2.80	2.64	0.17	0.10	
5.4	2.6	81,671	0.99	2.60	2.67	2.52	0.00	0.07	
5.5	2.5	82,448	0.89	2.47	2.53	2.38	0.03	0.03	
5.6	2.3	83,180	0.79	2.32	2.38	2.25	-0.02	0.08	
5.7	2.1	83,850	0.69	2.17	2.23	2.10	-0.07	0.13	
5.8	1.9	84,460	0.59	2.01	2.06	1.94	-0.11	0.16	
5.9	1.7	85,009	0.49	1.83	1.88	1.77	-0.13	0.18	
6.0	1.5	85,496	0.39	1.63	1.68	1.58	-0.13	0.18	

Flow rate - Check

Duration	0:26	hr:min
Volume	86938.104	cm^3
	5305.28861	inch^3
	22.9650225	gallons
Flow rate	0.88	gallons/min



Panel	Station	Distance (m)	Moisture	Note
1	T	0.15	103.9%	
1	M	0.6096	96.2%	
1	B	1.0692	97.1%	
2	T	1.3692	101.3%	
2	M	1.8288	104.8%	
2	B	2.2884	97.3%	
3	T	2.5884	96.8%	
3	M	3.048	99.3%	
3	B	3.5076	96.8%	
4	T	3.8076	96.2%	
4	M	4.2672	95.9%	
4	B	4.7268	93.8%	
5	T	5.0268	93.5%	
5	M	5.4864	93.4%	
5	B	5.946	94.2%	
6	T	6.246	95.4%	
6	M	6.246	95.4%	



Flume profile - 46.1% solids

Water content and percent solids determination

JOB #	1663241.9000.9005
DATE:	8/23/2019

SAMPLE/MODULE ID	Mod 1			Mod 2			
MODULE STATION (Top -> Mid -> Bot)	Top	Middle	Bottom	Top	Middle	Bottom	
VERT. LOCATION (Up/Center/Low)							
TARE	WU-10	JW-18	CATA	FEE	A7X	ROB-1	
WET WEIGHT + TARE, g	346.35	337.27	305.18	331.81	331.45	319.53	
DRY WEIGHT + TARE, g	235.69	235.29	217.83	225.61	226.35	226.26	
TARE WEIGHT, g	129.17	129.23	127.87	120.79	126.04	130.44	
MOISTURE CONTENT, %	**103.9%**	**96.2%**	**97.1%**	**101.3%**	**104.8%**	**97.3%**	-
WEIGHT OF SOLIDS, g	106.52	106.06	89.96	104.82	100.31	95.82	-
WEIGHT OF WATER, g	110.66	101.98	87.35	106.20	105.10	93.27	-
PERCENT SOLIDS	**49.0%**	**51.0%**	**50.7%**	**49.7%**	**48.8%**	**50.7%**	-

SAMPLE/MODULE ID	Mod 3			Mod 4			
MODULE STATION (Top -> Mid -> Bot)	Top	Middle	Bottom	Top	Middle	Bottom	
VERT. LOCATION (Up/Center/Low)							
TARE	TDM-2	MOE	SCI	STS9	B52	X-25	
WET WEIGHT + TARE, g	340.34	338.39	345.09	323.95	370.38	362.38	
DRY WEIGHT + TARE, g	236.48	231.84	236.67	227.17	259.74	256.76	
TARE WEIGHT, g	129.16	124.50	124.70	126.56	144.36	144.13	
MOISTURE CONTENT, %	**96.8%**	**99.3%**	**96.8%**	**96.2%**	**95.9%**	**93.8%**	-
WEIGHT OF SOLIDS, g	107.32	107.34	111.97	100.61	115.38	112.63	-
WEIGHT OF WATER, g	103.86	106.55	108.42	96.78	110.64	105.62	-
PERCENT SOLIDS	**50.8%**	**50.2%**	**50.8%**	**51.0%**	**51.0%**	**51.6%**	-

SAMPLE/MODULE ID	Mod 5			Mod 6			
MODULE STATION (Top -> Mid -> Bot)	Top	Middle	Bottom	Top	Middle	Bottom	
VERT. LOCATION (Up/Center/Low)							
TARE	S-1	PVD	OX-1	LR-1			
WET WEIGHT + TARE, g	375.40	317.42	236.30	179.01			
DRY WEIGHT + TARE, g	263.52	231.86	175.41	145.18			
TARE WEIGHT, g	143.85	140.28	110.77	109.73			
MOISTURE CONTENT, %	**93.5%**	**93.4%**	**94.2%**	**95.4%**	-	-	-
WEIGHT OF SOLIDS, g	119.67	91.58	64.64	35.45	-	-	-
WEIGHT OF WATER, g	111.88	85.56	60.89	33.83	-	-	-
PERCENT SOLIDS	**51.7%**	**51.7%**	**51.5%**	**51.2%**	-	-	-

SAMPLE/MODULE ID							
MODULE STATION (Top -> Mid -> Bot)							
VERT. LOCATION (Up/Center/Low)							
TARE							
WET WEIGHT + TARE, g							
DRY WEIGHT + TARE, g							
TARE WEIGHT, g							
MOISTURE CONTENT, %	-	-	-	-	-	-	-
WEIGHT OF SOLIDS, g	-	-	-	-	-	-	-
WEIGHT OF WATER, g	-	-	-	-	-	-	-
PERCENT SOLIDS	-	-	-	-	-	-	-

SAMPLE/MODULE ID							
MODULE STATION (Top -> Mid -> Bot)							
VERT. LOCATION (Up/Center/Low)							
TARE							
WET WEIGHT + TARE, g							
DRY WEIGHT + TARE, g							
TARE WEIGHT, g							
MOISTURE CONTENT, %	-	-	-	-	-	-	-
WEIGHT OF SOLIDS, g	-	-	-	-	-	-	-
WEIGHT OF WATER, g	-	-	-	-	-	-	-
PERCENT SOLIDS	-	-	-	-	-	-	-

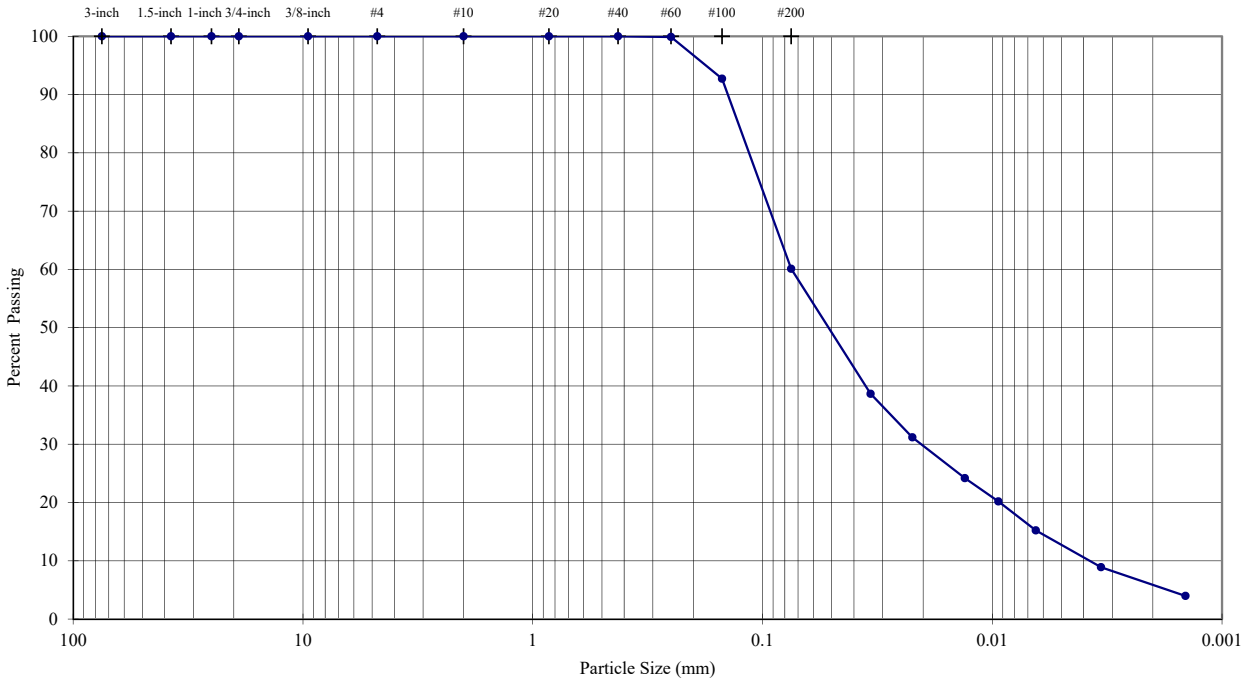
GOLDER

September-19 **1663241.9000.9005**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

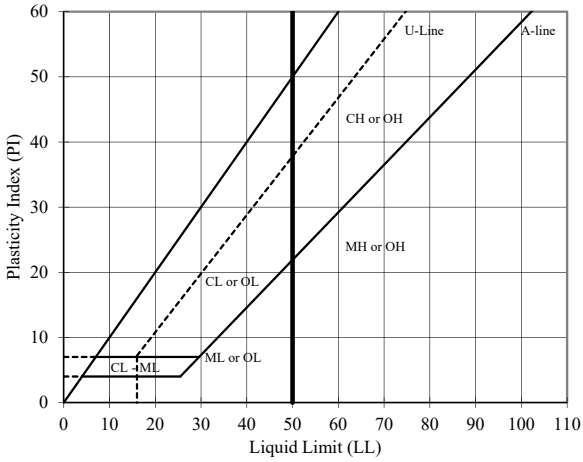
PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-1 & 2 Composite - "Beach"** DEPTH (ft): **--**
TYPE: **Bulk**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.00**
#40	0.425	**100.0**		
#60	0.250	**99.9**	Fine Sand	**39.90**
#100	0.150	**92.7**		
#200	0.075	**60.1**		
	0.034	**38.6**	Silt or Clay Fines	**60.10**
	0.022	**31.2**		
	0.013	**24.2**		
	0.009	**20.2**		
	0.006	**15.2**		
	0.003	**8.9**		
	0.001	**4.0**		

Sieve Analysis (Initial Separation on No. 4 Sieve)

Hydrometer Analysis



USCS Description (ASTM D 2487):

Sandy silt, light gray, dry

LL	PL	PI	SpG
NP	**NP**	**NP**	**2.64**

As-Received Moisture Content (%): **103.9**

USCS Group Symbol: ML

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	PRH
DATE	11-Sep-2019
REVIEW	MB

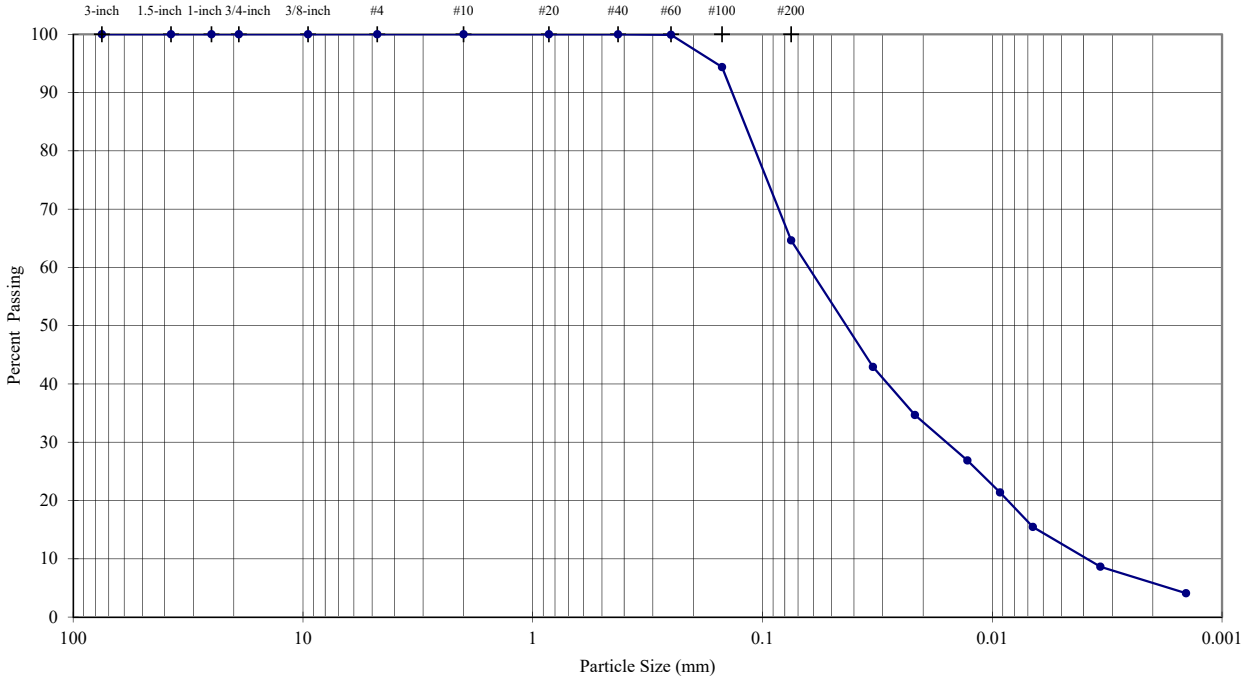
GOLDER

September-19 **1663241.9000.9005**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

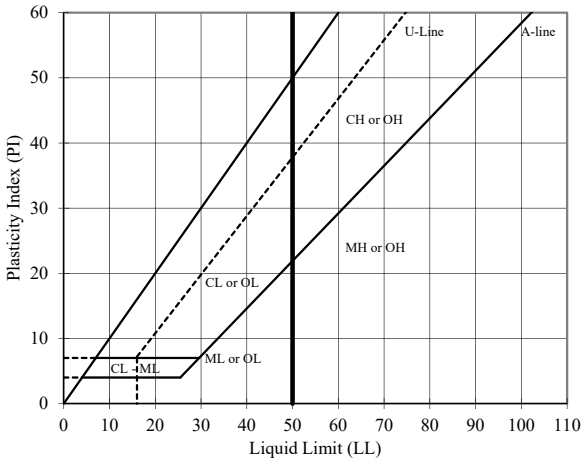
PROJECT NAME: **Grassy Mtn PFS/OR**
SAMPLE ID: **GMTC-1 & 2 Composite - "Slimes"** DEPTH (ft): **--**
TYPE: **Bulk**



Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.00	**100.0**	Coarse Sand	**0.00**
#20	0.850	**100.0**	Medium Sand	**0.02**
#40	0.425	**100.0**		
#60	0.250	**99.9**		
#100	0.150	**94.4**	Fine Sand	**35.35**
#200	0.075	**64.6**		
	0.033	**42.9**		
	0.022	**34.7**		
	0.013	**26.9**		
	0.009	**21.4**	Silt or Clay Fines	**64.64**
	0.007	**15.5**		
	0.003	**8.6**		
	0.001	**4.1**		

Sieve Analysis (Initial Separation on No. 4 Sieve)

Hydrometer Analysis



USCS Description (ASTM D 2487):

Sandy silt, light gray, dry

LL	PL	PI	SpG
NP	**NP**	**NP**	**2.66**

As-Received Moisture Content (%): **94.6**

USCS Group Symbol: ML

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	PRH
DATE	10-Sep-2019
REVIEW	MB

	Initial	Final		
Length =	5.424	3.243	cm	Approximately
Diameter =	7.100	7.100	cm	
Wet Mass =	400.82	248.55	g	
Area =	39.59	39.59	cm^2	
Volume =	214.75	128.40	cm^3	
Moisture Content =	104.7%	27.6%		
Specific Gravity =	2.64	2.64	(ASTM D854)	
Dry Mass of Solids =	195.81	194.79	g	
Density =	1.87	1.94	g/cm^3	
Dry Density =	0.91	1.52	g/cm^3	
Unit Weight =	116.5	120.8	lb/ft^3	
Dry Unit Weight =	56.9	94.7	lb/ft^3	
Solids Content =	48.9%	78.4%		

Piston Pressure:	7.0 psi	492.2 g/cm^2	Piston Pressure:	10.0 psi	703.1 g/cm^2	Piston Pressure:	15.0 psi	1,054.6 g/cm^2	Piston Pressure:	25.0 psi	1,757.7 g/cm^2	Piston Pressure:	45.0 psi	3,163.8 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**2.0 psi**	140.6 g/cm^2	Consolidation Pressure:	**5.0 psi**	351.5 g/cm^2	Consolidation Pressure:	**10.0 psi**	703.1 g/cm^2	Consolidation Pressure:	**20.0 psi**	1,406.2 g/cm^2	Consolidation Pressure:	**40.0 psi**	2,812.3 g/cm^2
Before Consolidation			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**		
Initial Sample Height:	5.424	cm	Initial Sample Height:	3.890	cm	Initial Sample Height:	3.843	cm	Initial Sample Height:	3.758	cm	Initial Sample Height:	3.588	cm
Initial Dry Unit Weight:	0.91	g/cm^3	Initial Dry Unit Weight:	1.26	g/cm^3	Initial Dry Unit Weight:	1.28	g/cm^3	Initial Dry Unit Weight:	1.31	g/cm^3	Initial Dry Unit Weight:	1.37	g/cm^3
Initial Void Ratio:	1.90		Initial Void Ratio:	1.09		Initial Void Ratio:	1.06		Initial Void Ratio:	1.02		Initial Void Ratio:	0.93	
After Consolidation			**After Consolidation**			**After Consolidation**			**After Consolidation**			**After Consolidation**		
Final Sample Height:	3.890	cm	Final Sample Height:	3.843	cm	Final Sample Height:	3.758	cm	Final Sample Height:	3.588	cm	Final Sample Height:	3.451	cm
Final Dry Unit Weight:	1.26	g/cm^3	Final Dry Unit Weight:	1.28	g/cm^3	Final Dry Unit Weight:	1.31	g/cm^3	Final Dry Unit Weight:	1.37	g/cm^3	Final Dry Unit Weight:	1.43	g/cm^3
Final Void Ratio:	1.09		Final Void Ratio:	1.06		Final Void Ratio:	1.02		Final Void Ratio:	0.93		Final Void Ratio:	0.85	
Calculations			**Calculations**			**Calculations**			**Calculations**			**Calculations**		
Coefficient of Compressibility, a_v	5.75E-03	cm^2/g	Coefficient of Compressibility, a_v	1.20E-04	cm^2/g	Coefficient of Compressibility, a_v	1.30E-04	cm^2/g	Coefficient of Compressibility, a_v	1.30E-04	cm^2/g	Coefficient of Compressibility, a_v	5.23E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	1.98E-03	cm^2/g	Coefficient of Volume Compressibility, m_v	5.73E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	6.29E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	6.43E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	2.72E-05	cm^2/g
Compression Index, C_c	-		Compression Index, C_c	0.06		Compression Index, C_c	0.15		Compression Index, C_c	0.30		Compression Index, C_c	0.24	

Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
2.4	9.4E-05	4.73E-02	5.1	2.1E-05	3.70E-01	2.8	2.4E-05	3.74E-01	4.0	1.5E-05	2.40E-01	5.3	1.1E-05	4.18E-01
4.6	7.0E-05	3.50E-02	9.0	1.8E-05	3.11E-01	6.2	1.7E-05	2.72E-01	8.4	1.2E-05	1.88E-01	10.6	9.1E-06	3.37E-01
8.6	5.5E-05	2.78E-02	13.8	1.6E-05	2.86E-01	10.3	1.5E-05	2.40E-01	13.6	1.1E-05	1.70E-01	17.3	8.3E-06	3.05E-01
11.5	4.8E-05	2.44E-02	16.9	1.6E-05	2.75E-01	15.7	1.4E-05	2.23E-01	20.4	1.0E-05	1.60E-01	25.8	7.8E-06	2.89E-01
14.1	4.4E-05	2.24E-02	20.6	1.5E-05	2.69E-01	19.0	1.4E-05	2.18E-01	24.6	1.0E-05	1.57E-01	31.1	7.7E-06	2.83E-01
18.2	4.0E-05	2.01E-02	25.2	1.5E-05	2.64E-01	22.9	1.4E-05	2.15E-01	29.6	1.0E-05	1.56E-01	37.4	7.6E-06	2.80E-01
			31.6	1.5E-05	2.60E-01	27.9	1.3E-05	2.13E-01	36.3	9.8E-06	1.53E-01	45.3	7.6E-06	2.79E-01
			37.2	1.5E-05	2.57E-01	34.6	1.3E-05	2.12E-01	44.5	9.9E-06	1.54E-01	56.4	7.5E-06	2.77E-01
			42.6	1.5E-05	2.53E-01	40.6	1.3E-05	2.10E-01	51.7	9.9E-06	1.54E-01	64.9	7.6E-06	2.79E-01
			51.4	1.4E-05	2.44E-01	45.9	1.3E-05	2.09E-01	57.9	1.0E-05	1.55E-01	73.1	7.6E-06	2.80E-01
						53.6	1.3E-05	2.09E-01	66.8	1.0E-05	1.56E-01	86.7	7.5E-06	2.74E-01
Average (of final 3 values)	4.43E-05	2.23E-02	Average (of final 3 values)	1.44E-05	2.52E-01	Average (of final 3 values)	1.32E-05	2.09E-01	Average (of final 3 values)	9.98E-06	1.55E-01	Average (of final 3 values)	7.54E-06	2.78E-01

Golder Associates Inc. **Denver, Colorado**	**Title:** **SLURRY CONSOLIDATION TEST** **SAMPLE DATA AND CALCULATIONS**		
Job Short Title: MDA/Grassy Mtn PFS/OR			
Sample No. Comp GMTC 1&2 Flume Beach	**Reviewed:** GG	**Date:** 25-Sep-2019	**Job Number:** 1663241.9000.9005	**Figure:** 1A

	Initial	Final	
Length =	5.424	3.243	cm
Diameter =	7.100	7.100	cm
Wet Mass =	400.82	248.55	g
Area =	39.59	39.59	cm^2
Volume =	214.75	128.40	cm^3
Moisture Content =	104.7%	27.6%	
Specific Gravity =	2.64	2.64	(ASTM D854)
Dry Mass of Solids =	195.81	194.79	g
Density =	1.87	1.94	g/cm^3
Dry Density =	0.91	1.52	g/cm^3
Unit Weight =	116.5	120.8	lb/ft^3
Dry Unit Weight =	56.9	94.7	lb/ft^3
Solids Content =	48.9%	78.4%	

Piston Pressure:	95.0 psi	6,679.2 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**90.0 psi**	6,327.7 g/cm^2
Before Consolidation		
Initial Sample Height:	3.451	cm
Initial Dry Unit Weight:	1.43	g/cm^3
Initial Void Ratio:	0.85	
After Consolidation		
Final Sample Height:	3.283	cm
Final Dry Unit Weight:	1.50	g/cm^3
Final Void Ratio:	0.76	
Calculations		
Coefficient of Compressibility, a_v	2.56E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	1.38E-05	cm^2/g
Compression Index, C_c	0.26	

Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
7.2	7.9E-06	5.70E-01
14.3	6.5E-06	4.66E-01
23.3	5.9E-06	4.23E-01
34.7	5.6E-06	4.01E-01
41.9	5.4E-06	3.93E-01
50.3	5.4E-06	3.90E-01
60.9	5.4E-06	3.87E-01
75.3	5.3E-06	3.86E-01
86.9	5.4E-06	3.89E-01
Average (of final 3 values)	5.37E-06	3.87E-01

Piston Pressure:	195.0 psi	13,710.0 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**190.0 psi**	13,358.5 g/cm^2
Before Consolidation		
Initial Sample Height:	3.283	cm
Initial Dry Unit Weight:	1.50	g/cm^3
Initial Void Ratio:	0.76	
After Consolidation		
Final Sample Height:	3.162	cm
Final Dry Unit Weight:	1.56	g/cm^3
Final Void Ratio:	0.70	
Calculations		
Coefficient of Compressibility, a_v	9.23E-06	cm^2/g
Coefficient of Volume Compressibility, m_v	5.24E-06	cm^2/g
Compression Index, C_c	0.20	

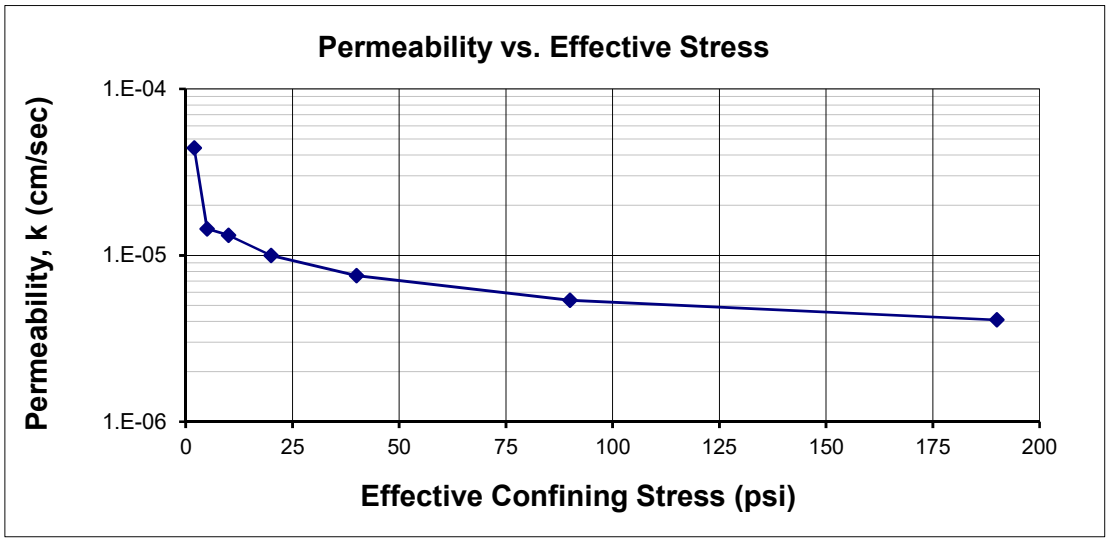
Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
10.3	5.3E-06	1.01E+00
19.3	4.6E-06	8.82E-01
30.3	4.3E-06	8.28E-01
36.9	4.2E-06	8.10E-01
44.3	4.2E-06	7.99E-01
53.3	4.1E-06	7.86E-01
63.6	4.1E-06	7.83E-01
71.4	4.1E-06	7.78E-01
77.1	4.1E-06	7.77E-01
86.7	4.1E-06	7.81E-01
94.5	4.1E-06	7.83E-01
Average (of final 3 values)	4.09E-06	7.80E-01

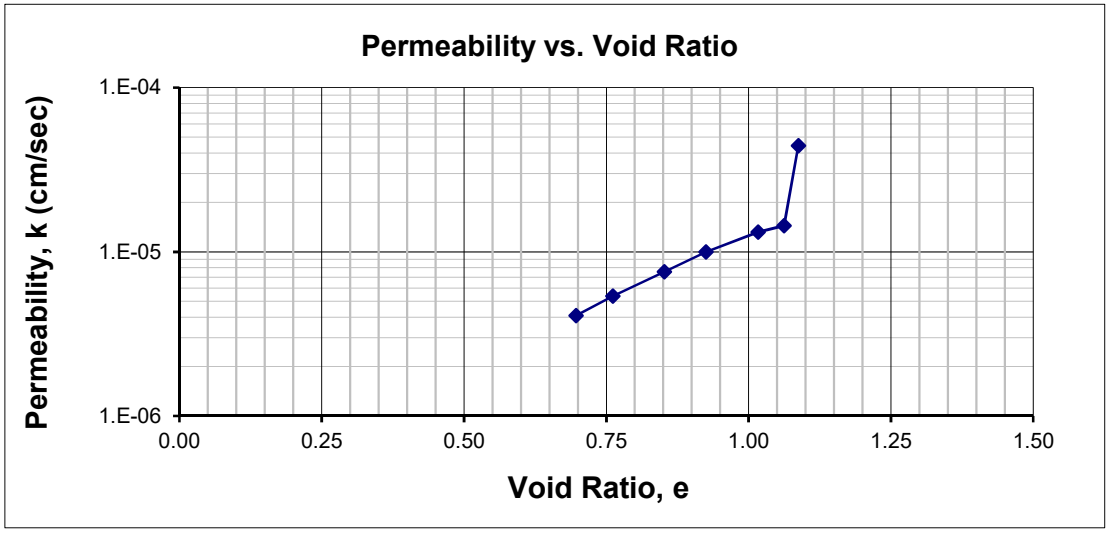
Golder Associates Inc.
Denver, Colorado

Job Short Title: MDA/Grassy Mtn PFS/OR

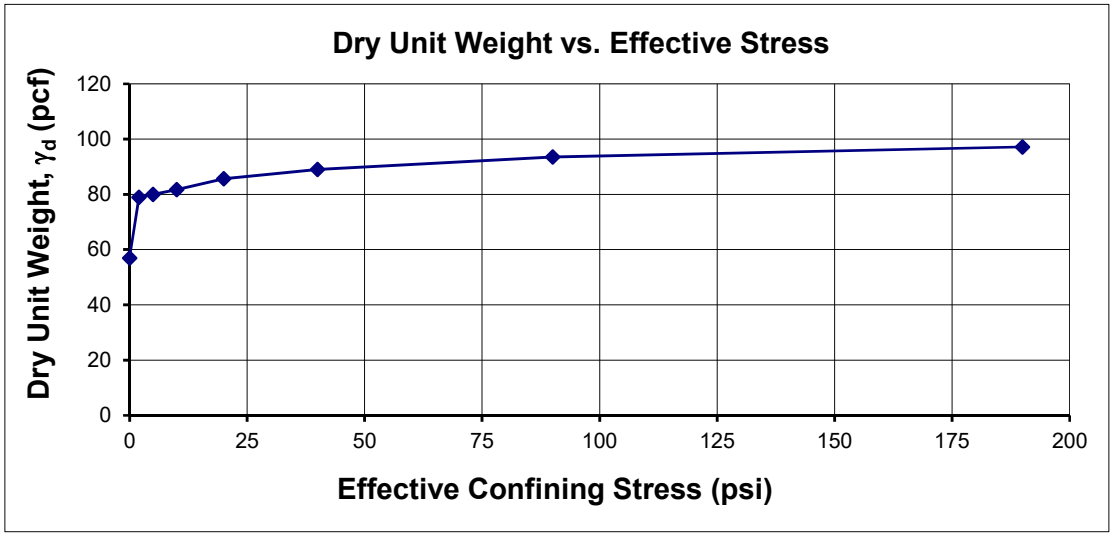
Title:
SLURRY CONSOLIDATION TEST
SAMPLE DATA AND CALCULATIONS

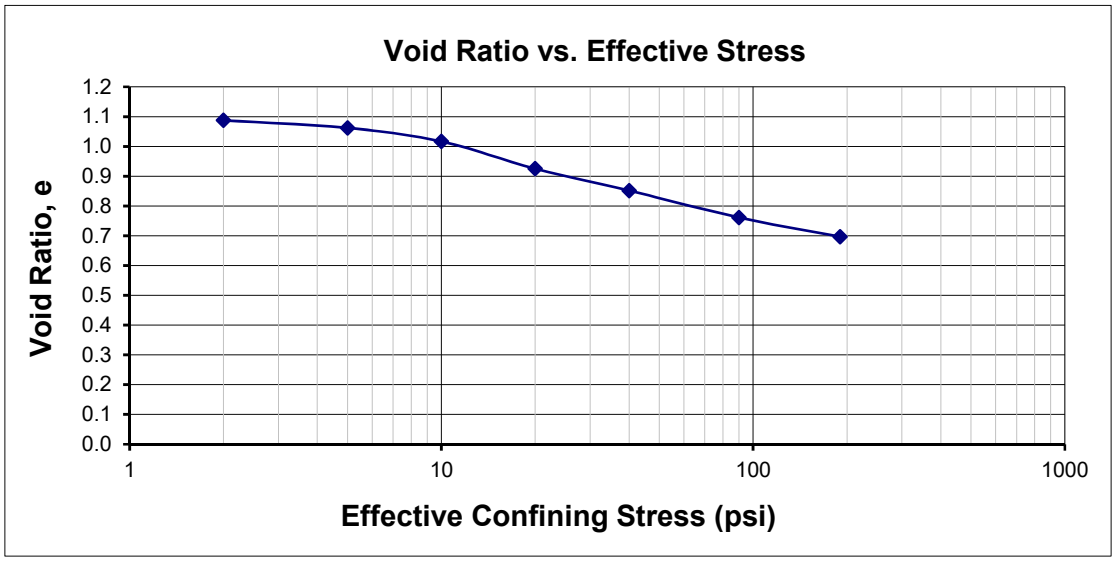
Sample No.	Reviewed:	Date:	Job Number:	Figure:
Comp GMTC 1&2 Flume Beach	GG	25-Sep-2019	1663241.9000.9005	1B



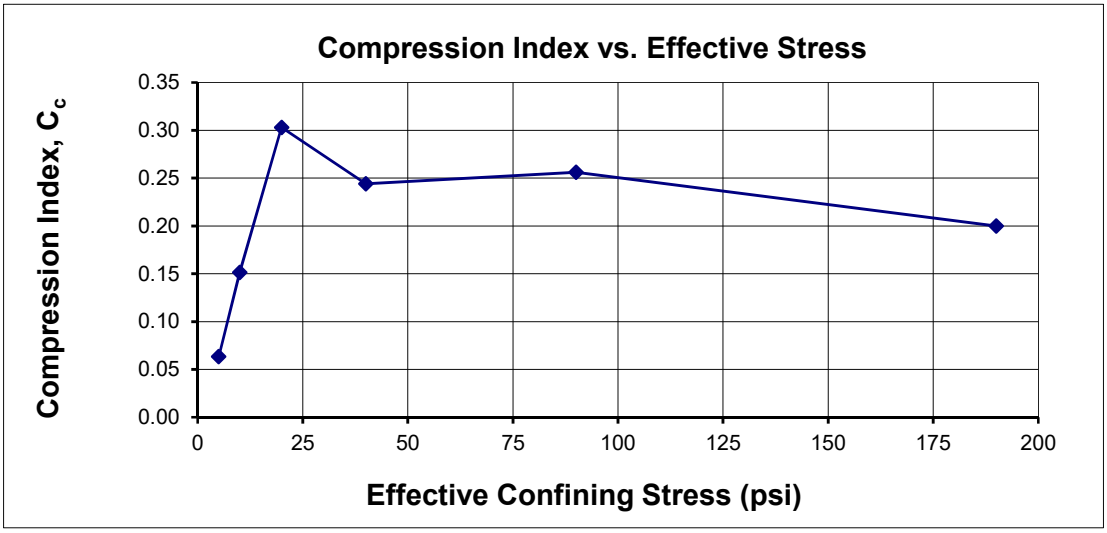


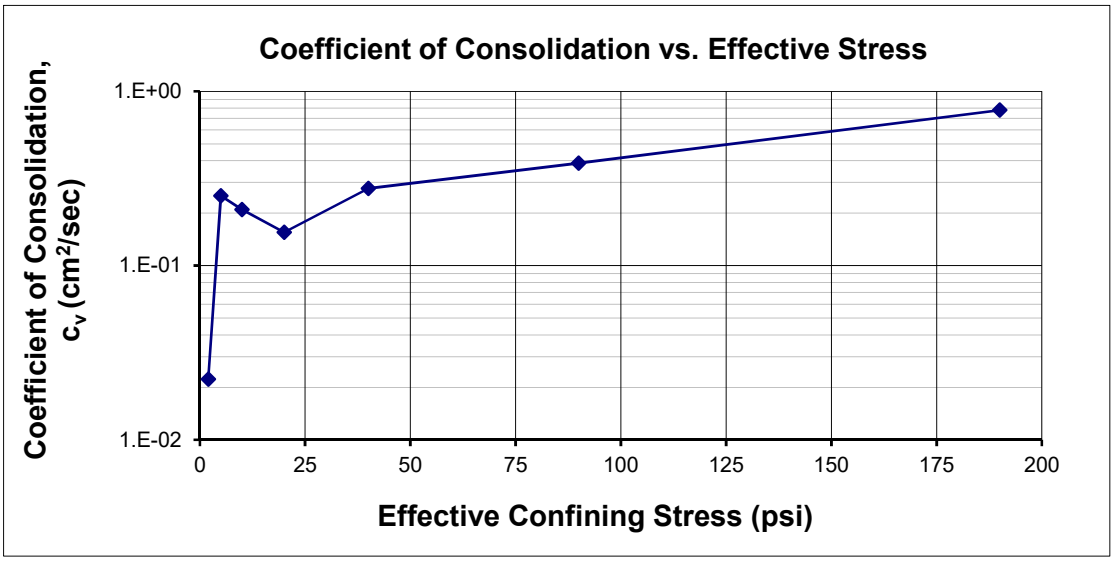
Golder Associates Inc. **Denver, Colorado**			**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **PERMEABILITY DATA**	
Job Short Title: MDA/Grassy Mtn PFS/OR				
Sample No. Comp GMTC 1&2 Flume Beach	**Reviewed:** GG	**Date:** 25-Sep-2019	**Job Number:** 1663241.9000.9005	**Figure:** 2





Golder Associates Inc. **Denver, Colorado**			**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **DENSITY DATA**	
Job Short Title: MDA/Grassy Mtn PFS/OR				
Sample No. Comp GMTC 1&2 Flume Beach	**Reviewed:** GG	**Date:** 25-Sep-2019	**Job Number:** 1663241.9000.9005	**Figure:** 3





Golder Associates Inc. **Denver, Colorado**		**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **COMPRESSION DATA**		
Job Short Title: MDA/Grassy Mtn PFS/OR				
Sample No. Comp GMTC 1&2 Flume Beach	**Reviewed:** GG	**Date:** 25-Sep-2019	**Job Number:** 1663241.9000.9005	**Figure:** 4

	Initial	Final	
Length =	6.087	3.498	cm
Diameter =	7.100	7.100	cm
Wet Mass =	411.00	269.57	g
Area =	39.59	39.59	cm^2
Volume =	241.00	138.49	cm^3
Moisture Content =	94.7%	27.9%	
Specific Gravity =	2.66	2.66	(ASTM D854)
Dry Mass of Solids =	211.09	210.77	g
Density =	1.71	1.95	g/cm^3
Dry Density =	0.88	1.52	g/cm^3
Unit Weight =	106.5	121.5	lb/ft^3
Dry Unit Weight =	54.7	95.0	lb/ft^3
Solids Content =	51.4%	78.2%	

Approximately 34.9 grams of supernatant water removed from test specimen prior to beginning test.

Piston Pressure:	6.0 psi	421.8 g/cm^2	Piston Pressure:	10.0 psi	703.1 g/cm^2	Piston Pressure:	15.0 psi	1,054.6 g/cm^2	Piston Pressure:	25.0 psi	1,757.7 g/cm^2	Piston Pressure:	45.0 psi	3,163.8 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2	Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**1.0 psi**	70.3 g/cm^2	Consolidation Pressure:	**5.0 psi**	351.5 g/cm^2	Consolidation Pressure:	**10.0 psi**	703.1 g/cm^2	Consolidation Pressure:	**20.0 psi**	1,406.2 g/cm^2	Consolidation Pressure:	**40.0 psi**	2,812.3 g/cm^2
Before Consolidation			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**			**Before Consolidation**		
Initial Sample Height:	6.087	cm	Initial Sample Height:	4.176	cm	Initial Sample Height:	4.067	cm	Initial Sample Height:	3.985	cm	Initial Sample Height:	3.848	cm
Initial Dry Unit Weight:	0.88	g/cm^3	Initial Dry Unit Weight:	1.27	g/cm^3	Initial Dry Unit Weight:	1.31	g/cm^3	Initial Dry Unit Weight:	1.34	g/cm^3	Initial Dry Unit Weight:	1.38	g/cm^3
Initial Void Ratio:	2.04		Initial Void Ratio:	1.09		Initial Void Ratio:	1.03		Initial Void Ratio:	0.99		Initial Void Ratio:	0.92	
After Consolidation			**After Consolidation**			**After Consolidation**			**After Consolidation**			**After Consolidation**		
Final Sample Height:	4.176	cm	Final Sample Height:	4.067	cm	Final Sample Height:	3.985	cm	Final Sample Height:	3.848	cm	Final Sample Height:	3.724	cm
Final Dry Unit Weight:	1.27	g/cm^3	Final Dry Unit Weight:	1.31	g/cm^3	Final Dry Unit Weight:	1.34	g/cm^3	Final Dry Unit Weight:	1.38	g/cm^3	Final Dry Unit Weight:	1.43	g/cm^3
Final Void Ratio:	1.09		Final Void Ratio:	1.03		Final Void Ratio:	0.99		Final Void Ratio:	0.92		Final Void Ratio:	0.86	
Calculations			**Calculations**			**Calculations**			**Calculations**			**Calculations**		
Coefficient of Compressibility, a_v	1.35E-02	cm^2/g	Coefficient of Compressibility, a_v	1.94E-04	cm^2/g	Coefficient of Compressibility, a_v	1.17E-04	cm^2/g	Coefficient of Compressibility, a_v	9.74E-05	cm^2/g	Coefficient of Compressibility, a_v	4.41E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	4.45E-03	cm^2/g	Coefficient of Volume Compressibility, m_v	9.28E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	5.74E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	4.89E-05	cm^2/g	Coefficient of Volume Compressibility, m_v	2.29E-05	cm^2/g
Compression Index, C_c	-		Compression Index, C_c	0.08		Compression Index, C_c	0.14		Compression Index, C_c	0.23		Compression Index, C_c	0.21	

Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)	Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
3.3	2.7E-05	5.96E-03	6.0	1.4E-05	1.52E-01	7.0	1.2E-05	2.06E-01	8.7	9.2E-06	1.89E-01	11.1	7.0E-06	3.05E-01
9.9	1.5E-05	3.32E-03	13.0	1.1E-05	1.17E-01	14.6	9.5E-06	1.65E-01	17.4	7.7E-06	1.58E-01	21.6	6.0E-06	2.62E-01
13.8	1.3E-05	2.94E-03	17.6	1.0E-05	1.08E-01	19.3	8.9E-06	1.56E-01	22.5	7.4E-06	1.51E-01	28.0	5.8E-06	2.51E-01
18.5	1.2E-05	2.68E-03	22.1	9.7E-06	1.05E-01	24.2	8.7E-06	1.52E-01	28.4	7.2E-06	1.47E-01	34.8	5.7E-06	2.48E-01
24.4	1.1E-05	2.48E-03	27.9	9.4E-06	1.02E-01	30.9	8.3E-06	1.45E-01	35.6	7.0E-06	1.43E-01	43.9	5.5E-06	2.39E-01
30.4	1.1E-05	2.44E-03	34.6	9.3E-06	1.00E-01	38.0	8.3E-06	1.45E-01	43.7	7.0E-06	1.42E-01	54.6	5.4E-06	2.35E-01
39.9	1.0E-05	2.30E-03	43.8	9.1E-06	9.80E-02	48.3	8.1E-06	1.41E-01	55.2	6.8E-06	1.40E-01	69.1	5.3E-06	2.30E-01
54.2	9.7E-06	2.17E-03	57.7	8.8E-06	9.53E-02	62.6	8.0E-06	1.39E-01	70.7	6.8E-06	1.40E-01	89.5	5.2E-06	2.28E-01
Average (of final 3 values)	1.02E-05	2.30E-03	Average (of final 3 values)	9.08E-06	9.78E-02	Average (of final 3 values)	8.12E-06	1.42E-01	Average (of final 3 values)	6.87E-06	1.41E-01	Average (of final 3 values)	5.29E-06	2.31E-01

Golder Associates Inc.
Denver, Colorado

Title:
SLURRY CONSOLIDATION TEST
SAMPLE DATA AND CALCULATIONS

Job Short Title:
MDA/Grassy Mtn PFS/OR

Sample No.	Reviewed:	Date:	Job Number:	Figure:
Comp GMTC 1&2 Flume Slimes	GG	25-Sep-2019	1663241.9000.9005	1A

	Initial	Final	
Length =	6.087	3.498	cm
Diameter =	7.100	7.100	cm
Wet Mass =	411.00	269.57	g
Area =	39.59	39.59	cm^2
Volume =	241.00	138.49	cm^3
Moisture Content =	94.7%	27.9%	
Specific Gravity =	2.66	2.66	(ASTM D854)
Dry Mass of Solids =	211.09	210.77	g
Density =	1.71	1.95	g/cm^3
Dry Density =	0.88	1.52	g/cm^3
Unit Weight =	106.5	121.5	lb/ft^3
Dry Unit Weight =	54.7	95.0	lb/ft^3
Solids Content =	51.4%	78.2%	

Piston Pressure:	95.0 psi	6,679.2 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**90.0 psi**	6,327.7 g/cm^2
Before Consolidation		
Initial Sample Height:	3.724	cm
Initial Dry Unit Weight:	1.43	g/cm^3
Initial Void Ratio:	0.86	
After Consolidation		
Final Sample Height:	3.571	cm
Final Dry Unit Weight:	1.49	g/cm^3
Final Void Ratio:	0.78	
Calculations		
Coefficient of Compressibility, a_v	2.17E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	1.17E-05	cm^2/g
Compression Index, C_c	0.22	

Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
14.4	5.2E-06	4.42E-01
28.0	4.4E-06	3.80E-01
36.1	4.3E-06	3.66E-01
45.0	4.2E-06	3.60E-01
56.6	4.1E-06	3.49E-01
69.5	4.1E-06	3.48E-01
88.4	4.0E-06	3.38E-01
Average (of final 3 values)	4.03E-06	3.45E-01

Piston Pressure:	195.0 psi	13,710.0 g/cm^2
Sample Pressure:	5.0 psi	351.5 g/cm^2
Consolidation pressure:	**190.0 psi**	13,358.5 g/cm^2
Before Consolidation		
Initial Sample Height:	3.571	cm
Initial Dry Unit Weight:	1.49	g/cm^3
Initial Void Ratio:	0.78	
After Consolidation		
Final Sample Height:	3.412	cm
Final Dry Unit Weight:	1.56	g/cm^3
Final Void Ratio:	0.70	
Calculations		
Coefficient of Compressibility, a_v	1.13E-05	cm^2/g
Coefficient of Volume Compressibility, m_v	6.33E-06	cm^2/g
Compression Index, C_c	0.24	

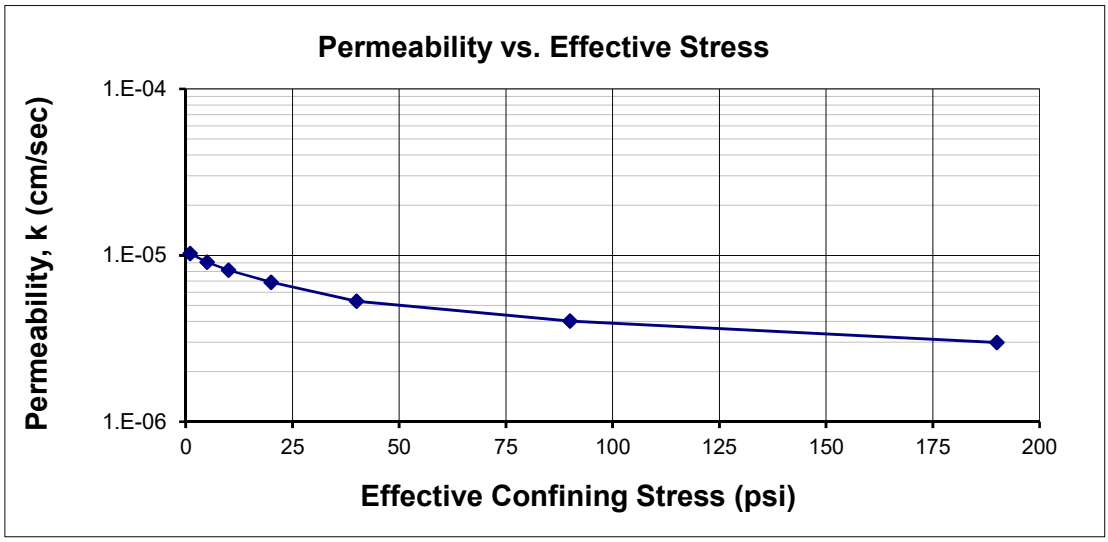
Δ Time (sec)	Permeability k (cm/sec)	Coefficient of Consolidation, c_v (cm^2/sec)
18.5	3.9E-06	6.09E-01
35.6	3.3E-06	5.28E-01
44.9	3.3E-06	5.19E-01
57.4	3.1E-06	4.97E-01
71.8	3.1E-06	4.85E-01
88.5	3.0E-06	4.81E-01
111.9	3.0E-06	4.71E-01
145.4	2.9E-06	4.65E-01
Average (of final 3 values)	2.99E-06	4.73E-01

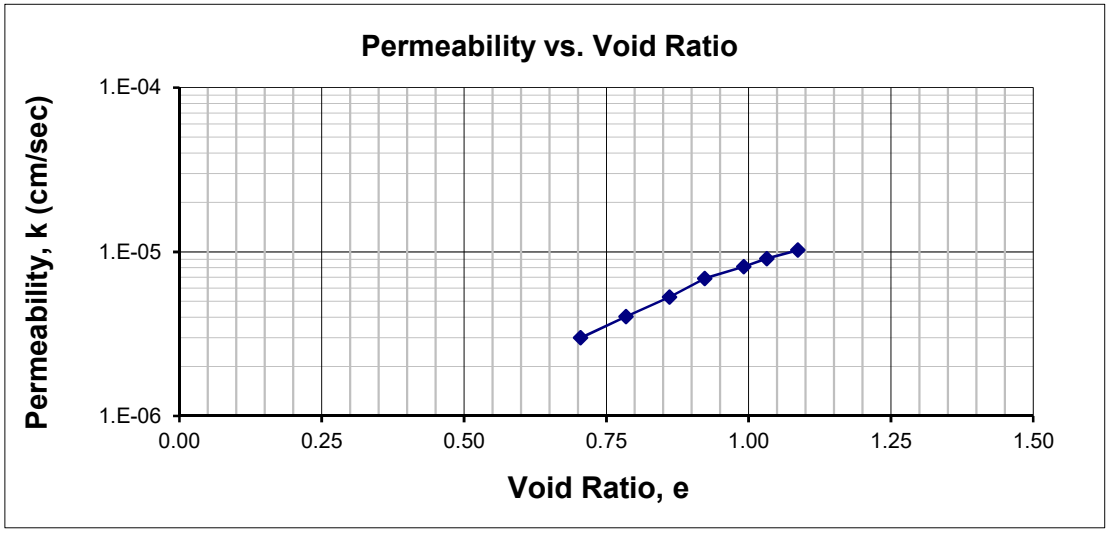
Golder Associates Inc.
Denver, Colorado

Job Short Title:
MDA/Grassy Mtn PFS/OR

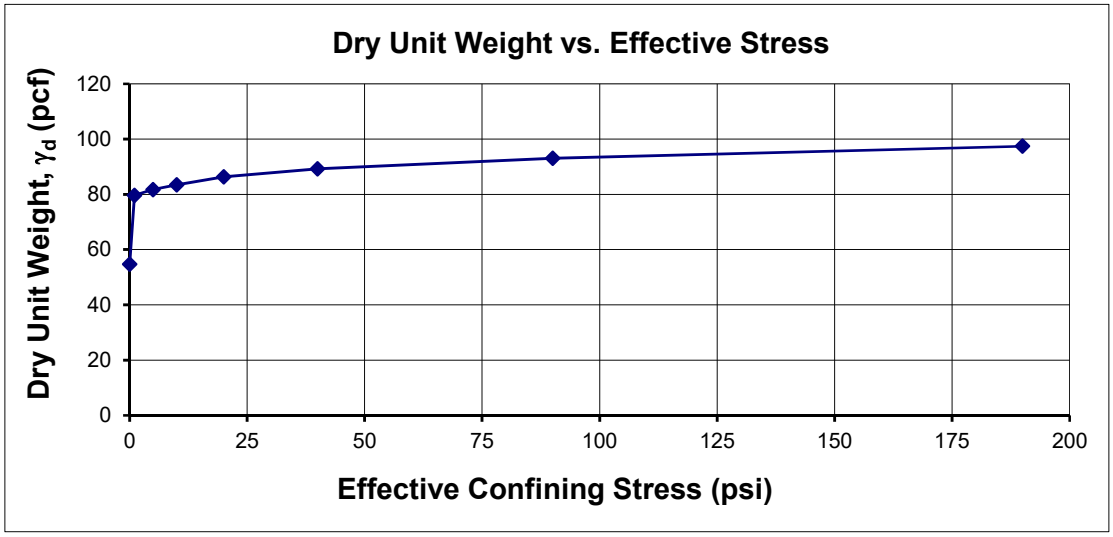
Title:
SLURRY CONSOLIDATION TEST
SAMPLE DATA AND CALCULATIONS

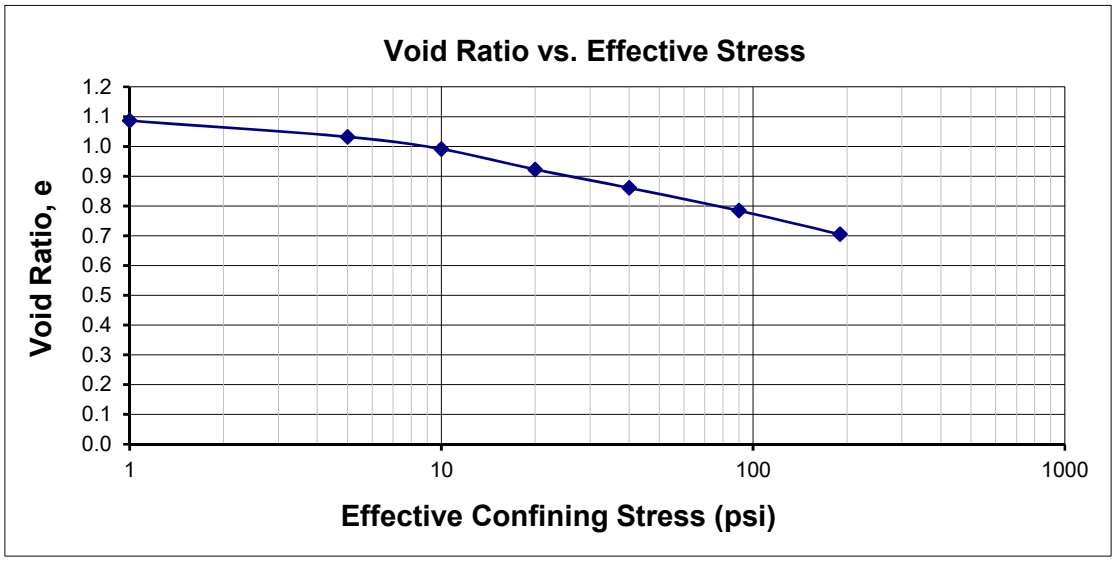
Sample No.	Reviewed:	Date:	Job Number:	Figure:
Comp GMTC 1&2 Flume Slimes	GG	25-Sep-2019	1663241.9000.9005	1B



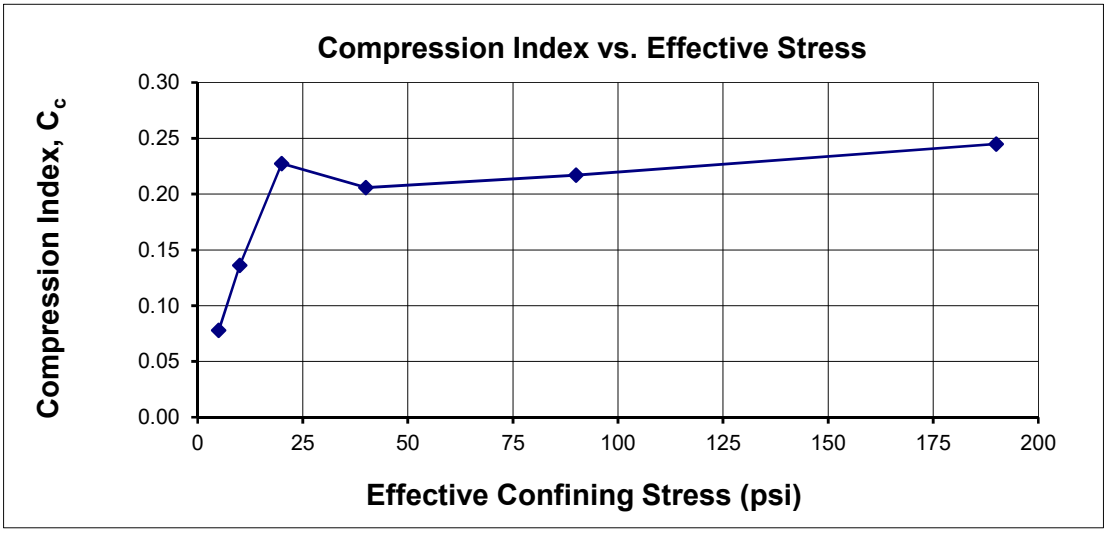


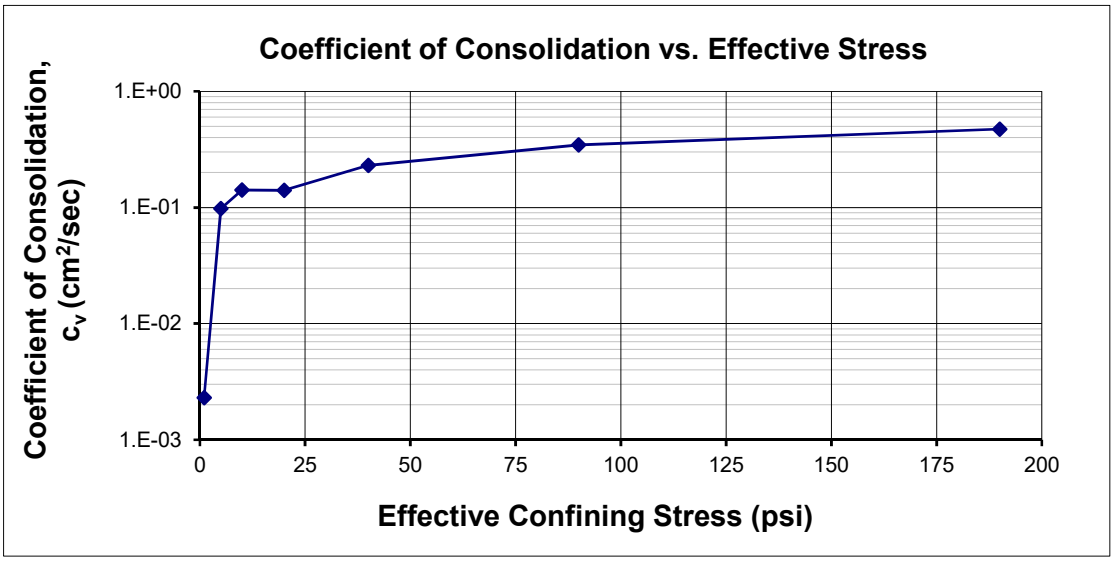
Golder Associates Inc. Denver, Colorado				Title: SLURRY CONSOLIDATION TEST RESULTS PERMEABILITY DATA
Job Short Title: MDA/Grassy Mtn PFS/OR				
Sample No.	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
Comp GMTC 1&2 Flume Slimes	GG	25-Sep-2019	1663241.9000.9005	2





Golder Associates Inc. **Denver, Colorado**			**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **DENSITY DATA**	
Job Short Title: MDA/Grassy Mtn PFS/OR				
Sample No. Comp GMTC 1&2 Flume Slimes	**Reviewed:** GG	**Date:** 25-Sep-2019	**Job Number:** 1663241.9000.9005	**Figure:** 3





Golder Associates Inc. **Denver, Colorado**		**Title:** **SLURRY CONSOLIDATION TEST RESULTS** **COMPRESSION DATA**		
Job Short Title: MDA/Grassy Mtn PFS/OR				
Sample No. Comp GMTC 1&2 Flume Slimes	**Reviewed:** GG	**Date:** 25-Sep-2019	**Job Number:** 1663241.9000.9005	**Figure:** 4

APPENDIX E

Lining System Evaluation

GOLDER

CALCULATIONS

DATE: Nov-19
PROJECT NO.: 1663241
SUBJECT: Lining System Comparison
PROJECT TITLE: Grassy Mountain TSF Detailed Design

Made by: CRL
Checked by: MDB
Reviewed by: CJM

1.0 Objectives

Compare performance of OAR 340-043-0130 with equivalent lining systems.

2.0 References

A. GSE BentoLiner NSL Geosynthetic Clay Liner, Product Data Sheet, GSE Environmental.
B. Cetco Bentomat CL, Product Data Sheet, Cetco

3.0 Calculations

3.1 Secondary Containment

The following table summarizes the performance of secondary containment alternative lining systems

Parameter	OAR Requirement	Standard GCL	Enhanced GCL
Secondary Containment Hydraulic Conductivity (cm/s)	1.00E-07	5.00E-09	5.00E-10
Soil Liner Thickness (cm)	91.44	0	0
GCL Thickness (cm)	0	0.6	0.75
Travel Time (sec)	9.16E+08	1.20E+08	1.50E+09
Travel Time (days)	**10,583**	**1,389**	**17,361**

3.2 Lining System Comparison (60 mil Liner)

The following table summarizes performance of equivalent lining systems with 60-mil liner (OAR Requirement).

Parameter	OAR Requirement	Standard GCL	Enhanced GCL
60-mil Geomembrane Liner Hydraulic Conductivity (cm/s)	1.00 E - 11		
Geomembrane Liner Thickness (cm)	0.15		
Secondary containment Hydraulic Conductivity (cm/s)	1.00E-07	5.00E-09	5.00E-10
Soil Liner Thickness	91.6	0	0
GCL Thickness (cm)	0	0.6	0.75
Travel Time (sec)	1.59E+10	1.51E+10	1.65E+10
Travel Time (Days)	**184,194**	**175,000**	**190,972**

3.3 Lining System Comparison (80 mil Liner)

The following table summarizes the performance of equivalent lining systems with 80 mil liner (exceeding the OAR requirement)

Parameter	OAR Requirement	Standard GCL	Enhanced GCL
80-mil Geomembrane Liner Hydraulic Conductivity (cm/s)	1.00E-11		
Geomembrane Liner Thickness (cm)	0.2		
Hydraulic Conductivity (cm/s)	1.00E-07	5.00E-09	5.00E-10
Soil Liner Thickness	91.6	0	0
GCL Thickness (cm)	0	0.6	0.75
Travel Time (sec)	2.09E+10	2.01E+10	2.15E+10
Travel Time (Days)	**242,065**	**232,870**	**248,843**

APPENDIX F

Water Balance

TECHNICAL MEMORANDUM

DATE November 6, 2019 **Project No.** 1663241-052-TM-Rev0

TO Christopher J. MacMahon, PE
Golder Associates Inc.

CC Russell A. Browne, PE (NV)

FROM Andrew Schaper, PE (NV) **EMAIL Aschaper@golder.com**

GRASSY MOUNTAIN TSF WATER BALANCE

1.0 INTRODUCTION

The purpose of the deterministic water balance model is to evaluate water management of the proposed Grassy Mountain Tailings Storage Facility (TSF) including:

- Predicting the volume of the supernatant pool located at the south boundary of the facility
- Sizing the Reclaim Pond at the base of the facility
- Estimating makeup water requirements
- Estimating return water flow rates from the supernatant pool to the mill
- Estimating return water flow rates from the underdrain pond to the mill

The water balance accounts for inflows and outflows to the process and tailings disposal system. Inflows include precipitation falling on lined facilities, runoff from an upstream basin reporting to the TSF, and fresh make-up water. Outflows include evaporation from the tailings surface and supernatant pool, and underdrain reclaim pond, and water lost in the void spaces of the stored tailings. For this analysis, only the process fluids within the TSF circuit were evaluated.

2.0 METHOD

Golder prepared the water balance model using Microsoft Excel spreadsheet software. The model approximates the circulation of fluids within the impoundment, underdrain reclaim pond, and mill, as well as the introduction of precipitation and evaporation as a function of time. The tailings impoundment and processing facilities are designed as zero discharge facilities to either surface water or ground water, so the impoundment liner was modeled as a no flow boundary. Golder evaluated the model for three climate scenarios which vary average monthly precipitation and evaporation: average year, 1:100 wet year, and 1:100 dry year. Each model was run from June 1, 2018 to April 30, 2031, which constitutes one realization and includes operations during Stage 1, 2, and 3.

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3.0 CLIMATE

For the climate portion of the model, Golder used regression analysis methods to predict average monthly precipitation using daily data from three nearby weather stations obtained from the Western Regional Climate Center (WRCC). Lake evaporation using the Combination Method of Penman was calculated using daily temperature, humidity, and wind speed from the Owyhee Ridge RAWS weather station. A detailed discussion and climate model development calculations are presented in Attachment A.

To obtain the one in one hundred (1:100) wet and dry year average monthly precipitation and lake evaporation values, a frequency analysis was performed on the annual precipitation and lake evaporation data from 1999 through 2017 and from 1999 through 2018, respectively. A three-parameter log-normal distribution was used to generate the extreme annual rates.

Table 1: Grassy Mountain Project Site Precipitation and Lake Evaporation Data

	Average Year Precipitation (in)	Average Year Lake Evaporation (in)	1:100 Wet Year Precipitation (in)	1:100 Wet Year Lake Evaporation (in)	1:100 Dry Year Precipitation (in)	1:100 Dry Year Lake Evaporation (in)
January	0.93	0.85	1.50	0.79	0.27	1.07
February	0.62	1.31	1.00	1.21	0.18	1.65
March	0.97	2.69	1.56	2.49	0.29	3.39
April	1.14	3.81	1.83	3.52	0.34	4.80
May	1.49	5.28	2.40	4.88	0.44	6.65
June	0.89	6.37	1.43	5.89	0.26	8.02
July	0.51	8.16	0.82	7.54	0.15	10.27
August	0.31	7.04	0.50	6.51	0.09	8.86
September	0.46	4.39	0.74	4.06	0.14	5.53
October	0.83	2.95	1.33	2.73	0.24	3.71
November	0.73	1.31	1.17	1.21	0.22	1.65
December	0.89	0.79	1.43	0.73	0.26	0.99
Total	9.77	44.97	15.71	41.55	2.88	56.59

4.0 VARIABLES USED IN WATER BALANCE

Golder obtained the following tailings, underdrain, and miscellaneous data from (1) tailings testing results provided by Golder's Denver, Colorado Geotechnical Laboratory; (2) Ausenco-provided data in Grassy Mountain

Prefeasibility Study Mass Balance report updated on March 29, 2018 (Doc. No. 101768-MB-0001); and (3) assumptions based on climatically and operationally similar mine sites in Nevada.

4.1 Given

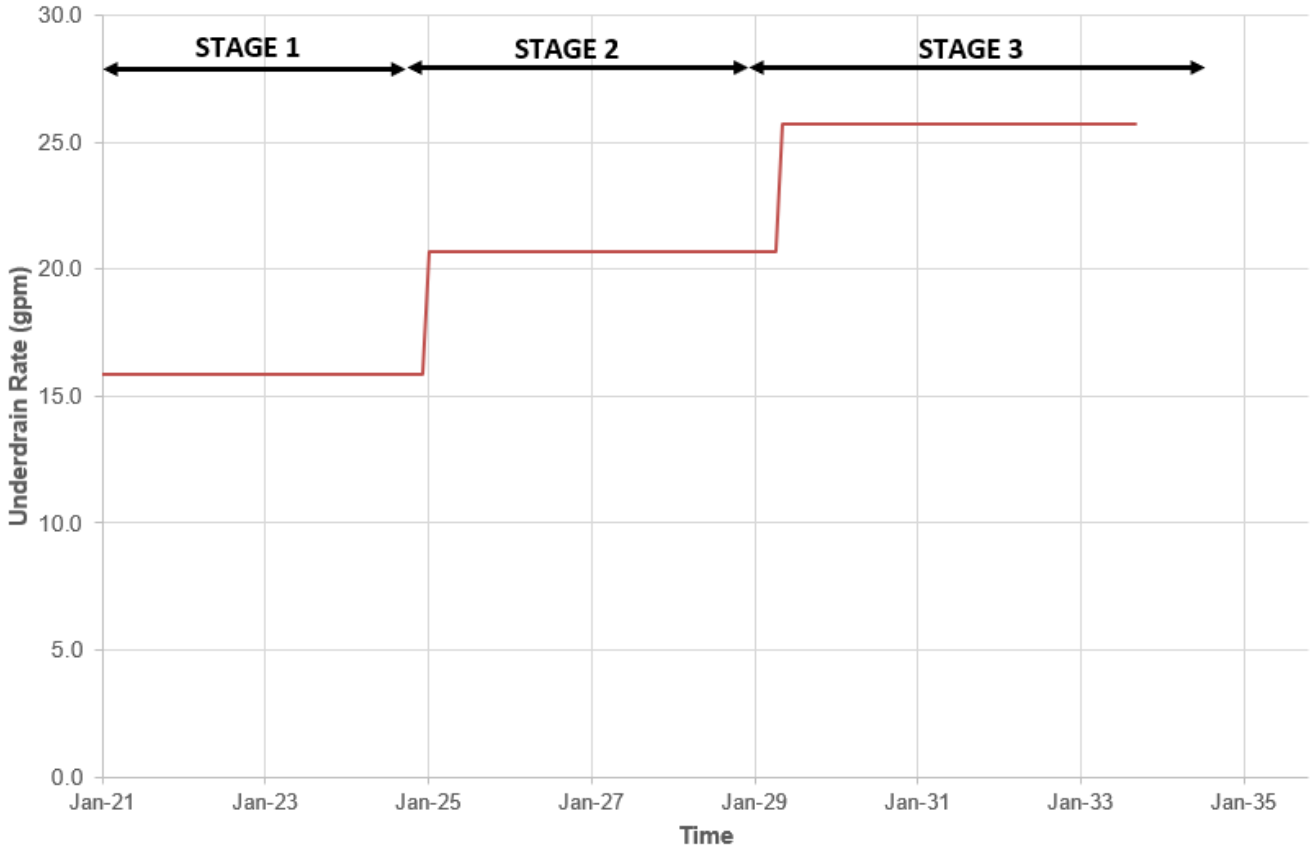
- Tailings are deposited in the TSF at a rate of 680 tons per day
- Tailings settled dry density of 80 lb/ft^3 at a saturation of 90 percent
- Tailings have a specific gravity of 2.65
- Tailings slurry contains 46 percent solids
- The dry beach area will make up 84% of the total exposed tailings area
- The wet beach area will make up 16% of the total exposed tailings area
- Evaporation rates from wet and dry tailings beach areas were developed using the tailings testing data performed in the Denver, Colorado Golder geotechnical laboratory and are presented in Table 2

Table 2: Tailings Beach Evaporation Rates

Stage	Wet Beach Evaporation Coefficient (% of ET)	Dry Beach Evaporation Coefficient (% of ET)
1	92	48
2	93	38
3	94	33

- Underdrain rates are constant and vary by stage. Tailings consolidation testing indicated the tailings underdrain rates shown in Figure 1.

Figure 1: Tailings Underdrain Rates by Stage



- Water discharge in tailings slurry at rate of 132.9 gpm

4.2 Assumptions

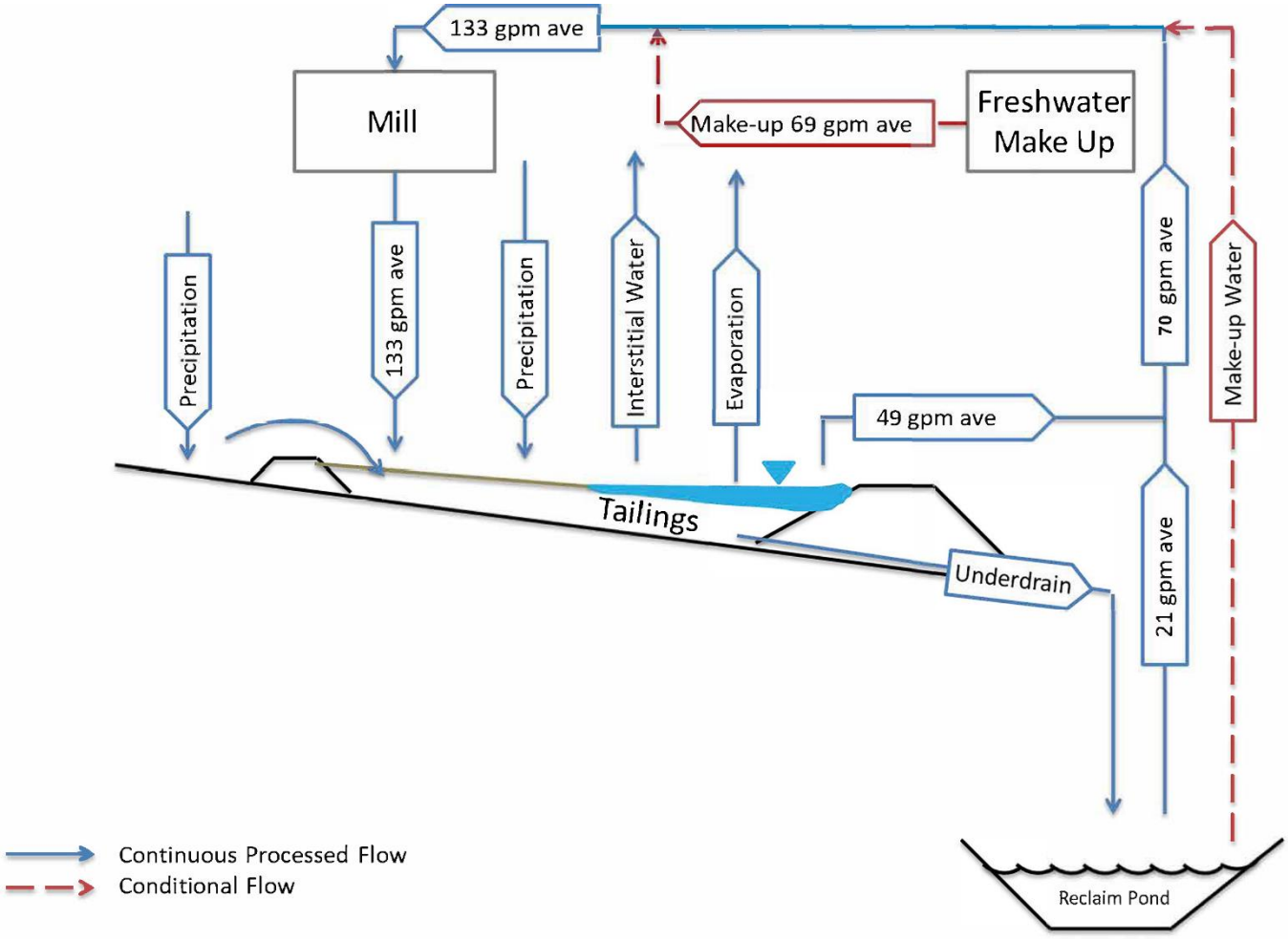
- Pool evaporation is 75 percent of the evapotranspiration rate
- Tailings have a runoff coefficient of 100 percent
- Upstream basins reporting to the TSF have a runoff coefficient of 40 percent
- No seepage through the underlying geomembrane liner
- The surface area of the supernatant pool corresponds to a minimum pool depth of 5-feet required for normal reclaim pump operations
- The area of the supernatant pool for each stage was held constant assuming that all solution above the 5-foot operating pool would be removed monthly
- Water losses in the mill are negligible and are not considered in this analysis

Total lined areas and tailings capacities of Stages 1 through 3 are presented in Table 3.

Table 3: Lined Areas and Tailings Capacities by Stage

Stage	Lined Area (ft^2)	Minimum Tailings Capacity (Million Tons)
1	1,949,200	1.01
2	2,983,900	2.07
3	4,011,100	3.67

Figure 2: Process Flow Diagram



5.0 METHOD

The reclaim rate to the mill from the supernatant pool was calculated as the rate required to:

- Maintain the supernatant pool at a minimum operating depth of 5-feet
- Maintain a minimum freeboard of 3-feet below the dam crest

The reclaim rate was determined after calculating the losses and gains to the impoundment. If in a given month there was excess water in the supernatant pool then the reclaim rate to the mill is equal to the rate water is reporting to the TSF in the tailings slurry. Conversely, if there is a monthly deficit of water in the TSF, only the minimum amount of water to maintain the 5-ft minimum supernatant pool depth would be removed from the supernatant pool, requiring the remaining water demand of the mill to be satisfied by make-up water.

Given the unknown water demands of the Grassy Mountain TSF Mill, make-up water required was defined as the rate of evaporation from the tailings beach and supernatant pool plus interstitial water loss minus precipitation. The make-up water rate is less than or equal to rate that water is reporting to the TSF in the tailings slurry.

6.0 RESULTS OF WATER BALANCE

6.1 Reclaim Rate to the Mill

The average reclaim rate from the supernatant pool is 49 gpm for Stages 1 through 3. Results for the average, 1:100 wet year, and 1:100 dry year are presented in Table 4 below. Calculations are included as an attachment to this memorandum.

Table 4: Reclaim Rates to Mill (gpm)

	Stage 1			Stage 2			Stage 3		
	Dry Year	Average Year	Wet Year	Dry Year	Average Year	Wet Year	Dry Year	Average Year	Wet Year
January	71	106	117	63	105	112	56	106	107
February	55	84	117	43	78	112	30	73	107
March	32	77	117	13	67	112	0	59	107
April	8	66	114	0	52	112	0	39	107
May	0	58	110	0	40	112	0	24	107
June	0	8	44	0	0	31	0	0	54
July	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0
September	0	22	41	0	0	23	0	0	4
October	25	66	94	4	54	87	0	36	74
November	58	89	113	46	84	112	35	81	107
December	72	105	117	64	104	112	57	105	107
Minimum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Maximum	**72**	**106**	**117**	**64**	**105**	**112**	**57**	**106**	**107**
Average	**27**	**57**	**82**	**20**	**51**	**80**	**14**	**41**	**71**

6.2 Make-up Water

The average make-up water rate is 69 gpm for Stages 1 through 3. Results for the average, 1:100 wet year, and 1:100 dry year are presented in Table 5 below. Calculations are included as an attachment to this memorandum.

Table 5: Make-up Water Requirements (gpm)

	Stage 1			Stage 2			Stage 3		
	Dry Year	Average Year	Wet Year	Dry Year	Average Year	Wet Year	Dry Year	Average Year	Wet Year
January	46	11	0	49	7	0	52	1	0
February	62	33	0	70	34	0	77	34	0
March	85	40	0	99	45	0	114	48	0
April	109	51	0	130	61	0	133	68	0
May	133	59	7	133	72	0	133	84	0
June	133	109	73	133	133	79	133	133	47
July	133	133	130	133	133	133	133	133	133
August	133	133	128	133	133	133	133	133	133
September	131	95	76	133	113	90	133	132	103
October	92	51	23	109	59	25	126	65	24
November	59	28	4	66	28	0	72	27	0
December	45	12	0	48	8	0	50	2	0
Minimum	**45**	**11**	**0**	**48**	**7**	**0**	**50**	**1**	**0**
Maximum	**133**	**133**	**130**	**133**	**133**	**133**	**133**	**133**	**133**
Average	**97**	**63**	**37**	**102**	**66**	**36**	**108**	**74**	**40**

6.3 Maximum Accumulation of Fluid in the Supernatant Pool

During average climate conditions, the supernatant pool will not accumulate any excess solution from precipitation. During the 1 in 100 wet year climate, the supernatant pool will accumulate a maximum of approximately 498,600 ft^3 of a water above its minimum operating level during January of Stage 3 operations. The accumulation will increase the pool maximum depth from 5.0 ft to 5.5 ft. The increase in the depth of the supernatant pool will not infringe on the TSF freeboard.

Golder also evaluated the available surge capacity of the supernatant pool to store the 500-year, 24-hour peak design storm event plus wave run-up due to wind action. Golder assumed that the 500-year, 24-hour storm would occur on the 5-foot deep operating pool and be subjected to the average annual wind in the prevailing direction of west to east.

Based on these calculations, the Stage 3 supernatant pool (most critical) would rise 1.8 feet above the 5-foot deep operating pool. Wave action due to the annual average wind would result in an additional rise of about ¼ foot. This results in a maximum storm and wind surge depth of about 2 feet. The design freeboard within the supernatant pool area is 3 feet above the normal operating pool, which is adequate to contain the 500-year, 24-hour peak design storm plus wave action resulting from the annual average wind speed.

Detailed calculations for storm surge and wave action are presented in Attachment E.

6.4 Reclaim Pond Sizing

The Reclaim Pond at the eastern base of the eastern TSF embankment will collect all the underdrain flows from the TSF. The Reclaim Pond has been sized to contain the sum of the following:

- Drain down of the average underdrain flow for a duration of 48-hours
- Drain down of the water in the reclaim return pipe due to power outage
- Runoff from the Reclaim Pond liner resulting from the 1 in 100-year, 24-hour storm event

Detailed calculations are included in Attachment F.

7.0 LIMITATIONS

The results of Golder's analysis are based on limited data or information. The accuracy and reliability of the data used in the analyses will have direct correlation to the accuracy and reliability of the results. Calico Resources Corporation (Calico) should be aware that values based on a limited data set, such as climate, and geotechnical properties does not guarantee that actual conditions will be accurately represented. Golder has not quantified the risk associated with recommendations that are based on the limited data available.

In addition to site conditions, operational variables can have a large impact on water consumption and accumulation. Golder's analyses and recommendations are based on design parameters such as; rate/volume of tailings placement, percent solids, beach evaporation rates, and reclaim and supernatant pond volume management. Calico should contact a qualified engineer prior to deviating from the basis of design parameters (including temporary shut downs), to evaluate what affect the changes could have on the facility.

Golder's water balance analysis uses monthly time steps, thus provides monthly flow rates and volumes, and not peak daily, or peak instantaneous pumping rates from makeup water wells or reclaim pumps. This approach may attenuate the peak rate as it averages the volumes over a month period.

8.0 CONCLUSIONS/RECOMMENDATIONS

As discussed in Section 7.0 (Limitations); this water balance has limitations and we recommend that the water balance be re-evaluated prior to changes in operations, ore rinsing, or closure.

As discuss in Section 6.3 (Maximum Accumulation of Fluid in the Supernatant Pool); under the 1 in 100 wet year climate conditions, the depth of the supernatant pool will increase by approximately 0.5 ft. This increase is not expected to infringe on the freeboard level of the TSF.

The 500-year, 24-hour peak design storm event and wave action resulting from the annual average wind will increase the supernatant pool depth approximately 2 feet. This increase is not expected to infringe on the freeboard level of TSF.

ATTACHMENTS

Attachment A Climate Data Development Memorandum
Attachment B Average Year Water Balance Calculations
Attachment C Wet Year Water Balance Calculations
Attachment D Dry Year Water Balance Calculations
Attachment E Supernatant Pool Storm Surge Capacity Calculations
Attachment F TSF Reclaim Pond Sizing

ATTACHMENT A

Climate Data Development Memorandum

MEMORANDUM

DATE October 18, 2019 **Project No.** 1663241.053.TM.REV0

TO Christopher J. MacMahon, PE

CC Russell A. Browne, PE (NV)

FROM Matthew Barton and Erin Chichlowski **EMAIL** Erin_Chichlowski@golder.com

GRASSY MOUNTAIN CLIMATE DATA – DETAILED DESIGN REVISION

There is no on-site weather station recording site specific data, therefore climate data for the Grassy Mountain project site was developed using nearby weather station data and regression analysis based on elevation of the proposed Grassy Mountain tailings storage facility (TSF) dam. For this project, climate data and station metadata of the closest Remote Automated Weather Stations (RAWS) and Cooperative Observer Network (COOP) stations to Grassy Mountain project site were identified and compared, along with the PRISM Climate Group (PRISM) spatial data, using statistical and regression analyses.

The goal was to establish quantifiable relationships which would assist in development of a representative climate data set for the Grassy Mountain project site to support the detailed design of the proposed TSF.

1.0 SUMMARY OF DATA SOURCES

The data used to develop a climate data set for the Grassy Mountain project site were selected based on proximity to the project site, period of record, and data available at the time of the analysis.

RAWS collect hourly data including air temperature, wind speed and direction, precipitation, solar radiation, and evapotranspiration. RAWS are typically stationed in remote locations and use solar and battery power to collect, store, and forward climate data. Data is forwarded to repositories such as the Western Regional Climate Center (WRCC) and available for free public download. The WRCC applied quality checks to daily and monthly time series by establishing thresholds and designating any data which falls outside these thresholds as “missing”.

The PRISM Climate Group from Oregon State University gathers climate data and observations from a range of monitoring networks and data repositories (including the WRCC) and develops spatial climate datasets based on short- or long- term climate patters. PRISM data set uses user-input coordinates, to factor in location, elevation, and coastal proximity to produce time series datasets for precipitation, air temperature, dewpoint temperature, and vapor pressure deficit values.

Data sets from five RAWS, one COOP station, and PRISM were considered based on orientation to the Grassy Mountain project site. Table 1 presents a summary of the stations used in the climate data analysis along with the station orientation to Grassy Mountain project site, the station elevation, and periods of record.

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Table 1: Summary of Climate Data Sources

	Owyhee Ridge Oregon COOP (356405)	**Red Butte Oregon RAWS (NWS ID 353616)**	**Kelsay Butte Oregon RAWS (NWS ID 353613)**	**Owyhee Dam, Oregon RAWS (NWS ID 353614)**	**PRISM**
Orientation to Grassy Mountain Project Site	Approximately 9 miles southeast	Approximately 25 miles southwest	Approximately 36 miles northwest	Approximately 6 miles southeast	Long: 43.6728°N, Lat: 117.36437°W
Elevation	4400 ft.	4460 ft.	5187 ft.	2400 ft.	3707 ft.
Earliest Period of Record	January 1985	September 1986	January 1985	February 1935	January 1895
Latest Period of Record	February 2018	February 2018	February 2018	February 2018	January 2018

2.0 PRECIPITATION

Daily values from the time period January 1, 1987 through December 31, 2017 were used to obtain average monthly precipitation and average annual precipitation. This period of record represents overlapping periods of records between all five data sets.

Table 2: Average Monthly and Annual Precipitation (in) for the Period 1987-2017

	Owhyee Ridge RAWS	**Kelsay Butte RAWS**	**Red Butte RAWS**	**PRISM**	**Owhyee Dam COOP**
JANUARY	0.92	0.90	0.68	1.20	0.98
FEBRUARY	0.61	0.71	0.52	0.79	0.60
MARCH	0.96	1.26	0.76	0.93	0.82
APRIL	1.13	1.18	0.65	0.99	0.87
MAY	1.48	1.53	1.07	1.22	1.13
JUNE	0.88	0.89	0.74	0.89	0.79
JULY	0.50	0.35	0.33	0.43	0.40
AUGUST	0.31	0.48	0.30	0.37	0.30
SEPTEMBER	0.46	0.53	0.39	0.39	0.39
OCTOBER	0.82	0.97	0.65	0.68	0.64
NOVEMBER	0.72	1.04	0.65	0.99	0.78
DECEMBER	0.88	1.18	0.79	1.25	1.04
AVERAGE ANNUAL	**9.68**	**11.03**	**7.52**	**10.13**	**8.72**
STATION ELEVATION (ft amsl)	4400	4460	5187	3707	2400

Given that elevation has a significant effect on temperature and precipitation, especially in mountainous regions, a relationship between precipitation and elevation was assumed in order to develop a climate set for the Grassy Mountain project site. Thus, regression analyses focused on developing a relationship between average annual precipitation and elevation for each station. The best-fit equation developed from this analysis and the resulting R-squared value was used to develop a factor (or multiplier) that could be used to predict average annual precipitation values for the Grassy Mountain project site. Given that regression analyses can sometimes result in false relationships between data variables, a variety of data set combinations and exclusions were considered.

The following data sets were excluded from the final analysis:

1. Red Butte RAWS: outlier in average monthly precipitation data that if included would only predict a lower annual average precipitation (i.e. a less conservative data set for the design)
2. PRISM data set: over-predicts average monthly precipitation data when compared to actual nearby station data. This spatial dataset has a resolution of 4 km which establishes a “best estimate” time series based on the long-term average patterns developed from station data (regardless of periods of record) from over 20 sources and consequently does not support observed data.

Based on the results of Golder’s analysis, a regression function estimated from the average annual precipitation and elevations of the Owhyee Ridge RAWS, Kelsay Butte RAWS, and Owhyee Dam COOP was used to develop the average annual precipitation values for the Grassy Mountain project site (see Figure 1). The power-based trendline provided the best-fit (largest R-squared value) and the resulting equation was used to calculate the average annual precipitation for Grassy Mountain:

$y=0.9851\ x^{0.2799}$

Where:

y = average annual precipitation (in)

x = elevation (ft)

An elevation of 3622 feet corresponds to the maximum embankment height of the proposed TSF main embankament and resulted in an average annual precipitation of 9.77 inches for the Grassy Mountain project site.

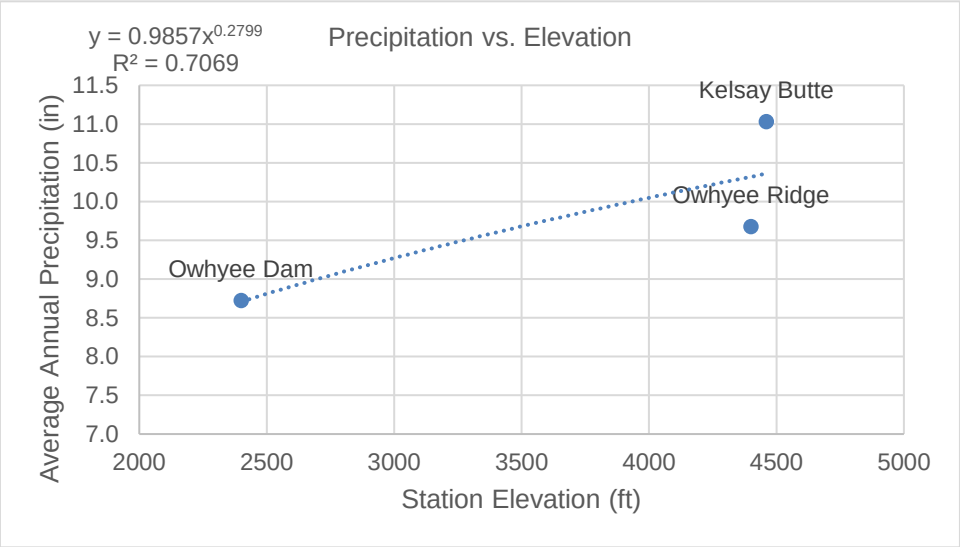

Figure 1: Precipitation vs. Elevation regression power relationship

The resulting average annual precipitation value for the Grassy Mountain project site was divided by the average annual precipitation for each of the three stations to develop a station-by-station "factor" presented in Table 3. This factor could then be multiplied by the respective stations average monthly precipitation to calculate the predicted average monthly precipitation for Grassy Mountain. A factor of 1.0 indicates no change or zero divergance between the actual value and the predicticed value.

It should be noted that only monthly average precipitation varies depending on which station and factor is chosen (i.e. total annual average precipitation is the same). The factors for each station were as follows: Owhyee Ridge RAWS = 1.01, Kelsay Butte RAWS = 0.89, and Owhyee Dam COOP = 1.12; and are presented in Table 3.

Since the Owyhee Ridge RAWS had monthly average precipitation data that best correlated with the results of the regression analysis, only the precipitation data from this station was used to develop the climate data for the Grassy Mountain project site. The Owhyee Ridge average monthly precipitation values were multipilied by 1.01 to obtain the predicted average monthly precipitation values for the Grassy Mountain project site.

Table 3: Average Annual Precipitation and Regression Factors

	Owhyee Ridge	**Kelsay Butte**	**Owhyee Dam**	**Grassy Mountain**
Average Annual Precipitation (in)	9.67	11.03	8.72	9.77
Factor	1.01	0.89	1.12	1.0

Prior to the factor adjustment, monthly precipitation values totalled from daily recorded values at the Owhyee Ridge RAWS for the period of record (1999-2017) were checked for any outliers.

Three monthly precipitation values were identified as outliers and replaced with the overall monthly average: (1) March 2003 reported 60.61 inches was replaced with 0.99 inches; (2) May 1988 reported 10.01 inches was replaced with 1.38 inches; and (3) May 1998 reported 6.02 inches was replaced with 1.38 inches.

Table 4: Factor Predicted Monthly Average Precipitation

Month	Factored Average Precipitation Depth (in)
January	0.93
February	0.62
March	0.97
April	1.14
May	1.49
June	0.89
July	0.51
August	0.31
September	0.46
October	0.83
November	0.73
December	0.89
Annual	9.77

2.1 1:100 Wet and Dry Monthly Precipitation Rates

Average monthly precipitation rates for the 1:100 wet-year and 1:100 dry-year climate scenarios were calculated using the factor predicted monthly average precipitation rates recorded at the Owhyee Ridge RAWS between the years 1999 and 2017 (summarized in Table 5).

A statistical analysis of the precipitation data was performed using an Excel workbook that performs wet year and dry year frequency analyses for specified return years using four different distribution methods. The Log Pearson III method, determined to be the best-fit for the data set, was used to calculate the average annual precipitation rates for both climate scenarios for the 100-year return period.

The 1:100 wet-year and 1:00 dry-year annual precipitation at the Grassy Mountain TSF project site is estimated to be 2.88 inches and 15.71 inches, respectively. To generate monthly average precipitation rates for each climate scenario, a multiplication factor equal to the annual average precipitation depth of each climate scenario was divided by the average annual Grassy Mountain project site precipitation depth of 9.77 inches was used.

The results of the frequency analysis, multiplication factor, and average monthly precipitation rates are presented in Table 5.

Table 5: Average Monthly Precipitation Rates for Extreme Climate Scenarios

	1:100 Dry Year Average Precipitation (in)	1:100 Wet Year Average Precipitation (in)
Multiplication Factor (dimensionless)	0.29	1.61
January	0.23	1.26
February	0.19	1.05
March	0.33	1.79
April	0.31	1.67
May	0.40	2.18
June	0.23	1.27
July	0.09	0.50
August	0.13	0.68
September	0.14	0.76
October	0.25	1.38
November	0.27	1.49
December	0.31	1.67
Annual	2.88	15.71

3.0 EVAPORATION

To develop monthly average pan evaporation data, climate data from the Owhyee Ridge RAWS was used to calculate evaporation rates using the Penman-Montieth equation. The Penman-Monteith equation combines energy-balance and mass-balance methods using available sunshine, temperature, humidity, and wind speed data to estimate evaporation from an open water surface. Penman-Monteith evaporation rates were calculated in an Excel workbook for the date range April 1998 through May 2019, beginning when solar radiation data was available from the Owhyee Ridge RAWS.

The Penman-Montieth equation used to calculate evaporation from an open water source at the Owhyee Ridge RAWS is shown below:

$$E = \frac{\Delta}{\Delta + \gamma} E_r + \frac{\gamma}{\Delta + \gamma} E_a$$

Where:

E=lake evaporation
Δ =gradient of saturated vapor pressure
γ =psychrometric constant
E_r=lake evaporation (Energy-balance Method)
E_a=lake evaporation (Aerodynamic Method)
A breakdown of the energy-balance and mass-balance (referred to as Aerodynamic Method) is shown in the following formulas:

Aerodynamic Method:

$$E_a = M(e_s - e_z)u_Z \qquad M = 0.622\frac{p_a C_E}{p_w P}$$

Where:

E_a=lake evaporation
M=mass-transfer coefficient, the dimension is the inverse of pressure
e_s=saturation vapor pressure at water temperature
e_z=vapor pressure of the air at level Z, e_z=RH(e_z^0)
e_z^0=saturation vapor pressure at air temperature at level Z
RH=relative humidity (fraction)
u_Z=wind velocity at level Z
p_a=density of air
p_w=density of water
C_E=bulk evaporation coefficient, dimensionless
P=atmosphere pressure at level Z

Energy Balance Method:

$$E_r = \frac{R_n - G}{p_w \lambda (1+\beta)} \qquad \beta = \gamma \frac{T_2 - T_1}{e_2 - e_1}$$

Where:

E_r=lake evaporation
R_n=net radiation flux at the surface, $Jm^{-2}s^{-1}$
p_w=density of water
λ =latent heat of vaporization
G=sensible heat flux to soil or water (+ if soil or water is warming)
β =Bowen ratio
γ =psychrometric constant
T_1,T_2=temperatures of the air at different elevations above the water surface
e_1,e_2=saturation vapor pressures of the air at different elevations above the water surface (function of air temperature)

Given the Owhyee Ridge RAWS only records one temperature, the second temperature that is required to calculate the Bowen ratio, β, was assumed to be recorded at the lake surface itself. To correlate air temperature to lake temperature, the following assumptions shown in Table 6 were made by Golder.

Table 6: Lake Temperature to Air Temperature Correlation

Air Temperature (C°)	Lake Temperature at the Surface (C°)
-50	1
-10	1
0	1
10	10
20	10
30	20
40	30
50	40

Table 7 presents the average monthly open water evaporation rates calculated for the Owhyee Ridge RAWS which were used to simulate pan evaporation at the Sage TSF project site.

Table 7: Average Monthly Open Water Evaporation Rates

Month	Calculated Average Evaporation Rate (in)
January	0.85
February	1.31
March	2.69
April	3.81
May	5.28
June	6.37
July	8.16
August	7.04
September	4.39
October	2.95
November	1.31
December	0.79
Annual	44.97

3.1 1:100 Wet and Dry Monthly Evaporation Rates

Average monthly evaporation rates for the 1:100 wet-year and 1:100 dry-year climate scenarios were calculated using the evaporation rates calculated from the Owhyee Ridge RAWS data between the years 1999 and 2018 (summarized in Table 7). 1998 and 2019 values were not included due to missing monthly measurements.

A statistical analysis of the precipitation data was performed using an Excel workbook that performs wet year and dry year frequency analyses for specified return years using four different distribution methods. The Log Pearson III method, determined to be the best-fit, was used to calculate the average annual evaporation rate for both climate scenarios for the 100-year return period.

The 1:100 wet-year and 1:00 dry-year annual evaporation at the Grassy Mountain TSF project site is estimated to be 41.55 inches and 56.59 inches, respectively. To generate monthly average evaporation rates for each climate scenario, a multiplication factor equal to the respective climate scenario value divided by the average mine site

value of 44.97 inches was used. The results of the frequency analyses, multiplication factor, and climate scenario average monthly evaporation rates are presented in Table 8.

Table 8: Average Monthly Evaporation Rates for Extreme Climate Scenarios

	1:100 Wet Year Average Evaporation (in)	1:100 Dry Year Average Evaporation (in)
Multiplication Factor (dimensionless)	0.92	1.26
January	0.79	1.07
February	1.21	1.64
March	2.49	3.39
April	3.52	4.80
May	4.88	6.64
June	5.89	8.03
July	7.54	10.27
August	6.51	8.86
September	4.05	5.52
October	2.73	3.71
November	1.21	1.65
December	0.73	1.00
Annual	41.55	56.59

EMC/CJM/kg

https://golderassociates.sharepoint.com/sites/17031g/1663241 grassy mountain tsf/500_reporting/520_letters/532_climate data/final/1663241.053.tm.rev0.docx

ATTACHMENT B

Average Year Water Balance Calculations

Average Year Model Simulation Results
WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

VARIABLES USED IN WATER BALANCE:

Variables by Month	Precip (in)	Evapotranspiration (in)	1-100 Wet Year Precip (in)	1-100 Wet Year ET (in)	1-100 Dry Year Precip (in)	1-100 Dry Year ET (in)
Jan	0.93	0.85	1.50	0.79	0.27	1.07
Feb	0.62	1.31	1.00	1.21	0.18	1.65
Mar	0.97	2.69	1.56	2.49	0.29	3.39
Apr	1.14	3.81	1.83	3.52	0.34	4.80
May	1.49	5.28	2.40	4.88	0.44	6.65
Jun	0.89	6.37	1.43	5.89	0.26	8.02
Jul	0.51	8.16	0.82	7.54	0.15	10.27
Aug	0.31	7.04	0.50	6.51	0.09	8.86
Sep	0.46	4.39	0.74	4.06	0.14	5.53
Oct	0.83	2.95	1.33	2.73	0.24	3.71
Nov	0.73	1.31	1.17	1.21	0.22	1.65
Dec	0.89	0.79	1.43	0.73	0.26	0.99
Totals	9.77	44.95	15.71	41.55	2.88	56.59
Monthly Avg.	0.81	3.7	1.31	3.46	0.24	4.72

Variables by Year	Tails Loading (tpd)
1	680
2	680
3	680
4	680
5	680
6	680
7	680
8	680
9	680
10	680
11	680
12	680
13	680
14	680
15	680
16	680
17	680

Variables by Stage	Lined Area (sq.ft.)	Maximum Tails Storage Vol. (tons)	Upstream Basin Area (sq.ft.)	Lined Reclaim and WRD Area (sq.ft.)	Pan Evaporation Coeff. For Dry Beach % of ET	Pan Evaporation Coeff. For Wet Beach % of ET
1	1,949,200	1,010,000	3,287,100	168,600	48	92
2	2,983,900	2,070,000	2,258,800	168,600	38	93
3	4,011,100	3,670,000	1,766,600	168,600	33	94

Unlined Areas Runoff Coefficient	0.4			
Tailings Runoff Coefficient	100	Percent of Precipitation		
Percent Wet Beach	16	Percent of Total Exposed Tailings Area		
Percent Dry Beach	84	Percent of Total Exposed Tailings Area		
Pan to Lake Evaporation Factor	75	Percent of ET		
Tailings Specific Gravity	2.65	From Prefeas Test Results		
Slurry Water Specific Gravity	1			
Tailings Percent Solids	46	Percent		
Tailings Void Ratio	1.07			
Tailings Saturation	90	Percent		
Settled Tailings Dry Density	80	pcf		
Minimum Supernatant Pool Depth	5	ft		
Minimum Supernatant Pool Area Stage 1	715,700	sq. ft.		
Minimum Supernatant Pool Volume	1,394,100	cu. ft.	10,428,592.21	US gallons
Minimum Supernatant Pool Area Stage 2	609,800	sq. ft.		
Minimum Supernatant Pool Volume	1,042,000	cu. ft.	7,794,701.30	US gallons
Minimum Supernatant Pool Area Stage 3	743,100	sq. ft.		
Minimum Supernatant Pool Volume	1,416,700	cu. ft.	10,597,651.95	US gallons

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Production Year	1	1	1	1	1	1	1	1	1	1	1	1
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	21,080	40,120	61,200	81,600	102,680	123,080	144,160	165,240	185,640	206,720	227,120	248,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
	132.9											
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	164,130	109,420	171,189	201,191	262,960	157,070	90,007	54,710	81,182	146,481	128,833	157,070
Precipitation Volume on Non-lined Areas (cu.ft.)	101,900	67,933	106,283	124,910	163,259	97,517	55,881	33,967	50,402	90,943	79,986	97,517
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	12,861	19,822	40,702	57,649	79,891	96,384	123,468	106,522	66,425	44,636	19,822	11,953
Evaporation from Dry Tailings Beach (cu.ft.)	35,229	54,294	111,489	157,908	218,833	264,008	338,196	291,777	181,946	122,265	54,294	32,742
Evaporation from Supernatant Pool (cu.ft.)	38,022	58,598	120,327	170,426	236,181	284,938	232,071	238,226	196,370	131,957	58,598	35,338
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	65,022	176,596	239,986	296,920	353,625	627,782	792,788	792,788	550,195	306,374	160,933	70,386
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	633,331	454,174	458,367	378,905	344,727	48,043	0	0	125,630	391,979	514,892	627,967
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	11	33	40	51	59	109	133	133	95	51	28	12
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	84	77	66	58	8	0	0	22	66	89	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Production Year	2	2	2	2	2	2	2	2	2	2	2	2
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	269,280	288,320	309,400	329,800	350,880	371,280	392,360	413,440	433,840	454,920	475,320	496,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	164,130	109,420	171,189	201,191	262,960	157,070	90,007	54,710	81,182	146,481	128,833	157,070
Precipitation Volume on Non-lined Areas (cu.ft.)	101,900	67,933	106,283	124,910	163,259	97,517	55,881	33,967	50,402	90,943	79,986	97,517
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	12,861	19,822	40,702	57,649	79,891	96,384	123,468	106,522	66,425	44,636	19,822	11,953
Evaporation from Dry Tailings Beach (cu.ft.)	35,229	54,294	111,489	157,908	218,833	264,008	338,196	291,777	181,946	122,265	54,294	32,742
Evaporation from Supernatant Pool (cu.ft.)	38,022	58,598	120,327	170,426	236,181	284,938	232,071	238,226	196,370	131,957	58,598	35,338
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	65,022	176,596	239,986	296,920	353,625	627,782	792,788	792,788	550,195	306,374	160,933	70,386
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	633,331	454,174	458,367	378,905	344,727	48,043	0	0	125,630	391,979	514,892	627,967
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	11	33	40	51	59	109	133	133	95	51	28	12
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	84	77	66	58	8	0	0	22	66	89	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Production Year	3	3	3	3	3	3	3	3	3	3	3	3
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	517,480	536,520	557,600	578,000	599,080	619,480	640,560	661,640	682,040	703,120	723,520	744,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	164,130	109,420	171,189	201,191	262,960	157,070	90,007	54,710	81,182	146,481	128,833	157,070
Precipitation Volume on Non-lined Areas (cu.ft.)	101,900	67,933	106,283	124,910	163,259	97,517	55,881	33,967	50,402	90,943	79,986	97,517
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	12,861	19,822	40,702	57,649	79,891	96,384	123,468	106,522	66,425	44,636	19,822	11,953
Evaporation from Dry Tailings Beach (cu.ft.)	35,229	54,294	111,489	157,908	218,833	264,008	338,196	291,777	181,946	122,265	54,294	32,742
Evaporation from Supernatant Pool (cu.ft.)	38,022	58,598	120,327	170,426	236,181	284,938	232,071	238,226	196,370	131,957	58,598	35,338
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	65,022	176,596	239,986	296,920	353,625	627,782	792,788	792,788	550,195	306,374	160,933	70,386
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	633,331	454,174	458,367	378,905	344,727	48,043	0	0	125,630	391,979	514,892	627,967
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	11	33	40	51	59	109	133	133	95	51	28	12
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	84	77	66	58	8	0	0	22	66	89	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
Production Year	4	4	4	4	4	4	4	4	4	4	4	4
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	765,680	784,720	805,800	826,200	847,280	867,680	888,760	909,840	930,240	951,320	971,720	992,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	164,130	109,420	171,189	201,191	262,960	157,070	90,007	54,710	81,182	146,481	128,833	157,070
Precipitation Volume on Non-lined Areas (cu.ft.)	101,900	67,933	106,283	124,910	163,259	97,517	55,881	33,967	50,402	90,943	79,986	97,517
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	12,861	19,822	40,702	57,649	79,891	96,384	123,468	106,522	66,425	44,636	19,822	11,953
Evaporation from Dry Tailings Beach (cu.ft.)	35,229	54,294	111,489	157,908	218,833	264,008	338,196	291,777	181,946	122,265	54,294	32,742
Evaporation from Supernatant Pool (cu.ft.)	38,022	58,598	120,327	170,426	236,181	284,938	232,071	238,226	196,370	131,957	58,598	35,338
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	65,022	176,596	239,986	296,920	353,625	627,782	792,788	792,788	550,195	306,374	160,933	70,386
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	633,331	454,174	458,367	378,905	344,727	48,043	0	0	125,630	391,979	514,892	627,967
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	11	33	40	51	59	109	133	133	95	51	28	12
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	84	77	66	58	8	0	0	22	66	89	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Production Year	5	5	5	5	5	5	5	5	5	5	5	5
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,013,880	1,032,920	1,054,000	1,074,400	1,095,480	1,115,880	1,136,960	1,158,040	1,178,440	1,199,520	1,219,920	1,241,000
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	244,319	162,879	254,827	299,488	391,435	233,810	133,981	81,440	120,846	218,048	191,777	233,810
Precipitation Volume on Non-lined Areas (cu.ft.)	70,023	46,682	73,035	85,834	112,187	67,011	38,400	23,341	34,635	62,493	54,964	67,011
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	25,023	38,565	79,190	112,162	155,437	187,525	240,221	207,249	129,237	86,845	38,565	23,257
Evaporation from Dry Tailings Beach (cu.ft.)	53,678	82,728	169,876	240,606	333,438	402,272	480,009	444,583	277,233	186,296	82,728	49,889
Evaporation from Supernatant Pool (cu.ft.)	32,396	49,927	102,523	145,209	201,234	241,200	0	796	167,314	112,432	49,927	30,109
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	41,695	182,895	268,668	349,693	431,426	767,215	792,788	792,788	655,341	349,971	161,517	47,373
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	627,715	421,733	400,742	298,123	237,984	0	0	0	0	319,440	486,299	622,037
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	7	34	45	61	72	133	133	133	113	59	28	8
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	105	78	67	52	40	0	0	0	0	54	84	104

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26
Production Year	6	6	6	6	6	6	6	6	6	6	6	6
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,262,080	1,281,120	1,302,200	1,322,600	1,343,680	1,364,080	1,385,160	1,406,240	1,426,640	1,447,720	1,468,120	1,489,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	244,319	162,879	254,827	299,488	391,435	233,810	133,981	81,440	120,846	218,048	191,777	233,810
Precipitation Volume on Non-lined Areas (cu.ft.)	70,023	46,682	73,035	85,834	112,187	67,011	38,400	23,341	34,635	62,493	54,964	67,011
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	25,023	38,565	79,190	112,162	155,437	187,525	240,221	207,249	129,237	86,845	38,565	23,257
Evaporation from Dry Tailings Beach (cu.ft.)	53,678	82,728	169,876	240,606	333,438	402,272	480,009	444,583	277,233	186,296	82,728	49,889
Evaporation from Supernatant Pool (cu.ft.)	32,396	49,927	102,523	145,209	201,234	241,200	0	796	167,314	112,432	49,927	30,109
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	41,695	182,895	268,668	349,693	431,426	767,215	792,788	792,788	655,341	349,971	161,517	47,373
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	627,715	421,733	400,742	298,123	237,984	0	0	0	0	319,440	486,299	622,037
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	7	34	45	61	72	133	133	133	113	59	28	8
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	105	78	67	52	40	0	0	0	0	54	84	104

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27
Production Year	7	7	7	7	7	7	7	7	7	7	7	7
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,510,280	1,529,320	1,550,400	1,570,800	1,591,880	1,612,280	1,633,360	1,654,440	1,674,840	1,695,920	1,716,320	1,737,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	244,319	162,879	254,827	299,488	391,435	233,810	133,981	81,440	120,846	218,048	191,777	233,810
Precipitation Volume on Non-lined Areas (cu.ft.)	70,023	46,682	73,035	85,834	112,187	67,011	38,400	23,341	34,635	62,493	54,964	67,011
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	25,023	38,565	79,190	112,162	155,437	187,525	240,221	207,249	129,237	86,845	38,565	23,257
Evaporation from Dry Tailings Beach (cu.ft.)	53,678	82,728	169,876	240,606	333,438	402,272	480,009	444,583	277,233	186,296	82,728	49,889
Evaporation from Supernatant Pool (cu.ft.)	32,396	49,927	102,523	145,209	201,234	241,200	0	796	167,314	112,432	49,927	30,109
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	41,695	182,895	268,668	349,693	431,426	767,215	792,788	792,788	655,341	349,971	161,517	47,373
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	627,715	421,733	400,742	298,123	237,984	0	0	0	0	319,440	486,299	622,037
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	7	34	45	61	72	133	133	133	113	59	28	8
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	105	78	67	52	40	0	0	0	0	54	84	104

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28
Production Year	8	8	8	8	8	8	8	8	8	8	8	8
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,758,480	1,777,520	1,798,600	1,819,000	1,840,080	1,860,480	1,881,560	1,902,640	1,923,040	1,944,120	1,964,520	1,985,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	244,319	162,879	254,827	299,488	391,435	233,810	133,981	81,440	120,846	218,048	191,777	233,810
Precipitation Volume on Non-lined Areas (cu.ft.)	70,023	46,682	73,035	85,834	112,187	67,011	38,400	23,341	34,635	62,493	54,964	67,011
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	25,023	38,565	79,190	112,162	155,437	187,525	240,221	207,249	129,237	86,845	38,565	23,257
Evaporation from Dry Tailings Beach (cu.ft.)	53,678	82,728	169,876	240,606	333,438	402,272	480,009	444,583	277,233	186,296	82,728	49,889
Evaporation from Supernatant Pool (cu.ft.)	32,396	49,927	102,523	145,209	201,234	241,200	0	796	167,314	112,432	49,927	30,109
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	41,695	182,895	268,668	349,693	431,426	767,215	792,788	792,788	655,341	349,971	161,517	47,373
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	627,715	421,733	400,742	298,123	237,984	0	0	0	0	319,440	486,299	622,037
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	7	34	45	61	72	133	133	133	113	59	28	8
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	105	78	67	52	40	0	0	0	0	54	84	104

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Production Year	9	9	9	9	9	9	9	9	9	9	9	9
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	2	2	2	2	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,006,680	2,025,720	2,046,800	2,067,200	2,088,280	2,108,680	2,129,760	2,150,840	2,171,240	2,192,320	2,212,720	2,233,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	244,319	162,879	254,827	299,488	518,979	309,994	177,637	107,976	160,222	289,096	254,265	309,994
Precipitation Volume on Non-lined Areas (cu.ft.)	70,023	46,682	73,035	85,834	87,741	52,409	30,032	18,255	27,088	48,876	42,987	52,409
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	25,023	38,565	79,190	112,162	216,263	260,908	334,225	288,351	179,810	120,829	53,656	32,358
Evaporation from Dry Tailings Beach (cu.ft.)	53,678	82,728	169,876	240,606	398,591	480,876	421,293	385,728	331,405	222,698	98,893	59,638
Evaporation from Supernatant Pool (cu.ft.)	32,396	49,927	102,523	145,209	245,223	150,795	0	0	203,888	137,009	60,841	36,691
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	41,695	182,895	268,668	349,693	498,297	767,215	792,788	792,788	764,831	387,504	153,177	11,222
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	627,715	421,733	400,742	298,123	141,126	0	0	0	0	251,920	465,620	628,201
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	7	34	45	61	84	133	133	133	132	65	27	2
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	105	78	67	52	24	0	0	0	0	42	81	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-30	Feb-30	Mar-30	Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30
Production Year	10	10	10	10	10	10	10	10	10	10	10	10
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA						-743,100	-743,100					
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,254,880	2,273,920	2,295,000	2,315,400	2,336,480	2,356,880	2,377,960	2,399,040	2,419,440	2,440,520	2,460,920	2,482,000
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	323,927	215,951	337,859	397,072	518,979	309,994	177,637	107,976	160,222	289,096	254,265	309,994
Precipitation Volume on Non-lined Areas (cu.ft.)	54,765	36,510	57,120	67,131	87,741	52,409	30,032	18,255	27,088	48,876	42,987	52,409
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	34,815	53,656	110,180	156,054	216,263	260,908	334,225	288,351	179,810	120,829	53,656	32,358
Evaporation from Dry Tailings Beach (cu.ft.)	64,167	98,893	203,070	287,620	398,591	480,876	421,293	385,728	331,405	222,698	98,893	59,638
Evaporation from Supernatant Pool (cu.ft.)	39,477	60,841	124,934	176,951	245,223	150,795	0	0	203,888	137,009	60,841	36,691
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	4,708	182,166	288,144	393,460	498,297	767,215	792,788	792,788	764,831	387,504	153,177	11,222
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	634,715	395,378	351,279	225,336	141,126	0	0	0	0	251,920	465,620	628,201
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	1	34	48	68	84	133	133	133	132	65	27	2
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	73	59	39	24	0	0	0	0	42	81	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31
Production Year	11	11	11	11	11	11	11	11	11	11	11	11
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,503,080	2,522,120	2,543,200	2,563,600	2,584,680	2,605,080	2,626,160	2,647,240	2,667,640	2,688,720	2,709,120	2,730,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	323,927	215,951	337,859	397,072	518,979	309,994	177,637	107,976	160,222	289,096	254,265	309,994
Precipitation Volume on Non-lined Areas (cu.ft.)	54,765	36,510	57,120	67,131	87,741	52,409	30,032	18,255	27,088	48,876	42,987	52,409
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	34,815	53,656	110,180	156,054	216,263	260,908	334,225	288,351	179,810	120,829	53,656	32,358
Evaporation from Dry Tailings Beach (cu.ft.)	64,167	98,893	203,070	287,620	398,591	480,876	421,293	385,728	331,405	222,698	98,893	59,638
Evaporation from Supernatant Pool (cu.ft.)	39,477	60,841	124,934	176,951	245,223	150,795	0	0	203,888	137,009	60,841	36,691
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	4,708	182,166	288,144	393,460	498,297	767,215	792,788	792,788	764,831	387,504	153,177	11,222
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	634,715	395,378	351,279	225,336	141,126	0	0	0	0	251,920	465,620	628,201
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	1	34	48	68	84	133	133	133	132	65	27	2
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	73	59	39	24	0	0	0	0	42	81	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-32	Feb-32	Mar-32	Apr-32	May-32	Jun-32	Jul-32	Aug-32	Sep-32	Oct-32	Nov-32	Dec-32
Production Year	12	12	12	12	12	12	12	12	12	12	12	12
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA						743,100	743,100					
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,751,280	2,770,320	2,791,400	2,811,800	2,832,880	2,853,280	2,874,360	2,895,440	2,915,840	2,936,920	2,957,320	2,978,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	323,927	215,951	337,859	397,072	518,979	309,994	177,637	107,976	160,222	289,096	254,265	309,994
Precipitation Volume on Non-lined Areas (cu.ft.)	54,765	36,510	57,120	67,131	87,741	52,409	30,032	18,255	27,088	48,876	42,987	52,409
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	34,815	53,656	110,180	156,054	216,263	260,908	334,225	288,351	179,810	120,829	53,656	32,358
Evaporation from Dry Tailings Beach (cu.ft.)	64,167	98,893	203,070	287,620	398,591	480,876	421,293	385,728	331,405	222,698	98,893	59,638
Evaporation from Supernatant Pool (cu.ft.)	39,477	60,841	124,934	176,951	245,223	150,795	0	0	203,888	137,009	60,841	36,691
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	4,708	182,166	288,144	393,460	498,297	767,215	792,788	792,788	764,831	387,504	153,177	11,222
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	634,715	395,378	351,279	225,336	141,126	0	0	0	0	251,920	465,620	628,201
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	1	34	48	68	84	133	133	133	132	65	27	2
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	73	59	39	24	0	0	0	0	42	81	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-33	Feb-33	Mar-33	Apr-33	May-33	Jun-33	Jul-33	Aug-33	Sep-33	Oct-33	Nov-33	Dec-33
Production Year	13	13	13	13	13	13	13	13	13	13	13	13
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,999,480	3,018,520	3,039,600	3,060,000	3,081,080	3,101,480	3,122,560	3,143,640	3,164,040	3,185,120	3,205,520	3,226,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	323,927	215,951	337,859	397,072	518,979	309,994	177,637	107,976	160,222	289,096	254,265	309,994
Precipitation Volume on Non-lined Areas (cu.ft.)	54,765	36,510	57,120	67,131	87,741	52,409	30,032	18,255	27,088	48,876	42,987	52,409
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	34,815	53,656	110,180	156,054	216,263	260,908	334,225	288,351	179,810	120,829	53,656	32,358
Evaporation from Dry Tailings Beach (cu.ft.)	64,167	98,893	203,070	287,620	398,591	480,876	421,293	385,728	331,405	222,698	98,893	59,638
Evaporation from Supernatant Pool (cu.ft.)	39,477	60,841	124,934	176,951	245,223	150,795	0	0	203,888	137,009	60,841	36,691
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	4,708	182,166	288,144	393,460	498,297	767,215	792,788	792,788	764,831	387,504	153,177	11,222
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	634,715	395,378	351,279	225,336	141,126	0	0	0	0	251,920	465,620	628,201
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	1	34	48	68	84	133	133	133	132	65	27	2
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	73	59	39	24	0	0	0	0	42	81	105

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-34	Feb-34	Mar-34	Apr-34	May-34	Jun-34	Jul-34	Aug-34	Sep-34	Oct-34	Nov-34	Dec-34
Production Year	14	14	14	14	14	14	14	14	14	14	14	14
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83	0.73	0.89
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95	1.31	0.79
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	3,247,680	3,266,720	3,287,800	3,308,200	3,329,280	3,349,680	3,370,760	3,391,840	3,412,240	3,433,320	3,453,720	3,474,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	323,927	215,951	337,859	397,072	518,979	309,994	177,637	107,976	160,222	289,096	254,265	309,994
Precipitation Volume on Non-lined Areas (cu.ft.)	54,765	36,510	57,120	67,131	87,741	52,409	30,032	18,255	27,088	48,876	42,987	52,409
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	34,815	53,656	110,180	156,054	216,263	260,908	334,225	288,351	179,810	120,829	53,656	32,358
Evaporation from Dry Tailings Beach (cu.ft.)	64,167	98,893	203,070	287,620	398,591	480,876	421,293	385,728	331,405	222,698	98,893	59,638
Evaporation from Supernatant Pool (cu.ft.)	39,477	60,841	124,934	176,951	245,223	150,795	0	0	203,888	137,009	60,841	36,691
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	4,708	182,166	288,144	393,460	498,297	767,215	792,788	792,788	764,831	387,504	153,177	11,222
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	634,715	395,378	351,279	225,336	141,126	0	0	0	0	251,920	465,620	628,201
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	1	34	48	68	84	133	133	133	132	65	27	2
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	73	59	39	24	0	0	0	0	42	81	105

Average Year Model Simulation Results
WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: AVERAGE YEAR
AVERAGE YEAR PRECIPITATION + AVERAGE EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10
Days in Month	31	28	31	30	31	30	31	31	30	31
Month-Yr	Jan-35	Feb-35	Mar-35	Apr-35	May-35	Jun-35	Jul-35	Aug-35	Sep-35	Oct-35
Production Year	15	15	15	15	15	15	15	15	15	15
Annual Precipitation	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
Active Stage	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA										
Mean Monthly Precipitation (in.)	0.93	0.62	0.97	1.14	1.49	0.89	0.51	0.31	0.46	0.83
Site Lake Evaporation (in.)	0.85	1.31	2.69	3.81	5.28	6.37	8.16	7.04	4.39	2.95
AREAS AND TAILINGS DEPOSITED INPUT DATA										
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA										
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	7,520
Total Tailings Deposited (Tons)	3,495,880	3,514,920	3,536,000	3,556,400	3,577,480	3,597,880	3,618,960	3,640,040	3,660,440	3,667,960
WATER IN DEPOSITED TAILINGS										
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	282,816
INFLOW VOLUME CALCULATION DATA										
Precipitation Volume on Lined Areas (cu.ft.)	323,927	215,951	337,859	397,072	518,979	309,994	177,637	107,976	160,222	289,096
Precipitation Volume on Non-lined Areas (cu.ft.)	54,765	36,510	57,120	67,131	87,741	52,409	30,032	18,255	27,088	48,876
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA										
Evaporation from Wet Tailings Beach (cu.ft.)	34,815	53,656	110,180	156,054	216,263	260,908	334,225	288,351	179,810	120,829
Evaporation from Dry Tailings Beach (cu.ft.)	64,167	98,893	203,070	287,620	398,591	480,876	421,293	385,728	331,405	222,698
Evaporation from Supernatant Pool (cu.ft.)	39,477	60,841	124,934	176,951	245,223	150,795	0	0	203,888	137,009
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	87,379
UNDERDRAIN DATA										
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365
NET SOLUTION BALANCE										
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	4,708	182,166	288,144	393,460	498,297	767,215	792,788	792,788	764,831	229,943
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	634,715	395,378	351,279	225,336	141,126	0	0	0	0	0
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	1	34	48	68	84	133	133	133	132	39
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	106	73	59	39	24	0	0	0	0	0

ATTACHMENT C

Wet Year Water Balance Calculations

Wet Year Model Simulation Results
WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

VARIABLES USED IN WATER BALANCE:

Variables by Month	Precip (in)	Lake Evap (in)	1-100 Wet Year Precip (in)	1-100 Wet Year Lake Evap (in)	1-100 Dry Year Precip (in)	1-100 Dry Year Lake Evap (in)
Jan	0.93	0.85	1.50	0.79	0.27	1.07
Feb	0.62	1.31	1.00	1.21	0.18	1.65
Mar	0.97	2.69	1.56	2.49	0.29	3.39
Apr	1.14	3.81	1.83	3.52	0.34	4.80
May	1.49	5.28	2.40	4.88	0.44	6.65
Jun	0.89	6.37	1.43	5.89	0.26	8.02
Jul	0.51	8.16	0.82	7.54	0.15	10.27
Aug	0.31	7.04	0.50	6.51	0.09	8.86
Sep	0.46	4.39	0.74	4.06	0.14	5.53
Oct	0.83	2.95	1.33	2.73	0.24	3.71
Nov	0.73	1.31	1.17	1.21	0.22	1.65
Dec	0.89	0.79	1.43	0.73	0.26	0.99
Totals	9.77	44.95	15.71	41.55	2.88	56.59
Monthly Avg.	0.81	3.7	1.31	3.46	0.24	4.72

Variables by Year	Tails Loading (tpd)
1	680
2	680
3	680
4	680
5	680
6	680
7	680
8	680
9	680
10	680
11	680
12	680
13	680
14	680
15	680

Variables by Stage	Lined Area (sq.ft.)	Maximum Tails Storage Vol. (tons)	Upstream Basin Area (sq.ft.)	Lined Reclaim and WRD Area (sq.ft.)	Pan Evaporation Coeff. For Dry Beach % of Lake E	Pan Evaporation Coeff. For Wet Beach % of Lake E
1	1,949,200	1,010,000	3,287,100	168,600	48	92
2	2,983,900	2,070,000	2,258,800	168,600	38	93
3	4,011,100	3,670,000	1,766,600	168,600	33	94

Unlined Areas Runoff Coefficient	0.4			
Tailings Runoff Coefficient	100	Percent of Precipitation		
Percent Wet Beach	16	Percent of Total Exposed Tailings Area		
Percent Dry Beach	84	Percent of Total Exposed Tailings Area		
Pan to Lake Evaporation Factor	75	Percent of Lake Evaporation		
Tailings Specific Gravity	2.65	From Prefeas Test Results		
Slurry Water Specific Gravity	1.00			
Tailings Percent Solids	46	Percent		
Tailings Void Ratio	1.07			
Tailings Saturation	90	Percent		
Settled Tailings Dry Density	80	pcf		
Minimum Supernatant Pool Depth	5.0	ft		
Minimum Supernatant Pool Area Stage 1	715,700	sq. ft.		
Minimum Supernatant Pool Volume	1,394,100	cu. ft.	10,428,592.21	US gallons
Minimum Supernatant Pool Area Stage 2	609,800	sq. ft.		
Minimum Supernatant Pool Volume	1,042,000	cu. ft.	7,794,701.30	US gallons
Minimum Supernatant Pool Area Stage 3	743,100	sq. ft.		
Minimum Supernatant Pool Volume	1,416,700	cu. ft.	10,597,651.95	US gallons

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Production Year	1	1	1	1	1	1	1	1	1	1	1	1
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	21,080	40,120	61,200	81,600	102,680	123,080	144,160	165,240	185,640	206,720	227,120	248,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
	5,930,454											
INFLOW VOLUME CALCULATION DATA	132.9											
Precipitation Volume on Lined Areas (cu.ft.)	263,918	175,945	275,269	323,512	422,836	252,566	144,729	87,973	130,540	235,539	207,161	252,566
Precipitation Volume on Non-lined Areas (cu.ft.)	163,854	109,236	170,901	200,853	262,518	156,806	89,855	54,618	81,046	146,235	128,616	156,806
Volume of Water Carried Over from Previous Month (cu.ft.)	0	103,233	44,503	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	11,888	18,322	37,624	53,288	73,848	89,094	114,129	98,465	61,400	41,260	18,322	11,049
Evaporation from Dry Tailings Beach (cu.ft.)	32,564	50,187	103,056	145,964	202,280	244,039	312,615	269,707	168,184	113,016	50,187	30,265
Evaporation from Supernatant Pool (cu.ft.)	35,146	54,166	111,226	157,535	218,316	263,385	337,398	291,088	181,517	121,976	54,166	32,665
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	103,233	44,503	0	0	0	0	0	0	0	0	0	90,453
Volume of Solution in Supernatant Pool (cu.ft)	1,497,333	1,438,603	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,484,553
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	0	0	6,171	69,461	54,031	424,184	774,498	761,610	436,554	139,418	23,936	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	698,353	630,770	692,181	606,364	644,322	251,641	0	0	239,271	558,935	651,889	698,353
Reclaim Rate from Underdrain to the Mill (gpm)	15.8	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	0	0	1	12	9	73	130	128	76	23	4	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	117	117	116	105	108	44	0	0	41	94	113	117

Wet Year Model Simulation Results
WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Production Year	2	2	2	2	2	2	2	2	2	2	2	2
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	269,280	288,320	309,400	329,800	350,880	371,280	392,360	413,440	433,840	454,920	475,320	496,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	263,918	175,945	275,269	323,512	422,836	252,566	144,729	87,973	130,540	235,539	207,161	252,566
Precipitation Volume on Non-lined Areas (cu.ft.)	163,854	109,236	170,901	200,853	262,518	156,806	89,855	54,618	81,046	146,235	128,616	156,806
Volume of Water Carried Over from Previous Month (cu.ft.)	90,453	193,686	134,956	84,282	14,821	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	11,888	18,322	37,624	53,288	73,848	89,094	114,129	98,465	61,400	41,260	18,322	11,049
Evaporation from Dry Tailings Beach (cu.ft.)	32,564	50,187	103,056	145,964	202,280	244,039	312,615	269,707	168,184	113,016	50,187	30,265
Evaporation from Supernatant Pool (cu.ft.)	35,146	54,166	111,226	157,535	218,316	263,385	337,398	291,088	181,517	121,976	54,166	32,665
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	193,686	134,956	84,282	14,821	0	0	0	0	0	0	0	90,453
Volume of Solution in Supernatant Pool (cu.ft)	1,587,786	1,529,056	1,478,382	1,408,921	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,484,553
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	0	0	0	0	39,210	424,184	774,498	761,610	436,554	139,418	23,936	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	698,353	630,770	698,353	675,825	659,143	251,641	0	0	239,271	558,935	651,889	698,353
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	0	0	0	0	7	73	130	128	76	23	4	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	117	117	117	117	110	44	0	0	41	94	113	117

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Production Year	3	3	3	3	3	3	3	3	3	3	3	3
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	517,480	536,520	557,600	578,000	599,080	619,480	640,560	661,640	682,040	703,120	723,520	744,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	263,918	175,945	275,269	323,512	422,836	252,566	144,729	87,973	130,540	235,539	207,161	252,566
Precipitation Volume on Non-lined Areas (cu.ft.)	163,854	109,236	170,901	200,853	262,518	156,806	89,855	54,618	81,046	146,235	128,616	156,806
Volume of Water Carried Over from Previous Month (cu.ft.)	90,453	193,686	134,956	84,282	14,821	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	11,888	18,322	37,624	53,288	73,848	89,094	114,129	98,465	61,400	41,260	18,322	11,049
Evaporation from Dry Tailings Beach (cu.ft.)	32,564	50,187	103,056	145,964	202,280	244,039	312,615	269,707	168,184	113,016	50,187	30,265
Evaporation from Supernatant Pool (cu.ft.)	35,146	54,166	111,226	157,535	218,316	263,385	337,398	291,088	181,517	121,976	54,166	32,665
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	193,686	134,956	84,282	14,821	0	0	0	0	0	0	0	90,453
Volume of Solution in Supernatant Pool (cu.ft)	1,587,786	1,529,056	1,478,382	1,408,921	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,484,553
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	0	0	0	0	39,210	424,184	774,498	761,610	436,554	139,418	23,936	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	698,353	630,770	698,353	675,825	659,143	251,641	0	0	239,271	558,935	651,889	698,353
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	0	0	0	0	7	73	130	128	76	23	4	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	117	117	117	117	110	44	0	0	41	94	113	117

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
Production Year	4	4	4	4	4	4	4	4	4	4	4	4
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	765,680	784,720	805,800	826,200	847,280	867,680	888,760	909,840	930,240	951,320	971,720	992,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	263,918	175,945	275,269	323,512	422,836	252,566	144,729	87,973	130,540	235,539	207,161	252,566
Precipitation Volume on Non-lined Areas (cu.ft.)	163,854	109,236	170,901	200,853	262,518	156,806	89,855	54,618	81,046	146,235	128,616	156,806
Volume of Water Carried Over from Previous Month (cu.ft.)	90,453	193,686	134,956	84,282	14,821	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	11,888	18,322	37,624	53,288	73,848	89,094	114,129	98,465	61,400	41,260	18,322	11,049
Evaporation from Dry Tailings Beach (cu.ft.)	32,564	50,187	103,056	145,964	202,280	244,039	312,615	269,707	168,184	113,016	50,187	30,265
Evaporation from Supernatant Pool (cu.ft.)	35,146	54,166	111,226	157,535	218,316	263,385	337,398	291,088	181,517	121,976	54,166	32,665
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	193,686	134,956	84,282	14,821	0	0	0	0	0	0	0	90,453
Volume of Solution in Supernatant Pool (cu.ft)	1,587,786	1,529,056	1,478,382	1,408,921	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,484,553
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	0	0	0	0	39,210	424,184	774,498	761,610	436,554	139,418	23,936	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	698,353	630,770	698,353	675,825	659,143	251,641	0	0	239,271	558,935	651,889	698,353
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	0	0	0	0	7	73	130	128	76	23	4	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	117	117	117	117	110	44	0	0	41	94	113	117

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Production Year	5	5	5	5	5	5	5	5	5	5	5	5
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,013,880	1,032,920	1,054,000	1,074,400	1,095,480	1,115,880	1,136,960	1,158,040	1,178,440	1,199,520	1,219,920	1,241,000
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	392,861	261,907	409,758	481,571	629,422	375,963	215,440	130,954	194,318	350,617	308,374	375,963
Precipitation Volume on Non-lined Areas (cu.ft.)	112,596	75,064	117,438	138,020	180,395	107,753	61,746	37,532	55,692	100,488	88,381	107,753
Volume of Water Carried Over from Previous Month (cu.ft.)	90,453	248,276	205,741	163,002	85,246	12,213	0	0	0	0	0	1,448
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	23,130	35,648	73,201	103,678	143,680	173,341	222,051	191,573	119,461	80,276	35,648	21,498
Evaporation from Dry Tailings Beach (cu.ft.)	49,618	76,470	157,027	222,406	308,217	371,845	476,335	410,955	256,263	172,204	76,470	46,116
Evaporation from Supernatant Pool (cu.ft.)	29,945	46,151	94,768	134,225	186,013	224,413	126,649	113,805	154,658	103,928	46,151	27,831
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	248,276	205,741	163,002	85,246	12,213	0	0	0	0	0	1,448	144,780
Volume of Solution in Supernatant Pool (cu.ft)	1,290,276	1,247,741	1,205,002	1,127,246	1,054,213	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,043,448	1,186,780
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	0	0	0	0	0	510,708	792,788	792,788	517,411	150,241	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	669,410	604,628	669,410	647,816	669,410	137,108	0	0	130,405	519,169	647,816	669,410
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	0	0	0	0	0	88	133	133	90	25	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	112	112	112	112	112	24	0	0	23	87	112	112

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26
Production Year	6	6	6	6	6	6	6	6	6	6	6	6
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,262,080	1,281,120	1,302,200	1,322,600	1,343,680	1,364,080	1,385,160	1,406,240	1,426,640	1,447,720	1,468,120	1,489,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	392,861	261,907	409,758	481,571	629,422	375,963	215,440	130,954	194,318	350,617	308,374	375,963
Precipitation Volume on Non-lined Areas (cu.ft.)	112,596	75,064	117,438	138,020	180,395	107,753	61,746	37,532	55,692	100,488	88,381	107,753
Volume of Water Carried Over from Previous Month (cu.ft.)	144,780	302,602	260,068	217,329	139,572	66,540	0	0	0	0	0	1,448
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	23,130	35,648	73,201	103,678	143,680	173,341	222,051	191,573	119,461	80,276	35,648	21,498
Evaporation from Dry Tailings Beach (cu.ft.)	49,618	76,470	157,027	222,406	308,217	371,845	476,335	410,955	256,263	172,204	76,470	46,116
Evaporation from Supernatant Pool (cu.ft.)	29,945	46,151	94,768	134,225	186,013	224,413	126,649	113,805	154,658	103,928	46,151	27,831
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	302,602	260,068	217,329	139,572	66,540	0	0	0	0	0	1,448	144,780
Volume of Solution in Supernatant Pool (cu.ft)	1,344,602	1,302,068	1,259,329	1,181,572	1,108,540	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,043,448	1,186,780
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	0	0	0	0	0	456,381	792,788	792,788	517,411	150,241	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	669,410	604,628	669,410	647,816	669,410	191,435	0	0	130,405	519,169	647,816	669,410
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	0	0	0	0	0	79	133	133	90	25	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	112	112	112	112	112	33	0	0	23	87	112	112

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27
Production Year	7	7	7	7	7	7	7	7	7	7	7	7
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,510,280	1,529,320	1,550,400	1,570,800	1,591,880	1,612,280	1,633,360	1,654,440	1,674,840	1,695,920	1,716,320	1,737,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	392,861	261,907	409,758	481,571	629,422	375,963	215,440	130,954	194,318	350,617	308,374	375,963
Precipitation Volume on Non-lined Areas (cu.ft.)	112,596	75,064	117,438	138,020	180,395	107,753	61,746	37,532	55,692	100,488	88,381	107,753
Volume of Water Carried Over from Previous Month (cu.ft.)	144,780	302,602	260,068	217,329	139,572	66,540	0	0	0	0	0	1,448
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	23,130	35,648	73,201	103,678	143,680	173,341	222,051	191,573	119,461	80,276	35,648	21,498
Evaporation from Dry Tailings Beach (cu.ft.)	49,618	76,470	157,027	222,406	308,217	371,845	476,335	410,955	256,263	172,204	76,470	46,116
Evaporation from Supernatant Pool (cu.ft.)	29,945	46,151	94,768	134,225	186,013	224,413	126,649	113,805	154,658	103,928	46,151	27,831
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	302,602	260,068	217,329	139,572	66,540	0	0	0	0	0	1,448	144,780
Volume of Solution in Supernatant Pool (cu.ft)	1,344,602	1,302,068	1,259,329	1,181,572	1,108,540	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,043,448	1,186,780
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	0	0	0	0	0	456,381	792,788	792,788	517,411	150,241	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	669,410	604,628	669,410	647,816	669,410	191,435	0	0	130,405	519,169	647,816	669,410
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	0	0	0	0	0	79	133	133	90	25	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	112	112	112	112	112	33	0	0	23	87	112	112

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28
Production Year	8	8	8	8	8	8	8	8	8	8	8	8
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,758,480	1,777,520	1,798,600	1,819,000	1,840,080	1,860,480	1,881,560	1,902,640	1,923,040	1,944,120	1,964,520	1,985,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	392,861	261,907	409,758	481,571	629,422	375,963	215,440	130,954	194,318	350,617	308,374	375,963
Precipitation Volume on Non-lined Areas (cu.ft.)	112,596	75,064	117,438	138,020	180,395	107,753	61,746	37,532	55,692	100,488	88,381	107,753
Volume of Water Carried Over from Previous Month (cu.ft.)	144,780	302,602	260,068	217,329	139,572	66,540	0	0	0	0	0	1,448
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	23,130	35,648	73,201	103,678	143,680	173,341	222,051	191,573	119,461	80,276	35,648	21,498
Evaporation from Dry Tailings Beach (cu.ft.)	49,618	76,470	157,027	222,406	308,217	371,845	476,335	410,955	256,263	172,204	76,470	46,116
Evaporation from Supernatant Pool (cu.ft.)	29,945	46,151	94,768	134,225	186,013	224,413	126,649	113,805	154,658	103,928	46,151	27,831
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	302,602	260,068	217,329	139,572	66,540	0	0	0	0	0	1,448	144,780
Volume of Solution in Supernatant Pool (cu.ft)	1,344,602	1,302,068	1,259,329	1,181,572	1,108,540	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,043,448	1,186,780
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	0	0	0	0	0	456,381	792,788	792,788	517,411	150,241	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	669,410	604,628	669,410	647,816	669,410	191,435	0	0	130,405	519,169	647,816	669,410
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	0	0	0	0	0	79	133	133	90	25	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	112	112	112	112	112	33	0	0	23	87	112	112

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Production Year	9	9	9	9	9	9	9	9	9	9	9	9
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	2	2	2	2	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,006,680	2,025,720	2,046,800	2,067,200	2,088,280	2,108,680	2,129,760	2,150,840	2,171,240	2,192,320	2,212,720	2,233,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	392,861	261,907	409,758	481,571	834,510	498,466	285,638	173,623	257,634	464,861	408,854	498,466
Precipitation Volume on Non-lined Areas (cu.ft.)	112,596	75,064	117,438	138,020	141,086	84,273	48,291	29,354	43,557	78,592	69,123	84,273
Volume of Water Carried Over from Previous Month (cu.ft.)	144,780	302,602	260,068	217,329	139,572	75,207	0	0	0	0	0	43,689
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	23,130	35,648	73,201	103,678	199,905	241,173	308,944	266,540	166,209	111,689	49,598	29,910
Evaporation from Dry Tailings Beach (cu.ft.)	49,618	76,470	157,027	222,406	368,442	444,503	569,411	484,285	306,337	205,853	91,413	55,127
Evaporation from Supernatant Pool (cu.ft.)	29,945	46,151	94,768	134,225	226,674	273,469	3,423	0	188,466	126,646	56,239	33,915
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	302,602	260,068	217,329	139,572	75,207	0	0	0	0	0	43,689	262,536
Volume of Solution in Supernatant Pool (cu.ft)	1,344,602	1,302,068	1,259,329	1,181,572	1,491,907	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,460,389	1,679,236
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	0	0	0	0	0	538,238	792,788	792,788	596,860	145,675	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	669,410	604,628	669,410	647,816	639,423	80,559	0	0	21,937	493,748	618,797	639,423
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	0	0	0	0	0	93	133	133	103	24	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	112	112	112	112	107	14	0	0	4	83	107	107

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-30	Feb-30	Mar-30	Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30
Production Year	10	10	10	10	10	10	10	10	10	10	10	10
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,254,880	2,273,920	2,295,000	2,315,400	2,336,480	2,356,880	2,377,960	2,399,040	2,419,440	2,440,520	2,460,920	2,482,000
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	520,869	347,246	543,272	638,484	834,510	498,466	285,638	173,623	257,634	464,861	408,854	498,466
Precipitation Volume on Non-lined Areas (cu.ft.)	88,061	58,707	91,848	107,945	141,086	84,273	48,291	29,354	43,557	78,592	69,123	84,273
Volume of Water Carried Over from Previous Month (cu.ft.)	262,536	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	32,182	49,598	101,846	144,250	199,905	241,173	308,944	266,540	166,209	111,689	49,598	29,910
Evaporation from Dry Tailings Beach (cu.ft.)	59,314	91,413	187,710	265,864	368,442	444,503	569,411	484,285	306,337	205,853	91,413	55,127
Evaporation from Supernatant Pool (cu.ft.)	36,491	56,239	115,484	163,566	226,674	273,469	3,423	0	188,466	126,646	56,239	33,915
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689	262,536
Volume of Solution in Supernatant Pool (cu.ft)	1,915,239	1,902,706	1,887,847	1,823,558	1,759,193	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,460,389	1,679,236
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	0	0	0	0	0	270,952	792,788	792,788	596,860	145,675	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	639,423	577,544	639,423	618,797	639,423	347,845	0	0	21,937	493,748	618,797	639,423
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	0	0	0	0	0	47	133	133	103	24	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	107	107	107	107	107	60	0	0	4	83	107	107

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31
Production Year	11	11	11	11	11	11	11	11	11	11	11	11
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,503,080	2,522,120	2,543,200	2,563,600	2,584,680	2,605,080	2,626,160	2,647,240	2,667,640	2,688,720	2,709,120	2,730,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	520,869	347,246	543,272	638,484	834,510	498,466	285,638	173,623	257,634	464,861	408,854	498,466
Precipitation Volume on Non-lined Areas (cu.ft.)	88,061	58,707	91,848	107,945	141,086	84,273	48,291	29,354	43,557	78,592	69,123	84,273
Volume of Water Carried Over from Previous Month (cu.ft.)	262,536	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	32,182	49,598	101,846	144,250	199,905	241,173	308,944	266,540	166,209	111,689	49,598	29,910
Evaporation from Dry Tailings Beach (cu.ft.)	59,314	91,413	187,710	265,864	368,442	444,503	569,411	484,285	306,337	205,853	91,413	55,127
Evaporation from Supernatant Pool (cu.ft.)	36,491	56,239	115,484	163,566	226,674	273,469	3,423	0	188,466	126,646	56,239	33,915
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689	262,536
Volume of Solution in Supernatant Pool (cu.ft)	1,915,239	1,902,706	1,887,847	1,823,558	1,759,193	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,460,389	1,679,236
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	0	0	0	0	0	270,952	792,788	792,788	596,860	145,675	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	639,423	577,544	639,423	618,797	639,423	347,845	0	0	21,937	493,748	618,797	639,423
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	0	0	0	0	0	47	133	133	103	24	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	107	107	107	107	107	60	0	0	4	83	107	107

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-32	Feb-32	Mar-32	Apr-32	May-32	Jun-32	Jul-32	Aug-32	Sep-32	Oct-32	Nov-32	Dec-32
Production Year	12	12	12	12	12	12	12	12	12	12	12	12
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA						743,100	743,100					
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,751,280	2,770,320	2,791,400	2,811,800	2,832,880	2,853,280	2,874,360	2,895,440	2,915,840	2,936,920	2,957,320	2,978,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	520,869	347,246	543,272	638,484	834,510	498,466	285,638	173,623	257,634	464,861	408,854	498,466
Precipitation Volume on Non-lined Areas (cu.ft.)	88,061	58,707	91,848	107,945	141,086	84,273	48,291	29,354	43,557	78,592	69,123	84,273
Volume of Water Carried Over from Previous Month (cu.ft.)	262,536	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	32,182	49,598	101,846	144,250	199,905	241,173	308,944	266,540	166,209	111,689	49,598	29,910
Evaporation from Dry Tailings Beach (cu.ft.)	59,314	91,413	187,710	265,864	368,442	444,503	569,411	484,285	306,337	205,853	91,413	55,127
Evaporation from Supernatant Pool (cu.ft.)	36,491	56,239	115,484	163,566	226,674	273,469	3,423	0	188,466	126,646	56,239	33,915
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689	262,536
Volume of Solution in Supernatant Pool (cu.ft)	1,915,239	1,902,706	1,887,847	1,823,558	1,759,193	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,460,389	1,679,236
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	0	0	0	0	0	270,952	792,788	792,788	596,860	145,675	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	639,423	577,544	639,423	618,797	639,423	347,845	0	0	21,937	493,748	618,797	639,423
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	0	0	0	0	0	47	133	133	103	24	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	107	107	107	107	107	60	0	0	4	83	107	107

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-33	Feb-33	Mar-33	Apr-33	May-33	Jun-33	Jul-33	Aug-33	Sep-33	Oct-33	Nov-33	Dec-33
Production Year	13	13	13	13	13	13	13	13	13	13	13	13
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,999,480	3,018,520	3,039,600	3,060,000	3,081,080	3,101,480	3,122,560	3,143,640	3,164,040	3,185,120	3,205,520	3,226,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	520,869	347,246	543,272	638,484	834,510	498,466	285,638	173,623	257,634	464,861	408,854	498,466
Precipitation Volume on Non-lined Areas (cu.ft.)	88,061	58,707	91,848	107,945	141,086	84,273	48,291	29,354	43,557	78,592	69,123	84,273
Volume of Water Carried Over from Previous Month (cu.ft.)	262,536	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	32,182	49,598	101,846	144,250	199,905	241,173	308,944	266,540	166,209	111,689	49,598	29,910
Evaporation from Dry Tailings Beach (cu.ft.)	59,314	91,413	187,710	265,864	368,442	444,503	569,411	484,285	306,337	205,853	91,413	55,127
Evaporation from Supernatant Pool (cu.ft.)	36,491	56,239	115,484	163,566	226,674	273,469	3,423	0	188,466	126,646	56,239	33,915
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689	262,536
Volume of Solution in Supernatant Pool (cu.ft)	1,915,239	1,902,706	1,887,847	1,823,558	1,759,193	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,460,389	1,679,236
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	0	0	0	0	0	270,952	792,788	792,788	596,860	145,675	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	639,423	577,544	639,423	618,797	639,423	347,845	0	0	21,937	493,748	618,797	639,423
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	0	0	0	0	0	47	133	133	103	24	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	107	107	107	107	107	60	0	0	4	83	107	107

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-34	Feb-34	Mar-34	Apr-34	May-34	Jun-34	Jul-34	Aug-34	Sep-34	Oct-34	Nov-34	Dec-34
Production Year	14	14	14	14	14	14	14	14	14	14	14	14
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33	1.17	1.43
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73	1.21	0.73
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	3,247,680	3,266,720	3,287,800	3,308,200	3,329,280	3,349,680	3,370,760	3,391,840	3,412,240	3,433,320	3,453,720	3,474,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	520,869	347,246	543,272	638,484	834,510	498,466	285,638	173,623	257,634	464,861	408,854	498,466
Precipitation Volume on Non-lined Areas (cu.ft.)	88,061	58,707	91,848	107,945	141,086	84,273	48,291	29,354	43,557	78,592	69,123	84,273
Volume of Water Carried Over from Previous Month (cu.ft.)	262,536	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	32,182	49,598	101,846	144,250	199,905	241,173	308,944	266,540	166,209	111,689	49,598	29,910
Evaporation from Dry Tailings Beach (cu.ft.)	59,314	91,413	187,710	265,864	368,442	444,503	569,411	484,285	306,337	205,853	91,413	55,127
Evaporation from Supernatant Pool (cu.ft.)	36,491	56,239	115,484	163,566	226,674	273,469	3,423	0	188,466	126,646	56,239	33,915
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	498,539	486,006	471,147	406,858	342,493	0	0	0	0	0	43,689	262,536
Volume of Solution in Supernatant Pool (cu.ft)	1,915,239	1,902,706	1,887,847	1,823,558	1,759,193	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,460,389	1,679,236
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	0	0	0	0	0	270,952	792,788	792,788	596,860	145,675	0	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	639,423	577,544	639,423	618,797	639,423	347,845	0	0	21,937	493,748	618,797	639,423
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	0	0	0	0	0	47	133	133	103	24	0	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	107	107	107	107	107	60	0	0	4	83	107	107

Wet Year Model Simulation Results
WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: WET YEAR
WET YEAR PRECIPITATION + WET EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10
Days in Month	31	28	31	30	31	30	31	31	30	31
Month-Yr	Jan-35	Feb-35	Mar-35	Apr-35	May-35	Jun-35	Jul-35	Aug-35	Sep-35	Oct-35
Production Year	15	15	15	15	15	15	15	15	15	15
Annual Precipitation	WET	WET	WET	WET	WET	WET	WET	WET	WET	WET
Active Stage	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA										
Mean Monthly Precipitation (in.)	1.50	1.00	1.56	1.83	2.40	1.43	0.82	0.50	0.74	1.33
Site Lake Evaporation (in.)	0.79	1.21	2.49	3.52	4.88	5.89	7.54	6.51	4.06	2.73
AREAS AND TAILINGS DEPOSITED INPUT DATA										
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA										
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	7,520
Total Tailings Deposited (Tons)	3,495,880	3,514,920	3,536,000	3,556,400	3,577,480	3,597,880	3,618,960	3,640,040	3,660,440	3,667,960
WATER IN DEPOSITED TAILINGS										
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	282,816
INFLOW VOLUME CALCULATION DATA										
Precipitation Volume on Lined Areas (cu.ft.)	520,869	347,246	543,272	638,484	834,510	498,466	285,638	173,623	257,634	464,861
Precipitation Volume on Non-lined Areas (cu.ft.)	88,061	58,707	91,848	107,945	141,086	84,273	48,291	29,354	43,557	78,592
Volume of Water Carried Over from Previous Month (cu.ft.)	262,536	498,539	486,006	471,147	406,858	342,493	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA										
Evaporation from Wet Tailings Beach (cu.ft.)	32,182	49,598	101,846	144,250	199,905	241,173	308,944	266,540	166,209	111,689
Evaporation from Dry Tailings Beach (cu.ft.)	59,314	91,413	187,710	265,864	368,442	444,503	569,411	484,285	306,337	205,853
Evaporation from Supernatant Pool (cu.ft.)	36,491	56,239	115,484	163,566	226,674	273,469	3,423	0	188,466	126,646
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	87,379
UNDERDRAIN DATA										
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365
NET SOLUTION BALANCE										
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	498,539	486,006	471,147	406,858	342,493	0	0	0	0	11,886
Volume of Solution in Supernatant Pool (cu.ft)	1,915,239	1,902,706	1,887,847	1,823,558	1,759,193	1,416,700	1,416,700	1,416,700	1,416,700	1,428,586
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	0	0	0	0	0	270,952	792,788	792,788	596,860	0
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	639,423	577,544	639,423	618,797	639,423	347,845	0	0	21,937	129,451
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	0	0	0	0	0	47	133	133	103	0
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	107	107	107	107	107	60	0	0	4	22

ATTACHMENT D

Dry Year Water Balance Calculations

Dry Year Model Simulation Results
WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

VARIABLES USED IN WATER BALANCE:

Variables by Month	Precip (in)	Lake Evap (in)	1-100 Wet Year Precip (in)	1-100 Wet Year Lake Evap (in)	1-100 Dry Year Precip (in)	1-100 Dry Year Lake Evap (in)
Jan	0.93	0.85	1.50	0.79	0.27	1.07
Feb	0.62	1.31	1.00	1.21	0.18	1.65
Mar	0.97	2.69	1.56	2.49	0.29	3.39
Apr	1.14	3.81	1.83	3.52	0.34	4.80
May	1.49	5.28	2.40	4.88	0.44	6.65
Jun	0.89	6.37	1.43	5.89	0.26	8.02
Jul	0.51	8.16	0.82	7.54	0.15	10.27
Aug	0.31	7.04	0.50	6.51	0.09	8.86
Sep	0.46	4.39	0.74	4.06	0.14	5.53
Oct	0.83	2.95	1.33	2.73	0.24	3.71
Nov	0.73	1.31	1.17	1.21	0.22	1.65
Dec	0.89	0.79	1.43	0.73	0.26	0.99
Totals	9.77	44.95	15.71	41.55	2.88	56.59
Monthly Avg.	0.81	3.7	1.31	3.46	0.24	4.72

Variables by Year	Tails Loading (tpd)
1	680
2	680
3	680
4	680
5	680
6	680
7	680
8	680
9	680
10	680
11	680
12	680
13	680
14	680
15	680

Variables by Stage	Lined Area (sq.ft.)	Maximum Tails Storage Vol. (ton)	Unlined Upstream Basin Area (sq.ft.)	Lined Reclaim and WRD Area (sq.ft.)	Pan Evaporation Coeff. For Dry Beach % of Lake E	Pan Evaporation Coeff. For Wet Beach % of Lake E
1	1,949,200	1,010,000	3,287,100	168,600	48	92
2	2,983,900	2,070,000	2,258,800	168,600	38	93
3	4,011,100	3,670,000	1,766,600	168,600	33	94

Unlined Areas Runoff Coefficient	0.4			
Tailings Runoff Coefficient	100	Percent of Precipitation		
Percent Wet Beach	16	Percent of Total Exposed Tailings Area		
Percent Dry Beach	84	Percent of Total Exposed Tailings Area		
Pan to Lake Evaporation Factor	75	Percent of Lake Evaporation		
Tailings Specific Gravity	2.65000	From Prefeas Test Results		
Slurry Water Specific Gravity	1.0			
Tailings Percent Solids	46.000	Percent		
Tailings Void Ratio	1.07			
Tailings Saturation	90	Percent		
Settled Tailings Dry Density	80.0	pcf		
Minimum Supernatant Pool Depth	5.0	ft		
Minimum Supernatant Pool Area Stage 1	715,700	sq. ft.		
Minimum Supernatant Pool Volume	1,394,100	cu. ft.	10,428,592.21	US gallons
Minimum Supernatant Pool Area Stage 2	609,800	sq. ft.		
Minimum Supernatant Pool Volume	1,042,000	cu. ft.	7,794,701.30	US gallons
Minimum Supernatant Pool Area Stage 3	743,100	sq. ft.		
Minimum Supernatant Pool Volume	1,416,700	cu. ft.	10,597,651.95	US gallons

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Production Year	1	1	1	1	1	1	1	1	1	1	1	1
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	21,080	40,120	61,200	81,600	102,680	123,080	144,160	165,240	185,640	206,720	227,120	248,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	48,382	32,255	50,463	59,307	77,515	46,301	26,532	16,127	23,931	43,180	37,977	46,301
Precipitation Volume on Non-lined Areas (cu.ft.)	30,038	20,025	31,330	36,821	48,126	28,746	16,473	10,013	14,858	26,808	23,578	28,746
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	16,192	24,954	51,242	72,577	100,580	121,343	155,441	134,106	83,626	56,195	24,954	15,049
Evaporation from Dry Tailings Beach (cu.ft.)	44,351	68,353	140,359	198,799	275,500	332,375	425,773	367,334	229,062	153,925	68,353	41,221
Evaporation from Supernatant Pool (cu.ft.)	47,867	73,772	151,486	214,559	297,341	151,506	9,639	72,549	247,221	166,128	73,772	44,489
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	274,930	336,036	506,234	626,845	792,720	767,215	792,788	792,788	758,159	551,200	342,563	270,651
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	423,422	294,734	192,118	48,980	0	0	0	0	0	147,152	333,262	427,702
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	46	62	85	109	133	133	133	133	131	92	59	45
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	71	55	32	8	0	0	0	0	0	25	58	72

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Production Year	2	2	2	2	2	2	2	2	2	2	2	2
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	269,280	288,320	309,400	329,800	350,880	371,280	392,360	413,440	433,840	454,920	475,320	496,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	48,382	32,255	50,463	59,307	77,515	46,301	26,532	16,127	23,931	43,180	37,977	46,301
Precipitation Volume on Non-lined Areas (cu.ft.)	30,038	20,025	31,330	36,821	48,126	28,746	16,473	10,013	14,858	26,808	23,578	28,746
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	16,192	24,954	51,242	72,577	100,580	121,343	155,441	134,106	83,626	56,195	24,954	15,049
Evaporation from Dry Tailings Beach (cu.ft.)	44,351	68,353	140,359	198,799	275,500	332,375	425,773	367,334	229,062	153,925	68,353	41,221
Evaporation from Supernatant Pool (cu.ft.)	47,867	73,772	151,486	214,559	297,341	151,506	9,639	72,549	247,221	166,128	73,772	44,489
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	274,930	336,036	506,234	626,845	792,720	767,215	792,788	792,788	758,159	551,200	342,563	270,651
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	423,422	294,734	192,118	48,980	0	0	0	0	0	147,152	333,262	427,702
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	46	62	85	109	133	133	133	133	131	92	59	45
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	71	55	32	8	0	0	0	0	0	25	58	72

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Production Year	3	3	3	3	3	3	3	3	3	3	3	3
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	517,480	536,520	557,600	578,000	599,080	619,480	640,560	661,640	682,040	703,120	723,520	744,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	48,382	32,255	50,463	59,307	77,515	46,301	26,532	16,127	23,931	43,180	37,977	46,301
Precipitation Volume on Non-lined Areas (cu.ft.)	30,038	20,025	31,330	36,821	48,126	28,746	16,473	10,013	14,858	26,808	23,578	28,746
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	16,192	24,954	51,242	72,577	100,580	121,343	155,441	134,106	83,626	56,195	24,954	15,049
Evaporation from Dry Tailings Beach (cu.ft.)	44,351	68,353	140,359	198,799	275,500	332,375	425,773	367,334	229,062	153,925	68,353	41,221
Evaporation from Supernatant Pool (cu.ft.)	47,867	73,772	151,486	214,559	297,341	151,506	9,639	72,549	247,221	166,128	73,772	44,489
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	274,930	336,036	506,234	626,845	792,720	767,215	792,788	792,788	758,159	551,200	342,563	270,651
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	423,422	294,734	192,118	48,980	0	0	0	0	0	147,152	333,262	427,702
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	46	62	85	109	133	133	133	133	131	92	59	45
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	71	55	32	8	0	0	0	0	0	25	58	72

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24
Production Year	4	4	4	4	4	4	4	4	4	4	4	4
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	1	1	1	1	1	1	1	1	1	1	1	1
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200	1,949,200
Supernatant Pool Area (sq.ft.)	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700	715,700
Tailings Beach Area (sq.ft.)	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500	1,233,500
Wet Tailings Beach Area (sq.ft.)	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360	197,360
Dry Tailings Beach Area (sq.ft.)	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140	1,036,140
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100	3,287,100
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	765,680	784,720	805,800	826,200	847,280	867,680	888,760	909,840	930,240	951,320	971,720	992,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	48,382	32,255	50,463	59,307	77,515	46,301	26,532	16,127	23,931	43,180	37,977	46,301
Precipitation Volume on Non-lined Areas (cu.ft.)	30,038	20,025	31,330	36,821	48,126	28,746	16,473	10,013	14,858	26,808	23,578	28,746
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	16,192	24,954	51,242	72,577	100,580	121,343	155,441	134,106	83,626	56,195	24,954	15,049
Evaporation from Dry Tailings Beach (cu.ft.)	44,351	68,353	140,359	198,799	275,500	332,375	425,773	367,334	229,062	153,925	68,353	41,221
Evaporation from Supernatant Pool (cu.ft.)	47,867	73,772	151,486	214,559	297,341	151,506	9,639	72,549	247,221	166,128	73,772	44,489
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100	1,394,100
Reclaim Rate from Underdrain to the Mill (gpm)	94,436	85,297	94,436	91,390	94,436	91,390	94,436	94,436	91,390	94,436	91,390	94,436
Make Up Water Required (cu.ft.)	274,930	336,036	506,234	626,845	792,720	767,215	792,788	792,788	758,159	551,200	342,563	270,651
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	423,422	294,734	192,118	48,980	0	0	0	0	0	147,152	333,262	427,702
Reclaim Rate from Underdrain to the Mill (gpm)	16	16	16	16	16	16	16	16	16	16	16	16
Make Up Water Required (gpm)	46	62	85	109	133	133	133	133	131	92	59	45
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	71	55	32	8	0	0	0	0	0	25	58	72

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Production Year	5	5	5	5	5	5	5	5	5	5	5	5
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,013,880	1,032,920	1,054,000	1,074,400	1,095,480	1,115,880	1,136,960	1,158,040	1,178,440	1,199,520	1,219,920	1,241,000
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	72,020	48,014	75,118	88,283	115,387	68,923	39,495	24,007	35,623	64,276	56,532	68,923
Precipitation Volume on Non-lined Areas (cu.ft.)	20,641	13,761	21,529	25,302	33,070	19,754	11,319	6,880	10,210	18,422	16,202	19,754
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	31,503	48,551	99,697	141,207	195,688	236,086	302,427	260,918	162,703	109,333	48,551	29,279
Evaporation from Dry Tailings Beach (cu.ft.)	67,579	104,151	213,867	302,911	419,783	382,766	296,236	317,818	349,024	234,538	104,151	62,808
Evaporation from Supernatant Pool (cu.ft.)	40,785	62,856	129,071	182,811	80,836	0	0	0	64,282	141,547	62,856	37,906
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	292,144	375,020	590,928	750,383	792,788	767,215	792,788	792,788	767,215	647,660	379,863	286,257
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	377,266	229,609	78,482	0	0	0	0	0	0	21,751	267,954	383,153
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	49	70	99	130	133	133	133	133	133	109	66	48
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	63	43	13	0	0	0	0	0	0	4	46	64

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26
Production Year	6	6	6	6	6	6	6	6	6	6	6	6
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,262,080	1,281,120	1,302,200	1,322,600	1,343,680	1,364,080	1,385,160	1,406,240	1,426,640	1,447,720	1,468,120	1,489,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	72,020	48,014	75,118	88,283	115,387	68,923	39,495	24,007	35,623	64,276	56,532	68,923
Precipitation Volume on Non-lined Areas (cu.ft.)	20,641	13,761	21,529	25,302	33,070	19,754	11,319	6,880	10,210	18,422	16,202	19,754
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	31,503	48,551	99,697	141,207	195,688	236,086	302,427	260,918	162,703	109,333	48,551	29,279
Evaporation from Dry Tailings Beach (cu.ft.)	67,579	104,151	213,867	302,911	419,783	382,766	296,236	317,818	349,024	234,538	104,151	62,808
Evaporation from Supernatant Pool (cu.ft.)	40,785	62,856	129,071	182,811	80,836	0	0	0	64,282	141,547	62,856	37,906
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	292,144	375,020	590,928	750,383	792,788	767,215	792,788	792,788	767,215	647,660	379,863	286,257
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	377,266	229,609	78,482	0	0	0	0	0	0	21,751	267,954	383,153
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	49	70	99	130	133	133	133	133	133	109	66	48
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	63	43	13	0	0	0	0	0	0	4	46	64

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27
Production Year	7	7	7	7	7	7	7	7	7	7	7	7
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,510,280	1,529,320	1,550,400	1,570,800	1,591,880	1,612,280	1,633,360	1,654,440	1,674,840	1,695,920	1,716,320	1,737,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	72,020	48,014	75,118	88,283	115,387	68,923	39,495	24,007	35,623	64,276	56,532	68,923
Precipitation Volume on Non-lined Areas (cu.ft.)	20,641	13,761	21,529	25,302	33,070	19,754	11,319	6,880	10,210	18,422	16,202	19,754
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	31,503	48,551	99,697	141,207	195,688	236,086	302,427	260,918	162,703	109,333	48,551	29,279
Evaporation from Dry Tailings Beach (cu.ft.)	67,579	104,151	213,867	302,911	419,783	382,766	296,236	317,818	349,024	234,538	104,151	62,808
Evaporation from Supernatant Pool (cu.ft.)	40,785	62,856	129,071	182,811	80,836	0	0	0	64,282	141,547	62,856	37,906
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	292,144	375,020	590,928	750,383	792,788	767,215	792,788	792,788	767,215	647,660	379,863	286,257
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	377,266	229,609	78,482	0	0	0	0	0	0	21,751	267,954	383,153
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	49	70	99	130	133	133	133	133	133	109	66	48
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	63	43	13	0	0	0	0	0	0	4	46	64

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28
Production Year	8	8	8	8	8	8	8	8	8	8	8	8
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	2	2	2	2	2	2	2	2	2	2	2	2
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900	2,983,900
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800	609,800
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100	2,374,100
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856	379,856
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244	1,994,244
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800	2,258,800
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	1,758,480	1,777,520	1,798,600	1,819,000	1,840,080	1,860,480	1,881,560	1,902,640	1,923,040	1,944,120	1,964,520	1,985,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	72,020	48,014	75,118	88,283	115,387	68,923	39,495	24,007	35,623	64,276	56,532	68,923
Precipitation Volume on Non-lined Areas (cu.ft.)	20,641	13,761	21,529	25,302	33,070	19,754	11,319	6,880	10,210	18,422	16,202	19,754
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	31,503	48,551	99,697	141,207	195,688	236,086	302,427	260,918	162,703	109,333	48,551	29,279
Evaporation from Dry Tailings Beach (cu.ft.)	67,579	104,151	213,867	302,911	419,783	382,766	296,236	317,818	349,024	234,538	104,151	62,808
Evaporation from Supernatant Pool (cu.ft.)	40,785	62,856	129,071	182,811	80,836	0	0	0	64,282	141,547	62,856	37,906
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000	1,042,000
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	123,378	119,398	123,378	123,378	119,398	123,378	119,398	123,378
Make Up Water Required (cu.ft.)	292,144	375,020	590,928	750,383	792,788	767,215	792,788	792,788	767,215	647,660	379,863	286,257
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	377,266	229,609	78,482	0	0	0	0	0	0	21,751	267,954	383,153
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	21	21	21	21	21	21	21	21
Make Up Water Required (gpm)	49	70	99	130	133	133	133	133	133	109	66	48
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	63	43	13	0	0	0	0	0	0	4	46	64

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Production Year	9	9	9	9	9	9	9	9	9	9	9	9
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	2	2	2	2	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	2,983,900	2,983,900	2,983,900	2,983,900	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	609,800	609,800	609,800	609,800	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	2,374,100	2,374,100	2,374,100	2,374,100	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	379,856	379,856	379,856	379,856	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	1,994,244	1,994,244	1,994,244	1,994,244	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	2,258,800	2,258,800	2,258,800	2,258,800	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,006,680	2,025,720	2,046,800	2,067,200	2,088,280	2,108,680	2,129,760	2,150,840	2,171,240	2,192,320	2,212,720	2,233,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	72,020	48,014	75,118	88,283	152,985	91,380	52,364	31,829	47,230	85,220	74,952	91,380
Precipitation Volume on Non-lined Areas (cu.ft.)	20,641	13,761	21,529	25,302	25,864	15,449	8,853	5,381	7,985	14,408	12,672	15,449
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	31,503	48,551	99,697	141,207	272,265	328,472	420,774	363,021	226,372	152,118	67,551	40,737
Evaporation from Dry Tailings Beach (cu.ft.)	67,579	104,151	213,867	302,911	454,432	308,534	188,292	222,038	359,019	280,366	124,502	75,081
Evaporation from Supernatant Pool (cu.ft.)	40,785	62,856	129,071	182,811	0	0	0	0	0	172,488	76,596	46,192
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	123,378	111,439	123,378	119,398	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,042,000	1,042,000	1,042,000	1,042,000	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	123,378	111,439	123,378	119,398	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	292,144	375,020	590,928	750,383	792,788	767,215	792,788	792,788	767,215	750,285	418,063	300,120
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	377,266	229,609	78,482	0	0	0	0	0	0	0	200,733	339,303
Reclaim Rate from Underdrain to the Mill (gpm)	21	21	21	21	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	49	70	99	130	133	133	133	133	133	126	72	50
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	63	43	13	0	0	0	0	0	0	0	35	57

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-30	Feb-30	Mar-30	Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30
Production Year	10	10	10	10	10	10	10	10	10	10	10	10
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,254,880	2,273,920	2,295,000	2,315,400	2,336,480	2,356,880	2,377,960	2,399,040	2,419,440	2,440,520	2,460,920	2,482,000
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	95,487	63,658	99,594	117,049	152,985	91,380	52,364	31,829	47,230	85,220	74,952	91,380
Precipitation Volume on Non-lined Areas (cu.ft.)	16,144	10,762	16,838	19,789	25,864	15,449	8,853	5,381	7,985	14,408	12,672	15,449
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	43,831	67,551	138,711	196,464	272,265	328,472	420,774	363,021	226,372	152,118	67,551	40,737
Evaporation from Dry Tailings Beach (cu.ft.)	80,784	124,502	255,656	362,100	454,432	308,534	188,292	222,038	359,019	280,366	124,502	75,081
Evaporation from Supernatant Pool (cu.ft.)	49,700	76,596	157,286	108,449	0	0	0	0	0	172,488	76,596	46,192
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	307,623	415,464	680,161	767,215	792,788	767,215	792,788	792,788	767,215	750,285	418,063	300,120
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	331,800	162,079	0	0	0	0	0	0	0	0	200,733	339,303
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	52	77	114	133	133	133	133	133	133	126	72	50
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	56	30	0	0	0	0	0	0	0	0	35	57

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31
Production Year	11	11	11	11	11	11	11	11	11	11	11	11
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,503,080	2,522,120	2,543,200	2,563,600	2,584,680	2,605,080	2,626,160	2,647,240	2,667,640	2,688,720	2,709,120	2,730,200
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	95,487	63,658	99,594	117,049	152,985	91,380	52,364	31,829	47,230	85,220	74,952	91,380
Precipitation Volume on Non-lined Areas (cu.ft.)	16,144	10,762	16,838	19,789	25,864	15,449	8,853	5,381	7,985	14,408	12,672	15,449
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	43,831	67,551	138,711	196,464	272,265	328,472	420,774	363,021	226,372	152,118	67,551	40,737
Evaporation from Dry Tailings Beach (cu.ft.)	80,784	124,502	255,656	362,100	454,432	308,534	188,292	222,038	359,019	280,366	124,502	75,081
Evaporation from Supernatant Pool (cu.ft.)	49,700	76,596	157,286	108,449	0	0	0	0	0	172,488	76,596	46,192
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	307,623	415,464	680,161	767,215	792,788	767,215	792,788	792,788	767,215	750,285	418,063	300,120
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	331,800	162,079	0	0	0	0	0	0	0	0	200,733	339,303
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	52	77	114	133	133	133	133	133	133	126	72	50
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	56	30	0	0	0	0	0	0	0	0	35	57

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-32	Feb-32	Mar-32	Apr-32	May-32	Jun-32	Jul-32	Aug-32	Sep-32	Oct-32	Nov-32	Dec-32
Production Year	12	12	12	12	12	12	12	12	12	12	12	12
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA						743,100	743,100					
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,751,280	2,770,320	2,791,400	2,811,800	2,832,880	2,853,280	2,874,360	2,895,440	2,915,840	2,936,920	2,957,320	2,978,400
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	95,487	63,658	99,594	117,049	152,985	91,380	52,364	31,829	47,230	85,220	74,952	91,380
Precipitation Volume on Non-lined Areas (cu.ft.)	16,144	10,762	16,838	19,789	25,864	15,449	8,853	5,381	7,985	14,408	12,672	15,449
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	43,831	67,551	138,711	196,464	272,265	328,472	420,774	363,021	226,372	152,118	67,551	40,737
Evaporation from Dry Tailings Beach (cu.ft.)	80,784	124,502	255,656	362,100	454,432	308,534	188,292	222,038	359,019	280,366	124,502	75,081
Evaporation from Supernatant Pool (cu.ft.)	49,700	76,596	157,286	108,449	0	0	0	0	0	172,488	76,596	46,192
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
											5	
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	307,623	415,464	680,161	767,215	792,788	767,215	792,788	792,788	767,215	750,285	418,063	300,120
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	331,800	162,079	0	0	0	0	0	0	0	0	200,733	339,303
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	52	77	114	133	133	133	133	133	133	126	72	50
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	56	30	0	0	0	0	0	0	0	0	35	57

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-33	Feb-33	Mar-33	Apr-33	May-33	Jun-33	Jul-33	Aug-33	Sep-33	Oct-33	Nov-33	Dec-33
Production Year	13	13	13	13	13	13	13	13	13	13	13	13
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	2,999,480	3,018,520	3,039,600	3,060,000	3,081,080	3,101,480	3,122,560	3,143,640	3,164,040	3,185,120	3,205,520	3,226,600
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	95,487	63,658	99,594	117,049	152,985	91,380	52,364	31,829	47,230	85,220	74,952	91,380
Precipitation Volume on Non-lined Areas (cu.ft.)	16,144	10,762	16,838	19,789	25,864	15,449	8,853	5,381	7,985	14,408	12,672	15,449
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	43,831	67,551	138,711	196,464	272,265	328,472	420,774	363,021	226,372	152,118	67,551	40,737
Evaporation from Dry Tailings Beach (cu.ft.)	80,784	124,502	255,656	362,100	454,432	308,534	188,292	222,038	359,019	280,366	124,502	75,081
Evaporation from Supernatant Pool (cu.ft.)	49,700	76,596	157,286	108,449	0	0	0	0	0	172,488	76,596	46,192
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	307,623	415,464	680,161	767,215	792,788	767,215	792,788	792,788	767,215	750,285	418,063	300,120
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	331,800	162,079	0	0	0	0	0	0	0	0	200,733	339,303
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	52	77	114	133	133	133	133	133	133	126	72	50
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	56	30	0	0	0	0	0	0	0	0	35	57

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10	11	12
Days in Month	31	28	31	30	31	30	31	31	30	31	30	31
Month-Yr	Jan-34	Feb-34	Mar-34	Apr-34	May-34	Jun-34	Jul-34	Aug-34	Sep-34	Oct-34	Nov-34	Dec-34
Production Year	14	14	14	14	14	14	14	14	14	14	14	14
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	3	3	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA												
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24	0.22	0.26
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71	1.65	0.99
AREAS AND TAILINGS DEPOSITED INPUT DATA												
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA												
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	21,080	20,400	21,080
Total Tailings Deposited (Tons)	3,247,680	3,266,720	3,287,800	3,308,200	3,329,280	3,349,680	3,370,760	3,391,840	3,412,240	3,433,320	3,453,720	3,474,800
WATER IN DEPOSITED TAILINGS												
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	792,788	767,215	792,788
INFLOW VOLUME CALCULATION DATA												
Precipitation Volume on Lined Areas (cu.ft.)	95,487	63,658	99,594	117,049	152,985	91,380	52,364	31,829	47,230	85,220	74,952	91,380
Precipitation Volume on Non-lined Areas (cu.ft.)	16,144	10,762	16,838	19,789	25,864	15,449	8,853	5,381	7,985	14,408	12,672	15,449
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA												
Evaporation from Wet Tailings Beach (cu.ft.)	43,831	67,551	138,711	196,464	272,265	328,472	420,774	363,021	226,372	152,118	67,551	40,737
Evaporation from Dry Tailings Beach (cu.ft.)	80,784	124,502	255,656	362,100	454,432	308,534	188,292	222,038	359,019	280,366	124,502	75,081
Evaporation from Supernatant Pool (cu.ft.)	49,700	76,596	157,286	108,449	0	0	0	0	0	172,488	76,596	46,192
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	244,940	237,039	244,940
UNDERDRAIN DATA												
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
NET SOLUTION BALANCE												
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	307,623	415,464	680,161	767,215	792,788	767,215	792,788	792,788	767,215	750,285	418,063	300,120
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	331,800	162,079	0	0	0	0	0	0	0	0	200,733	339,303
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	52	77	114	133	133	133	133	133	133	126	72	50
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	56	30	0	0	0	0	0	0	0	0	35	57

WATER BALANCE ESTIMATE FOR GRASSY MOUNTAIN TSF

PROJECT: GRASSY MOUNTAIN TSF PREFEASBILITY STUDY
SIMULATION SCENARIO: DRY YEAR
DRY YEAR PRECIPITATION + DRY EVAPORATION FROM SITE DATA

month	1	2	3	4	5	6	7	8	9	10
Days in Month	31	28	31	30	31	30	31	31	30	31
Month-Yr	Jan-35	Feb-35	Mar-35	Apr-35	May-35	Jun-35	Jul-35	Aug-35	Sep-35	Oct-35
Production Year	15	15	15	15	15	15	15	15	15	15
Annual Precipitation	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Active Stage	3	3	3	3	3	3	3	3	3	3
PRECIPITATION AND EVAPORATION INPUT DATA										
Mean Monthly Precipitation (in.)	0.27	0.18	0.29	0.34	0.44	0.26	0.15	0.09	0.14	0.24
Site Lake Evaporation (in.)	1.07	1.65	3.39	4.80	6.65	8.02	10.27	8.86	5.53	3.71
AREAS AND TAILINGS DEPOSITED INPUT DATA										
Total Lined Area (sq.ft.)	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100	4,011,100
Supernatant Pool Area (sq.ft.)	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100	743,100
Tailings Beach Area (sq.ft.)	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000	3,268,000
Wet Tailings Beach Area (sq.ft.)	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880	522,880
Dry Tailings Beach Area (sq.ft.)	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120	2,745,120
Lined Reclaim Channel and Waste Rock Dump (sq.ft.)	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600	168,600
Upstream Unlined Basin Area (sq.ft.)	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600	1,766,600
AREA AND DISTRIBUTED TAILINGS DATA										
Tailings Deposited (Tons)	21,080	19,040	21,080	20,400	21,080	20,400	21,080	21,080	20,400	7,520
Total Tailings Deposited (Tons)	3,495,880	3,514,920	3,536,000	3,556,400	3,577,480	3,597,880	3,618,960	3,640,040	3,660,440	3,667,960
WATER IN DEPOSITED TAILINGS										
Water Volume (cu.ft.)	792,788	716,067	792,788	767,215	792,788	767,215	792,788	792,788	767,215	282,816
INFLOW VOLUME CALCULATION DATA										
Precipitation Volume on Lined Areas (cu.ft.)	95,487	63,658	99,594	117,049	152,985	91,380	52,364	31,829	47,230	85,220
Precipitation Volume on Non-lined Areas (cu.ft.)	16,144	10,762	16,838	19,789	25,864	15,449	8,853	5,381	7,985	14,408
Volume of Water Carried Over from Previous Month (cu.ft.)	0	0	0	0	0	0	0	0	0	0
OUTFLOW VOLUME CALCULATION DATA										
Evaporation from Wet Tailings Beach (cu.ft.)	43,831	67,551	138,711	196,464	272,265	328,472	420,774	363,021	226,372	152,118
Evaporation from Dry Tailings Beach (cu.ft.)	80,784	124,502	255,656	362,100	454,432	308,534	188,292	222,038	359,019	142,947
Evaporation from Supernatant Pool (cu.ft.)	49,700	76,596	157,286	108,449	0	0	0	0	0	0
Interstitial Water Lost (cu.ft.)	244,940	221,236	244,940	237,039	244,940	237,039	244,940	244,940	237,039	87,379
UNDERDRAIN DATA										
Tailings Underdrain (cu.ft.)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365
NET SOLUTION BALANCE										
Volume of Solution in the Supernatant Pool Above its Min Operational Level (cu.ft.)	0	0	0	0	0	0	0	0	0	0
Volume of Solution in Supernatant Pool (cu.ft)	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700	1,416,700
Reclaim Rate from Underdrain to the Mill (gpm)	153,365	138,523	153,365	148,418	153,365	148,418	153,365	153,365	148,418	153,365
Make Up Water Required (cu.ft.)	307,623	415,464	680,161	767,215	792,788	767,215	792,788	792,788	767,215	282,816
Reclaim Rate to the Mill from the Supernatant Pool (cu.ft.)	331,800	162,079	0	0	0	0	0	0	0	0
Reclaim Rate from Underdrain to the Mill (gpm)	26	26	26	26	26	26	26	26	26	26
Make Up Water Required (gpm)	52	77	114	133	133	133	133	133	133	47
Reclaim Rate to the Mill from the Supernatant Pool (gpm)	56	30	0	0	0	0	0	0	0	0

ATTACHMENT E

Supernatant Pool Storm Surge Capacity Calculations

GOLDER

CALCULATIONS

DATE:	Oct-19	**Made by:**	JRP
PROJECT NO.:	1663241	**Checked by:**	MDB
SUBJECT:	Wave Run-up Calcuation for 500-year, 24-hour Storm Event	**Reviewed by:**	CJM
PROJECT SHORT TITLE:	Grassy Mountain TSF Detailed Design		

1.0 Objectives

The following objectives were completed for each stage at the maximum design tailings capacity with a 5-ft deep supernatant pool:
- Calculate the maximum wave run-up generated from the average recorded wind speed in the prevailing wind direction across the surface of the supernatant pool after the 500-year, 24-hour storm event.

2.0 References

A - US Army Corps of Engineers, Shoreline Protection Manual, Volumes I and II, Chapters 3 and 7
B - US Army Corps of Engineers, Water Levels and Wave Heights for Coastal Engineering Design, EM-1110-2-1414, Chapter 5, p 5-28
C - Owyhee Ridge Oregon Weather Station wind speed and direction data, 1985 to 2018

3.0 Project Description

See the design report for detailed description of the project and the proposed design modifications.

4.0 Wave Run-up Calculations

Reference A:

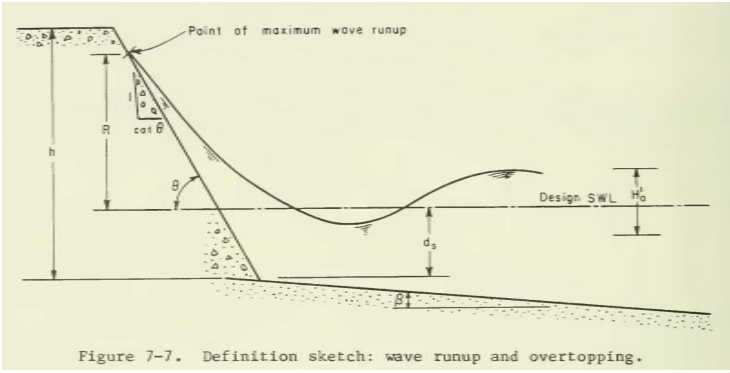

Figure 7-7: Definition Sketch: Wave Run-up and Overtopping (Reference A)

Equations:

Wave Forecasting Equations (Reference B, Table 5-3, p5-46)
Fetch Length Limited
Wave Height: $H'_0 = 1.77 \cdot 10^{-2} \cdot {U_c}^{1.23} \cdot F^{0.5}$
Wave Peak Period: $T_p = 46.86 \cdot 10^{-2} \cdot {U_c}^{0.41} \cdot F^{0.33}$
Fetch Duration Limited
Wave Height: $H'_0 = 90.79 \cdot 10^{-4} \cdot {U_c}^{1.58} \cdot t^{0.714}$
Wave Peak Period: $T_p = 24.16 \cdot 10^{-2} \cdot {U_c}^{0.724} \cdot t^{0.411}$

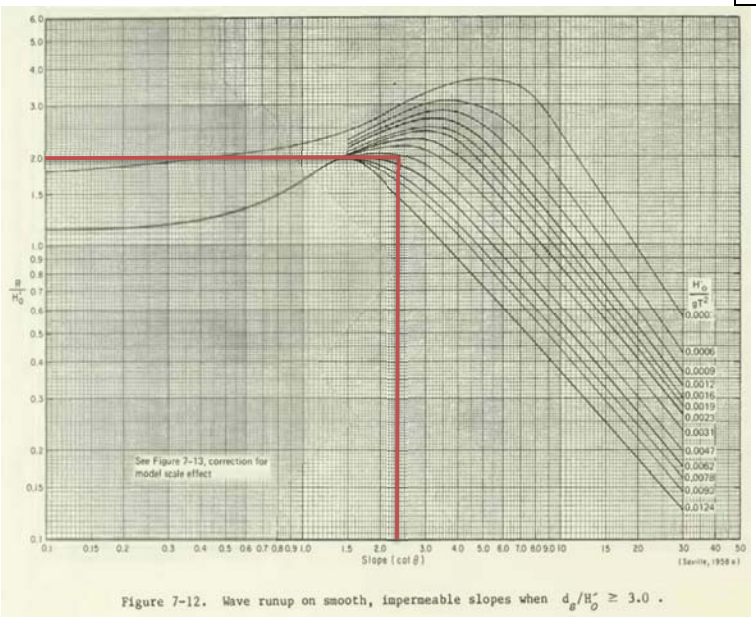

Figure 7-12: Wave Run-up on Smooth, Impermeable Slopes when $d_s/H'_0 \geq 3$ (Reference A)

Wave Height to Pool Depth Relationship: $\frac{d_s}{H'_0}$

Run-up to Wave Height Relationship: $\frac{R}{H'_0}$ (Figure 7-12)

Adjusted Overwater Wind Speed: $U_c = 1.2 \cdot U_L$ (Ref. B)

Adjusted Fetch Duration: $t = \frac{3600}{U_c}$

Fetch Limited Wind Duration: $t_f = 1.91 \cdot F^{0.67} \cdot {U_c}^{-0.41}$

Where:
- **U_L** = Wind Speed at 10m Above Ground, mph
- **U_c** = Adjusted Wind Speed Over Water, mph
- **t** = Adjusted Fetch Duration, hr
- **F** = Effective Fetch Length, mi
- **d_s** = Depth of Reservoir, ft
- **T_p** = Wave Peak Period, s
- **H'_0** = Wave Height, ft
- **t_f** = fetch limited wind duration, hr

DATE:	Oct-19	**Made by:**	JRP
PROJECT NO.:	1663241	**Checked by:**	MDB
SUBJECT:	Wave Run-up Calcuation for 500-year, 24-hour Storm Event	**Reviewed by:**	CJM
PROJECT SHORT TITLE:	Grassy Mountain TSF Detailed Design		

4.1 Wind Speed Normal to the Embankment Face at the Supernatant Pool

Wind data from Reference C suggests that the majority of recorded wind gusts are from the West. In order to appropriately estimate the wind speed associated with a rolling wave, the average of the wind speeds recorded in the West-East direction were used in the wave run-up analysis. Wind speeds in the prevailing wind direction averaged 7.79 mph.

Recorded Wind Speeds		**Reference**
Average Wind Speed	7.79 mph	(Reference C)

4.2 Effective Fetch Length and Pool Depth

The effective fetch length for the supernatant pool is the longest length of the water surface in the wind direction normal to the embankment slope. The prevailing wind direction is from the West so the fetch length generally trended West-East. This fetch length coincides with the average supernatant pool depth of 5 feet and the additional volume collected during the 500-year, 24-hour storm event.

Stage	Wind Source Direction	Effective Fetch Length (ft)	Pool Depth (ft) (5-ft Operating Depth + 500-yr, 24-hr Storm Event)
1	West	1,314 ft	6.65
2	West	1,200 ft	6.80
3	West	1,160 ft	6.60

4.3 Wave Forecastings

Deep water wave height can vary depending on the fetch length, wind velocity, and fetch duration. Depending on these variables, the wave height may be limited by either the fetch length or the fetch duration. Overland wind speeds should be adjusted for overwater. For fetch lengths less than 10 miles, the wind has not fully adjusted to the frictional characteristics of the waves, in such cases, the adjusted overwater wind speed is estimated to be 120 percent of the overland wind speed (Reference B).

Inputs	**Stage 1**	**Stage 2**	**Stage 3**
Effective Fetch, F	0.25 mi	0.23 mi	0.22 mi
Adjusted Wind Speed, U_c	9.3 mph		
Adjusted Fetch Duration, *t*	0.107 hr		

Fetch Length Limited			
Forecasting Parameter	**Stage 1**	**Stage 2**	**Stage 3**
Wave height, H'_0	0.14 ft	0.13 ft	0.13 ft
Wave Peak Period, T_p	0.7 s	0.7 s	0.7 s
Required Wind Duration, t_f (Note 1)	0.301 hr	0.283 hr	0.277 hr

Note 1: The required wind duration for the fetch limited condition was not met, however the wave height calculated for the fetch limited condition was greater that the fetch duration limited condition and therefore used in calculating wave run-up to provide additional conservatism.

Fetch Duration Limited			
Forecasting Parameter	**Stage 1**	**Stage 2**	**Stage 3**
Wave height, H'_0	0.06 ft	0.06 ft	0.06 ft
Wave Peak Period, T_p	0.5 s	0.5 s	0.5 s

4.4 Wave Run-up

Wave Run-up is dependent on tailings pond shape, roughness of the slope, water depth, and incident wave characteristics. For smooth, impermeable slopes, a ratio of wave run-up to wave height can be determined using Figures in Reference A. The depth of water to wave height must first be determined.

Parameter	**Stage 1**	**Stage 2**	**Stage 3**
Wave Height to Pool Depth Relationship, d_s/H'_0	48.2	51.6	50.9
Embankment Slope 2.5H: 1V (21.8°)	2.50		
Ave. H'_0/gT_p^2 (Use on Figure 7-12)	0.0078	0.0079	0.0080
Run-up to Wave Height Relationship, R/H'_0, (Figure 7-12)	2.00	1.95	1.90
Wave Run-up Height, R	**0.28 ft**	**0.26 ft**	**0.25 ft**

Freeboard Summary			
Parameter	**Stage 1**	**Stage 2**	**Stage 3**
Depth of Operating Pool, ft	5 ft	5 ft	5 ft
Depth Increase (500-yr, 24-hr storm), ft	1.65 ft	1.80 ft	1.60 ft
Wave Run-up Height, R	0.28 ft	0.26 ft	0.25 ft
Total of Depth Increase (500-yr, 24-hr storm) and Wave Run-up, ft	1.93 ft	2.06 ft	1.85 ft
Minimum Freeboard in Pool Area, ft	**2.0 ft**	**3.0 ft**	**2.0 ft**
Design Freeboard in Pool Area, ft	**3.0 ft**	**3.0 ft**	**3.0 ft**

ATTACHMENT F

TSF Reclaim Pond Sizing

GOLDER

CALCULATIONS

DATE:	Oct-19	**Made by:**	MDB
PROJECT NO.:	18111356	**Checked by:**	CJM
SUBJECT:	TSF Reclaim Pond Sizing	**Reviewed by:**	RAB
PROJECT SHORT TITLE:	Grassy Mountain TSF Pre-Feasibility Design		

1.0 Pond Storage Capacity Criteria

- 48 hours of underdrain flows due to power outage
- Draindown of 4-inch diameter DR17 Return Water Pipeline
- 100-yr, 24-hr storm event falling on the pond surface
- Freeboard of 2-feet below the crest of the pond

Pond Length (ft)	65
Pond Width (ft)	85
Pond Depth (ft)	7

1.1 Design Storm Event Volumes

Storm Event	Precipitation Depth (in)	Volume (gallons)
100-yr, 24-hr	2.28	7,853

1.2 Aggregate Volumes

Underdrain Flow		Draindown of Return Water Pipe		
Average Underdrain Flow (gpm)[1]	48 hr Power Outage Volume (gal)	Pipe Flow Area (ft^2) (4-IN HDPE DR17 Pipe)	Pipe Length (ft)	Drain Down (gal)
21.4	61,632	0.086	3,150	2,026

Notes: 1. Average underdrain flow rate represents the peak average rate during Stage 1 operations.

1.3 Total Required and Design Volumes

Pond	Required Storage Volume (gal)	Design Storage Volume (gal)
Event Pond	69,485	100,900
Freeboard	-	71,900
Total Pond Volume (gal) =		**172,800**

APPENDIX G

Hydrologic and Hydraulic Assessment

TECHNICAL MEMORANDUM

DATE October 18, 2019 **Project No.** 1663241-062-TM-Rev0

TO Nancy Wolverson
Calico Resources USA Corp.

CC

FROM Christopher J. MacMahon, PE **EMAIL Chris_MacMahon@Golder.com**

HYDROLOGIC AND HYDRAULIC DESIGN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
GRASSY MOUNTAIN MINE
MALHEUR COUNTY, NEVADA

1.0 OBJECTIVE

This report presents the detailed design of stormwater diversion channels around the tailings storage facility (TSF) at Calico Resources USA Corp.'s (Calico's) Grassy Mountain Mine in Malheur County, Oregon. These stormwater diversion channels are designed to meet the minimum design criteria defined by Oregon Administrative Rules (OAR), Division 43 – Chemical Mining requirements.

Golder's scope included the following tasks:

- Develop peak flow rates from stormwater run-off during the 25-year, 24-hour storm event for temporary stormwater diversion channel sizing
- Develop peak flow rates from stormwater run-off during the 100-year, 24-hour storm event for temporary and permanent stormwater diversion channel sizing
- Develop peak flow rates from stormwater run-off during the 500-year, 24-hour storm event for permanent stormwater diversion channel sizing
- Hydraulic design of temporary stormwater diversion channels in the TSF area
- Hydraulic design of permanent stormwater diversion channels in the TSF area
- Stormwater erosion protection design

2.0 SYNTHETIC STORM EVENTS

The National Oceanic and Atmospheric Administration (NOAA) Atlas 2 was used to develop the probabilistic-based synthetic storm events for the calculation of the peak flows. Atlas 2, Volume 10 (Oregon) contains precipitation frequency estimates for the western United States (NOAA, 1973). Atlas 2 generates the precipitation frequency estimates based on analysis of previously recorded weather patterns. The precipitation frequency estimates for Grassy Mountain were obtained using the latitudinal/longitudinal coordinates of N43.669819° and W117.35926°.

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A frequency analysis was conducted to determine annual extreme daily rainfall depths for the 1 in 25-year, 24-hour and 1 in 500-year, 24-hour storm events that were not presented in the NOAA Atlas 2. Thirty-three years of maximum daily annual precipitation data from 1986 through 2018 was obtained from the Owyhee Ridge Oregon RAWS weather stations that is located approximately 8 miles southeast of the project site. Table 1 presents the precipitation data for the storms used in this analysis.

Table 1: 24-Hour Storm Event Precipitation Depths

Recurrence Interval (years)	Precipitation Depth (in)	
	NOAA Atlas 2	Lognormal Analysis
2	0.99	-
25	Not Available	1.87
100	2.28	-
500	Not Available	3.03

Peak stormwater runoff flows generated from the 25-year, 100-year, and 500-year, 24-hour storm events, presented in Table 1, were calculated using methodologies published in Technical Release 55 (TR-55) by the USDA NRCS (USDA, 2011) and HEC-HMS Version 4.1, utilizing the SCS Rainfall Distribution Method (Type II), by the USACE (HEC, 2015). Malheur County, Oregon is located in the western United States where there are distinct dry and wet seasons and the Type II SCS Rainfall Distribution Method is most applicable. Type II rainfall distribution was used for the hydrologic models presented in this report.

Soil characteristic curve numbers (CNs) used to predict stormwater run-off potential were determined using the WIN TR-55 software for each hydrologic basin using a weighted average of natural soil, vegetation, and proposed ground conditions. Using the NRCS TR-55 Method and Golder's knowledge of the site conditions, CNs were assigned for the revegetated closure cover (placed above the TSF during closure), undisturbed existing ground, and newly graded areas.

Times of Concentration (Tc) were calculated for each hydrologic catchment area using WIN TR-55 by inputting the longest flow path in each basin and the calculated composite CNs discussed in Section 3.2 (USDA, 2011).

Temporary and permanent stormwater diversion channels were designed using the Manning's Equation via Bentley's hydraulic modeling software FlowMaster (Flowmaster, 2009). Manning's roughness coefficients were selected for multiple channel lining systems based on Golder's experience and review of various technical publications.

3.0 HYDROLOGIC ANALYSIS

Golder developed two hydrologic basin models for the Grassy Mountain TSF:

- Permanent Stormwater Diversion: The permanent stormwater diversion channels will collect stormwater runoff generated up-gradient of the TSF and divert the collected water around the TSF to existing natural drainages. This scenario includes all channels that will remain in place during closure along with the drainage swale that will be constructed across the top of the reclaimed surface of the TSF during closure.

- Temporary Stormwater Diversion: During staged construction of the TSF, temporary diversion channels will be constructed to divert stormwater falling downgradient of the permanent diversion channels around the TSF impoundment perimeter road, reclaim pond, underdrain channel, and WRD pad. These channels will be in effect during the stages presented in Table 3.

The stormwater models were prepared using the U.S. Army Corp of Engineers (USACE) Hydrologic Modelling System (HEC-HMS) (HEC, 2015). The models incorporate characteristics of the hydrologic sub-basins, existing drainages and proposed stormwater diversions to calculate peak storm water runoff flow rates from each sub-basin and at critical design locations. The models were developed and run using the following model parameters:

- Rain Distribution
  - SCS Storm Precipitation Meteorological Model
  - Type II Storm Distribution
- Sub-Basin Routing
  - SCS Curve Number Loss Method
  - SCS Unit Hydrograph Transform Method
- Reach Routing
  - Kinematic Wave Routing Method

Figures 1 and 2 schematically present the hydrologic models for the two scenarios.

3.1 Hydrologic Basin Models

Sub-basins were developed based on existing site topography, the overall project layout, the proposed TSF grading plan and identifying features where calculated peak flows would be required for hydraulic design of stormwater diversion improvements. Hydrologic catchment areas were delineated in AutoCAD and 2D surface areas for each sub-basin were extracted for use in the model.

3.1.1 Permanent Stormwater Diversion Condition

The total upgradient hydrologic catchment area for the permanent stormwater diversion channels is 785 acres. To calculate channel geometries for specific areas of each diversion channel, the total catchment area was divided into 10 smaller catchment areas ranging from under 3 acres to 480 acres. A hydrologic basin map depicting the catchment area with respective flow paths is presented in Figures 1 and 2.

The HEC-HMS model presented in Attachment A includes only non-contact water catchment areas, Catchment Areas W-1 through W-3 and E-1 through E-7. During operations and closure, all water generated from Catchment Areas W-1 through W-3, E-1 through E-3, and E-5 through E-7 will be collected and conveyed around the TSF and reclaim pond the natural drainages shown on Figures 1 and 2.

Stormwater falling onto Catchment Area E-4 (TSF impoundment surface) during operations will be is accounted for, and will be managed, in the TSF water balance. Stormwater falling on Catchment Area E-4 will not discharged into the environment. Stormwater falling on Catchment Area E-4 during closure will be conveyed by a drainage swale constructed over top of the TSF's closure cover toward the northeast corner of the TSF where it will

discharge into the east permanent diversion channel at the TSF Swale Outlet shown on Figures 1 and 2. The permanent east and west diversion channels, V-Ditch R-2 and Stage 3 Toe V-Ditch, will remain in place during TSF closure.

Table 2: Permanent Stormwater Diversion Condition Catchment Areas

Catchment Area	Catchment Area (acres)	Channel Name
W-1	17.99	Diversion Channel W-1
W-2	479.61	Diversion Channel W-2
W-3	3.62	Diversion Channel W-3
E-1	7.04	Diversion Channel E-1
E-2	91.28	Diversion Channel E-1
E-3	39.4	Diversion Channel E-1
E-4	136.5	Diversion Channel E-2
E-5	3.03	Diversion Channel E-3
E-6	5.06	Stage 3 Toe V-Ditch
E-7	1.73	Diversion V-Ditch R-1
Total	785.26	

3.1.2 Temporary Stormwater Diversion Condition

During staged construction of the TSF, areas between the TSF impoundment limits and the permanent diversion channels will be managed in temporary diversion channels that convey stormwater falling down gradient of the permanent diversion channels around the staged TSF impoundment. These temporary diversion channels will convey collected stormwater down to permanent diversion channels constructed during Stage 1.

As shown in Figure 3, the temporary stormwater diversion condition will require two temporary diversion channels to be constructed at various points in time throughout the mine staging process, as shown in Figure 3.Table 3 presents the catchment areas for each temporary diversion channel.

Table 3: Temporary Stormwater Diversion Condition Catchment Areas

Catchment Area	Catchment Area (acres)	Channel Name	Phases in Effect
T-1	7.44	Stage 1 Temporary Diversion Channel	1
T-2	7.51	Diversion V-Ditch R-2	1, 2, 3

3.1.3 SCS Curve Numbers

The SCS curve number (CN) is an empirical value accounting for soil type, infiltration characteristics, land use and vegetative cover characteristics that are used to predict stormwater runoff potential; developed by the Soil Conservation Service (SCS) now known as the Natural Resource Conservation Service (NRCS). The NRCS divides soils into four Hydrologic Soil Groups A through D, based on runoff potential of the soils. A Hydrologic Soil Group C was chosen for this area. Soils belonging to the Hydrologic Soil Group C have a slow infiltration rate when thoroughly wet and are generally fine in texture as observed during geotechnical investigation of the Project site.

Weighted average CN values were developed for each hydrologic catchment area for each of the ground conditions listed below:

- Natural soils and vegetation, CN = 80 (classified as Sagebrush with Grass Understory)
- TSF closure cover with vegetation, CN = 85 (classified as Natural Desert (pervious areas only))
- Unlined TSF embankment slopes, CN = 91 (classified as Newly Graded Area (pervious areas only))

Table 4 presents composite CN values for the Permanent Stormwater Diversion Channel contributing areas.

Table 4: Permanent Stormwater Diversion Condition Curve Numbers

Catchment Area	Composite CN
W-1	80
W-2	80
W-3	80
E-1	80
E-2	80
E-3	80
E-4	85
E-5	80
E-6	88
E-7	80

Table 5 presents the composite CN values for the Temporary Stormwater Diversion Channel contributing areas.

Table 5: Temporary Stormwater Diversion Condition Curve Numbers

Catchment Area	Composite CN
T-1	80
T-2	83

3.2 Times of Concentration and Lag Time

Times of concentration (Tc) for each catchment area was calculated by determining the flow path, gradient, and approximate drainage geometry along longest hydraulic flow path of each catchment area.

Tc calculations use flow lengths, gradients of sheet flow, shallow concentrated flow, and channelized flow conditions, where applicable. A maximum sheet flow length of 100 feet was used (USDA, 2011). Tc's are calculated using the WIN TR-55 method (USDA, 2011).

The Tc is then used to calculate the travel time (lag time, L) it takes for storm water to travel downstream from the most hydraulically distant point in the sub-basin to its outlet point. Tc is reduced by 40 percent to account for the delay between the time a storm event begins and when the run-off reaches its maximum peak flow. Table 6 and Table 7 present a summary of the Tc and L for the permanent and temporary stormwater hydrologic catchment areas, respectively. Attachment A presents the detailed calculations for developing the Tc and L for each contributing area.

Table 6: Permanent Stormwater Diversion Channel Catchment Areas Tc and L

Catchment Area	Time of Concentration, Tc (min)	Lag Time, L (min)
W-1	0.207	0.124
W-2	0.367	0.220
W-3	0.266	0.159
E-1	0.145	0.087
E-2	0.340	0.204
E-3	0.382	0.229
E-4	0.299	0.179
E-5	0.192	0.115
E-6	0.222	0.133
E-7	0.100	0.060

Table 7: Temporary Stormwater Diversion Channels Catchment Areas Tc and L

Catchment Area	Time of Concentration, Tc (min)	Lag Time, L (min)
T-1	0.325	0.195
T-2	0.286	0.172

3.3 Hydrologic Model Outputs

Using the data presented in the previous sections, Golder calculated the peak discharge flow rates from each of the contributing area using HEC-HMS 4.1 (HEC, 2015). The following section presents the model output estimate for peak stormwater flows reporting from the delineated catchment areas presented on Figures 1 and 3 for permanent and temporary stormwater diversion channels, respectively.

Calculated peak discharge flow rates for the 25-year, 24-hour storm event under the Permanent Stormwater Diversion Channels are presented in Table 8.

Table 8: Permanent Stormwater Diversion Channel, 25-year, 24-hour Peak Discharge Flow Rates

Catchment Area	25-year, 24-hour Peak Discharge (ft^3/s)
W-1	13.2
W-2	228.7
W-3	2.1
E-1	4.9
E-2	45.5
E-3	18.4
E-4	113.1
E-5	2.0
E-6	5.9
E-7	1.9

Calculated peak discharge flow rates for the 100-year, 24-hour storm event under the Permanent Stormwater Diversion Channels are presented in Table 9.

Table 9: Permanent Stormwater Diversion Channel, 100-year, 24-hour Peak Discharge Flow Rates

Catchment Area	100-year, 24-hour Peak Discharge (ft^3/s)
W-1	20.8
W-2	368.7
W-3	3.3
E-1	7.1
E-2	73.2
E-3	29.6
E-4	164.7
E-5	3.1
E-6	8.2
E-7	2.0

Table 10 presents the calculated peak discharge flow rates for the 500-year, 24-hour storm event under the Permanent Stormwater Diversion Condition.

Table 10: Permanent Stormwater Diversion Channels, 500-year, 24-hour Peak Discharge Flow Rates

Catchment Area	500-year, 24-hour Peak Discharge (ft^3/s)
W-1	36.5
W-2	657.7
W-3	5.9
E-1	13.6
E-2	130.4
E-3	52.9
E-4	266.2
E-5	5.5
E-6	12.6
E-7	3.6

Table 11 presents the calculated peak discharge flow rates for the 25-year, 24-hour storm event under the Temporary Stormwater Diversion Condition.

Table 11: Temporary Stormwater Diversion Condition, 25-year, 24-hour Peak Discharge Flow Rates

Catchment Area	25-year, 24-hour Peak Discharge (ft^3/s)
T-1	3.8
T-2	5.4

Table 12 presents the calculated peak discharge flow rates for the 100-year, 24-hour storm event under the Temporary Stormwater Diversion Condition.

Table 12: Temporary Stormwater Diversion Condition, 100-year, 24-hour Peak Discharge Flow Rates

Catchment Area	100-year, 24-hour Peak Discharge (ft^3/s)
T-1	6.1
T-2	8.1

Due to their temporary nature, the peak discharges resulting from the 500-year, 24-hour were not calculated for the Temporary Stormwater Diversion Channels. All Temporary Stormwater Diversion Channels will be removed during staged construction of the TSF.

4.0 CHANNEL HYDRAULIC CALCULATIONS

4.1 Stormwater Diversion Channels

Using the peak discharge flow rates presented in Section 3.3, Golder performed a hydraulic analysis of each Permanent and Temporary Stormwater Diversion Channel. Detailed design of each channel is presented on the Design Drawings , appended to the Tailings Storage Facility and Waste Rock Dump Final Design Report. The Permanent Stormwater Diversion Channels were sized under the for the greater of the following scenarios:

- 100-year, 24-hour storm event, 9-inches freeboard
- 500-year, 24-hour storm event, no freeboard

The Temporary Stormwater Diversion Channels were sized for the greater of the following scenarios:

- 25-year, 24-hour storm event, 9-inches freeboard
- 100-year, 24-hour storm event, no freeboard

To estimate the open channel flow characteristic of diversion channels, Golder used the Manning's formula and the Bentley software FlowMaster (Flowmaster, 2009). Detailed channel hydraulic characteristics are presented in Attachment B.

Golder assigned the following Manning's roughness coefficients each type of channel lining expected:

- Earth lined channels, n = 0.035
- Riprap lined channels, n = 0.045

4.1.1 Permanent Stormwater Diversion Channels

The Permanent diversion channels around the TSF each have unique geometries, lining systems, with a minimum design grade of 1.4%.

The West Permanent Diversion Channel utilizes two different geometries along its flow path, Diversion Channels W-1 and W-2. Diversion Channel W-1 is a triangular channel (V-ditch) and transitions to trapezoidal Diversion Channel W-2 as the channel collects more flow. The West Permanent Diversion Channel is approximately 0.5-miles long and is designed to flow towards the natural saddle west of the TSF.

The East Permanent Diversion Channel is approximately 1.0-mile long and contains three different geometries along its flow path, Diversion Channels E-1, E-2, and E-3, adjusting geometry as necessary for the increase of contributing flow. Each section of the East Permanent Diversion Channel is trapezoidal with different dimensions. The East Permanent Diversion Channel is designed to flow around the southeast to northeast side of the TSF and discharge into the natural drainage north (down gradient) of the reclaim pond.

Upon closure of the TSF, a drainage swale will be constructed above the impoundment closure cover to convey stormwater to the East Permanent Diversion Channel as shown on Figure 2.

Golder has also designed two permanent triangular (V-ditch) shaped channels, V-Ditch R-1 and Stage 3 Toe V-Ditch. V-Ditch R-1 is located on the northwest side of the reclaim pond that discharges into the same natural drainage as the East Permanent Diversion Channel described above. V-Ditch R-1 is designed to minimize runoff into the reclaim pond. Stage 3 Toe V-Ditch is located at the downstream toe of the Stage 3 north embankment and is designed to minimize runoff onto the access road along the East Diversion Channel.

Culverts installed along the East Permanent Diversion Channel are designed as temporary facilities and will remain during operation for light vehicle access and haul road crossings as shown on Figure 2.Culverts have been sized to convey the 25-year, 24-hour storm event.

. Upon closure, culverts will be removed from the permanent diversion channels as roads are reclaimed.

Locations, cross sections, dimensions, design grade, and lining system for each channel and culvert are presented on construction-level Design Drawings for the Grassy Mountain Tailings Storage Facility and Waste Rock Dump Facility.

4.1.2 Temporary Stormwater Diversion Channels

The following temporary diversion channels have been designed around the TSF:

- Temporary Diversion Channel R-2: to be constructed at the beginning of stage 1 operations and in effect through stage 3 operation
- Stage 1 Temporary Diversion Channel: to be constructed at the beginning of stage 1 operations and in effect through stage 1 operation

Locations, Cross sections, dimensions, design grade, and lining system for each channel are presented on construction-level Design Drawings for the Grassy Mountain Tailings Storage Facility and Waste Rock Dump Facility.

5.0 EROSION PROTECTION DESIGN

5.1 Channel Outlet Aprons

, Riprap energy dissipation aprons have been designed to reduce the velocities to a maximum velocity of 5 feet per second at the downstream end of the apron. Riprap aprons have been designed at the following locations:

- Apron 1 – East Permanent Diversion Discharge into the Natural Drainage
- Apron 2 – West Permanent Diversion Discharge into the Natural Drainage
- Apron 3 – Concentrated flows from Catchment Area W-2 prior to entering the West Permanent Diversion Channel

Apron geometry is based on the flow characteristics of the up-gradient channel or drainage and the downstream conditions of the natural drainage or diversion channel. The outlet aprons were designed using the American Society of Agricultural Engineer's Design of Rock Chutes methods. The lengths of the aprons were calculated as 15 time the D_{50} riprap stone size (Robinson, 1998). The transition length from the channel or drainage outlet to the full width of the apron was calculated as 5 times the D_{50} riprap stone size.

Table 13 presents the minimum outlet apron dimensions. Detailed calculations for selection of outlet apron riprap stone size are presented in Attachment C. Detailed design of the aprons is presented on the construction-level Design Drawings for the Grassy Mountain Tailings Storage Facility and Waste Rock Dump Facility.

Table 13: Diversion Channel Outlet Apron Geometry

Apron	Apron Width (ft)	Recommended Apron Length (ft)
Apron 1	30	13.5
Apron 2	30	13.5
Apron 3	40	13.5

5.2 Riprap Stone Sizing

At the conclusion of designing the diversion channel geometries, the velocities and critical flow states were reviewed for erosion potential. Diversion channels that are expected to have flows with velocities greater than 5 ft/s, as well as supercritical flows, have been designed with riprap lining systems.

FHWA HEC-11 was used to calculate the required D_{50} riprap stone size to resist shear forces resulting from the maximum calculated flow velocity (FWHA, 1989). The resulting D_{50} for all channels and outlet aprons varies between D_{50} = 12 and 28 in. The D_{max} of the riprap was selected as 1.5 times the D_{50} size and a total thickness of the riprap layer was selected as 1.5 times the D_{50} size. Calculations for riprap stone sizing and outlet aprons are presented in Attachment C.

6.0 REFERENCES

Flowmaster, 2009. Bentley® FlowMaster® V8i (SELECTseries 1) [software], build 08.11.01.03. Bentley Systems, Inc. November 4, 2009.

FHWA, 1989. Design of Riprap Revetment, Hydraulic Engineering Circular No. 11 (HEC-11). Report No. FHWA-IP-89-016 HEC-11, Metric Version, U.S. Federal Highway Administration.

HEC, 2015. Hydrologic Engineering Center – Hydrologic Modeling Software (HEC-HMS), Version 4.1, Build 1628, Date 31 July 2015. Developed by U.S. Army Corp of Engineers (USACE)

NOAA 1973. *Precipitation-Frequency Atlas of the Western United States, Volume X – Oregon. Prepared for the US Department of Agriculture, Soil Conservation Service, Engineering Division*. 1973.

Robinson, Rice, Kadavy. 1998. Design of Rock Chutes. ASAE.

USDA, 2011. WinTR-55 Small Watershed Hydrology, Technical Release 55. Version 1.00.10 Compiled on 1 April 2011. Developed by US Department of Agriculture, National Resource Conservation Society .

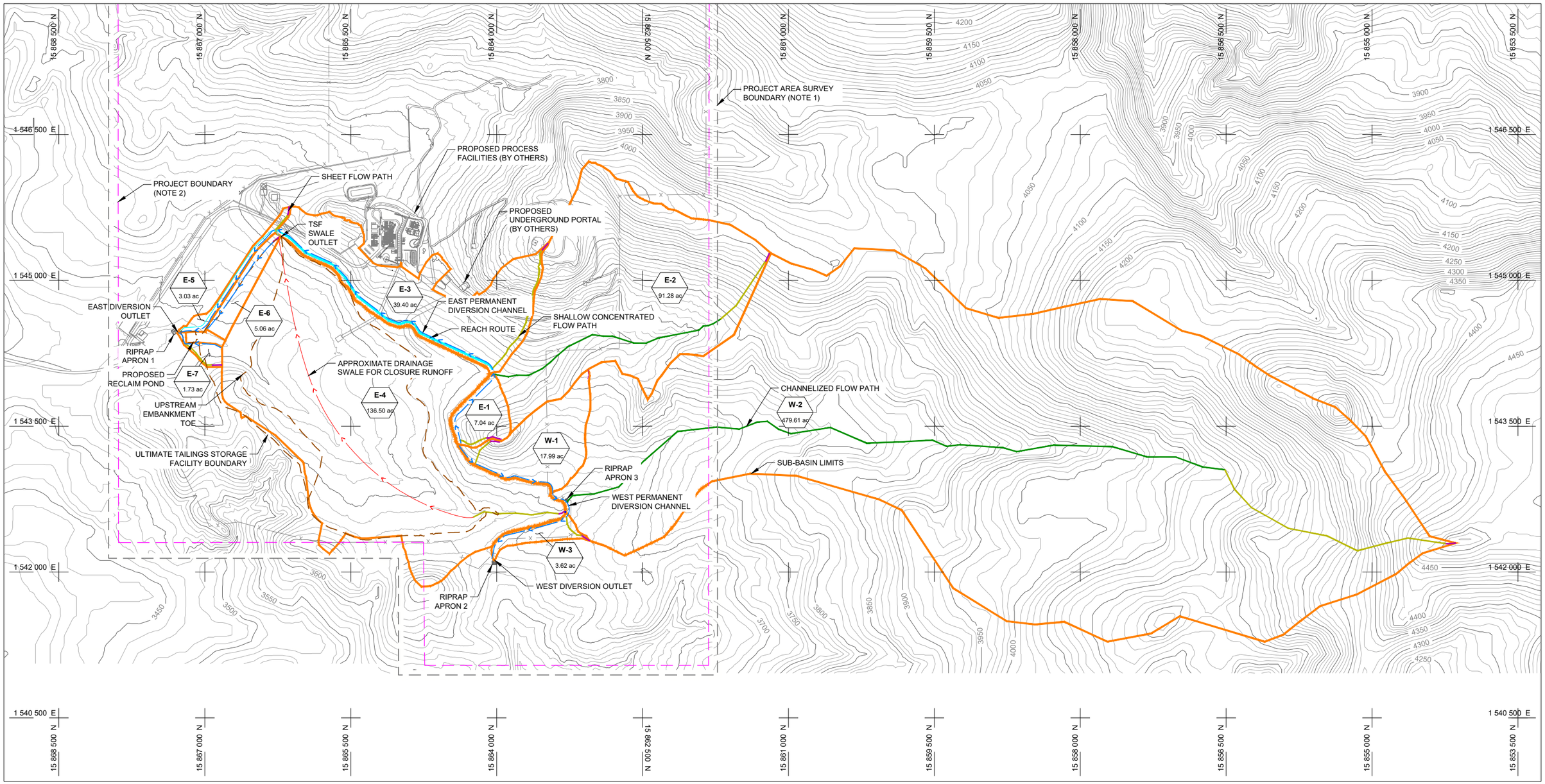
FIGURES

Figure 1 Permanent Stormwater Condition (1 of 2)
Figure 2 Permanent Stormwater Condition (2 of 2)
Figure 3 Temporary Stormwater Condition

ATTACHMENTS

Attachment A Times of Concentration and Lag Time Calculations
Attachment B Diversion Channel Hydraulic Design Calculations
Attachment C Erosion Protection Design Calculation

FIGURES



0 500 1000
1" = 500' FEET

LEGEND

- EXISTING GROUND CONTOURS (10 FT) (NOTE 1)
- PROJECT BOUNDARY (NOTE 2)
- REACH ROUTE
- PERMANENT STORMWATER DIVERSION CHANNEL
- SHALLOW CONCENTRATED FLOW PATH
- SHEET FLOW PATH
- SUB-BASIN LIMITS
- ULTIMATE TAILINGS STORAGE FACILITY BOUNDARY
- PROJECT AREA SURVEY BOUNDARY (NOTE 1)

NOTES

1. EXISTING GROUND TOPOGRAPHY WITHIN THE PROJECT AREA SURVEY BOUNDARY WAS PROVIDED BY CALICO RESOURCES USA CORP. ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf". TOPOGRAPHY OUTSIDE THE PROJECT AREA SURVEY BOUNDARY WAS AVAILABLE FROM WEBGIS DIGITAL ELEVATION MODELS WITH 30 m RESOLUTION.
2. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-01
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
PERMANENT STORMWATER CONDITION (1 OF 2)

PROJECT NO.	REV.	FIGURE
1663241	0	1

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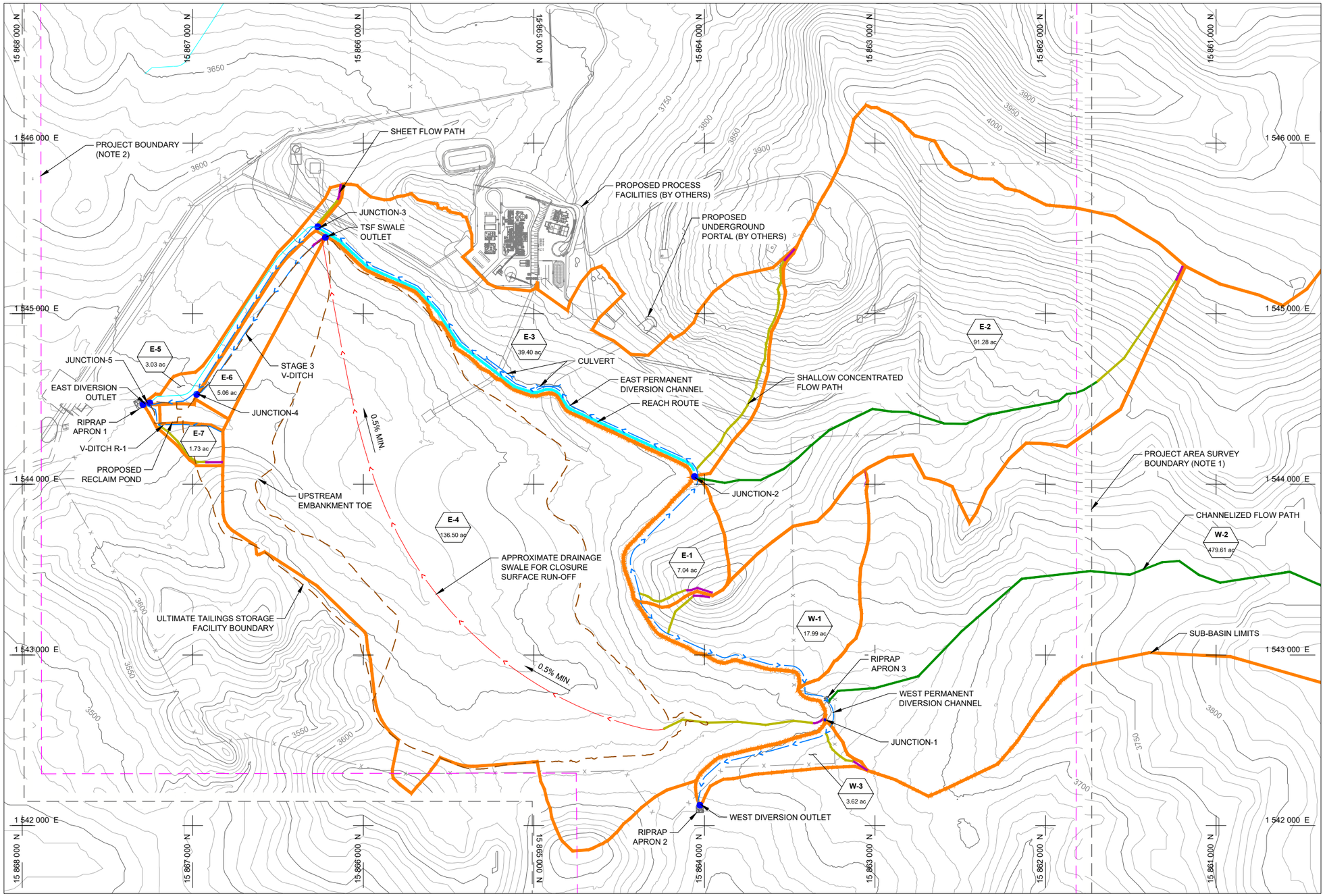

NOTES

1. EXISTING GROUND TOPOGRAPHY WITHIN THE PROJECT AREA SURVEY BOUNDARY WAS PROVIDED BY CALICO RESOURCES USA CORP. ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf". TOPOGRAPHY OUTSIDE THE PROJECT AREA SURVEY BOUNDARY WAS AVAILABLE FROM WEBGIS DIGITAL ELEVATION MODELS WITH 30 m RESOLUTION.
2. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".

LEGEND

- 3600 EXISTING GROUND CONTOURS (10 FT) (NOTE 1)
- PROJECT BOUNDARY (NOTE 2)
- ULTIMATE TAILINGS STORAGE FACILITY BOUNDARY
- APPROXIMATE DRAINAGE SWALE FOR CLOSURE SURFACE RUN-OFF
- CULVERT
- PROJECT AREA SURVEY BOUNDARY (NOTE 1)
- REACH ROUTE
- PERMANENT STORMWATER DIVERSION CHANNEL
- SHEET FLOW PATH
- SHALLOW CONCENTRATED FLOW PATH
- SUB-BASIN LIMITS

0 300 600
1" = 300' FEET

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-01
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
PERMANENT STORMWATER CONDITION (2 OF 2)

PROJECT NO. 1663241 | REV. 0 | FIGURE 2

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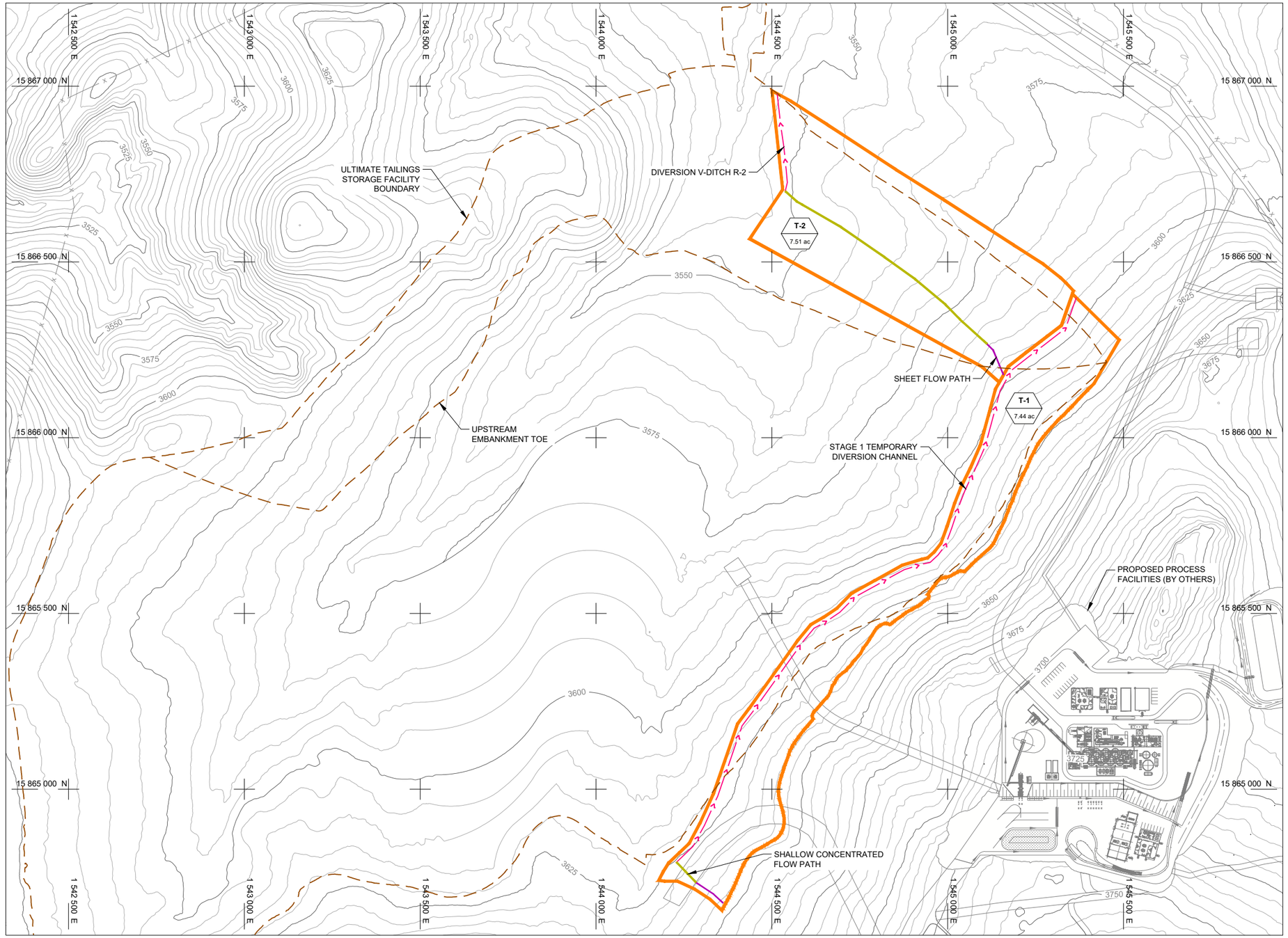

NOTES

1. EXISTING GROUND TOPOGRAPHY PROVIDED BY CALICO RESOURCES USA CORP. ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf".

LEGEND

- 3600 — EXISTING GROUND CONTOURS (5 FT) (NOTE 1)
- ULTIMATE TAILINGS STORAGE FACILITY BOUNDARY
- TEMPORARY STORMWATER DIVERSION CHANNEL
- SHEET FLOW PATH
- SHALLOW CONCENTRATED FLOW PATH
- SUB-BASIN LIMITS

0 150 300
1" = 150' FEET

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-01
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
TEMPORARY STORMWATER CONDITION

PROJECT NO.	REV.	FIGURE
1663241	0	3

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ATTACHMENT A

Times of Concentration and Lag Time Calculations

WinTR-55 Current Data Description

--- Identification Data ---

User: J.Price
Project: Grassy Mountain
SubTitle: Permanent Stormwater Condition - East
State: Nevada
County:
Filename: C:\Users\JePrice\Golder Associates\18111356, Calico Grassy Mountain Civil Design Support Oregon

Date: 10/31/2019
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
E3		Outlet	39.4	80	.382
E4		Outlet	136.5	85	0.299
E6		Outlet	5.06	88	.222
E5		Outlet	3.03	80	0.192
E7		Outlet	1.73	80	0.1
E2		Outlet	91.28	80	.34
E1		Outlet	7.04	80	0.145

Total area: 284.04 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	500-Yr (in)
.99	1.27	1.53	1.87	2.13	2.28	3.03

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

WinTR-55 Current Data Description

--- Identification Data ---

User: J.Price
Project: Grassy Mountain TSF
SubTitle: Permanent Stormwater Condition - West
State: Nevada
County:
Filename: C:\Users\JePrice\Golder Associates\18111356, Calico Grassy Mountain Civil Design Support Oregon

Date: 10/31/2019
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
W-2			479.61	80	.367
W-3			3.62	80	.255
W-1			17.99	80	.114

Total area: 501.22 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	500-Yr (in)
.99	1.27	1.53	1.87	2.13	2.28	3.03

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

WinTR-55 Current Data Description

--- Identification Data ---

User: J.Price
Project: Grassy Mountain TSF
SubTitle: Temporary Stormwater Condition
State: Nevada
County:
Filename: C:\Users\JePrice\Golder Associates\18111356, Calico Grassy Mountain Civil Design Support Oregon

Date: 10/31/2019
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T-1			7.43	80	.325
T-2			7.51	83	.286

Total area: 14.94 (ac)

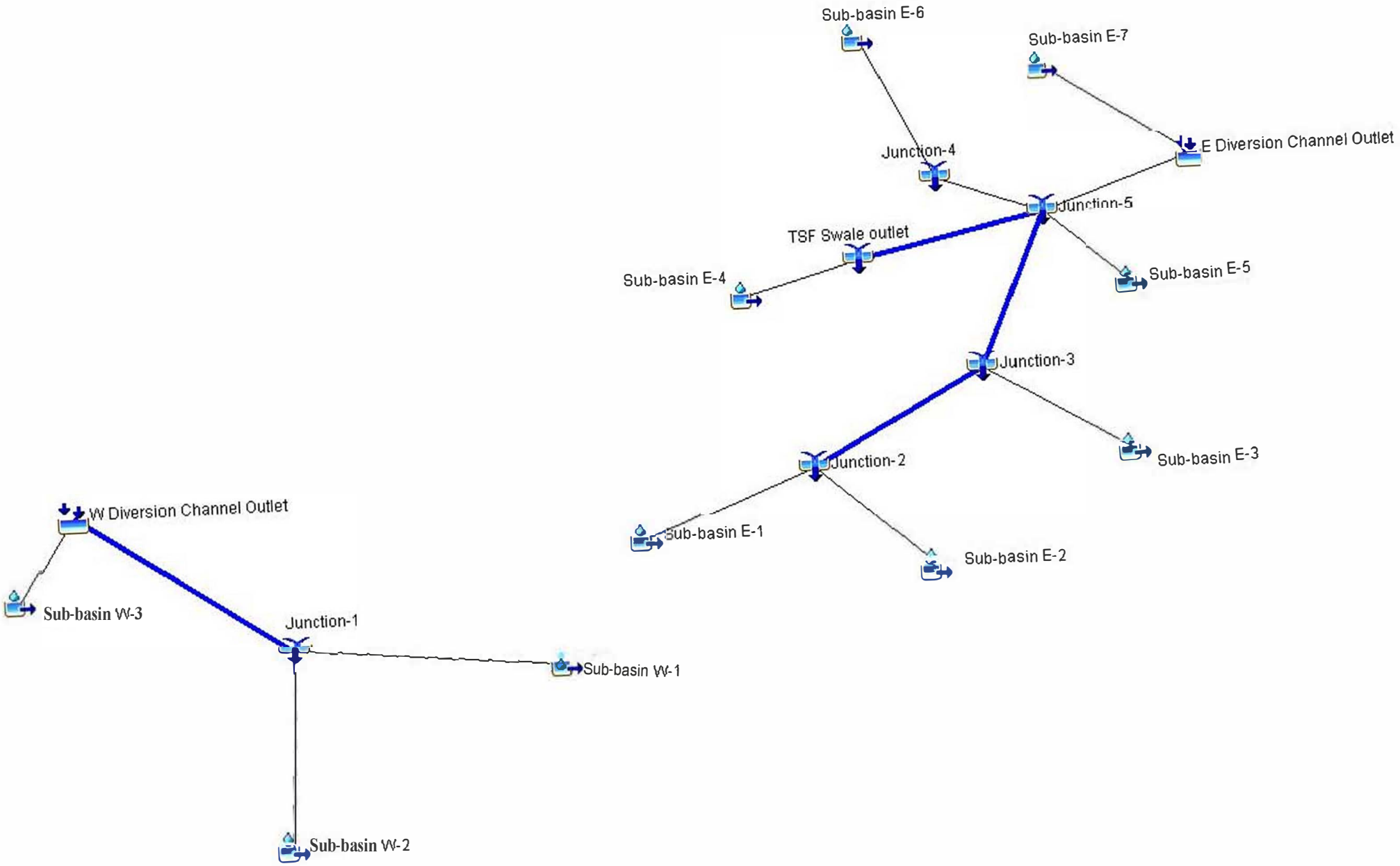
--- Storm Data --

Rainfall Depth by Rainfall Return Period

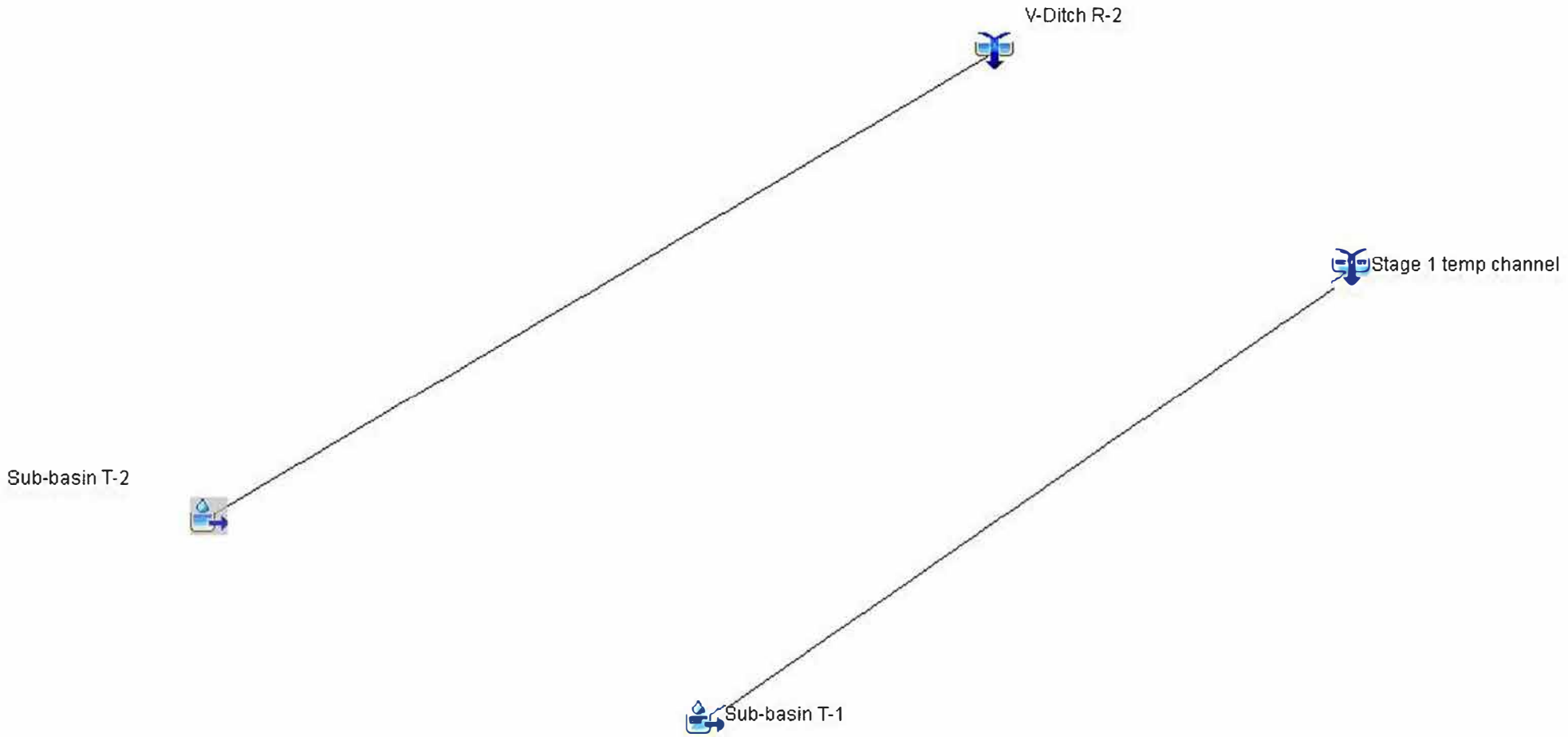
2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	500-Yr (in)
.99	1.27	1.53	1.87	2.13	2.28	3.03

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Grassy Mountain Project
HEC-HMS Permanent Stormwater Conditions Basin Layout
Projcet Number: 1663241



Grassy Mountain Project
HEC-HMS Temporary Stormwater Conditions Basin Layout
Projcet Number: 1663241



ATTACHMENT B

Diversion Channel Hydraulic Design Calculations

Permanent Channel Hydraulics - Diversion Channel E-1 - 100 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01400	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	12.00	ft
Discharge	106.90	ft³/s

Results

Normal Depth	1.31	ft
Flow Area	20.87	ft²
Wetted Perimeter	20.29	ft
Hydraulic Radius	1.03	ft
Top Width	19.86	ft
Critical Depth	1.21	ft
Critical Slope	0.01843	ft/ft
Velocity	5.12	ft/s
Velocity Head	0.41	ft
Specific Energy	1.72	ft
Froude Number	0.88	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.31	ft
Critical Depth	1.21	ft
Channel Slope	0.01400	ft/ft
Critical Slope	0.01843	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel E-1 - **5**00 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01400	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	12.00	ft
Discharge	191.10	ft³/s

Results

Normal Depth	1.80	ft
Flow Area	31.31	ft²
Wetted Perimeter	23.38	ft
Hydraulic Radius	1.34	ft
Top Width	22.80	ft
Critical Depth	1.71	ft
Critical Slope	0.01683	ft/ft
Velocity	6.10	ft/s
Velocity Head	0.58	ft
Specific Energy	2.38	ft
Froude Number	0.92	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.80	ft
Critical Depth	1.71	ft
Channel Slope	0.01400	ft/ft
Critical Slope	0.01683	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel E-**2** - 100 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.04000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	270.00	ft³/s

Results

Normal Depth	2.07	ft
Flow Area	31.41	ft²
Wetted Perimeter	21.15	ft
Hydraulic Radius	1.49	ft
Top Width	20.35	ft
Critical Depth	2.32	ft
Critical Slope	0.02612	ft/ft
Velocity	8.60	ft/s
Velocity Head	1.15	ft
Specific Energy	3.22	ft
Froude Number	1.22	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.07	ft
Critical Depth	2.32	ft
Channel Slope	0.04000	ft/ft
Critical Slope	0.02612	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel E-**2** - **5**00 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.04000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	458.60	ft³/s

Results

Normal Depth	2.73	ft
Flow Area	45.92	ft²
Wetted Perimeter	24.70	ft
Hydraulic Radius	1.86	ft
Top Width	23.65	ft
Critical Depth	3.10	ft
Critical Slope	0.02427	ft/ft
Velocity	9.99	ft/s
Velocity Head	1.55	ft
Specific Energy	4.28	ft
Froude Number	1.26	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.73	ft
Critical Depth	3.10	ft
Channel Slope	0.04000	ft/ft
Critical Slope	0.02427	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel E-**3** - 100 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.03000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	270.00	ft³/s

Results

Normal Depth	2.23	ft
Flow Area	34.80	ft²
Wetted Perimeter	22.03	ft
Hydraulic Radius	1.58	ft
Top Width	21.17	ft
Critical Depth	2.32	ft
Critical Slope	0.02612	ft/ft
Velocity	7.76	ft/s
Velocity Head	0.94	ft
Specific Energy	3.17	ft
Froude Number	1.07	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.23	ft
Critical Depth	2.32	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.02612	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel E-**3** - **5**00 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.03000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	458.60	ft³/s

Results

Normal Depth	2.94	ft
Flow Area	50.96	ft²
Wetted Perimeter	25.82	ft
Hydraulic Radius	1.97	ft
Top Width	24.69	ft
Critical Depth	3.10	ft
Critical Slope	0.02427	ft/ft
Velocity	9.00	ft/s
Velocity Head	1.26	ft
Specific Energy	4.20	ft
Froude Number	1.10	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.94	ft
Critical Depth	3.10	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.02427	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel **W-1** - 100 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	20.80	ft³/s

Results

Normal Depth	1.44	ft
Flow Area	5.22	ft²
Wetted Perimeter	7.78	ft
Hydraulic Radius	0.67	ft
Top Width	7.22	ft
Critical Depth	1.34	ft
Critical Slope	0.02253	ft/ft
Velocity	3.98	ft/s
Velocity Head	0.25	ft
Specific Energy	1.69	ft
Froude Number	0.83	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.44	ft
Critical Depth	1.34	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02253	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel **W-1** - **5**00 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	35.60	ft³/s

Results

Normal Depth	1.77	ft
Flow Area	7.81	ft²
Wetted Perimeter	9.52	ft
Hydraulic Radius	0.82	ft
Top Width	8.84	ft
Critical Depth	1.66	ft
Critical Slope	0.02097	ft/ft
Velocity	4.56	ft/s
Velocity Head	0.32	ft
Specific Energy	2.09	ft
Froude Number	0.85	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.77	ft
Critical Depth	1.66	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02097	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel **W-2** - 100 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.01400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	377.90	ft³/s

Results

Normal Depth	3.23	ft
Flow Area	58.39	ft²
Wetted Perimeter	27.40	ft
Hydraulic Radius	2.13	ft
Top Width	26.15	ft
Critical Depth	2.79	ft
Critical Slope	0.02492	ft/ft
Velocity	6.47	ft/s
Velocity Head	0.65	ft
Specific Energy	3.88	ft
Froude Number	0.76	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.23	ft
Critical Depth	2.79	ft
Channel Slope	0.01400	ft/ft
Critical Slope	0.02492	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel **W-2** - **5**00 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.01400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	657.70	ft³/s

Results

Normal Depth	4.25	ft
Flow Area	87.59	ft²
Wetted Perimeter	32.88	ft
Hydraulic Radius	2.66	ft
Top Width	31.24	ft
Critical Depth	3.76	ft
Critical Slope	0.02311	ft/ft
Velocity	7.51	ft/s
Velocity Head	0.88	ft
Specific Energy	5.12	ft
Froude Number	0.79	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.25	ft
Critical Depth	3.76	ft
Channel Slope	0.01400	ft/ft
Critical Slope	0.02311	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel **R-1** - 100 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.02000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	2.00	ft³/s

Results

Normal Depth	0.57	ft
Flow Area	0.81	ft²
Wetted Perimeter	3.06	ft
Hydraulic Radius	0.26	ft
Top Width	2.84	ft
Critical Depth	0.52	ft
Critical Slope	0.03078	ft/ft
Velocity	2.47	ft/s
Velocity Head	0.09	ft
Specific Energy	0.66	ft
Froude Number	0.82	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.57	ft
Critical Depth	0.52	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.03078	ft/ft

Permanent Channel Hydraulics **-** Diversion Channel **R-1** - **5**00 Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.02000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	3.60	ft³/s

Results

Normal Depth	0.71	ft
Flow Area	1.26	ft²
Wetted Perimeter	3.82	ft
Hydraulic Radius	0.33	ft
Top Width	3.55	ft
Critical Depth	0.66	ft
Critical Slope	0.02846	ft/ft
Velocity	2.86	ft/s
Velocity Head	0.13	ft
Specific Energy	0.84	ft
Froude Number	0.85	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.71	ft
Critical Depth	0.66	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.02846	ft/ft

Permanent Channel Hydraulics **- Stage 3 Toe V-Ditch - 100** Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.07000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	8.20	ft³/s

Results

Normal Depth	0.76	ft
Flow Area	1.46	ft²
Wetted Perimeter	4.11	ft
Hydraulic Radius	0.35	ft
Top Width	3.82	ft
Critical Depth	0.92	ft
Critical Slope	0.02550	ft/ft
Velocity	5.63	ft/s
Velocity Head	0.49	ft
Specific Energy	1.26	ft
Froude Number	1.61	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.76	ft
Critical Depth	0.92	ft
Channel Slope	0.07000	ft/ft
Critical Slope	0.02550	ft/ft

Permamemt Channel Hydraulics **- Stage 3 Toe V-Ditch - 500** Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.07000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	12.60	ft³/s

Results

Normal Depth	0.90	ft
Flow Area	2.01	ft²
Wetted Perimeter	4.83	ft
Hydraulic Radius	0.42	ft
Top Width	4.48	ft
Critical Depth	1.10	ft
Critical Slope	0.02408	ft/ft
Velocity	6.27	ft/s
Velocity Head	0.61	ft
Specific Energy	1.51	ft
Froude Number	1.65	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.90	ft
Critical Depth	1.10	ft
Channel Slope	0.07000	ft/ft
Critical Slope	0.02408	ft/ft

Temporary Channel Hydraulics **- Stage 1 Temp Channel - 25** Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	3.80	ft³/s

Results

Normal Depth	0.76	ft
Flow Area	1.46	ft²
Wetted Perimeter	4.11	ft
Hydraulic Radius	0.35	ft
Top Width	3.82	ft
Critical Depth	0.68	ft
Critical Slope	0.02826	ft/ft
Velocity	2.61	ft/s
Velocity Head	0.11	ft
Specific Energy	0.87	ft
Froude Number	0.74	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.76	ft
Critical Depth	0.68	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02826	ft/ft

Temporary Channel Hydraulics **- Stage 1 Temp Channel - 100** Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	6.10	ft³/s

Results

Normal Depth	0.91	ft
Flow Area	2.08	ft²
Wetted Perimeter	4.91	ft
Hydraulic Radius	0.42	ft
Top Width	4.56	ft
Critical Depth	0.82	ft
Critical Slope	0.02653	ft/ft
Velocity	2.93	ft/s
Velocity Head	0.13	ft
Specific Energy	1.05	ft
Froude Number	0.77	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.91	ft
Critical Depth	0.82	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02653	ft/ft

Temporary Channel Hydraulics **- V-Ditch R-2 - 25** Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	5.40	ft^3/s

Results

Normal Depth	0.87	ft
Flow Area	1.90	ft^2
Wetted Perimeter	4.69	ft
Hydraulic Radius	0.40	ft
Top Width	4.36	ft
Critical Depth	0.78	ft
Critical Slope	0.02697	ft/ft
Velocity	2.84	ft/s
Velocity Head	0.13	ft
Specific Energy	1.00	ft
Froude Number	0.76	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.87	ft
Critical Depth	0.78	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02697	ft/ft

Temporary Channel Hydraulics **- V-Ditch R-2 - 100** Year Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	8.10	ft³/s

Results

Normal Depth	1.01	ft
Flow Area	2.57	ft²
Wetted Perimeter	5.46	ft
Hydraulic Radius	0.47	ft
Top Width	5.07	ft
Critical Depth	0.92	ft
Critical Slope	0.02555	ft/ft
Velocity	3.15	ft/s
Velocity Head	0.15	ft
Specific Energy	1.17	ft
Froude Number	0.78	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.01	ft
Critical Depth	0.92	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02555	ft/ft

ATTACHMENT C

Erosion Protection Design Calculations

Grassy Mountain Project
Channel Riprap Calculations
Project Number: 1663241

Date:	11/1/19
By:	JRP
Chkd:	MDB
Aprvd:	CJM

Rip Rap Sizing

Channel	Design Grade	Maximum Velocity (mps)	Average Flow Depth (m)	Safety Factor	Specific Gravity of Rip Rap	Angle of Repose of Rip Rap (°)	Channel Side Slope Angle (°)	C_s	C_{sf}	K_1	Required Rip Rap D_{50} (m)	Rip Rap D_{15} (m)	Recommended Rip Rap D_{50} (m)	Recommended Rip Rap Thickness (m) ($1.5xD_{50}$)	Rip Rap Filter Fill Thickness (m)
E-1	2-6%	3.0	0.57	1.2	2.75	40	21.8	0.92	1.00	0.82	0.27	0.11	0.305	0.46	0.30
E-1	6-8.5%	3.3	0.52	1.2	2.75	40	21.8	0.92	1.00	0.82	0.38	0.16	0.406	0.61	0.30
E-1	>8.5%	3.9	0.46	1.2	2.75	40	21.8	0.92	1.00	0.82	0.65	0.27	0.711	1.07	0.30
W-2	1.40%	2.0	0.98	1.2	2.75	40	21.8	0.92	1.00	0.82	0.06	0.02	0.102	0.15	0.30

Apron	Design Grade	Maximum Velocity (mps)	Average Flow Depth (m)	Safety Factor	Specific Gravity of Rip Rap	Angle of Repose of Rip Rap (°)	Channel Side Slope Angle (°)	C_s	C_{sf}	K_1	Required Rip Rap D_{50} (m)	Rip Rap D_{15} (m)	Recommended Rip Rap D_{50} (m)	Recommended Rip Rap Thickness (m) ($1.5xD_{50}$)	Rip Rap Filter Fill Thickness (m)
Apron 1	6%	2.5	0.30	1.2	2.75	40	18.4	0.92	1.00	0.87	0.19	0.08	0.203	0.30	0.30
Apron 2	5%	2.7	0.4	1.2	2.75	40	18.4	0.92	1.00	0.87	0.21	0.09	0.203	0.30	0.30
Apron 3	5%	2.4	0.3	1.2	2.75	40	18.4	0.92	1.00	0.87	0.17	0.07	0.203	0.30	0.30

$$D_{50} = C_S C_{SF} \frac{0.00594\, V_a^{\ 3}}{\sqrt{d}\, K_1^{1.5}}$$

$$C_S = \frac{2.12}{(G_S - 1)^{1.5}}$$

$$C_{SF} = \left(\frac{SF}{1.2}\right)^{1.5}$$

$$K_1 = \left(1 - \frac{\left(\sin^2\theta\right)}{\left(\sin^2\Phi\right)}\right)^{1/2}$$

APPENDIX H

Underdrain Collection Piping Design

GOLDER

CALCULATIONS

DATE:	Oct-19	**Made by:**	MDB
PROJECT NO.:	1663241 - Grassy Mountain TSF Detailed Design	**Checked by:**	CJM
SUBJECT:	TSF Underdrain Pipe Sizing	**Reviewed by:**	RAB

Assumptions:

- Solid wall underdrain pipes will maintain a minimum slope of 1.0%, after settlement, beneath the embankment.
- Underdrain pipes will be DR17 HDPE.
- Underdrain pipes will be sized to convey the maximum flow estimated by Golder in the Consolidation and Thin-Lift Modeling Technical Memorandum.
- Full flow capacity of the underdrain pipes was calculated using Bentley Flowmaster Version 8i.
- Manning's Roughness Coefficient of 0.012 (smooth wall HDPE).

areas of the tailings however for redundancy each underdrain pipe will be sized to convey the entire drainage rate.

Given:

- Golder developed drainage rates through the tailings for two scenarios in the *Consolidation and Thin-Lift Modeling* Technical Memorandum.
- The drainage rates developed for Case 2, which assumes water lost at the surface of the tailings during the sedimentation process reports to the supernatant pool, were used to size the solid wall underdrain pipes used to convey solution collected at the base of the TSF to the reclaim pond
- The volume of water reporting to the supernatant pool was estimated by based on the results of the settling column tests.

Year	Case 2 – Drainage Rate (gpm)		
	Min	Max	Average
1	2.3	99.3	13.5
2	3.3	30.3	12.5
3	5.1	72.1	20.7
4	4.3	52.4	16.6
5	4.9	73.5	19.5
6	5.7	46.3	18.3
7	6.5	57.8	24.6
8	7.9	47.0	20.3
9	8.0	91.4	25.0
10	8.6	58.4	21.7
11	9.1	65.7	26.4
12	10.9	58.8	25.3
13	12.6	64.7	27.0
14	13.7	63.1	28.8

Calculations:

Full flow capacity of 6-inch DR17 HDPE (5.8" I.D.):	**249.3**	gpm	*(Calculation attached)*
Maximum drainage rate:	99.3	gpm	*(Case 2 above)*
Average drainage rate:	21.4	gpm	*(Case 2 above)*

In the event that any of the underdrains were to become plugged, a single 6-inch solid wall DR17 HDPE pipe will convey the maximum estimated drainage rate at 40% capacity and the average drainage rate at 18% capacity. This additional capacity will accommodate long term pipe scaling and roughening of the inner wall of the pipe.

Attachment A

Underdrain Flow Capacity Calculations

6" DR17 HDpE Underdrain Pipe - Full Flow

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01000	ft/ft
Normal Depth	5.80	in
Diameter	5.80	in
Discharge	249.23	gpm

Results

Discharge	249.23	gpm
Normal Depth	5.80	in
Flow Area	0.18	ft²
Wetted Perimeter	1.52	ft
Hydraulic Radius	1.45	in
Top Width	0.00	ft
Critical Depth	0.38	ft
Percent Full	100.0	%
Critical Slope	0.01071	ft/ft
Velocity	3.03	ft/s
Velocity Head	0.14	ft
Specific Energy	0.63	ft
Froude Number	0.00	
Maximum Discharge	0.60	ft³/s
Discharge Full	0.56	ft³/s
Slope Full	0.01000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

6" DR17 HDpE Underdrain Pipe - Full Flow

GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	5.80	in
Critical Depth	0.38	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.01071	ft/ft

Worksheet for 6" DR17 HDPE Underdrain Pipe - Max Drainage Rate

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01000	ft/ft
Diameter	5.80	in
Discharge	99.30	gpm

Results

Normal Depth	2.54	in
Flow Area	0.08	ft²
Wetted Perimeter	0.70	ft
Hydraulic Radius	1.33	in
Top Width	0.48	ft
Critical Depth	0.24	ft
Percent Full	43.9	%
Critical Slope	0.00663	ft/ft
Velocity	2.86	ft/s
Velocity Head	0.13	ft
Specific Energy	0.34	ft
Froude Number	1.25	
Maximum Discharge	0.60	ft³/s
Discharge Full	0.56	ft³/s
Slope Full	0.00159	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	43.86	%
Downstream Velocity	Infinity	ft/s

Worksheet for 6" DR17 HDPE Underdrain Pipe - Max Drainage Rate

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.54	in
Critical Depth	0.24	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00663	ft/ft

Worksheet for 6" DR17 HDPE Underdrain Pipe - Avg. Drainage Rate

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01000	ft/ft
Diameter	5.80	in
Discharge	21.40	gpm

Results

Normal Depth	1.15	in
Flow Area	0.03	ft²
Wetted Perimeter	0.45	ft
Hydraulic Radius	0.69	in
Top Width	0.39	ft
Critical Depth	0.11	ft
Percent Full	19.8	%
Critical Slope	0.00626	ft/ft
Velocity	1.85	ft/s
Velocity Head	0.05	ft
Specific Energy	0.15	ft
Froude Number	1.26	
Maximum Discharge	0.60	ft³/s
Discharge Full	0.56	ft³/s
Slope Full	0.00007	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	19.83	%
Downstream Velocity	Infinity	ft/s

Worksheet for 6" DR17 HDPE Underdrain Pipe - Avg. Drainage Rate

GVF Output Data

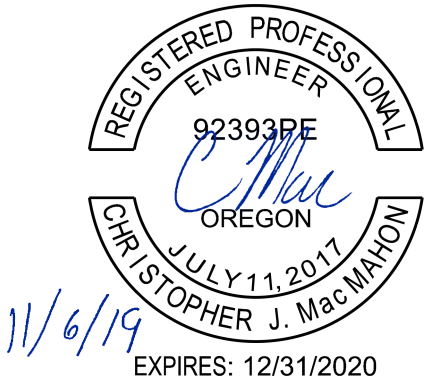
Upstream Velocity	Infinity	ft/s
Normal Depth	1.15	in
Critical Depth	0.11	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00626	ft/ft

APPENDIX I

Technical Specifications

Technical Specifications
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon



Submitted to:

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1662341-056-SP-Rev0

November 6, 2019

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01041	Project Coordination	0	November 6, 2019
01042	Mobilization	0	November 6, 2019
01050	Field Engineering	0	November 6, 2019
01051	Geotechnical Exploration	0	November 6, 2019
01090	Reference Standards and Regulations	0	November 6, 2019
01300	Submittals	0	November 6, 2019
01400	Quality Control Assurance	0	November 6, 2019
01410	Testing Laboratory Services	0	November 6, 2019
01500	Construction Facilities and Temporary Controls	0	November 6, 2019
01600	Materials and Equipment	0	November 6, 2019
01700	Demobilization	0	November 6, 2019
02110	Site Clearing and Stripping	0	November 6, 2019
02205	Fill Materials	0	November 6, 2019
02211	Rough Grading	0	November 6, 2019
02222	Excavating	0	November 6, 2019
02223	Filling	0	November 6, 2019
02272	Geotextile	0	November 6, 2019
02273	Geonet	0	November 6, 2019
02350	Geosynthetic Clay Liner	0	November 6, 2019
02710	Gravity Piping	0	November 6, 2019
02775	Geomembranes	0	November 6, 2019
03110	Concrete Formwork	0	November 6, 2019
03220	Reinforcing Steel	0	November 6, 2019
03300	Cast-in-Place Concrete	0	November 6, 2019
11207	Parshall Flumes	0	November 6, 2019
17150	Meters and Instrumentation	0	November 6, 2019

SECTION 01010
SUMMARY OF WORK

1.0 GENERAL

1.1 Section Includes

A. Work Scope

B. Definitions

C. Contradictions

D. Contractor's Responsibilities

1.2 Work Scope

A. The scope of work for this project shall consist of construction of Tailings Storage Facility (TSF) and Waste Rock Dump (WRD) at the Grassy Mountain Mine as shown on the Drawings. The Work under this contract will include, but is not limited to:

1. Mobilization of all equipment and material required for the Work including: mobilization of temporary power facilities, sanitation facilities, and communication facilities.
1. Installation of temporary and permanent surface water control.
2. Furnishing and placement of construction water for both fill moisture control and dust control on roads and fills associated with construction of the Work in coordination with the Owner.
3. Backfilling and compaction of exploration test pits and boreholes, as required by the Owner, within the TSF and WRD footprints.
4. Clearing, grubbing, and stripping as required for the Work.
5. Construction of temporary access and haul roads.
6. Excavation, hauling, placement, of fill materials for the embankment, including Embankment Fill, Grading Fill, and Prepared Subgrade including moisture-conditioning and compaction.
7. Excavation, hauling, processing, and placement of fill materials Drainage Layer, Filter Fill, Anchor Trench Backfill, Drain Gravel, Leak Detection Fill, Pipe Bedding Fill, and Cable Bedding Fill including moisture-conditioning and compaction.
8. Subgrade preparation for geosynthetic clay liner (GCL) and high-density polyethylene (HDPE) geomembrane liner and embankment foundations.
9. Furnishing and installing 60 and 80 mil HDPE Geomembrane liner in the areas shown on the Drawings.
10. Furnishing and installing GCL.
11. Furnishing and installing Non-woven Geotextile in areas shown on the Drawings.
12. Furnishing and installing geonet in areas shown on the Drawings.
13. Furnishing, welding, and installing corrugated polyethylene (CPE) and HDPE piping and filling.
14. Demobilization, which includes: removal of temporary structures, shaping, contouring, and grading of final surfaces in preparation of reclamation seeding.

1.3 DEFINITIONS

B. The following definitions apply to these Technical Specifications:

1. "Owner" is defined as an authorized representative of Calico Resources USA Corp. (Calico).

2. “Engineer” is defined as a representative appointed and authorized by the Owner (Golder Associates, Inc.). The Engineer shall be a registered Professional Engineer in the State of Oregon, or a designated site representative under his supervision during construction.
3. “Resident Engineer” is defined as the Engineer’s on-site representative to oversee the completion of Quality Assurance of the Work.
4. “Quality Control Team” is defined as the individuals working under the direction of Engineer to perform on-site Quality Control tasks at the frequencies listed in these Specifications. The Quality Control Team shall be approved by the Owner. All field and laboratory testing shall be supervised by a registered Professional Engineer licensed in the State of Oregon.
5. “Quality Assurance Team” is defined as the individuals working under the direction of Engineer to perform on-site quality assurance tasks for the Owner during earthwork placement, pipe installation, and geomembrane installation.
6. “Contractor” is defined as the party which has executed a contract agreement for the specified work with the Owner.
7. “Geomembrane Installation Contractor: is defined as the Subcontractor retained by the Contractor or the Owner to install the geomembrane, geotextile, geonet and related appurtenances.
8. “Vendor” is defined as the supply or manufacturer of fabricated materials retained by the Contractor or Owner required to complete the Work.
9. “Subcontractor” is defined as a party retained by the Contractor to provide services or materials required to complete the Work. The Subcontractor shall be under direct supervision and report directly to the Contractor.
10. “Quality Control” is defined as inspection and testing performed prior to manufactured material being placed as well as inspection and testing performed on earthwork materials placed during construction of the Work. Performed by the Contractor, Manufacturer, or facility retained by the Contractor or Manufacturer.
11. “Quality Assurance” is defined as inspection and testing performed by the Quality Assurance Team and third-party laboratories retained by the owner.
12. “Specifications” are defined as this document of Technical Specifications prepared by Golder Associates Inc. (Golder) for the Owner.
13. “Report” is defined as the Construction-level Design Report presented as Appendix C in the Grassy Mountain Consolidated Permit Application and titled *Detailed Design, Tailings Storage Facility and Waste Rock Dump, Grassy Mountain Mine, Malheur County, Oregon,* Revision 0, dated November 6, 2019 prepared by Golder in conjunction with these Specifications and Drawings.
14. “Drawings” are defined as the construction-level design drawings prepared by Golder in conjunction with these Specifications titled *Grassy Mountain Mine, Tailings Storage Facility and Waste Rock Dump,* Revision 0, dated November 6, 2019.
15. “Modifications” are defined as changes made to the Specifications or the Drawings that are approved by the Owner and Engineer in writing after the Specifications or the Drawings have been finalized.
16. “On-Site Material” is defined as borrow soils obtained from within required facility excavations.
17. “Off-Site Materials” is defined as material obtained from sources other than on-site.
18. “Record Documents” are defined as the documents prepared by the contractor documenting the progress, location, type and quantity of materials placed to complete the Work.
19. “Products” are defined as new material, machines, components, equipment, fixtures, and systems forming the Work. This does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing material or components required for reuse.

20. “Work is defined as the entire complete construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.
21. “Contract Documents” are defined as the Agreement, Addenda (which pertain to the Contract Documents), Contractor’s Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Bonds, the General Conditions, the Supplementary Conditions, the Specifications, the Drawings, the CQA Plan, together with all Modifications issued after the execution of the Agreement.
22. All slopes are described in terms of horizontal distance to vertical distance (H:V).

1.4 CONTRADICTIONS

A. Should any contradiction, either implied or real, exist between the Specifications and the Drawings, the Contractor shall:

1. Notify the Owner and Engineer.
2. Stop all work that concerns the contradiction until the contradiction is remedied or clarified by the Engineer.

B. The decision of the Engineer is final.

1.5 CONTRACTOR’S RESPONSIBILITIES

A. The Contractor Shall:

1. Maintain Oregon Workman’s Compensation Insurance and provide evidence of such to the Owner.
2. Familiarize himself/herself with the relevant regional and site-specific conditions which may have an impact upon the work.
3. Be responsible for making his own measurements and installing his work to fit the conditions encountered.
4. Before proceeding with the Work, examine all Drawings, Specifications, CQA Plan, and Reports and notify the Engineer and Owner in writing of any apparent discrepancies or interferences. The Engineer, in consultation with the Owner, shall make minor alterations to the Drawings as needed. All alterations shall be issued under a covering work order signed by the Owner prior to the start of alteration, if the alteration will affect the terms of Contract.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01041
PROJECT COORDINATION

1.0 GENERAL

1.1 Section Includes

A. Contractor's Responsibilities

B. Submittals

1.2 Related Sections

A. Section 01010 – Summary of Work

B. Section 01300 – Submittals

C. Section 01500 – Reference Standards

1.3 Contractor's Responsibilities

A. Cooperate with the Owner in allocation of mobilization areas, areas for field offices, access, traffic, and parking facilities.

B. During construction, coordinate use of site and facilities through the Owner.

C. Comply with Owner's and Engineer's procedures for intra-project communications

D. Comply with instructions from the Owner for use of temporary utilities and construction facilities.

E. Submit request for interpretation of the Contract Documents to the Owner, and obtain instructions through the Owner.

F. All Contractor's personnel may be required to take site specific hazard training session, conducted by the Owner, and must have updated MSHA training in order to work at the site.

1.4 Submittals

A. Submit Contractor's MSHA number to Owner.

B. Submit MSHA health and safety certification of each employee that will work on site to the Owner prior to working at the site.

C. Submit preliminary deployment drawings, show drawings, product data, and samples in accordance with Section 01300 for review and compliance with Contract Documents. Revise and resubmit as required.

D. Maintain a record of man-hours worked on site and lost time accident hours. Submit the record weekly to the Owner.

E. Submit copies of air quality permits, if such permits are required to construct the Work.

F. Submit Material Safety Data Sheets (MSDS) to Owner for all chemicals or hazardous materials used on site, or stored on site, in support of performance of the Work. Submit weekly quantity use of TRI chemicals to the Owner, as requested by the Owner.

G. Submit a disposal plan for all waste r contaminated materials developed on site during performance of the Work. Submit plan prior to mobilization.

H. Submit statement at the end of the project stating that all waste and contaminated materials were disposed of in accordance with the approved plan.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01042
MOBILIZATION

1.0 GENERAL

1.1 Section Includes

A. General

1.2 Work Scope

A. Section 01010 – Summary of Work

B. Section 01500 – Construction Facilities and Temporary Controls

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 General

A. Upon receipt of notice to proceed, the Contractor shall furnish, mobilize and install such temporary works, materials, equipment, and construction plants as necessary for the successful completion of the Work. The Contractor shall also operate and maintain such temporary works, equipment and construction plants throughout the period of construction. All applicable temporary works, such as sanitation facilities, shall fully comply with the rules and regulations of the government agency having jurisdiction. Portable screening or crushing facilities used on-site shall have applicable air emissions permits. Clearing, grading, earthwork and construction of access roads necessary for the temporary works, if any, shall be included as mobilization.

B. The Contractor shall obtain any permits necessary to complete the Work at Contractor's expense.

*****END OF SECTION*****

SECTION 01050
FIELD ENGINEERING

1.0 GENERAL

1.1 Section Includes

A. Project Record Documents

B. Examination

C. Survey

D. Alterations to Drawings and Specifications

1.2 Related Sections

A. Section 01010 – Summary of Work

B. Section 01090 – Reference Standards

C. Section 01300 – Submittals

1.3 Project Record Documents

A. The Contractor shall:

1. Maintain a complete and accurate log of survey control and survey work.
2. Make the log available for review to the Owner and Engineer without limitation.

B. After project completion, submit record documents per Section 01300 – Submittals: As-built Documentation.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 General

A. The Contractor shall notify the Owner and Engineer of any discrepancies discovered in the surveying or Drawings.

3.2 Survey

A. The Owner shall provide a minimum of three (3) survey control points to layout and control the Work.

B. The Contractor shall:

1. Retain the services of a surveyor licensed in the State of Oregon.
2. Use the survey control points provided by the Owner to lay out the Work.
3. Triangulate between the three control-points to verify accuracy prior to using the points for control work.
4. Perform a survey of the site in its original form on a minimum 100-foot grid. The survey will be submitted to the Engineer for review prior to initiation of growth media stripping. The survey will be used as a basis for quantity verification for site grading. If earthworks are performed prior to survey verification, Contract shall remedy at Contractor's expense.
5. Survey the grid after completion of the following tasks and submit the topographic survey to the Owner and Engineer.
    a. Growth Media Stripping.

b. Excavation and placement of Embankment Fill.

c. Placement of Liner Bedding Fill (survey will be used to determine finish geomembrane liner limits and elevations).

d. Placement of Drainage Layer.

e. Placement of Filter Layer.

f. All permanent cut slopes or water diversion/control areas affected during construction.

6. Submit each survey to the Engineer within two (2) weeks of completion of each task.

7. Provide additional surveying necessary to accurately maintain slopes and grades for control of the Work.

8. The Contractor shall make every effort to preserve Owner-provided control and points. If, in the opinion of the Owner, any survey control points have been carelessly or willfully disturbed or destroyed by the Contractor or his employees, the cost of replacement shall be incurred by the Contractor.

3.3 Alterations To Drawings and Specifications

A. Alterations made by the Contractor to either the Specifications or Drawings shall be subject to the Owner's and Engineer's approval and, where applicable, to the approval of regulatory agencies. All alterations shall be issued under a covering work order signed by the Owner prior to the start of alteration.

*****END OF SECTION*****

SECTION 01051
GEOTECHNICAL EXPLORATION

1.0 GENERAL

1.1 Section Includes

A. Summary

B. Verification

C. Warranty

1.2 Summary

A. Geotechnical explorations in the Tailings Storage Facility and Waste Rock Dump footprints were conducted during the following:

1. December 2017 – 15 Borings, 44 Test Pits and six (6) field falling head permeability tests conducted in boreholes
2. March 2019 – Six geotechnical boreholes at previously completed Test Pits
3. July 2019 – 11 cone penetration test soundings at previously completed Borings and Test Pits

B. The design for the Grassy Mountain TSF and WRD, written by Golder in November 2019 titled D*etailed Design, Tailings Storage Facility and Waste Rock Dump, Grassy Mountain Mine, Malheur County, Oregon,* Revision 0, dated November 2019 references the geotechnical investigation findings.

C. Test Pit, Boring, and CPT exploration locations located within the TSF embankment, TSF basin, and WRD footprint will require over-excavation and backfill in accordance with Section 02222 and Section 02223.

1.3 Verification

A. Field verify the location of all exploration boreholes and test pits with the Engineer and Owner.

B. Contractor shall supply certification that all test pits have been filled in accordance with these Specifications. The Contractor will supply a list of the boreholes/pits backfilled with the certification, including the depth of each borehole/test pit.

1.4 Warranty

A. The conclusions and recommendations described in the Golder Report cited above were based on Golder's understandings of the project, as described in the Report, and the site conditions as documented during Golder's geotechnical investigation. Unanticipated soil and subsurface conditions are commonly encountered and cannot be fully determined by reviewing soil logs from the borings or test pits. The report prepared by Golder should not be construed as a warranty of actual subsurface conditions.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Verification

A. Bidders shall visit the site and familiarize themselves with all existing surface and subsurface conditions, whether covered in the reports or not, and shall understand all recommendations associated with the earthwork.

*****END OF SECTION*****

SECTION 01090
REFERENCE STANDARDS AND REGULATIONS

1.0 GENERAL

1.1 Section Includes

A. Codes and Regulations

B. Schedule of References

1.2 Related Sections

A. Section 01400 – Quality Control/Assurance

B. Section 01600 – Materials and Equipment

C. Section 02110 – Site Clearing and Stripping

D. Section 02205 – Fill Materials

E. Section 02211 – Rough Grading

F. Section 02223 – Filling

G. Section 02273 – Geonet

H. Section 02350 – Geosynthetic Clay Liner

I. Section 02710 – Gravity Piping

J. Section 02775 – Geomembrane

K. Section 03300 – Cast-in-Place Concrete

1.3 Codes and Regulations

A. The work shall conform to applicable federal, state, county, and local regulations.

B. The following publications current at the date of Contract Documents, unless specified otherwise, are a part of this specification, except where modified or replaced by local codes or ordinances having jurisdiction, in which case such local codes or ordinances shall govern:

1. Occupational Safety and Health Administration, General Industry and Health Standards – OSHA 2206.
2. Mine Safety and Health Administration - Code of Federal Regulations - Title 30 (Mineral Resources)
3. Oregon Department of Transportation.
4. U.S. Department of Transportation.
5. Clean Water Act – Oregon Department Environmental Quality.
6. Environmental Impact Statement and the Plan of Operations at the site, if applicable.
7. Water Resources Department (WRD), Dam Safety Regulations, OAR 690, Division 20.
8. Department of Geology and Minerals Industries (DOGAMI), Chemical Process Mine Regulations, OAR 632, Division 37.
9. Department of Fish and Wildlife (ODFW), Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420.

10. Department of Environmental Quality (DEQ), Chemical Mining, OAR Chapter 340, Division 43.

1.4 Schedule of References

A. For products of workmanship specified by association, trade, or Federal Standards, all shall comply with the requirements of the standard, except when more rigid requirements are specified or are required by applicable codes. Conform to reference standard that is current at the date of Contract Documents. As a minimum the following reference standards shall be used for this project:

1. AASHTO — American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W.
Washington, DC 20001

2. ACI — American Concrete Institute
Box 19150
Redford Station
Detroit, MI 48219

3. ANSI — American National Standards Institute
1430 Broadway
New York, NY 10018

4. ASTM — American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

5. AWWA — American Water Work Association
6666 West Quincy Avenue
Denver, CO 80235

6. CRSI — Concrete Reinforcing Steel Institute
933 Plum Grove Road
Schaumburg, IL 60195

7. NSF — National Sanitation Foundation
Box 1468
Ann Arbor, MI 48106

8. GRI — Geosynthetics Research Institute
Drexel University
West Wing – Rush Building, #10
Philadelphia, PA 19104

9. NSF — National Sanitation Foundation
Box 1468
Ann Arbor, MI 48106

10. PPI — Plastic Pipe Institute
105 Decker Court, Suite 825
Irvine, TX 75062

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01300
SUBMITTALS

1.0 GENERAL

1.1 Section Includes

A. Technical Data

B. Progress Schedules

C. As-Built Documentation

1.2 Related Sections

A. Section 01400 – Quality Control/Assurance

B. Section 01600 – Materials and Equipment

C. Section 02205 – Fill Materials

D. Section 02223 – Filling

E. Section 02273 – Geonet

F. Section 02350 – Geosynthetic Clay Liner

G. Section 02710 – Gravity Piping

H. Section 02775 – Geomembrane

I. Section 03220 – Reinforcing Steel

J. Section 03300 – Cast in Place Concrete

1.3 Technical Data

A. Engineering data covering all equipment and fabricated materials to be furnished under this contract shall be submitted to the Engineer for review. This data shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and operation of component material and devices: the external connections, anchorages, and supports required: performance characteristics; and dimensions needed for installations and correlation with other materials and equipment. Data submitted shall include drawings showing essential details of any changes proposed by Contractor.

B. No work shall be performed in connection with the fabrication or manufacture of materiaI and equipment, nor shall any accessory or appurtenance be purchased until the drawings and data have been reviewed and approved by the Engineer, except at the Contractor's own risk and responsibility.

C. Three (3) copies of each submittal, drawing, and necessary data shall be submitted to the Engineer. Each drawing or data sheet shall be clearly marked with the name of the project, the Contractor's name, references to applicable Specification paragraphs, and Drawing sheets. When catalog pages are submitted, the applicable items shall be identified. The Engineer shall return one (1) copy of the submittal to the Contractor with comments.

D. When the drawings and data are returned marked REVISE AND RESUBMIT the corrections shall be made as noted thereon and as instructed the Engineer and not less than three (3) corrected copies resubmitted.

E. When the drawings and data are returned marked REJECTED, the Contractor shall take necessary corrective actions to comply with contract documents. All items marked REJECTED will not be accepted and a substitute must be submitted for approval from the Engineer.

F. Unless otherwise directed by the Engineer, when drawings and data are returned marked APPROVED AS NOTED, the changes shall be made as noted thereon and not less than three (3) corrected copies shall be furnished to the Engineer.

G. When the drawings and data are returned marked APPROVED, one (1) copy, shall be returned to the Contractor, one (1) copy shall be retained for the Owner, and one (1) copy shall be retained by the Engineer.

H. The Engineer's review of drawings and data submitted by the Contractor shall cover only general conformity to the Drawings and Specifications, external connections, and dimensions which affect the layout. The Engineer's review of drawings and data returned marked APPROVED or APPROVED AS NOTED does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, devices, or items shown, and does not relieve the Contractor from any responsibility for errors or deviations from the contract requirements.

I. All drawings and data, after the final processing by the Engineer, shall become a part of the Contract Documents and the Work shown or described thereby shall be performed in conformity therewith unless authorized by the Owner or the Engineer.

1.4 Progress Schedules

A. Procedure

1. Submit a preliminary progress schedule to the Owner.
2. After Owner's review, revise and resubmit schedule to comply with Owners review.
3. Submit revised progress schedule every two weeks or according to a scheduled agreed upon by the Owner.

B. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

C. Provide subcontractors activity schedules.

D. Provide separate schedule of submittal dates for shop drawings, product data, and samples, including Owner furnished products, and dates that reviewed submittals shall be required from the Owner and Engineer. Indicate delivery data for products.

E. Schedules shall be in a form that is acceptable to the Owner.

F. Distribute copies of reviewed schedules to the project file, Subcontractors, suppliers, and the Engineer.

G. Instruct recipients to promptly report in writing problems anticipated by projections indicated in schedules.

1.5 Quality Control Test Results and Daily Field Reports

A. The Contractor shall be responsible for material property testing of soil, rock, and aggregate material in accordance with the testing frequencies in Section 02223.

B. Quality Control testing shall be performed by qualified personnel under direct supervision of a Professional Engineer licensed in the State of Oregon.

C. Complete Quality Control Test results shall be submitted to the Owner and Engineer within twenty-four (24) hours of collecting sample for testing, or upon request, for review and approval.

D. All Quality Control test results shall be stored in hard copy in the Contractor's or Quality Control's on-site facility and shall be available for review from the Owner and Engineer at all times.

E. The Quality Control Team shall be responsible for accurately testing and reporting results of all Quality Control test results and observations in a timely manner to the Owner and Contractor throughout the project in the form of a Daily Field Report.

1. Daily Field Reports shall be typed and submitted to the Engineer and/or Owner within one (1) working day.
2. Minimum information required, and example Daily Field Report are presented in the CQA Plan

1.6 As-Built Documentation

A. As-built Survey Documentation

1. The Contractor shall be responsible for accurately surveying the locations and elevations and, where applicable, the type, thickness and geometry of any and all pipes and fittings, ditches, geosynthetic materials, breaks in fill or cut slopes, general grading, change in fill or synthetic material type and any other aspect of the work required by the Engineer.
2. The Contractor shall submit as-built documentation surveys as described in Section 01050.
3. Submittal: Completed as-built documentation will be submitted within two (2) weeks of project acceptance in the following manner:
    a. Submit one (1) digital reproducible copy each to the Owner and Engineer.
    b. Submit one (1) paper copy each to the Owner and Engineer.
        i. As-built documentation survey shall be sealed by a registered Professional Land Surveyor licensed in the State of Oregon.

B. Quality Control Documentation

1. Submittal: Within two (2) weeks of project acceptance, the Quality Control Team shall submit a Quality Control Summary Report sealed by a Professional Engineer licensed in the State of Oregon documenting all manufacturer, field, and laboratory quality control test result and data sheets that include the following:
    a. One (1) digital reproducible copy and one (1) paper copy of each of the following Quality Control Report(s):
        i. Earthwork Quality Control Documentation in accordance with Section 02223.
        ii. Geonet Quality Control Documentation in accordance with Section 02273.
        iii. Geosynthetic Clay Liner Quality Control Documentation in accordance with Section 02350.
        iv. Piping Quality Control Documentation in accordance with Section 02710
        v. Geomembrane Quality Control Documentation in accordance with Section 02275.
        vi. Reinforcing Steel Quality Control Documentation in accordance with Section 03220.
        vii. Cast in Place Concrete Quality Control Documentation in accordance with Section 03300.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01400
QUALITY CONTROL AND ASSURANCE

1.0 GENERAL

1.1 Section Includes

A. References

B. General Quality Control Requirements

C. Manufacturer's Quality Control Inspection, Sampling, and Testing

D. Quality Control Sampling and Testing Frequency

E. Quality Assurance and Referee Inspection and Testing

1.2 Related Sections

A. Section 01090 – Reference Standards

B. Section 01300 – Submittals

C. Section 01410 – Testing Laboratory Services

D. Section 01600 – Materials and Equipment

E. Section 02205 – Fill Materials

F. Section 02211 – Rough Grading

G. Section 02223 – Filling

H. Section 02273 – Geonet

I. Section 02350 – Geosynthetic Clay Liner

J. Section 02710 – Gravity Piping

K. Section 02775 – Geomembrane

L. Section 03300 – Cast-in-Place Concrete

1.3 References

A. Conform to reference standard by date of issue current on date of Contract Documents unless specified otherwise in the specific section.

B. Should specified reference standards conflict with Contract Documents, the Contractor shall request clarification from Engineer before proceeding.

C. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.4 General Quality Control Requirements

A. The Quality Control Team as defined in Section 01010 shall perform the Quality Control testing and inspection required by these Specifications for all earthworks, geosynthetics, and piping installation.

B. The Quality Control Team shall be under the direct supervision of a Professional Engineer licensed in the State of Oregon. All Quality Control test results shall be used as the record tests documented in the Quality Control As-built Report in accordance with Section 01300.

C. Results of Quality test results are subject to verification by the Engineer. Should a discrepancy between results of the Quality Control Team and the Engineer, the Engineer's, results and conclusions shall prevail.

D. Quality Control test results are not a basis of acceptance of Work. Results of inspection and testing on in-place material approved the Engineer or performed by the Quality Assurance Team shall prevail.

E. The Contractor shall be responsible to monitor Quality Control over Vendors, Manufacturers, products, services, site conditions and workmanship to produce Work of specified quality.

F. Comply fully with Manufacturers' instructions. Should Manufacturers' instructions conflict with the Contract Documents, the Contractor shall request clarification from the Engineer prior to proceeding.

G. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes or specified requirements indicate higher standard or more precise workmanship.

H. The Quality Control Team's inspections will not relieve the Contractor of responsibility for the acceptance of the finished Work or portions thereof.

I. Work performed by the Quality Control Team personnel shall be qualified to perform specified testing in accordance with specified test methods and procedures as required by these Specifications.

J. A summary report of the Quality Control Work performed shall be submitted to the Engineer in accordance with Section 01300 and be sealed by a Professional Engineer licensed in the State of Oregon.

K. Re-testing required due to the Contractor's non-conformance to specified requirements of these Specifications shall be performed by the same Quality Control Team, Quality Assurance Team, or independent third party, as instructed by the Engineer. The cost of re-resting shall be borne by the Contractor if re-testing requires the testing agency to work extra hours or overtime.

1.5 Manufacturer's Quality Control Inspection, Sampling, and Testing

A. The Manufacturer shall sample and perform Quality Control testing at the frequencies specified in these Specifications. Test results shall be submitted by the Contractor and/or the Manufacturer to the Engineer in accordance with Section 01300.

B. The Manufacturer and/or Contractor will cooperate with the Quality Control Team; furnish samples of materials, design mixes, equipment, tools, storage, and assistance as required and:

1. Notify the Engineer and Quality Control Team twenty-four (24) hours prior to expected time for operations requiring services.
2. Make arrangements with Quality Control Team and pay for additional samples and tests required for Contractor's use.

C. The Quality Control Team will submit to the Engineer one (1) copy of reports indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents in accordance with Section 01300.

1. If observations, inspections, or Manufacture Quality Control test results identify any materials or methods used to complete the Work that do not meet these Specifications, the Engineer shall be notified immediately.

2. In the event that a test failed to meet these Specifications and a retest is performed, the Engineer shall be notified regardless of the retest results.
3. Removal of materials, repairs, or retests shall be determined by the Engineer. Costs associated with the Contractor's actions to remediate deficiencies shall be borne by the Contractor.

1.6 Quality Control Sampling and Testing Frequency

A. The frequency of Contractor and Manufacturer Quality Control testing of materials is specified in the following sections:

Table 01400-1: Testing Frequency Reference Sections

MATERIAL	REFERENCE SECTION
Fill Materials	02205
Rough Grading	02211
Filling	02223
Geonet	02273
Geosynthetic Clay Liner	02350
Gravity Piping	02710
Geomembrane	02775
Cast-in-Place Concrete	03300

1.7 Quality Assurance and Referee Inspection and Testing

A. The Quality Assurance Team as defined in Section 01010 shall perform the Quality Assurance testing and inspection required by these Specifications.

B. At any time during the project Work, the Engineer may collect a sample split from the Quality Control sample and perform a referee test for Quality Assurance.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Quality Control

A. Maintain access at all times for the Engineer and/or Quality Assurance Team to perform inspection, sampling, and testing. At no time deny the Quality Assurance Team personnel, Engineer, or Owner access to any Work area, fabrication area, staging area, or any other area associated with the Work.

B. Make allowance for the Quality Assurance or referee sampling and testing to be performed and divert equipment elsewhere during the required sampling and testing.

C. Quality Control test results shall be provided to the Owner and/or Engineer within 24 hours of collecting sample for testing, or upon request, for review and approval in accordance with Section 01300.

D. Daily Field Reports shall be completed and submitted to the Engineer and/or Owner within one (1) working day in accordance with Section 01300. The minimum information required for each Daily Field Report as well as an example is provided in the CQA Plan.

E. There is no provision for claims of delays due to Quality Assurance inspection, testing, or sampling. Should Contractor feel that delays are being incurred due to Quality Assurance inspection, testing, sampling, or other activities, notify Owner and Engineer in writing documenting in detail the date, time, and quality assurance activity of each occurrence. Should Owner and/or Engineer determine that excessive time is being spent at quality assurance activities causing delay to Work, corrective action will be taken.

F. If any Work should be covered up without prior approval or consent of the Engineer, it must, if required by the Engineer, be uncovered for examination. After the uncovered Work has been observed and authorization given by the Engineer, the Work shall be recovered in accordance with the Specifications. The cost of uncovering and recovering the Work and any consequential costs shall be the responsibility of the Contractor regardless of the condition of the Work uncovered. If the Work is found to be deficient, the Contractor shall expose all Work that was covered prior to approval, correct any Work that is deficient, and proceed according to the Specifications. The cost of uncovering deficient Work, correcting deficient Work and any consequential costs shall be borne entirely by the Contractor.

G. All Work performed by the Contractor shall meet the approval of the Engineer. The method and manner of doing the Work will be under the control of the Contractor. The Engineer may review the Contractor's work practices and make adjustments as necessary to minimize the risk of damage to critical components of the Work.

3.2 Submittals

A. The Contractor shall submit all Quality Control test results to the Engineer for review and approval on a regular basis, or at the request of the Engineer.

B. Fill materials proposed by the Contractor for use to complete the Work shall be tested by the Quality Control Team prior to placement to verify that the materials meets these Specifications.

C. Initial Quality Control test results of proposed materials shall be submitted to the Engineer for the approval at least 24 hours prior to material placement.

D. At the completion of the Work, a sealed Quality Control Report shall be submitted to the Owner and Engineer in accordance with Section 01300 and include at a minimum:

1. Cover letter summarizing the quantities of materials placed, required testing frequency, and actual testing frequency achieved. The Quality Control Report shall be sealed by a Professional Engineer licensed in the State of Oregon.
2. Typed field documentation including daily field reports, field and laboratory test results summary tables and individuals test results forms for all tests performed for each construction material for tests specified in the Specifications.
3. Summary tables shall be suitable for report presentation and regulatory agency review. One (1) digital reproducible copy of the summary tables shall be provided to the Engineer.

*****END OF SECTION*****

SECTION 01410
TESTING LABORATORY SERVICES

1.0 GENERAL

1.1 Section Includes

A. Selection and Payment

B. Laboratory Reports

C. Limits on Testing Laboratory Authority

D. Contractor Responsibilities

1.2 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Control/Assurance

C. Section 01600 – Materials and Equipment

D. Section 02205 – Fill Materials

E. Section 02211 – Rough Grading

F. Section 02223 – Filling

G. Section 02273 – Geonet

H. Section 02350 – Geosynthetic Clay Liner

I. Section 02775 – Geomembrane

J. Section 03300 – Cast-in-Place Concrete

1.3 Selection and Payment

A. The Contractor shall perform, or will employ and pay for services of an independent testing laboratory to perform specified inspection and testing.

B. All laboratory testing shall be performed under the direct supervision of a registered Professional Engineer licensed in the State of Oregon.

C. Employment of testing laboratory shall in no way relieve the Contractor of obligation to perform work in accordance with requirements of Contract Documents.

1.4 Laboratory Reports

A. After each inspection and test, promptly submit a copy of laboratory report to the Engineer, and a copy to the Owner.

B. Include in Report:

1. Date issued
2. Project title and number
3. Name of inspector
4. Date and time of sampling or inspection
5. Identification of product and Specifications Section

6. Location in the Project
7. Type of inspection or test
8. Date of test
9. Results of test
10. Conformance with Contract Documents
11. When requested by Engineer, provide interpretation of test results

1.5 Limits On Testing Laboratory Authority

A. Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Laboratory may not approve or accept any portion of the Work.

C. Laboratory many assume any duties of Contractor.

D. Laboratory has no authority to stop Work.

1.6 Contractor Responsibilities

A. The Contractor shall notify the laboratory and Engineer at least five (5) working days in advance of intended use of materials that require laboratory testing to allow sufficient time for laboratory to retrieve samples and perform testing.

B. Provide proposed mix designs at least five (5) working days in advance of intended use.

C. Cooperate with laboratory personnel, and provide access to the Work.

D. Provide incidental labor and facilities to provide access to Work to be tested, to obtain and handle samples at the site or at source of products to be tested, to facilitate tests and inspections, storage and curing of test samples.

E. When requested by the Engineer prior to sampling, the Contractor shall provide Engineer a split sample for Quality Assurance testing. The sample shall be split in accordance with ASTM C702-*Standard Practice for Reducing Samples of Aggregate to Testing Size,* and shall be of sufficient quantity to meet minimum testing requirements.

F. Notify the laboratory and Engineer 24 hours prior to expected time for operations requiring field inspection and field testing services.

G. Arrange with the laboratory and pay for additional testing and inspection services required by Contractor beyond specified requirements.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

1.0 GENERAL

1.1 Section Includes

A. Access

B. Power

C. Construction Water

D. Fugitive Dust Control

E. Surface Water Control

F. Work Limits

G. Traffic Control/Road Use

1.2 Related Sections

A. Section 01010 – Summary of Work

1.3 Access

A. Access to the site shall be provided by the Owner.

B. The Contractor shall not construct any staging areas, temporary facilities, haul roads, or access roads without the approval of the Owner.

1.4 Power

A. Contractor shall provide his own temporary power needs, unless provided by the Owner.

1.5 Construction Water

A. Water for dust control on haul roads, moisture conditioning of borrow material to be placed as fill, and for maintaining in place fill soils shall be obtained by the Contractor. The Contractor shall supply all the pumps and tanks necessary to provide an adequate supply of water fulfill the conditions of the contract. Water will be available in a pond and/or truck standpipe at a location designated by the Owner.

1.6 Fugitive Dust Control

A. During the performance of the Work defined by these Specifications or any operations appurtenant thereto, whether on right-of-way provided by the Owner or elsewhere, the Contractor shall:

1. Furnish all labor, equipment, materials, and means required to perform proper and efficient measures to reduce the dust nuisance.
2. Prevent dust which has originated from the Work from damaging land, vegetation, and dwellings or causing a nuisance to persons.
3. Control dust to a degree acceptable to the appropriate State and Federal Agencies, and to the Owner.
4. Notify Owner in writing, and obtain Owner's approval, to use chemical additives to control fugitive dust. Provide Material Safety Data Sheets (MSDA) for such chemicals to Owner.

1.7 Surface Water Control

A. Install permanent ditches and/or channels shown on the drawings and construct facilities to control surface water resulting from precipitation.

B. Provide temporary erosion protection for prepared surfaces and all potential erosion areas associated with the Work, or as directed by the Engineer, until all such portions of the Work have been accepted by the Owner. Erosion control shall consist of silt fences, fiber rolls, and sediment traps in accordance with best management practices.

C. If precipitation or runoff damage occurs to the Work prior to acceptance of the Owner, repair the damaged Work in accordance to these Specifications at the Contractor's expense.

D. All temporary and final design storm water diversion ditches, sedimentation basins, and/or channels shall be installed prior to site grading.

1.8 Work Limits

A. Confine apparatus, equipment, the storage of Materials, and the operation of workmen to the limits indicated by law, ordinances, permits, or as directed by the Owner.

B. Avoid unreasonable encumbering the premises with materials or equipment.

C. Do not block plant or other access roads or traveled ways.

D. Avoid interfering with the Owners operations.

E. Do not present a hazard to the Owner's personnel and equipment or to the public.

F. Use existing roads whenever possible.

G. Minimize construction of new roads.

H. Keep the site neat, tidy and free of waste materials or rubbish.

I. Store and dispense fuel, lubricating oils, and chemicals in such a manner as to prevent or contain spills and prevent said materials from reaching local streams or groundwater according to regulatory requirements.

J. Dispose of waste in accordance with state and local regulations.

K. Keep MSDS on file at the site and provide copies of such sheets to the Owner for all hazardous materials.

L. Avoid damage to monitoring wells, piezometers, survey monuments, or any other instrumentation used at the site.

M. Notify Owner if monitoring wells, piezometers, or instrumentation is in conflict with the Work prior to construction.

1.9 Traffic Control/Road Use

A. Owner's mine haulage traffic has the right-of-way at all times. The Contractor shall conduct his haul operations in a safe manner yielding to Owner's haulage equipment and providing flagmen, if necessary, to stop Contractor's equipment at haul road crossings, public road crossings, or other

traffic areas. Flag persons will not be required at haul road crossings during water truck hauling. A stop sign will be installed at crossings to give the Owner's haulage equipment right-of-way.

B. Any Public or private roads that become damaged as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

C. Contractor's personnel will park personal vehicles in areas designated by the Owner. The quantity and routes of normal construction or supervisory vehicles through the mine site will agreed on by the Owner and Contractor.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01600
MATERIALS AND EQUIPMENT

1.0 GENERAL

1.1 Section Includes

A. Transportation and Handling

B. Storage and Protection

C. Product Options

D. Substitutions

1.2 Related Sections

A. Section 01400 – Quality Assurance/Control

1.3 Transportation and Handling

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.4 Storage and Protection

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

B. For exterior storage or fabricated products, place on sloped supports, above ground.

C. Cover products subject to deterioration from ultraviolet light or weather with impervious sheet covering.

D. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surface in a well-drained area.

F. Prohibit mixing with foreign matter.

G. Arrange storage of products to permit access for inspection.

H. Contractor shall inspect products to assure products are undamaged and maintained under specified conditions.

I. At the end of construction, catalog all remaining unused permanent materials and provide catalog list to Owner, including description, quantity, and location. Store unused permanent materials in the location directed by the Owner. Except for soil and rock products, all permanent materials shall be stored on pallets or other methods to prevent ground contact. Containers holding permanent materials shall be protected against deterioration from rain and water.

1.5 Product Options

A. Products Specified by Reference Standard or by Description Only: Any product meeting those standards or descriptions.

B. Products Specified by Naming One or More Manufacturers. Products of manufacturers named and meeting Specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.6 Substitutions

A. Engineer will consider request for Substitutions only within 15 days after date established in Notice to Proceed.

B. Substitutions may be considered when a products becomes unavailable through no fault of the Contractor.

C. Substitution Submittal Procedure:

1. Submit three (3) copies of Request for Substitution for Consideration. Limit each request to one proposed substitution.
2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
3. The Engineer shall notify the Contractor, in writing, of decision to accept or reject request.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01700
DEMBOLIZATION

1.0 GENERAL

1.1 Section Includes

A. General

B. Warranty

C. Summary

1.2 Related Sections

A. Section 01010 – Summary of Work

B. Section 01600 – Materials and Equipment

1.3 General

A. The demobilization work consists of repairing all slopes disturbed during construction, the removal of all construction debris, and returning the site to a suitable condition for permanent stabilization and reclamation of disturbed surfaces as required by the Owner.

1.4 Warranty

A. All materials and workmanship furnished by the Contractor under this specification shall be guaranteed by the Contractor against failure due to defective materials or improper installation for a period of one year from the date of final acceptance, or as noted otherwise in these Specifications. Upon receipt of written notice of failure of guaranteed workmanship or materials during the guarantee period, the Contractor shall promptly furnish and install new materials and/or furnish the labor necessary to correct the failure at the expense of the Contractor.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Summary

A. Permanent cut slopes outside of the Work area that have been affected by the Work shall not have a slope steeper than 2.5H:1V unless otherwise shown in the Drawings or otherwise approved by the Owner and Engineer.

B. The Contractor shall remove all trash, debris, hazardous and dangerous chemicals or waste, and waste material from the site that was brought on site by the contractor and properly dispose of all said materials. The Owner will have the right to determine what is waste or rubbish and the manner and place of disposal. All materials furnished for the execution of the Work and thereby purchased by the Owner shall remain the property of the Owner.

C. The Contractor shall clean out all installations and tear down and remove all temporary structures built by the Contractor. Any existing structures or installations that were in place prior to construction shall be left in a condition at least as good as the condition prior to construction. All trash and remnants of the Contractor's work shall be removed by the Contractor prior to final inspection and acceptance by the Owner.

D. Unused permanent materials shall be cataloged and stored in accordance with specification Section 01600.

E. The final condition of the site is subject to approval by the Owner.

*****END OF SECTION*****

SECTION 02110
SITE CLEARING AND STRIPPING

1.0 GENERAL

1.1 Section Includes

A. Clearing

B. Stripping

1.2 Related Sections

A. Section 02205 – Fill Materials

B. Section 02211 – Rough Grading

C. Section 02222 – Excavating

D. Section 02223 – Filling

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Summary

A. Clearing area required for access to site and execution of Work as shown on the Drawings.

B. Remove shrubs and other vegetative growth within the required areas. Remove stumps and roots great than ½ inch in diameter to a minimum depth of 6 inches.

C. Remove man-made structures, debris, or waste material as directed by the Owner/Engineer.

D. All clearing shall be completed prior to the start of any grading operations.

E. Clearing shall extend laterally beyond excavation, liner systems, and fill slopes a minimum of 10 feet but shall not extend past the Plan of Operations Boundary as designated by the Owner.

F. Clearing shall not be performed until all exploration test pits and boreholes within the limits of the proposed site grading have been excavated and re-compacted in accordance with Sections 02222 and 02223 as approved by the Owner. The location of the test pits and boreholes are shown on the Drawings.

3.2 Stripping

A. Growth media (the surficial soils often referred to as Topsoil) shall be stripped from cleared areas to a depth approved by the Engineer. In undisturbed areas, the typical stripping depth is anticipated to be 6-inches. The actual depth will be determined in the field by the Engineer during the stripping operation.

B. Growth media shall be stockpiled in areas designated by the Owner. Construct stockpiles with maximum 3H:1V slopes and in a manner that the soil receive the maximum amount of compactive effort from the haulage equipment.

C. Growth media stripping shall include removal of all organic sod, grass, topsoil and roots greater than ½ inch in diameter.

D. Stripping shall be performed in the footprint of the TSF embankments and basin, reclaim pond, waste rock dump facility, containment channels, temporary and permanent access roads, haul roads, construction and staging areas, on-site borrow areas, and temporary and permanent diversion facilities.

E. Stripping shall extend laterally beyond excavations, liner systems, and fill slopes a minimum of 10 feet but shall not extend past the Plan of Operations Boundary as designated by the Owner.

F. Stripping shall not be performed until all exploration test pits and boreholes within the limits of the proposed site grading have been excavated and re-compacted in accordance with Sections 02222 and 02223 as approved by the Owner. The location of the test pits and boreholes are shown on the Drawings.

G. All stripping shall be completed prior to the start of any grading.

H. Excess stripping without the prior approval of the Owner will be at the expense of the Contractor.

*****END OF SECTION*****

SECTION 02205
FILL MATERIALS

1.0 GENERAL

1.1 Section Includes

A. Definitions
B. References
C. General
D. Embankment Fill
E. Grading Fill
F. Prepared Subgrade
G. Drainage Layer
H. Filter Fill
I. Anchor Trench Backfill
J. Drain Gravel
K. Leak Detection Fill
L. Pipe Bedding Fill
M. Cable Bedding Fill
N. Riprap
O. Safety Berm Material

1.2 Related Sections

A. Section 01051 –Geotechnical Exploration
B. Section 01400 – Quality Control/Assurance
C. Section 02110 – Site Clearing and Stripping
D. Section 02211 – Rough Grading
E. Section 02222 – Excavating
F. Section 02223 – Filling

1.3 Definitions

A. Embankment Fill: Fill material that is non-gold-bearing blasted run-of-mine rock or native alluvial overburden soils borrowed from on-site grading and quarry operations. Embankment Fill will be placed and compacted in controlled lifts and used as the primary fill material for TSF embankment construction in accordance with Section 02223.

B. Grading Fill: Native alluvial soils excavated to be placed and compacted in controlled lifts below the geomembrane liner within the TSF basin and WRD pad.

C. Drainage Layer: Crushed rock or screened native alluvium material placed above the geomembrane liner within the TSF basin to promote drainage into the perforated underdrain collection pipes.

D. Filter Fill: Alluvial fill material placed above the Drainage Layer within the TSF basin to act as a filter between the Drainage Layer and the tailings and promote drainage into the perforated underdrain collection pipes.

E. Anchor Trench Backfill: Soil or rock material placed and compacted in the geomembrane anchor trenches and placed as ballast on the above ground process conveyance pipes.

F. Drain Gravel: Crushed rock material installed around the primary perforated CPE and HDPE underdrain collection pipes and in the reclaim pond leak detection sump.

G. Leak Detection Fill: Crushed rock material placed around the PVC leak detection pipes below the TSF geomembrane liner to promote drainage into the perforated leak detection pipes.

H. Riprap: Crushed and screened rock material placed in permanent diversion channels and outlet aprons for erosion protection.

I. Safety Berm Material: native or processed material placed along travel to protect proposed structures from vehicle traffic.

1.4 References

A. American Society for Testing and Materials (ASTM)

B. ASTM C 702 – Standard Practice for Reducing Samples of Aggregate to Testing Size

C. ASTM D 422 – Stand Test Method for Particle-Size Analysis of Soils

D. ASTM D 1140 – Standard Test Method for Amount of Materials in Soils Finer than the No.200 (75 Micrometers)

E. ASTM D 1556 – Test Method for Density of Soils in Place by the Sand-Cone Method

F. ASTM D 1557 – Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer ad 18-in. (457-mm) Drop

G. ASTM D 2216 – Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

H. ASTM D 4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

I. ASTM D 4643 – Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

JJ. ASTM D 5519 - Standard Test Methods for Particle Size Analysis of Natural and Man-made Riprap Materials

J. ASTM D 5856 – Standard Test Method for Measurement of Hydraulic Conductivity of Porous Material Using a Rigid-wall, Compaction-mold Permeameter.

K. ASTM D 6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-aggregate by Nuclear Methods (Shallow Depth)

2.0 PRODUCTS

2.1 General

A. All fill materials shall be obtained from required excavations, designated borrow areas, and stockpiles as directed by the Owner. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the Engineer.

B. Fill materials shall contain no sod, brush, roots or other perishable, unsuitable materials, debris, and the type of materials used as earth fill shall be as described in the Specifications and Drawings. The suitability of all fill materials intended for use in the Work shall be subject to approval by the Engineer.

2.2 Embankment Fill

A. Embankment Fill shall be material that is non-gold-bearing blasted run-of-mine rock from on-going mining operations or the basalt borrow.

B. If Embankment Fill contains greater than 30% of particles in excess of three-quarter inch (3/4") nominal grain size it shall be considered a rock fill and placed accordingly as described in Specification 02223.

C. Embankment Fill shall meet the following gradational and plasticity requirement and shall be placed and compacted in accordance with Section 02223:

Table 1: 02205-1 Embankment Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
16 inch*	100
12 inch*	50-100
8 inch*	30-100
¾ inch	0-80
No. 4	0-40
No. 200	0-20

Plastic Limit: N/A

D. A maximum of any one (1) sieve size is allowed to be out of the specified range list above for any individual test.

E. * Maximum particle size shall be limited to 2/3 the allowable loose lift height based on the Embankment Fill being classified as a Soil or Rock Fill material. Allowable loose lift thickness shall determined in accordance with Section 02223.

2.3 Grading Fill

A. Native alluvial materials excavated during on-site grading operation within the TSF basin and WRD pad or imported native alluvial materials.

B. Native foundation clay materials, as defined by the Engineer, shall not be used as Grading Fill.

C. If Grading Fill contains greater than 30% of particles in excess of three-quarter inch (3/4") nominal grain size it shall be considered a rock fill and placed accordingly as described in Specification 02223.

Table 2: 02205-2 Grading Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
6 inch	100
¾ inch	20-100
No. 4	10-70
No. 40	0-40
No. 200	0-30

Plastic Limit: Less than or equal to 15

2.4 Prepared Subgrade

A. Native material generated from on-site grading operations or developed from on-site borrow area to be place immediately below the geosynthetic clay liner within the TSF basin, WRD Pad, on the TSF upstream embankment slopes, and below the reclaim pond.

B. Prepared Subgrade shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

2. Table 3: 02205-3 Prepared Subgrade Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
3 inch	100
¾ inch	70-100
No. 4	20-100
No. 40	0-60
No. 200	0-50

Plastic Limit: Less than or equal to 20

2.5 Drainage Layer

A. Crushed rock material or processed native alluvium placed above the geomembrane liner within the TSF basin and WRD Pad to promote drainage into the perforated underdrain collection pipes.

B. Drainage Layer shall have a maximum hydraulic conductivity of 5×10^{-3} cm/sec (ASTM D5856).

C. The Drainage Layer shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 4: 02205-4 Drainage Layer Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
3 inch	100
¾ inch	50-100
No. 4	20-50
No. 40	0-25
No. 200	0-15

Plastic Limit: Less than or equal to 10

2.6 Filter Fill

A. Crushed rock material, processed or native alluvium placed above the Drainage Layer within the TSF basin to act as a filter between the Drainage Layer and the tailings and promote drainage into the perforated underdrain collection pipes.

B. Filter Fill shall have a maximum hydraulic conductivity of 5×10^{-4} cm/sec (ASTM D5856).

C. Filter Fill shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 5: 02205-5 Filter Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
1.5 inch	100
¾ inch	30-90
No. 4	55-85
No. 40	25-50
No. 200	10-30

Plastic Limit: Less than or equal to 10

2.7 Anchor Trench Backfill

A. Anchor Trench Backfill shall be on-site native alluvium placed in geomembrane anchor trenches and placed as ballast on the Tailings Distribution and Decant Return pipes in accordance with the Drawings.

B. Anchor Trench Backfill shall be placed in accordance with Section 02223.

C. Anchor Trench Backfill has no gradational or plasticity requirements.

2.8 Drain Gravel

A. Drain Gravel shall be a manufactured, crushed rock installed around the primary underdrain collection pipes, within the underdrain outlet channel, and the reclaim pond leak detection sump.

B. Drain Gravel shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 6: 02205-6 Drain Gravel Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
2 inch	100
¾ inch	50-80
No. 4	15-50
No. 200	0-5

Plastic Limit: Less than or equal to 10

2.9 Leak Detection Fill

A. Crushed rock material installed around the leak detection pipes in accordance with the drawings to promoted drainage into the perforated leak detection pipes.

B. The Leak Detection Fill shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 7: 02205-7 Leak Detection Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
1 inch	100
¾ inch	75-100
⅜ inch	20-55
No. 200	0-10

Plastic Limit: Less than or equal to 5

2.10 Pipe Bedding Fill

A. Pipe Bedding Fill shall be on-site native alluvium placed as backfill around culverts and buried HDPE Piping in locations as shown on the Drawings.

B. Pipe Bedding Fill shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 8: 02205-8 Drainage Layer Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
2 inch	100
¾ inch	70-100
No. 4	20-70
No. 40	0-35
No. 200	0-25

Plastic Limit: Less than or equal to 20

2.11 Cable Bedding Fill

A. Cable Bedding Sand shall be placed as backfill around instrumentation signal cables in locations as shown on the Drawings.

B. Cable Bedding Fill shall the finer fraction of on-site native alluvium or Drainage Layer processed over the ⅜-inch screen and placed in accordance with Section 02223.

2.12 Riprap

A. Riprap shall be a process rock material placed as erosion protection as the finish surface layer on the side slope and toe diversion channel as shown on the Drawings.

B. Riprap shall consist of a competent rock material with a specific gravity greater than 2.65 and a rock strength of R4 or greater in accordance with ISRM and from an on-site borrow area or raveling from exposed rock cut slopes near the Work area.

C. Riprap shall meet the following gradational and plasticity requirements and be placed in accordance with Section 02223.

Table 9: 02205-8 Drainage Layer Gradation

Rip Rap D_{50}	Rock Gradation	Rock Size (in.)
8”	D_{100}	12
	D_{85}	10
	D_{50}	8
	D_{15}	3
12”	D_{100}	18
	D_{85}	14
	D_{50}	12
	D_{15}	4
16”	D_{100}	24
	D_{85}	20
	D_{50}	16
	D_{15}	6
28”	D_{100}	42
	D_{85}	36
	D_{50}	28
	D_{15}	12

2.13 Safety Berm Material

A. Safety Berm Material shall be on-site native alluvium placed along the edges of access and haul roads as needed for vehicle and structure protection.

B. Safety Berm Material has no gradational or plasticity requirements.

2.14 Source Quality Control

A. Quality Control inspection and testing will be performed under provisions of Sections 01010, 01400, and 01410 under the supervision of a professional engineer licensed in the State of Oregon.

B. Frequency of testing will be in accordance with Section 02223.

C. Quality Control tests and analysis of soil materials will be in accordance with ASTM D 422, ASTM D 1557, ASTM D 4318 and ASTM D 2167, and D 6938.

D. If tests indicate materials do not meet specified requirements, changes in material or placement conditions, retests shall be performed by the Quality Control Team at no cost to Owner.

3.0 EXECUTION

3.1 Stockpiling

A. If stockpiling is performed, materials shall be stockpiled at locations designated by the Owner. Stockpile sufficient material to meet project schedule and requirements. Separate different materials to prevent mixing. Direct Surface water away from stockpile to prevent erosion or deterioration of material.

B. Leave unused stockpile material in a neat, compact stockpile.

C. Prevent mixing of native subgrade soils with stockpile material.

D. Refer to Section 02223 for fill placement requirements.

3.2 Borrow Area Cleanup

E. Leave area in a clean and neat condition. Grade site surface to prevent free standing surface water. Grade slopes to a maximum 2.5H:1V slope.

*****END OF SECTION*****

SECTION 02211
ROUGH GRADING

1.0 GENERAL

1.1 Section Includes

A. References

B. Lines and Grades

C. Subgrade Preparation

D. Site Grading

E. Field Quality Assurance

1.2 Related Sections

A. Section 01051 – Geotechnical Exploration

B. Section 01400 – Quality Control/Assurance

C. Section 01410 – Testing Laboratory Services

D. Section 02110 – Site Clearing and Stripping

E. Section 02205 – Fill Materials

F. Section 02222 – Excavating

G. Section 02223 – Filling

1.3 References

A. American Society for Testing and Materials (ASTM)

1. ASTM D 422 – Stand Test Method for Particle-Size Analysis of Soils
2. ASTM D 1556 – Test Method for Density of Soils in Place by the Sand-Cone Method
3. ASTM D 1557 – Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer ad 18-in. (457-mm) Drop
4. ASTM D 2216 – Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
5. ASTM D 4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
6. ASTM D 4643 – Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
7. ASTM D 6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Lines and Grades

A. Locate control points and verify that the vertical and horizontal positioning are as indicated on the Drawings.

B. Stake required lines, levels, contours, and datum.

C. Protect Owner-supplied control points from excavation equipment and vehicular traffic.

D. Replacement of destroyed or lost Owner-supplied control points shall be at the expense of the Contractor.

E. As required in Section 01050, prior to commencement of grading within Work area, and after completion of site stripping activities, the Contractor shall provide a detailed survey of the stripped ground surface of the Owner. The survey shall have an accuracy of plus or minus 0.2 feet with a 2 foot contour interval. The survey will be used by the Owner and Engineer to confirm that the general grading requirement provided in these Specifications are met and to detail areas where additional site grading may be required.

3.2 Subgrade Preparation

A. Remove all stockpiles, roadway fills, and any other undocumented fills prior to subgrade preparation.

B. *Under Embankment Foundation and Grading Fill:* Proof-roll subgrade under the footprint of the dam embankment with a loaded scrapper, a loaded water truck, or a loaded haul truck to identify soft spots in the presence of the Engineer. Remove soft or yielding subgrade soils identified by the proof-roll to the depth determined by the Engineer. Fill these areas in accordance with Section 02223. Prior to placement of the Embankment Fill material, scarify the subgrade to a minimum depth of 12 inches, moisture condition to near optimum moisture content, and compact the subgrade to a minimum of 90 percent of the soils maximum dry density as determined by ASTM D 1557, or as approved by the Engineer. Roughen the final surface with at least two (2) passes of sheepsfoot compactor, wedge foot compactor, or other equipment approved by the Engineer.

C. *In Areas within the TSF Basin to Receive Geomembrane where Grading Fill is Required:* Proof-roll subgrade under the Grading Fill with a loaded scrapper, a loaded water truck, or a loaded haul truck to identify soft spots in the presence of the Engineer. Remove soft or yielding subgrade soils identified by the proof-roll to the depth determined by the Engineer. Fill these areas in accordance with Section 02223. Prior to placement of the Grading Fill material, scarify the subgrade to a minimum depth of 12 inches, moisture condition to near optimum moisture content, and compact the subgrade to a minimum of 90 percent of the soils maximum dry density as determined by ASTM D 1557, or as approved by the Engineer. Roughen the final surface with at least two (2) passes of sheepsfoot compactor, wedge foot compactor, or other equipment approved by the Engineer.

D. *In Areas within the TSF Basin to Receive Geomembrane on Native or Excavated Ground:* Following compaction, the upper surface of Prepared Subgrade shall be graded and oversized rock greater than 1-inch diameter, and projections shall be removed from the exposed surface. Prior to geosynthetics placement, the final surface of the Prepared Subgrade shall be proof-rolled with a minimum of 4 passes with vibratory smooth drum roller with a 10-ton static and 25 ton dynamic drum weight. The final surface shall be free draining, compact, free of protrusions, and suitable for geosynthetics placement

E. If prior placed or prepared, tested, and accepted Prepared Subgrade or fills become loosened, softened, or disturbed by construction equipment traffic, during dry or wet weather, these materials shall be moisture-conditioned or dried, and recompacted. If weather or soil conditions prevent soils

from being properly compacted, the unsuitable soils shall be removed and replaced with properly compacted fill at no expense to the Owner.

3.3 Site Grading

A. Grading Fill may be required to fill depressions or other areas identified by the Engineer. This material shall be placed according to Specifications 02223.

B. Where fill is required in areas that are inaccessible using conventional compaction equipment, these area shall be compacted using hand-held equipment or backfilled using Lean Mix Concrete with the approval of the Engineer.

3.4 Field Quality Control

A. Field Quality Control inspections and testing shall be performed in accordance with Sections 01010, 01400 and 01410. The Quality Control Team shall be under the supervision of a Professional Engineer licensed in the State of Oregon.

B. In place density testing shall be performed in accordance with ASTM D 1556 or D 6938.

C. Laboratory compaction testing to determine the soils maximum dry density shall be performed in accordance with ASTM D 1557.

D. Frequency of tests: Field and laboratory testing of the Prepared Subgrade shall be performed in accordance with Section 02223.

*****END OF SECTION*****

SECTION 02222
EXCAVATING

1.0 GENERAL

1.1 Section Includes

A. Lines and Grades

B. Excavation

C. Tolerances

D. Quality Assurance

1.2 Related Sections

A. Section 01051 – Geotechnical Explorations

B. Section 01400 – Quality Control/Assurance

C. Section 01500 – Construction Facilities and Temporary Controls

D. Section 02110 – Site Clearing and Stripping

E. Section 02211 – Rough Grading

F. Section 02205 – Fill Materials

G. Section 02223 – Filling

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Lines and Grades

A. Locate control points and verify that the vertical and horizontal positioning are as indicated on the Drawings.

B. Stake required lines, levels, contours, and datum.

C. Protect Owner-supplied control points from excavation equipment and vehicular traffic.

D. Replacement of destroyed or lost Owner-supplied control points shall be at the expense of the Contractor.

E. As required in Section 01050, prior to commencement of grading within Work area, and after completion of site stripping activities, the Contractor shall provide a detailed survey of the stripped ground surface of the Owner. The survey shall have an accuracy of plus or minus 0.2 feet with a 2-foot contour interval. The survey will be used by the Owner and Engineer to confirm that the general grading requirement provided in these Specifications are met and to detail areas where additional site grading may be required.

3.2 Excavation

A. Contractor shall excavate all loose and disturbed soil from exploration borings and test pits within the TSF, WRD, and reclaim pond footprints, as shown on the Drawings and presented in Section 01051 and backfill in accordance with Section 02223. Excavation and backfill borings and test pits shall be performed prior to site clearing and stripping.

B. Excavate soils and rock to the lines and slopes shown on the Drawings.

C. On-site materials encountered in excavations are anticipated to be alluvial soils, residual soils, and waste material.

D. Grade the top perimeter of excavations to prevent surface water from draining into the excavation.

E. Alluvial soils excavated on-site may be used for fill in the dam, subject to the specifications described in Section 02205 and Section 02223.

F. All final cut surfaces will be moisture-conditioned and compacted in accordance with Section 02211 prior to subsequent fill placement.

G. Remove loose, soft, and yielding material from the bottom and sides of excavations at the direction of the Engineer.

H. During excavating operations, underlying foundation clays materials may be exposed. Contractor shall protect excavations from surface water run-on. In the event that foundation clay materials become saturated, or deemed unacceptable by the engineer, the Contractor shall overexcavate unsuitable materials and backfill the excavation with General Fill in accordance with Section 02223.

I. Excavation extending beyond the lines, grades, and dimensions shown on the Drawings shall be backfilled with Grading Fill in accordance with Section 02223 at no expense to the Owner.

J. Excavations shall be graded and properly maintained to provide adequate drainage at all times. Ponding shall not be allowed to develop. In excavation that cannot be properly graded to drain, such as ponds, the Contractor will provide equipment and labor to keep the excavation free of standing water.

K. Excavation shall be suspended when the site is wet, muddy or in any other condition where the area cannot be properly maintained.

L. Correct areas over-excavated in accordance with Section 02223.

M. Stockpiles excess excavated material as directed by the Owner.

N. The Contractor shall lay out diversion ditches and channels, so channels are excavated in original site soils and not fill. Ditches shall be laid out to provide minimum grades of 1 percent, unless shown flatter on the Drawings. Channel grade breaks shall not exceed 2 percent, unless otherwise shown on the Drawings.

3.3 Tolerances

A. Local slopes shall be within 5 percent of those shown on the Drawings. Overall slopes will be within 0.1 percent of those shown on the Drawings.

B. Finished grades shown on the Drawings are given in feet and tenths or hundredths of feet and shall slope uniformly between given spot and contour elevations. All grades shall provide for natural runoff of water without low spots or pockets.

C. All excavations shall not exceed 0.3 feet in variation from dimensions and elevations shown on the Drawings, unless authorized by the Engineer.

D. Minimum grades and slopes shown on the Drawings to provide drainage control shall be maintained.

E. Correction of over-excavated and backfilling past the tolerances identified above shall be to the Contractor's account, at no expense to the Owner.

3.4 Quality Control

A. Field Quality Control inspection and testing will be performed in accordance with Sections 01400 and 01410.

B. Visual inspection of the excavated surface will be made to verify that all loose material has been removed or compacted and that there are no soft and yielding areas.

C. In place density testing will be performed in accordance with Sections 02211 and 02223.

*****END OF SECTION*****

SECTION 02223
FILLING

1.0 GENERAL

1.1 Section Includes

JJ. Related Sections
KK. References
LL. Fill Materials
MM. Verification
NN. Subgrade Preparation
OO. Fill Placement
PP. Tolerances
QQ. Protection of Finished Work
RR. Quality Control
SS. Submittals
TT. Quality Assurance

1.2 Related Sections

A. Section 01051 – Geotechnical Explorations
B. Section 01300 – Submittals
C. Section 01400 – Quality Control/Assurance
D. Section 01500 – Construction Facilities and Temporary Controls
E. Section 02205 – Fill Materials
F. Section 02222 – Excavating
G. Section 02273 – Geonet
H. Section 02350 – Geosynthetic Clay Liner
I. Section 02775 – Geomembranes
J. Section 02710 – Gravity Piping
K. Section 03300 – Cast-in-Place Concrete

1.3 References

A. ASTM D 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate.
B. ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils
C. ASTM D 1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method
D. ASTM D 1557 - Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
E. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
F. ASTM D 2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
G. ASTM D 4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

H. ASTM D 4643 – Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

I. ASTM D 5519 – Standard Test Methods for Particle Size Analysis of Natural and Man-made Riprap Materials

J. ASTM D 5856 – Standard Test Method for Measurement of Hydraulic Conductivity of Porous Material Using a Rigid-Wall, Compaction-Mold Permeameter

K. ASTM D 6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.0 PRODUCTS

A. Embankment Fill

B. Grading Fill

C. Drainage Layer

D. Filter Fill

E. Anchor Trench Backfill

F. Drain Gravel

G. Leak Detection Fill

H. Riprap

I. Safety Berm Material

3.0 EXECUTION

3.1 VERIFICATION

A. Verify that lines and grades of fill limits and slopes have been established as required.

B. Field verify location of all exploration boreholes and test pits with Engineer and Owner prior to site clearing and stripping.

C. Contractor shall supply certification that all boreholes and test pits have been filled in accordance with these Specifications. The Contractor will supply a list of the boreholes/pits backfilled with the certification, including the depth of each borehole/pit.

3.2 SUBGRADE PREPARATION

A. Prepare subgrade according to Section 02211 and Section 02222.

B. Do not place fill until subgrade has been tested and approved by the Engineer.

3.3 FILL PLACEMENT

A. Do not place frozen material as fill.

B. Do not place fill on frozen ground. EXCEPTION: Fill may be placed on frozen subgrade provided that the depth of freezing is no more than 2 inches AND the subgrade has been previously tested and proof-rolled and approved by the Engineer. Engineer shall be consulted prior to fill placement when freezing depths are greater than 2 inches. Fill placement on frozen subgrade shall only be performed with the approval of the Engineer.

C. Prior to topsoil stripping, boreholes and test pits within the TSF, WRD, and reclaim pond footprints shall be re-excavated to their original depths in accordance with Section 02222. All loose soils and debris shall be removed. The re-excavated explorations shall be backfilled with General Fill, placed in 12-inch maximum loose lifts, moisture-conditioned, compacted with tampers, vibratory compactors, hoe-packs, or other suitable approved compaction methods, to achieve a stable, non-yielding surface. Open boreholes shall be backfilled with bentonite seal in accordance with regulatory requirements.

D. Fill materials shall be obtained from designated borrow areas or areas designated by the Engineer and Owner. For fill materials that are proposed to be imported by the Contractor from areas other than those designated by the Engineer, the Contractor shall give the Owner at least five (5) working days' notice prior to using the imported material to enable the Owner's representative to sample and test the material. Imported material must be tested for compliance with the Specifications and the results approved by the Engineer prior to the material being delivered to the site.

E. Placement of fill shall be made only in areas approved by the Engineer for fill placement. Fill shall be placed to the lines and grades shown on the Drawings and according with these Specifications.

F. Fill placement shall be temporarily stopped due to inclement weather conditions at the direction of the Engineer. Under marginal weather conditions, the Contractor may place fill, provided the fill, when tested, meets these Specifications.

G. The distribution of materials shall be such that the fill is free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. The combined borrow excavation and fill placement operation shall be such that the materials, when compacted in the fill, will be blended sufficiently to provide the best practicable distribution of the material, subject to the approval of the Engineer.

H. If, in the opinion of the Engineer, the surface of the subgrade or the surface of any layer of the fill is too dry or too smooth to bond properly with the layer of material to be placed thereon, it shall be scarified to a depth of 6 inches, or as directed by the Engineer, then moisture-conditioned to provide a satisfactory bonding surface before the next layer of fill material is placed.

I. If, in the opinion of the Engineer, the surface of the subgrade or the rolled surface of any layer of the fill in place is too wet for proper compaction of the layer of fill material to be placed thereon, it shall be removed and allowed to dry or shall be worked with discs, scarifier, or other equipment to reduce the moisture content to the required amount, and then compacted before the next layer of fill material is placed.

J. The Contractor shall place fill only after the subgrade below fills has been adequately compacted and approved by the Engineer. Should any of the work be covered before it has been approved, the Contractor shall uncover all such work at no cost to the Owner. After the work has been examined, tested and approved by the Engineer, the Contractor shall make all repairs and replacements necessary to restore the work to the contract specifications at no additional cost to the Owner.

K. All fill materials shall be moisture-conditioned prior to applying compactive effort. Moisture-conditioning may be performed to fill material either in the borrow area or at the fill site or in both areas as directed by the Engineer. The Owner may also require additional moisture conditioning in the cut or fill to limit fugitive dust.

L. During compaction operations, the borrow and reworked in-place materials requiring moisture conditioning shall be maintained within the range of moisture content required in these Specifications to achieve, with the equipment being used, adequate compaction to the specified density. The moisture content of the fill material prior to and during compaction shall be uniform throughout the material.

M. When material is too dry for proper compaction and/or is below the minimum moisture content specified, the Contractor shall spray water on the fill and work the moisture into the fill by discing or scarifying, or other means approved by the Engineer, until a uniform distribution of moisture is obtained.

N. Material that is too wet for proper compaction and/or is above the maximum moisture content specified, shall be removed from the fill or the material may be spread and permitted to dry, assisted by discing or scarifying until the moisture content is reduced to an amount suitable for obtaining the specified degree of compaction. The Contractor shall not mix underlying fill materials with fill materials being moisture conditioned.

O. The upper 1-foot of final travel way surfaces shall not contain oversize materials greater than 3 inches.

P. For purposes of these Specifications, soil fills are defined as a material where greater than 70% (by weight) passes the ¾-inch screen and rock fills are defined as materials where greater than 30% (by weight) is retained on the ¾-inch screen.

Q. The relative compaction of fill materials shall be tested in-place to check compliance with the Specifications. Rock fills shall be compacted using compactive efforts and performance-based specifications as herein specified, or by an Engineer's approved method based on test fills with specific roller equipment. For the purposes of these specifications, relative compaction of soil fill is the ratio of the in-place dry density of the constructed fill to the maximum laboratory dry density determined by ASTM D 1557 (Modified Proctor).

R. The Engineer shall continuously evaluate the Contractor's equipment and methods. If such equipment or methods are found unsatisfactory for the intended use, the Engineer will require the Contractor to replace the unsatisfactory equipment with other types or adjust methods until proper compaction is achieved.

S. The Contractor shall maintain and protect fills in a condition satisfactory to the Engineer at all times until the final completion and acceptance of the work. Any approved fill material which becomes unsuitable for any reason whatsoever, after being placed in the fill and before final acceptance of the Work, shall be removed and replaced by the Contractor in a manner satisfactory to the Engineer.

T. The Contractor shall route equipment and take all actions necessary to prevent material of one type from being deposited inadvertently, either by dumping or through travel of equipment, in or on material of another type. Such improperly deposited material shall be removed from the fill areas, as directed by the Engineer. If in-place material becomes contaminated, it shall also be removed. All removed material shall be wasted in locations designated by the Engineer. Removal of all such material shall be at no cost to the Owner.

U. At no time shall the native foundation clay be used as General Fill or Embankment Fill. Any foundation clay that becomes exposed during rough grading operations, it shall be over excavated and backfilled, or capped with a minimum 12 inches of General Fill to the lines and grades shown on the Drawings at the direction of the owner.

V. If prior placed, tested and accepted in-place fills become loosened, softened, or disturbed by construction equipment traffic, during dry or wet weather, these materials shall be moisture-conditioned or dried as previously described and recompacted. If weather or soil conditions prevent soils from being properly compacted, the unsuitable soils shall be removed and replaced with properly compacted fill. Such replacement and/or re-compaction shall be at no expense to the Owner.

W. Berms and fills placed for diversion ditches shall be placed, compacted, and tested in accordance with these Specifications. When backfilling staged diversion ditches, fill shall be placed, compacted, and tested in accordance with these Specifications.

X. Embankment Fill:

1. Areas to receive Embankment Fill shall include, but are not limited to: embankment, diversion ditches, access and perimeter roads, and diversion berms.
2. Condition to a moisture content which allows compaction to the required density without an excessive amount of effort and that results in a stable non-yielding surface.
3. Prior to subsequent staged Embankment Fill placement, the dam crest shall be scarified to a depth of 6 inches, or as directed by the Engineer, then moisture-conditioned prior to placement of the first lift of new Embankment Fill. The first lift placed over the scarified dam crest shall be placed to a maximum loose lift thickness of 12 inches to 18 inches, or less as required by these Specifications.
4. Embankment Fill with less than 30 percent rock materials above 3/4-inch size and 8-inch maximum rock size (Embankment Soil Fill) shall be placed in 12-inch maximum loose lifts and compacted to 92 percent of maximum dry density (ASTM D1557).
5. Embankment Fill containing more than 30 percent rock materials above 3/4-inch size (Compacted Rockfill) shall be placed as a rock fill and compacted according to the following method. However, in all cases vibratory drum compactors, if used as the primary means of compaction, must have a minimum 10-ton static and 25-ton dynamic drum weight.

6. For Rock Fills, a test fill shall be conducted to determine the maximum lift thickness and compactive effort for the material. The test fill may be located so that it is incorporated within the limits of the compacted fill area. The test fill shall be constructed and monitored as per U.S. Army Corps of Engineers' guidelines for test fill construction. The Contractor shall outline his proposed procedures for moisture conditioning and fill placement of Compacted Rock Fill and submit them to the Engineer for review and approval prior to placing the test fill.
7. Loose lift thicknesses of 12, 18, and 24 inches or as determined by the Engineer shall be used for the Test Fill; (three test fills to determine optimum lift thickness)
8. The data to be collected during construction of the test fill shall include:
    a. Amount of settlement after every two passes of the proposed compaction equipment to a maximum of ten (10) passes;
    b. Gradation and moisture content of in-place material; and
    c. In-place fill density at completion of the test by bulk density or Nuclear Gauge methods.
    d. A curve showing change in settlement versus number of passes shall be produced from the data. This curve will be used to determine the number of passes for acceptable compaction. In general, the minimum number of passes will be that number required to achieve 80 percent of the total settlement obtained after ten complete passes of the compaction equipment. Final determination by the Engineer of the lift thickness and minimum required passes will be based on a review of the test data.
    e. Maximum rock size for rock fills shall be two-thirds of the compacted lift thickness, unless otherwise approved by the Engineer. Provisions shall be made by the Contractor for removal of oversize materials from fills for use as riprap or exterior slope protection. No additional payment will be made to remove oversize materials.

Y. Grading Fill

1. Areas to receive General Fill shall include, but are not limited to: TSF basin, perimeter access roads, reclaim pond, underdrain channel, WRD pad, and permanent diversion channels.
2. It is the intent of the design to use excavated materials within the TSF basin footprint as much as possible for General Fill.
3. Condition the fill to a moisture content which allows compaction to the required density without an excessive amount of effort and that results in a stable non-yielding surface.
4. Soil General Fill:
    a. General Fill with less than 30 percent rock materials above 3/4-inch in size and 8-inch maximum rock size shall be placed in 12-inch maximum loose lifts and compacted to 92 percent of maximum dry density (ASTM D 1557).
5. Rock General Fill:
    a. General Fill containing more than 30 percent rock materials above 3/4-inch size (Compacted Rockfill) shall be placed as a rockfill based on the results of a Test Fill as described in the Embankment Fill Section below. The type of compaction equipment, number of passes, lift thickness, and maximum rock size shall be approved by the Engineer in writing based on the acceptable Test Fill performance.
    b. Maximum rock size for rock fills shall be two-thirds of the compacted lift thickness, unless otherwise approved by the Engineer. Provisions shall be made by the Contractor for removal of oversize materials from fills for use as riprap or exterior slope protection. No additional payment will be made to remove oversize materials.
6. The Contractor shall adopt methods to remove all oversize rock from the fill. Oversize rock will be stockpiled in a location designated by the Owner. No additional payment shall be made to the Contractor for oversize rock removal.

7. Where bedrock is encountered within 12 inches of the bottom of Prepared Subgrade, the Contractor shall place a 12-inch thick lift of soil General Fill as a “Rock Cap”.

Z. Prepared Subgrade

1. Condition Prepared Subgrade to a moisture content which allows compaction to the required density without an excessive amount of effort and that results in a stable non-yielding surface.
2. Prepared Subgrade shall be placed in 12-inch maximum loose lifts and compacted to 92 percent of maximum dry density (ASTM D1557).
3. Following compaction, the upper surface of the Prepared Subgrade shall be treated as described in Section 02211 of these Specifications in preparation of geomembrane liner placement.
4. On slopes steeper than 20 percent, Prepared Subgrade shall be placed in 18-inch lifts be as measured perpendicular to the slope. Prepared Subgrade may be placed in a single 6-inch lift if the underlying Embankment Fill material is free from excessive coarse material, cobbles, and boulders. Reduction of the total lift thickness shall be approved by the Engineer.

AA. Drainage Layer

1. Drainage Layer shall not be placed until final inspection and approval of the geosynthetics has been made by the Engineer
2. Drainage Layer shall be placed over the geomembrane liner in one lift to result in a minimum eighteen (18)-inch-thick layer after construction is complete.
3. Drainage Layer shall not be compacted.
4. Drainage Later shall have an in-place hydraulic conductivity of 5×10^{-3} cm/sec when tested in accordance with ASTM D 5856.
5. Drainage Layer shall be placed by dumping with trucks or loaders at the edge of geomembrane cover and spreading over the geomembrane with a dozer equipped with Low Ground Pressure (LGP) tracks that exert a pressure of seven (7.0) psi or less, or similar equipment, as approved by the Engineer, that will prevent heavy loads on the liner. Equipment shall not be allowed to come in direct contact with the plastic liner. Rubber-tire equipment shall not be allowed to cross over collection and distribution pipe at any time unless it can be proved by a field test that the subject equipment will not crush the pipe. It may be necessary to place a thicker lift of Drainage Fill over piping if an alternate method of placement is used. Alternative methods of placement proposed by the Contractor will be considered. However, such methods shall be proposed to and approved by the Engineer prior to mobilization of equipment to the site. The Engineer reserves the right to accept or reject any such alternative placement proposal.
6. Thickness of the Drainage Layer will be monitored by the Contractor with twenty-four (24)-inch-high highway cones, or an alternative method proposed by the Contractor and approved by the Engineer.
7. Hauling equipment shall operate on a minimum thickness of Drainage Layer Material above any geosynthetic layer as determined by the Engineer. Prior to commencing Work, Contractor shall provide a list of proposed equipment to operate on the Drainage Layer for approval and minimum roadway thickness determination.
8. In locations with the TSF basin and WRD pad where heat seaming has been used to join geomembrane sections, the protective cover material shall be spread in the same direction as the seam overlap to avoid placing additional stress on the seam.
9. The finished surface of the Drainage Layer shall be bladed with the LGP dozer to provide a surface free of ridges, mounds, and ponding areas.
10. The Contractor shall protect underlying geosynthetics from mechanical damage at all times during placement of Drainage Layer.

11. The geomembrane Installation Contractor shall take steps to minimize wrinkle generation in underlying geosynthetic materials during placement of the Drainage Layer. The measures may include placing protective layer material in the early morning hours when the geosynthetic materials are cool and monitoring and walking out wrinkles in the geosynthetic materials that appear at the edge of the placement area.
12. Placement of Drainage Layer shall not be performed when the ambient air temperature exceeds 100°F or if excessive wrinkles developed in the geomembrane as determined by the Engineer.

BB. The Contractor shall survey to control overall protective cover and drainage layer thickness as specified in Section 01050. Results shall be provided to the Engineer.

CC. Filter Fill

1. Filter Fill shall be placed in a single 6-inch loose lift above the Drainage Layer and under riprap in the permanent diversion channels.
2. Filter Fill shall not be compacted above the drainage layer.
3. Filter Fill shall be compacted to a smooth and non-yielding surface where used as bedding below riprap.
4. Filter Fill shall be placed by dumping with trucks or loaders and spreading over the Drainage Layer with a dozer equipped with Low Ground Pressure (LGP) tracks that exert a pressure of seven (7.0) psi or less, or similar equipment, as approved by the Engineer, that will prevent heavy loads on the liner. Rubber-tire equipment shall not be allowed to cross over collection and distribution pipe at any time unless it can be proved by a field test that the subject equipment will not crush the pipe. Alternative methods of placement proposed by the Contractor will be considered. However, such methods shall be proposed to and approved by the Engineer prior to mobilization of equipment to the site. The Engineer reserves the right to accept or reject any such alternative placement proposal.
5. Thickness of the Filter Fill will be monitored by the Contractor with twenty-four (24)-inch-high highway cones, or an alternative method proposed by the Contractor and approved by the Engineer.
6. Hauling equipment shall operate on a minimum thickness of Drainage Layer Material above any geosynthetic layer as determined by the Engineer. Prior to commencing Work, Contractor shall provide a list of proposed equipment to operate on the Drainage Layer for approval and minimum roadway thickness determination.
7. The finished surface of the Filter Fill shall be bladed with the LGP dozer to provide a surface free of ridges, mounds, and ponding areas.

DD. The Contractor shall survey to control overall protective cover and Filter Fill thickness as specified in Section 01050. Results shall be provided to the Engineer

EE. Anchor Trench Backfill

1. Anchor Trench Backfill shall be placed in geomembrane anchor trenches.
2. Fill placed in geomembrane anchor trenches shall be placed in maximum 12-inch thick compacted horizontal lifts and compacted by tamping with a minimum of two passes with a mechanical “whacker” type tamper or bucket compacted.
3. Anchor Trench Backfill may be used as pipe ballast as directed by the Owner.

FF. Drain Gravel

1. Drain Gravel shall be placed around the primary perforated CPE and HDPE underdrain collection pipes.
2. Drain Gravel shall be placed around the pipe with a minimum clearance of 6-inches on all sides then wrapped with a non-woven geotextile.

3. No equipment other than track-mounted vehicle shall be allowed on the Drain Gravel.

GG. Leak Detection Fill

1. Leak Detection Fill shall be placed around the perforated PVC leak detection pipes.
2. Leak Detection Fill shall be around the pipe with a minimum clearance of 8-inches above and on the sides of the pipe.
3. Leak Detection Fill and leak detection pipe shall be placed directly above the GCL within the leak detection channel as shown on the Drawings.
4. No equipment other than track-mounted vehicle shall be allowed on the Leak Detection Fill.

HH. Pipe Bedding Fill

1. Pipe bedding fill shall be placed around leak detection risers, culverts and buried HDPE piping as shown on the Drawings.
2. Pipe Bedding Fill shall be brought up in horizontal lifts to prevent unbalanced pressure on structures or pipes.
3. Pipe Bedding Fill shall be placed a minimum of 6 inches below the pipe and shall be compacted and approved by the Engineer prior to pipe placement.
4. Pipe Bedding Fill shall be worked under pipe haunches by hand to provide uniform support of the pipe.
5. Pipe Bedding Fill shall be placed in maximum 6-inch loose lift, moisture-conditioned, and compacted to 92 percent of maximum dry density (ASTM D1557).
6. Only hand-guided mechanical tampers or hand-guided vibratory rollers shall be used for compaction around, over, near, or adjacent to pipes.

II. Cable Bedding Fill

1. Cable Bedding Fill shall be placed below and around instrumentation signal cables as shown on the Drawings.
2. Cable Bedding Fill shall be placed in a minimum 6 inches compacted lift below the signal cables and compacted to a smooth and non-yielding surface using hand-guided compaction equipment.
3. Cable Bedding Fill shall be placed in a single 12-inch loose above the signal cables and compacted with hand-guided compaction equipment to achieve a smooth and non-yielding surface.
4. Cable Bedding Fill shall extend a minimum of 12 inches on either side of the maximum extents of the signal cable layout.

JJ. Riprap

1. Riprap shall be placed above Filter Fill in permanent diversion channel and outlet aprons to the lines and grades shown on the Drawings.
2. Riprap shall be placed in a single lift equivalent to 1.5 times D_{50}.
3. Riprap shall be track walked or bucket compacted.

KK. Safety Berm Material

1. Safety Berm Material shall be placed along light vehicle and haul roads.
2. Safety Berm Material shall be uncompacted and placed by either front end loader, dozer, or motor grader.
3. Safety Berm Material shall be placed to such a height as to be equal to the middle of the axel of the largest vehicle assigned to the Work Area.

3.4 TOLERANCES

A. Local slopes shall be within 5 percent of those shown on the Drawings, and overall slopes shall be within 0.1 percent of those shown on the Drawings.

B. Finished grades shown on the Drawings are given in feet and tenths or hundredths of feet, and shall slope uniformly between given spot and contour elevations. All grades shall provide for natural runoff of water without low spots or pockets.

C. Fill and backfill shall be placed within a tolerance of plus or minus 0.2 feet, unless otherwise approved by the Engineer. Where the thickness of fill or backfill is specified as a minimum thickness on the Drawings and/or in the Specifications, place fill to the minimum thickness shown. Layer thicknesses shown on the drawings are compacted thicknesses.

D. Minimum grades and slopes shown on the Drawings provide drainage control and shall be maintained.

E. Correction of over-excavation and backfilling beyond the tolerances identified above shall be to the Contractor's account, at no expense to the Owner.

3.5 PROTECTION OF FINISHED WORK

A. Protect finished Work and Work in progress in accordance with of Section 01500.

3.6 QUALITY CONTROL

A. Quality Control inspection and testing will be performed under provisions of Sections 01010, 01300, 01400, and 01410 under the supervision of a Professional Engineer licensed in the State of Oregon.

B. In place density testing shall be performed in accordance with ASTM D 1556 or D 6938.

C. Laboratory compaction testing to determine the soils maximum dry density shall be performed in accordance with ASTM D 1557.

D. Laboratory permeability testing to determine hydraulic conductivity of the Drainage Layer shall be performed in accordance with ASTM D 5856.

E. Field particle size analyses of riprap materials shall be performed in accordance with ASTM D 5519.

F. If Quality Control test results indicate Work does not meet specified requirements, perform remedial action as described below.

1. Immediately notify the Engineer.
2. Compaction below specified minimum density:
    a. Apply additional effort, or scarify, moisture condition, recompact, and retest.
3. Moisture content outside of specified limits during compaction:
    a. Moisture content below specified minimum: Scarify the depth of the lift, moisture condition, mix to achieve uniform moisture content, recompact, and retest.
    b. Moisture content above specified maximum: Scarify the depth of the lift, allow to air dry, mix to achieve uniform moisture content, recompact, and retest or remove the wet material. Mixing of dry material to lower the moisture content will not be allowed without the prior approval of the Engineer and on a case by case basis.
4. Moisture content outside of specified limits after compaction and approved prior to covering: Determine depth of material outside of specified limits and correct as specified above.
5. Material not in accordance with material specification requirements of Section 02205: Remove material in its entirety as determined by the Engineer.

G. Frequency of tests:

The following table shows the minimum frequency of Quality Control testing of soil, rock, and aggregate materials placed, unless otherwise approved by the Engineer:

Table 1: 02233-1 QUALITY CONTROL - MINIMUM TESTING FREQUENCIES

Materia Type		**Number of Units Per Test**					
	Test	Field Density and Moisture	Field Particle Size Analysis	Laboratory Sieve Analysis	Laboratory Atterberg Limits	Laboratory Moisture Density Relationship	Laboratory Permeability
	ASTM	**D 6938**	**D 5519**	**D 422**	**D 4318**	**D 1557**	**D 5856**
Subgrade	sq.ft	50,000	N/A	200,000	200,000	500,000	
Embankment Fill	cu.yds	2,000	N/A	5,000	5,000	20,000 per material type	
Grading Fill	cu.yds	1,000	N/A	5,000	5,000	20,000	
Prepared Subgrade	cu.yds	1,000	N/A	5,000	5,000	15,000	
Drainage Layer	cu.yds	N/A	N/A	5,000	5,000	N/A	2 per material type
Filter Fill	cu.yds	N/A	N/A	3,000	3,000	N/A	2 per material type
Anchor Trench Backfill	cu.yds	N/A	N/A	500	N/A	N/A	
Drain Gravel	cu.yds	N/A	N/A	200 (or 3 per material type)	200 (or 3 per material type)	N/A	
Leak Detection Fill	Each	N/A	N/A	2 per material type	2 per material type	N/A	
Pipe Bedding Fill	LF	100	N/A	100 (2 per material type)	100 (2 per material type)	200 (1 per material type)	
Cable Bedding Fill	cu.yds	N/A	N/A	2 per material type	2 per material type	N/A	
Riprap	cy.yds	N/A	2 per material type	N/A	N/A	N/A	
Safety Berm Material	cu.yds	N/A	N/A	N/A	N/A	N/A	

6. Tests may be conducted more or less frequently at the direction of the Engineer. More frequent testing shall be performed, where indicated by the following guidelines:
    a. Areas where special compaction equipment or methods are used.
    b. Areas where the height of fill rises quickly versus the quantity of fill placed.
    c. Areas where doubtful construction procedures are being used.
    d. Areas where the required compaction may not have been achieved based upon visual observations.
    e. Areas where unacceptable material may have been placed.
7. If additional Quality Control testing is required by the Engineer, costs for additional testing shall be borne by the Contractor.

H. Quality Control test results shall be made available to the Owner and Engineer within twenty-four (24) hours after completion of test.

I. Quality Control test results shall be stored in hard copy in the Quality Control Team's on-site facility for from the Owner or Engineer at all times. If no hard copies are stored on-site, the Quality Control Team shall provide the electronic test results to the Engineer within twenty-four (24) hours after completion of the test.

3.7 Submittals

A. The Quality Control test results shall be submitted to the Engineer for review and approval on a regular basis, or at the request of the Engineer.

B. The Quality Control Team shall be responsible for accurately testing and reporting results of all Quality Control test results and observations in a timely manner to the Owner and Contractor throughout the project in the form of a Daily Field Report.

1. Daily Field Reports shall be typed and submitted to the Engineer and/or Owner within one (1) working day.

C. Fill materials proposed by the Contractor for use to complete the Work shall be tested by the Quality Control Team prior to placement to verify that the material meets these Specifications.

D. Initial Quality Control test results of proposed materials shall be submitted to the Engineer for approval at least twenty-four (24) hours prior to material placement.

E. At the completion of the Work, a sealed Quality Control Report shall be submitted to the Owner and Engineer in accordance with Section 01300 and include at a minimum:

1. Cover letter summarizing the quantities of materials placed, required testing frequency, and actual testing frequency achieved. The Quality Control Report shall be sealed by a professional engineer licensed in the State of Oregon.
2. Typed field documentation including daily field reports, field and laboratory test results summary tables and individual test results forms for all tests performed for each construction material for the tests specified in these Specifications.
3. Summary tables shall be suitable for report presentation and regulatory agency review. One (1) digital reproducible copy of the summary tables shall be provided to the Engineer.

3.8 Quality Assurance

A. The Quality Assurance Team shall perform Quality Assurance or Referee testing at the direction of the Engineer.

B. The Engineer has the final decision regarding the use of a proposed material for completion of the Work.

C. At any time, the Engineer or Quality Assurance Team may collect a sample split from the Quality Control Team's sample and perform a referee test for Quality Assurance.

1. Quantity of tests and frequencies shall be at the discretion of the Engineer. Costs for Quality Assurance testing where test results do not meet these Specifications shall borne by the Contractor.

*****END OF SECTION*****

SECTION 02272
GEOTEXTILE

1.0 GENERAL

1.1 Section Includes

A. References
B. Performance Requirements
C. Submittals
D. Delivery, Storage, and Handling
E. Material
F. Deployment
G. Seaming
H. Quality Control
I. Quality Assurance

1.2 Related Sections

A. Section 01300 – Submittals
B. Section 01400 – Quality Control/Assurance
C. Section 01410 – Testing Laboratory Services
D. Section 02205 – Fill Materials
E. Section 02223 – Filling

1.3 References

A. American Society for Testing and Materials (ASTM)
   1. ASTM D 4354 – Practice for Sampling of Geosynthetics for Testing
   2. ASTM D 4355 – Test Method for Deterioration of Geotextile from Exposure to Ultraviolet Light and Water
   3. ASTM D 4533 -Test Method for Trapezoidal Tearing Strength of Geotextiles
   4. ASTM D 4632 – Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
   5. ASTM D 4751 – Test Method for Determining Apparent Opening Size of a Geotextile
   6. ASTM D 4759 – Practice for Determining the Specification Conformance of Geosynthetics
   7. ASTM D 4873 – Guide for Identification, Storage and Handling of Geotextiles
   8. ASTM D 5035 – Test Method for Break Strength and Elongation of Textile Fabrics (2” Strip Method)
   9. ASTM D 5261 – Test Method for Determining Mass Per Unit Area
   10. ASTM D 6241 – Test Method for Static Puncture Strength of Geotextiles and Geotextile Related Products Using a 50-mm Probe
   11. ASTM D 7238 – Test Method for Effect of Exposure of Unreinforced Polyfin Geomembrane Using Fluorescent Condensation Apparatus
B. Geosynthetic Research Institute (GRI)
   1. GT12a – Test Method and Properties for Nonwoven Geotextile Used as Protection (or cushioning) Materials

1.4 Performance Requirements

A. Contractor shall furnish and install the geotextile and all materials incidental to the installation in accordance with these Specifications.

B. Alignment, lengths, and areas for geotextile placement are shown on the Drawings. Exact locations and lengths may be varied to suit conditions encountered in the field only as approved by the Engineer.

A. Contractor shall furnish sufficient material to provide the finished geotextile shown on the Drawings; including material for all seams and laps. Contractor shall balance the actual project geotextile requirements, as determined by their quantity take-offs, against those shown on the Drawings.

1.5 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Product Data: Provide manufacturer's data regarding filtration, permeability, and mechanical properties.

2. Sample: Submit one (5 feet by 5 feet) sample with the machine direction marked.

C. During Installation:

1. Manufacturer Quality Control certificates

1.6 Delivery, Storage, and Handling

D. Transportation: The geotextile shall be packaged and shipped in such a manner that the material is not damaged or exposed to damaging substances. Transportation shall be the responsibility of the Geomembrane Installation Contractor unless agreed to by the Manufacturer and the Owner, in writing, prior to the initiation of shipment of geotextile to the site.

E. Off-Loading: Off-loading of the geotextile is the responsibility of the Geomembrane Installation Contractor. No off-loading of geotextile shall be performed unless the Owner's representative is present. Any damage to the rolls during off-loading shall be documented by the Owner's representative and the Geomembrane Installation Contractor. All damaged rolls must be stored separate from the undamaged rolls until. The rolls shall be unrolled to determine the extent of the damage. The use of the roll or portions of the roll shall be only at the approval of the Engineer. The cost of evaluating, replacing or repairing rolls damaged during off-loading shall be the sole responsibility of the Installation Contractor.

F. Storage: The geotextile shall be stored according to manufacturer's recommendations, ASTM D 4873, and such that it is protected from puncture, dirt, grease, gasoline, diesel fuel, water, moisture, mud, mechanical abrasion, excessive heat and other causes of damage to the geotextile material.

A. Rolls without the proper documentation shall be stored separately until all the required documentation is received and approved by the Engineer.

2.0 PRODUCTS

2.1 Material

A. The geotextile as referenced in the Drawings and these Specifications shall be Non-woven Needle Punched Geotextile.

1. Composition: Geotextile shall be of polypropylene or polyethylene fibers.

2. Rolls shall be free of holes, contamination, and foreign matter.

B. The geotextile supplied to the project shall meet or exceed the minimum (unless noted otherwise) roll values shown in the table below:

Table 02272-1: Minimum Average Roll Values For Geotextile Material (per GRI-GT12a)

Property[1]	ASTM Test Method	Value
Weight	D 5261	12 oz/sq.yd.
Grab Tensile	D 4632	300 lb
Grab Tensile Elongation	D 4632	50%
Trapezoidal Tear Strength	D 4533	115 lb
Puncture (CBR) Strength	D 6241	800 lb
UV Resistance (at 500 hrs)	D 7238	70% strength retained
Apparent Opening Size	D 4751	No. 100 Sieve (0.15 mm)

Notes:
1. Evaluation to be on a 2.0 inch strip tensile specimens per ASTM D 5035 after 500 light hour exposure.

C. Rolls shall be manufactured a minimum of 15 feet wide and 300 feet long.

D. The geotextile will be warranted by the Manufacturer to be free from defects in materials and workmanship and to have a useful life of 5 years from the date of purchase under normal weathering and normal use.

3.0 EXECUTION AND DEPLOYMENT

3.1 Deployment

A. Procedure and methods shall not damage the geotextile. Manufacturer's recommended deployment techniques shall be followed by the Contractor to the greatest extent possible.

B. Do not deploy frozen geotextile.

C. Do not deploy geotextile over frozen ground.

D. Deploy only in areas approved by the Engineer.

E. Placement of drainage aggregate should proceed immediately following placement of the geotextile. If a perforated collection pipe is to be installed, a bedding layer of drainage aggregate should be placed below the pipe, with the remainder of the aggregate placed to the minimum required construction depth.

3.2 Seaming

A. Seams can be sewn or overlapped a minimum of 12 inches.

3.3 Quality Assurance

A. Quality Assurance shall consist of:

1. Review of required documentation.
2. Approval of geotextile rolls for deployment.
3. Observation of unrolled material for damage.
4. Observation of seaming procedure and completed seams.

B. Engineer has final authority in the Quality Assurance for the project.

C. Compliance Testing:

1. At the option of the Engineer, compliance testing may be performed at any time prior to, during, or after the installation.

2. The cost of the compliance testing shall be negotiated between the Owner and Contractor.
3. The tests performed for the compliance testing shall be directed by the Engineer.
4. Compliance testing shall not include any tests that are not listed in these Specifications as a basis for evaluating compliance of the geotextile to the Specifications.
5. Sampling for Compliance Testing:
    a. Samples shall be obtained by the Engineer.
    b. The sample shall be taken as close to the middle of the roll as practical but shall, at a minimum, be sampled no closer than three (3) feet from the end of a roll.
6. The sample shall be labeled by the Engineer, using a permanent marker, with the roll number, machine direction, date sampled, and name of individual that sampled the material.

D. Seams:

1. Will be observed for required overlap and seaming procedures.
2. Seams that do not have the required overlap will be marked for adjustment.

*****END OF SECTION*****

SECTION 02273
GEONET

1.0 GENERAL

1.1 Section Includes

A. Definitions
B. Performance Requirements
C. Submittals
D. Delivery, Storage, and Handling
E. Material
F. Deployment
G. Seaming
H. Quality Assurance

1.2 Related Sections

A. Section 02775 – Geomembrane

1.3 References

A. American Society for Testing and Materials (ASTM)

1. ASTM D 792 – Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2. ASTM D 1505 – Standard Test Method for Density of Plastic by the Density-Gradient Technique
3. ASTM D 1603 – Test Method for Carbon Black in Olefin Plastics
4. ASTM D 4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
5. ASTM D 4354 – Practice for Sampling of Geosynthetics and Rolled Erosion Control (RECPs)
6. ASTM D 4355 – Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
7. ASTM D 4491 – Test Methods for Water Permeability of Geotextiles by Permittivity D 4533 Test Method for Trapezoidal Tearing Strength of Geotextiles
8. ASTM D 4632 – Test Method for Grab Breaking Load and Elongation of Geotextiles
9. ASTM D 4716 – Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthectic using a Constant Head
10. ASTM D 4716 – Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
11. ASTM D 4751 – Test Method for Determining Apparent Opening Size of a Geotextile
12. ASTM D 4873 – Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples
13. ASTM D 5035 – Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
14. ASTM D 5199 – Standard Test Method for Measuring Nominal Thickness of Geotextile and Geomembranes
15. D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles

16. ASTM D 6241 – Standard Test Method for Static Puncture Strengths of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
17. ASTM D 6364 – Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics
18. ASTM D 7005 – Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposite
19. ASTM D7179 – Standard Test Method for Determining Geonet Breaking Force
20. ASTM D7238 – Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembranes Using Fluorescent UV Condensation Apparatus

B. Geosynthetic Research Institute (GRI)

1. GRI-GN2 and GC13 – Joining and Attaching Geonets and Drainage Composites
2. GRI-GN4 – Test Methods, Required Properties and Testing Frequencies for Biplaner Geonets and Biplaner Geonet Composites

1.4 Definitions

A. Installation Contractor: Subcontractor retained by the General Contractor to install the geonet or General Contractor, if General Contractor elects to install the geonet.

1.5 Performance Requirements

A. Installation Contractor shall furnish and install the geonet and all materials incidental to the installation in accordance with these Specifications.

B. Alignment, lengths, and areas for geonet placement are shown on the Drawings. Exact locations and lengths may be varied to suit conditions encountered in the field only as approved by the Engineer.

C. Installation Contractor shall furnish sufficient material to provide the finished geonet shown on the Drawings; including material for all seams and laps. Installation Contractor shall balance the actual project geonet requirements, as determined by his quantity take-offs, against those shown on the Drawings.

1.6 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Product Data: Provide manufacturer's data sheet.
2. Sample: Submit one (5 feet by 5 feet) sample with the machine direction marked.

1.7 Delivery, Storage, and Handling

A. Transportation: The geonet shall be packaged and shipped in such a manner that the material is not damaged or exposed to damaging substances. Transportation shall be the responsibility of the Geonet Installation Contractor unless agreed to by the Manufacturer and the Owner, in writing, prior to the initiation of shipment of geonet to the site.

B. Off-Loading: Off-loading of the geonet is the responsibility of the Geonet Installation Contractor. No off-loading of geonet shall be performed unless the Owner's representative is present. Any damage to the rolls during off-loading shall be documented by the Owner's representative and Geonet Installation Contractor. All damaged rolls must be stored separate from the undamaged rolls until. The rolls shall be unrolled to determine the extent of the damage. The use of the roll or portions of the roll shall be only at the approval of the Engineer. The cost of evaluating, replacing or repairing rolls damaged during off-loading shall be the sole responsibility of the Installation Contractor.

C. Storage: The geonet shall be stored according to manufacturer's recommendations and such that it is protected from puncture, dirt, grease, gasoline, diesel fuel, water, moisture, mud, mechanical abrasion, excessive head and other causes of damage to the geotextile material.

D. Rolls without the proper documentation shall be stored separately until all the required documentation is received and approved by the Engineer.

2.0 PRODUCTS

2.1 Material

Table 02273-1: Minimum Average Roll Values for Geonet Material (per GRI-GN4)

Property	ASTM Test Method	Minimum Average Roll Value
Thickness[1] (min. ave.)	D 5199	200 mil
Density[2] (min. ave.)	D 1505/D 792	0.950 g/cm^3
Carbon Black Content (%)	D 1603/D 4218	1.5-3.0%
Tensile Strength[3] (MD)	D 7179	180 lb/in
Compressive Strength[4] (min. ave.)	D 6364	120
Transmissivity[5]	D 4716	5.0 gal/min-ft

Notes:

1. The diameter of the presser foot shall be 2.22 in. and the pressure shall be 2.9 lb./in^2.
2. Density is of the formulated material; the base resin will be slightly lower.
3. This is the average peak value for five equally spaced machine direction tests across the roll width.
4. Test to be conducted using Section 6.3, the movable plate method.
5. Geonets shall be tested between rigid end platens at a hydraulic gradient of 1.0; a pressure of 10,000 lb/ft^2, and a seating dwell time of 15 min. Test values are for machine direction only.

3.0 EXECUTION AND DEPLOYMENT

3.1 Installation

A. Do not deploy frozen geonet.

B. Do not deploy geonet over frozen ground.

C. Deploy only in areas approved by the Engineer.

D. Deploy the geonet in a downhill manner, when applicable, with the long dimensions of the panel sloping downhill.

E. Install the overlying geomembrane liner without damaging the geonet layer or underlying geomembrane.

3.2 Seaming

A. Use plastic wire ties of a color contrasting to the color of the geonet.

B. Tie Spacing: According to manufacturer's recommendations but at a minimum of 5 feet on seam perpendicular to slopes, 2 feet on seams parallel to slopes, 5 feet on seams on grades of less than 5percent, and 6 inches on seams in anchor trenches.

C. Do not overlap.

3.3 Construction Quality Assurance

A. Construction Quality Assurance (CQA) shall consist of:

1. Observation of geonet prior to and during deployment for dirt and debris that may clog the leak detection system.
2. Observation of tie spacing.
3. Observation of procedures for damage to secondary liner.

*****END OF SECTION*****

SECTION 02350
GEOSYNTHETIC CLAY LINER

1.0 GENERAL

1.1 Section Includes

A. References
B. Performance Requirements
C. Submittals
D. Delivery, Storage, and Handling
E. Material
F. Deployment
G. Seaming
H. Quality Assurance

1.2 Related Sections

A. Section 01300 – Submittals
B. Section 01400 – Quality Control/Assurance
C. Section 02205 – Fill Materials
D. Section 02223 – Filling

1.3 References

A. American Society for Testing and Materials (ASTM)
   1. ASTM D 4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
   2. ASTM D 5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
   3. ASTM D 5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
   4. ASTM D 5887 – Standard Test Method for Measuring the Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
   5. ASTM D 5993 – Standard Test Method for Measuring Mass per Unit Area of Geosynthetic Clay Liners
   6. ASTM D 5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembranes
   7. ASTM D 6243 – Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punch Geosynthetic Clay Liners
   8. ASTM D 6496 – Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
   9. ASTM D 6768 – Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
B. Geosynthetic Research Institute (GRI)
   1. GCL3 – Geosynthetic Research Institute Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)

1.4 Performance Requirements

A. This Work shall include the furnishing of all labor, tools, equipment, and other items necessary for the installation of geosynthetic clay liner (GCL) as shown on the Drawings. All Work shall be performed in accordance with the lines, grades, sections, and dimensions shown on the Drawings, or as directed by the Engineer

1.5 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Product Data: Provide manufacturer's data regarding filtration, permeability, and mechanical properties.

2. Sample: Submit one (5 feet by 5 feet) sample with the machine direction marked.

C. During Installation:

1. Manufacturer Quality Control certificates

D. After Installation:

1. At the completion of the Work, the GCL Installation Contractor shall submit the Quality Control Documentation outlined in Section 01300 and shall include at a minimum:

   a. Typed summary tables of the field documentation including summaries of on-site field personnel, GCL panel deployment, heat-bonded test seams, samples and test results recorded during installation, if any.

   b. A GCL record drawing showing panels and heat-bonded test locations. The record drawing shall be drawn on a 22 –inch by 34-inch sheet.

   c. The summary tables and record drawings shall be suitable for report presentation and agency review. One (1) digital reproducible copy of the summary tables and record drawings shall be provided to the Engineer.

1.6 Delivery, Storage, and Handling

A. Rolls shall be stored following all Manufacturer's recommendations and the requirements of ASTM D 4873.

B. Rolls shall be stored on a flat dry surface. Store to protect the GCL from dust, dirt, and debris. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

C. Rolls shall be handled utilizing a solid steel bar inserted through the core bar and slings or chains attached to the ends of the bar. The core bar shall be suspended from a spreader bar so that the edges of the liner are not damaged by the suspending straps or chains.

2.0 PRODUCTS

2.1 Material

A. The GCL as referenced in the Drawings and these Specifications shall be reinforced geofilm-related GCL similar to ContainMAT manufactured by GSE Environmental of Houston, Texas, or similar which has a maximum allowable composite hydraulic conductivity of 5×10^{-10} cm/sec.

B. The GCL shall be formulated and manufactured from polypropylene geotextiles and high swelling, containment resistant sodium bentonite.

C. The GCL shall be manufactured reinforced by the mechanical bonding of the needle punch process to enhance the friction characteristics of the GCL and to maintain the integrity of the GCL under hydration. No glues or adhesives shall be used in lieu of the needle punch process so as to retain these characteristics.

D. Needle-punched GCL's are those which, by the process of a needling board (similar to that used in the manufacture of standard non-woven geotextiles) have fibers of a non-woven geotextile pushed through the bentonite clay core and integrated into a woven or non-woven geotextile without the use of any chemical binders or adhesives.

E. No disassociation of geotextile components from the bentonite core shall occur. A sample of the GCL placed in 70º F tap water for 1 hour shall not delaminate.

F. The GCL supplied to the project shall meet or exceed the minimum (unless noted otherwise) roll values shown in the table below:

Table 02350-1: Minimum Average Roll Values For Reinforced Geofilm Related GCL Material (per GRI-GCL3)

PROPERTY	ASTM TEST METHOD	VALUE
Geotextile/Geofilm Properties		
Cap Geosynthetic		
Type	-	Non-woven
Weight	ASTM D 5261	6.0 oz/sq.yd.
Carrier Geosynthetic		
Type	-	Woven
Weight	ASTM D 5261	3.0 oz/sq.yd.
Geofilm		
Thickness	ASTM D 5199/ D 5994	4 mil
Break Tensile Strength (MD & XMD)	ASTM D 882	12 lb/in
Clay Properties		
Clay Type	-	80% or more montmorillonite
Bentonite Mass at 0% Moisture[2]	ASTM D 5993	0.75 psf
Maximum Allowable Moisture Content	ASTM D 5993	35%, by weight
Swell Index	ASTM D 5890	24 ml/2g min
Fluid Loss	ASTM D 5891	18 ml max
GCL Composite Properties		
GCL Permeability[1]	ASTM D 5887	5 x 10^{-10} cm/sec max at 5.0 psi
Tensile Strength in Machine Direction	ASTM D 6768	23 lb/in
Peel Strength	ASTM D 6496	2.1 lb/in
Geofilm Durability[4]	ASTM D 5721	80% strength
Internal Shear Strength	ASTM D 6243	150 psf typical

Notes:
1. Maximum allowable permeability per Golder.
2. For both cap and carrier fabrics for non-woven reinforced GCLs; one, or the other, must contain a scrim component of mass > 2.9 oz/sq.yd. for dimensional stability. This only applies to GM/GCL composites which are exposed to the atmosphere for several months or longer so as to mitigate panel separation.
3. If the GCL is manufactured at a higher moisture content, it shall have a minimum of 1 psf of bentonite when adjusted to a 12% moisture level.
4. Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60° C for 50 days.

G. Rolls shall be manufactured a minimum of 15.5 feet wide and 150 feet long. A minimum 6-inch lap line and a 9-inch match line shall be printed on both edges of the woven geotextile of the GCL (the upper surface as installed) to assist in overlap quality control.

H. The GCL will be warranted by the Manufacturer to be free from defects in materials and workmanship and to have a useful life of 5 years from the date of purchase under normal weathering and normal use.

3.0 EXECUTION AND DEPLOYMENT

3.1 Deployment

A. Procedure and methods shall not damage the GCL. Manufacturer's recommended deployment techniques shall be followed by the Contractor to the greatest extent possible.

B. Prior to deployment of the GCL, the subgrade shall be final graded and rolled to provide a smooth surface free of any soft areas, rocks protruding greater than 1/2 inches above the subgrade, or ruts in accordance with Section 02223. Subgrade shall also be free from any chemicals which could damage the GCL. The subgrade shall be approved by the Engineer prior to GCL deployment.

C. Panels shall be placed with the non-woven side against the subgrade and the woven polypropylene coated side oriented upwards. The GCL shall be smoothed to be free of wrinkles and creases.

D. The Contractor shall only Work on an area that can be completed in one working day. Completion shall be defined as the full installation of the liner and placement of the geomembrane liner. The GCL shall be covered immediately to protect it from any precipitation that may occur during construction.

E. Whenever possible, direct contact to the GCL will be avoided. If access requires travel over the GCL, the Contractor shall use low ground pressure (LGP) that exerts 7.0 psi or less to the contact area of GCL. Equipment tracks shall be made of rubber. Care shall be taken to avoid sharp turns and any quick stops or starts so as to avoid pinching or moving the GCL. Any damage caused by direct contact to the GCL will be repaired at the Contractor's expense.

F. The Contractor shall keep the GCL dry during installation. Installation shall not take place during high humidity, rain, or other types of precipitation. Any GCL which becomes hydrated prior to covering with drainage layer material or protective soil shall be removed and replaced at the Contractor's expense.

3.2 Seaming

A. Seams shall be flat without wrinkles and shall be overlapped a minimum of 18-inches on all sides.

B. Granular bentonite shall be placed between the upper and lower panels for a minimum width of 12-inches at a rate of the-quarter (1/4) pound per lineal foot of seam.

C. All seams shall be continuously heat-bonded together. Heat bonding techniques shall be approved by the Engineer. Care shall be taken to not place granular bentonite where it may interfere with heat-bonding of the seam.

D. Repair Procedures:

1. Rips, tears, or holes in the GCL shall be repaired by completely exposing the affected area, removing all foreign objects or soil, and then placing a patch over the defect, with a minimum overlap of 18-inches on all edges.

2. All seams shall be continuously heat-bonded to the underlying GCL panel.

3. Granular bentonite shall be placed between the patch and the repaired material at a rate of one-quarter (1/4) pound per lineal foot of edge.

    a. Defective seams, tears, and holes, shall be repaired as described above.

    b. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.

3.3 Quality Assurance

A. Quality Assurance shall consist of:

1. Review of required documentation.
2. Approval of GCL rolls for deployment.
3. Observation of unrolled material for damage.
4. Observation of seaming procedure and completed seams.

B. Engineer has final authority in the Quality Assurance for the project.

C. Compliance Testing:

1. At the option of the Engineer, compliance testing may be performed at any time prior to, during, or after the installation.
2. The cost of the compliance testing shall be negotiated between the Owner and Contractor.
3. The tests performed for the compliance testing shall be directed by the Engineer.
4. Compliance testing shall not include any tests that are not listed in these Specifications as a basis for evaluating compliance of the GCL to the Specifications.
5. Sampling for Compliance Testing:
    a. Samples shall be obtained by the Engineer.
    b. The sample shall be taken as close to the middle of the roll as practical but shall, at a minimum, be sampled no closer than three (3) feet from the end of a roll.
6. The sample shall be labeled by the Engineer, using a permanent marker, with the roll number, machine direction, date sampled, and name of individual that sampled the material.

D. Seams:

1. Will be observed for required overlap and seaming procedures.
2. Seams that do not have the required overlap will be marked for adjustment.

*****END OF SECTION*****

SECTION 02710
GRAVITY PIPING

1.0 GENERAL

1.1 Section Includes

A. Related Sections
B. References
C. Submittals
D. Piping
E. High Density Polyethylene Pipe and Fittings
F. Fabrication
G. Handling and Storage
H. Installation
I. Pipe Connections
J. Bedding and Backfill

1.2 Related Sections

A. Section 02205 – Fill Materials
B. Section 02222 – Excavating
C. Section 02223 – Filling
D. Section 11207 – Parshall Flumes
E. Section 03300 – Cast-in-place Concrete

1.3 References

A. AASHTO M252 - Standard Specification for Corrugated Polyethylene Drainage Pipe
B. ASTM D1693 – Standard Test Method for Environmental Stress Cracking Ethylene Plastics
C. ASTM 2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity Flow Applications
D. ASTM D3350 – Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
E. ASTM D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

1.4 Submittals

A. Submit the following under provisions of Section 01300:
   1. The Contractor shall provide detailed information to the Owner and Engineer for: pipe, valves, fittings, and joining manufacturer's data, including type/class, method of joining, specifications, manufacturer's name, and manufacturer’s certificate of compliance.
   2. If an equivalent product is proposed, submit samples, technical data, test data, and specifications sufficient to allow evaluation by Engineer.

2.0 PRODUCTS

2.1 Pipe

A. Tailings Storage Facility Underdrain Collection Piping
   1. 6-inch diameter perforated Underdrain Outlet Pipe (HDPE DR17)
   2. 6-inch diameter solid wall Underdrain Outlet Pipe (HDPE DR17)

3. 6-inch diameter, 20-foot long with 3-inch wide water stop Underdrain Outlet Pipe (HDPE DR17)
4. 6-inch diameter perforated CPE Underdrain Collection Pipe
5. 4-inch diameter perforated CPE Underdrain Collection Pipe

B. Waste Rock Dump Underdrain Collection Piping

1. 6-inch by 10-inch diameter dual containment Underdrain Outlet Pipe (HDPE DR17)
2. 6-inch diameter perforated Underdrain Outlet Pipe (HDPE DR17)
3. 6-inch diameter perforated CPE Underdrain Collection Pipe
4. 4-inch diameter perforated CPE Underdrain Collection Pipe

C. Reclaim Pond

1. 10-inch diameter solid wall Leak Detection Riser Pipe (HDPE DR17)

2.2 High Density Polyethylene Pipe and Fittings

A. The polyethylene pipe and fittings shall meet or surpass the physical property values. Pipe and fittings shall be made of polyethylene compounds which meet or exceed the requirements of Type III, Category 4 or 5, Grade P33 or P24, Class C per ASTM D 1248. Pipe fittings shall be manufactured from the same resin and by the same pipe Manufacturer.

B. HDPE pipe material shall be PE4710. The PE4710 material shall conform to ASTM D 3350 with the cell classification of 445574C.

C. All pipe shall comply with ASTM F 714.

D. The polyethylene compound shall contain a minimum of 2 percent carbon black to withstand outdoor exposure without loss of properties. The polyethylene compound shall have a minimum resistance of 5,000 hours when tested for environmental stress crack in accordance with requirements of ASTM D 1693.

E. Minimum parallel plate pipe stiffness values at 5% deflection shall be 50 psi per test method ASTM D 2412.

F. Pipes and fittings shall be homogenous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.

G. Fittings at the ends of pipes shall consist of polyethylene unless indicated otherwise on the Drawings. Fittings supplied by manufacturers other than the supplier of the pipe shall not be permitted without the approval of the Engineer. HDPE fittings shall be in accordance with ASTM D 3261.

H. Segments of pipe having cuts or gouges in excess of 10% of the wall thickness of the pipe shall be cut out, removed, and replaced.

I. The standard dimension ratio (DR) for the piping shall be as shown on the Drawings.

J. Where polyethylene pipe is to be slotted, slots shall be completed at the manufacturing plant or by the Contractor prior to installation of the Work.

K. Polyethylene pipe shall be supplied in standard laying lengths not exceeding 50 feet.

L. Underdrain water stop segments shall be cast-in-place to the lines and grades shown on the Drawings for the underdrain outlet pipes at the upstream toe of the Stage 1 embankment. Underdrain Pipe water stops shall be constructed of 20-foot long pipe segments with continuous 3-inch wide by ½-inch thick rig factory-fabricated at the midpoint of the segment length.

2.3 Valves

A. Butterfly Valve:

1. 6-inch gear operated butterfly valve, Class 150 manufactured by a company whose products are approved by the Engineer. Valve bodies shall be cast iron, ductile iron, or other approved material mounted with approved non-corrosive metals. All wearing surfaces shall be bronze or other approved non-corrosive materials compatible with the sodium cyanide solution used for the Project. There shall be no moving, bearing, or contact surfaces of iron in contact with iron. Contact surfaces shall be machined and finished in the best workmanlike manner, and all wearing surfaces shall be easily renewable or replaceable.

B. The valves shall be standard pattern of the Manufacturer whose products are approved by the Engineer. The valves shall have the name or mark of the Manufacturer, year valve casting was made, size, and working pressure plainly cast in raised letters on the valve body.

2.4 Fabrication

A. Finished pipe lengths shall have beveled ends for field welding.

B. Pipe shall be fabricated in accordance with manufacturer's recommendations and ASTM F 2620.

C. Underdrain water stop segments shall be prefabricated in the manufacturing facility. Pipe segment shall be a minimum of 20 feet long and suitable for field butt fusion welding.

3.0 EXECUTION

3.1 Handling and Storage

A. Transportation of pipe, valves, and fittings shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the pipe, valves, and fittings incurred prior to and during transportation to the site.

B. Handling, storage and care of the pipe, valves, and fittings prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Engineer.

C. The Contractor shall be responsible for storage of pipe, valves, and fittings at the site. Pipe, valves, and fittings shall be stored on clean level ground, which is free of sharp objects which could damage these materials. Stacking shall be limited to a height that shall not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitable and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

3.2 Installation

A. There is no guarantee that existing utilities are properly located or that other utilities are not present. It shall be the Contractor's responsibility to request locates, confirm locates, expose, and protect all nearby utilities or other potential subsurface facilities that may interfere with the work.

3.3 Work Staging Area

A. Installation of piping, fittings, and valves shall be done to replace existing damaged or malfunctioning parts, as directed by the Engineer.

B. Install all piping, fittings, and valves according to manufacturer's recommendations.

3.4 Pipe Connections

A. All connections for the piping system shall be watertight under maximum anticipated pressure head.

B. The ends of all pipe shall be capped with a manufactured pipe cap unless otherwise noted on the Drawings.

C. TSF underdrain outlet pipe cast-in-place water stops shall be prefabricated.

D. HDPE pipe shall be butt-heat-fusion welded in accordance with the manufacturer's guidelines and ASTM D3261 unless otherwise noted on the Drawings.

E. Perforated to solid wall HDPE pipe connections at the upstream toe of the Stage 1 embankment within the basin shall be electrofusion couplings.

3.5 Bedding and Backfill

A. Pipe Bedding Fill shall be placed only in the locations shown on the Drawings.

A. Backfill and compact Pipe Bedding Fill in accordance with Section 02223.

B. Pipe Bedding Fill shall be hand-worked under the haunches of the pipe to uniformly bed and support the pipe.

3.6 Tolerances

A. Grade surface in a manner so that piping can be laid straight at a uniform grade, without sags or humps.

3.7 Quality Control

A. A short description of the Quality Control program shall be submitted by the Contractor with the bid to the Engineer and Owner. This description shall state the Quality Control standard to be used and as a minimum containing the following:

1. An organization chart with a brief job description of Quality Control function
2. A list of applicable procedures for implementation of the Quality Control program
3. A general description of how each Quality Control requirement is to be fulfilled during the design, procurement, manufacture, assembly and testing

B. During award phase, the Quality Control documentation shall be forwarded to the Engineer as specified in Section 01300. Pertinent Quality Control documentation including Quality Control manuals shall be approved by the Engineer prior to any production work commencing. A minimum of five working days shall be allowed for the Engineer's review.

C. Upon delivery of the pipe, the Contractor shall forward the following documentation:

1. All Vendor certificates and tests performed per these Specifications
2. All Vendor documents verifying that inspection, control, and tests performed are in accordance with these Specifications
3. Identification lists with cross references between documents and hardware/materials for traceability purposes

D. The Engineer or Owner shall have the right to carry out audits at the Contractor’s, Vendor’s, and their subcontractor’s facilities, to verify compliance with all aspects of the documentation included in the purchase order. For the purpose of evaluating and auditing, the Contractor, Vendor, and their subcontractors shall give free access to all facilities concerned and to all the Quality Control documents and records

E. Applicable records may be requested by the Engineer or Owner at any time during production, these shall be forwarded to the Engineer or Owner upon request within five working days. The Contractor or Vendor shall give a written response to the Engineer or Owner for any corrective action requests and if requested, take the necessary corrective action in a timely manner

3.8 Mechanical Properties Testing

A. All mechanical properties shall be tested and records submitted per applicable codes and Vendor standards.

3.9 Non-Destructive Examination Requirements

A. All non-destructive examinations and records shall be submitted per applicable code and Vendor standards

3.10 Hydrostatic Pressure Tests

A. All piping must be hydrostatically tested per ASME B31.11 and the pipe class sheets. Test records shall be submitted by the Contractor as part of the turnover package

B. The Contractor shall continuously monitor the hydrostatic pressure throughout the test, from the start of pressurization to the completion of depressurization. Suitable equipment shall be used to provide a continuous record of test pressure, time and the ambient temperature.

C. Hydrostatic test gauges shall be calibrated prior to the commencement of production and shall be recalibrated weekly. Certified dead weight testers shall be used for calibration. The Engineer shall witness the calibration of the gauges.

D. The hydrostatic pressure test shall show no variation in pressure which is not directly related to a change in recorded temperature. The test medium shall be clean, filtered non-saline potable water with added corrosion inhibitors. The inhibited water shall be free from sand, dirt and organic materiaI. The hydrostatic testing records and certificates shall be identified to the individual pipe section numbers.

E. No welding shall be allowed after hydrostatic testing has been completed.

3.11 Supplemental Requirements

A. The Contractor shall submit the Vendor’s schedule showing the complete plan for drawing submittal, manufacturing, testing and delivery to site. This schedule shall include hold points pertaining to the entire Work.

B. The Engineer reserves the right to enter the Contractor’s, Vendor's, or any Subcontractor's facility, at any time, with 48 hours prior written notice, for verification of Work. The Engineer shall have the right to reject any and all materials or order the rework of any and all parts and components not meeting these Specifications at no additional cost to the Owner.

C. The Contractor shall provide the Engineer with all Vendor inspection records, laboratory certificates and any other documentation deemed by the Engineer to be required for verification of materials used or work done. The Contractor shall keep Vendor’s records of chemical and physical mill certifications for all materials. These records shall be made available to the Engineer and Owner, upon request.

D. The Contractor or Vendor shall be responsible for the inspection, Quality Assurance and Quality Control of the all the Vendor’s work. The Engineer reserves the right to supplement and amend the Contractor’s or Vendor's Quality Control program if determined necessary at any time.

E. Certification of all levels of personnel is the responsibility of the Vendor. A Vendor who purchases outside services is responsible for assuring that training and examination services are in accordance with the Vendor’s written practices and these Specifications.

3.12 Repair of Defects

A. All defect repair procedures require written approval by the Engineer.

B. Defects are to be reported to Engineer as soon as they are identified.

C. HDPE pipe repairs and defects:

1. Items that contain defects shall be rejected or repaired. Such injurious defects include defects that reduce the mechanical properties, such as internal or external surface gouges, scars, scratches, blisters, or discontinuities that produce a notch effect or reduce the specified pipe wall thickness by 10% or more.

2. The Contractor shall mark all bonds that have been examined and accepted inspected per the pipe manufacturer’s recommended inspection method. All bonds requiring repair shall be marked as defective. When a repaired bond is subsequently accepted, it shall be marked over with green paint signifying its acceptance. The marking shall be done in such a manner so as to enable the Quality Assurance Team, Engineer, and Contractor to determine the status of the bonds on the pipeline.

3. All repairs made to defects shall be re-inspected using the same inspection methods recommended by the pipe manufacturer.

4. Butt-heat-fusion welds that do not meet the acceptance criteria as noted in these Specification, Manufacturer's recommendations, or any Code shall be completely removed. All butt-heat-fusion welds are subject to visual inspection.

*****END OF SECTION*****

SECTION 02775
GEOMEMBRANES

1.0 GENERAL

1.1 Summary

A. This Section describes requirements for the manufacture and installation of geomembrane liner materials for the tailings storage facility.

B. The Work includes furnishing all labor, tools, equipment, and supervision required to install the geomembrane in accordance with the Drawings and these Specifications.

1.2 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Control/Assurance

C. Section 01500 – Testing Laboratory Services

D. Section 02205 – Fill Materials

E. Section 02211 – Rough Grading

F. Section 02223 – Filling

G. Section 02273 – Geonet

H. Section 02350 – Geosynthetic Clay Liner

1.3 References

A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Society for Testing and Materials (ASTM)

a. ASTM D 792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

b. ASTM D 882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting

c. ASTM D 1004 – Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting

d. ASTM D 1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique

e. ASTM D 1603 – Standard Test Method for Carbon Black in Olefin Plastics

f. ASTM D 1790 – Standard Test Method for Brittleness Temperature of Plastic Sheeting by Impact

g. ASTM D 3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry

h. ASTM D 4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

i. ASTM D 4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

j. ASTM D 5199 – Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

k. ASTM D 5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

l. ASTM D 5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembrane Using Notched Constant Tension Load Test

m. ASTM D 5596 – Standard Test Method Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

n. ASTM D 5721 – Standard Practice for Air-Oven Aging of Polyolefin Geomembranes

o. ASTM D 5885 – Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Colorimetry

p. ASTM D 5994 – Standard Test Method for Measuring Core Thickness of Textured Geomembrane

q. ASTM D 6392 – Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

r. ASTM D 6693 – Standard Test Method Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

s. ASTM 7003 - Standard Test Method for Strip Tensile Properties of Reinforced Geomembranes

2. Geosynthetic Research Institute (GRI):

a. GM10 – Specification for Stress Crack Resistance of Geomembrane Sheet

b. GM13 – Test Properties, Testing Frequency, and Recommended Warranty for HDPE Smooth and Textured Geomembranes

c. GM19a – Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.4 Submittals Prior To Construction

A. The Geomembrane Installation Contractor shall provide the following information to the Owner prior to mobilization:

1. Manufacturer information including; company name, address, telephone number, the names of the company president and quality control manager, and narrative of the company history. Additional information required includes factory size and production capability.

2. Quality Control Manuals from the Manufacturer and Geomembrane Installation Contractor for the installation and testing of the geomembrane, including trial seams, seaming, nondestructive testing, destructive testing procedures, repair procedures and in-field quality control forms. Upon review of the Quality Control Manuals, the Owner may request additional testing during the manufacturing process at no additional cost to the Owner.

3. A list of at least five completed facilities from the Manufacturer totaling a minimum of 5,000,000 square feet of the type of geomembrane that is being installed for this project. Each entry in this list should specify the name and purpose of the facility, its location and date of installation, the name of the Owner, the project manager, designer, fabricator (if any), and Geomembrane Installation Contractor and the name and telephone number of the contact at the facility who can discuss the project. In addition, the geomembrane thickness and total square footage of the installation surface should be included.

4. A list of at least five completed facilities, totaling 5,000,000 square feet for which the Geomembrane Installation Contractor has installed the type of geomembrane that is being installed for this project. For each installation, the following information shall be provided:

a. Name and purpose of facility, its location, and date of installation

b. Name of Owner, design engineer, manufacturer, fabricator, if applicable, and name and telephone number of the contact at the facility who can discuss the project

c. Geomembrane type and surface area of the installed geomembrane

d. Type of seaming, patching, and tacking equipment

e. A copy of the Manufacturer’s and/or fabricator's approval letter(s) and/or license(s), if applicable

f. applicable

B. The Geomembrane Installation Contractor shall provide the following information 14 days prior to geomembrane arrival on-site and prior to commencement of the Work:

1. A copy of each of the Quality Control Certificates on each lot of resin issued by the resin Supplier for the specific material at this project including certification of the resin for extrusion welding.
2. The results of Quality Control testing conducted by the Manufacturer on the resin used in manufacturing the specific material for this project.
3. A listing that correlates the resin to the individual geomembrane rolls and welding rods.
4. A copy of the geomembrane roll Quality Control Certificates. These certificates shall be supplied at a minimum frequency of one per every 50,000 square feet of geomembrane material produced. These certificates shall be issued only for the individual geomembrane rolls sampled and tested by the Manufacturer or its representative. The certificates shall contain test results of properties outlined in Article 2.1 of this Section. The Engineer reserves the right to refuse use of any geomembrane supplied without the proper quality control documentation at no cost to the Owner.
5. A detailed list of performance criteria for the geomembrane material being produced for this project. (Note: Performance criteria are sometimes referred to as "minimum property values". Refer to Articles 2.1 of this Section for geomembrane properties and Test Methods).
6. Resumes from the Geomembrane Installation Contractor of the Installation Superintendent, Master Seamer, and Quality Control Inspector to be assigned to the work, including dates and duration of employment.
7. Certification from the Geomembrane Installation Contractor that Installation Supervisor, Quality Control Inspector, and Master Seamer have reviewed the Specifications, Construction Quality Assurance Plan, and the Drawings.
8. A panel layout drawing showing the proposed installation layout identifying field seams and including areas such as sumps, trenches and pipe penetrations as well as any variance or additional details that deviate from the Drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc. Any proposed variance or deviation from these documents shall be submitted to the Engineer in writing a minimum of seven working days prior to the scheduled start of geomembrane installation and shall be accepted/rejected by the Engineer prior to start of installation.
9. A list of personnel performing field seaming operations along with pertinent experience information.
10. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

C. The Geomembrane Installation Contractor shall provide the following information daily to the Engineer during the course of the work:

1. Summaries of geomembrane panel deployment, field test seams, fusion and extrusion seams, extrusion seam repairs, nondestructive seam tests, seam pressure tests, defects and repairs, and seam destructive samples and test results recorded during installation.
2. Daily reports detailing arrival and departure times, the personnel present on-site, the progress of the Work, the arrival of materials, and any problems encountered.
3. Geomembrane record drawings identifying the panels, seams, and test locations. The Quality Control Inspector’s geomembrane record drawing shall be made available for review by the Engineer at any time during the day.
4. Subgrade surface acceptance certificates for each area to be covered by the lining system, signed by the Geomembrane Installation Contractor.
5. It is the Quality Control Inspector’s responsibility to ensure that the documentation is checked for errors and conflicts prior to submitting the documentation to the Engineer. The daily field documentation and record drawings shall be completed in a neat and professional manner.

1.5 Submittals After Construction

A. At the completion of the Work, the Geomembrane Installation Contractor shall submit the Quality Control Documentation outlined in Section 01300 and shall include at a minimum:

1. Typed summary tables of the field documentation including summaries of on-site field personnel, geomembrane panel deployment, field test seams, fusion and extrusion seams, extrusion seam repairs, nondestructive seam tests, seam pressure tests, defects and repairs, and seam destructive samples and test results recorded during installation.
2. A geomembrane record drawing showing panels and destructive test locations. The record drawing shall be drawn on a 22-inch by 34-inch sheet and in AutoCAD .dwg electronic format.
3. The summary tables and record drawings shall be suitable for report presentation and agency review. One (1) digital reproducible copy of the summary tables and record drawings shall be provided to the Engineer.

1.6 Quality Control

A. The geomembrane Manufacturer shall have the following qualifications:

1. Experience in the manufacture of the type of geomembrane that is being installed for this project totaling at least five completed facilities totaling a minimum of 5,000,000 square feet.
2. Sufficient production and qualified personnel to meet the demands of the work and shall have an internal quality control program for its product.
3. Shall permit the Quality Assurance Team, Engineer, or their authorized representatives to visit the manufacturing plant.

B. The Geomembrane Installation Contractor shall have the following qualifications:

1. The Manufacturer or an approved Geomembrane Installation Contractor trained and certified to install the Manufacturer's geomembrane.
2. Installation shall be performed under the constant direction of a single Installation Superintendent who shall remain on-site and be responsible, throughout the geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs, and all other installation activities related to geomembrane installation.
3. The Installation Superintendent shall have installed or supervised, at a minimum three installation projects that entailed the installation of at least a total of 1,000,000 square feet of the type of geomembrane that is being installed for this project.
4. Actual seaming shall be performed under the direction of a Master Seamer who has seamed a minimum of 1,000,000 square feet of the type of geomembrane that is being installed for this project, using the same type of seaming equipment specified for the Work.
5. The Installation Superintendent and/or Master Seamer shall be present whenever seaming is performed.

C. All Work shall be constructed, monitored, and tested in compliance with the requirements of these Specifications. The Geomembrane Installation Contractor and Manufacturer shall participate in and comply with all items in these Specifications.

D. The Geomembrane Installation Contractor shall ensure that geomembrane material supplied to this project has an internal product quality control program that meets Specifications.

E. During manufacturing of the geomembrane, samples of geomembrane shall be removed for laboratory conformance testing to ensure compliance with these Specifications. Conformance sampling and testing shall be performed by the Quality Assurance Team in accordance with Article 3.11 of this Section.

F. The Contractor shall assure that the geomembrane is delivered to the site at least 14 calendar days prior to installation. The Contractor shall provide required Quality Control information to the Quality Assurance Team and the Engineer 14 calendar days prior to geosynthetics being delivered to this project and on delivery of geosynthetics to the project site.

G. Geomembrane rolls that do not meet the requirements of this Specification shall be rejected. The Contractor shall replace the rejected material with new material that conforms to the Specification requirements, at no additional cost to the Owner.

H. The Geomembrane Installation Contractor shall ensure that all personnel performing geomembrane seaming operations are qualified by experience or by successfully passing seaming tests in accordance with Article 3.7 of this Section. The Engineer reserves the right to reject any welding technician whose performance is unsatisfactory.

I. The Geomembrane Installation Contractor's Installation Superintendent and QC Inspector shall attend the pre-construction meeting.

J. The Geomembrane Installation Contractor shall perform Quality Control during geomembrane installation in accordance with the Quality Control Manual.

K. Field Samples

1. Geomembrane sampling and testing shall be conducted in accordance with the project Specifications for the following:
    a. Trial seam testing (Article 3.7 of this Section)
    b. Non-destructive seam testing (Article 3.8 of the Section)
    c. Destructive seam testing (Article 3.9 of this Section)
2. The Geomembrane Installation Contractor shall maintain on-site a minimum of one spare operable tensiometer and provide documentation indicating that all tensiometers used at the project were calibrated within 60 days prior to the tensiometer arriving on-site for testing field samples.

L. In order to prevent wind damaged geomembrane from being placed, the following Quality Control procedures shall be followed:

1. The Geomembrane Installation Contractor shall utilize sufficient ballast as necessary to prevent wind uplift of the geomembrane panels.
2. If wind damage should occur, the Engineer shall determine if the geomembrane shall be repaired or replaced. Wind damage to the geomembrane shall include wrinkles, creases, and tears, as determined by Engineer.
3. Repair or replacement of the wind-damaged geomembrane shall be completed by the Geomembrane Installation Contractor at no additional cost to the Owner.
4. As determined by the Engineer, the geomembrane panel may be rejected at no cost to the Owner.

M. In order to prevent thermal stress damage to installed geomembrane, the following Quality Control procedures shall be followed:

1. The Geomembrane Installation Contractor shall perform its Work and utilize sufficient slack as necessary for temperature compensation to prevent bridging or trampolining of the installed geomembrane.
2. If bridging or trampolining should occur, the Engineer shall determine if the geomembrane shall be repaired or replaced.
3. Repair or replacement of the bridging or trampolining geomembrane shall be completed by the Geomembrane Installation Contractor at no additional cost to the Owner.

1.7 Delivery, Storage, and Handling

A. Packing and Shipping

1. Labels on each roll delivered to site shall identify the following:
    a. Manufacturer’s Name
    b. Product Identification

c. Thickness

d. Roll number

e. Batch or resin lot number

f. Panel number (when applicable)

g. Roll dimensions

h. Roll weight

2. The Geomembrane Installation Contractor shall ensure that geomembrane rolls are properly loaded and secured to prevent damage during transit in accordance with the Manufacturer's recommendations.

3. The Geomembrane Installation Contractor shall protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions in accordance with Manufacturer's recommendations.

4. The Geomembrane Installation Contractor shall ensure personnel responsible for loading, transport, and unloading of geomembrane are fully aware of the consequences of damage to geomembrane and are familiar with handling and transport constraints in accordance with the Manufacturer's recommendations.

5. Geomembrane shall be supplied in rolls with straps for unloading.

B. Acceptance at Site

1. The Quality Assurance Team or Engineer shall perform inventory and surface inspection for defects and damage of all geomembrane rolls upon delivery.

2. The Geomembrane Installation Contractor shall unroll and inspect any geomembrane roll that may be damaged below the outer surface of the roll.

3. The Geomembrane Installation Contractor shall repair damage resulting from handling and transport of geomembrane at no additional cost to the Owner. If irreparable, in the opinion of the Quality Assurance Team or the Engineer, damaged materials shall be replaced at no additional cost to the Owner.

C. Storage and Protection

1. The Owner shall provide area for on-site storage of the geomembrane rolls from time of delivery until installation.

2. The storage and handling of the materials is the responsibility of the Geomembrane Installation Contractor from the time the materials are manufactured until the time the completed installation is accepted by the Engineer. The Geomembrane Installation Contractor is responsible for preparing the storage location and for the protection of the materials from the elements (e.g. ultraviolet light, moisture, temperature, etc.).

3. The rolls shall be stored on a prepared continuous surface free of large protrusions (e.g. not wooden pallets) and should not be stacked more than two rolls high. Proper blocking shall be used to prevent rolls from moving (e.g. tire chocks).

4. After the Geomembrane Installation Contractor has removed material from storage, the Geomembrane Installation Contractor shall protect geomembrane from puncture, dirt, grease, water, moisture, mud, mechanical abrasion, excessive heat and other sources of damage.

5. The Geomembrane Installation Contractor shall preserve integrity and readability of the geomembrane roll labels and store the rolls such that the Engineer has access to the package slips or roll labels for each roll to verify roll acceptance.

1.8 Site Conditions

A. Geomembrane Deployment

1. Do not proceed with deployment at an ambient temperature below 14ºF or above 100ºF unless otherwise authorized, in writing, by the Engineer.
2. Do not deploy during precipitation, in the presence of excessive moisture (e.g. fog, dew, frost, rain, snow, sleet, hail), in an area of ponded water, or in the presence of excessive winds.
3. Do not undertake deployment if weather conditions shall preclude material seaming on same day as deployment.

B. Seaming

1. Normal Weather Conditions. Normal seaming procedures may take place if the following weather conditions exist:

a. Ambient temperature between 35ºF and 100ºF

b. Dry conditions, i.e., no precipitation or other excessive moisture, such as fog, dew, rain, snow, sleet, or hail

c. No excessive winds

2. Adverse Weather Conditions

a. Do not seam if ambient temperature is below 14ºF or above 102ºF

b. Do not seam during precipitation, in the presence of excessive moisture (e.g. fog, dew, frost, rain, snow, sleet, hail), in an area of ponded water, in the presence of excessive winds

c. If the ambient air temperature is between 14ºF and 35ºF for the entire shift, the following Cold Weather Seaming provisions shall govern:

i. In accordance with these Specifications, trial seaming shall be conducted under the same ambient temperature and condition as the production seams. A minimum of four trial seams for each welding apparatus shall be required during the shift, at approximately the same time interval throughout the scheduled work day; additional trial seams may be required, at the discretion of the Quality Assurance Team or Engineer.

ii. If the subgrade is frozen, geomembrane rub-sheets will be placed between the liner and the subgrade during fusion welding of the seams.

iii. It may be necessary for the Geomembrane Installation Contractor to pre-heat the liner using a hand-held leister type device during field seaming. If this procedure is used, a trial seam for each welding apparatus shall be performed using the same technique.

iv. Destructive testing for peel adhesion shall be conducted at the beginning and end of each extrusion welded seam in excess of 25 feet. The coupon sample shall exhibit a film tear bond (FTB) type of failure and may be pulled by hand by the welding technician using vice grip pliers. The testing shall be witnessed by the Quality Assurance Team.

v. Destructive testing frequencies may be increased at the discretion of the Quality Assurance Team and/or the Engineer.

vi. Air testing/vacuum testing of the seams/patches shall be performed on the same day as the welding, to ensure any potential problems are identified as early as possible.

vii. All patches shall be completed by the end of shift.

2.0 PRODUCTS

2.1 Materials

A. The geomembrane shall be 60-mil smooth and 80-mil double sided textured high-density polyethylene (HDPE) as shown in the Drawings. The geomembranes shall be manufactured of new, first-quality resin produced in the United States and shall meet or exceed all manufacturing requirements and recommendations for HDPE geomembranes specified by the American Society for Testing and Material (ASTM) and the Geosynthetics Research Institute (GRI).

B. All geomembrane shall be manufactured by the same manufacturer using the same resin compound or mixture. Geomembrane from more than one manufacture for each phase of Work shall not be permitted unless approved by the Engineer. If geomembrane between phases is of different manufacturing origin, prior to installation, documentation shall be provided to the Engineer showing that welds between both manufacturers' geomembrane meet the minimum requirements of these Specifications for seaming.

C. The geomembrane sheet shall be comprised of a minimum 96 percent pure polyethylene. The remaining portion shall be made up of materials necessary for the performance of the liner (such as carbon black, anti-oxidants, etc.) The geomembrane rolls shall meet the following Specifications:

1. The surface of the geomembrane shall not have striations, roughness (except texture as specified), pinholes, or bubbles and shall be free of holes, blisters, undispersed raw materials, or any contamination by foreign matter. The Engineer may request additional testing in order to support such acceptance. All such testing shall be done at the sole expense of the Geomembrane Installation Contractor.

2. The geomembrane supplied for the project shall meet or exceed the minimum values and testing requirements:

Table 02775-1: Required Minimum Geomembrane Properties for Textured HDPE Geomembrane (per GRI-GM13)

Property	Test Value		Test Method	MQC Testing Frequency
	60 mil	**80 mil**		
Thickness mils (min avg.)	57 mil	76 mil	ASTM D 5994	Per Roll
Thickness (Minimum 8 of 10)	-10% (54 mil)	-10% (72mil)		
Lowest individual for any of the 10 values	-15% (51 mil)	-15% (68 mil)		
Asperity Height	16 mil	18 mil	ASTM D 7466	Every 2nd Roll(1)
Density (g/cc) min.	0.940	0.940	ASTM D 1505/ D 792	200,000 lb
Tensile Properties (min. avg.)(2)				
Yield Strength (lb/in)	126	168	D 6993 Type IV	20,000 lb
Break strength (lb/in)	90	120		
Yield Elongation (%)	12%	12%		
Break Elongation (%)	100%	710%		
Tear Resistance (lbs) (min. ave)	42	56	D 1004	45,000 lb
Puncture Resistance (lbs) (min. ave)	90	120	D 4833	45,000 lb
Stress Crack Resistance (3)	500 hr	500 hr	D 5397	Per GRI GM-10
Carbon Black Content (%)	2.0-3.0	2.0-3.0	D 4218	20,000 lb
Carbon Black Dispersion (5)	*Note 5*	*Note 5*	D 5596	45,000 lb
Oxidative Induction Time (OIT)				
a. Std OIT, or	100 min	100 min	D 3895	200,000 lb
b. High Pressure (HP) OIT	400 min	400 min	D 5885	
Oven Aging at 85°C (min. avg.)(6),(7)			D 5721	Per Each Formulation
a. Std OIT (% ret. after 90 days) min. avg. or;	55%	55%	D 3895	
b. HP OIT (% ret. after 90 days) min. avg.	80%	80%	D 5885	
UV Resistance (min avg.)(8)			D 7238	Per Each Formulation
a. Std. OIT (min. avg.), or	N.R.	N.R.	D 3895	
b. HP OIT (min. avg.) (% ret. after 1600 hrs) (9)	50%	50%	D 5885	

*MQC = Manufacturing Quality Control

Notes:

1. Alternate measurement side for double sided textured sheet.
2. Machine direction and cross machine direction average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gage length of 33 mm. Break elongation is calculated using a gage length of 50 mm.
3. The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the Manufacturers mean value via MQC testing.
4. Other methods such as D 1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
5. Carbon Black Dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
6. The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.
7. Evaluate samples at thirty (30) and sixty (60) days and compare with the ninety (90) day response.
8. The condition of the test shall be a twenty (20) hour UV cycle at 75 degrees C followed by a four (4) hour condensation cycle at 60 degrees C.
9. UV Resistance is based on percent retained values regardless of the original HP-OIT value.

D. Seam Properties: The finished seams shall meet or exceed the values specified in the following table.

Table 02775-2: HDPE Geomembrane Seam Properties Wedge and Extrusion Welds (per GRI-GM19a)

Property	Test Value for 60 mil HDPE	Test Value for 80 mil HDPE	Test Method	MQC Testing Frequency
Seam Shear Strength lb/in	120	160	ASTM D6392	500 LF
Shear elongation at break %	50	50		500 LF
Seam Peel Strength (lb/in)	91 for hot wedge 78 for extrusion	121 for hot wedge 104 for extrusion		500 LF
Peel separation %	25	25		500 LF

Notes:

1. Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area. Failures in Non-FTB mode are allowed if the failure is classified as “AD-BRK” and the strength at failure exceeds the listed value.
2. Where applicable, both tracks of a double hot wedge seam shall be tested for peel adhesion.
3. Value listed for shear and peel strengths are for 4 out of 5 test specimens, the 5th specimen can be as low as 80 percent of the listed value.

E. Stainless steel clamps shall be used to fasten pipe to the polyethylene pipe boot (if any) as shown on the Drawings. The stainless steel clamps shall be approved by the Engineer prior to their installation.

2.2 Seaming and Test Equipment

A. Seaming:

1. Approved field seaming processes are hot shoe double fusion welding and extrusion welding, when approved by the Engineer. Use double fusion welding as primary method of seaming adjacent field panels.
2. The Geomembrane Installation Contractor shall maintain on-site a minimum of two spare operable seaming apparatuses.
3. Seaming equipment shall not damage the geomembrane.
4. The Geomembrane Installation Contractor may use a hot air device ("Leister") to temporarily bond geomembrane panels that are to be extrusion welded.
5. The Geomembrane Installation Contractor shall use extrusion welding apparatus equipped with gauges giving temperature of preheat and extrudate at nozzle of apparatus.

6. Welding rods or beads used for extrusion welding shall have the same physical properties as that used for the resin used in the manufacture of the type of geomembrane that is being installed for this project.
7. The Geomembrane Installation Contractor shall use fusion welding apparatus which are self-propelled devices equipped with a gauge indicating temperature of heating element, and a gauge indicating the speed of the welding apparatus.

B. Vacuum Testing (for extrusion seam only)

1. The equipment shall consist of the following:

a. Vacuum box assembly consisting of a rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing or port hole and valve assembly, and vacuum gauge.

b. Pump assembly equipped with pressure controller and pipe connections.

c. Rubber pressure/vacuum hose with fittings and connections.

d. Bucket of soapy solution.

e. Wide paint brush, or other means of applying soapy solution.

C. Air Pressure Testing (for double fusion seam only)

a. The equipment shall consist of the following:

b. Air pump (manual or motor driven), equipped with a pressure gauge, capable of generating, sustaining, and measuring pressure between 25 and 30 pounds per square inch (psi) and mounted on a cushion to protect geomembrane.

c. Rubber hose with fittings and connections.

d. Sharp hollow needle, or other approved pressure feed device.

e. An air pressure monitoring device.

3.0 EXECUTION

3.1 Subgrade

A. The Geomembrane Installation Contractor, on a daily basis, shall certify in writing that the surface on which the geomembrane shall be installed is acceptable. It shall be the Geomembrane Installation Contractor's responsibility to maintain and protect the subgrade in the condition that was originally accepted, prior to geosynthetic deployment until accepted by the Owner and Engineer.

3.2 Acceptance

A. The Geomembrane Installation Contractor shall retain all Ownership and responsibility for the geomembrane until final acceptance.

B. The geomembrane shall be accepted by the Owner and Engineer when all of the following conditions are met:

1. Installation is finished.
2. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
3. Certification, including QC documentation is provided by the Geomembrane Installation Contractor to the Engineer.
4. Recommended acceptance by the Engineer.

3.3 Anchor Trench

A. The anchor trenches shall be excavated to the lines, grade, and width shown on the Drawings, prior to geosynthetic placement. The Engineer shall verify that the anchor trench has been constructed according to the Drawings.

B. Slightly rounded corners shall be provided in the trench where the geomembrane adjoins the trench so as to avoid sharp bends in the geomembrane.

C. The anchor trench shall be backfilled and compacted in accordance with Section 02223 and as approved by the Engineer. Anchor Trench Backfill material shall be placed in 12-inch thick loose lifts and compacted by wheel rolling with light, rubber-tired or other light compaction equipment, as approved by the Engineer.

D. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. At no time shall construction equipment come into direct contact with the geomembrane. If damage occurs, it shall be repaired by the Geomembrane Installation Contractor prior to the completion of backfilling, at no additional cost to the Owner.

E. Extend geomembrane into the anchor trench as shown in the Drawings. The geomembrane shall be seamed along its entire length within the anchor trench.

3.4 Protection

A. The Geomembrane Installation Contractor shall be responsible for the following:

1. Do not use equipment or tools which may damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.
2. Ensure prepared surface underlying geomembrane has not deteriorated since previous acceptance, and remains acceptable until acceptance by the Owner, as detailed in Article 3.2 of this Section.
3. Keep any geotextile elements immediately underlying the geomembrane clean and free of debris.
4. Personnel shall not be permitted to smoke or wear damaging shoes while working on geomembrane.
5. Unroll panels in a manner which prevents scratches or crimps in geomembrane and does not damage supporting soil.
6. Place panels in a manner that prevents wrinkles (especially differential wrinkles between adjacent panels).
7. Prevent wind uplift and damage to geomembrane subgrade by providing temporary and permanent loading and/or anchoring that shall not damage geomembrane.
8. Prevent bridging of installed geomembrane by providing adequate slack.
9. Minimize direct contact of equipment and personnel with geomembrane.
10. Protect geomembrane in areas where excessive traffic is expected with geotextile, extra geomembrane, or other materials acceptable to the Engineer.

3.5 Field Panel Development

A. The Geomembrane Installation Contractor shall install field panels at locations indicated on the Geomembrane Installation Contractor's layout plan, as approved by the Engineer.

B. The Geomembrane Installation Contractor shall replace damaged (i.e., torn, twisted, or crimped) field panels, or portions thereof, at no cost to the Owner. The Geomembrane Installation Contractor shall repair less serious damage according to Article 3.10 of this Section, at no cost to the Owner. The Engineer shall determine if material is to be repaired or replaced.

C. The Geomembrane Installation Contractor shall remove damaged panels, portions of damaged panels, and other geomembrane scrap.

D. Geomembrane Installation Contractor shall not deploy more geomembrane field panels in one day than can be seamed during the day of deployment.

E. Geomembrane deployment shall proceed between ambient temperatures of 14º F to 102º F. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew) or in the presence of excessive winds, as determined by the Engineer.

F. Following the installation of the geomembrane, an examination of the entire surface shall be conducted to detect potentially harmful objects. Any such objects shall be removed and the geomembrane repaired by the Geomembrane Installation Contractor, at no cost to the Owner.

3.6 Factory Seams

A. The Engineer may require the Geomembrane Installation Contractor to test up to as much as 20 percent of factory fusion welds (non-destructive air pressure test) in the field to verify factory test results. Additional testing at Geomembrane Installation Contractor's expense shall be required if failed tests are obtained in the field.

3.7 Field Seams

A. Seam Layout

1. Seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

2. No horizontal or base T-seam or tie-in seams shall be closer than 5 feet from the toe or crest of the slope. Seams shall be aligned to prevent wrinkles and "fish mouths". If a fish mouth or wrinkle is found, it shall be relieved and capped.

3. The previous phase geomembrane shall be cut adjacent to the existing anchor trench and double fusion welded to the new geomembrane in accordance with the Design Drawings.

4. Panels of geomembrane shall have sufficient overlap provided to allow peel tests to be performed on the seam.

B. Seaming Method

1. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

2. The Geomembrane Installation Contractor shall use double fusion welding as primary method of seaming adjacent field panels.

a. For cross seam tees associated with fusion welding, the Geomembrane Installation Contractor shall patch panel intersections consisting of three or more panels and extrusion weld to a minimum distance of 4 inches on each side of patch. The edge of the sheet shall be ground to a 45º angle prior to welding.

b. Place a protective layer, e.g., insulting plate or fabric, beneath hot welding apparatus after usage.

c. When subgrade conditions dictate, use a moveable protective layer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent debris from collecting around pressure rollers.

d. Remove seaming sheets and excess geomembrane trimmed to provide required overlap.

3. Use conventional extrusion welding as a secondary method for seaming between adjacent panels and as a primary method of welding for detail and repair work.

a. Purge heat-degraded extrudate from barrel of extruder under the following conditions:

i. Prior to beginning a seam.

ii. Whenever extruder has been inactive.

b. Place a smooth insulating plate or fabric beneath hot welding apparatus after usage

i. Use clean and dry welding rods or extrudate pellets.

ii. Complete grinding process without damaging geomembrane according to Manufacturer's instructions no more than one hour prior to seaming operations.

iii. Prevent exposed grinding marks adjacent to an extrusion weld. Do not extend exposed grinding marks more than 1/4 inch from seam area. The Engineer may request that any and all abraded areas be covered with extrudate.

iv. Extrusion weld all cross seam tees to a minimum distance of 4 inches on each side of the tee.

v. For extrusion welds, the edge of the top sheet shall be beveled by grinding the edge of the sheet to approximately a 45 degree angle. Extrusion welds cannot be placed on previous extrusion welds.

C. Seaming Procedures

1. General Seaming Procedures

a. Areas to be seamed shall be cleaned and free of moisture, debris, or any marking on the geomembrane.

b. Use a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support if required.

c. Cut fish mouths or wrinkles at the seam overlap along the ridge of the wrinkle in order to achieve a flat overlap. The cut fish mouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

d. Extend seaming to the outside edge of panels placed in the anchor trench.

e. Do not field seam without the Seaming Supervisor present.

D. Field Trial Seams

1. Trial seams shall be conducted at the beginning of each seaming period and within 30 minutes of commencement of seaming, at the Engineer's discretion, and immediately following any work stoppage (i.e., lunch, weather conditions, etc.) of 30 minutes or more for each seaming apparatus used that day. Each Seamer shall make at least one trial seam each day.

2. Testing shall include visual observation of a trial seam on the geomembrane material. The Geomembrane Installation Contractor shall mark the trial seam with date, ambient air temperature, welding machine number, welding technician identification, and machine temperature and speed. For extrusion welding, the Geomembrane Installation Contractor shall include the nozzle and extrusion settings and welding technician identification. The remainder of trial seam should be cut in two pieces; one to be retained in the Owner's archive; and one to be retained by the Geomembrane Installation Contractor.

3. All trial seams shall be made at a location selected by the Engineer in the area of the seaming and in contact with the subgrade. The trial seam samples shall be a minimum of 5 feet long for fusion seaming and a minimum of 5 feet long for extrusion seaming, with the seam centered lengthwise. Specimens one inch wide shall be cut from opposite ends of the test seam by the Geomembrane Installation Contractor. The Geomembrane Installation Contractor shall use a tensiometer to test these specimens for shear and peel. Both inside and outside tracks of fusion welds shall be tested for peel. For both fusion and extrusion welds, two coupons shall be tested for peel and one coupon for shear. The tensiometer shall have a grip separation of 4 inches plus the width of the seam. The seam is to be centered between the clamps. These tests shall not fail according to the criteria in Article 2.1 of this Section. A break through the weld or at the weld/sheet interface shall be considered a failure in both shear and peel strength tests unless the weld strength exceeds the minimum strength, as discussed in Article 3.9 of this Section. If a trial seam fails to meet field seam

Specifications, the seaming apparatus and/or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

4. The Geomembrane Installation Contractor shall mark the test weld with date, ambient temperature, welding machine number, welding technician identification, machine temperature and speed. For extrusion welding, the Geomembrane Installation Contractor shall record the nozzle and extrusion settings.
5. The Geomembrane Installation Contractor shall cut remainder of successful trial seams into two pieces, one to be retained in the Owner's archives and one to be retained by Geomembrane Installation Contractor

3.8 Non-Destructive Testing

A. The Geomembrane Installation Contractor shall non-destructively test all field seams over their full length. All test equipment shall be furnished by the Geomembrane Installation Contractor.

B. The following vacuum box procedures are applicable to extrusion seaming and shall be followed by the Geomembrane Installation Contractor:

1. Clean the vacuum box window, gasket surfaces and check for leaks.
2. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.
3. Wet a strip of geomembrane the approximate dimensions of the vacuum box with the soapy solution.
4. Place the box over the wetted area and compress.
5. Close the bleed valve and open the vacuum valve.
6. Ensure that a leak-tight seal is created.
7. For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
8. If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap and repeat the process.
9. All areas where soap bubbles appear shall be marked and repaired and then retested.
10. Test locations, documentation number, date and tester shall be indicated with an indelible marker on the geomembrane for each repair or seam section. The color code for indelible markers is to be determined at the pre-construction meetings, and strictly adhered to.

C. The following nondestructive test procedures are applicable to fusion seaming and shall be followed by the Geomembrane Installation Contractor:

1. Seal one end of the seam to be tested.
2. Insert needle or other approved pressure feed device through the sealed end of the channel created by the double wedge fusion weld.
3. Energize the air pump to verify the unobstructed passage of air through the channel.
4. Seal the other end of the channel.
5. Energize the air pump to the pressure of approximately 30 psi, close valve, and sustain pressure for approximately 5 minutes.
6. If loss of pressure exceeds 3 psi, or pressure does not stabilize, locate faulty area, repair and retest.
7. Remove needle or other approved pressure feed device.
8. Repair pressure test locations as described in Article 3.10 of this Section.

9. Beginning and ending pressures and times, test locations, documentation number, date and tester shall be indicated with an indelible marker on the liner at each test interval location.

D. The following procedures shall apply to locations where seams cannot be non-destructively tested, as determined by the Engineer:

1. If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.

2. If the seam cannot be tested prior to final installation, the seaming operations shall be observed by the Engineer for uniformity and completeness.

E. In the event that seam continuity cannot be demonstrated for a non-destructive test of a fusion seam as outlined above, the Geomembrane Installation Contractor shall perform the non-destructive testing over smaller areas as a means of defining the questionable area, and shall:

1. Extrusion weld the outside edge of the questionable seam area and vacuum box test the extrusion weld, or

2. Cap the questionable area and vacuum test the cap.

3.9 Destructive Testing

A. The Geomembrane Installation Contractor shall test a minimum of one destructive test sample per 500 feet of seam length per welding machine from a location specified by the Engineer. The Geomembrane Installation Contractor shall not be informed in advance of the sample location. The samples shall be taken centered over the seam and prioritized as follows:

1. All areas identified as suspect during seaming, non-destructive testing/monitoring, and in unusual working conditions.

2. A minimum of one sample for each geomembrane seamer.

3. A minimum of one sample every 500 feet of seaming.

B. Samples shall be cut by the Geomembrane Installation Contractor as the seaming progresses. Sampling locations shall be determined by the Engineer. The Engineer must witness the obtainment of all destructive test samples by the Geomembrane Installation Contractor. All samples shall be marked with their seam number, date, welding machine number, welding technician identification, extruder and nozzle/wedge temperature, and ambient air temperature. The Geomembrane Installation Contractor shall document the date, time, roll and seam number, ambient temperature, and pass or fail description. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired. All patches shall be vacuum tested.

C. The samples shall be a minimum 12 inches wide by 24 inches long with the seam centered lengthwise. The sample shall be cut into two equal length pieces, half to be given to the Owner for archiving and the other kept by the Geomembrane Installation Contractor for testing.

D. Geomembrane Installation Contractor shall cut and test ten (10) one-inch (1”) wide specimens from his sample. All testing shall be conducted at room temperature (60ºF to 80ºF). The Geomembrane Installation Contractor shall test five (5) specimens for seam shear strength and five (5) for peel strength. Both inside and outside tracks of fusion seams shall be tested for peel strength. To be acceptable, four (4) out of the five (5) specimens must pass according to criteria established in Article 2.1 of this Section. Any specimen that fails through the weld or at the weld/sheet interface shall be considered a failure, unless the weld strength exceeds the minimum strength specified in Table 02775-2, as discussed Article 2.1. The tensiometer shall have a grip separation of 4 inches plus the width of the seam. The seam is to be centered between the clamps.

E. The Engineer must witness the testing of all destructive samples. Destructive tests shall be performed within two (2) days of the samples being obtained.

F. Failing tests shall be subjected to additional testing until a passing area is found. A passing area is defined as a seam(s) bounded at each end by a passing destructive test. Seams shall be tracked in each direction until a passing destructive test is found or until a previous passing destructive test is

reached. Seams shall be tracked according to the welding apparatus and the machine operator. The following procedures shall apply whenever a sample fails the field destructive test:

1. The Geomembrane Installation Contractor can retrace the welding path to an intermediate location (at a minimum of 10 feet from the location of the failed test), at the Engineer's discretion, and take a small sample for an additional field test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, the process shall be repeated.
2. Over the length of seam failure, the Geomembrane Installation Contractor shall either cut out the old seam, reposition the panel and reseam, or add a cap strip, as required by the Engineer.
3. After reseaming or placement of the cap strip, additional destructive field test(s) shall be taken within the reseamed area. The reseamed sample shall be found acceptable if test results are approved by the Engineer. If test results are not acceptable, this process shall be repeated until the reseamed length is judged satisfactory by Engineer.
4. Samples taken as the result of failed tests do not count toward the total number of destructive tests required.

G. The Geomembrane Installation Contractor shall document all actions taken in conjunction with destructive test failures, with the Engineer providing Quality Assurance documentation.

H. Cap strips shall be non-destructively tested as described in Article 3.8 of this Section.

3.10 Defects and Repairs

A. All seams and non-seam areas of the geomembrane shall be observed by the Engineer for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of observation. The geomembrane surface shall be brushed, blown, or washed by the Geomembrane Installation Contractor if the amount of dust or mud inhibits inspection. The Engineer shall determine if cleaning of the geomembrane is needed to facilitate observation.

B. Each suspect location in seam and non-seam areas shall be non-destructively tested as determined appropriate by the Engineer, in the presence of the Engineer. Each location that fails the non-destructive testing shall be marked by the Geomembrane Installation Contractor, and repaired accordingly.

C. Repair Procedures

1. Defective seams shall be reconstructed as described in these Specifications.
2. Small holes shall be repaired by abrading the sheet surface and welding an extrusion bead. If the hole is larger than ¼-inch in diameter it shall be patched.
3. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded prior to patching.
4. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.
5. Surface of geomembrane that are to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. No more than 10 percent of the thickness shall be removed.

D. Patches shall be round or oval in shape, and extend a minimum of 6 inches beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled to an approximately 45º angle with an angle grinder prior to placement of the patch. Patches shall be applied using approved methods only.

E. The extrusion welding process shall restart by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least 2 inches. Reseaming over an existing seam without regrinding shall not be permitted.

F. Each repair shall be non-destructively tested, except when the Engineer requires a destructive seam sample obtained from a repaired seam. Repairs that pass the destructive test shall be taken as an

indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved.

G. Recording the Results: Daily documentation of all non-destructive and destructive testing shall be provided to the Engineer. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

3.11 Conformance Testing

A. During manufacturing of the geomembrane, the Engineer shall be present to observe manufacturing of geomembrane and shall ensure that samples are obtained and forwarded to the Geomembrane Quality Assurance Testing Laboratory for testing to ensure conformance with the Specifications.

B. Samples shall be taken across the entire width of the roll and shall not include the first 3 feet. Unless otherwise stated, samples shall be 3 feet long by the width of the roll. The Engineer shall mark the machine direction on the samples with an arrow. Unless otherwise stated, samples shall be taken at a frequency of no less than one per 2,000,000 square feet or one per lot, whichever is less. As a minimum, the following tests shall be performed to verify conformance to the design Specifications with minimum values specified in Article 2.1 of this Section:

Table 02775-3: Minimum Conformance Testing

PROPERTY	TEST METHOD	FREQUENCY
Thickness (mils)	ASTM D 5199	2,000,000 sq. ft or Minimum 1 test per resin lot, whichever is greater (each test)
Compound Density (g/cc)	ASTM D 1505	
Tensile Strength (Both yield and ultimate strength and elongation, as specified)	ASTM D 6693	
Carbon Black Content (%)	ASTM D 1603	

C. Manufacturer shall provide current certification for Oxidation Induction Time (OIT) for each formulation and shall meet the minimum test values presented in Article 2.1 of this Section.

3.12 Placement of Soil or Granular Materials

A. All soil materials located on top of a geomembrane shall be placed in such a manner as to ensure:

1. The geomembrane and any underlying geotextile is not damaged.
2. Minimal slippage of the geomembrane on underlying layers occurs.
3. Minimal movement and wrinkling or folding of the underlying geosynthetics layer(s) occurs.

No excess tensile stresses shall occur in the geomembrane, such as by earth moving equipment making sudden starts, stops, turns. The allowable ground pressure for equipment shall be prescribed by the Engineer for the material type and layer thickness.

3.13 Warranty

A. Without limiting the provisions of the Contract, the Geomembrane Installation Contractor shall warrant the Work to the Owner in accordance with the following:

B. The geomembrane supplied is suitable for the environmental conditions at the site and the service conditions as described in this Specification.

C. The geomembrane supplied meets or exceeds all published Specifications as referenced by the Specification.

D. The geomembrane is free of defects in materials and workmanship.

E. The Geomembrane Installation Contractor shall repair or replace all defects in the material detected on-site, including uncovering and recovering the work, in compliance with the Specifications.

F. The Geomembrane Installation Contractor shall repair any detected leaks in any seams (Manufactured or field joined), including uncovering and recovering the work, in compliance with the Specifications.

G. All workmanship furnished by the Geomembrane Installation Contractor under this Specification shall be guaranteed by the Geomembrane Installation Contractor against failure due to improper installation for a period of not less than two (2) years. All permanent materials furnished by the Geomembrane Installation Contractor under this Specification shall be guaranteed by the Geomembrane Installation Contractor and the geomembrane manufacturer for a period of not less than twenty (20) years.

H. Upon written notice that the material fails to meet the original intent of the design, or of failure of guaranteed materials or workmanship during the guarantee period, the Geomembrane Installation Contractor shall promptly furnish and install new materials and/or furnish the workmanship necessary to correct the failure at the expense of the Geomembrane Installation Contractor. The Geomembrane Installation Contractor shall bear all costs for labor and materials associated with repair of guaranteed work.

*****END OF SECTION*****

SECTION 03110
CONCRETE FORMWORK

1.0 GENERAL

1.1 Section Includes

A. Related Sections

B. Products

C. Execution

1.2 Related Sections

A. Section 03300 – Cast-in-place Concrete

1.3 Products

1.3.1 Materials

A. Forms shall be 5-ply, ¾-inch, waterproof, exterior type plywood, free of loose knots, splinters, or other defects. The face adjacent to concrete shall be Grade B or better. Forms may be fiberboard, Fed. Spec. LLL-B-810, Type II, tempered, waterproof, screenback, concrete form hardboard.

B. Form ties shall be of the removable end, permanently embedded body type. Cones shall be provided on the outer ends of each tie and the permanently embedded portion shall be at least one inch back from the concrete face. Form ties for water bearing walls, shall be provided with water seal washers located on the permanently embedded portions of the tie at the approximate center of the wall. The cone ends of the form ties shall have a diameter of 1 inch and shall be constructed so that they are easily removed or broken off without damage to the concrete. Form ties may be Burke BA Penta-Tie with a water seal washer, or an equivalent approved by the Engineer.

C. Form release or coating shall be nontoxic after 30 days and non-staining, such as Nox-Crete "Form Coating" or Protex "Pro-Cote", or Richmond "Rich-Cote".

2.0 EXECUTION

2.1 Installation

A. The Contractor shall be responsible for the location and placement of all sleeves, pipe fittings, anchors, ties, and inserts, and shall make certain that offsets, recesses, openings, and block-outs are in place in the forms before concrete is placed.

B. Form release agents shall be applied at no more than the manufacturer's recommended application rates.

C. Where forms are placed above geomembrane liner, no anchoring of the forms will be allowed that damage the geomembrane liner. Use of sandbags, earth forms, or other form of anchoring/bracing maybe employed and approved by the Engineer prior to construction of formwork.

D. Horizontal joints shall be level and continuous. Vertical joints shall be plumb.

E. Forms shall be sufficiently tight and rigid to prevent leakage of concrete.

F. Forms shall be properly tied, braced, shored, and supported to insure stability against pressure from any source and without deflection or failure of any component or part.

G. Forms shall be removed without damage to the concrete, chamfers, inserts, anchors, geomembrane liners, and piping.

H. Forms shall not be removed until concrete has sufficiently hardened. Unless otherwise approved by the Engineer, forms shall not be removed within five (5) days of placement.

*****END OF SECTION*****

SECTION 03220
REINFORCING STEEL

1.0 GENERAL

1.1 Section Includes

A. Related Sections
B. References
C. Submittals
D. Quality Control
E. Delivery, Storage, and Handling
F. Products
G. Execution

1.2 Related Sections

A. Section 03110 – Concrete Formwork
B. Section 03300 – Cast-in-place Concrete

1.3 References

A. ACI 301 - Specifications for Structural Concrete
B. ACI 315 - Details and Detailing of Concrete Reinforcement
C. ACI 318 – Building Code Requirements for Structural Concrete
D. ASTM A 82/A82M- Steel Wire, Plain, for Concrete Reinforcement
E. ASTM A 184/A 184M - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
F. ASTM A 416/A 416M - Steel Strand, Uncoated Seven-Wire for Pre-stressed Concrete
G. ASTM A 496/A 496M - Steel Wire, Deformed, for Concrete Reinforcement
H. ASTM A 497/A 497M - Steel Welded Wire Reinforcement, Deformed, for Concrete
I. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
J. ASTM A 704/A 704M-06 (R2011) - Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
K. ASTM A 775/A 775M-07B - Epoxy-Coated Reinforcing Steel Bars
L. ASTM A 1064/A 1064M-14 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
M. AWS D1.4 - Structural Welding Code - Reinforcing Steel
N. IBC 2018 - International Building Code 2018

1.4 Submittals

A. Detail reinforcement in accordance with ACI 301, ACI 315 and ACI 318.
B. Provide complete bar lists together with location and setting drawings with sufficient plans, elevations, sections and details to clearly show the positioning and number of bars. Identify bar lists with drawings. Identify by mark number of each bar. Show relationship of reinforcement with construction joints, control joints, expansion joints and embedded parts.
C. Ensure that embedded parts not shown on the Drawings, but required for the Work, are shown on the reinforcing setting drawings when submitted to the Owner or His Representative for review.

D. Do not prepare work until the bar lists and drawings covering that work have been reviewed and approved by the Owner or his Representative. Submit bar list well in advance of required fabrication to avoid construction delay.

E. Improperly prepared bar lists and drawings are subject to rejection on that basis alone without further review. Redraw and resubmit.

1.5 Quality Control

A. Personnel Qualifications

1. Contractor shall employ personnel skilled and experienced in the fabrication and installation of reinforcement.

B. Tolerances

1. Fabricate and install concrete reinforcement in accordance with ACI 301 except as required by the Drawings.

1.6 Delivery, Storage, and Handling

A. In addition to the requirements of ACI 301:

1. Store and handle reinforcing steel so as not to alter the shape and dimensions.
2. Prevent contamination of the reinforcing steel.
3. Do not dump materials when unloading or handling.

2.0 PRODUCTS

2.1 Materials

A. Reinforcing steel and rock dowels

1. In accordance with ASTM A615 GRADE 60.

B. Welded wire fabric:

1. In accordance with ASTM A1064.

C. Headed Studs:

1. Headed studs shall be mild streel studs from Nelson Stud Welding conforming to the requirement of ASTM A108.

D. Support of reinforcement

1. Supports, spacers and chairs:
   a. Precast concrete blocks, for bottom bars in ground supported slabs and foundations only.
   b. Plastic of approved design and manufacture.
   c. Steel of approved design and manufacture with rust-proof finish where any part extends to the surface of the concrete.

2.2 Fabrication

A. Reinforcing steel

1. Fabricate reinforcing steel in accordance with ACI 301 to the dimensions shown on the bar lists and shop drawings.
2. Do not bend or straighten reinforcing bars in a manner, which might damage the bars or reduce the cross-section. Do not use bars with kinks or sharp bends.
3. Identify each bar, with the same code used for it in the bar lists and shop drawings.
4. Verify foundation elevations at the Site before cutting and bending reinforcing steel.

3.0 EXECUTION

3.1 Examination

A. Prior to commencing installation, thoroughly examine other work upon which the Work of this Section is dependent. Report any deficiencies discovered and propose adjustments to the Owner or His Representative and obtain written authorization before proceeding.

B. Check that forms are in satisfactory condition for the Work of this Section to proceed.

3.2 Installation

A. Install reinforcement in accordance with ACI 301, ACI 315, ACI 318 and the following:

B. Secure crossing bars at every intersection (unless otherwise noted on the Drawing) by using black tie-wire of not less than No. 16 gage.

C. Ensure concrete cover, placing and maintaining position of reinforcement is in accordance with ACI 301, ACI 315, ACI 318 and as shown on the Drawings.

D. Install tension and compression splices for reinforcing steel in accordance with ACI 318 and as shown on the Drawings.

E. At running joints, place starter bars or dowels equivalent in size and spacing to the continuing reinforcing of the member.

F. At wall corners, provide embedment and splice all horizontal bars according to code requirements.

G. Welding of Reinforcing Steel:

1. Obtain approval of the Owner or His Representative before welding or tack welding reinforcement. Rebar may only be welded along the longitudinal axis only with the approval of the Owner or His Representative.
2. Perform welding in accordance with AWS D1.4.
3. Weld structural reinforcement in accordance with the requirements of ACI 301.
4. Do not weld reinforcing steel closer than 2 inches from the beginning of a bend and within a bend.

H. Openings in Concrete

1. Provide additional reinforcing bars around opening as shown on the Drawings.
2. Where opening of 18 inches diameter or square and larger occur and interrupt more than two reinforcing bars, add reinforcing bars equivalent to the interrupted reinforcing bars at each side of the opening.

*****END OF SECTION*****

SECTION 03300
CAST-IN-PLACE CONCRETE

1.0 GENERAL

1.1 Section Includes

A. Submittals
B. Materials
C. Mixes
D. Curing Compounds
E. Installation
F. Quality Control

1.2 Relation Sections

A. Section 01010 – Summary of Work
B. Section 01300 – Submittals
C. Section 02710 – Gravity Piping
D. Section 11207 – Parshall Flumes

1.3 References

A. American Concrete Institute (ACI)

1. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete
2. ACI 305R - Hot Weather Concreting
3. ACI 306R - Cold Weather Concreting
4. ACI 318 - Building Code Requirements for Structural Concrete

B. American Society of Testing and Materials (ASTM)

1. ASTM C 33 – Standard Specification for Concrete Aggregates
2. ASTM C 39 – Standard Specification for Compressive Strength of Cylindrical Concrete Specimens
3. ASTM C 94 – Standard Specification for Ready-Mix Concrete
4. ASTM C 143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
5. ASTM C 150 – Standard Specification for Portland Cement
6. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
7. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete
8. ASTM C 309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
9. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete
10. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete

C. International Building Code

1. IBC 2018 – International Building Code 2018

1.4 Submittals

A. Submit mix designs to the Engineer under provisions of Section 01300 and this section.

B. Product Data: Mix design for each tentative mix for Lean Mix Concrete:

1. Slump on which design is based
2. Total gallons of water per cubic yard
3. Brand, type, composition, and quantity of cement
4. Specific gravity and gradation of each aggregate
5. Ration of fine to total aggregates
6. Weight (surface dry) of each aggregate per cubic yard
7. Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture
8. Air content
9. Compressive strength based on 7 day and 28-day compression tests
10. Time of initial set

2.0 PRODUCTS

2.1 Materials

A. Portland cement, ASTM C 150, Type II.

B. Coarse aggregate, ASTM C 33, except that clay and shale particles shall not exceed on percent.

C. Fine aggregate, ASTM C 33, washed natural sand.

2.2 Mixes

A. Mix Designs

1. Concrete mix design shall be designed by an independent testing laboratory.

B. Cast-in-Place Concrete, reinforced

1. Cast-in-Place Concrete shall have a minimum 28-day compressive strength of 4,000 psi.
2. Maximum aggregate size of ¾-inch.
3. Placement slump of 4 inches, with tolerances of plus 1-inch or minus 1-inch.
4. Design mix shall assure 4 to 6 percent air entrainment.

C. Lean Mix Concrete, unreinforced

1. Lean Concrete shall have a minimum 28-day compressive strength of 2,000 psi.
2. Maximum aggregate size of 1-½ inches.
3. Placement slump of 4 inches, with tolerances of plus 1-inch or minus 1-inch.

2.3 Curing Compounds

A. Concrete curing compounds shall be a clear compound conforming to ASTM C 309, Type 1-D, Class A and B, such as “RES-X” by Burke, or an equivalent approved by the Engineer.

3.0 EXECUTION

3.1 Installation

A. Ready-mix concrete shall be batched, transported, and placed in accordance with ASTM C94. Each batch delivered to the site shall be accompanied by a certified weightmaster's delivery ticket.

B. All mixed concrete delivered to the site shall be placed within 90 minutes from the time of introduction of cement and water into the mix.

C. No water shall be added after leaving the batch plant without the approval of the Engineer.

D. Placement of concrete, once started, shall be performed as a continuous operation until the scheduled pour is completed.

E. Concrete placed under water will be placed using tremie methods. Concrete will not be allowed to free fall through water.

F. Concrete shall not be placed during freezing weather conditions.

3.2 Schedules

A. The Contractor shall notify the Engineer at least 48-hours before each concrete placement.

3.3 Quality Control

A. Concrete testing will be performed by the Quality Assurance Team. Such testing shall not relieve the Contractor from providing quality control to make sure concrete is in compliance with specification.

B. Four standard 6-inch diameter by 12-inches long test cylinders shall be prepared for every 50 cubic yards of concrete poured or for each pour, whichever is greater.

C. Standard compression tests shall be performed to determine the compressive strength: one at 7 days, one at 14 days, and one at 28 days. The fourth cylinder shall be kept in reserve for additional testing, if necessary.

D. Slump and air entrainment testing shall be performed at the time the cylinders are prepared.

*****END OF SECTION*****

SECTION 11207
PARSHALL FLUMES

1.0 GENERAL

1.1 Section Includes

A. References
B. Submittals
C. Parshall Flumes
D. Fabrication
E. Handling and Storage
F. Installation
G. Pipe Connections
H. Cast-in-place Concrete

1.2 Related Sections

A. Section 02205 – Fill Materials
B. Section 02222 – Excavating
C. Section 02223 – Filling
D. Section 03110 – Concrete Formwork
E. Section 03220 – Reinforcing Steel
F. Section 03300 – Cast-in-place Concrete

1.3 References

A. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
B. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials.
C. ASTM D 1941-91(2001) – Standard Test Method for Open Channel Flow Measurement of Water with Parshall Flume
D. ASTM D 2583 – Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol impressor.
E. ISO 982-92 – Measurement of Liquid Flow in Open Channel – Parshall and SANIIRI Flumes.
F. United States Department of the Interior, Bureau of Reclamation, Water Measurement Manual.

1.4 Submittals

A. Submit the following under provisions of Section 01300.
B. The Contractor shall provide detailed information to the Owner and Engineer for: flume, fittings, measurement attachments, and joining manufacturer's data, including type/class, method of joining, specifications, manufacturer's name, and manufacturer’s certificate of compliance.
C. Shop Drawings:
    1. Critical dimensions, jointing and connections, fasteners, and anchors.
    2. Materials of construction.
    3. Sizes, spacing, location of structural members, connections, attachments, openings, and fasteners.
D. Contractor to follow Manufacturer’s recommended installation instructions. Deviations from Manufacturer’s installation instructions shall be approved by the Engineer.

E. If an equivalent product is proposed, submit samples, technical data, test data, and specifications sufficient to allow evaluation by Engineer.

2.0 PRODUCTS

2.1 Parshall Flumes

A. Flumes shall be manufactured by TRACOM, Inc. of Alpharetta, Georgia, USA, or an equivalent approved by the Engineer.

B. Flumes shall be 2-inch Parshall type and shall be of one-piece construction

C. Materials:

1. Fiberglass reinforced plastic.
2. Gloss inside surfaces, free of irregularities.
3. Minimum 3/16-inch wall thickness.
4. Minimum 30% glass, by weight.
5. Isophthalic polyester resin.
6. Removable pultruded fiberglass bracing at top of flume with T-304 stainless steel hardware.
7. 2-inch (minimum) top and end stiffening flanges.
8. Molded-in stiffening ribs, maximum 12-inch center-to-center spacing.
9. 15 mil Isophthalic UV resistant gel coat on all surfaces, white interior, grey exterior.
10. Anchor clips, pre-drilled with ¾-inch hole, pultruded fiberglass construction
11. Tensile strength (ASTM D 638) – 14,000 psi.
12. Flexural strength (ASTM D 790) – 27,000 psi.
13. Flexural modulus (ASTM D 790) – 1.0 million psi.
14. Barcol hardness (ASTM D 2583) – 50.

2.2 Flume Attachments

A. Ultrasonic Mounting Bracket:

1. Fixed Position stainless steel.
2. Horizontally and vertically adjustable stainless steel.
3. 2-inch diameter NPT coupling for third-party mounting bracket, if required.

2.3 End Connections

A. Inlet and outlet end adaptors

1. 6-inch inlet and outlet pipe stubs shall be fitted with a bolt pattern to allow bolting to a 6-inch IPS flange adaptor and ANSI 150 lb. flat-faced flange.

3.0 EXECUTION

3.1 Handling and Storage

A. Transportation of Parshall Flumes and fittings shall be the responsibility of the Contractor. The Contractor shall be liable for all damage incurred prior to and during transportation to the site.

B. Handling, storage and care of the pipe, valves, and fittings prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Engineer.

C. The Contractor shall be responsible for storage of Parshall Flumes and fittings at the site. Pipe, valves, and fittings shall be stored on clean level ground, which is free of sharp objects which could damage these materials. Stacking shall be limited to a height that shall not cause excessive deformation of the bottom flumes under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitable and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

3.2 Installation

A. Parshall Flumes shall be installed above an 80-mil HDPE geomembrane rubsheet within the Underdrain Collection Channel in accordance with the Design Drawings.

B. Parshall Flumes shall be installed to the lines and grades shown on the Design Drawings.

C. Parshall Flumes shall be installed plumb and the upstream floor of the Flume is level.

D. Parshall Flumes shall be embedded in concrete. Pour concrete in maximum 6-inch lifts. Internally line and brace the flume as necessary to prevent bowing or distortion of the of the flume until concrete in cured. Concrete shall meet the specifications of Section 03300 – Cast-in-place Concrete.

3.3 Tolerances

A. Parshall Flumes shall be installed to the lines and grades in the Design Drawings.

B. Parshall Flumes shall be installed plump and the upstream floor level.

3.4 Quality Control

A. A short description of the Quality Control program shall be submitted by the Contractor with the bid to the Engineer and Owner. This description shall state the Quality Control standard to be used and as a minimum containing the following:

1. An organization chart with a brief job description of Quality Control function
2. A list of applicable procedures for implementation of the Quality Control program
3. A general description of how each Quality Control requirement is to be fulfilled during the design, procurement, manufacture, assembly and testing

B. During award phase, the Quality Control documentation shall be forwarded to the Engineer as specified in Section 01300. Pertinent Quality Control documentation including Quality Control manuals shall be approved by the Engineer prior to any production work commencing. A minimum of five working days shall be allowed for the Engineer's review.

C. Upon delivery of the pipe, the Contractor shall forward the following documentation:

1. All Vendor certificates and tests performed per these Specifications
2. All Vendor documents verifying that inspection, control, and tests performed are in accordance with these Specifications
3. Identification lists with cross references between documents and hardware/materials for traceability purposes

D. The Engineer or Owner shall have the right to carry out audits at the Contractor’s, Vendor’s, and their subcontractor’s facilities, to verify compliance with all aspects of the documentation included in the purchase order. For the purpose of evaluating and auditing, the Contractor, Vendor, and their subcontractors shall give free access to all facilities concerned and to all the Quality Control documents and records

E. Applicable records may be requested by the Engineer or Owner at any time during production, these shall be forwarded to the Engineer or Owner upon request within five working days. The Contractor or Vendor shall give a written response to the Engineer or Owner for any corrective action requests and if requested, take the necessary corrective action in a timely manner.

*****END OF SECTION*****

SECTION 17150
METERS AND INSTRUMENTATION

1.0 GENERAL

1.1 Section Includes

A. Prequalification
B. Performance Requirements
C. Design Requirements
D. Submittals
E. Delivery, Storage, and Handling
F. Products
G. Execution

1.2 Performance Requirements

A. This Work shall include the furnishing of all labor, tools, equipment, and other items necessary for the installation meters and instrumentation as shown on the Drawings. All Work shall be performed in accordance with the lines, grades, sections, and dimensions shown on the Drawings, or as directed by the Engineer.

1.3 Design Requirements

A. All instrumentation materials, installation methods and materials, and data collection prior to, during, and after installation shall meet the minimum requirements of Manufacturer's recommendation and the **Geotechnical Monitoring Plan for the Grassy Mountain TSF and WRD, Revision 0 prepared by Golder Associates Inc.**

B. All instrumentation installation shall be performed by, or at the direction of, the Engineer.

1.4 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Submit equipment models, operation, installation, and maintenance manuals for vibrating wire piezometers, settlement cells and gauges, readout equipment, and inclinometers. Obtain Engineer approval for all instrumentation prior to shipping to the site.
2. Submit shop drawings of prefabricated instruments and materials for approval by the Engineer.
3. Submit proof of qualification for installation of any instrumentation.

C. After Installation:

1. Submit installation details for all instrumentation, including boring logs, location and elevation of the piezometers, piezometer cables, riser pipes, readout stations, surface monuments, inclinometers, and underdrain flow meters.
2. Submit the installation-specific operation manual developed for the vibrating wire piezometers, inclinometers, underdrain flow meters, and readout stations including calibration data for conversion of gauge readings to pressure.

2.0 PRODUCTS

2.1 Product Handling

A. Shipping Precautions: After completion of shop assembly, factory test, and approval, instruments shall be packed and secured to provide complete protections from damage, dust and moisture.

A. Special Instructions: Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of instrument prior to packaging and shipment.

B. Tagging: Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment. Identification shall be prominently displayed on the outside of the package.

C. Storage: Instruments shall not be stored outdoors. Instruments shall be stored in dry permanent shelters and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor.

2.2 Manufacturer's Services

A. Contractor may need to furnish some or all of the manufacturer's services for the instrumentation listed in this specification:

1. Perform factory bench calibration
2. Oversee installation
3. Verify installation of installed instrument
4. Site verification of calibration

2.3 Material

A. Vibrating Wire (VW) Piezometers

1. Impoundment (PZ-TI and PZ-WI Series) and Underliner VW Piezometers (PZ-TU, PZ-WU Series)
   a. Impoundment and Underliner VW piezometers shall have a pressure range of 0 to 100 psi with a resolution of 0.03 psi at 100 psi (Model Number VW2100-XXXX).
   b. Signal output shall be a frequency output in the millivolt range or digits.
   c. The filter shall be Standard: 50 micron sintered stainless steel.
   d. VW piezometers shall be manufactured by RST Instruments, based in Maple Ridge, British Columbia, or other manufacturer approved by the Engineer.
2. Embankment Foundation VW Piezometers (PZ-TF Series)
   a. Embankment Foundation VW piezometers shall be of standard VW piezometers prefabricated in nested construction (Multi-point Piezometer Strings).
   b. Embankment Foundation VW piezometers shall have a pressure range of 0 to 150 psi with a resolution of 0.04 psi at 150 psi (Model Number VW2100MP).
   c. Nesting of the Embankment Foundation VW piezometers will be at the vertical intervals described in the Geotechnical Monitoring Plan, or at the direction of the Engineer.
   d. Signal output shall be a frequency output in the millivolt range or digits.
   e. The filter shall be Standard: 50 micron sintered stainless steel.
   f. VW piezometers shall be manufactured by RST Instruments, based in Maple Ridge, British Columbia, or other manufacturer approved by the Engineer

B. VW Piezometer Signal Cables

1. Impoundment VW Piezometer (PZ-TI, PZ-WI Series) and Underliner (PZ-TU, PZ-WU Series) Signal Cable
   a. Shall be standard vibrating wire signal cable (Model EL380004) manufactured by RST Instruments, based in Maple Ridge, British Columbia.

b. Shall be with 22-gauge tinned-copper conductors and polyurethane jacket.

c. Signal cable shall be prefabricated to the VW piezometer during manufacturing to the specific cable length required for each instrument as shown on the Drawings and Geotechnical Monitoring Plan.

d. Cable conduit shall be 2-inch diameter Schedule 80 PVC pipe with flush interior glue joints.

2. Embankment Foundation VW Piezometers (PZ-TF Series)

a. Shall be 12 conductor, Kevlar® wire with water-blocked polyurethane jacket signal cable (Model EL380012) manufactured by RST Instruments, based in Maple Ridge, British Columbia.

b. Shall be with 22-gauge tinned-copper conductors and polyurethane jacket.

c. Signal cable shall be prefabricated to the VW piezometer during manufacturing to the specific cable length required for each instrument as shown on the Drawings and Geotechnical Monitoring Plan.

3. Cable splicing shall be limited to areas where vertical overburden pressures are limited to less than 25 psi and as directed by the Engineer. Cable splicing kits shall be manufactured by RST Instruments, based in Maple Ridge, British Columbia and shall be compatible with the specific VW piezometer signal cables.

4. Impoundment (PZ-TI and PZ-WI Series) and Underliner VW Piezometers (PZ-TU, PZ-WU Series) shall be placed in canvas bags supplied by the manufacturer and surrounded by No. 30 concrete sand.

C. Readout Stations

1. Single Channel VW portable readout (model number VW2106), shall be used for all VW piezometers for instantaneous field measurements during and after installation. The readout will measure a frequency range of 400 Hz to 6000 Hz, a temperature readout range between -50 and 80 °C, with a frequency resolution of 0.01 µs and temperature resolution of 0.1 °C.

2. After initial installation, Data loggers and multiplexers shall be installed within each Readout Station to collect real-time measurements of all WV piezometers.

3. Data Loggers shall be the RST FlexDAQ system and include the following:

a. CR6 Data Logger manufactured by Campbell Scientific, Inc. of Logan, Utah

b. RST Flexi-Mux Multiplexer(s) manufactured by RST Instruments.

c. AC or DC (solar) power supply with battery backup module

d. Electrical grounding if DC-powered

e. Lightning protection

f. Communication module (if required by, and at the direction of, the Owner)

g. Weatherproof NEMA-rated enclosure

h. Mounting post and hardware

4. Each Readout Station shall be constructed such that it has the capability to read and record in real-time the following quantity of instruments:

a. RS-1 – Twenty-two (22) VW piezometer signal cables

b. RS-2 – Four (4) VW piezometer signal cables

c. RS-3 – Four (4) Ultrasonic transducer signal cables and dataloggers

d. RS-4 – Eight (8) VW piezometer signal cables

e. RS-5 – Six (6) VW piezometer signal cables

D. Inclinometers

1. Inclinometer casing shall be installed along the downstream dam crest of the Stages 1 through 3 main north embankments as shown on the Drawings and in accordance with the Geotechnical Monitoring Plan.
2. Inclinometer casings shall be 70-mm (2.75-inch) diameter Snap Seal type (Model ICS205 or ICS210) manufactured by RST Instruments, based in Maple Ridge, British Columbia.
3. Inclinometer casings shall be either 5-foot or 10-foot segments and constructed of non-recycled virgin ABS resin.
4. Associated attachments such as bottom cap, top cap, casing anchor, alignment tool, and grout cap shall be manufactured by RST Instrumentation and approved by the Engineer.
5. Inclinometers shall be measured during and after installation with an RST MEMS Digital Inclinometer System or other suitable device approved by the Engineer.
6. Inclinometer signal cable shall have a minimum length of 200 feet.

E. Dam Crest Survey Monuments

1. Survey monuments shall be imbedded into the embankment at least 18 inches and constructed 12-inch diameter corrugated CPE pipe backfilled with grout.
2. Grout shall have a minimum 2,000 psi compressive strength at 28 days.
3. The survey marker shall be 2½-inch diameter cast-in-place brass survey cap (Model M/M-BCS-2 1/2FS) as manufactured by Surv-Kap, or an equivalent approved by the Owner.

F. Underdrain Flow Meters

1. Underdrain Flow Meters shall be installed above the Underdrain Parshall Monitoring Flumes as shown on the Drawings.
2. Underdrain Flow Meters shall be of Open Channel Flow Meter type (Model Dynasonics iSonic 4000) as manufactured by Badger Meter, Inc., of Milwaukee, Wisconsin.
3. Ultrasonic transducer shall be the EchoPod DL-10 mafactured by Badger Meter.
4. Underdrain Flow Meters shall be capable of measuring flume water levels in standard Parshall Flumes with an accuracy 0.125 inches (3 mm).

3.0 EXECUTION

3.1 Vibrating Wire Piezometer Installation

A. Impoundment (PZ-TI and PZ-WI Series) and Underliner VW Piezometers (PZ-TU and PZ-WU Series)

1. Installation of the Impoundment and Underdrain VW piezometers shall be installed at the locations identified on the Drawings and Geotechnical Monitoring Plan.
2. Installation methods, materials, and data collection procedures shall be in accordance with manufacturer's recommendations and at the direction of the Engineer.
3. VW Piezometers shall be placed in canvas sand filter bags provided by the piezometer manufacturer. Bags will be filled with No. 30 concrete sand with the piezometer centered in the bag.

B. Embankment Foundation VW Piezometers (PZ-TF Series)

1. Installation of the Impoundment and Underdrain VW piezometers shall be installed at the locations identified on the Drawings and Geotechnical Monitoring Plan.
2. Installation methods, materials, and data collection procedures shall be in accordance with manufacturer's recommendations and at the direction of the Engineer.

3. Boreholes shall be advanced below the TSF embankment foundation to the depths required for down-hole installation of the nested multi-point VW piezometers.
    a. Boreholes shall be advanced to a minimum of 1 foot (12 inches) below the deepest VW piezometer.
4. Downhole VW piezometers shall be installed using the Fully Grouted Method per RST Instruments recommendations.
    a. A bentonite-Type I/II cement mix shall be used to backfill the boreholes after nested VW piezometer installation.
    b. Viscosity of bentonite-cement backfill mix may be adjusted by the cutting short or additional bentonite to allow mixture to remain flowable for downhole pumping.
    c. Care shall be taken to prevent air entrapment in the VW piezometer filter stone. The VW piezometers shall be installed upside down and secured to either the signal cable or PVC guide pipe.
    d. If a PVC guide pipe is used during installation, it shall remain in place and be backfilled with bentonite-cement backfill mix.
    e. The PVC guide pipe shall be terminated no shallower than 2 feet below the native ground surface.

C. Calibrate piezometers to site-specific factors.

D. All cable shall be placed to loosely meander in the trench and the riser casing to allow for settlement and avoid development of tension in cable. Minimum cable meander shall be between 12 inches and 18 inches of amplitude for every 36 inches of pitch.

E. All cables shall be surrounded with Cable Bedding Fill as shown in the Drawings. Cable Bedding Fill will be compacted using hand-guided compaction equipment to form a smooth and non-yielding surface. Where placed as backfill in cable risers, Cable Bedding Fill shall be placed in lifts of 4 inches and tamped to a dense condition using a wood pole or rod.

F. Survey the precise location and elevation of each of the piezometers to an accuracy of 0.1 feet in all directions. Survey the location of wiring and conduits leading to the piezometers to an accuracy of 0.5 feet. Provide the surveyed locations with the as-built documentation. Permanently label piezometers in the readout stations and protect the stations from damage due to traffic and construction operations.

3.2 Readout Station Installation

A. Instrumentation Readout Stations shall be installed at the general locations shown on the Drawings.

B. Installation Criteria and Validation: Field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on manufacturers' installation requirements.
2. Technical assistance from the Engineer is available to installation personnel at least by telephone.
3. Installation personnel have one copy of the approved Drawings, Geotechnical Monitoring Plan and pertinent data.
4. Power and signal wires shall be terminated with crimp type lugs, where the terminal block requires this.
5. Connectors shall be, as a minimum, water tight.
6. Wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
7. Wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected without splices unless specifically approved by the Engineer. Wiring shall be protected from sharp edges and corners.

8. Lightning protection shall be installed on the Readout Stations.

C. Verify the correctness of each installation, including polarity of electric power and signal connections, and make sure process connections are free of leaks.

3.3 Inclinometer Installation

A. Boreholes shall be advanced from the TSF embankment dam crest and into the clay foundation at the locations shown on the Drawings.

B. Boreholes shall be advanced to a minimum of 1 foot (12 inches) below the deepest VW piezometer.

C. Inclinometers shall be installed using the per RST Instruments recommendations.

D. The “A” axis of the inclinometer shall be installed perpendicular to the dam alignment. Proper alignment of the casing shall be maintained at all times during installation. Casing shall not be twisted or pushed from top during installation.

E. A bentonite-Type I/II cement mix shall be used to backfill the boreholes after nested VW piezometer installation.

A. Viscosity of bentonite-cement backfill mix may be adjusted by the cutting short or additional bentonite to allow mixture to remain flowable for downhole pumping.

3.4 Dam Crest Survey Monument Installation

A. Embankment Crest Survey Monuments shall be made an 18” diameter CPE pipe with smooth interior and backfilled with Lean Mix Concrete in accordance with Section 03300.

B. A minimum 6-inch wide base of concrete shall be pours around the outside of the vertical CPE pipe to for a minimum depth of 6 inches from the base of the pipe.

C. A 12-inch long ⅝ inch diameter “All Thread” rod with coarse thread shall be cast plumb into the concrete with a minimum 2½ inch extending above the top of the concrete.

D. 1-inch diameter weep holes shall be drilled through the CPE pipe immediately above the top of the concrete to provide drainage of surface water. A minimum of six weep holes shall be installed equally spaced around the circumference of the CPE pipe.

E. The annular space between the edges of the excavation and the CPE pipe shall be backfilled with Pipe Bedding Fill and placed in accordance with Section 02223.

F. The CPE pipe shall be capped with a removable lid to protect concrete and survey monument.

3.5 Underdrain Flow Meter Installation

G. Ultrasonic transducers shall be installed in accordance with the manufacturer’s recommendation.

H. Ultrasonic transducers shall be mounted to the Parshall Flumes using manufacturer-supplied mounting brackets.

I. Signal cables shall be routed to Readout Station RS-3 shown on the Drawings.

J. Signal cables shall be secured and protected from damage.

K. Transducer readouts shall be installed in a weatherproof NEMA enclosure adjacent to the reclaim pond as shown on the Drawings.

L. Weatherproof enclosure shall be mounted to fence post installed below grade and founded in Lean Mix Concrete meeting the requirements of Section 03300.

M. Power shall be supplied to the transducers in either AC (275V max, 50-60 Hz) or DC (9 to 36 V, max 9W).

3.6 Calibration

A. General: Devices provided shall be calibrated according to the manufacturer's recommended procedures to verify operation readiness and ability to meet the indicated functional and tolerance requirements.

B. Calibration Points: When possible each instrument shall be calibrated at 5, 50, and 90 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

C. Bench Calibration: Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment.

D. Field Calibration: Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument data sheets.

3.7 Performance Test

A. All instruments shall operate for 30 days without failure.

B. The Contractor shall furnish support staff as required to satisfy the repair or replacement requirements at no cost to the Owner.

C. If any component fails during the performance test, it shall be repaired or replaced at no Cost to the Owner.

3.8 Acceptance

A. The following conditions shall be fulfilled before the WORK is considered substantially complete:

1. Submittals have been completed and approved.
2. The instruments have been calibrated.
3. Any necessary training has been performed.
4. Spare parts and expendable supplies and test equipment have been delivered.
5. The performance test has been successfully completed.
6. Record drawings have been submitted.
7. Revisions to the Technical Manuals that may have resulted from the field tests have been made and reviewed.
8. Debris associated with installation of instrumentation has been removed.

*****END OF SECTION*****

APPENDIX J

Construction Quality Assurance Plan

Construction Quality Assurance Plan
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon

Submitted to:

Calico Resources USA Corp.
665 Anderson St.
Winnemucca, NV 98445

Submitted by:

Golder Associates Inc.
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Reno, Nevada, USA 89521

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1663241-055-R-REV0

November 6, 2019

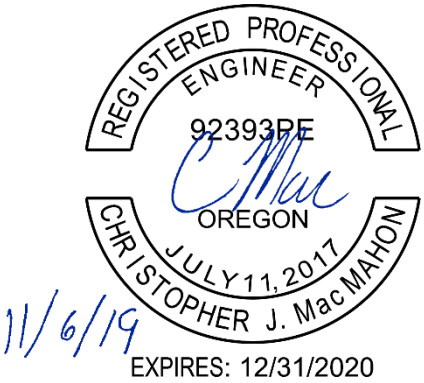
Construction Quality Assurance Plan
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon

The following Construction Quality Assurance Plan has been prepared by the staff of Golder Associates Inc. under the professional supervision of the engineers whose signatures appear herein.

This Plan is presented to Calico Resources USA Corp. and has been prepared in accordance with generally accepted profession engineering principles and practices.

Golder Associates Inc.



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Document Revisions

Date	Revision	Comment
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APPENDIX

Appendix A Example of CQA Daily Field Report

1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan has been prepared by Golder Associates Inc. (Golder) on behalf of Calico Resources USA Corp. (Calico). This CQA Plan describes the program used to verify and document that earthwork construction, geomembrane installation, gravity pipe installation, and structural concrete installation for the Grassy Mountain Tailings Storage Facility (TSF) and Waste Rock Dump (WRD) are conducted in accordance with the Technical Specifications and the Drawings included in the Contract Documents for the Project.

This Plan is intended as summary of the Technical Specifications prepared as part of the Grassy Mountain TSF and WRD construction-level design presented as Appendix C in the Grassy Mountain Mine consolidated Permit Application.

Quality Control (QC) is a planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the requirements of the Technical Specifications and the Owner's needs. The objective of QC is to provide a work product that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification to meet the Owner's needs, production to meet the full intent of the Technical Specifications, inspection to determine whether the resulting material, product, service, etc. is in accordance with the Technical Specifications. In practice, QC refers to those procedures, criteria, and tests employed by the Quality Control Team to confirm the Work meets industry standards of practice and complies with the approved Design Drawings, Technical Specifications, and the CQA Plan. This plan does not address quality control procedures, criteria and/or tests employed by the Contractor.

Quality Assurance (QA) is a planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves evaluating the adequacy and effectiveness of the overall Quality Control program and implementing corrective measures where necessary. For a specific material, product, service, etc., this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment. In practice, QA refers to those procedures, criteria, and tests required by the Owner or Engineer to confirm the Work performed by the Contractor is in compliance with the approved Design Drawings and Technical Specifications and any additional requirements of this Plan.

The inspection and testing activities addressed under this CQA Plan include the following:

- Excavation
  - Embankment Fill Borrow Areas
  - Reclaim Pond
  - Waste Rock Dump
  - Stormwater Diversion Channels
  - Geotechnical Explorations
- Fill Materials
  - Subgrade

  - Embankment Fill
  - Grading Fill
  - Prepared Subgrade
  - Drainage Layer
  - Filter Fill
  - Anchor Trench Backfill
  - Drain Gravel
  - Leak Detection Fill
  - Pipe Bedding Fill
  - Cable Bedding Fill
  - Riprap
  - Safety Berm Material
- Geosynthetic Materials
  - Geomembrane
  - Geotextile
  - Geosynthetic Clay Liner
  - Geonet
- Monitoring Systems
  - Vibrating Wire Piezometers
  - Underdrain Flow Rate Monitoring and Flumes
  - Survey Monuments
  - Inclinometers
  - Leak Detection
- Cast-in-place Concrete
- Gravity Piping and Valves

2.0 ORGANIZATION

This section of the CQA Plan describes the parties involved during construction.

Owner: The Owner is the individual, corporation, entity, public body, or authority with whom the Contractor has entered into the Agreement and for whom the Work is performed. For this Project, the Owner is Calico Resources USA Corp. (Calico).

Engineer of Record (EOR): Engineer, or EOR, is the representative appointed and authorized by the Owner. The Engineer is responsible for preparation of the Design Drawings and Technical Specifications and this CQA Plan for the Project. The Engineer is also responsible for the interpretation of those documents and for resolution of technical matters that arise during construction. For this Project, the Engineer is Golder Associates Inc. (Golder). The Engineer-of-Record for this project is Christopher J. MacMahon, PE from Golder's Reno, Nevada Office.

Resident Engineer (RE): The RE is the on-site representative of the Engineer and oversees the Quality Assurance Team. The RE is responsible for overseeing the completion of the Work in accordance with the Drawings, Technical Specifications, and this CQA Plan. Other responsibilities include documenting daily construction activities, review of material submittals, review of the Quality Control program, and acceptance of completed Work. The RE will work directly with the Engineer and oversee the Quality Assurance Team. For this project, the RE will be a senior field technician provided by Golder.

Earthworks Contractor: Party, independent of the Owner, whose primary responsibility is to ensure the TSF is constructed in accordance with the Drawings, Technical Specifications, and this CQA Plan developed by the Engineer and approved by the permitting agency. Other responsibilities include the performance of all construction activities (including Subcontractors) at the site including site facilities, administration, material purchasing (other than materials procured by the Owner and Geomembrane Contractor), material handling and storage, safety, supervision, construction Quality Control program, installation, and subcontracting. The Contractor is also responsible for informing the Owner, Engineer, and Quality Assurance Team of the scheduling and occurrence of all construction activities and shall be fully responsible for scheduling and coordinating the work of the Quality Control Team and Subcontractor(s). The Contractor is responsible for the protection of completed work until it is accepted by the Owner.

Geosynthetics Contractor: Party, independent of the Owner, contracted through the Owner or Earthworks Contractor, responsible for field handling, sorting, placing, seaming, ballasting (against wind), and other aspects of the geosynthetics installation, including geomembranes, geotextiles, geonet, and Geosynthetic clay liners. The Geosynthetics Contractor is also responsible for transportation of these materials to the site, unless otherwise directed by the Owner. In addition, the Geosynthetics Contractor is responsible for the protection of the materials once they arrive on site, until the Work is accepted by the Owner.

Quality Control Team (QCT): Party, independent from the Owner, contracted through the Owner or Earthworks Contractor, responsible for performing the earthwork and geomembrane Quality Control field and laboratory testing, observations, and inspections required by the Technical Specifications. The QCT shall be approved by the Owner and Engineer. The QCT shall have experience in testing earth fills, aggregates, concrete, and geosynthetics and be familiar with the test methods and standards as required in the Technical Specifications.

At a minimum, the QCT shall consist of the following personnel:

- QC Manager – Registered Professional Engineer licensed in the State of Oregon responsible for all QC material testing, observation, and reporting of all QC activities required by the Technical Specifications

- QC Field Technician(s) – Qualified field technicians responsible for performing all earthwork, geomembrane and concrete field sampling, testing, and observations required by the Technical Specifications
- QC Earthwork Testing Laboratory – Qualified geotechnical testing laboratory responsible for performing all geotechnical laboratory testing required by the Technical Specifications
- QC Geomembrane Testing Laboratory – Qualified geomembrane testing laboratory responsible for performing all geomembrane laboratory testing during manufacturing required by the Technical Specifications

At a minimum, the QCT shall be responsible for the following:

- Performing all QC geotechnical testing required by the Technical Specifications
- Performing all QC geomembrane testing as required by the Technical Specifications
- Performing all QC concrete testing as required by the Technical Specifications
- Procuring all material data sheets and certifications of manufactured materials used to complete the Work and submitting to the Engineer for approval as required by the Technical Specifications
- Formally submitting test results, observations, manufacturer certifications, and QC daily field reports to the Engineer as required by the Technical Specification
- Preparation of the Quality Control Report and shall be approved and sealed by the QC Manager

At a minimum, the QC Manager shall have the following responsibilities:

- Oversee the QC Technicians and review of testing and analytical procedures employed to perform the QC testing, observation, and reporting of all QC activities as required by the Technical Specifications
- Review of all QC test results, observations, and QC daily field reports for all QC activities as required by the Technical Specifications
- Reporting of all QC tests and daily field reports to the Engineer as required by the Technical Specifications
- Report identified deficiencies and proposed corrective action to the QAT

Quality Assurance Team (QAT): Party, independent from the Contractor and QCT, responsible for QA field and laboratory testing, observations, documenting activities required by the Technical Specifications. The QAT shall be contracted through the Owner and perform assigned duties at the direction of the RE and Engineer. The QCT shall have experience in testing earth fills, aggregates, concrete, and geosynthetics and be familiar with the test methods and standards as required in the Technical Specifications.

At a minimum the QAT shall consist of the following personnel:

- RE – On-site representative of the Engineer overseeing the QAT

- QA Field Technician(s) – Qualified field technicians responsible for performing all geotechnical and geomembrane QA sampling, testing, and observations required by the Technical Specifications and at the direction of the Engineer
- QA Geotechnical Laboratory - Qualified geotechnical testing laboratory responsible for performing geotechnical laboratory at the direction of the Engineer
- QA Geomembrane Laboratory – Qualified geomembrane testing laboratory responsible for performing all geomembrane laboratory conformance testing during manufacturing required by the Technical Specifications

At a minimum, the QAT shall be responsible for the following:

- Review and approval of manufacturer QC certificates and test results as required by the Technical Specifications
- Review and approval of QC test results, observations, and QC daily field reports
- Review and approval of compaction procedures for materials placed and compacted as required by the Technical Specifications
- Sampling and performing geomembrane conformance tests as required by the Technical Specifications
- Initiation of design changes or clarifications required by the Engineer or Contractor
- Verify that the Work is constructed in accordance with industry standards of practice, Technical Specifications, and the Owner's needs
- Prepare the Record of Construction Report and shall be approved and sealed by the Engineer

Geosynthetic Manufacturer (Manufacturer): The party responsible for manufacturing the geomembrane, geosynthetic clay liner, geotextile, and appurtenances.

Subcontractor: The Subcontractor is an entity or individual who has a direct contract with the Contractor for the performance of a part of the Work. The Subcontractor shall communicate with the Owner or Engineer through the Contractor. The Subcontractor shall adhere to the requirements of the Drawings, Technical Specifications, and this CQA Plan as it relates to the Subcontractor's part of the Work.

3.0 MEETINGS

3.1 General Preconstruction Activities

Prior to the start of construction, a preconstruction meeting shall be held among the Owner, the Engineer, RE, QCT, QAT, and the Contractor(s) responsible for completing the Work. If necessary, a separate preconstruction meeting shall be held upon mobilization of the Geosynthetics Contractor if they cannot attend the first preconstruction meeting. The topics covered at this meeting shall include, but not be limited to:

- Providing each party with all relevant Construction Documents and supporting information
- Familiarizing each Party with this site-specific CQA Plan, its role relative to accomplishing the intent of the design, as well as review of the Design Drawings and Technical Specifications

- Reviewing the responsibilities of each Party
- Reviewing lines of authority and communication for each Party
- Discussing the established procedures or protocols for construction, deficiencies, repairs, and retesting
- Reviewing methods of documenting and reporting inspection data
- Reviewing work area security and safety protocols
- Discussing procedures for the location and protection of construction materials, and for the prevention of damage of the materials from inclement weather or other adverse events
- Conducting a site walk to review site conditions as well as material staging and storage locations
- Discussing the construction plan, schedule, and procedures
- Clarifying installation, testing, and acceptance criteria and procedures

3.2 Progress Meetings

Progress meetings will be held throughout progress of the Work at least once per week unless more frequent meetings are required. The RE and/or the Contractor will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record the minutes, and distribute copies of the minutes within three days to the participants and those affected by decisions made. At a minimum, progress meetings shall be attended by the RE, the Contractor, and major Subcontractors. The purpose of a progress meeting is to address the following items:

- Review minutes of previous meetings
- Review Work progress and schedule
- Field observations, problems, and decisions
- Identify problems that impede planned progress
- Review submittals schedule and status of submittals
- Review material availability and quality
- Plan Work activities and progress during succeeding work period
- Coordinate projected progress
- Discuss construction quality and work standards
- Discuss other issues relating to the work

3.3 Problem or Work Deficiency Meeting

A special meeting shall be held when, and if, a problem or deficiency is present or is anticipated. At a minimum, the meeting shall be attended by the RE and the Contractor. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- Define and discuss the problem or deficiency

- Review alternative solutions
- Implement an action plan to resolve the problem or deficiency

The meeting shall be documented by the RE. Copies of the meeting minutes shall be distributed within three days to participants and those affected by decisions made.

4.0 CONSTRUCTION QUALITY ASSURANCE REQUIREMENTS

4.1 General

This section of the CQA Plan describes the observations and testing activities that will be performed during construction. The scope of this section addresses the construction method, including material installation and the manufacture/fabrication as specified in the following Technical Specification sections:

- Section 01041 – Project Coordination
- Section 01050 – Field Engineering
- Section 01051 – Geotechnical Exploration
- Section 01400 – Quality Control and Assurance
- Section 02110 – Site Clearing and Stripping
- Section 02205 – Fill Materials
- Section 02211 – Rough Grading
- Section 02222 – Excavating
- Section 02223 – Filling
- Section 02272 - Geotextile
- Section 02272 – Geonet
- Section 02350 – Geosynthetic Clay Liner
- Section 02710 – Gravity Piping
- Section 02775 – Geomembranes
- Section 03110 – Concrete Formwork
- Section 03220 – Reinforcing Steel
- Section 03300 – Cast-in-Place Concrete
- Section 11207 – Parshall Flumes
- Section 17150 – Meters and Instrumentation

Acceptance criteria for construction work shall be as identified in the Technical Specifications. The RE will be on-site at all times while construction is ongoing, observing and documenting all relevant activities. QA shall consist of observing the work as construction proceeds and review of laboratory and field testing

performed by the QCT to ensure that the materials conform to the Specifications and construction performance specifications are achieved. The RE will also review the required Contractor/Subcontractor submittals as specified in the Technical Specifications.

The Engineer shall visit the site periodically as construction progress warrants. Such visits will be frequent enough to allow the Engineer to be fully knowledgeable of the construction methods and performance. The Engineer may then determine if QC/QA observation and testing activities are adequate to meet the requirements of this CQA Plan.

4.2 List of Applicable Methods

List of applicable methods (references) are provided in the Technical Specifications.

4.3 Sampling and Testing Requirements

The QC\QA sampling and testing requirements for the construction activities are summarized in the tables in Section 6.0.

5.0 GENERAL QUALITY CONTROL/ASSURANCE PROCEDURES

5.1 General Description

The QCT shall be responsible for implementing a QC program that satisfies the requirements of the Technical Specifications and this CQA Plan. The QAT shall be responsible for reviewing all QC field and laboratory test results, observations, and QC daily field reports and document that the project construction has been completed in conformance with the Technical Specifications, Design Drawings, and the CQA Plan.

For this Project, QA testing performed by the QAT will satisfy the QC testing requirements of the Project. If selected by the Contractor and approved by the Owner, the Contractor may elect to not perform field QC testing in solely rely on the QAT to document contractor QC. This does not eliminate the requirements of the Contractor from performing assigned Work in accordance with the Technical Specifications and Design Drawings.

5.2 Visual Observations

5.2.1 Quality Control Team

Visual observations shall be performed by the QCT that include, but not be limited to, the following:

- Compaction method for materials placed (placement, moisture conditioning, equipment type, number of passes) as required by the Technical Specifications
    - Adherence to the procedures established during the test fills (if any)
- Consistency of materials during processing and/or placement
- Deleterious material that may hinder proper construction
- Attention to areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred
- Safe working procedures and construction methods

5.2.2 Quality Assurance Team

Visual observations shall be performed by the QAT that include, but no be limited to, the following:

- Compaction method for materials placed (placement, moisture conditioning, equipment type, number of passes)
  - Adherence to the procedures established during the test fills (if any)
- Proper material usage
- Reviewing QCT procedures for sampling, testing, observations, and documentation
- Approval of areas where Work has been completed
- Safe working procedures and construction methods

5.3 Defects and Repairs

5.3.1 Identification

If a defect is identified, the QCT shall determine the extent and the nature of the defect and notify the QAT immediately. If the defect is indicated by an unsatisfactory test result, the QAT shall determine the extent of the deficient area by additional QC tests, observations, review of records, or other means that the QAT deems appropriate.

5.3.2 Notification

After determining the extent and nature of the defect, the QAT shall promptly notify the Contractor. The QAT shall review the QCT's determination regarding the extent of the defect. If the QAT agrees with the QCT's determination, the Contractor shall be notified of the defect. If in the opinion of the QAT, disagrees with the QCT's determination, additional observations and testing may be required prior to notifying the Contractor.

5.3.3 Repairs and Retesting

Upon notification from the QAT, the Contractor shall correct all deficiencies to meet the Contract Documents. The QAT and QCT shall schedule appropriate retests when the Work deficiencies have been corrected. All retests by the QCT or QAT must verify that the deficiencies have been corrected before additional Work may be performed by the Contractor in the deficient area. The QAT shall observe any repair and report any noncompliance with the above requirements in writing to the Engineer.

5.4 Documentation

5.4.1 General

Proper documentation shall be maintained throughout the duration of the construction activities. The QCT will be responsible for ensuring that applicable forms and written records are completed daily. Originals of applicable forms and written documentation will be stored on-site and shall be made available for the QAT's review upon request. Copies of written documentation will be made each week and shall be sent to the QAT. Further details of typical documentation are presented below.

5.4.2 Daily Records

5.4.2.1 Quality Control Daily Reports

The QCT shall issue a typed daily report of activities. QC daily reports shall include the following:

- Date and shift
- List of organizations and their responsibilities
- List of equipment used for construction of Work
- Health and safety issues
- Summary of QC activities
  - Materials used for construction
  - Summary of samples taken, sample locations and elevations as appropriate, and test results
  - Test equipment calibrations
  - List of materials received
- Issues and problems encountered, and resolutions reached
- Summary of meetings and discussions (if any)
- QCT personnel hours, gear, and vehicles
- Photographs taken with a description

A template for daily reports is provided in Appendix A.

5.4.2.2 Quality Assurance Daily Reports

The QAT shall issue a typed daily report of activities. QA daily reports shall include the following:

- Date and shift
- Weather conditions
- List of organizations and their responsibilities
- List of equipment operating on-site
- Health and safety issues
- Summary of QC documentation review
- Summary of QC activities
- Issues and problems encountered, and resolutions reached
- Summary of meetings and discussions
- QAT personnel hours, personal protective equipment used, and vehicles
- Photographs taken with a description

A template for daily reports is provided in Appendix A.

5.4.3 Construction Reporting

5.4.3.1 Construction Quality Control Report

Following completion of construction, the QCT shall provide a Construction Quality Control Report by that will include the following:

- Description of Quality Control activities
- Summary of test results
- Copies of QC daily reports
- As-Built Survey documentation
- Color photographs of major project features

The Construction Quality Control Report shall be submitted to the Engineer within 14 days upon acceptance of the completed Work. The Construction Quality Control Report shall be sealed by a registered Professional Engineer, licensed in the State of Oregon certifying that the activities performed by the QCT have been performed in accordance with the Contract Documents.

5.4.3.2 As-built Survey Documentation

Following completion of construction, the Contractor shall provide As-built Survey Documentation of all Work performed by the Contractor that will include the following:

- Survey of all areas disturbed by the Contractor that pertain to the completion of the Work
- Survey of all structures, pipes, utilities, and other facilities that pertain to the completion of the Work

The As-built Survey Documentation shall be submitted to the Engineer within 14 days upon acceptance of the completed Work. The As-built Survey Documentation shall be sealed by a registered Professional Land Surveyor, licensed in the State of Oregon certifying that the surveys are in accordance with the Contract Documents.

5.4.3.3 Record of Construction Report

Following completion of Construction and receipt of the Construction Quality Control Report and As-built Survey Documentation, the Engineer shall prepare the Record of Construction report documenting the following:

- Description of construction activities
- Summary of test results
- Copies of QCT and Resident Engineer Daily Reports
- As-built Survey documentation
- As-built Drawings
- Critical correspondence pertaining to the Work including changes and clarifications to the Drawings

- Description of deviations from the Technical Specifications and justification for such changes
- Color photographs of major project features

The Record of Construction Report will be sealed by the Engineer, certifying that the facility has been constructed in accordance with the Contract Documents.

6.0 QUALITY CONTROL REQUIREMENTS

Table 1: Subgrade

Type	Parameter	Standard	Test Method	Frequency (units per test)	Comments
Subgrade Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	N/A	
	Sieve Analysis	N/A	ASTM D 6913	200,000 sq.ft of prepared surface	
	Atterberg Limits	N/A	ASTM D 4318	200,000 sq.ft of prepared surface	
	Moisture-Density Relationship	Modified Proctor	ASTM D 1557	500,000 sq.ft of prepared surface	
Subgrade Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Scarification Depth	6 inches below	N/A	Continuous Monitoring	
	Field Density	90% of Max Dry Density as determined by ASTM D 1557	ASTM D 6938	50,000 sq.ft of prepared surface	
	Field Moisture Content	N/A	ASTM D 6938	50,000 sq.ft of prepared surface	May be collected during field density test
	Sand Cone Referee Density	N/A	ASTM D 1556	1 test per 10 field density tests	As required by the Engineer
	Laboratory Moisture Content	N/A	ASTM D 4643	1 test per 10 field moisture tests	As required by the Engineer

Table 2: Embankment Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Embankment Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	N/A		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	- A maximum of any 1 sieve is allowed to be out of spec for an individual test - Maximum particle size shall be less than 2/3 loose lift thickness
		16 inch	100			
		12 inch	50 – 100			
		8 inch	30 – 100			
		¾ inch	0 – 80			
		No. 4	0 – 40			
		No. 200	0 – 15			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	20,000 cu.yds	Per material type
Embankment Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	12, 18, and 24-inch test fill		USACOE	Continuous Monitoring	Per test fill procedures described in Section 02223
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	2,000 cu.yds	
	Field Moisture Content	N/A		ASTM D 6938	Continuous Visual Monitoring	
	Sand Cone Referee Density	N/A		ASTM D 1556	N/A	
	Laboratory Moisture Content	N/A		ASTM D 2216 or D 4643	N/A	

Table 3: Grading Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Grading Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 15		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	
		6 inch	100			
		¾ inch	20 – 100			
		No. 4	10 – 70			
		No. 40	0 – 40			
		No. 200	0 – 30			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	20,000 cu.yds	Per material type
Grading Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	Soil Fill: Maximum 12-inch thick loose lift Rock Fill: 12, 18, and 24-inch test fill		USACOE	Continuous Monitoring	Per test fill procedures described in Section 02223
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	1,000 cu.yds	
	Field Moisture Content	N/A		ASTM D 6938	Continuous Visual Monitoring	
	Sand Cone Referee Density	N/A		ASTM D 1556	N/A	
	Laboratory Moisture Content	N/A		ASTM D 2216 or D 4643	N/A	

Table 4: Prepared Subgrade

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Prepared Subgrade Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 20		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	
		3 inch	100			
		¾ inch	70 – 100			
		No. 4	20 – 100			
		No. 40	0 – 60			
		No. 200	0 – 50			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	15,000 cu.yds	Per material type
Prepared Subgrade Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	Maximum 12-inch thick loose lift On slopes steeper than 20% maximum 18-inch lifts measured perpendicular to slope		N/A	Continuous Monitoring	May be placed in a single 6-inch lift if the underlying Embankment Fill is free of coarse material. Lift thickness shall be approved by Engineer.
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	1,000 cu.yds	
	Field Moisture Content	N/A		ASTM D 6938	Continuous Visual Monitoring	
	Sand Cone Referee Density	N/A		ASTM D 1556	N/A	
	Laboratory Moisture Content	N/A		ASTM D 2216 or D 4643	N/A	

Table 5: Drainage Layer

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Drainage Layer Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 10		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	
		3 inch	100			
		¾ inch	50 – 100			
		No. 4	20 – 50			
		No. 40	0 – 25			
		No. 200	0 – 15			
	Moisture-Density Relationship	N/A		N/A	N/A	
	Hydraulic Conductivity	5 x 10^{-3} cm/sec or faster		ASTM D 5856	2 per material type	
Drainage Layer Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only Low Ground Pressure (LGP) tracks allowed for material spreading
	Lift Thickness	Single 18-inch thick loose layer		N/A	Continuous Monitoring	Not Compacted
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 6: Filter Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Filter Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 10		ASTM D 4318	3,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	3,000 cu.yds	
		8 inch	100			
		3 inch	70 – 100			
		¾ inch	30 – 90			
		No. 40	0 – 25			
		No. 200	0 – 15			
	Moisture-Density Relationship	N/A		N/A	N/A	
	Hydraulic Conductivity	5×10^{-4} cm/sec or faster		ASTM D 5856	2 per material type	
Filter Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only Low Ground Pressure (LGP) tracks allowed for material spreading.
	Lift Thickness	Single 6-inch thick loose lift		N/A	Continuous Monitoring	Not Compacted
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 7: Anchor Trench Fill

Type	Parameter	Standard	Test Method	Frequency (units per test)	Comments
Anchor Trench Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Atterberg Limits	N/A	ASTM D 4318	N/A	
	Sieve Analysis	N/A	ASTM D 6913	500 cu.yds	
	Moisture-Density Relationship	N/A	N/A	N/A	
Anchor Trench Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Lift Thickness	Maximum 12-inch-thick loose lifts	N/A	Continuous Monitoring	
	Field Density	N/A	N/A	Continuous Monitoring	Hand guided or bucket compacted
	Field Moisture Content	N/A	N/A	Continuous Monitoring	
	Sand Cone Referee Density	N/A	N/A	N/A	
	Laboratory Moisture Content	N/A	N/A	N/A	

Table 8: Drain Gravel

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Drain Gravel Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 10		ASTM D 4318	200 cu.yds or 3 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	200 cu.yds or 3 per material type	
		2 inch	100			
		¾ inch	50 – 80			
		No. 4	15 – 50			
		No. 200	0 – 5			
	Moisture-Density Relationship	N/A		N/A	N/A	
Drain Gravel Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only LGP track-mounted equipment allowed on Drain Gravel
	Lift Thickness	6-inch above and laterally around perforated pipe		N/A	Continuous Monitoring	Not Compacted
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 9: Leak Detection Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Leak Detection Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Native borrow material or process Waste Overburden
	Atterberg Limits	PI ≤ 15		ASTM D 4318	2 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	2 per material type	
		1 inch	100			
		¾ inch	75 – 100			
		⅜ inch	20 – 55			
		No. 200	0 – 10			
	Moisture-Density Relationship	N/A		N/A	N/A	
Leak Detection Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only track-mounted equipment allowed on Leak Detection Fill
	Lift Thickness	8 inch above and laterally around perforated pipe		N/A	Continuous Monitoring	Hand placed below spring line of pipe
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 10: Pipe Bedding Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Pipe Bedding Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 20		ASTM D 4318	200 lineal feet or 2 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	200 lineal feet or 2 per material type	
		2 inch	100			
		¾ inch	70 – 100			
		No. 4	20 – 70			
		No. 40	0 – 35			
		No. 200	0 – 25			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	200 lineal feet or 3 per material type	Per material type
Pipe Bedding Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	Maximum 6-inch thick loose lift		N/A	Continuous Monitoring	
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	100 lineal feet	Only hand-guided, mechanical tampers, or hand-guided vibratory rollers shall be used around pipes
	Field Moisture Content	N/A		N/A	Continuous Monitoring	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 11: Cable Bedding Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Cable Bedding Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	N/A		ASTM D 4318	2 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	2 per material type	Screened Drainage Layer or Native Alluvium
		⅜ inch	100			
	Moisture-Density Relationship	smooth and non-yielding		ASTM D 1557	N/A	
Cable Bedding Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Lift Thickness	6-inch loose lift below cables 12-inch loose lift above cables		N/A	Continuous Monitoring	Hand guided-compaction equipment only
	Field Density	Visually documentation of a smooth and non-yielding surface		N/A	Continuous Monitoring	
	Field Moisture Content	N/A		N/A	Continuous Monitoring	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 12: Riprap

Type	Parameter	Standard					Test Method	Frequency (units per test)	Comments
Riprap Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials					N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 20					N/A	N/A	
	Sieve Analysis	**Riprap D50**	**8”**	**12”**	**16”**	**28”**	ASTM D 5519	2 per material type	
			Rock Size (in.)						
		D_{100}	12	18	24	42			
		D_{85}	10	14	20	36			
		D_{50}	8	12	16	28			
		D_{15}	3	4	6	12			
	Moisture-Density Relationship	N/A					N/A	N/A	
Riprap Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials					N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	1.5 x D_{50}					N/A	Continuous Monitoring	
	Field Density	N/A					N/A	Continuous Monitoring	Track-walked or bucket compacted
	Field Moisture Content	N/A					N/A	N/A	
	Sand Cone Referee Density	N/A					N/A	N/A	
	Laboratory Moisture Content	N/A					N/A	N/A	

Table 13: Safety Berm Material

Type	Parameter	Standard	Test Method	Frequency (units per test)	Comments
Safety Berm Material Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Atterberg Limits	N/A	N/A	N/A	
	Sieve Analysis	N/A	N/A	N/A	
	Moisture-Density Relationship	N/A	N/A	N/A	
Safety Berm Material Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Lift Thickness	N/A	N/A	N/A	Shall be placed by loader, dozer or grader
	Field Density	N/A	N/A	N/A	Uncompacted
	Field Moisture Content	N/A	N/A	N/A	
	Sand Cone Referee Density	N/A	N/A	N/A	
	Laboratory Moisture Content	N/A	N/A	N/A	

Table 14: Textured Geomembrane Required Minimum Properties (Per GRI-GM13)

Parameter	Test Value		Test Method (ASTM)	Manufacturer Quality Control Frequency (units per test)
	60 mil	80 mil		
Thickness mils (min avg.)	57 mil	76 mil	D 5994	Per roll
Thickness (Minimum 8 of 10)	-10% (54 mil)	-10% (72mil)		
Lowest individual for any of the 10 values	-15% (51 mil)	-15% (68 mil)		
Asperity Height	16 mil	18 mil	D 7466	Every 2nd roll*
Density (g/cc) min.	0.940	0.940	D 1505/D 792	200,000 lb
Tensile Properties (min. avg.)*				
Yield Strength (lb/in)	126	168	D 6693 Type IV	20,000 lb
Break strength (lb/in)	90	120		
Yield Elongation (%)	12	12		
Break Elongation (%)	100	710		
Tear Resistance (lbs) (min. ave)	42	56	D 1004	45,000 lb
Puncture Resistance (lbs) (min. ave)	90	120	D 4833	45,000 lb
Stress Crack Resistance (hr)*	500 hr	500 hr	D 5397	Per GRI GM-10
Carbon Black Content (%)	2.0-3.0	2.0-3.0	D 4218*	20,000 lb
Carbon Black Dispersion*	See Notes*	See Notes*	D 5596	45,000 lb
Oxidative Induction Time (OIT)				
Standard OIT (minutes), or	100	100	D 3895	200,000 lbs
High Pressure OIT (HP OIT) (minutes)	400	400	D 5885	
Oven Aging at 85°C (min. avg.)*)			D5721	Per each formulation
a. Std OIT (% retained after 90 days) min. avg. or;	55	55	D 3895	
b. HP OIT (% retained after 90 days) min avg.	80	80	D 5885	
UV Resistance (min ave)*			D5721	Per each formulation
a. Std. OIT (min. avg.), or	N.R.	N.R.	D 3895	
b. HP OIT (min. avg.) (% ret. after 1600 hrs)*	50%	50%	D 5885	

*Refer to Notes presented in Table 02775-1 of Section 02775 in the Technical Specifications

Table 15: HDPE Geomembrane Seam Properties Wedge and Extrusion Welds (per GRI GM-19a)

Parameter	Textured HDPE Test Values		Test Method (ASTM)	Testing Frequency (units per Test)	Comments
	60 mil	80 mil			
Seam Shear Strength (lbs/in) minimum*	120	160	D 6392	500 LF per machine	Peel and Shear seams must fail in the Film Tear Bond mode*
Lowest Individual Seam Shear Strength of 5 tests (lbs/in)*	96	128			
Shear elongation at break (%)	50	50			
Seam Peel Strength (lbs/in) minimum*	91 for hot wedge 78 for extrusion	121 for hot wedge 104 for extrusion			
Lowest Individual Seam Peel Strength of 5 tests (lbs/in)*	73 for hot wedge 62 for extrusion	97 for hot wedge 83 for extrusion			
Peel separation (%)	25	25			

*Refer to Notes presented in Table 02775-2 of Section 02775 in the Technical Specifications

Table 16: Geomembrane Conformance Testing

Property	Test Value	Test Method (ASTM)	Testing Frequency (units per Test)
Thickness (mils)	See Table 13	D 5199	2,000,000 sq. ft. per liner type, or per resin lot, whichever is greater (each test)
Compound Density (g/cc)	See Table 13	D 1505	
Tensile Strength (Both yield and ultimate strength and elongation, as specified)	See Table 13	D 6693	
Carbon Black Content (%)	See Table 13	D 4218	

Table 17: Minimum Average Roll Values For Reinforced Geofilm Related GCL Material (per GRI-GCL3)

Property	ASTM Test Method	Value	Comments
Cap Geosynthetic			Material Data Sheets shall be provided to the Engineer per Section 01300 of the Technical Specifications
Type	-	Non-woven	
Weight	ASTM D 5261	6.0 oz/sq.yd.	
Carrier Geosynthetic			
Type	-	Woven	
Weight	ASTM D 5261	3.0 oz/sq.yd.	
Geofilm			
Thickness	ASTM D 5199/ D 5994	4 mil	
Break Tensile Strength (MD & XMD)	ASTM D 882	12 lb/in	
Clay Properties			
Clay Type	-	80% or more montmorillonite	
Bentonite Mass at 0% Moisture*	ASTM D 5993	0.75 psf	
Maximum Allowable Moisture Content	ASTM D 5993	35%, by weight	
Swell Index	ASTM D 5890	24 ml/2g min	
Fluid Loss	ASTM D 5891	18 ml max	
GCL Composite Properties			
GCL Permeability*	ASTM D 6766	5×10^{-10} cm/sec max at 5.0 psi	
Tensile Strength in Machine Direction	ASTM D 6768	23 lb/in	
Peel Strength	ASTM D 6496	2.1 lb/in	
Geofilm Durability*	ASTM D 5721	80% strength	
Internal Shear Strength	ASTM D 6243	150 psf typical	

*Refer to Notes presented in Table 02350-2 of Section 02350 in the Technical Specifications

Table 18: Minimum Average Roll Values For Geotextile Material (per GRI-GT12a)

Parameter	ASTM Test Method	Value	Testing Frequency	Comments
Weight	D 5261	12 oz/sq.yd.	1 per material type, or as requested by the Engineer	Material Data Sheets shall be provided to the Engineer per Section 01300 of the Technical Specifications
Grab Tensile	D 4632	300 lb		
Grab Tensile Elongation	D 4632	50%		
Trapezoidal Tear Strength	D 4533	115 lb		
Puncture (CBR) Strength	D 6241	800 lb		
UV Resistance (at 500 hrs)	D 7238	70% strength retained		
Apparent Opening Size	D 4751	No. 100 Sieve (0.15 mm)		

*Refer to Notes presented in Table 02272-1 of Section 02272 in the Technical Specifications.

Table 19: Minimum Average Roll Values for Geonet Material (per GRI-GN4)

Parameter	ASTM Test Method	Value	Testing Frequency	Comments
Thickness* (min. ave.)	D 5199	200 mil	1 per material type, or as requested by the Engineer	Material Data Sheets shall be provided to the Engineer per Section 01300 of the Technical Specifications
Density* (min. ave.)	D 1505/D 792	0.950 g/cm*		
Carbon Black Content (%)	D 1603/D 4218	1.5-3.0%		
Tensile Strength* (MD)	D 7179	180 lb/in		
Compressive Strength* (min. ave.)	D 6364	120		
Transmissivity*	D 4716	5.0 gal/min-ft		

*Refer to Notes presented in Table 02273-1 of Section 02273 in the Technical Specifications.

Table 20: Cast-In-Place Concrete

Type	Parameter	Test Value	Test Method (ASTM)	Testing Frequency	Comments
Cast-In-Place Concrete (Reinforced)	Compressive strength	4,000 psi at 28 days	C 39	4 Standard 6-inch diameter by 12-inches long test cylinders for every 50 yards of concrete poured or for each pour, whichever is greater	One at 7 days, one at 14 days, and one at 28 days, one reserve
	Maximum aggregate size	3/4-inch	C 136		
	Slump	3 to 5 inches	C 143	Every 50 yards of concrete poured or for each pour, whichever is greater	
	Air Entrainment (%)	4 to 6%	C 233	Every 50 yards of concrete poured or for each pour, whichever is greater	
Lean Mix Concrete (unreinforced)	Compressive strength	2,000 psi at 28 days	C 39	4 Standard 6-inch diameter by 12-inches long test cylinders for every 50 yards of concrete poured or for each pour, whichever is greater	One at 7 days, one at 14 days, and one at 28 days, one reserve
	Maximum aggregate size	1.5-inch	C 136		
	Slump	3 to 5 inches	C 143	Every 50 yards of concrete poured or for each pour, whichever is greater	

APPENDIX A

Example of CQA Daily Field Report

DAILY FIELD REPORT

DATE: **PROJECT NO.**

REPORT NO.
FILE TO:

GRASSY MOUNTAIN TSF CONSTRUCTION

Table 1: Present at Site

Organization	Responsibility

Table 2: Equipment Present at Site

Qty	Type	Make/Model	Notes

Health and Safety

■

Construction Activity Summary

■

QA/QC Activity Summary

■

Issues and Resolution

■

Meetings and Discussions Summary

■

Signature
First and Last Name
Title

Total Hours On-site:
Field Equipment:
Vehicle:

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Photographs

Description

APPENDIX K

Geotechnical Monitoring Plan

REPORT

Geotechnical Monitoring Plan
Tailings and Waste Rock Dump Facilities
Grassy Mountain Mine

Malheur County, Oregon

Submitted to:

Calico Resources USA Corp.
665 Anderson St.
Winnemucca, Nevada 89445

Submitted by:

Golder Associates Inc.
595 Double Eagle Ct., Suite 1000
Reno, Nevada, USA 89521

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1663241-057-R-Rev0

November 6, 2019

Geotechnical Monitoring Plan
Tailings and Waste Rock Dump Facilities
Grassy Mountain Mine

Malheur County, Oregon

The following geotechnical monitoring plan has been prepared by the staff of Golder Associates Inc. under the professional supervision of the engineers whose signatures appear herein.

The monitoring plan and recommendations presented to Calico Resources USA Corp. have been prepared in accordance with generally accepted profession engineering principles and practices.

Golder Associates Inc.

11/6/19

EXPIRES: 12/31/2020

Christopher J. MacMahon, PE
Associate, Engineer of Record

Russell A. Browne, PE (NV)
Principal, Senior Tailings Practice Leader

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Lead Civil Design Engineer

Document Revisions

Date	Revision	Comment
November 6, 2019	0	Final Plan Prior to Construction

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1.0 INTRODUCTION

This Geotechnical Monitoring Plan (Plan) was prepared by Golder Associates Inc. (Golder) for Calico Resources USA Corp. (Calico) to monitor the geotechnical performance and stability of the planned Tailings Storage Facility (TSF) and Waste Rock Dump (WRD) at the Grassy Mountain Mine in Malheur County, Oregon.

This Plan was prepared in accordance with the design as presented in the Detailed Design Tailings Storage Facility and Waste Rock Dump Facility Report (Golder, 2019).

Monitoring instrumentation described in this Plan includes vibrating wire (VW) piezometers, flow meters, survey monuments, and inclinometers. At the time of this report, construction has not started on either the TSF and WRD. Upon completion of Stage 1 TSF and WRD construction, this Plan shall be updated to reflect the as-built instrumentation.

The goals of monitoring the Grassy Mountain TSF and WRD are to:

- Monitor pore pressure in the foundation clay to detect development of excess pore pressures during the construction of the Stages 1 through 3 North Embankment to confirm short-term construction stability and to monitor pore pressures throughout the operating life of the facility.
- Monitor the pore pressure at the base of the impounded tailings above the toe drain pipe and primary underdrain collection pipes in the TSF and WRD to confirm that the drainage system continues to operate within design parameters.
- Monitor pore pressures in the foundation below the TSF basin and WRD pad lining systems to confirm the proper containment performance.
- Monitor leakage flow rates between the primary and secondary containment layers in the TSF and WRD liner systems.
- Monitor flow rates from the Primary TSF collection pipes, and the TSF toe drain pipe, prior to discharge into the reclaim pond to verify proper functioning of the pipes and to support water balance estimates.
- Monitor displacements of the TSF dam embankment crest that could indicate instability and/or excessive settlement.
- Monitor potential subsurface displacements within the TSF dam embankment and in the underlying foundation soils to provide early indication of potential instability prior to development of evidence that can be measured or recognized at the surface.
- Visually inspect the operation and general condition of the TSF and WRD during operation and construction to monitor the overall performance of the facilities.

Monitoring is through both measurements of Monitoring Points and visual observations of surface conditions. For the purposes of this Plan, a Monitoring Point is defined as any geotechnical instrument or Dam Crest Survey Monument installed to monitor the geotechnical field conditions at the TSF and WRD. The parties that will be responsible for the data collection, instrument maintenance, reporting, and data review, are defined as follows:

Owner/Operator – As the owner and operator of the TSF and WRD, Calico will be responsible for implementation of this Plan, data collection, instrument maintenance, summarizing data, reporting internally and to regulatory agencies, identifying trends in the data that could be of concern as outlined in this plan, assuring the involvement

of an Engineer of Record throughout construction, operation, and closure of the TSF and WRD, and notifying the EOR when needed as required by the Plan. Calico staff are responsible for data collection will be referred to as the Monitor.

Monitor – Calico will directly employ or subcontract qualified personnel to collect readings of the instrumentation presented in this Plan. The Monitor will be responsible for collecting and managing data obtained from the vibrating wire piezometers, inclinometers, leak detection ports, and regular visual inspections. The Monitor will be responsible for completing internal quality control checks before the data is submitted to the Operator and/or the EOR for review.

Surveyor – Calico will use their own surveyor or a subcontracted professionally-licensed surveyor to monitor Survey Monuments. The Surveyor will be responsible for routine and as-needed data collection, and for completing internal quality control checks before the data is submitted to the Operator and/or the EOR for review.

Engineer of Record (EOR) – Engineer, or EOR, refers to a geotechnical engineering firm that is experienced in monitoring and assessing stability and performance of mining facilities, and who is familiar with the Grassy Mountain TSF and WRD designs, construction, and operation. The EOR should be a Professional Engineer licensed in the State of Oregon. The EOR will assist Calico with installation of the monitoring points, review and interpret monitoring data, and provide engineering recommendations in their role as EOR or when requested by Calico. For this project, the EOR is Christopher J. MacMahon, PE of Golder Associates in our Reno, Nevada office.

This Plan describes the geotechnical monitoring and reporting for the TSF and WRD with the intent of developing consistent and accurate data for use in geotechnical interpretation. Specifically, this Plan:

- Summarizes the location and installation information of planned monitoring points;
- Outlines monitoring requirements, including frequency, responsible parties, calibration, monitoring protocol, and monitoring quality control methods;
- Defines routine reporting requirements, including frequency, responsible parties, and reporting format; and
- Summarizes notification and reporting requirements for unusual data readings or data trends.

This Plan will be used by the Operator and their consultants or subcontractors assigned to tasks associated with monitoring and reporting. The Plan is dynamic, and modifications may be appropriate based on changes to staged construction, operation, readings, and embankment performance. It will be updated by the Operator as details of the monitoring program change, which could include addition, replacement, or abandonment of monitoring points, changes in the frequency of monitoring, changes in site conditions, refinement or revisions in monitoring protocol, and changes in reporting requirements.

2.0 MONITORING POINT TYPE, LOCATIONS, AND INSTALLATION

Figure 1 shows the types and locations of planned monitoring points for the Stage 1 construction. Table 1 summarizes the type, location, depth/elevation, and installation date of each of the monitor points. A description of installation details follows. The following systems will be installed to monitor the performance of the TSF and WRD:

- Vibrating wire (VW) Foundation Piezometers

- VW Impoundment Piezometers
- VW Underliner Piezometers
- Underdrain Flow Monitoring System
- Dam Crest Survey Monuments
- Inclinometers
- Leak Detection Piping System

2.1 Vibrating Wire Piezometers

This Plan presents the VW piezometers to be installed at strategic locations throughout the TSF and WRD. Each VW piezometer identification ID referenced in this Plan is considered a Monitoring Point. At each Monitoring Point, either a matching pair or nested VW piezometers will be installed. Paired/nested piezometer systems provide redundancy and confirmation on measured readings.

As construction and operations progress, instruments are sometimes abandoned due to malfunction, failure, damage from construction equipment, and blinding or plugging. Redundant pairs are often installed in an attempt to maintain adequate monitoring points throughout construction and operation when monitoring is most critical.

As presented in the Plan Tables, each VW ID includes an “a,” “b,” or “c” providing a unique identifier for each instrument at each Monitoring Point.

Figure 1 presented in this Plan is intended as a schematic showing the relative location of each Monitoring Point. Construction-level installation details for the Monitoring Points are presented in the *Grassy Mountain Mine, Tailings Storage Facility and Waste Rock Dump,* Revision 0, dated November 2019 prepared by Golder and should be reviewed parallel with this Plan.

2.1.1 Vibrating Wire Foundation Piezometers

A total of eight nested groups of VW Foundation Piezometer (PZ-TF series) will be installed in the foundation clay below the North and West embankment footprints to monitor the pore pressures in the foundation soils during embankment placement and throughout operations. The locations of the piezometers are shown on Figure 1 and Table 1. Each nested group will contain three VW piezometers as shown on Figure 2.

Three nested Foundation Piezometers will be installed in vertical boreholes drilled into the foundation clay below the following locations:

- Stage 1
  - Four boreholes below the North embankment (PZ-TF-1, 2, 4 and 5)
  - One borehole below the West embankment (PZ-TF-7)
- Stage 2
  - Two borehole below the North embankment (PZ-TF-3 and 6)
  - One borehole below the West embankment (PZ-TF-8)

- Stage 3
  - None

All Foundation Piezometers will be installed prior to each planned expansion stage embankment construction as described above. The Foundation Piezometers will be installed at variable depths as determine by the trigger level stability modeling discussed in Section 5.2.2. Sensor depth below the native ground surface and nesting intervals for each Foundation Piezometer are presented on Table 1. Foundation Piezometers will be grouted in-place using manufacturer recommended bentonite-Type II cement grout mix.

The piezometer signal cables will be directly buried in trenches excavated through the native foundation soils and routed toward the TSF reclaim pond. Cables will be bedded and backfilled with cable bedding sand to prevent damage to the cables due to embankment construction.

The cables will be routed to a readout station installed along the access road adjacent to the reclaim pond and underdrain channel.

Readout Stations will be installed near the Stage 3 downstream toe of the North and West Embankments where the Foundation Piezometer signal cables will be routed to. The following Readout Stations will be installed for the instrumentation listed:

- RS-1: PZ-TF-1 through PZ-TF-6
- RS-5: PZ-TF-7 and PZ-TF-8

Location of the embankment Foundation Piezometers and sensor depths are presented on Table 1 and readout station locations are presented on Table 2.

2.1.2 Vibrating Wire Impoundment Piezometers

PZ-TI Series – Drainage Layer above TSF Lining System

A total of five VW piezometer pairs (PZ-TI series) will be installed at the base of the impoundment to monitor hydraulic head within the Drainage Later above the TSF lining system:

- Two Impoundment Piezometer pairs (PZ-TI-1 and PZ-TI-2) adjacent to the primary underdrain collection pipes at the inlet to the underdrain channel (Stage 1 upstream toe)
- One Impoundment Piezometer pair in the northern portion of the basin (PZ-TI-3)
- One Impoundment Piezometer pair below the supernatant pool (PZ-TI-4)

The Impoundment Piezometers will be installed directly in the drainage layer, within the geotextile which surrounds the primary underdrain collection pipes and the toe drain pipe. The piezometer cables will run through the drainage layer to the upstream embankment slope. The cables will be routed up the upstream slope to a temporary readout station on the embankment crest. The cables will be secured to the upstream geomembrane liner by placing a strip of HDPE geonet above the cables on the primary layer that is spot extrusion welded.

Locations of the Impoundment Piezometer pairs are presented on Table 1 and readout station locations are presented on Table 2.

PZ-WI Series – Drainage Layer Above WRD Lining System

A VW piezometer (PZ-WI series) will be placed in the Drainage Layer adjacent to the primary collection pipe at the outlet from the WRD pad. The cables will be routed to a Readout Station RS-2 installed along the access road adjacent WRD Pad berm at the haul road as shown on Figure 1 and Table 2. Locations of the WRD Impoundment Piezometer pair and Readout Station RS-2 are presented in Table 1.

2.1.3 Vibrating Wire Underliner Piezometers

PZ-TU Series – Below TSF Lining System

Two VW piezometer pairs (PZ-TU series) will be installed below the GCL of the TSF lining system within the subgrade and at the general locations as the PZ-TI series located at the upstream toe of the Stage 1 embankment, immediately below the underdrain outlet channel to monitor development of pore pressures below the TSF lining system.

The signal cables will be bedded and routed in a cable trench in the subgrade embankments. The signal cable will route adjacent to the underdrain channel to Readout Station RS-1 on the east side of the underdrain channel adjacent to the reclaim pond and access road as shown on Figure 1 and Table 2. Locations of each TSF basin Underliner Piezometer pair are presented in Table 1.

PZ-WU Series – Below WRD Lining System

An Underliner Piezometer pair (PZ-WU series) will be installed below the GCL of the WRD lining system and within the subgrade. The signal cables will be bedded in a cable trench in the subgrade below the containment berm and be routed to Readout Station RS-2 as shown on Figure 1 and Table 2. Location of the WRD Underliner Piezometer pair is presented in Table 1.

2.2 Underdrain Flow Monitoring

Parshall Flumes will be installed along the TSF and WRD underdrain outlet pipes in the underdrain channel prior to discharge to the reclaim pond (Figure 1). The Parshall Flumes will be permanent installations, capable of measurement of open channel flow (i.e. not pipe full) flow rates. The Parshall Flumes will allow independent assessment of the performance of the underdrain pipes and provide flow rate data for use in calibration of the water balance model. Three Parshall Flumes (TUF-1 through 3) will monitor underdrain flow rates from the TSF Basin. One Parshall Flume (WUF-1) will monitor underdrain flow rates from the WRD Pad.

Ultrasonic Transducers will be mounted to each Parshall Flume to monitor flow rates. Signal cables from the ultrasonic transducers will be routed overland to Readout Station RS-3 located adjacent to the TSF reclaim pond as shown on Figure 1 and Table 2. Locations of each underdrain monitoring flume are presented in Table 1.

2.3 Survey Monuments

Dam crest survey monuments will be installed along the North and West Embankment crests for each construction stage. The crest survey monuments monitor vertical and horizontal displacements of the embankment after construction to assess settlement and horizontal movement of the embankment.

Survey monuments will be imbedded into the embankment at least 18 inches and constructed of corrugated CPE pipe backfilled with Lean Mix Concrete and a 2.5-inch diameter flush-mounted brass survey cap cast into top surface. For each stage of construction, two survey monuments will be installed along the downstream crest of the North Embankment and two monuments along the West Embankment. The locations of the survey monuments are shown on Figure 1. Locations of dam crest survey monument are presented in Table 1.

2.4 Inclinometers

Three sets of inclinometers (INC1, INC2, and INC3 series) will be installed through the North and West embankments at the locations shown in Figure 1 to monitor stability of the embankment. For each construction stage, two inclinometers will be installed in North Embankment. One inclinometer will be installed in the West Embankment for Stages 2 and 3, each. No inclinometer will be installed in the West Embankment during Stage 1.

Prior to construction of subsequent stages, existing inclinometers will be abandoned by backfilling with bentonite-Type II cement grout mix or flowable concrete backfill. At the completion of each subsequent stage of embankment expansion, three new inclinometers will be installed for Stage 2 (INC2-1, INC2-2, and INC2-3) and Stage 3 (INC3-1, INC3-2, and INC3-3).

The bottom of each inclinometer casing was set below the deepest anticipated potential critical failure surface below the embankment. The inclinometer alignment grooves on the casings are to be designated as “A” axis and “B” axis. The “A” axis is to be installed perpendicular to the dam alignment to monitor inclinations in the direction of potential movement. Location and total depth of each inclinometer is presented on Table 1. The top of the inclinometer will be protected using a steel surface completion and traffic bollards on the staged dam crest.

2.5 Leak Detection

The TSF and WRD are equipped with leak detection systems to monitor the performance of the containment systems. Although leak detection systems do not directly indicate geotechnical performance of the TSF and WRD, they can be used as an early warning system for instrumentation that may experience elevated pore pressure that would relate to geotechnical stability. Therefore, leak detection of the TSF and WRD is included in this Plan.

Leak detection system will be installed during all stages of construction and will consist of:

- Perforated 2-inch diameter Schedule 80 PVC pipes installed below the primary geomembrane liner in areas where concentrated underdrain flows are expected in the TSF and WRD basins for all stages of construction
- Secondary containment geomembrane liner, geonet leakage collection recover system (LCRS) with HDPE evacuation riser pipe at TSF reclaim pond
- Secondary containment pipe (dual containment HDPE piping) for the Reclaim Pipe from the reclaim pond to the Mill
- Secondary containment pipe (dual containment HDPE piping) for the Tailings Delivery Pipe from the Mill to the TSF
- Secondary containment pipe (dual containment HDPE piping) for the Supernatant Return Water Pipe from the TSF to the Mill
- Secondary containment pipe (dual containment HDPE piping) for the WRD Underdrain Pipe from the WRD to the TSF basin
- Visual monitoring of the underdrain channel from the TSF basin to the reclaim pond

The leak detection pipes report to independent risers for monitoring and fluid evacuation. Locations of the leak detection piping and monitoring risers are shown on Figure 1.

Dual containment piping will be monitored visually during dry climate conditions as discussed in Section 5.2.9. All outlet points for dual containment piping are located above either the TSF basin, underdrain channel, or reclaim pond lining systems.

3.0 ACTIONS FOR DAMAGED OR LOST MONITORING POINTS

Over the course of monitoring or data collection, it may be discovered that one or more monitoring points has become damaged or lost. Inclinometer and survey monitoring points installed on the Stage 1 and Stage 2 embankments will require abandonment or relocation during the subsequent dam raises.

For all other instrumentation, if damaged or disturbed, readings will still be taken, if possible, and the damage reported. If lost or inaccessible, reasonable attempts will be made to access the point and the reason for inaccessibility will be reported. Damaged or lost monitoring points will be noted on the data collection sheets and remitted to those responsible for review and interpretation. These notes should include comments regarding the condition of the monitoring point and the feasibility of repairing a damaged monitoring point.

The Operator staff reviewing the data and preparing the monitoring report will be responsible for recommending actions regarding these lost or damaged monitoring points. The recommendations will also consider input from the EOR. Actions may include replacement, abandonment, or continued use, and such actions will be based on trends observed in the point or other points in its vicinity prior to the occurrence of damage.

4.0 MONITORING METHODS

4.1 Monitoring Frequency

Monitoring frequencies will generally be quarterly but will be increased during staged embankment construction and may also be triggered by visual observations, earthquake, intense rain or flood events, above-average seasonal precipitation, or Trigger Level readings from monitoring points. The monitoring frequencies are provided in Table 4 through Table 10.

4.2 VW Piezometers

4.2.1 Description and Specifications

The recommended VW piezometers and data loggers are manufactured by RST Instruments, based in Maple Ridge, British Columbia. The piezometers are pluck-type vibrating wire sensors with built-in thermistors.

Underliner and Impoundment VW piezometers (PZ-TI, PZ-WI, PZ-TU, and PZ-WU series) will have a pressure range of 0 to 100 psi with a resolution of 0.03 psi at 100 psi (Model Number VW2100).

Embankment Foundation VW piezometers (PZ-TF series) will be standard VW piezometers prefabricated for nested construction (Mutli-point Piezometer Strings) and will have a pressure range of 0 to 150 psi with a resolution of 0.04 psi at 150 psi (Model Number VW2100MP). Nesting of the Embankment Foundation VW piezometers will be at the vertical intervals described in Section 2.1.1.

A single channel VW portable readout (model number VW2106), will be provided for all VW piezometers for instantaneous field measurements during and after installation. The readout will measure a frequency range of 400 Hz to 6000 Hz, a temperature readout range between -50 and 80 °C, with a frequency resolution of 0.01 µs and temperature resolution of 0.1 °C.

After initial installation, Data loggers and multiplexers will be installed within each Readout Station to collect real-time measurements of all VW piezometers. The RST FLexDAQ system is recommended. The RST FlexDAQ system includes a CR6 data logger, manufactured by Campbell Scientific, Inc. of Logan, Utah, and an RST Flexi-Mux multiplexer system capable to managing the quantity VW piezometer signal cables at each Readout Station presented in Table 2. Each Readout Station stall will be equipped with an internal or solar power supply, lightning protection, and weatherproof enclosure.

If required by Calico, each Readout Station can be equipped with cellular, satellite, ethernet, or radio transmission capabilities to connect to the Mine's wired or wireless communication network for remote and real time monitoring.

Specifications, installation instructions, and detailed operation instruction sheets for VW piezometers, single channel portable readout, and data loggers and multiplexers, are presented in Appendix A.

4.2.2 Accuracy

The Impoundment and Underliner PZ-TI, PZ-WI, PZ-TU, and PZ-WU series VW piezometers will have a pressure range of 0 to 100 psi with a resolution of 0.03 psi at 100 psi (Model Number VW2100).

VW piezometers (PZ-TF series) will be of standard VW piezometers prefabricated in nested construction (Multi-point Piezometer Strings) and will have a pressure range of 0 to 150 psi with a resolution of 0.04 psi at 150 psi (Model Number VW2100MP).

For optimum accuracy, water level measurements should be taken using the same VW data recorder or datalogger and should be measured and recorded to the nearest 0.1 Hz.

4.2.3 Installation Protocol and Quality Control

During installation of the VW piezometers, recommended manufacture installation procedures are to be followed. The EOR shall oversee or directly perform the installation of VW piezometers. During installation, an RST VW2016 portable readout device, manufactured by RST Instruments, will be used to record initial and baseline readings. Upon acceptance by the EOR, the VW piezometers may continue to be monitored by the Operator using the RST VW2106 readout device approved by the EOR or install a remotely operated data logger.

If a remotely operated data logger is installed, an RST FlexDAQ Data Logger and Flexi-Mux Multiplexer, manufactured by RST Instruments can be installed at each Readout Station where VW piezometer signal cables are terminated. Each Readout Station should be equipped with a suitable quantity of Flexi-Mux Multiplexers to allow concurrent connection of all VW piezometers at each Station.

4.2.4 Monitoring Protocol and Quality Control

Locations and identification of the piezometers are summarized in Figure 1 and Table 1. The Monitor will refer to the checklist/table of active piezometers during monitoring to ensure that all piezometers have been measured.

The VW piezometers will be measured using RST VW2016 portable readout device or RST FlexDAQ data logger. Initial calibration and continuity testing of the VW piezometers should be performed with the RST VW2016 portable readout device during installation to ensure all Impoundment Piezometers are functioning properly.

Portable Data Recorder

When taking readings with the VW2016 portable readout device, the following protocol, field calibration, and measurement procedures will be followed:

- Bring the water pressure readings from the previous survey and check current water head against the previous survey to identify in the field any unusual piezometric readings.
- Turn on the VW data recorder; check the battery and replace if necessary.
- The connection wires should be cleaned prior to use as necessary.
- Take the readings, including both temperatures and frequencies, and examine the accuracy by comparison of the new readings and previous readings.
- If a significant discrepancy is observed, check wire connections and take another reading. Repeat the above two steps until the difference between two consecutive readings is within ±0.2 Hz.
- Measure water level readings to the nearest 0.1 Hz. The readings should be recorded only after piezometric readings are stable.
- In the event of an unusual reading, the piezometric level will be measured again to confirm or revise the original measurement.
- The Monitor will also enter on the form the loss or damage of a piezometer with a description of any damage and whether the piezometer remains usable.

After the data is collected, the measured frequencies and temperatures will be converted into water pressure (fluid head in feet) using the spreadsheet attached in Appendix B. Depending on the selected instrumentation manufacturer, the final spreadsheet implemented may vary based on specific requirements of the manufacturer.

Data Logger

When taking readings with the RST FlexDAQ data logger, the following protocol, field calibration, and measurement procedures will be followed:

- Data collection frequency should be set to a minimum one reading per day per instrument.
- Bring the water pressure readings from the previous survey and check current water head against the previous survey to identify in the field any unusual piezometric readings.
- Download recorded data from data logger using either the remote communication system or hardwire connection to the data logger.
    - Downloaded readings should include the following data:
        - Channel Number
        - Instrument ID as defined in this Plan
        - Instrument serial number
        - Raw data reading (Hz, or digits and temperature) to the nearest 0.1

  - Calculated pressure (if programmed) to the nearest 0.1 feet

- Examine the accuracy by comparison of the new readings and previous readings.
- If a significant discrepancy is observed, check wire connections and take another reading. Repeat the above two steps until the difference between two consecutive readings is within ±0.2 Hz.
- In the event of an unusual reading, the piezometric level will be measured again to confirm or revise the original measurement.
- The Monitor will also enter on the form the loss or damage of a piezometer with a description of any damage and whether the piezometer remains usable. The Monitor will also record the date and time when readings were lost.

After the data is collected, the measured frequencies and temperatures will be recorded in a separate database file and provided to the EOR on a monthly basis. If the data logger is not configured to calculate pore pressures, the spreadsheet attached in Appendix B will be used. Depending on the selected instrumentation manufacturer, the final spreadsheet implemented may vary based on specific requirements of the manufacturer.

Manufacturer's calibration factors are applied in the spreadsheet and can be applied to the data logger configuration files. According to manufacturer's specifications in Appendix A, elevation and barometric calibration will not be required since the piezometers are unvented and buried at depths are not influenced by ambient barometric pressure.

4.3 Flow Monitoring

4.3.1 Underdrain Flumes

Recommended underdrain flow monitoring will be performed by installing open channel flumes adjacent to the reclaim pond within the underdrain channel as shown on Figure 1. A total of four flumes will be installed to monitor independent underdrain flow rates from the TSF basin (TUF Series) and from the WRD pad (WUF Series). The flumes will each be a 2-inch fiberglass reinforced Parshall Flume manufactured by TRACOM, Inc. of Alpharetta, Georgia.

The flumes will be located adjacent to the reclaim pond and within the lined underdrain channel. Flumes will be installed such that the flume crest is level in all directions. The flumes will be placed in pairs such that two flume pairs are separated by a minimum 3 feet of clear span for access. Flumes will be cast in concrete to prevent movement.

Mounting brackets will be prefabricated on each flume above the throat for mounting of the ultrasonic flow meter.

Manufacturer shop drawings, specifications, installation instructions, and detailed operation instruction sheets for VW piezometers, single channel portable readout, and data loggers and multiplexers, are presented in Appendix A.

4.3.2 Water Level Measurements

Recommended flow meters for the underdrain monitoring flumes will be the Dynasonics iSonic 4000 Open Channel Flow Meter by Badger Meter, Inc. of Milwaukee, Wisconsin for fixed-installation open channel flow meter type applications. The iSonic 4000 flow meter measures the open channel water surface level using the EchoPod

DL-10 sensor manufactured by Flowline of Los Alamitos, California. Flow rates are calculated in the iSonic 4000 by programing the data logger with the Parshall Flume geometry provided by the Flume manufacture.

Flow rates are measured by using ultrasonic waves and rely on fluid level, and average velocity measurements using acoustic doppler profiling technology. The electronics are DC powered (12V) but can be equipped with an AC power source if selected by the Owner. The electronics incorporate a datalogger that can store flow rate data in memory for later retrieval either through modem or via a USB link to a computer. The data logger can store up to 130,000 distinct readings of flow rate at pre-defined intervals. However, measurement intervals are adjustable from 1 second to 24 hours. The integral LCD display provides instantaneous flow rate reading as well as date, time, and water level.

Specifications, installation instructions, and detailed operation instruction sheets for VW piezometers, single channel portable readout, and data loggers and multiplexers, are presented in Appendix A.

4.3.3 Accuracy

The ultrasonic transducers installed on the Parshall Flumes can measure flow rates ranging from a minimum of 3 gallons per minute (gpm) to 194 gpm. The EchoPod DL-10 sensor has a measurement accuracy of 0.125 inches. This accuracy equates to an error of between 0.8 gpm and 4 gpm depending on the water level within the flume.

4.3.4 Monitoring Protocol and Quality Control

The underdrain pipe flow monitoring will be used to confirm the TSF and WRD underdrain system are functioning properly and flows are not obstructed, limiting drainage of the tailings and WRD that could raise the hydraulic head on the liner, and possible reduction of predicted tailings consolidation.

The underdrain flow rates will vary depending on tailings thickness above the drainage layer. During initial tailings deposition of each stage of construction, a high percentage of the process flow will be collected by the underdrain and report to the reclaim pond through the flumes.

The pipe flow rate data will also be used to calibrate the process water balance. Flow rate and totalized volume data at 15-minute increments should be collected at least quarterly.

4.4 Dam Crest Survey Monuments

4.4.1 Description and Specifications

Recommended dam crest survey monuments are 2½-inch diameter cast-in-place brass survey cap (Model M/M-BCS-2 1/2FS) manufactured by Surv-Kap LLC of Tucson, Arizona. The survey cap will be installed in a 12-inch diameter CPE pipe that is backfilled with grout. The monument will be embedded into the dam crest a minimum of 18-inches.

The northing, easting, and elevation of the top of the survey monuments will be monitored using GPS surveying equipment equipped with a high-accuracy receiver. The position of the monuments will be measured using the Post-Process Mode on the GPS receiver.

If elected to do so by Calico, remote GPS monitoring stations can be installed in lieu of survey monuments. The remote GPS monitoring stations will collect real-time location information and store the reading in a data logger that can be retrieve either by direct download or remote communication equipment.

4.4.2 Accuracy

Accuracy of survey monitoring point readings is a function of the equipment used. The Surveyor will use methods and equipment to achieve an accuracy in each of the northing, easting, and elevation readings of about 0.04 feet.

Crest Monument surveys will be completed and reported to the nearest 0.01 feet for northing, easting, and elevation.

Real-time data recording through remote GPS monitoring stations would provide a daily average of all collected GPS data and account for variability in GPS satellite communication. Whereas instantaneous GPS readings using conventional survey equipment will include a level of inaccuracy due to variability in GPS satellite communications.

4.4.3 Calibration and Maintenance

The Surveyor will be responsible for regular equipment maintenance and reading corrections for atmospheric conditions, such as temperature and pressure. The Operator will be responsible for maintaining the survey monuments and making sure the survey monuments are clear of fill materials, are accessible, and remain properly marked or flagged to reduce the risk of damage.

4.4.4 Monitoring Protocol and Quality Control

The locations and designations of crest survey monuments are summarized in Figure 1, and Table 1. The Surveyor will review the figure and table during monitoring to ensure that all points have been surveyed. Prior to mobilizing to the site, the Surveyor will enter the coordinates and elevations of each point from the most recent previous survey. This data will be used as a quality control check against current readings to allow additional surveying in the event of unusual readings.

The position of all survey monuments will be shot at the top and center of the monument or survey cap. When surveying, if any monument appears to be disturbed, a note will be made using the example visual observation sheet attached in Appendix B. The Surveyor will also enter on the monitoring form the loss or damage of a monitoring point, with a description of any damage and whether the monitoring point remains usable.

4.5 Inclinometers

4.5.1 Description and Specifications

Recommended inclinometer instruments are RST Digital MEMS Inclinometer System manufactured by RST Instruments. The system includes the 2.75-inch diameter Snap Seal inclinometer casing, Digital MEMS Inclinometer digital probe, 200-foot long Kevlar® reinforced polyurethane cable, the Ultra-Rugged Field PC, and Inclinalysis software.

Tilt is positive on one side of the vertical and negative on the other side. Tilt is converted to a lateral displacement and the incremental lateral distances are summed to give a cumulative displacement. The probe measures tilt in two perpendicular directions; parallel to the probe wheels (A-orientation) and perpendicular to the wheels (B-orientation). The A-orientation should be in the direction of the expected slope movement.

The specifications for the casing, probe, data recorder, and software system are provided in Appendix A. The inclinometer probe does not measure displacement directly. Instead, it measures the tilt of the casing.

4.5.2 Accuracy

As documented in the specifications, the accuracy of the recommended inclinometer probe is ±0.02 inches over 100 ft, which is well within the accuracy requirements of the project.

4.5.3 Monitoring Protocol and Quality Control

Using proper care of the inclinometer probe and recommended sampling measurement protocol will result in little error in inclinometer readings and little need for calibration. However, the inclinometer probe should be field checked for calibration before each round of monitoring and, if needed, be calibrated by a qualified person such as the manufacturer.

The survey is performed by lowering the probe in the grooved casing to the bottom of the bottom of the hole. The survey is started in the same groove for each survey (referred to as the 0-direction) with the wheels parallel to the expected direction of slope movement. As the probe is raised it is stopped at typically 2 feet intervals and allowed to stabilize. Pressing a button on the datalogger records a reading. Readings are taken at 2 feet intervals to the top of the hole.

The probe is then rotated 180 degrees (referred to as the 180-direction) and the survey repeated. Ideally the sum of the two readings at each interval (referred to as checksums) should be zero since the readings have opposite signs. In practice, variations in casing grooves, the positioning of the probe and offset within the probe itself contribute to non-zero check sums. A check sum is the sum of the 0- and 180-direction reading at the same depth. The average of the 0- and 180-degree readings are applied to compute the lateral displacements.

Locations and identifications of planned inclinometer casings are shown on Figure 1, and Table 1. The Monitor will refer to Table 10 of this report during monitoring to ensure that all inclinometers have been measured. The Monitor will also enter on the field form the loss or damage of an inclinometer casing, any blockage in the inclinometer casing that prevents a full sounding, a description of any damage to the inclinometer casing, and whether the casing remains usable.

The inclinometer readings will be taken using the Ultra-Rugged Field PC, manufactured by RST Instruments. With this system, readings are taken at depth intervals of 2 feet. The following procedures will be used for collecting inclinometer readings:

- Make sure that the battery is charged prior to mobilizing to the site.
- For the highest accuracy, always use the same probe and control cable. If a different probe is used, be sure to note the serial number of the probe being used for each data set so corrections can be made during data processing.
- Always use the same reference for the depth marks on the control cable. If one technician uses the cleat on the pulley assembly as reference and another technician uses the top of the casing as reference, there will be a one-foot variation in the probe position from survey to survey. Accurate results require placement repeatability of ¼ inch or less.
- Mark the “A“ axis groove in the casing with paint or with a notch in the casing. Always start the survey by placing the top wheels of the probe in that groove.

- Two sets of readings will be taken in each set of two slots. For each set of slots, the first reading will be taken on the “A” axis position (top wheels of probe in the 0-direction). The second reading will be taken by rotating the instrument 180 degrees (top wheels in the 180-direction, “B” axis).
- For future new casing installation, survey the casing two to three times and compare the “checksum.” Choose a representative set as the initial reading set. All other data sets will be compared with this set.
- It is preferable to use the same software and same user for data input and presentation. See Appendix B for the example sheet that shows the format used for data reporting.

Before submitting the data to the Operator personnel and the EOR for review and interpretation, the Monitor taking the readings will perform a quick quality control check by completing the following:

- Plot the results and compare with the historic readings. If movement distribution or magnitude does not roughly follow or match the historic data, a new reading will be taken to validate the reading. The magnitude of the largest movement readings between consecutive probing should be within the accuracy of the inclinometer probe.
- Compare the movements of the inclinometer at the ground surface with that of nearby surface monuments. If the difference of recent surface movements is found to be greater than ½ inch, a new reading should be taken to validate the reading of the inclinometer. The magnitude of the largest movement readings between consecutive probing should be within the accuracy of the inclinometer probe.

4.6 Leak Detection

The Monitor will perform inspection of leak detection systems defined in Section 2.5 and findings recorded on facility-specific checklists (to be prepared prior to operation). Leak detection monitoring will be performed a minimum of once per week.

Leak detection monitoring will be performed using both visual and mechanical detection methods. For leak detection risers installed to monitoring the TSF basin, reclaim pond, and WRD pad, leak detection will be performed using a field mirror to observer the riser sumps.

For dual containment piping and secondary containment channels, visual observations during dry weather will be recorded.

If convict water is observed in any of the leak detection risers or dual containment monitoring points, the following will be performed by the Monitor:

- Record the date and item leakage is observed
- Record the location where leakage is observed
- Evacuate the convict fluid into an area where primary containment exists
- Record total volume of convict water evacuated
- Turn off submersible pump (if used for fluid evacuation) and observe if leak detection riser continues to fill with water. Record observations.

If convict water continues to report to leak detection monitoring point, immediately notify the Operator. The Operator should notify the EOR to assist with determination in the source of the leak and develop a mitigation or corrective action plan.

Prior to operation, the EOR and Operator will prepare facility-specific checklists to be used by the Monitor or EOR for visual inspections. The documentation checklist, as well as any supporting documentation, will be submitted to the Operator staff responsible for reporting and coordinating with the EOR.

4.7 Visual Monitoring

Visual observations will typically be made quarterly coinciding with the measurement of Monitoring Points. Additional inspections may be completed during construction, following large storm events, earthquakes, and operational abnormality, or may be triggered by a Monitoring Point Reading. The visual observations will be completed by the Operator's staff or its Surveyor but should be completed at least annually by the EOR.

Visual monitoring will include:

- Walking the crest and toe of the embankment and observing surface conditions
- Checking the conditions of exposed Monitoring Points, readout stations, and wirings (where exposed)
- Observing upstream and downstream slope conditions of the embankment and ground conditions near the downstream toe of the embankment
- Inspection of all leak detection monitoring points

Visual monitoring is intended to identify new development or changes in surface cracks, surface displacements, bulges in slopes, slumps, sag ponds (depressions), and seepage and/or wet areas.

Observations of any changes will be documented by:

- Recording the locations observed on a drawing
- Recording an estimate of the observed change in writing, including the magnitude of the change (seepage flow, wet area, width or length of crack, etc.
- Photographing the change

An example visual inspection checklist is presented in Appendix B. Prior to operation, the EOR and Operator will prepare facility-specific checklists to be used by the Monitor or EOR for visual inspections. The documentation checklist, as well as any supporting documentation, will be submitted to the Operator staff responsible for reporting and coordinating with the EOR.

5.0 MONITORING AND ACTION PLAN

This section provides guidance on expected trends in both short-term construction monitoring and long-term monitoring so that unusual readings can be identified, and appropriate actions be taken in response to those readings. Readings from the monitoring points that are above normal trends will activate Trigger Levels that increase in severity from Trigger Level 1 to Trigger Level 3 with associated changes in the monitoring frequency and notifications.

5.1 Normal Trends

The following normal trends are anticipated during and after staged embankment construction:

VW Foundation Piezometers (PZ-TF Series): These piezometers monitor pore pressures in the foundation clay soils beneath the North and West Embankments. During staged construction, some short-term increases in pore pressure in the Foundation Piezometers can be expected. After staged construction, pore pressures are expected to dissipate, and piezometric readings should decrease over time. During embankment fill placement, pore pressure readings should be reviewed regularly by the EOR to identify any concerns of lowered stability.

VW Impoundment Piezometers (PZ-TI and PZ-WI Series): These piezometers monitor water pressure development in the TSF and WRD underdrain systems prior to water leaving the TSF impoundment or WRD pad. The piezometers monitor fluid head in feet. Under normal conditions, these piezometers should be monitoring fluid heads of less than 3 feet. Higher heads could be caused by closed valves where underdrain outlets enter the reclaim pond, an obstruction in the underdrain outlet pipe, or construction activity.

VW Underliner Piezometers (PZ-TU and PZ-WU Series): These piezometers monitor water pressure development in the native soils or prepared subgrade below the TSF and WRD lining systems at the upstream toe of each facility adjacent to, and below, the VW Impoundment Piezometers. The piezometers monitor fluid head in feet. Under normal conditions, these piezometers should be monitoring fluid heads of negative or zero feet. Higher heads could be caused construction related pore pressures or leakage in the impoundment lining system.

Underdrain Flumes (TUF and WUF Series): These flumes and associated flow meters measure flow rates of each underdrain pipe prior to release in the reclaim pond. Flow rates are expected to fluctuate throughout operation depending on the stage of deposition and the area of exposed TSF basin and WRD pad. As tailings deposition and waste rock stacking progress, the exposed basin and pad areas will reduce, and the underdrain flow rates are expected to drop to a lower and steady-state condition.

Dam Crest Survey Monuments (SM Series): Crest survey monuments will measure both vertical and horizontal movement during and after staged construction. Only minor movements can be expected with movements expected to diminish after staged construction has been completed. If dam crest survey monuments are monitored during construction, movements are expected to be larger.

Inclinometers (INC Series): Inclinometers will monitor vertical and lateral stress relaxation in the embankment fill and foundation clay, in addition to monitoring for the presence of shear displacements which could be indicators of lowered stability. The normal condition is some slow lateral deformation without signs of shear deformations.

Leak Detection Systems: Leak detection systems will monitor for convict water between primary and secondary containment systems within the TSF impoundment, underdrain channel, reclaim pond, WRD, and process pipelines. The normal condition is no convict water detected.

5.2 Trigger Levels

The following section presents measurable or quantifiable values and observations for determination if a reading or event activates a Trigger Level. If a Trigger Level is activated, the Trigger Action Response Plans presented in Section 5.3 will be executed.

Trigger Levels listed below are specific to seismic activity and geotechnical monitoring of instruments. Additionally, increased monitoring frequency of the process solution containment systems should be performed in the event of extreme weather conditions such as prolonged heavy rainfall, prolonged freezing or intense snowfall..

5.2.1 Seismic Activity

During operation of the TSF, there is a potential for seismic activity. In the event that seismic activity is recorded or observed at the Site, the following Trigger Levels will be used to determine the level of response required:

Trigger Level 1: A seismic event of a Magnitude IV (Light) earthquake on the Modified Mercalli scale. A Magnitude IV is characterized as being felt by most people; windows and doors are rattled; creaking walls and/or a sensation like a heavy truck striking a building are felt; and vehicles are noticeably rocked. No injuries, severe property damage or disruption to operations.

Trigger Level 2: A seismic event of a Magnitude V to VII (Moderate to Very Strong) earthquake on the Modified Mercalli scale. A Magnitude V to VII is characterized as being felt by all people; many people are frightened and run outdoors; some windows broken; cracked plaster on building walls; unstable objects overturned; sloughing of embankment; sliding or rockfalls outside of construction activity; and disturbance of poles and other tall objects is noted. Injury or severe property damage occurs, disruption to operations.

Trigger Level 3: A significant earthquake (M ≥ 7.2) within 17 miles of the TSF regardless of observable damage at the Site or a seismic event of an earthquake of Magnitude VIII or larger (Severe or greater) on the Modified Mercali scale. A Magnitude VIII or greater is characterized as being felt by all people; some people are knocked off balance; changes are noted in the water depths of wells; considerable damage occurs in buildings; panel walls are thrown out of frames in buildings; heavy furniture is overturned; the ground cracks conspicuously; waves can be seen on the ground surface; and underground pipes are broken. Severe injuries or fatality, widespread property damage, operations severely affected or shut down.

For up-to-date earthquake activity, the Monitor should regularly monitor the United States Geologic Survey's website for Earthquake Hazards, Latest Earthquakes map for earthquakes in the near vicinity (within 60 miles) of the Grassy Mountain Mine site (USGS 2019, https://earthquake.usgs.gov/earthquakes/map/).

If a Trigger Level is activated, the Trigger Action Response Plans presented in Section 5.3 will be executed.

5.2.2 TSF Foundation Piezometers

These piezometers monitor pore pressure in the clayey foundation soils that underly the TSF. The regional groundwater is below the depth of the Foundation Piezometers and under normal circumstances, these piezometers are expected to record unsaturated conditions (zero or negative pore pressures) or possibly fluid heads of less than 2 to 3 feet reflecting local perched zones of groundwater or immediate pore pressure increases due to construction loading.

During staged embankment construction, the embankment will impose loads on the foundation of up to approximately 75 psi. Foundation soils with high degrees of saturation may develop excess pore pressures that may not dissipate at the rates of construction loading, resulting in a reduction of the effective stresses and the potential for instability.

Pore pressure readings in Foundation Piezometers in the TSF embankment foundation clay (PZ-TF Series) will be used as indicators of reduced confidence of stability during periods of staged construction and long-term

operation. The following discussion provides the Monitor with information on the impact of high piezometric pore pressure readings and helps set trigger levels for stability-related piezometers.

5.2.3 Pore Pressure Measurement in Foundation Piezometers

The piezometers installed in the dam foundations (PZ-TF Series) are used to monitor pore pressure development in the clay foundation and its impact on the static stability of the North and West Embankments.

As indicated during the 2017 and 2019 geotechnical field investigations, and as modeled in the stability analyses that supported the construction-level design, groundwater is sufficiently deep such that existing groundwater conditions will not influence overall long-term stability of the tailings dam. However, the geotechnical investigations in the foundation clay soils identified zones that are close to saturation and interbedded with less saturated sandy zones, although no static water level or piezometric surface was encountered. There is a risk that staged construction could temporarily create pore pressures in the foundation clay soils, which could lead to a short-term reduction in the strength of the foundation, potentially influencing short-term stability of the dam.

Personnel responsible for monitoring and evaluating the pore pressures in the Foundation Piezometers need guidelines for what piezometric levels constitute a concern so that notifications and evaluations can be made during staged construction. Accordingly, Golder has established Trigger Levels by using stability models to compare stability response to creation and/or changes in a piezometric surface within the foundation clay soils below the embankments.

The following stability case scenarios were evaluated to develop Trigger Levels using the most critical dam sections for the North and West Embankments. For assignment of these Trigger Levels, Golder assumed that pore pressure under the embankment would be developed uniformly at the levels recorded in the Foundation Piezometers. The following stability cases were evaluated:

- Dry conditions with no pore pressure development in foundation clay soils
- Geotechnical material properties used in the construction-level design are presented on Table 3.
- Foundation piezometric elevation in the foundation clay soils required to reduce the overall static factor of safety:
  - Trigger Level 1: Below the design criteria of 1.5
  - Trigger Level 2: To about 1.3
  - Trigger Level 3: To about 1.05

For each of the above cases, the critical failure mode is a deep rotational failure through the dam and foundation clay soils under static conditions. Results of the trigger level stability analyses are presented in Appendix C.

The stability analysis results indicate that significant development and/or changes in pore pressures in the foundation clay soils will affect the stability of the embankment.

It should be noted that short-term development and fluctuation of piezometric levels within the foundation clay soils would only be expected during staged construction or in the event of a significant leak in the TSF impounding lining system. Any detection of pore pressure should be confirmed with a minimum of two consecutive readings.

If significant changes of pore pressures are measured during construction, the EOR should review the readings to determine whether the pore pressure response is expected or not, and to evaluate its potential influence on the stability and performance of the embankment. If the EOR's review identifies a potential stability risk during active embankment fill placement, a solution may be to slow fill placement to allow sufficient pore pressure dissipation.

Build-up of pore pressures in the embankment foundations when embankment loading is not ongoing could signal high leakage rates through the impoundment liner or a rise in the regional water table.

Trigger Level criteria and TARPs are the same during construction and outside of construction with only the frequency of monitoring reduced when construction is not on-going. Based on the above stability analyses, Table 4 presents the Monitoring Plan and Trigger Levels for the Foundation Piezometers.

If a Trigger Level is activated, the Trigger Action Response Plans presented in Section 5.3 will be executed.

5.2.4 Impoundment Piezometers

The piezometers installed at the base of the TSF impoundment and WRD pad, within the Drainage Layer above the lining system, and adjacent to the primary underdrain collection pipes (PZ-TI and PZ-WI Series).

These piezometers monitor pore pressure development in the underdrain system prior to water exiting the impoundment or pad. The underdrain spacing design was developed based on estimates on the hydraulic conductivity of the tailings and the gradient of the lined surface and was intended to limit pore pressure on the lining system to reduce the potential leakage through the liner if there were a hole. Under normal conditions, these piezometers are predicted to record fluid heads less than approximately 3 feet.

High fluid head levels at the base of the tailings may signal an impeded collection system and Drainage Layer potentially resulting from crushed pipes, clogged Drainage Layer or Filter Fill, or an obstruction of the underdrain outlet pipes.

Trigger Levels for the Impoundment Piezometers are separated into three groups of instruments:

- Impoundment Piezometers PZ-TI-1 and PZ-TI-2 are located immediately adjacent to the Stage 1 upstream toe and monitor the performance of the underdrain pipes as it exits the lined TSF impoundment.
- Impoundment Piezometers PZ-TI- 3 and PZ-TI-4 are located within the TSF basin and monitor performance of the drainage layer and underdrain collection pipe network. Elevated pore pressures within the TSF Basin do not pose a risk to geotechnical stability, therefore, higher pore pressures Trigger Levels are assigned.
- Impoundment Piezometer PZ-WI-1 is located at the upstream toe of the WRD perimeter containment berm and monitors the performance of the underdrain pipe as it exits the lined WRD pad.

Table 5 and Table 6 provide the Monitoring Plan for the TSF and WRD Impoundment Piezometers, respectively.

If a Trigger Level is activated, the Trigger Action Response Plans presented in Section 5.3 will be executed.

5.2.5 Underliner Piezometers

These piezometers monitor water pressures below the TSF lining system at the upstream toe of the Stage 1 embankment and the WRD containment berm. These piezometers should indicate dry (zero or negative pore pressures) conditions. Development of saturated conditions or significant head pressures would indicate leakage

through the liner system. Table 7 and Table 8 present the Monitoring Plans and Trigger Levels for the TSF and WRD Underliner Piezometers, respectively.

If a Trigger Level is activated, the Trigger Action Response Plans presented in Section 5.3 will be executed.

5.2.6 Underdrain Flow Monitoring

The underdrain flow rates will vary depending on the depth of burial of the underdrain piping. During the early stage of tailings construction, a high percentage of the process flow will be collected by the underdrain system. During tailings deposition directly onto the TSF basin, combined underdrain flows are predicted to be as high 100 gpm. As tailings cover the TSF basin, combined underdrain flow rates are expected to drop to between about 15 gpm and 30 gpm.

No Trigger Levels are required for the underdrain flows. If Trigger Levels are activated for the VW Impoundment or Underliner piezometers (PZ-TI, PZ-WI, PZ-TI, and PZ-WU Series), the underdrain flow rates will be used in determining if a reduction in underdrain flows reporting to the reclaim pond is an indicator for adverse performance within the TSF basin.

5.2.7 Survey Monuments

Settlement of the embankment crests is anticipated in response to the consolidation settlement of the foundation clay soil and within the embankment fill due to long term settlement and consolidation. Up to 3.5 feet of foundation settlement is predicted below the maximum embankment height. Dam crest settlements are expected to be less than foundation settlements due to staged constructions and reestablishment of design dam crest elevations.

The dam crest survey monuments measure the movement of the embankment crest, including horizontal movement and vertical settlements. Movement of these monuments is expected to occur for a period of time during, and following, embankment construction and tailings deposition.

The dam crest survey monuments will be installed upon completion of each stage of embankment construction. Locations are shown on Figure 1 and the coordinates for all survey monuments are provided in Table 1 .

Trigger Levels have been assigned for dam crest survey monuments during construction and during operation (no active construction). Table 9 presents the Monitoring Plan and Trigger Levels for the dam crest survey monuments.

If a Trigger Level is activated, the Trigger Action Response Plans presented in Section 5.3 will be executed.

5.2.8 Inclinometers

The inclinometer measures the horizontal deformation of the embankment over the height of the embankment and into the foundation to a depth where no movement is predicted. Under normal conditions, some horizontal movement can be expected from settlements, but there should be no evidence of shear movement at a discrete depth. Shear movement is characterized as a significant differential displacement over a relatively short vertical distance. Table 10 presents the Monitoring Plan and Trigger Levels for the inclinometers.

If a Trigger Level is activated, the Trigger Action Response Plans presented in Section 5.3 will be executed.

5.2.9 Leak Detection

Leak detection systems will collect any water between primary and secondary containment layers for the TSF and WRD. In the event that fluid is detected in the leak detection risers, portable submersible pumps will be used to evacuate the monitoring risers of the convict water and reduce fluid head on the secondary containment layer.

Fluid level monitoring in the leak detection risers will be performed visually the Monitor using a field mirror or water level indicator. Any flows observed in the leak detection piping system are considered abnormal and activate Trigger Level 1. Flows observed in the underdrain channel during dry weather are considered to activate Trigger Level 1.

5.2.10 Visual Monitoring

The Monitor should watch for any signs of distress in the dam crest, upstream and downstream slopes, and foundation near the downstream toe. Distress would include vertical offsets, cracks, heaves, seepage, or wet spots during dry periods. The triggering conditions are discussed below:

- **Trigger Level 1**: Localized cracking on the crest or slopes with crack openings or vertical offsets up to ½-inch for any length of crack; any wet spots (during dry weather) or intermittent seepage from the embankment slopes or foundation near the downstream toe of the dam.
- **Trigger Level 2:** Fracture zones forming a cone-shape on the dam crest or downstream slope; any cracks or vertical offsets wider than ½ inch wide traceable for up to 20 feet in the dam crest or slopes; visible bulging or deformation at the toe area any continued or significant seepage from the embankment slopes or from the foundation near the downstream toe of the dam.
- **Trigger Level 3:** Continued propagation of cracks and slope deformation; and increase in seepage or leakage rates from visible seeps.

5.3 Trigger Action Response Plans

5.3.1 Seismic TARPS

In the event that seismic activity is recorded that is considered to meet the conditions of the seismic Trigger Levels presented in Section 5.2.1, the corresponding Seismic TARP will be implemented:

Trigger Level 1:

- Record the date and time of the earthquake and provide a description of the earthquake, such as the duration, the indicators, and the consequences.
- Inspect the fluid management systems for signs of leaks or releases and implement response measures as appropriate.
- Continue to monitor leak detection systems twice daily for two days for the presence of leaks; implement response measures as appropriate.
- Continue to monitor the VW piezometer and inclinometers twice daily for two days for presence of pore pressure increases or displacement.

Trigger Level 2:

- Record the date and time of the earthquake and provide a description of the earthquake, such as the duration, the indicators, and the consequences.
- Inspect the fluid management systems for evidence of damage and signs of leaks or releases and implement response measures as appropriate. Record all damage noted. Inspection should include all piping and vessels in the mill and process facilities. Solution and collection ponds and the tailings impoundment should be inspected for embankment movement, sudden changes in water levels, or seepage flowing from the ground in the vicinity of the pond.
- In the event of damage such that process fluid may escape, implement measures to prevent a release as soon as possible.
- Continue to monitor the VW piezometer and inclinometers twice daily for seven days for presence of pore pressure increases or displacement.
- Perform a survey of the dam crest survey monuments to detect deformation at least twice daily for seven days.
- If differential displacement has occurred in the tailings impoundment, in the tailings dam, or in solution ponds, processing will be stopped until the EOR (or at their direction) has evaluated the damage and determined that the integrity of the lining systems has not been impaired. If damage is observed in reclaim pond, solution from the pond should be recirculated to the TSF impoundment.
- If no leakage is noted in leak detection systems, continue to monitor leak detection systems twice daily for seven days.

Trigger Level 3:

- Record the date and time of the earthquake and provide a description of the earthquake, such as the duration, the indicators, and the consequences.
- Immediately notify the Process Operations Superintendent. Notification will be escalated from the Process Operations Superintendent to the Process, Environmental, Projects Managers, and the EOR.
- Cease operations until the structural integrity of the fluid management systems including the tailings impoundment and solution ponds can be inspected by the EOR (or at their direction).
- Immediately inspect the embankment and top of the impoundment for obvious deformation, cracks, raveling, or any other noticeable movements.
- Inspect the fluid management systems for evidence of damage and signs of leaks, releases or obstruction and implement response measures as appropriate.
- In the event of damage such that process fluid may escape, implement measures to prevent a release as soon as possible.
- If it is determined that the structural integrity of the facilities has not been diminished by the earthquake and there is no evidence of leaks or releases from the fluid management system, continue to monitor the leak detection system twice daily for 14 days.

- If facility is safely accessible, collect VW piezometer and inclinometers data leading up to and after the seismic event.
- If facility is safely accessible, continue monitoring the VW piezometer and inclinometers once daily for 14 days for presence of pore pressure increases and displacement.
- If facility is safely accessible, perform a survey of the dam crest survey monuments to detect deformation at least once daily for 14 days.
- Review underdrain flow-rates against previous or historic flow-rates, and immediately report any variance or anomalies to the Process Operations Superintendent.
- Check water level switches in drainage collection sump for possible malfunctions caused by line breaks or shorts. If switched off, activate immediately.
- Restart tailings deposition only after all inspections have provided satisfactory results, and release for service has been granted by Process, Environmental, Projects Managers, and the EOR.
- If facilities have been damaged beyond repair and require closure, continue to monitor the leak detection systems for those facilities through the closure period.

For a lesser earthquake (M < 7.2 and closer than 17 miles), **the same inspections will be carried out**, but deposition of tailings may continue unless the inspections indicate that continued operations may be detrimental to any component of the facility.

5.3.2 Instrumentation, Leak Detection, and Visual Monitoring TARPs

In the event that monitoring instrumentation measurement recordings, leak detection recordings, or visual observations are considered to meet the conditions of Trigger Levels presented in Section 5.2, the corresponding TARPs will be implemented:

Trigger Level 1: Not of immediate geotechnical concern to the integrity and performance of the dam. Trigger Level 1 readings or observations should be reviewed by the Monitor. If, through review, Level 1 readings are verified as accurate, the Operator shall be notified, and the Monitor shall increase the monitoring frequency to see whether they could develop to the conditions of Trigger Level 2.

Trigger Level 1 events requires notification of a reading outside of the range of anticipated values to the Operator (Tailings Supervisor) AND EOR. All or some of the following actions should be considered in response to a Trigger Level 1 event:

- Record the date and time of the trigger event and provide a description of the event and subsequent follow-up action taken by Monitor.
- One to two additional readings of the Monitoring Point(s) that exceeded the trigger level to confirm the reading(s), taken within one week of the initial reading.
- A review of the triggering readings, adjacent readings, and spreadsheet calculations to make sure the instruments are functioning properly to confirm that the problem is not associated with input or data reduction.

- Increasing the monitoring frequency of the Monitoring Point(s) with the high reading(s) and surrounding Monitoring Points.
- If not a data error, the Monitor will notify the Process Operations Superintendent. Notification will be escalated from the Process Operations Superintendent to the Process, Environmental, Projects Managers, and the EOR.
- If recommended by the EOR and/or Operator, an engineering analysis to check the implication of the conditions.
- A close out memorandum prepared to document the trigger event, investigation, engineering analyses (if any), recommendations, and follow-up action items.

Trigger Level 2: A concern for the integrity and performance of the dam. Readings or observations that exceed Level 2 will require immediate team attention and response. Trigger Level 2 may require additional monitoring, heightened monitoring, and/or initiation of remedial measures.

Trigger Level 2 events require notification and attention by the Operator and the EOR. The following actions should be implemented by the team, which should consist of Operator project management and engineers, and the EOR:

- Record the date and time of the trigger event and provide a description of the event and subsequent follow-up action taken by Monitor.
- One to two additional readings of the Monitoring Point(s) that exceeded the trigger level to confirm the reading(s), taken as soon as possible after the triggering data has been reduced.
- If not a data error, the Monitor will notify the Process Operations Superintendent. Notification will be escalated from the Process Operations Superintendent to the Process, Environmental, Projects Managers, and the EOR.
- A review of the triggering readings, adjacent readings, and spreadsheet calculations to make sure the instruments are functioning properly to confirm that the problem is not associated with input or data reduction.
- If recommended by the Operator or EOR, a site inspection by the EOR, or designee, should be performed.
- Inspection of pertinent leak detection monitoring points.
- A meeting or a conference call to discuss reading history, trends, likely causes and actions to be taken.
- Increasing the monitoring frequency of the Monitoring Point(s) with the high reading(s) and surrounding Monitoring Points.
- If not data error, a review of the site data by the EOR to assess the potential cause of the readings and to provide recommendations for additional data collection.
- If recommended by the EOR and/or Operator, an engineering analysis to check the implication of the conditions.
- If recommended by the EOR and/or Operator, a remediation plan prepared by the team.

- A review of the conditions to see whether they exceed the Environmental permitting limits.
- An individual report documenting the conditions, actions and remediation actions.
- A close out memorandum prepared to document the trigger event, investigation, engineering analyses (if any), recommendations, and follow-up action items.

Trigger Level 3: A condition of imminent concern that could lead to a failure of the dam embankment and trigger the implementation of the Emergency Action Plan (EAP) for the TSF. The EAP will be prepared and issued prior to construction.

Trigger Level 3 events require notification and attention by the Operator and the EOR. The following actions should be implemented by the team, which should consist of Operator project management and engineers, and the EOR:

- Record the date and time of the trigger event and provide a description of the event and subsequent follow-up action taken by Monitor.
- One to two additional readings of the Monitoring Point(s) that exceeded the trigger level to confirm the reading(s), taken as soon as possible after the triggering data has been reduced.
- If not a data error, the Monitor will notify the Process Operations Superintendent. Notification will be escalated from the Process Operations Superintendent to the Process, Environmental, Projects Managers, and the EOR.
- A review of the triggering readings, adjacent readings, and spreadsheet calculations to make sure the instruments are functioning properly to confirm that the problem is not associated with input or data reduction.
- Site visit by the EOR to inspect the instrumentation or monitoring point and to meet with the Operator and Monitor and review.
- Increasing the monitoring frequency of the Monitoring Point(s) with the high reading(s) and surrounding Monitoring Points.
- If not a data error, a site visit and a visual observation by the EOR as soon as possible to observe site conditions and monitoring conditions.
- If recommended by the EOR and/or Operator, an engineering analysis to check the implication of the conditions.
- If recommended by the EOR and/or Operator, a remediation plan prepared by the team.
- A review of the conditions to see whether they exceed the Environmental permitting limits.
- A review of the EAP to see whether it meets the conditions listed in the EAP and requires corresponding actions.
- An individual report documenting the conditions, actions and remediation actions.

6.0 MONITORING NOTIFICATIONS AND REPORTING

Monitoring data will be collected from all available monitoring points at the frequencies discussed in the previous Sections and summarized in Table 4 through Table 10. Any triggering events or unusual conditions, such as intense storm events, earthquakes, or operational abnormality may prompt more frequent monitoring.

If unusual conditions are observed during visual inspection, or if Trigger Levels are activated, the Monitor will immediately notify the Process Operations Superintendent in charge of monitoring and the EOR and implement the corresponding TARP presented in Section 5.3.

- Trigger Level 1 requires the Process Operations Superintendent to be informed and the Monitor will follow the steps outlined in Section 5.0 and inform the Process Operations Superintendent of their findings.
- Trigger Level 2 requires notification to the Process Operations Superintendent and the Mine Superintendent and review of the data by the EOR.
- Trigger Level 3 requires a site visit by the EOR and meetings with the Process Operations Superintendent, Mine Superintendent and EOR. Engineering analyses would be completed to determine the causes of the abnormal readings and develop mitigating strategies.

The monitoring data will be collected, recorded, reduced, and presented using the spreadsheets and reporting templates provided in Appendix B, so similarly prepared by the Operator. Use of these templates may promote the need for minor changes in the format for simplicity or accuracy. Upon operation, such changes to monitoring and reporting templates will be incorporated into future revisions of this Plan.

Monitoring data will be measured and reported to the following tolerances:

- VW piezometers – to the nearest 0.1 feet in fluid head
- Underdrain Flow Monitoring – to the nearest 0.1 gpm
- Survey Monuments – to the nearest 0.01 feet in northing, easting, and elevation
- Inclinometers – as presented using the equipment and applicable software
- Leak Detection – total volume in gallons to the nearest 1 gallon and flow rate to the nearest to 0.1 gpm.

Unless monitoring is driven by Trigger Level 3, the Operator will provide the EOR with all geotechnical monitoring data for review and interpretation on a quarterly basis, or more frequent. Annually, the geotechnical monitoring data will be presented in either the Engineer of Record's Annual Inspection Report or a Geotechnical Monitoring Report. The Report will be used to summarize the data collected, provide a geotechnical evaluation of the data, and document the data, conclusions, and recommendations.

If readings or observations activate Trigger Level 3, a geotechnical evaluation will be conducted as soon as possible, and the results and recommendations will be provided in a Geotechnical Monitoring Report.

In preparation of developing the Engineer or Record's Annual Inspection Report or annual Geotechnical Monitoring Report, all monitoring data will be remitted by the Monitor and Surveyor to the Process Operations Superintendent and the EOR, who will review the data, draw conclusions from data trends observed, and provide recommendations as appropriate. The Geotechnical Monitoring Report will be prepared by the EOR with input from the Monitor and Process Operations Superintendent.

The annual Geotechnical Monitoring Report will include the following:

- Summary of the monitoring data collected since submittal of the previous Report.
- Summary of any additional monitoring points installed or monitoring points abandoned since submittal of the previous Report.
- Interpretation of monitoring data and identification of data showing unusual movements or variation in past trends of movements, including data which exceeded Trigger Levels.
- Conclusions and/or confirmations for facilities, or portions of facilities, that show little to no data trends outside of the normal trends defined in this Plan.
- Explanation of possible cause(s) of unusual trends in the recent Monitoring Point data.
- Recommendations for additional monitoring, response, or remediation (if needed), for portions of facilities where recent monitoring data indicates unusual trends.

In addition, the Report should identify the need for updating this Plan as the details of the monitoring program or the site conditions change.

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Tables

Table 1: Summary of Monitoring Point Installation Locations

Monitoring Point Series	Monitoring Point ID	Easting (ft)	Northing (ft)	Elevation (ft)	Sensor Depth Below Ground Surface (ft)	Comment
Foundation Piezometers	PZ-TF-1a	1,544,584	15,866,622	3545	4	
	PZ-TF-1b	1,544,584	15,866,622	3521	28	
	PZ-TF-1c	1,544,584	15,866,622	3505	44	
	PZ-TF-2a	1,544,613	15,866,672	3545	8	
	PZ-TF-2b	1,544,613	15,866,672	3521	32	
	PZ-TF-2c	1,544,613	15,866,672	3505	48	
	PZ-TF-3a	1,544,680	15,866,766	3545	10	
	PZ-TF-3b	1,544,680	15,866,766	3521	34	
	PZ-TF-3c	1,544,680	15,866,766	3505	50	
	PZ-TF-4a	1,544,336	15,866,678	3524	18	
	PZ-TF-4b	1,544,336	15,866,678	3500	42	
	PZ-TF-4c	1,544,336	15,866,678	3484	58	
	PZ-TF-5a	1,544,378	15,866,798	3524	16	
	PZ-TF-5b	1,544,378	15,866,798	3500	40	
	PZ-TF-5c	1,544,378	15,866,798	3484	56	
	PZ-TF-6a	1,544,434	15,866,928	3524	13	
	PZ-TF-6b	1,544,434	15,866,928	3500	37	

Monitoring Point Series	Monitoring Point ID	Easting (ft)	Northing (ft)	Elevation (ft)	Sensor Depth Below Ground Surface (ft)	Comment
	PZ-TF-6c	1,544,434	15,866,928	3484	53	
	PZ-TF-7a	1,543,274	15,866,086	3583	9	
	PZ-TF-7b	1,543,274	15,866,086	3552	40	
	PZ-TF-7c	1,543,274	15,866,086	3540	52	
	PZ-TF-8a	1,543,232	15,866,153	3583	17	
	PZ-TF-8b	1,543,232	15,866,153	3552	48	
	PZ-TF-8c	1,543,232	15,866,153	3540	60	
TSF Impoundment Piezometers	PZ-TI-1a	1,543,530	15,865,808	3564	N/A	
	PZ-TI-1b	1,543,530	15,865,808	3564	N/A	
	PZ-TI-2a	1,544,354	15,865,777	3572	N/A	
	PZ-TI-2b	1,544,354	15,865,777	3572	N/A	
	PZ-TI-3a	1,544,130	15,866,515	3545	N/A	
	PZ-TI-3b	1,544,130	15,866,515	3545	N/A	
	PZ-TI-4a	1,544,138	15,866,514	3545	N/A	
	PZ-TI-4b	1,544,138	15,866,514	3545	N/A	
WRD Pad Piezometers	PZ-WI-1a	1,543,979	15,864,769	3624	N/A	
	PZ-WI-1b	1,543,979	15,864,769	3624	N/A	

Monitoring Point Series	Monitoring Point ID	Easting (ft)	Northing (ft)	Elevation (ft)	Sensor Depth Below Ground Surface (ft)	Comment
TSF Underliner Piezometers	PZ-TU-1a	1,544,142	15,866,511	3544		
	PZ-TU-1b	1,544,142	15,866,511	3544	N/A	
	PZ-TU-2a	1,544,127	15,866,511	3544	N/A	
	PZ-TU-2b	1,544,127	15,866,511	3544	N/A	
WRD Underliner Piezometers	PZ-WU-1a	1,543,979	15,864,765	3624	N/A	
	PZ-WU-1b	1,543,979	15,864,765	3624	N/A	
TSF Underdrain Flow Meters	TUF-1	1,544,411	15,867,107	3533.7	N/A	Upstream Flume Invert
	TUF-2	1,544,413	15,867,107	3533.7	N/A	Upstream Flume Invert
	TUF-3	1,544,420	15,867,107	3533.7	N/A	Upstream Flume Invert
WRD Underdrain Flow Meter	WTUF-3	1,544,418	15,867,107	3533.7	N/A	Upstream Flume Invert
Survey Monuments	SM1-1	1,544,596	15,866,537	3593.4	N/A	Dam Crest
	SM1-2	1,544,287	15,866,699	3594.6	N/A	Dam Crest
	SM1-3	1,543,507	15,866,204	3595.0	N/A	Dam Crest
	SM1-4	1,543,346	15,866,036	3595.1	N/A	Dam Crest
	SM2-1	1,544,627	15,866,600	3608.0	N/A	Dam Crest
	SM2-2	1,544,347	15,866,751	3608.7	N/A	Dam Crest
	SM2-3	1,543,448	15,866,236	3607.9	N/A	Dam Crest

Monitoring Point Series	Monitoring Point ID	Easting (ft)	Northing (ft)	Elevation (ft)	Sensor Depth Below Ground Surface (ft)	Comment
	SM2-4	1,543,308	15,866,088	3608.1	N/A	Dam Crest
	SM3-1	1,544,655	15,866,649	3620.9	N/A	Dam Crest
	SM3-2	1,544,351	15,866,811	3621.8	N/A	Dam Crest
	SM3-3	1,543,402	15,866,269	3622.0	N/A	Dam Crest
	SM3-4	1,543,255	15,866,116	3622.0	N/A	Dam Crest
Inclinometers	INC1-1	1,544,572	15,866,549	3596.7	105	Total depth from crest
	INC-1-2	1,544,315	15,866,690	3597.5	110	Total depth from crest
	INC2-1	1,544,606	15,866,612	3611.0	135	Total depth from crest
	INC2-2	1,544,416	15,866,876	3554.7	95	Total depth from crest
	INC2-3	1,543,289	15,866,070	3611.1	110	Total depth from crest
	INC3-1	1,544,632	15,866,662	3623.9	150	Total depth from crest
	INC3-2	1,544,444	15,866,965	3553.5	100	Total depth from crest
	INC3-3	1,543,208	15,866,142	3604.5	95	Total depth from crest

Table 2: Summary of Readout Station Installation Locations

Readout Station ID	Assigned Instrumentation	Easting (ft)	Northing (ft)	Ground Elevation (ft)	Comment
RS-1	PZ-TF-1a, 1b, 1c PZ-TF-2a, 2b, 2c PZ-TF- 3a, 3b, 3c PZ-TF-4a, 4b, 4c PZ-TF-5a, 5b, 5c PZ-TF-6a, 6b, 6c PZ-TU-1a, 1b PZ-TU-2a, 2b	1,544,436	15,867,069	3536.8	
RS-2	PZ-WI-1a, 1b PZ-WU-1a, 1b	1,544,186	15,864,680	3642.2	
RS-3	TUF-1 TUF-2 TUF-3 WUF-1	1,544,439	15,867,104	3536.7	
RS-4	PZ-TI-1a, 1b PZ-TI-2a, 2b PZ-TI-3a, 3b PZ-TI-4a, 4b	1,544,116	15,866,643	3595.0	
RS-5	PZ-TF-7a, 7b, 7c PZ-TF-8a, 8b, 8c	1,543,296	15,866,237	3601.8	

Table 3: Material Properties Used in Action Level Stability Analyses

Unit	Unit Weight (pcf)	Strength Type	Stress Shear Strength		
			s_u (psf)	Φ' (deg)	c' (psf)
Tailings	95	Mohr-Coulomb	-	15	0
Lining System	120	Mohr-Coulomb	-	11	0
Embankment Fill	135	Mohr-Coulomb	-	40	0
Alluvium	125	Mohr-Coulomb	-	30	
Clay	120	Mohr-Coulomb	-	14	315

Table 4: Foundation (PZ-TF-Series) Piezometer Monitoring Plan During Normal Operations

Trigger Level	Monitoring Point ID	Trigger Level Criteria (PE=Piezometric Elevation)	Monitoring Schedule		Comment
			During Construction	Outside of Construction	
No Trigger	PZ-TF-Series	Head ≤ 3 feet	Weekly	Monthly	NA
Trigger Level 1	PZ-TF-1a, 1b, 1c PZ-TF-2a, 2b, 2c PZ-TF-3a, 3b, 3c	PE ≥ 3515 feet	Weekly	Weekly	**Corresponds to a Static FOS ≤ 1.5**
	PZ-TF-4a, 4b, 4c PZ-TF-5a, 5b, 5c PZ-TF-6a, 6b, 6c	PE ≥ 3494 feet			
	PZ-TF-7a, 7b, 7c PZ-TF-8a, 8b, 8c	PE ≥ 3550 feet			
Trigger Level 2	PZ-TF-1a, 1b, 1c PZ-TF-2a, 2b, 2c PZ-TF- 3a, 3b, 3c	PE ≥ 3531 feet	2x Daily	2x Daily	**Corresponds to a Static FOS ≤ 1.3** .
	PZ-TF-4a, 4b, 4c PZ-TF-5a, 5b, 5c PZ-TF-6a, 6b, 6c	PE ≥ 3510 feet			
	PZ-TF-7a, 7b, 7c PZ-TF-8a, 8b, 8c	PE ≥ 3562 feet			
Trigger Level 3	PZ-TF-1a, 1b, 1c PZ-TF-2a, 2b, 2c PZ-TF- 3a, 3b, 3c	PE ≥ 3570 feet	2x Daily	2x Daily	**Corresponds to a Static FOS ≤ 1.05**
	PZ-TF-4a, 4b, 4c PZ-TF-5a, 5b, 5c PZ-TF-6a, 6b, 6c	PE ≥ 3549 feet			
	PZ-TF-7a, 7b, 7c PZ-TF-8a, 8b, 8c	PE ≥ 3593 feet			

Table 5: TSF Impoundment (PZ-TI-Series) Piezometer Monitoring Plan

Trigger Level	Monitoring Point ID	Trigger Level Criteria	Monitoring Schedule		Comment
			During Construction	Outside of Construction	
No Trigger	PZ-TI-Series	Head ≤ 3 feet	Weekly	Monthly	
Trigger Level 1	PZ-TI-1a, 1b PZ-TI-2a, 2b	3 feet ≤ Head ≤ 6 feet	Weekly	Weekly	
	PZ-TI-3a, 3b PZ-TI-4a, 4b	5 feet ≤ Head ≤ 8 feet	Weekly	Weekly	
Trigger Level 2	PZ-TI-1a, 1b PZ-TI-2a, 2b	5 feet ≤ Head ≤ 10 feet	Weekly	Daily	
	PZ-TI-3a, 3b PZ-TI-4a, 4b	8 feet ≤ Head ≤ 15 feet	Weekly	Daily	
Trigger Level 3	PZ-TI-1a, 1b PZ-TI-2a, 2b	Head ≥ 10 feet	Daily	Daily	
	PZ-TI-3a, 3b PZ-TI-4a, 4b	Head ≥ 15 feet	Daily	Daily	

Table 6: WRD Impoundment (PZ-WI-Series) Piezometer Monitoring Plan

Trigger Level	Monitoring Point ID	Trigger Level Criteria	Monitoring Schedule		Comment
			During Construction	Outside of Construction	
No Trigger	PZ-WI-Series	Negative or zero	Weekly	Monthly	
Trigger Level 1	PZ-WI-1a, 1b	0 feet ≤ Head ≤ 2 feet	Weekly	Weekly	
Trigger Level 2	PZ-WI-1a, 1b	2 feet ≤ Head ≤ 5 feet	Weekly	Daily	
Trigger Level 3	PZ-WI-1a, 1b	Head ≥ 5 feet	Daily	Daily	

Table 7: TSF Underliner (PZ-TU-Series) Piezometer Monitoring Plan

Trigger Level	Monitoring Point ID	Trigger Level Criteria	Monitoring Schedule	Comment
No Trigger	PZ-TU-Series	Negative or zero	Quarterly	
Trigger Level 1	PZ-TU-1a, 1b PZ-TU-2a, 2b	0 feet ≤ Head ≤ 2 feet	Monthly	
Trigger Level 2	PZ-TU-1a, 1b PZ-TU-2a, 2b	2 feet ≤ Head ≤ 5 feet	Weekly	
Trigger Level 3	PZ-TU-1a, 1b PZ-TU-2a, 2b	Head ≥ 5 feet	Daily	

Table 8: WRD Underliner (PZ-WU-Series) Piezometer Monitoring Plan

Trigger Level	Monitoring Point ID	Trigger Level Criteria	Monitoring Schedule	Comment
No Trigger	PZ-TU-Series	Negative or zero	Quarterly	
Trigger Level 1	PZ-TU-1a, 1b, 2a, 2b	0 feet ≤ Head ≤ 2 feet	Monthly	
Trigger Level 2	PZ-TU-1a, 1b, 2a, 2b	2 feet ≤ Head ≤ 5 feet	Weekly	
Trigger Level 3	PZ-TU-1a, 1b, 2a, 2b	Head ≥ 5 feet	Daily	

Table 9: Survey Monument Monitoring Plan

Trigger Level	Trigger Level Criteria		Monitoring Schedule		Comment
	During Construction	Outside of Construction	During Construction	Outside of Construction	
No Trigger	Horizontal and vertical movements rates less than ½ inch per month	Horizontal and vertical movements rates less than ¼ inch per month	Weekly	Quarterly	All Monuments
Trigger Level 1	Horizontal and vertical movements rates between ½ inch and 1 inch per month, or total movement between 2 and 3 inches	Horizontal and vertical movements rates between ¼ inch and ½ inch per month, or a total movement between 1 and 2 inches	Weekly	Monthly	All Monuments
Trigger Level 2	Horizontal and vertical movement rates between 1 inch and 2 inches per month, or total movement of 3 and 6 inches	Horizontal and vertical movement rates between ½ inch and 1 inch per month, or a total movement between 2 and 3 inches	Weekly	Weekly	All Monuments
Trigger Level 3	Horizontal and vertical movement rates greater than 2 inches per month, or total movement greater than 6 inches	Horizontal and vertical movement rates greater than 1 inch per month, or a total movement greater than 3 inches	Daily	Daily	All Monuments

Table 10: Inclinometer Monitoring Plan

Trigger Level	Monitoring Point ID	Trigger Level Criteria	Monitoring Schedule	Comment
No Trigger	INC1-Series INC2-Series INC3-Series	Total displacement rate less than ½ inch per month or total differential displacement less than ½ inch in 2 feet	Quarterly	
Trigger Level 1	INC1-Series INC2-Series INC3-Series	Total displacement rate of ½ inch per month or total differential displacement of ½ inch in 2 feet	Weekly	
Trigger Level 2	INC1-Series INC2-Series INC3-Series	Total displacement rate of 1 inch per month or a total shear strain of 1 inches in 2 feet	Weekly	
Trigger Level 3	INC1-Series INC2-Series INC3-Series	Total displacement rate of 1 inch per month or a total shear strain of 2 inches in 2 feet	Daily	

Figures

INCLINOMETERS CONTROL POINT TABLE

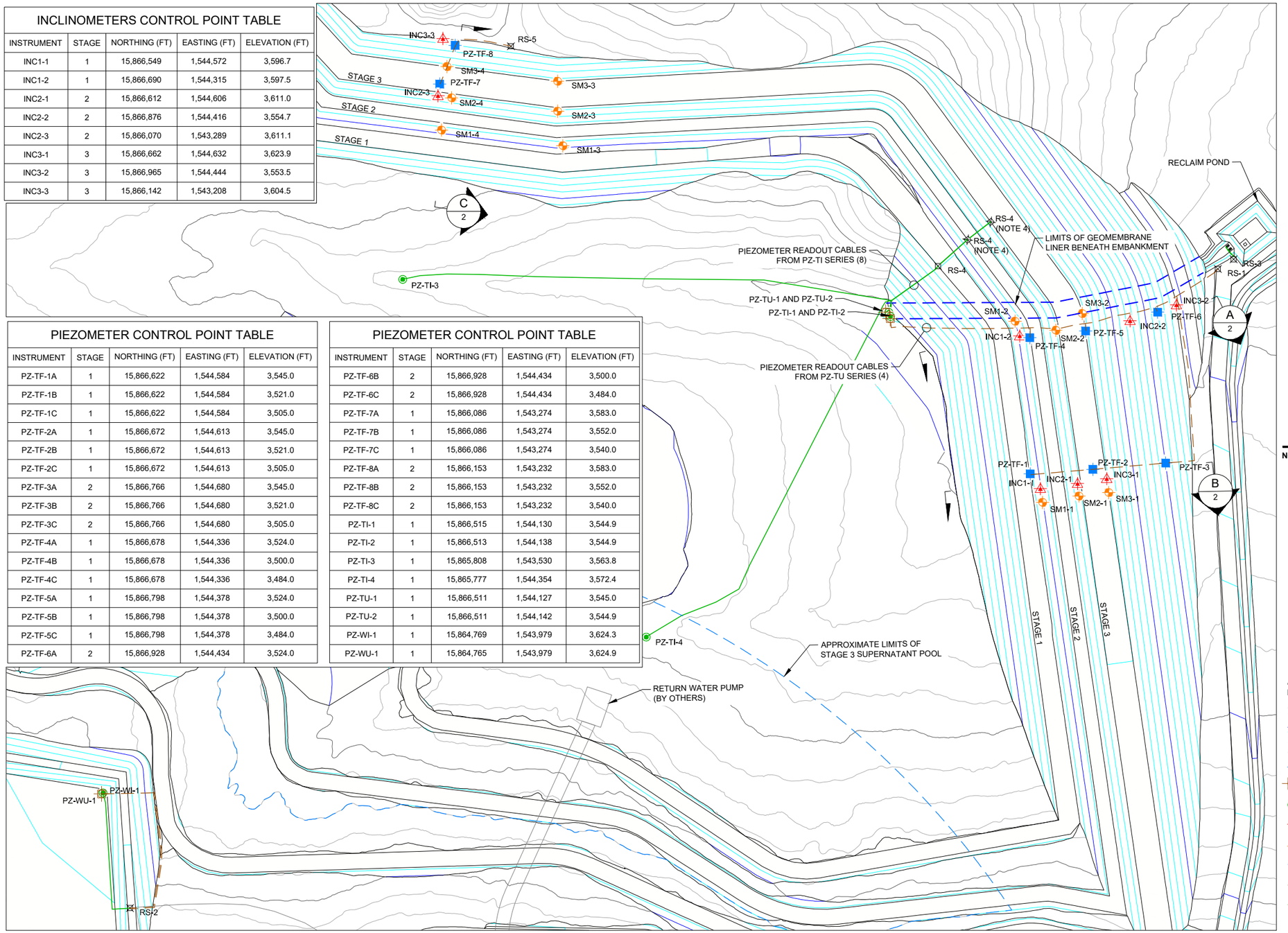
INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
INC1-1	1	15,866,549	1,544,572	3,596.7
INC1-2	1	15,866,690	1,544,315	3,597.5
INC2-1	2	15,866,612	1,544,606	3,611.0
INC2-2	2	15,866,876	1,544,416	3,554.7
INC2-3	2	15,866,070	1,543,289	3,611.1
INC3-1	3	15,866,662	1,544,632	3,623.9
INC3-2	3	15,866,965	1,544,444	3,553.5
INC3-3	3	15,866,142	1,543,208	3,604.5

PIEZOMETER CONTROL POINT TABLE

INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
PZ-TF-1A	1	15,866,622	1,544,584	3,545.0
PZ-TF-1B	1	15,866,622	1,544,584	3,521.0
PZ-TF-1C	1	15,866,622	1,544,584	3,505.0
PZ-TF-2A	1	15,866,672	1,544,613	3,545.0
PZ-TF-2B	1	15,866,672	1,544,613	3,521.0
PZ-TF-2C	1	15,866,672	1,544,613	3,505.0
PZ-TF-3A	2	15,866,766	1,544,680	3,545.0
PZ-TF-3B	2	15,866,766	1,544,680	3,521.0
PZ-TF-3C	2	15,866,766	1,544,680	3,505.0
PZ-TF-4A	1	15,866,678	1,544,336	3,524.0
PZ-TF-4B	1	15,866,678	1,544,336	3,500.0
PZ-TF-4C	1	15,866,678	1,544,336	3,484.0
PZ-TF-5A	1	15,866,798	1,544,378	3,524.0
PZ-TF-5B	1	15,866,798	1,544,378	3,500.0
PZ-TF-5C	1	15,866,798	1,544,378	3,484.0
PZ-TF-6A	2	15,866,928	1,544,434	3,524.0

PIEZOMETER CONTROL POINT TABLE

INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
PZ-TF-6B	2	15,866,928	1,544,434	3,500.0
PZ-TF-6C	2	15,866,928	1,544,434	3,484.0
PZ-TF-7A	1	15,866,086	1,543,274	3,583.0
PZ-TF-7B	1	15,866,086	1,543,274	3,552.0
PZ-TF-7C	1	15,866,086	1,543,274	3,540.0
PZ-TF-8A	2	15,866,153	1,543,232	3,583.0
PZ-TF-8B	2	15,866,153	1,543,232	3,552.0
PZ-TF-8C	2	15,866,153	1,543,232	3,540.0
PZ-TI-1	1	15,866,515	1,544,130	3,544.9
PZ-TI-2	1	15,866,513	1,544,138	3,544.9
PZ-TI-3	1	15,865,808	1,543,530	3,563.8
PZ-TI-4	1	15,865,777	1,544,354	3,572.4
PZ-TU-1	1	15,866,511	1,544,127	3,545.0
PZ-TU-2	1	15,866,511	1,544,142	3,544.9
PZ-WI-1	1	15,864,769	1,543,979	3,624.3
PZ-WU-1	1	15,864,765	1,543,979	3,624.9



READOUT STATION CONTROL POINT TABLE

READOUT STATION	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
RS-1	1	15,867,069	1,544,436	3,536.8
RS-2	1	15,864,680	1,544,186	3,642.2
RS-3	1	15,867,104	1,544,439	3,536.7
RS-4	1	15,866,643	1,544,116	3,595.0
RS-5	1	15,866,237	1,543,296	3,601.8

SURVEY MONUMENT CONTROL POINT TABLE

INSTRUMENT	STAGE	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
SM1-1	1	15,866,537	1,544,596	3,593.4
SM1-2	1	15,866,699	1,544,287	3,594.6
SM1-3	1	15,866,204	1,543,507	3,595.0
SM1-4	1	15,866,036	1,543,346	3,595.1
SM2-1	2	15,866,600	1,544,627	3,608.0
SM2-2	2	15,866,751	1,544,347	3,608.7
SM2-3	2	15,866,236	1,543,448	3,607.9
SM2-4	2	15,866,088	1,543,308	3,608.1
SM3-1	3	15,866,649	1,544,655	3,620.9
SM3-2	3	15,866,811	1,544,351	3,621.8
SM3-3	3	15,866,269	1,543,402	3,622.0
SM3-4	3	15,866,116	1,543,255	3,622.0

NOTE

1. AT EACH DESIGNATED MONITORING POINT FOR PZ-TI, PZ-TU, PZ-WI, PZ-WU SERIES PLACE 2 PIEZOMETERS APPROXIMATELY 1 ft APART.
2. SEE DRAWING C15 FOR DETAILS AND UNDERDRAIN PIPING SYSTEM.
3. INCLINOMETER ELEVATIONS REPRESENT COLLAR ELEVATION 3 FT ABOVE PROPOSED GROUND.
4. READOUT STATION RS-4 AND REQUIRED CABLES TO BE RELOCATED TO NEW UPSTREAM DAM CREST WITH EACH DAM RAISE.
5. SURVEY MONUMENTS LOCATED ALONG DOWNSTREAM CREST OF EACH STAGE.
6. EXISTING GROUND TOPOGRAPHY PORVIDED BY CALICO RESOURCES USA CORP. ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf".

LEGEND

- 3600 — EXISTING GROUND (5 FT CONTOURS) (NOTE 6)
- 3600 — PROPOSED GRADING (5 FT CONTOURS)
- RS-1 READOUT STATION
- PZ-TF1 FOUNDATION PIEZOMETER
- PZ-TU-1 UNDERLINER PIEZOMETER
- PZ-TI-1 IMPOUNDMENT PIEZOMETER
- INC1-1 INCLINOMETER (NOTE 3)
- SM1-1 SURVEY MONUMENT
- LIMITS OF SUPERNATANT POOL
- CABLE ROUTES BELOW LINER
- CABLE ROUTES ABOVE LINER

0 100 200
1" = 100' FEET

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL MONITORING PLAN
GEOTECHNICAL INSTRUMENTATION LAYOUT

PROJECT NO.	REV.	FIGURE
1663241	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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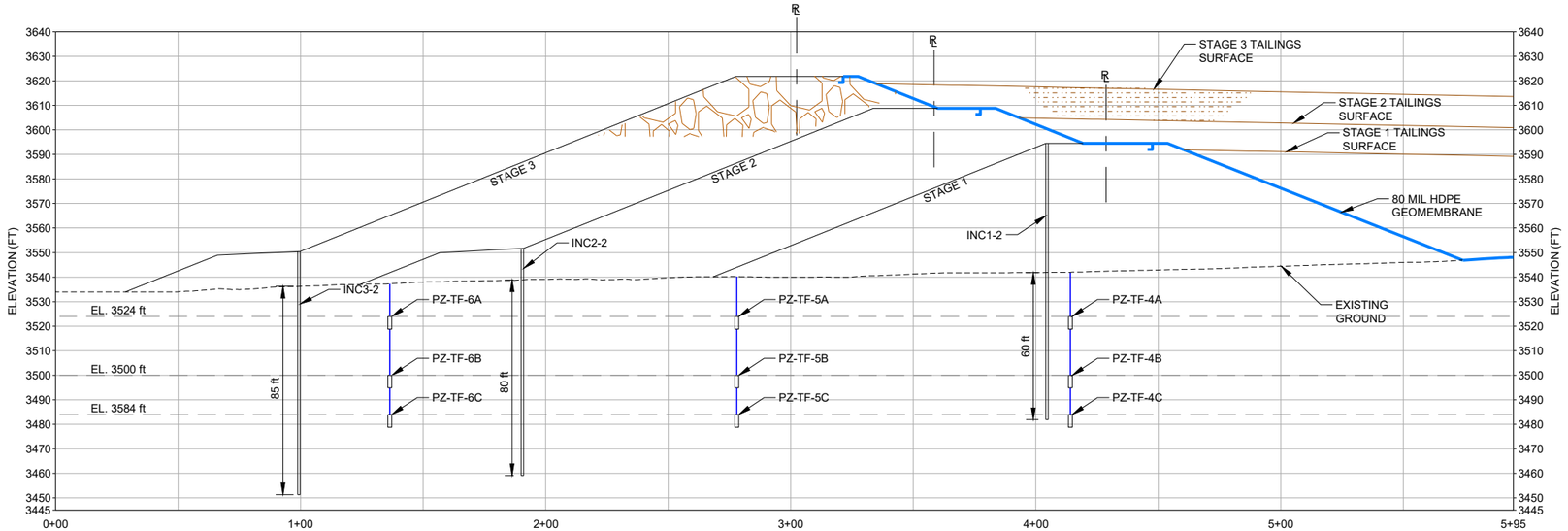
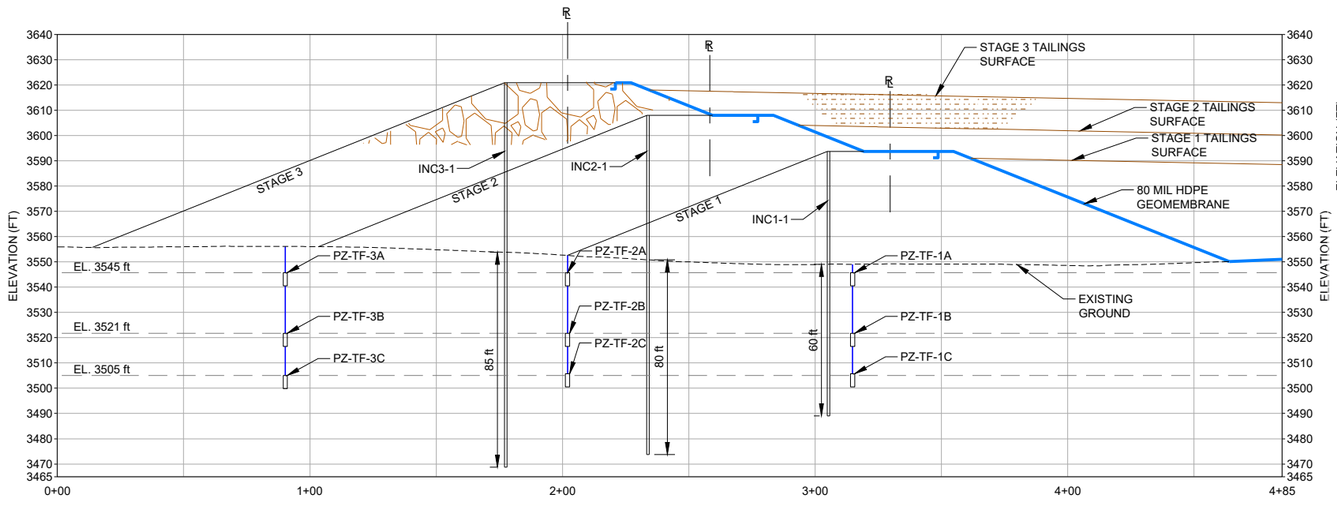


SCALE 1" = 30' A 1 NORTH EMBANKMENT PIEZOMETER LOCATIONS (1 OF 2)

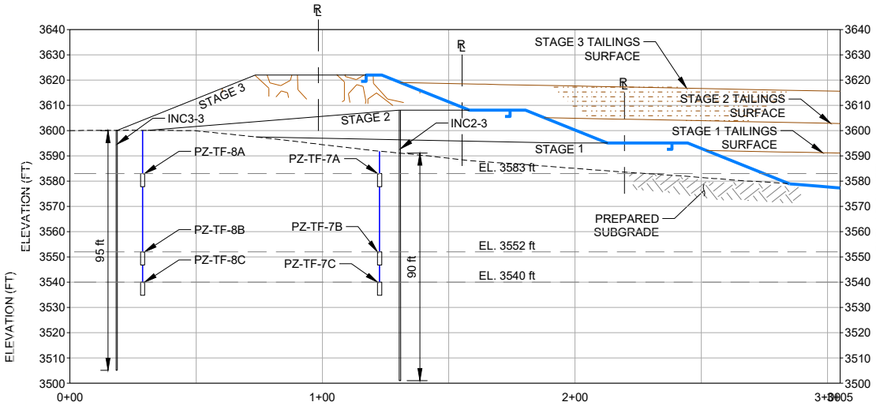
LEGEND

- EMBANKMENT LINING SYSTEM
- EXISTING GROUND
- TAILINGS SURFACE
- FOUNDATION PIEZOMETER (PZ-TF SERIES)
- INCLINOMETER

0 30 60 90
1" = 30' FEET



SCALE 1" = 30' B 1 NORTH EMBANKMENT PIEZOMETER LOCATIONS (2 OF 2)



SCALE 1" = 30' C 1 WEST EMBANKMENT PIEZOMETER LOCATIONS

CLIENT
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	MDB
PREPARED	JRP
REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL MONITORING PLAN
GEOTECHNICAL INSTRUMENTATION SECTIONS

PROJECT NO.	REV.	FIGURE
1663241	0	2

0 1in
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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APPENDIX A

Instrumentation Specifications

Underliner and Impoundment Vibrating Wire Piezometers

Monitor with Confidence

TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

PRODUCT CATEGORY:
PIEZOMETERS + TRANSDUCERS

Vibrating Wire Piezometer

The RST Vibrating Wire Piezometer provides excellent long-term accuracy, stability of readings, and reliability under demanding geotechnical conditions. Vibrating Wire Piezometers are the electrical piezometers of choice as the frequency output of VW devices is immune to external electrical noise and able to tolerate wet wiring common in geotechnical applications.

Vibrating Wire Piezometers contain a high tensile steel wire with a fixed anchor at one end and are attached to a diaphragm in contact with water pressure at the other end. The wire is electrically plucked, with the resonant frequency of vibration proportional to the tension in the wire. This frequency induces an alternating current in a coil which is detected by the readout unit, such as the VW2106 Vibrating Wire Readout (see separate brochure), and can then be converted to a pressure. The frequency output is immune to external electrical noise.

The frequency signal is exceptionally immune from cable effects, including length (to several kilometers), splicing, resistance, noise pickup, and moisture. The vibrating wire coil circuit contains no semiconductor devices and has built-in ionized gas discharge device protection against transient damage. As a result, the vibrating wire piezometer provides excellent reliability in typical geotechnical situations – i.e. long outdoor cables buried in saturated soil.

The piezometer is equipped with a standard sintered stainless steel porous filter to prevent soil particles from contacting the diaphragm. A thermistor is built into the piezometer body to permit temperature measurement and temperature compensation of the piezometer. Standard construction is all stainless steel. RST vibrating wire piezometers are shipped with extremely tough polyurethane-jacketed foil-shielded cable for maximum endurance in field conditions.

> APPLICATIONS

Slope stability investigations.	Monitoring well and standpipe water levels.
Assessing performance and investigating stability of earth fill dams and embankments.	
Monitoring pressures behind retaining walls and diaphragm walls.	
Monitoring pore pressures during fill or excavation.	
Monitoring pore pressure in land reclamation applications.	

> FEATURES

Field proven reliability and accuracy.	Integral lightning protection.
Signal transmission of several kilometer.	Data logger compatible.
High Accuracy - IE a low pressure vented model will measure water level changes as small as 0.5 mm (0.02 in.).	
Will tolerate wet wiring common in geotechnical applications.	
Thermistor for temperature measurement is standard.	Hermetically sealed, stainless steel construction.
Negligible displacement of pore water during the measurement process.	
Heavy case to minimize reading errors caused by overburden pressure.	
Cable lengths may be changed without affecting the calibration.	

Available for **QUICK DELIVERY** Info on reverse.

> BENEFITS

✓ **Increase Safety**	✓ **High Accuracy**

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RST Instruments Ltd. reserves the right to change specifications without notice. ELB0055M September 16, 2019

Monitor with Confidence

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info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

Vibrating Wire Piezometer

PRODUCT CATEGORY:
PIEZOMETERS + TRANSDUCERS

SPECIFICATIONS + ORDERING

SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Over range	2 X F.S.
Resolution	0.025% F.S. minimum
Accuracy	0.1% F.S.
Linearity	<0.5% F.S.
Operating Temperature	-20 to 80°C (-4 to 176°F)
Diaphragm Displacement	<0.001 cc at F.S.
Thermal Zero Shift	<0.05% F.S./°C
Materials	Hermetically sealed stainless steel housing
Thermistor Type	NTC 3K Ohms @ 25°C
Thermistor Interchangeability	±0.2°C
Thermistor Resolution	0.1°C
Filter	50 micron sintered filter. (High air entry alumina filter 1 Bar available)

VW2100-DPC
Drive point model

ELECTRICAL CABLE SPECS

PART #	DESCRIPTION
EL380004	Two twisted pairs cable with polyurethane jacket
EL380004HDL	Two twisted pairs heavy duty cable with a thick polyurethane jacket mold for added protection
EL380004K	Two twisted pairs Kevlar® reinforced, non-stretch polyurethane jacketed cable for rigorous installations where the stretching of cable is a concern

Other types of cables, depending on site conditions and atmospheric reference requirements, are available upon request. These include vented, FEP, PVC, polyurethane, and armored varieties.

OPTIONAL EQUIPMENT

VW2106 Vibrating Wire Readout
Data loggers
Cable splice kits

ORDERING

Available for QUICK DELIVERY
Contact RST for Details

PART #	DESCRIPTION	PRESSURE RANGE	DIMENSION
VW2100	Standard model for general applications	0.35, 0.7, 1.0, 2.0, 3.0 MPa	19 mm Ø X 130 mm
VW2100-HD	Heavy duty piezometer for direct burial in fills and large dam embankments or for high pressure borehole installations	0.35, 0.7, 1.0, 2.0 3.0, 5.0, 7.5, 10, 20 MPa	25.4 mm Ø X 146 mm
VW2100-DPC	Drive point model with CPT thread	0.07, 0.175, 0.35, 0.7, 1.0, 2.0, 3.0, 5.0, 7.5 MPa	33.4 mm Ø X 508 mm
VW2100-DPEW	Drive point model with EW thread	0.07, 0.175, 0.35, 0.7, 1.0, 2.0, 3.0, 5.0, 7.5 MPa	34.6 mm Ø (body) X 304.8 mm
VW2100-L	Low Pressure, unvented	70, 175 kPa	25 mm Ø X 133 mm
VW2100-LV	Low Pressure vented	70, 175 kPa	25 mm Ø X 133 mm
VW2100-M	Miniature version – 17.5 mm diameter	0.35, 0.7, 1.0, 2.0, 3.0 MPa	17.5 mm Ø X 133 mm
VW2100-MM	Micro-miniature version – 11.1 mm diameter	0.35, 0.7 MPa	11.1 mm Ø X 165 mm
VW2190	Heavy duty piezometer with bladder for brine environment	0.07, 0.175, 0.35, 0.7, 1.0, 2.0, 3.0, 5.0, 7.5 MPa	42 mm Ø X 319 mm
VW2191	Heavy duty piezometer with bladder for acidic environment with secondary corrosion protection	0.07, 0.175, 0.35, 0.7, 1.0, 2.0, 3.0, 5.0, 7.5 MPa	42 mm Ø X 319 mm

VW2190 - Heavy Duty Piezometer with Bladder

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Foundation
Vibrating Wire Piezometers

Monitor with Confidence

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RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

PRODUCT CATEGORY:
PIEZOMETERS + TRANSDUCERS

Fully Grouted Multi-Point Piezometer String

Fully grouted installation permits multiple piezometers to be simply and reliably installed in a single borehole. The piezometer string and grout pipe are placed in the borehole and cement-bentonite grout is pumped until the borehole is filled.

Multi-point Piezometer Strings allow for multiple Vibrating Wire Piezometers to be connected on a single cable. This facilitates the installation of fully grouted multiple piezometers. The single cable prevents vertical void channels. Tough polyurethane-jacketed, Kevlar® reinforced, non-stretch cable is employed to withstand the rigors of installation and is entirely water-blocked to minimize any leakage. No conductors are shared to maximize independent reliability of each sensor.

RST Vibrating Wire Piezometers provide excellent long-term accuracy, stability of readings, and reliability under demanding geotechnical conditions. Vibrating Wire Piezometers are the electrical piezometers of choice as the frequency output of vibrating wire devices is immune to external electrical noise and able to tolerate wet wiring common in geotechnical applications.

> APPLICATIONS

Ideal when more than one piezometer reading is needed at various depths at the same location.

Assessing performance and investigating stability of:

Earth fill dams & embankments.	Slope stability.

Monitoring of:

Pressures behind retaining walls and diaphragm walls.	Pore pressure in land reclamation applications.
Pore pressures during fill or excavation.	

> FEATURES

No inter-zone leakage.	Straightforward installation.
Field proven reliability and accuracy.	Immune from external electrical noise.
Will tolerate wet wiring common in geotechnical applications.	Cable lengths may be changed without affecting the calibration.
Thermistor for temperature measurement is standard.	Hermetically sealed, stainless steel construction.
Heavy case to minimize reading errors caused by overburden pressure.	Negligible displacement of pore water during the measurement process.
Signal transmission of several kilometers.	Data logger compatible.
Integral lightning protection.	

> BENEFITS

✓ **Increase Safety**	✓ **High Accuracy**
✓ **Increase Productivity**	✓ **High Reliability**
✓ **Custom Options**	

Traditionally, multiple piezometer installations in a borehole was slow, complex, and subject to unintended communication between piezometers. Grouted piezometers are quick and easy to install, have excellent zone isolation, and have rapid response to pore pressure changes. The fully grouted method is increasingly the preferred standard approach for installing piezometers in boreholes. For more information see:

McKenna, G.T. (1995),"Grouted-in Installation of Piezometers in Boreholes," Canadian Geotechnical Journal, Volume 32, pp 355-363.

Contreras, I.A. Grosser, A.T., VerStrate, R.H. (2007), "The Use of the Fully-grouted Method for Piezometer Installation". Proceedings of the Seventh International Symposium on Field Measurements in Geomechanics. FMGM, 2007. Boston, MA. ASCE Geotechnical Special Publication 175.

Also published in: Geotechnical News, June 2008, Vol. 26, No.2, http://www.bitech.ca/pdf/GeoTechNews/2008/GIN_June08.pdf

Contreras, I.A. Grosser, A.T., VerStrate, R.H. (2011), "Practical Aspects of the Fully-Grouted Method for Piezometer Installation", Proceedings of the Eigth International Symposium on Field Measurements in Geomechanics. FMGM, 2011. Berlin, Germany, September 12-16, 2001

For further references and information regarding grout mixes, contact RST Instruments Ltd.

WORKS WITH flexDAQ DATALOGGERS

READY TO RUN
pre-assembled
pre-wired
pre-tested
pre-programmed

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RST Instruments Ltd. reserves the right to change specifications without notice. MIB0051E

Monitor with Confidence

TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

Fully Grouted Multi-Point Piezometer String

PRODUCT CATEGORY:
PIEZOMETERS + TRANSDUCERS

SPECIFICATIONS + ORDERING

VIBRATING WIRE PIEZOMETER SPECIFICATIONS

The following specifications are for an individual vibrating wire piezometer.

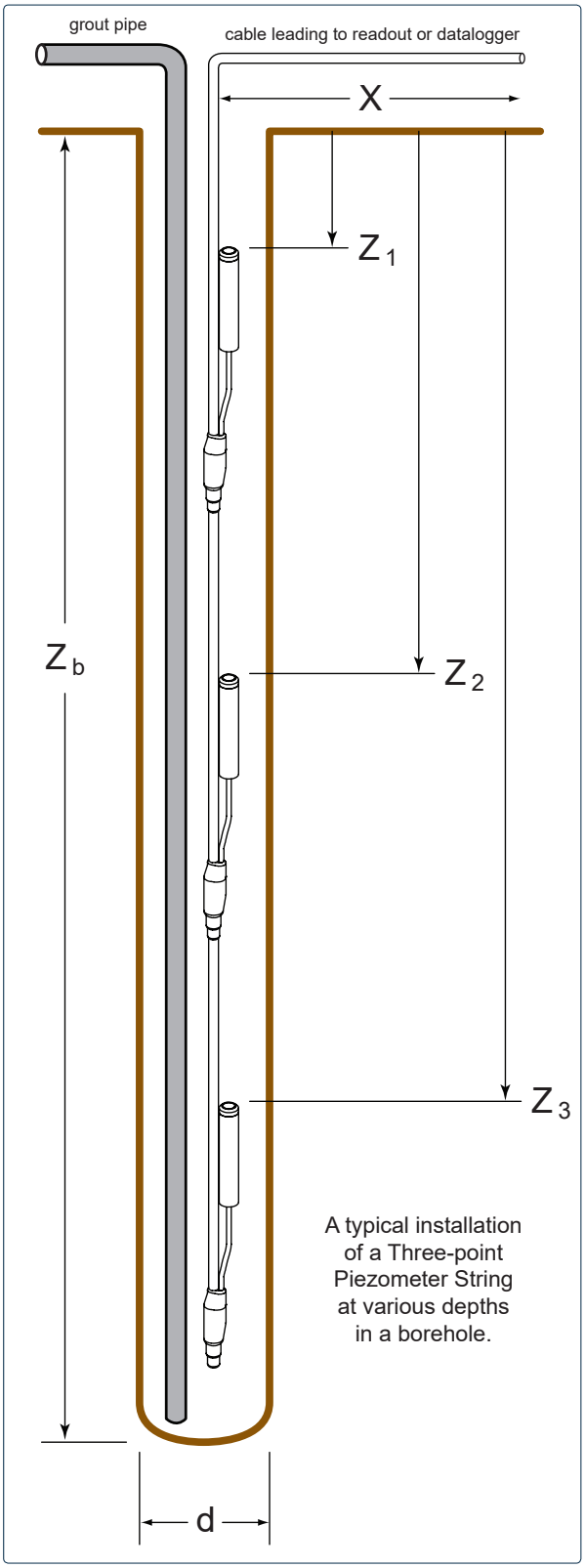
DESCRIPTION	SPECIFICATION
Over range	2 X F.S.
Resolution	0.025% F.S. minimum
Accuracy	0.1% F.S.
Operating Temperature	-20 to 80°C (-4 to 176°F)
Diaphragm Displacement	<0.001 cc at F.S.
Thermal Zero Shift	<0.05% F.S./°C
Materials	Hermetically sealed stainless steel housing
Thermistor Type	NTC 3K Ohms @ 25°C
Thermistor Interchangeability	±0.2°C (optional ±0.1°C)
Thermistor Resolution	0.1°C
Filter	50 micron sintered filter.

ELECTRICAL CABLE SPECIFICATIONS

PART #	DESCRIPTION
2-3 Piezometers	
EL380012	12 conductor, Kevlar® wire with water-blocked polyurethane jacket
4-6 Piezometers	
EL380013P	13 pair, Kevlar® wire with water-blocked polyurethane jacket

ORDERING INFO

PART #	DESCRIPTION	PRESSURE RANGES	DIMENSION
Due to the semi-custom nature of Multi-Point Piezometer Strings, please contact RST Instruments for complete ordering info. Ordering info will be dependent on required cable depth, number of piezometers per string and measurement parameters regarding pressure and/or temperature.			
VW2100MP-XXXX	Multi-Point Piezometer String	0.35, 0.7, 1.0, 2.0, 3.0, 5.0, 7.0, and 10.0 MPa (Standard model vibrating wire piezometer ranges shown).	Dimensions dependent on cable and pressure ranges chosen.



A typical installation of a Three-point Piezometer String at various depths in a borehole.

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Vibrating Wire Piezometer Signal Cables

Monitor with Confidence

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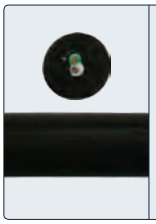
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

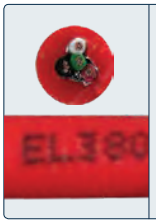
PRODUCT CATEGORY:
READOUTS + DATA LOGGERS

Cables

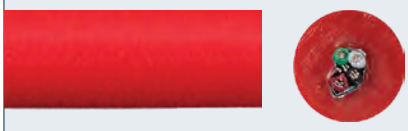
RST Instruments Ltd. offers a variety of cables that can be effectively matched to any instrument that requires a signal cable. RST uses Meter Marked Cable for a majority of our instruments that require a signal cable such as those used in Vibrating Wire Piezometers, Load/Pressure Cells, Crack Meters, Joint Meters, etc. In the unfortunate event of the cable being accidentally severed, the meter cable markings can be cross-referenced with the calibration record.



EL380002	USED FOR	CONDUCTORS	DIAM. O.D.
Abrasion-resistant polyurethane jacket.	· Single Point Thermistors	2 (1 twisted pair), 24 AWG (0.20 mm²)	5.33 mm (0.210 in.)



EL380004	USED FOR	CONDUCTORS	DIAM. O.D.
Standard vibrating wire cable, abrasion-resistant polyurethane jacket.	· Vibrating Wire Piezometers and most other VW instruments · Strain Gauge Load Cells · MEMS In-place Inclinometers · MEMS Tilt Meters & Beams	4 (2 twisted pairs), 22 AWG (0.33 mm²)	6.35 mm (0.250 in.)



EL380004HDL	USED FOR	CONDUCTORS	DIAM. O.D.
Heavy Duty Cable with a thick polyurethane jacket mold for added protection.	Direct burial of surface cable for: · Vibrating Wire Piezometers and most other VW instruments · MEMS In-place Inclinometers · MEMS Tilt Meters & Beams	4 (2 twisted pairs), 22 AWG (0.33 mm²)	9.52 mm (0.375 in.)

EL380004K	USED FOR	CONDUCTORS	DIAM. O.D.
Kevlar® reinforced, non-stretch polyurethane jacketed cable for rigorous installations where the stretching of the cable is a concern.	· VW Piezometers	4 (2 twisted pairs), 22 AWG (0.33 mm²)	6.35 mm (0.250 in.)

EL370004	USED FOR	CONDUCTORS	DIAM. O.D.
Thin polyurethane jacket mold.	· VW Rebar Strain Meters · VW Embedment Strain Gauges · VW Arc Weldable Strain Gauges	4 (2 twisted pairs), 24 AWG (0.20 mm²)	4.76 mm (0.1875 in.)

EL342202	USED FOR	CONDUCTORS	DIAM. O.D.
HDPE jacket.	· Used in acidic applications (leachate) and land fills · Saltwater	4 (2 twisted pairs), 22 AWG (0.33 mm²)	6.35 mm (0.250 in.)

*NOTE: IMAGES ARE NOT SHOWN TO SIZE; VIEW SPECIFICATIONS FOR ACTUAL DIAMETERS. Contact RST for complete details on exact specifications and suitable applications.

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Certified System ISO 9001

Cables

PRODUCT CATEGORY:
READOUTS + DATA LOGGERS

EL35VT04	USED FOR	CONDUCTORS	DIAM. O.D.
Vented polyurethane cable for barometric compensation; Kevlar® reinforced.	· Low-Pressure Vented Transducers	4 (2 twisted pairs), 22 AWG (0.33 mm²)	7.92 mm (0.312 in.) (jacket) 3.17 mm (0.125 in.) OD (vent tube)

EL380006	USED FOR	CONDUCTORS	DIAM. O.D.
Water blocked, polyurethane jacket. Grease blocked.	· In-Place Tiltmeters (analog biaxial) · Strain Gauge Analog Piezometer with Thermistor · Push-In Pressure Cells · Thermistor Strings	6 (3 twisted pairs), 22 AWG (0.33 mm²)	6.35 mm (0.250 in.)

EL360008	USED FOR	CONDUCTORS	DIAM. O.D.
Polyurethane jacket.	· MPBX Heads · VW Load Cells · Remote multiplexer connection cable to logger · Thermistor Strings	8 (4 twisted pairs), 20 AWG (0.52 mm²)	8.13 mm (0.320 in.)

EL380012	USED FOR	CONDUCTORS	DIAM. O.D.
Kevlar® reinforced, polyurethane jacket. Grease blocked.	· Thermistor Strings and VW Piezometer Strings · VW Load Cells · MPBX Heads	12 (6 twisted pairs), 24 AWG (0.20 mm²)	10.54 mm (0.415 in.)

EL380007P	USED FOR	CONDUCTORS	DIAM. O.D.
Polyurethane jacket.	· Thermistor Strings and VW Piezometer Strings · VW Load Cells · MPBX Heads	14 conductors (7 pairs), 22 AWG (0.33 mm²)	9.84 mm (0.3875 in.)

EL380013P	USED FOR	CONDUCTORS	DIAM. O.D.
Kevlar® reinforced, polyurethane jacket. Grease blocked.	· Thermistor Strings and VW Piezometer Strings · VW Load Cells · MPBX Heads	26 (13 twisted pairs), 24 AWG (0.20 mm²)	10.88 mm (0.425 in.)

*NOTE: IMAGES ARE NOT SHOWN TO SIZE; VIEW SPECIFICATIONS FOR ACTUAL DIAMETERS. Contact RST for complete details on exact specifications and suitable applications.

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Vibrating Wire Piezometer Manual

Monitor with Confidence

VW2100 Vibrating Wire Piezometer

Instruction Manual

All efforts have been made to ensure the accuracy and completeness of the information contained in this document. RST Instruments Ltd reserves the right to change the information at any time and assumes no liability for its accuracy.

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REVISION HISTORY

Rev.	Revision History	Date	Prepared By	Approved By
P	Corrected typo in Table 7-1 (0.05% changed to 0.5%); Corrected linear equation in Section 4.4.1 to include F factor; corrected minor typos throughout; added Revision Table; reworded Section 4.3 for clarity.	2019-Jul-10	QR	EG
Q	Added instructions for installation of heavy-duty piezometer with bladder (5.6). Expanded instructions for removing the cap from the pre-saturated HAE filter (5.3.2).	2019-Aug-28	MP	AP, TW
R	Removed Appendix B: Casagrande Style Filter Assembly and reference to Appendix B on p. 8; updated reference to Appendix C in 5.7.1.	2019-Sep-17	MP	CJ

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1 INTRODUCTION

The RST Vibrating Wire Piezometer is a stable, robust pressure transducer designed to allow very accurate remote measurements of piezometric levels and borehole pressures over extended periods of time and through all conditions. The vibrating wire pressure transducer output is a frequency signal which is unaffected by line impedance and/or contact resistance of the conductor. This allows for the accurate transmission of the frequency signal over very long distances. These types of vibrating wire sensors can be installed in boreholes or driven into soft ground.

A standard integral thermistor is included within each transducer, which measures the temperature of the transducer and its surroundings. This temperature information is used to provide temperature correction to the output pressure readings. A gauge calibration factor and temperature correction factor are supplied with each manufactured gauge based on the factory calibrations which are carried out for each sensor, immediately following manufacture.

A portable vibrating wire readout unit, such as the RST VW2106 Readout Unit, is used to display the frequency of the vibrating wire which is proportional to the pressure being applied to the vibrating wire transducer diaphragm. Additionally, the VW2106 readout unit will display the transducer temperature directly in degrees Celsius.

Complete data logging systems are available from RST to provide automated data collection from vibrating wire transducers. Consult RST for more information, if required.

FIGURE 1-1 VIBRATING WIRE PIEZOMETER (0.7 MPA)

The RST VW piezometer is a Vibrating Wire diaphragm pressure sensor. Pressure applied to the transducer diaphragm will cause a change in the Vibrating Wire tension, resulting in a change to the resonant frequency, which is directly proportional to the pressure change.

The Vibrating Wire sensors are made of two small diameter cylindrical parts joined by a length of steel tubing. The diaphragm is welded to the front cylinder. A high strength steel wire (the Vibrating Wire) is clamped to the center of the diaphragm, then is run through the first cylinder, and then clamped to the base of the second cylinder which is the end block. The Vibrating Wire is clamped to the diaphragm and end block by low temperature hydraulic swaging which virtually welds the parts together without affecting the elastic properties of the wire. All parts of the sensor, other than the actual Vibrating Wire are machined from a high-grade stainless steel, selected for its low yield and high corrosion resistance.

The Vibrating Wire is set to a pre-determined tension during the manufacture. The instrument housing is evacuated and sealed using electron beam welding to ensure a perfect seal and a long working life. An O-ring placed behind the diaphragm seals the back of the assembly within the housing. A coil/magnet assembly is built into every VW transducer which is used in conjunction with the RST readout box, to pluck the Vibrating Wire and measure the VW's vibration period.

1.1 MODEL VW2100

The RST VW2100 Vibrating Wire Piezometer is designed to be embedded in earth fills and concrete or inserted into boreholes and pipes as small as 19 mm (3/4 inch) in diameter. The VW2100 piezometer consists of a small diameter cylindrical housing containing a pressure transducer and thermistor. One end is fitted with an insert that holds a micrometric high air or low air entry filter. The opposite end contains the cable entry sealed with an epoxy compound. All parts are made of stainless steel.

The entry filter is set in the front end of the housing and sealed with an O-ring. With the filter in place, the diaphragm is protected from solid particles, and senses only the fluid pressure to be measured. The filter housing is easily removable for calibration of the transducer. The filter assembly can also be replaced with a pipe thread adapter to use the gauge as a pressure transducer (Model VW2100-PT).

1.2 MODEL VW2100-DP

The RST VW2100-DP Vibrating Wire Piezometer is designed to be driven into unconsolidated fine grain material such as sand, silt, or clay. The external housing is a thick-walled cylinder fitted with a pointed shoe at one end. The opposite end is fitted with a male thread adapter at the cable entry, which fits standard "EX" drill rods. Three port holes above the point are equipped with micrometric filters. The data cable passes through the threaded end and can be fed up through the drill rods to the surface. The cable entry is sealed with an epoxy compound. Both high and low air entry filters are available.

2 VIBRATING WIRE PRINCIPLE

The sensing element of the Vibrating Wire piezometer is a high strength steel wire attached to the diaphragm. The vibrating wire is excited by two coil/magnets set around the connecting over tube. In operation, external pressure on the diaphragm will move the diaphragm a very small amount, which changes the tension on the vibrating wire. This tension change is directly proportional to the resonant, or natural, frequency at which the vibrating wire will vibrate.

The VW2106 Readout Unit generates plucking voltages to the coil/magnet in a spectrum of frequencies, spanning the natural frequency of the vibrating wire. This plucking allows the vibrating wire to find its current natural frequency related to the pressure it is currently experiencing. In turn, the oscillation of the vibrating wire generates AC voltage in the coil. This output signal is amplified by the VW2106 Readout Unit, which also discriminates against harmonic frequencies, to determine the resonant frequency of the wire.

The VW2106 Readout Unit measures 100 cycles of vibration with a precise quartz oscillator and displays a value proportional to the frequency squared, which is called B-Units (Frequency^2 x 10^{-3}). The relationship between B-Unit readings and the pressure being exerted on the diaphragm is expressed by the following equation:

$$\mathbf{P = CF\ (L_0 - L)}$$

where:

P = Corrected Pressure Reading

CF = Linear Calibration Factor in kPa\B-Unit digit. The CF is a unique value for each manufactured VW sensor, as determined by the initial laboratory calibration

L_0 = Initial B-Unit Reading at zero applied pressure on the diaphragm. The L_0 is a unique value for each manufactured VW sensor and is determined by initial laboratory calibration

L = B-Unit Reading under the currently applied pressure on the diaphragm

The Vibrating Wire technology offers the unique advantage of frequency output signal virtually unaffected by line impedance or contact resistance. Up to 1.5 km of cable length can be used without signal deterioration.

3 CALIBRATION

All RST vibrating wire piezometers are individually calibrated in the laboratory before shipment. Each vibrating wire piezometer is calibrated over its full working pressure range. A Linear Calibration Factor (CF) is established by using the calibration data points to do a linear regression. In addition, the calibration data is also fitted to a polynomial regression which provides slightly more accurate data output over the full reading range. Both formulas are provided on the instrument Calibration Record sheet for use as appropriate. It is also noted that RST data loggers are set up to use either formula to calculate the instrument output in engineering units.

As part of the calibration procedure, all vibrating wire piezometers are tested to 150% of the standard working range to prove their function at overpressure. The sensor calibration is carried out over a temperature range of -20º C to +80º C which proves their function at a wide temperature range and provides the input data for the Temperature Correction Factor for each sensor.

A Calibration Record sheet is provided with each vibrating wire sensor for use in calculating the applied loads on the vibrating wire sensors. The following general information is contained in the Calibration Record sheet:

- Model, Serial, and Manufacturing Numbers;
- Pressure Range;
- Temperature and Barometric Pressure at time of Calibration;

- Work Order Number;
- Cable Information (Length, Meter Markings, Color Code, and Type);
- Thermistor Type;
- Linear Calibration Factor (CF);
- Temperature Correction Factor (Tk);
- Polynomial Gauge Factors (A, B, and C);
- Calibration Data Table;
- Linear and Polynomial Formulas;
- Zero Reading, Temperature, and Barometric Pressure at time of Shipment;
- Calibration Certification.

Refer to Appendix A for an example of a Calibration Record sheet.

3.1 FIELD CALIBRATION CHECK

The following procedure can be used in the field to verify the validity of a vibrating wire piezometer calibration as supplied on the Calibration Record sheet.

Note that VW2100 piezometers will require the filter stone to be saturated prior to calibration. Place the VW2100 piezometer in water to saturate the filter stone. Ensure the entire space between the instrument diaphragm and the filter stone is filled with water.

1. Lower the piezometer to depth in a vertical, water filled borehole using the cable markings to accurately control and set the depth. A minimum emersion depth of 10 m is recommended to ensure adequate accuracy of the field calibration check.

2. Allow 20 to 30 minutes for the piezometer to come to complete thermal equilibrium in the borehole. Record the B-unit and temperature readings at that depth using an RST VW2106 readout unit.

3. Raise the piezometer a known amount while keeping it fully submerged. If the temperature reading is changing, allow the instrument to come to the new thermal equilibrium. This may take another 20 to 30 minutes.

4. Record the new B-Unit and temperature readings at the higher elevation. Calculate the instrument Calibration Factor (CF) (kPa per B-Unit) from this information, given the change in pressure head and B-Unit readings.

5. Compare this field calibration to the calibration factor value provided on the Calibration Record sheet. The two values should agree within ± 0.5%. Repeat this calibration check as required to confirm the sensor is in proper working condition.

It is not recommended to install the piezometer if the calibration record sheet CF value cannot be confirmed by the field calibration test. The instrument will need to be inspected and undergo a full shop function test and re-calibrated before being returned to service. Contact RST for further information.

If the diameter of the water filled borehole is too small, the volume of water that the vibrating wire piezometer cable displaces, when raised or lowered into position, could potentially raise, or lower the borehole water level. This effect may seriously impact the accuracy of the above detailed Field Calibration Check. Note that this potential effect will be further dependent on the available permeability of the borehole to absorb small amounts of volume change.

To avoid this potential problem, it is recommended that the water filled borehole used for Field Calibration Checks be large enough in diameter so that the potential error caused by cable volume displacement will be insignificant in the calculation of the pressure change. It is recommended to use a borehole diameter that is a minimum of 10 times greater than the wire diameter. A borehole with a moderate degree of permeability would be preferred to a “tight” borehole.

4 READING PROCEDURES

4.1 VW INSTRUMENT READINGS

It is strongly recommended that the instruction manual for the RST VW2106 Readout Unit be read thoroughly before proceeding. Failure to become familiar with the function and operation of the VW2106 Readout could potentially result in damage to the VW2106 Readout unit and/or the vibrating wire sensors that are connected to it.

4.2 INITIAL INSPECTION AND CHECK READINGS

A full inspection of all received vibrating wire instrumentation equipment is required immediately upon receipt at site to ensure that the vibrating wire instruments have not been damaged in any way during shipment and are fully functional/ready for use.

Test readings should be taken of each vibrating wire instrument and compared to the vibrating wire instrument reading information provided on the Calibration Record sheet. Any discrepancies should fully investigated and satisfactorily resolved before the vibrating wire instrument is released for field installation and service.

The individual performing the inspection and initial test readings must be familiar with the vibrating wire instrument operation and contents of this instruction manual.

4.3 INITIAL READINGS

Vibrating wire piezometers differ from other types of pressure sensors as the core of the vibrating wire sensor is manufactured with an initial tension. The piezometers have a positive B-Unit reading without any external pressure being applied. Vibrating wire piezometers are acutely sensitive to pressure changes at zero point as there is no zero-point hysteresis to overcome. The determination of vibrating wire instrument

initial readings at the “zero point” is extremely important for the accuracy of the subsequent readings.

Before installing the vibrating wire piezometer, it is necessary to take the initial zero reading with no applied load. The initial zero reading can be taken in one of the following ways:

- With the filter stone removed, or
- With the stone completely saturated and installed.

More information can be found in Section 5.

If the filter stone is saturated, initial zero readings should be taken with the piezometer exposed to the open air.

CAUTION: DO NOT SUBMERGE THE INSTRUMENT IN WATER TO TAKE THE INITIAL READINGS. ONLY ATMOSPHERIC PRESSURE SHOULD BE APPLIED TO THE PIEZOMETER AT THIS TIME. FAILURE TO DO SO MAY IMPACT THE ACCURACY OF THE SUBSEQUENT READINGS.

The temperature reading from the internal thermistor must also be recorded. The barometric pressure for piezometers with a total range lower than 2 MPa must also be recorded. These values are needed to apply the correct correction factors for changes in temperature and/or barometric pressure, which will impact the reading accuracy of the vibrating wire piezometers through their intended range.

Initial zero readings are generally obtained immediately prior to installation with no external pressure and a constant ambient temperature and barometric pressure.

NOTE: BE SURE TO RECORD THE VIBRATING WIRE PIEZOMETER TEMPERATURE AND BAROMETRIC PRESSURE AT THE SAME TIME THE B-UNIT ZERO READINGS ARE TAKEN.

The following checks are required to obtain accurate initial zero readings:

- Has the temperature of the vibrating wire piezometer body reached full thermal equilibrium?
  - Variations in temperature across the mass of the piezometer body may result in a temperature reading which is not consistent with the entire vibrating wire instrument. This inconsistency will result in an error to the calculated pressure being read by the vibrating wire sensor. Allow 20 to 30 minutes for the temperature of the vibrating wire piezometer to equilibrate. Sources of temperature fluctuation, such as water flow, may have to be eliminated.
- Is the filter stone saturated?
  - Surface tension effects within the pore spaces of the filter could affect the zero readings if the filter stone is only partially saturated. This can be a problem particularly at low pressures (less than 350 kPa). Remove the filter

stone to allow direct atmospheric connection with the transducer diaphragm if there is any question regarding the adequate saturation of the filter stone.

4.4 PRESSURE EQUATION (USING THE VW2106 READOUT)

The VW2106 Readout Unit displays vibrating wire piezometer readings in frequency units called B-Units, which equal Frequency^2 x 10^{-3}, where frequency is in Hertz.

The B-Unit values represent absolute pressure and must be corrected for changes in temperature and barometric pressure. B-Unit changes from the initial zero reading are converted to the actual pressure changes using equations in Sections 4.4.1 and 4.4.2, which include corrections for temperature and barometric pressure changes.

4.4.1 Linear Equation

$$P = CF(L_0 - L) - T_K(T_0 - T) + F(S_0 - S)$$

EQUATION 1 LINEAR EQUATION

Where:

P = Corrected Pressure in kPa

CF = Calibration Factor in kPa/B-Unit (From the VW Piezometer Calibration Record sheet for each individual sensor)

L_0 , L = Initial and Current B-Unit reading (Frequency^2 x 10^{-3})

T_K = Temperature Correction Factor in kPa/ºC (From the VW Piezometer Calibration Record sheet in each individual sensor)

T_0 , T = Initial and current temperature readings in (ºC)

F = Barometric Pressure Constant = 0.1 kPa/mbar

S_0 , S = Initial and Current Barometric pressure readings in mbar

4.4.1.1 Example for a 350 kPa Range Piezometer

CF = 0.11594 kPa/B-Unit

L_i = 8776 B-Unit

L = 7200 B-Unit

T_K = - 0.03413 kPa/ºC

T_i = 22.9 ºC

T = 5.0 ºC

F = 0.1 kPa/mbar

S_i = 1003.1 mbar

S = 995 mbar

P = [(0.11594) x (8776 - 7200)] - [(-0.03413) x (22.9 - 5.0)] + [0.1 x (1003.1 - 995)]

= [182.72] - [-0.61] + [0.81]

= 184.14 kPa

NOTE: BAROMETRIC COMPENSATION IS NOT REQUIRED WITH VENTED AND DIFFERENTIAL PRESSURE TRANSDUCERS.

4.4.2 Second Order Polynomial Equation

$$P = A(L)^2 + B(L) + C - T_K(T_0 - T) + F(S_0 - S)$$

EQUATION 2 SECOND ORDER POLYNOMIAL EQUATION

Where:

P = Corrected Pressure in kPa

A = Polynomial Gauge Factor A in kPa/B-Unit^2 (Second Order Polynomial Expression derived from the VW Piezometer Calibration data, for each individual sensor)

B = Polynomial Gauge Factor B in kPa/B-Unit (Second Order Polynomial Expression derived from the VW Piezometer Calibration data, for each individual sensor)

C = Polynomial Gauge Factor C kPa (Second Order Polynomial Expression derived from the VW Piezometer Calibration data, for each individual sensor)

NOTE: POLYNOMIAL GAUGE FACTOR C MUST BE CALCULATED USING THE SITE ZERO READINGS, AS PER THE EQUATION BELOW.

$$C = -[A(L_0)^2 + B(L_0)]$$

L_0 , L = Initial and Current B-Unit reading (Frequency^2 x 10^{-3})

T_K = Temperature Correction Factor in kPa/ºC (From the VW Piezometer Calibration Record sheet in each individual sensor)

T_0, T = Initial and current temperature readings in (ºC)

F = Barometric Pressure Constant = 0.1 kPa/mbar

S_0, S = Initial and Current Barometric pressure readings in mbar

4.4.2.1 Example for a 350 kPa Range Piezometer

A = - 4.1484E-07 kPa/(B-Unit^2)

B = - 0.10991 kPa/B-Unit

C = 996.58 kPa

L = 7200 B-Unit

$\mathbf{T_K}$ = -0.03413 kPa/ºC

$\mathbf{T_0}$ = 22.9 ºC

T = 5.0 ºC

F = 0.1 kPa/mbar

$\mathbf{S_0}$ = 1003.1 mbar

S = 995 mbar

P = [(-4.1484 E-07) x (7200)^2] + [-0.10991 x 7200] + [996.58]

+ [-0.03413 x (5.0 - 22.9)] - [0.1 x (995 - 1003.1)]

= [-21.51] + [-791.35] + [996.58] + [0.61] - [-0.81]

= 185.14 kPa

5 INSTALLATION

Vibrating wire piezometers can be installed in various ways to suit the individual application. Specific guidelines for piezometer installation have been developed by various agencies and technical specialists. Appendix E provides a list of references.

The following instructions summarize the generally accepted practice for:

- Filter saturation;
- Cable identification;
- Piezometers installed in clay fill, granular material, or boreholes;
- Cable routing.

It is not recommended that vibrating wire piezometers be installed in wells or standpipes where an electrical pump and/or a power supply cable is present or nearby. Electrical interference from these sources can cause unstable readings. Ground fault currents from this type of equipment can easily damage the sensitive low voltage vibrating wire piezometers. Additional steps must be performed on site to ensure complete isolation and adequate grounding of the instrumentation circuits if

installation under these conditions is unavoidable. The instrument shield wire should be well grounded, but isolated from sources of external electrical interference.

In situations where vibrating wire piezometers and packers are used at the same time in standpipes or wells, special care must be taken to avoid damaging or cutting the cable jacket with the packer equipment or tools. Any cuts in the cable jacket will allow water entry, which can potentially result in damage or failure of the vibrating wire sensor.

5.1 Filter Saturation

High air entry ceramic or low air entry sintered stainless steel filters are available. The filters are intended to protect the delicate diaphragm area of the vibrating wire piezometer while allowing the transmission of external pressures. The filters and bottom cavity of the piezometer body must be saturated to allow the accurate transmission of hydraulic pressures to the vibrating wire diaphragm. Filter saturation provides the following reading advantages:

- There is no fluid movement in a saturated environment - only pressure transmission. This reduces the possibility of the filter becoming clogged with debris due to oscillating water movement;
- Decreased response times due to pressure changes, which means increased sensor sensitivity;
- Ensure hydraulic continuity between the pore water and the piezometer diaphragm in unsaturated soils, which will provide the highest accuracy of pressure measurement.

5.2 Low Air Entry Sintered Stainless-Steel Filters

Total saturation of the filter is necessary for accurate reading results. For the standard filter supplied, the low air entry filter, saturation will start to occur as the piezometer is lowered into the water. Water will be forced into the filter, compressing the air in the space between the filter stone and the pressure sensitive diaphragm. Given enough time, this air will dissolve into the water until the space below the diaphragm and within the filter is entirely saturated. This could take multiple days, which could mean slightly inaccurate reading results the first few days.

The following procedure will speed up the filter saturation process and allow accurate readings to be taken immediately:

- Turn the vibrating wire piezometer upside down. Remove the end filter assembly, which is held in place with an internal O-ring.
- Submerge the inverted piezometer in a bucket of flat water (water which has been sitting for 24 hours). This will fill the space above the piezometer diaphragm with water.
- While keeping the piezometer submerged, slowly replace the filter housing onto the inverted piezometer end, allowing the water to be forced out through the filter sinter.

- Note that with a low-pressure range piezometer (less than 350 kPa), it is recommended that vibrating wire readings be taken with a VW2106 Readout Unit while the filter housing is being pushed slowly into place, to ensure that the sensor does not over-range due to this operation.

- The vibrating wire piezometer should be stored in the bucket of water until ready to install downhole to maintain the filter saturation prior to installation.

- During the installation, the vibrating wire piezometers should be handled as gently as possible to keep the water in the filter sinter and the bottom chamber until submerging in the borehole.

CAUTION: VIBRATING WIRE PIEZOMETERS CANNOT BE ALLOWED TO FREEZE WHEN FULLY SATURATED, OTHERWISE DAMAGE WILL OCCUR TO THE TRANSDUCER DIAPHRAGM, WHICH WILL INVALIDATE THE TRANSDUCER FUNCTION AND CALIBRATION.

The O-ring providing the friction fit may become worn and the filter housing may become loose if the vibrating wire piezometer must undergo multiple removals and reinstallations of the filter housing. Replace the O-ring immediately if the filter housing is loose.

Coarser screen housings are available for use on vibrating wire piezometers if salts or other precipitates are clogging the stainless sinter filter. Screens are less likely to become clogged by precipitates and other debris found in some water sources.

Note that salts and other dissolved solids can be deposited within a stainless sintered filter if the filter is allowed to dry out completely. Thoroughly rinse out the filter with clean distilled water prior to drying to prevent filter clogging.

5.3 HIGH AIR ENTRY CERAMIC FILTERS

The ceramic filter on high air entry piezometers is also removable for de-airing. Because of the high air entry characteristics of the filter, proper de-airing is particularly important for this type of filter assembly in order to ensure that accurate readings can be taken. High air entry filters are available with different air entry values, which will require different procedures. It is therefore very important to know which type of high air entry filter is installed.

5.3.1 One Bar High Air Entry Filters

1. Remove the filter housing from the piezometer body by carefully twisting and pulling on the filter housing assembly. Remove the filter housing slowly to avoid causing a vacuum pressure on the piezometer diaphragm.

2. Boil the filter assembly in de-aired water for 30 minutes to force all air out of the filter and to saturate the filter material. Place the filter into de-aired water when boiling is completed.

3 Re-assemble the filter housing into the piezometer body under the surface of de-aired water, while keeping the piezometer oriented with the diaphragm pointing upward. Take care to ensure that no air is trapped in the transducer cavity.

4 Vibrating wire readings must be taken with a VW2106 readout unit while the filter housing is being pushed slowly into place. Allow any over-range pressures to fully dissipate before pushing the filter on any further.

5 The vibrating wire piezometer with a high air entry filter installed must be stored in de-aired water until the unit is installed.

CAUTION: VIBRATING WIRE PIEZOMETERS CANNOT BE ALLOWED TO FREEZE WHEN FULLY SATURATED, OTHERWISE DAMAGE WILL OCCUR TO THE TRANSDUCER DIAPHRAGM, WHICH WILL INVALIDATE THE TRANSDUCER FUNCTION AND CALIBRATION.

5.3.2 Two Bar (or Higher) High Air Entry Filters

The proper procedure for de-airing and saturating two bar (or higher) high air entry filters is complex and difficult to complete properly. It is recommended that it be performed either at the factory or by carefully following the instructions below:

1 Place the assembled piezometer, with the filter housing facing downward, at the bottom of a vacuum chamber. The vacuum chamber is to have an inlet port at the bottom to later allow introduction of de-aired water into the chamber.

2 Close the valve for the de-aired water inlet and evacuate the chamber. The piezometer should be monitored with a VW2106 readout unit while the chamber is being evacuated.

3 When the maximum vacuum has been achieved in the vacuum chamber, use the VW2106 readout unit to read the piezometer until it has also reached the same maximum vacuum pressure.

4 Open the de-aired water inlet valve to allow de-aired water to enter the bottom of the chamber and reach an elevation of approximately 50 mm above the top of the piezometer high air entry filter.

5 Close the de-aired water inlet valve when the de-aired water has reached the required height.

6 Release the vacuum, allowing the chamber to return to atmospheric pressure.

7 Observe the transducer output on the VW2106 readout unit. Up to 24 hours may be required for the (5 bar high entry) filter to completely saturate and for the piezometer pressure to return to zero. The saturation of the high entry filter is considered to be completed at this point.

8 After saturation, the transducer must be kept in a sealed container of de-aired water until ready for installation.

9 If de-aired at the factory, a special plastic cap is applied to the piezometer tip to maintain the saturation level. The plastic cap must be removed immediately before installation. When removing the cap, there will always be an unavoidable amount of movement of the filter when the O-ring drags past the filter adapter. The instructions below will help to minimize the movement:

a Remove the sealing screw from the top of saturation cap before trying to remove the cap from the sensor (Figure 5-1). This will eliminate the vacuum effect created when the cap is pulled off.

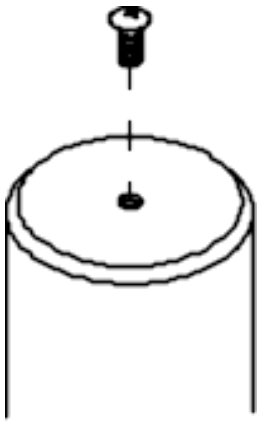


FIGURE 5-1 REMOVING THE SEALING SCREW

b Gently twist the saturation cap slightly to loosen the O-ring inside of the cap, and then pull to remove the cap from the piezometer tip.

If the filter becomes loose when the cap is removed, follow the steps outlined in Sections 5.3.1 to replace it.

CAUTION: VIBRATING WIRE PIEZOMETERS CANNOT BE ALLOWED TO FREEZE WHEN FULLY SATURATED, OTHERWISE DAMAGE WILL OCCUR TO THE TRANSDUCER DIAPHRAGM, WHICH WILL INVALIDATE THE TRANSDUCER FUNCTION AND CALIBRATION.

5.4 INSTALLATION IN FULL

5.4.1 Compacted Clay

1 Excavate a vertical trench or recess approximately 50 cm deep in the clay material. Form a horizontal cylindrical hole in the sidewall of the excavated trench near the bottom. The hole diameter should be slightly smaller than the piezometer body to ensure a snug fit when the piezometer is inserted in the hole.

2 Push the piezometer into the hole in the trench side, and into the host clay material. Smear the filter ceramic with a thin paste of the saturated clay material if necessary, to ensure continuity of the saturated air entry filter and pore water.

3 Place the cable with the utmost care to avoid any damage due to kinking or stretching. Look the cable and route it out of the trench. Make sure it rests on a bed of hand placed and lightly compacted screened clay. Ensure that the cable does not come into direct contact with itself or other cables in the area. Always maintain a few centimeters of compacted clay material between any two cables.

4 Backfill the trench with screened clay containing no particles larger than 3 mm in dimension. The backfill should have a water content and density equal to that of the surrounding material.

5 Ensure that the cable is well protected from any potential damage caused by any angular fill material, compacting equipment, and any settlement that might occur due to construction work or subsequent fill placement.

5.4.2 Granular Materials

1 Excavate a vertical trench or recess about 50 cm deep in the granular material.

2 Place the piezometer horizontally in the center of the trench or recess.

3 Loop the cable and backfill the bottom 10 cm of the trench around the piezometer with screened granular material not exceeding 3 mm in dimension.

4 Above that level, the trench can be backfilled in 10 cm lift with the same granular material that was excavated. The granular backfill should contain the same moisture content and be compacted to the same density as the surrounding fill. Care must be exercised to not subject the piezometer instrument to damage during compaction work.

5 In rock fill (particle sizes greater than 10mm), the large interstitial voids will not allow fine backfill materials around the piezometer to stay in place. The fine filter materials will migrate into the rock fill, eventually leaving the piezometer body in direct contact with the angular rock fill material. It will be necessary to place a graded filter zone around the piezometer to ensure that the filter materials will not be moved. Fine grained clean sand, grading to pea gravel or larger, will be required around the piezometer instrument. The particle size of the backfill will have to increase in size outwards toward the rock fill. The sand placed around the piezometer instrument and cable should range in size from 0.5 to 3mm in diameter and should not be angular.

- Note that it may be necessary or advisable to use geotextile filter fabric layers and/or envelopes to provide hard boundaries when attempting to place a fine grained zoned backfill around a piezometer within courser fill materials. This practice will ensure that fine grained backfill materials used within a graded filter will not become mobilized and wash away.

5.5 INSTALLATION IN BOREHOLES

5.5.1 Sand/Bentonite Method

The method used to install a piezometer in a borehole depends on the technical requirements for the instrument, the drilling method that was employed, the particular downhole conditions, and the materials which the installation must be carried out in. The general method described below will have general applicability to most installations. However, the Field Engineer must be aware of the unique conditions that may be present in the subject borehole, which could make downhole installations a major challenge. Conditions such as artesian pressures, squeezing ground, shear zones, and borehole wall instabilities will impact the piezometric instrumentation method chosen and installation techniques required. Refer to Appendix E for references of descriptions of other potential instrumentation methods.

5.5.1.1 General Installation Methodology

The drill casing is drilled 30 cm below the required piezometer installation elevation. If the piezometer is intended to measure the pore water pressure at a specific horizon, it may be necessary to drill hole to 90 cm below the required piezometer elevation to provide room for the placement of a bentonite bottom seal.

After the drilling is completed to the required depth, the drill cuttings and other downhole debris must be removed from inside the drill casing. The borehole is washed to bottom, inside the drill casing, until the water emerging runs clear.

If the borehole walls are stable enough to remain open, the drill casing can be withdrawn a certain distance above the hole bottom to allow the piezometer installation to proceed in the open length of the borehole. This is the desired method because the work will able to proceed in much easier fashion.

The piezometer installation will have to proceed with multiple small withdrawals of the drill casing to minimize the risk of losing the installation if the borehole walls are considered to be unstable or likely to cave or collapse. This method is described below and it will be obvious why longer drill rod or casing pulls will be more desirable if possible.

In general, boreholes in bedrock are more stable than boreholes in soil. Boreholes in cohesive soils are also more stable than boreholes in less cohesive, granular soils.

5.5.1.2 Bentonite Plug Method

Bentonite chips are recommended for downhole backfill work because they are a made from solid bentonite which will not hydrate as quickly when exposed to water compared to bentonite pellets, which are a manufactured product. Bentonite pellets will become sticky very quickly when exposed to water and can easily clump together, bridging inside the casing well above the target zone. Use of either bentonite products for downhole seals should be limited to holes which are less that 20 meters, due to the difficulty involved with this method.

CAUTION: DO NOT ROTATE THE DRILL CASING. THE DRILL CASING CANNOT BE ROTATED WHEN BEING PULLED. ROTATING THE DRILL CASING WILL LIKELY RESULT IN DAMAGE TO THE INSTALLED PIEZOMETERS.

1. Place a 60 cm bentonite seal at the bottom of the borehole to seal (if required).

2. Raise the drill casing 15 cm and start placing the bentonite chips until the bentonite level is 30 cm below the required piezometer elevation.

3. Pull the drill casing as the bentonite is set in place. Be very careful not to bridge or plug the drill casing with the bentonite.

   - This is accomplished by ensuring the bentonite level is at all times below the casing bottom and by slowly dropping the bentonite chips one at a time down the hole. Feeding the bentonite chips in too rapidly will result in bridging of the chips in the drill casing or borehole. Bridging will make completing downhole installations extremely difficult.

   - Tamping is not required because the natural swelling of the chips will provide an adequate seal to the borehole walls once the bentonite chips are in place.

4. Lower a cylindrical weight down the drill casing to the top of the bentonite plug to ensure the hole is clear of any obstructions prior to setting filter sand in place for the piezometer zone.

5. Rinse the borehole with clean water to remove any obstructions or debris.

6. Place 30 cm of fine, clean sand in 15 cm increments by dropping from surface. The drill casing will also have to be pulled as the sand back-filling proceeds.

7. Lower the piezometer into the hole and take the initial readings, as described in Section 4.3.

8. Raise the drill casing 15 cm and backfill the hole around the piezometer with fine, clean sand. Repeat until the sand is 30 cm above the top of the piezometer.

9. Take a second reading on the piezometer.

10. Lift the casing in 15 cm increments and backfill with bentonite chips until a minimum four-foot seal has been placed. Keep the piezometer cable taut to prevent the bentonite chips from adhering to the wall of the drill casing during the bentonite chip placement. Drop the bentonite chips into the hole one at a time to avoid bridging.

    - If more than one piezometer is to be installed in the drill hole, the intervening distance between the top of the first piezometer zone and the bottom of the next piezometer zone can be backfilled with either cement grout or cement/bentonite grout delivered by tremie method. The second piezometer can then be constructed in the same general manner as described above.

11. Top off the borehole collar with grout and a protective steel collar casing once all the drill casing has been removed from the hole.

5.5.2 Fully Grouted Method

The fully grouted method of piezometer installation involves the installation of the vibrating wire piezometers directly within a cement-bentonite grout mixture. This method has now become widely accepted based on the technical theory and on extensive field testing and application. It provides a simple and accurate method to obtain precision piezometric monitoring results. Refer to Mikkelson & Green (2003) and Contreras et al. (2008) in Appendix E for more details on this method.

The general method described below was taken from the two above technical papers and outlines the basic concepts and methodology of the Fully Grouted Method:

When using the fully grouted method, it is very important that proper filter saturation is performed. This ensures that there are no air-filled voids in the filter and that cement-bentonite grout will not be able to plug the filter stone. The best practice is to install the piezometers upside down with the filter tips facing upwards which will ensure that the water stays inside the filter stone. The piezometer can be inverted and tied off to its own cable or it can be inverted and taped onto a PVC pipe which can be used as either a downhole carrier pipe or as a tremie pipe for grout delivery.

The design of a bentonite-cement mixture is intended to approximate the strength and deformation characteristics of the surrounding soil or rock (rather than the surrounding permeability). The strength of the grout can be controlled by adjusting the Water-Cement ratio which is easy to control in the field. The water and cement are mixed first prior to adding any bentonite. This ensures that the water-cement ratio stays fixed and the strength/modulus of the mix is more predictable. Any type of bentonite drilling mud can be combined with Type I or II Portland Cement to make the mix. The quantity of bentonite powder will vary depending on the grade of the bentonite, the mixing agitation, the water pH, and the water temperature. As the bentonite solids content increases, the mix density increases and the permeability decreases.

The final mix point has to be carefully monitored to ensure that the completed grout remains pumpable. Although the grout mix has a target bentonite content, it may be cut short or extra bentonite may be added to attain the required pumping viscosity. In the end, the low permeability cement bentonite grout will provide adequate permeability for the vibrating wire piezometer diaphragm to react to any pressure changes occurring at the location. A number of installation methods have been identified using the fully grouted method:

- Install piezometers one by one from the borehole bottom to the collar over multiple days. Use a single PVC plastic tremie pipe, which is reduced in length, as each successive installation is competed to the hole collar.

- Attach the multiple piezometers to a PVC plastic tremie pipe and install to depth in the borehole. Use the PVC plastic tremie pipe to grout the entire hole in one stage and leave it in place. Note that you need to ensure that the piezometers being grouted into the borehole will not be over ranged by the grout column being placed. Vibrating wire piezometers can be over pressured to 200% of the full-scale range. However, in practice, it is recommended that 150% of FS not be exceeded to ensure an adequate safety buffer.

- For deep holes with lower range piezometers, multiple grouted in PVC plastic tremie pipes may be required. If multiple PVC tremie pipes are used, they should have their annulus fully grouted to ensure that no internal to external pressure communication can occur, if one or both PCV pipes should break.
- Install piezometers attached to a PVC plastic tremie pipe inside a casing or hollow stem auger. Leave in place while casing or auger stem is pulled out. Downhole grouting may be carried out before the casing or auger stem is pulled or following. This method is well suited to boreholes with wall stability issues.
- Complete drilling and then grout the hole with casing or hollow stem auger still in hole. Next, pull the casing or auger stem and top up the hole collar with grout. Install piezometers in the borehole, from the bottom to the top. Add weights to each piezometer as required, to overcome viscous resistance of the grout while lowering the piezometer.
- Attach piezometers directly to the outside of the inclinometer casing and grout in place. Piezometers should be placed midway between the casing couplings.
- Attach directly to the outside of corrugated polyethylene settlement pipe (Sondex) or similarly attach to magnet/reed switch casing between the magnet sensors so that pore water pressure and settlement can be measured along the same borehole.
- Install a series of vibrating wire piezometers inside a length of perforated 2-inch PVC plastic pipe. The piezometer filter housings will be located in close proximity to one or more of the perforation holes and will therefore be able to monitor the external pressures when fully grouted in-place. This technique is useful in deep installations inside of drill casing or hollow stem augers to prevent cable and/or sensor damage when rotation is required during casing extraction. Later tremie grouting outside the PVC pipe will result in the piezometers being fully grouted in-place.

5.6 INSTALLATION OF HEAVY-DUTY PIEZOMETERS WITH BLADDERS

The method used to install a heavy-duty piezometer in a borehole depends on the particular site conditions. Artesian conditions, borehole stability, available drilling equipment, and sealing materials are among the factors that will influence the most appropriate method. The method described below will cover most applications.

1 Drive the casing one foot below the required piezometer elevation. If the piezometer is to measure the pore water pressure in a specific horizon, drive the casing three feet below the piezometer elevation to allow for the placement of a bentonite seal at the bottom of the hole.

2 Remove the cuttings. Wash the borehole until the water emerging runs clear.

3 If required, place a two-foot bentonite seal at the bottom of the borehole. Raise the casing six inches and place the bentonite in six-inch increments until the bentonite level is one foot below the piezometer elevation. Pull the casing as the bentonite is set in place. Be very careful not to plug or allow bentonite to stick to the inside walls of the casing. This is accomplished by making sure the

bentonite level is below the casing at all times and by **slowly** dropping the bentonite chips down the hole in single file. Feeding the bentonite chips too rapidly will result in bridging of the chips in the casing or borehole. This will make it extremely difficult to complete the seal. Tamping of compressed bentonite chips is not required.

4 Lower a cylindrical weight down the borehole to ensure that it is clear from any obstructions. Rinse the borehole until clear water emerges, if necessary.

5 Place twelve inches of fine, clean sand in six-inch increments below the level of the piezometer tip, following the same procedure as Step 3. Pull the casing back as the sand back-filling proceeds. Lower the piezometer into the hole.

6 Pull the casing up six inches and backfill with fine clean sand. Repeat until the sand and casing are one foot above the top of the piezometer. Take another reading on the piezometer.

7 Lift the casing up in six-inch increments and backfill with bentonite until a seal of at least four feet has been formed. Keep the cable taut to prevent the bentonite from hooking up in the casing. Pour the bentonite in the hole one chip at a time to avoid bridging.

8 If more than one piezometer will be installed in the hole, backfill the casing with a cement/bentonite grout, host material, or sand/bentonite mixture to an elevation of 4 feet below the second piezometer, then use 3 feet of bentonite, 1 foot of sand, then the piezometer. Follow the procedure outlined in Steps 3 – 10.

9 Pull the casing out of the borehole. Take care when pulling the casing to not twist or damage the cable.

10 Once the entire casing has been removed, top off the borehole with grout. The profile of the borehole should resemble Figure 5-2.

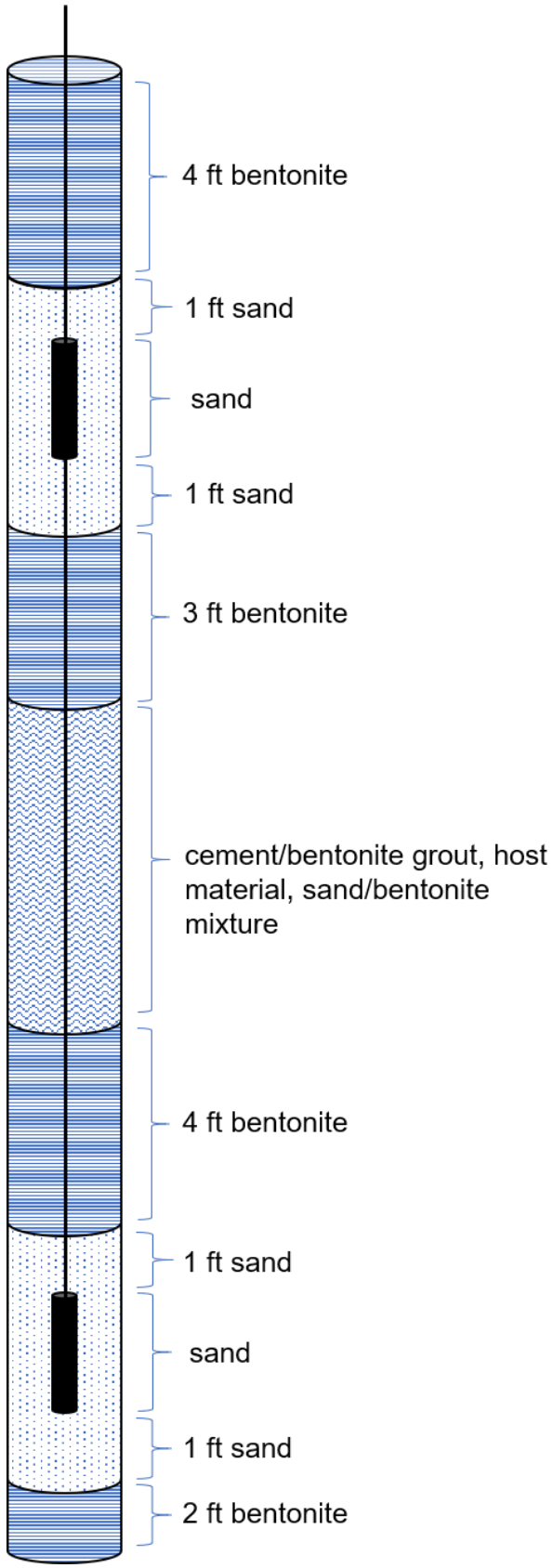


FIGURE 5-2 HEAVY-DUTY PIEZOMETER WITH BLADDER INSTALLATION

5.7 PIEZOMETERS DRIVE IN SOFT GROUND

RST Model VW2100-DP is designed to be pushed into place from the surface in soft soil. For deeper installations where driving from the surface would not be possible, the piezometer may be pushed into place from the bottom of a pre-drilled borehole.

The model VW2100-DP piezometer comes with an adapter fitting which can be connected to AW, CPT, 1" NPT, or 1-1/4" NPT threaded pipe or drill rod for pushing.

The drive rods are larger in diameter than the VW2100-DP and form an effective seal above the piezometer. The drive rods are left in the ground with the piezometers and can only be retrieved when and if the piezometer is recovered. Should other rods need to be adapted to push the VW2100-DP piezometer in place, it is important to ensure that the first 1.5 meters of these rod have a diameter which is larger than the outside diameter of the VW2100 piezometer housing.

5.7.1 Installation

1. Total saturation of the VW2100-DP filter is necessary for accurate results. Refer to Appendix B which outlines the steps required to saturate a drive point piezometer filter.

2. Prepare the rods to be used downhole. Lay a sufficient number of rods for the push side by side, alternating between male threaded and female threaded ends.

3. Thread the piezometer cable through the rods leaving a 0.5 m loop of extra cable laying flat on the ground at each rod end.

4. Leave an 8-meter length of free cable extending beyond the lower extremity of the first rod (assuming 3-meter rod lengths). This should provide sufficient slack to allow easy manipulation of the rods as they are screwed together and pushed into the drill hole.

5. Pull back the spare cable. Screw the lower rod onto the piezometer body. Use a pipe sealing compound or Teflon tape on the threads to form a permanent seal preventing pore-water from flowing into the rod string, thus causing delay response.

6. Add on the required number of rods in sequence to reach the push point.

7. Connect the VW2106 readout unit to the VW2100-DP and start monitoring the readings prior to pushing.

8. Push the piezometer into place while monitoring any pressure build-up at the tip. Stop the driving and wait until the pressure dissipates should the pressure exceed the working pressure range.

9. Complete the installation and ensure the cable leads are protected.

5.8 CABLE IDENTIFICATION

The vibrating wire cables are identified with a serial number tag that is attached to the cable jacket at the readout end. If the cable must be cut, this VW serial number tag must be removed and reattached at the new cable end. As an added identification feature, the large cable rolls used in the manufacture of all RST vibrating wire sensors have meterage numbers marked on the cable at every meter. The start and end point of the numbering sequence is unique to each sensor and is recorded on the instrument calibration sheet for later reference. Inspection of the cable meterage numbers can therefore be easily used to verify the ID of an installed vibrating wire sensor.

If the vibrating wire cable is cut and needs to be repaired, or the cable must be lengthened with a cable splice, RST recommends the use of an RST ELSPLICE4 Electrical Cable Splice Kit for Vibrating Wire Cable. Any cable splice that will be exposed to any moisture should be protected in this manner to eliminate the potential of water egress, short circuiting, and conductor corrosion.

5.9 CABLE ROUTING

5.9.1 Transition from Vertical Borehole to Horizontal Trench

The vibrating wire cable should be routed along a curved path as it goes from a vertical to a horizontal position. At the collar of the borehole, prepare a large radius circular transition path within a cushion of screened sand/5% bentonite mix, hand compacted to the surrounding fill density. Embed the cable along this transition pathway and bury it in place to ensure the cable will not be stretched or kinked by uneven loading.

5.9.2 Horizontal Cable Runs

Two methods are currently used to protect horizontal cable runs from damage. The first method is embedment within selected materials on the surface of the fill. The second method is embedment in an excavated trench in the fill. The second method is the most commonly used because once the trench is backfilled and compacted, the surface can be used for access. The trench method is discussed below. Refer to Clements (1982) in Appendix E for a description of this method.

All surface cable installations require continuous surveillance and protection from traffic and earth moving equipment which must move around on the fill surface.

Note that the trench dimensions should be 300 mm wider than the width required for the cable layout and a minimum 600 mm deep. A 100-150 mm bedding layer of 1 mm minus sand is then placed along the trench bottom. Bentonite can be added to the sand to form an impervious section or plug if required.

1. Cover cable completely with a 150 mm lift of 10 mm minus select material.

2. Completely backfill the trench with selected material. Compact it with light hand operated equipment.

3 Avoid traversing transition zones in the fill where large differential settlements could occur and create excessive strain in the cable. If cables must traverse these zones, install them with additional length for cable snaking which will allow slack for settlement to occur, rather than creating excessive cable strain.

4 Avoid cable splices. Only use an RST ELSPLICE4 Electrical Cable Splice Kit for Vibrating Wire Cables if splicing is required. The kit will ensure a strong and waterproof splice.

5 Spend time on the design of the cable layout in the trench. Avoid overlaying or crossing the cable runs on top of each other. If overlaying and crossing cannot be avoided, the cables must be separated by a 50 mm blanket of compacted fine-grained soil.

6 Use horizontal or vertical snaking of the cable within trenches to provide a certain amount of potential slack to avoid overstressing the cables during backfilling and the subsequent fill placement.

   - For most materials, a pitch of 1.8 m with an amplitude of 0.4 m will be suitable.
   - In very wet clays, which could be subject to settlement, increase the amplitude from 0.4 m to between 0.6 m and 1.0 m.

7 During cable routing, read the instruments at regular intervals to ensure their continued function. This is especially important prior to backfilling any trenches.

5.10 LIGHTNING PROTECTION

All RST Model 2100 Vibrating Wire Piezometers have highly reliable surge/lightning protection incorporated into the sensor circuitry. This surge protection is adequate for most applications. The entire instrumentation system needs to be considered to be effectively isolated in all situations, especially when multiple instruments are connected by wires into a large area network. The network could be subject to transient and/or induced currents which could damage sensors and/or data acquisition equipment.

In cases where there may be additional risks of surge damage to the network and/or data loss, the following suggestions for additional surge protection are provided:

- If a vibrating wire piezometer is connected to a terminal box or multiplexer on surface, components such as plasma surge arrestors (spark gaps) could be installed in the terminal box/multiplexer to provide an increased measure of transient protection. Terminal boxes and multiplexers available from RST provide built-in locations for the installation of these surge protection devices.
- Lightning arrestor boards and enclosures are available from RST that install at the exit point of an instrument cable from a drill hole or structure. The enclosure can be easily accessed and opened so that in the event that the protection board (Surge 4C) is damaged by a surge event, the user may easily service the components or replace the board. A connection is made between this enclosure

and ground to facilitate the passing of transients away from the vibrating wire instrument.

Additional information on surge protection alternatives is available from RST. Additional sources of information on protecting instruments, junction boxes, and data logging systems against power surges, transients, and electromagnetic pulses are listed in available in Appendix E.

6 TROUBLESHOOTING

Maintenance and troubleshooting of Vibrating Wire Piezometers is confined to periodic checks of cable connections and maintenance of terminals. The transducers themselves are sealed and are not user serviceable. The following are typical problems with suggested remedial actions.

6.1 VW PIEZOMETER FAILS TO GIVE A READING

1. Check the resistance of the vibrating wire coils by connecting an ohmmeter across the gauge terminals (red and black wires). Nominal resistance is approximately 180Ω (±5%), plus cable resistance at approximately 15Ω per 300 m of 22 AWG wire. Ensure to account for the two lengths of 22 AWG wire (i.e. red wire AND black wire) in this calculation. If the resistance is very high or infinite, the cable is possibly broken or cut. If the resistance is very low, the gauge conductors may be shorted.

2. Check the VW2106 Readout Unit with another vibrating wire piezometer to confirm that the VW2106 Readout Unit is working.

3. The vibrating wire piezometer may have been over-ranged or physically damaged. Inspect the diaphragm and housing for any obvious damage. Contact RST Instruments if necessary.

6.2 VW PIEZOMETER READING UNSTABLE

1. Connect the blue shield drain wire on the vibrating wire readout to the shield wire of the vibrating wire instrument. In the absence of a shield wire on the vibrating wire instrument, the blue shield drain wire can be connected to the black or green wires from the vibrating wire instrument. If this does not result in more stable readings, proceed to step 2 below.

2. Isolate the vibrating wire readout from ground sources by placing it on a piece of wood or similar non-conductive material. If this does not result in more stable readings, proceed to step 3 below.

3. Check for sources of nearby electrical noise such as motors, generators, antennas, or electrical cables. Move the vibrating wire piezometer cables as far as possible away from any sources of electrical noise. Filtering and shielding equipment is likely required if the noise cannot be eliminated. Contact RST for technical advice.

4 The vibrating wire piezometer housing may be shorted to the shield. Check the resistance between the shield drain wire and piezometer housing. The resistance should very high.

5 The vibrating wire piezometer may have been over-ranged or physically damaged. Inspect the diaphragm and housing for any obvious damage. Contact RST Instruments if necessary.

6.3 THERMISTOR READING IS TOO LOW

1 If the calculated temperature from the thermistor resistance reading is unrealistically low, it is very likely that there is an open circuit or poor connection in the thermistor wiring which is resulting in excessive resistance.

2 Check all connections, terminals, and plugs for any damage or corrosion that could cause excessive in-line resistance.

3 If cable damage or a cut is located, a splice must be performed to return the function of the wire connection to normal. It is recommended that an RST ELSPLICE4 Electrical Cable Splice Kit for Vibrating Wire Cables be used to ensure a strong and waterproof splice.

6.4 THERMISTOR READING IS TOO HIGH

1 If the calculated temperature from the thermistor resistance reading is unrealistically high, it is very likely that there is a short circuit in the thermistor wiring which is resulting in a lower resistance reading.

2 Check all connections, terminals and plugs for any damage or current leakage that could explain a partial short that could result in a reduced circuit resistance. If a short or partial short is located in the cable, the cable must be repaired with a splice. It is recommended that an RST ELSPLICE4 Electrical Cable Splice Kit for Vibrating Wire Cables be used to ensure a strong and waterproof splice.

3 If no obvious sources of shorting are found, it is possible that water may have penetrated into the interior of the piezometer. There are no remedial actions available if this is concluded to be the case

7 SPECIFICATIONS

TABLE 7-1 GENERAL SPECIFICATIONS FOR ALL MODELS

Specification	Value
Range	0.07, 0.175, 0.35, 0.7, 1, 2, 3, 5, 7.5, 10 MPa
Over-range	1.5 x FS
Temperature Range	-20°C to 80°C
Resolution	<0.025% FS
Accuracy	±0.1% FS
Non-Linearity	<0.5% FS
Zero Stability	0.02% FS/year
Thermal Zero Shift	< 0.05% FS/°C
Frequency Range	1200-3550 Hz
Coil Resistance	180 Ω ± 5%
Diaphragm Displacement	<0.001 cc @ FS
Thermistor Type	NTC 3k Ω @ 25°C
Filter	50 micron sintered stainless steel (High air entry alumina ceramic filter available for 1, 3 and 5 MPa versions)

TABLE 7-2 SPECIFICATIONS FOR INDIVIDUAL MODELS

Model	Description	Pressure Range	Dimensions
VW2100	Standard model for general applications	0.35, 0.7, 1, 2, 3 MPa	19mm ϕ x 130mm
VW2100-HD	Heavy-duty piezometer for direct burial in fills and large dam embankments	0.35, 0.7, 1, 2, 3, 5, 7.5, 10 MPa	25.4mm ϕ x 130mm
VW2100-XHD	Extra heavy-duty piezometer for direct burial in fills and large dam embankments	1, 2, 3, 5, 7.5 ,10 MPa	38.1mm ϕ x 130mm
VW2100-DPC	Drive point with CPT thread	0.07, 0.175, 0.35, 0.7, 1, 2, 3, 5, 7.5 MPa	33mm ϕ x 130mm
VW2100-DPC-CT	Drive point model with drop-off shoe	0.07, 0.175, 0.35, 0.7, 1, 2, 3 MPa	50.8mm ϕ (tip) 33.4 ϕ (body) x 130mm
VW2100-DPE	Drive point model with extension rod (31.8mm ϕ x 127mm)		
VW2100-L	Low pressure, unvented	70, 175 kPa	25mm ϕ x 133mm
VW2100-LV	Low pressure, vented	70, 175 kPa	25mm ϕ x 133mm
VW2100-M	Miniature version	0.35, 0.7, 1, 2, 3 MPa	17.5mm ϕ x 133mm
VW2100-MM	Micro-miniature version	0.35, 0.7 MPa	11.1mm ϕ x 165mm
VW2190	Heavy duty piezometer with bladder for brine environment	0.07, 0.175, 0.35, 0.7, 1, 2, 3, 5, 7.5 MPa	42mm ϕ x 319mm
VW2191	Heavy duty piezometer with bladder for acidic environment and secondary corrosive protection	0.07, 0.175, 0.35, 0.7, 1, 2, 3, 5, 7.5 MPa	42mm ϕ x 319mm

8 SERVICE AND REPAIR

The product contains no user-serviceable parts. Contact RST for product service or repair not covered in this manual.

Appendix A : VW2100 CALIBRATION SHEET

Vibrating Wire Piezometer

Customer:		RST Instruments Ltd.
Model:		VW2100-0.35
Serial Number:		**VW21345**
Mfg Number:		P101940
Range:		350.0 kPa
Temperature:		23.0 °C
Barometric Pressure:		1024.4 millibars
Work Order Number:		54049
Cable Length:		50 meters
Cable Markings:		802296 m - 802345 m
Cable Colour Code:	Red / Black (Coil)	Green / White (Thermistor)
Cable Type:		EL380004
Thermistor Type:		3 kΩ

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (% FS)	Calculated Polynomial (kPa)	Polynomial Error (% FS)
0.000	8507	8508	8507	-0.004	0.00	0.006	0.00
70.000	7718	7719	7718	70.057	0.02	70.055	0.02
140.000	6932	6933	6932	139.851	-0.04	139.843	-0.04
210.000	6141	6142	6141	210.090	0.03	210.081	0.02
280.000	5353	5354	5353	280.062	0.02	280.060	0.02
350.000	4566	4567	4566	349.945	-0.02	349.956	-0.01
			Max. Error (%):		0.04		0.04

Linear Calibration Factor: **CF = 8.8797E-02 kPa/B unit**
Temperature Correction Factor: **Tk = -9.4569E-02 kPa/°C rise**

Polynomial Gage Factors:

A = 5.1074E-09 kPa/(B unit)² **B = -8.8864E-02 kPa/B unit** **C = _____ kPa**

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

Users must establish site zero readings for calculation purposes
Polynomial C = - $[A(L_0^2) + B(L_0)]$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = $Hz^2/1000$ ie: 1700 Hz = 2890 B units

	Date (dd/mm/yy)	VW Reading (B units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	25-Apr-18	8505	21.8	1008.8

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: E. Gilboe Date: 25-Apr-18

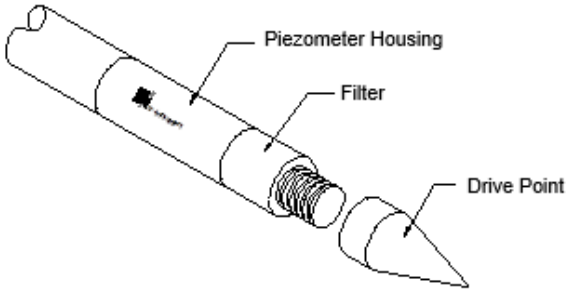
Appendix B : VW2100-DP (DRIVE POINT) PIEZOMETER

Pre-Operation Instructions:

1 Remove the protective plastic bag from the piezometer. Avoid touching the ceramic filter element, as oil from fingers may affect the permeability of the filter material.

2 Fill a bucket with water.

3 Unscrew the drive point of the piezometer, so that water can flow freely into the piezometer housing.



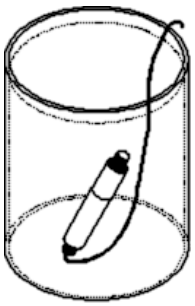
4 Immerse the piezometer upside-down in the bucket of water and ensure that all air is removed from the inside of the piezometer housing.

5 While the piezometer is still immersed in the water, thread the drive point back on. The drive point should be hand tightened. The filter should be slightly compressed by this process.

6 Note that with low pressure range piezometers (<70 kPa), readings must be taken with a readout box while carefully pushing the filter housing on so as not to over-range the sensor.

7 Remove the piezometer from the water and slide the wires through the adapter pipe. The unit should be kept under water to maintain saturation if the piezometer is not being installed immediately.

8 Thread the adapter pipe onto the VW2100-DP piezometer. Install the piezometer.



Appendix C : USING THE SECOND ORDER POLYNOMIAL TO IMPROVE THE ACCURACY OF THE CALCULATED PRESSURE

Most Vibrating Wire Pressure Transducers are sufficiently linear (<0.2% FS) that the use of a Linear Equation and a Linear Calibration Factor will satisfy most normal output requirements. However, it must be noted that the accuracy of the calibration data used to establish the Linear Calibration Factor is dictated by the accuracy of the calibration procedure and apparatus, which is always <0.1% FS.

The level of accuracy for a Vibrating Wire Pressure Transducer can be improved, especially when the transducer output is non-linear, by using the Second Order Polynomial Expression, which is better suited to the real pressures than the Linear Equation.

The Second Order Polynomial Expression has the following form:

$$\mathbf{P\ (pressure) = A(L)^2 + B(L) + C}$$

Where, L is the current Vibrating Wire reading (in B-Units) and A, B, and C are the polynomial coefficients determined by the individual instrument calibration procedure.

Appendix A shows a sample calibration sheet for a Vibrating Wire pressure transducer which has a comparatively low non-linearity. In this case, there will only be a very small difference between the pressure value calculated by the Linear Equation and by the Second Order Polynomial Expression.

In contrast, it is noted that the Second Order Polynomial Expression method will provide more accurate pressure values for VW transducers which have a high non-linearity (greater than 0.2% FS). The vibrating wire calibration sheet contains a column labeled “Linearity Error (% Full Scale)”. This column displays the calculated linear error percentage for the calibration steps. If the average of these percentage values (usually 6) exceeds 0.2%, it would be advisable to carry out all pressure calculations using the Second Order Polynomial Expression.

The Linearity Error (% Full Scale) is calculated as follows:

LE = [(Calculated Pressure – Applied Pressure) / Full Scale Pressure] * 100%

The Second Order Polynomial Expression will provide a calculated pressure which is more accurate to the actual pressure monitored and will contain less error. However, it should be noted that where the accuracy of absolute pressure measurement is not required, such as monitoring relative water level changes, it makes little difference whether the Linear Equation or the Second Order Polynomial Expression is used.

Appendix D : THERMISTOR TEMPERATURE DERIVATION

Thermistor Type: YSI 44005, Dale 41C3001 B3, Alpha #13A3001 B3
Resistance to Temperature Equation:

$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.2$$

EQUATION D-1 CONVERT THERMISTOR RESISTANCE TO TEMPERATURE

where:
- T = Temperature in °C
- Ln(R) = Natural Log of Thermistor Resistance
- A = 1.4051×10^{-3} (coefficient calculated over the -50 to +150°C span)
- B = 2.369×10^{-4}
- C = 1.019×10^{-7}

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
201.1K	-50	16.60K	-10	2417	+30	525.4	+70	153.2	+110
187.3K	-49	15.72K	-9	2317	31	507.8	71	149.0	111
174.5K	-48	14.90K	-8	2221	32	490.9	72	145.0	112
162.7K	-47	14.12K	-7	2130	33	474.7	73	141.11	113
151.7K	-46	13.39K	-6	2042	34	459.0	74	137.2	114
141.6K	-45	12.70K	-5	1959	35	444.0	75	133.6	115
132.2K	-44	12.05K	-4	1880	36	429.5	76	130.0	116
123.5K	-43	11.44K	-3	1805	37	415.6	77	126.5	117
115.4K	-42	10.86K	-2	1733	38	402.2	78	123.2	118
107.9K	-41	10.31K	-1	1664	39	389.3	79	119.9	119
101.0K	-40	9796	0	1598	40	376.9	80	116.8	120
94.48K	-39	9310	+1	1535	41	364.9	81	113.8	121
88.46K	-38	8851	2	1475	42	353.4	82	110.8	122
82.87K	-37	8417	3	1418	43	342..2	83	107.9	123
77.99K	-36	8006	4	1363	44	331.5	84	105.2	124
72.81K	-35	7618	5	1310	45	321.2	85	102.5	125
68.30K	-35	7252	6	1260	46	311.3	86	99.9	126
64.09K	-33	6905	7	1212	47	301.7	87	97.3	127
60.17K	-32	6576	8	1167	48	282.4	88	94.9	128
56.51K	-31	6265	9	1123	49	283.5	89	92.5	129
53.10K	-30	5971	10	1081	50	274.9	90	90.2	130
49.91K	-29	56.92	11	1040	51	266.6	91	87.9	131
46.94K	-28	5427	12	1002	52	258.6	92	85.7	132
44.16K	-27	5177	13	965.	53	250.9	93	83.6	134
39.13K	-25	4714	15	895.8	55	236.2	95	79.6	135
36.86K	-24	4500	16	863.3	56	229.3	96	77.6	136
34.73K	-23	4297	17	832.2	57	222.6	97	75.8	137
32.74K	-22	4105	18	802.3	58	216.1	98	73.9	138
30.87K	-21	3922	19	773.7	59	209.8	99	72.2	139
29.13K	-20	3748	20	746.3	60	203.8	100	70.4	140
27.49K	-19	3583	21	719.9	61	197.9	101	68.8	141
25.95K	-18	3426	22	694.7	62	192.2	102	67.1	142
24.51K	-17	3277	23	670.4	63	186.8	103	65.5	143
23.16K	-16	3135	24	647.1	64	181.5	104	64.0	144
21.89K	-15	3000	25	624.7	65	176.4	105	62.5	145
20.70K	-14	2872	26	603.3	66	171.4	106	61.1	146
19.58K	-13	2750	27	582.6	67	166.7	107	59.6	147
18.52K	-12	2633	28	562.8	68	162.0	108	58.3	148
17.53K	-11	2523	29	543.7	69	157.6	109	56.8	149
								55.6	150

FIGURE 8-1 THERMISTOR RESISTANCE VERSUS TEMPERATURE

Appendix E : REFERENCES

A-1 Terzaghi, K and Peck, R.B.; “Soil Mechanics in Engineering Practice”, John Wiley and Sons, Inc., 1967. (Article 68 of Chapter 12 provides a survey of tip types and recommendations on installation procedure.)

A-2 U.S. Department of the Interior, Bureau of Reclamation; “Earth Manual”, U.S. Government Printing Office, Washington 1974. (Designations E-27 and E-28 in the Appendix give detailed guidance on piezometer installations in dam foundations.)

A-3 Bishop, A.W., Vaughan, P.R., and Green, G.E. (1969); Report on specialty session, “Pore Measurements in the Field and in the Laboratory”, Proc. 7th, Int. Conf. Soil Mech. and Found. Eng. 3, 427. (A review of recent practice and instrumentation, related principally to earth structures.)

A-4 “Suggested Methods for Determining In-Situ Permeability, Groundwater Pressure and Flow”; Int. Soc. for Rock Mechanics, committee on Field Tests (Draft report, 1974; Final report in course of preparation.)

A-5 Hanna, T.H.; “Foundation Instrumentation”, Trans. Tech. Publications, Ohio, USA, 1973. (Chapter 3 describes different types of piezometer tip, methods of installation, methods of recording and the protection of piezometer.)

A-6 Clements, D.J., and A.C. Durney (1982); “Instrumentation Developments”, Proceedings of the Autumn Conference on the British National Committee on Large Dams (BNCOLD) Keele University, Institution of Civil Engineers, London, pp. A5-55.

A-7 General Electric (1976); Transient voltage suppression manual, G.E. Semiconductor products Department, Syracuse, New York.

A-8 Baker, C. (1978); “Surge Protection for Instrumentation”, proceedings of the Tempcon Conference, London. Available from Measurement Technology, Inc., 7541 Gary Road, Manassas, Virginia, 22110, U.S.A.

A-9 Baker, C., (1980); “Protecting Electronic Circuits from Lightening and Transients”. Available from Measurement Technology, Inc., 7541 Gary Road, Manassas, Virginia, 22110, U.S.A.

A-10 Corps of Engineers (1984); “Publications Relating to Geotechnical Activities”, USACE DAENECE-G, September 27th.

A-11 McKenna, G.T. (1995); “Grouted-In Installation of Piezometers in Boreholes”, Canadian Geotechnical Journal, Vol.32(2), pp. 355-263.

A-11 Mikkelsen, P.E. and Green, G.E. (2003); “Piezometers in fully grouted boreholes”. Field Measurements in Geomechanics, -Myrvoll(ed.). Swets & Zeitlinger, Lisse, ISBN 90 5809 602 5.

A-12 Contreras, I.A., Grosser. A.T., Ver Strate, R.H. (2008); `The Use of the Fully-Grouted Method for Piezometer Installations``, Geotechnical Instrumentation News, Episode 55

A-13 Contreras, I.A., Grosser. A.T., Ver Strate, R.H. (2011); `Practical Aspects of the Fully-Grouted Method for Piezometer Installations``, Proc 8th International Symposium on Field Measurements in Geomechanics, Berlin.

A-14 Simeoni, L., De Polo, F., Caloni, G., Pezzetti, G. (2011); Field Performance of Fully Grouted Piezometers`, Proc 8th International Symposium on Field Measurements in Geomechanics, Berlin.

A-15 Contreras, I.A., Grosser. A.T., Ver Strate, R.H. (2012); `Update of the Fully-Grouted Method for Piezometer Installation``, Geotechnical Instrumentation News, Episode 70

Vibrating Wire Piezometer
Portable Readout

Monitor with Confidence

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Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

The VW2106 Vibrating Wire Readout shown connected to a Vibrating Wire Piezometer.

PRODUCT CATEGORY:
READOUTS + DATA LOGGERS

VW2106
Vibrating Wire Readout

The portable VW2106 Vibrating Wire Readout reads, displays, and logs both vibrating wire sensors and thermistors. Vibrating wire load cells can be read without any additional accessories.

Available for IMMEDIATE DELIVERY
Contact RST for Details

Unprecedented accuracy, flexible memory options, and ease of use make the VW2106 invaluable for projects requiring vibrating wire sensor monitoring. Maximum download time is only 15 seconds.

Complementing its high level of accuracy, the VW2106 is also designed for maximum efficiency with the user in mind. In addition to the simple power requirements of only 3 "AA" batteries, the VW2106 comes well-equipped with standard features such as a large graphics display with backlight, a built-in multiplexer, "no-tools" vibrating wire transducer inputs and a convenient on-board speaker for sensor diagnostics.

> APPLICATIONS

Reads, displays, and logs both vibrating wire sensors and thermistors.

> FEATURES

- Durable, compact design for excellent portability and field use.
- Large graphics display with a convenient backlight.
- Readings in raw or engineering units.
- Built-in multiplexer for load cells up to 6 vibrating wire gauges.
- "No-tools" vibrating wire transducer inputs.
- Field-replaceable "AA" alkaline batteries eliminate the need for a large, bulky 12 V battery and charger.
- On-board speaker for sensor diagnostics.
- Stores up to 254 instrument locations per route, each with a text label, calibration constants, previous data, and up to 11,400 time/date stamped data points.
- Data transfer to a host computer via USB in a compatible file format for Microsoft Excel® and other spreadsheets. User friendly host software for Microsoft Windows® included.

> BENEFITS

- ✓ **High Reliability**
- ✓ **High Accuracy**

SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Vibrating Wire Readout Excitation Range	400 Hz to 6000 Hz, 5 V Square Wave
Vibrating Wire Readout Resolution	0.01 μs
Vibrating Wire Readout Timebase Accuracy	±50 ppm
Supported Temperature Readout Sensors	NTC3000 (standard), NTC2252, NTC10K, RTD
Temperature Readout Accuracy	±0.1°C
Temperature Readout Range	-50°C to 80°C
Display	Graphic 128 x 64 pixels large character display
Display Backlight	High efficiency LCD with auto off
Max Instrument Locations	254
Memory Capacity	11,400 custom labelled points
Location Identification String	Up to 20 characters
Download Speed	15 seconds (full memory)
Battery	3 "AA" alkaline
Battery Indicator	On-screen, low battery indicator
Operating Temperature	-20°C to 60°C
Dimensions	W 22 cm x D 19 cm x H 9.5 cm (8.75 x 7.5 x 3.75in.)
Weight	1.1 kg (2.4 lbs)

ORDERING INFO

ITEM	PART #
Vibrating Wire Readout	VW2106
Fly Lead	VW2106-AG

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VW2106 Vibrating Wire Readout Manual

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REVISION TABLE

Rev.	Revision History	Date	Prepared By	Approved By
J	Added revision table, section 4.6 instruction 4 “thermistor” changed to “sensor”, updated column heading in Table 4-2 from “Thermistor Type” to “Sensor Type”.	2019-09-03	MP	JW

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1 INTRODUCTION

The RST VW2106 Readout is a lightweight device used to read and display vibrating wire sensor and thermistor data. It is suitable for harsh environments and the user interface is simple to use.

The VW2106 readout is powered by 3 standard "AA" alkaline batteries to facilitate replacement in the field. Data can be reviewed either on-board or downloaded to the computer using RST-provided software.

FIGURE 1-1 VW 2106 READOUT

1. USB Connector
2. Large character LCD display
3. Backlight (hold down to display Engineering Units)
4. ESC (navigates back one menu)
5. Scroll Up
6. Scroll Down
7. Enter
8. Terminal Strip (for sensor connection)
9. Expansion port (VW Load Cells and external Multiplexers)

2 SAFETY

This product is battery operated. There are no major safety concerns associated with use.

It is important to keep the unit clean during use in the field. Ensure there is no dirt or dust in the wire terminals, battery compartment, and weather seal along the edge of the lid of the enclosure. Make sure that weather caps for the USB port and expansion port are properly secured when not in use.

3 GETTING STARTED

3.1 POWERING ON

The VW2106 Readout unit can be powered on any time by pressing any key.

3.2 POWERING OFF

The VW2106 unit can be powered off either manually or automatically.

The following instructions illustrate how to power off the unit manually:

1. Use the up/down arrows to scroll to the **Power Off** screen (Figure 3-1).

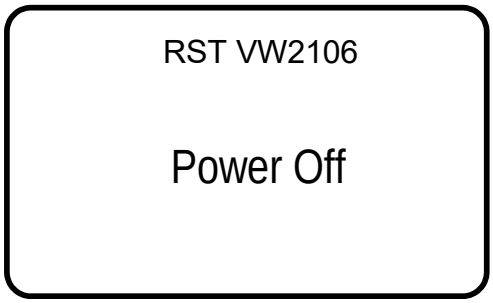

FIGURE 3-1 POWER OFF SCREEN

2. Press **Enter** and the unit will turn off.

The following instructions detail how to configure the unit to power off automatically.

1. Navigate to the **Auto Off** screen (Figure 3-2).

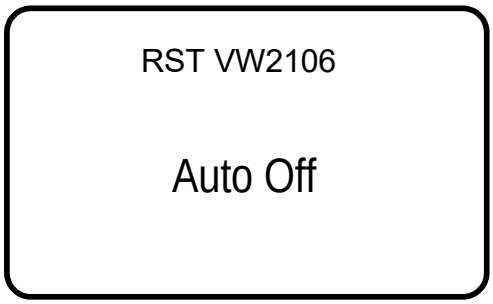

FIGURE 3-2 AUTO OFF SCREEN

2. Press **Enter**. The following screen will appear (Figure 3-3):

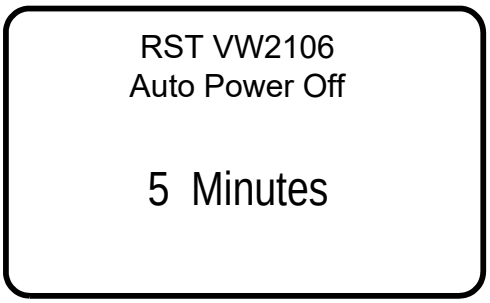

FIGURE 3-3 AUTO POWER OFF TIME

3. Use the up/down arrows to scroll to the desired auto power off time. Press **Enter** to select the time. The default time is five minutes.

NOTE: THE AUTO POWER OFF FEATURE IS ALWAYS ACTIVE AND CANNOT BE DISABLED TO CONSERVE BATTERY LIFE.

4. The next screen prompts the user to select the Auto Backlight Off (Figure 3-4). Use the up/down arrows to adjust the desired time and press **Enter**.

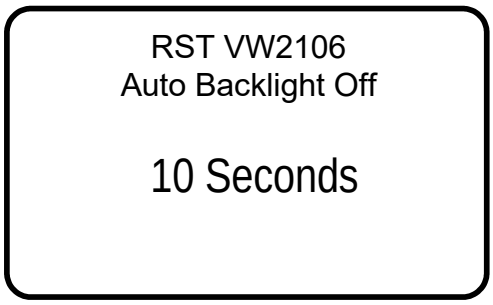

FIGURE 3-4 AUTO BACKLIGHT OFF

5. The next screen prompts the user to select the Speaker On time. Use the up/down arrows to select the desired time and press **Enter**. The unit will return to the previous menu.

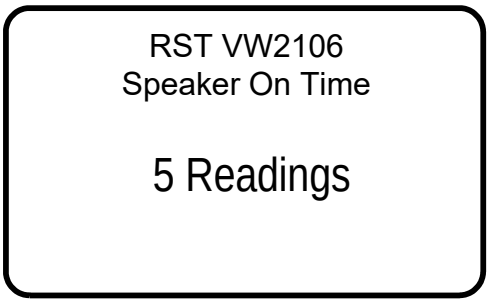

FIGURE 3-5 SPEAKER ON TIME

NOTE: IT IS RECOMMENDED TO KEEP THE UNIT OFF UNLESS IN USE TO PRESERVE BATTERY LIFE

4 CONFIGURATION

The VW2106 may be connected to **either** single field instruments **or** multi-channel instruments.

4.1 SINGLE FIELD INSTRUMENT CONNECTION

The following instructions outline the steps to connect single field instruments:

1. Using hands or a screw driver, lift the gates on the terminal strip.
2. Insert the stripped ends of the instrument cable to the matching wire transducer. Refer to Table 4-1 for matching colours and wire transducers.

TABLE 4-1 STANDARD WIRING COLOUR CODES

Colour	Wire Transducer
Red	Coil +
Black	Coil -
Green	Therm +
White	Therm -
Bare	Shield

CAUTION: MAKE SURE THAT THE WIRES ARE CLEAN AND FREE OF DIRT BEFORE INSERTING THEM INTO THE TERMINALS.

CAUTION: ENSURE THAT THE TERMINALS ARE FREE FROM DIRT AND DEBRIS BEFORE INSERTING THE WIRES. TERMINALS CAN BE BLOWN OUT WITH COMPRESSED AIR IF NECESSARY.

3. Close each gate to secure the wire.

CAUTION: ENSURE THAT THE GATES ARE SECURED BEFORE CLOSING THE LID TO THE UNIT TO AVOID DAMAGING THE GATES.

NOTE: APPLYING SOLDER TO THE BARE ENDS OF THE CABLE REDUCES FRAYING OVER TIME. ALL RST SENSORS ARE PRE-TINNED IN THE FACTORY.

4.2 MULTI-CHANNEL CONNECTION

The VW 2106 may be connected to multi-channel instruments through its expansion connection (Figure 1-1, 9).

Mating halves of the connectors are available through RST if your current sensors are not equipped with the appropriate connector.

The most common instrument with multiple channels is a Load Cell. Typical load cells have either 3 or 6 Vibrating Wire sensors with a common thermistor. During location setup, the number of sensors can be specified. Please refer to section 4.6 for detailed instructions.

The expansion connection is also able to control external multiplexers, which can facilitate connecting multiple single-channel instruments simultaneously.

For specific applications and configurations, please contact RST Instruments.

4.3 SETTING DATE AND TIME

Each reading includes a date and time stamp and it is stored in the unit's memory. To ensure accurate historical records of the readout data, keep the date and time current.

The following outlines the steps to set the date and time on the readout.

1. Turn on the readout by pressing any key.

2. Scroll to the **Set Time** screen (Figure 4-1) using the up/down arrows and press 'Enter'.

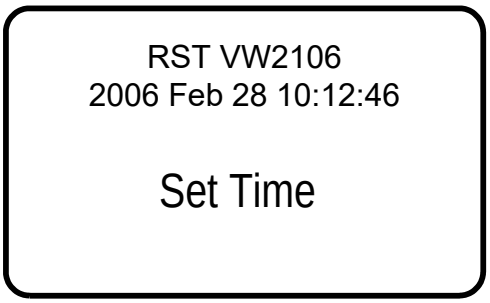

FIGURE 4-1 SET TIME SCREEN

4.4 CREATING LOCATIONS

The VW2106 Readout may be pre-configured either using the software on a host computer or directly on the device.

It is recommended that the VW2106 be pre-configured with the software prior to use in the field, as the site location names can be defined ahead of time.

If taken directly to the field prior to defining locations, each location will be assigned a generic name which can be edited once the VW2106 is connected to a host computer.

NOTE: THE MAXIMUM NUMBER OF PRE-DEFINED LOCATIONS IS 254.

The following instructions outline the steps to define new locations and location parameters on the device.

1. Turn on the readout by pressing any key.

2. Scroll to the **Memory** screen (Figure 4-2) using the up/down arrows and press **Enter.**

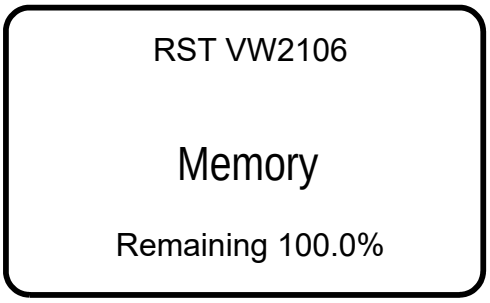

FIGURE 4-2 MEMORY SCREEN

3. Scroll to the **Create Location** screen (Figure 4-3) using the up/down arrows and press **Enter**.

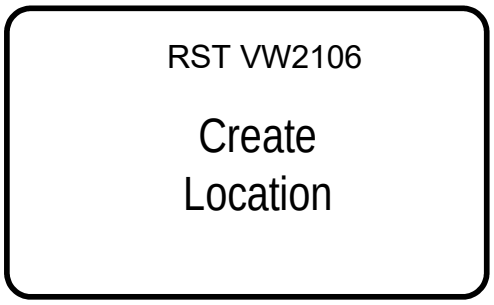

FIGURE 4-3 CREATE LOCATION SCREEN

4. The VW2106 will automatically create a site called Location X, where 'X' is the next storage location available in the unit's memory. Make note of the real location name in your field notebook and its relation to the location number. When connected to the Host Software back in the office, a custom name can be entered, which replaced the site name assigned by the readout.

NOTE: NEW SITES CREATED IN THE FIELD ARE ASSIGNED THE NAME 'LOCATION X' BY DEFAULT. THE READOUT AUTOMATICALLY INCREMENTS THE 'X' TO THE NEXT NUMBER AVAILABLE IN THE UNIT'S MEMORY. LOCATION NAMES CAN ONLY BE CHANGED WHEN THE VW2106 IS CONNECTED TO HOST SOFTWARE.

5. Use the up/down arrows to select between 1 and 6 sensors to read and press **Enter**.

NOTE: IN MOST CASES, THE SENSOR NUMBER WILL BE EQUAL TO 1. CASES WHERE MORE THAN ONE SENSOR IS USED ON THE LOAD CELLS REQUIRE THE EXPANSION CONNECTOR WHICH WILL BE AUTOMATICALLY ENABLED.

6. When connecting a single sensor, you will be given a choice between reading from the terminal strip or the expansion connector when connecting a single sensor. Select the appropriate connection and press **Enter**.

7. Use the up/down arrows to select the appropriate 'Sweep Frequency' for the gauge being measured at that location (Figure 4-4) and press **Enter**. The default is the "B" sweep (1200-3550Hz), which is the standard range for the RST model VW2100 series piezometers. Additional Sweep Frequencies are summarized in

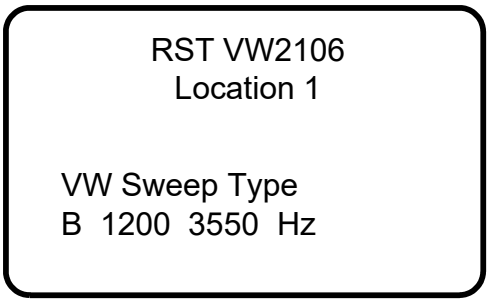

FIGURE 4-4 SELECTING THE SWEEP FREQUENCY

8. Use the up/down arrows to select the type of thermistor (Figure 4-5) and press **Enter**. The default is 3K, which is the standard thermistor in all RST Vibrating Wire sensors.

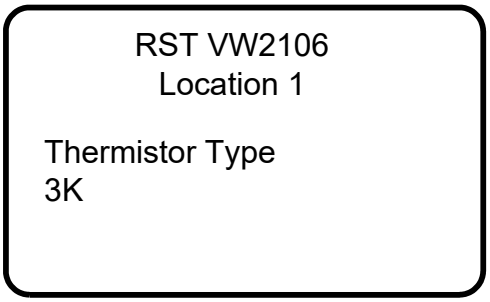

FIGURE 4-5 THERMISTOR TYPE

You may now use the newly created location to store readings. For instructions on how to store readings, refer to section 5.2.

4.5 IMPORTING PARAMETERS

If at least one location has previously been defined, the following instructions outline the steps to import parameters.

1. Scroll to the **Monitor Settings** screen using the up/down arrows and press **Enter**.

2. Select the **Import from Loc.** option and scroll to the desired location using the up/down arrows and press **Enter** when complete.

The location label will appear at the top of the screen to indicate the current location in use.

NOTE: THE DEVICE WILL DISPLAY THE MESSAGE "NO LOCATIONS" IF NO LOCATIONS EXIST IN THE READOUT'S MEMORY.

4.6 CREATING CUSTOM PARAMETERS

The following instructions outline the steps to set up custom parameters.

1. Scroll to the **Monitor Settings** screen using the up/down arrows and press **Enter**.

2. Select the **Custom Setup** option and press **Enter.**

3. Select the number of sensors connected and press **Enter**. Most devices will be set to connect to one sensor per terminal strip (Figure 4-6). The expansion connector is automatically enabled when more than one sensor is selected.

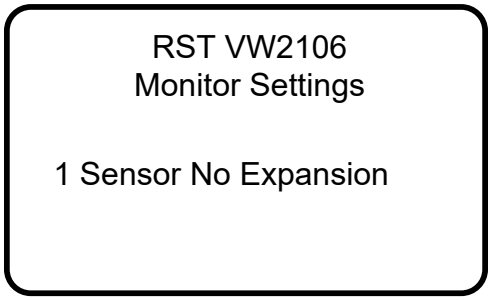

FIGURE 4-6 ONE SENSOR CONNECTED

4. Select the appropriate sweep frequency and press **Enter**. Refer to Table 4-2 for sweep frequencies corresponding to sensor type.

TABLE 4-2 SWEEP FREQUENCIES

Sweep	Frequency	Sensor Type
A	450-6000Hz	Wide Sweep
B (Default)	1200-3550Hz	Piezometer, Strain Gauge, Borehole Stressmeter, Jointmeter, Crackmeter, Displacement, Settlement, Temperature, Load Cells
C	450-1200Hz	Arc Weldable Strain Gauge
D	450-1200Hz	Embedment Strain Gauge
E	1000-3600Hz	Spot Weldable Strain Gauge
F	2500-6000Hz	Borehole Stressmeter
U (Custom)	1200-3550Hz	Custom user specified sweep frequency. May only be set within the readout software.

5. Select the Thermistor Type and press **Enter.** Options include 2252, 3K (default), 10K, and RTD.

6. Select the desired display units and press **Enter.**

7. The unit will return to the previous menu.

5 OPERATION

This section describes the operation of the VW2106 Readout once the unit has been powered on (see Section 3.1).

5.1 STARTUP

Once powered on, an opening screen will appear with the RST Instruments logo. If the user wishes to view the details of the readout, **press any key** immediately. Details of the unit (Figure 5-1) including the model, version number, serial number and current date and time settings are displayed.

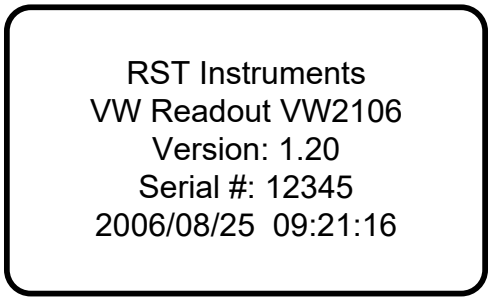

FIGURE 5-1 VW2106 READOUT DETAILS

NOTE: CHECK THAT THE DATE AND TIME SETTINGS ARE CORRECT, AS THIS MAY AFFECT ANY READINGS STORED IN THE UNIT'S MEMORY.

If no keys are pressed after powering on, the unit will default to the readings screen (Figure 5-2).

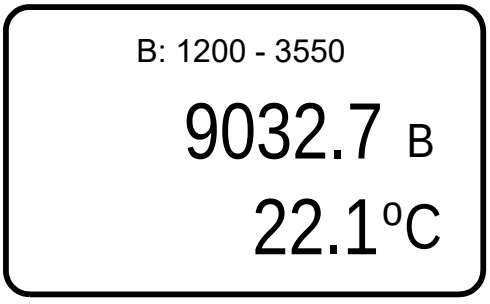

FIGURE 5-2 READINGS SCREEN

If a unit is connected, the readings screen will display the current sweep settings and a reading from the VW instrument and its internal thermistor. The default units are B units ($f^2 \times 10^{-3}$) and degrees Celsius. Units can be changed if desired (see section 4.6).

5.2 STORING READINGS IN MEMORY

The VW2106 readout has 128k of internal memory, allowing it to store over 11,000 time-stamped readings.

The following instructions outline the steps required to store readings in the unit's memory.

1. Using the up/down arrows, scroll to the **Store Data** screen and press **Enter**.
2. Using the up/down arrows, scroll to the desired location and press **Enter**.
3. Press **Enter** when prompted to store the reading (Figure 5-3).

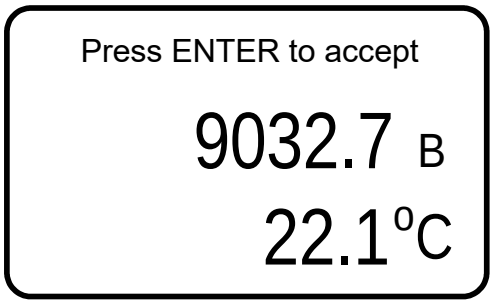

FIGURE 5-3 STORING A READING

4. If the unit has more than once sensor, the unit will display both average readings (in bold) and individual readings (Figure 5-4).

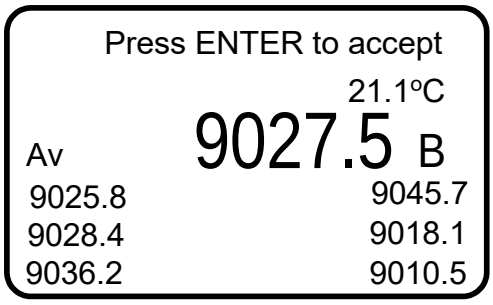

FIGURE 5-4 STORING A READING WITH 6 SENSORS

NOTE: AVERAGE READINGS WILL NOT BE STORED IN THE UNIT'S MEMORY.

5.3 REVIEWING DATA

The following instructions outline the steps to review readings on the VW2106.

1. Press any key to turn the readout on.

2. Using the up/down arrows, scroll to the **Memory** screen and press **Enter.**

3. Using the up/down arrows, scroll to **Review Data** and press **Enter.**

4. Scroll to the desired location using the up/down arrows and press **Enter**.

5. If a location contains more than one reading, the readings can be scrolled through using the up/down arrow.

5.4 DATA LOGGING

The VW2106 has a basic datalogging function where the user can set the datalogging interval and the number of iterations.

The following instructions detail the steps to log data at a given location.

1. Use the up/down arrows to scroll to the **Memory** screen and press **Enter**.

2. Use the up/down arrows to scroll to the **Data Logging** screen and press **Enter.**

3. Use the up/down arrows to select the location to record the data. If no locations are currently defined, the readout with respond with “No Locations.” See section 4.4 for detail about how to define locations.

4. Use the up/down arrows to set the reading interval and press **Enter**. For example, if 4 is selected, the data will log every 4 seconds (Figure 5-5).

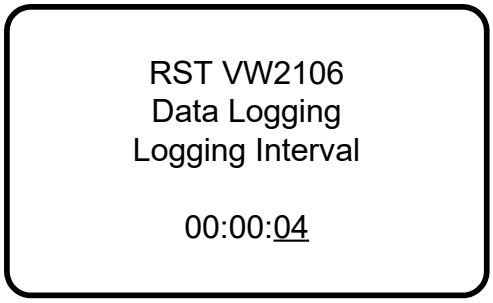

FIGURE 5-5 DATA LOGGING INTERVAL

5. Using the up/down arrows, select the data logging number and press **Enter**. For example, if the number 4 is selected, the data will log 4 times every interval, as illustrated in Figure 5-6. To continuously log data until the memory is full, set the data logging number to 0.

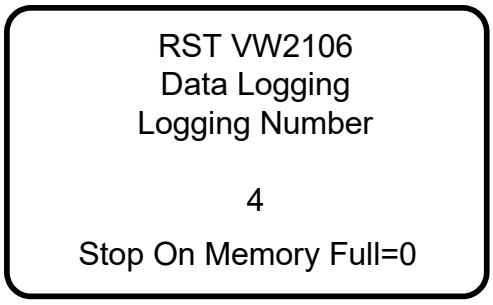

FIGURE 5-6 DATA LOGGING NUMBER

6. The readout will start the data logging process and will end with a message stating “Logging completed”. **ESC** can be pressed any time to abort the data logging process.

5.5 DATA LOGGING THROUGH STORE DATA

Once the intervals and iteration preferences have been defined (see section 5.4 step 4), data logging can also be accessed through the **Store Data** screen.

1. Using the up/down arrows, scroll to the **Store Data** screen and press **Enter**.
2. Select the location where the data will be stored. Press **Enter**.
3. Press and HOLD the **Enter** button to commence data logging. The logging screen will appear (Figure 5-7).

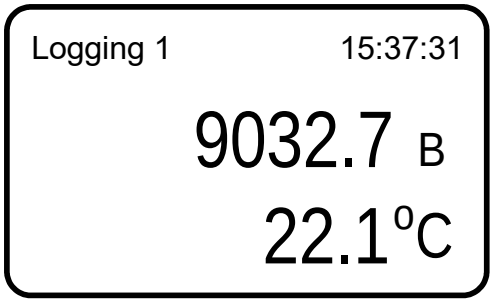

FIGURE 5-7 LOGGING SCREEN

During the logging process, the logging number and the corresponding time stamp will increase in the upper right-hand corner of the screen.

A message will appear indicating the logging process has been completed. The readout will automatically turn off.

5.6 ZEROING READOUT

The readout can be zeroed once the calibration factors are set for a specific location and the correct sensor engineering units are selected and uploaded from the

Multireadout Host Software to the VW2106 unit. Please refer to the Multi Readout Software Manual to set up sensor engineering units.

The following instructions detail the procedure for zeroing the sensor:

1. Using the up/down arrows, scroll to the **Memory** screen and press **Enter**.
2. Scroll to the **Zero Readout** screen and press **Enter**.
3. Scroll to the desired location and press **Enter**.
4. Select **Zero Readout** and press **Enter**.
5. Press **Enter** to accept the value displayed or press **ESC** for more options (Figure 5-8).

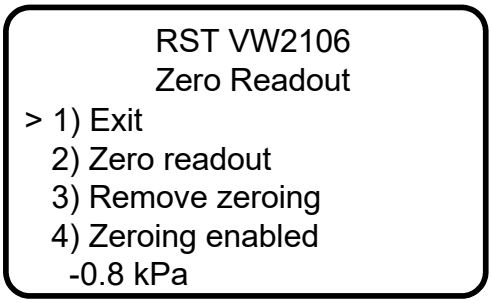

FIGURE 5-8 ZEROING OPTIONS

6. Using the up/down arrows, scroll to the desired option and press **Enter**.
   - **Selection 1** will exit the current screen.
   - **Selection 2** will zero the readout.
   - **Selection 3** will delete the current zeroing value.
   - **Selection 4** will toggle between zeroing enabled/disabled.

NOTE: "ENABLE/DISABLE" WILL SAVE THE ZERO OFFSET, SO IT CAN BE RE-APPLIED AT A LATER TIME. WHEN ZEROING IS ENABLED FOR A GIVEN LOCATION, 'TARE' WILL APPEAR IN THE READINGS SCREEN TO CONFIRM A READING IS BEING TAKEN WITH AN APPLIED ZERO OFFSET.

5.7 DELETING DATA

All location information can be deleted from the readout or through the Multi Readout Host Software. The following instructions detail the process for deleting data in the readout.

1. Press **any key** to power on the display.

2. Scroll to the **Memory** screen using the up/down arrows and press **Enter**.

3. Scroll to **Delete** using the up/down arrows and press **Enter**.

4. Scroll to the desired delete option (Figure 5-9) using the up/down arrows and press **Enter**.

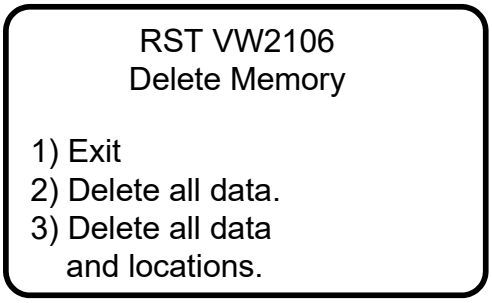

FIGURE 5-9 DELETE OPTIONS

NOTE: ESC CAN BE PRESSED AT ANY TIME TO ABORT THE DATA DELETION PROCESS.

6 MAINTENANCE

6.1 DEVICE HEALTH

The VW2106 Readout contains a built-in speaker. The following procedure outlines the steps to determine the health of the device by listening to the ring of the wire.

1. Simultaneously press the **Up** and **Down** arrows for several seconds to enable the audio feature. Once enabled, a small speaker graphic will appear on the screen.

2. Listen to the ring emitted from the device, If the instrument is functioning correctly, a steady ping without distortion will be audible.

3. This feature can be disabled by either waiting for it to time out or by simultaneously pressing both the **Up** and **Down arrows.**

6.2 BATTERY

The VW2106 operates on 3 standard “AA” batteries. The battery terminal can be found the left side of the readout unit (Figure 6-1).

FIGURE 6-1 BATTERY COMPARTMENT

The following instructions detail the process for accessing the battery compartment:

1. Using a flat-head screwdriver, turn the cap on the battery cover one quarter turn counter clockwise.
2. Remove the cap.
3. To replace the cap, ensure the notched on the cap align with the notches on the compartment. Firmly press the cap into place and turn the cap one quarter turn to the right.

CAUTION: ENSURE THE NOTCHES OF THE BATTERY COMPARTMENT COVER AND THE BATTERY COMPARTMENT ITSELF ARE ALIGNED BEFORE REPLACING AND TIGHTENING THE COMPARTMENT COVER TO PREVENT DAMAGING THE COVER.

Battery polarity is described in Figure 6-2:

FIGURE 6-2 BATTERY POLARITY DIAGRAM

The status of the battery can be checked using the following steps:

1. Turn on the readout by pressing **any key**.
2. Using the up/down arrow keys, scroll to the **Battery Voltage** screen.
3. The readout will display the current battery status, as illustrated in Figure 6-3.

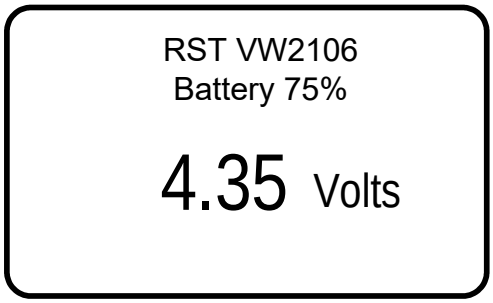

FIGURE 6-3 BATTERY VOLTAGE SCREEN

When the battery level is low (i.e. the battery voltage drops below 3.5 volts), "BATT" will appear on the upper right corner of every screen. All 3 batteries should be changed once this warning appears.

NOTE: REPLACE ALL 3 BATTERIES WHEN THE "BATT" WARNING APPEARS.

CAUTION: DO NOT REPLACE BATTERIES IN WET CONDITIONS TO PREVENT WATER INGRESS.

6.3 PROTECTING THE DEVICE

There are a number of steps that can be taken to protect the integrity of the unit:

- Ensure wires and terminals are free from dirt before inserting wires into the terminals.
- Check that the latch on the terminal block is in the closed position prior to closing the lid of the enclosure.
- It is important to keep the weather seal free from dust and dirt to maintain the water ingress protection.
- Make sure the weather caps are secured before closing the lid of the enclosure.
- Ensure the unit is dry before storing it to avoid damage from standing water.

7 SOFTWARE AND FIRMWARE UPDATES

The VW2106 Readout is designed so that the unit's software and firmware can be easily updated by the customer by connecting a host computer to the unit via the USB port. Please visit http://www.rstinstruments.com for product updates.

8 SERVICE AND REPAIR

The product contains no user-serviceable parts. Contact RST for product service or repair not covered in this manual.

Vibrating Wire Piezometer
Data Logger System

Vibrating Wire Piezometer
FlexDAQ Data Logger

rst INSTRUMENTS
Monitor with Confidence

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Maple Ridge, BC V2X 0Z5 Canada

Certified System ISO 9001

PRODUCT CATEGORY:
READOUTS + DATA LOGGERS

FlexDAQ Data Loggers

Ideal for remote monitoring in both common and demanding geotechnical conditions, RST FlexDAQ Data Loggers offer precise measurement and reliable data acquisition from various sensor types and gauges including vibrating wire, thermistor, MEMS (analog and digital), Tensmeg, linear potentiometer, strain gauge, LVDT, TDR, etc.

The 4 main FlexDAQ models are the CR6, CR300, CR800, and CR1000X. All offer extreme flexibility in their design configurations and are custom made to accommodate a variety of sensor types as they pertain to the parameters of your project. The framework for building a FlexDAQ Data logger is dependent on the type, number, precision, and speed of measurements required. Best of all, FlexDAQ Data Loggers arrive to you completely pre-assembled, pre-wired, pre-tested, and pre-programmed; ready to be put to work straight out of the box with minimal set-up.

All FlexDAQ Data Loggers bear similarities in measurement and programming capabilities and can easily incorporate additional sensor and telecommunication options.

CR6 FlexDAQ Data Logger (with optional wi-fi) in a weatherproof enclosure with RST Flexi-Mux Multiplexers.

CR300 FlexDAQ Data Logger shown with optional cellular modem for data communication.

> APPLICATIONS

Remote data logging of various types of geotechnical instrumentation used in dams, tunnels, bridges, mines, and natural slopes.	Alarm triggering when movement reaches a preset critical rate or levels reach a present value.
Real time data logging and analysis.	

> FEATURES

Immediate functionality straight out of the box - "Ready to Run".	Weatherproof housing available.
Pre-assembled, pre-wired, pre-programmed and pre-tested.	
Flexible data logger configurations made to exact customer specifications.	

Multiplexers, such as the RST Flexi-Mux (see reverse) may be added to augment measurement and control capabilities that include:

Adding extra sensors that can be monitored by the data logger (RST Flexi-Mux).	Providing non-volatile data storage and on-board battery-backed clock.
On-board data processing.	Initiating measurement and control functions based on time or event.
Controlling external devices such as pumps, motors, alarms, freezers, valves, etc.	Using PC support software or keyboard/display to program.
Operating independently of AC power, computers, and human interaction.	Consuming minimal power from a 12 Vdc source.
Interfacing with on-site and telecommunication devices such as cellular modems, radio transceivers, Wi-Fi routers, satellite transmitters, and ethernet interfaces. See diagram on reverse.	

ORDERING INFO

ITEM	PART #
CR6	ELGL1206
CR300	ELGL1430
CR800	ELGL1300
CR1000X	ELGL1200
Flexi-Mux Multiplexer	ELGL2042

NOTE: Due to the customizable nature of each FlexDAQ Data Logger model, specifications can vary greatly in accordance to customer specifications and optional additions. Please contact RST Instruments Ltd. for complete information.

> BENEFITS

- ✓ **Increase Productivity**
- ✓ **High Reliability**
- ✓ **Custom Options**
- ✓ **High Accuracy**
- ✓ **Technical Support**
- ✓ **Increase Safety**

RST Instruments Ltd. reserves the right to change specifications without notice. ELB0030I

Monitor with Confidence

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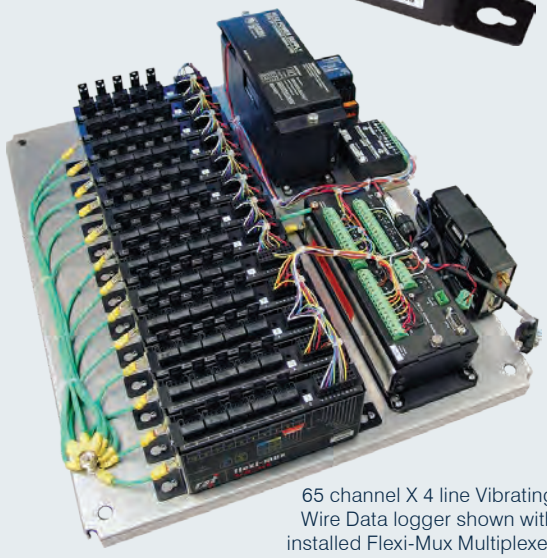
ISO 9001

FlexDAQ Data Loggers

PRODUCT CATEGORY:
READOUTS + DATA LOGGERS

SPECIFICATIONS + ORDERING

RST Flexi-Mux Multiplexer



65 channel X 4 line Vibrating Wire Data logger shown with installed Flexi-Mux Multiplexers.

Flexi-Mux

The RST Instruments Flexi-Mux allows a single channel of data loggers, such as the Campbell CR1000X, to be sequentially connected to numerous sensors. Each Flexi-Mux can sequentially multiplex 5 groups of 4 lines for a total of 20 lines. Alternatively, internal DIP switch settings permits the multiplexing of 10 groups of 2 lines.

The extremely slim and compact (8.15"H x 1.05"W x 3.17"D) vertical design permits the Flexi-Mux to occupy minimal space in the control box which allows for more Flexi-Mux units to be installed. By utilizing a unique cascade feature, there is theoretically no limit to the number of channels which can be connected to the data logger.

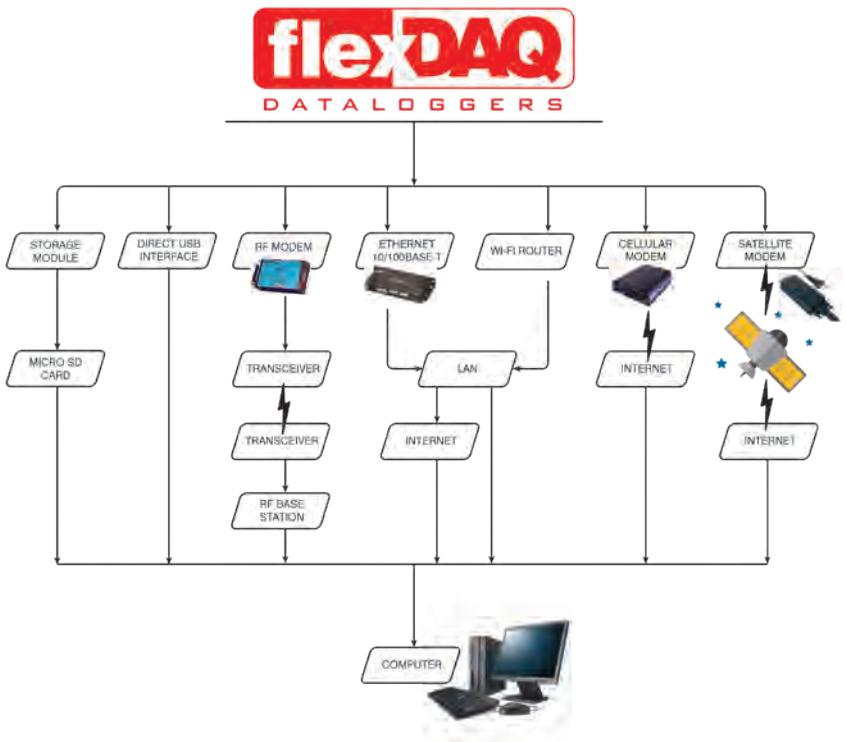
Conveniently designed detachable screw terminals allow rapid wiring of large systems, with straightforward testing and substitution of both sensors and multiplexers. Built-in transient protection on every line safeguards against damage which can be caused by occurrences such as nearby lightning.

The Flexi-Mux requires only 2 data logger control ports; one for "enable" (Reset terminal), and a second for channel stepping (Clock terminal). The Flexi-Mux is compatible with most sensors including load cells, pressure transducers, vibrating wire sensors, thermistors, potentiometers, and numerous other specialty sensors.

FLEXI-MUX SPECIFICATIONS

ITEM	DESCRIPTION
Power	12 Vdc (under load), unregulated
Current Drain	10μ quiescent; 8 mA active
Reset Active Levels, max.	2.0 V
Clock Active Levels, max.	2.0 V
Min. Clock Pulse Width	1 ms
Max. Actuation Relay Time	20 ms
Relay Operation	Break before make
Initial Relay Resistance, max.	0.1 Ohm
Max. Switching Current	1 A
Min. Contact Life	10^7 closures
Operating Temp.	-40°C to 70°C (-40°F to 158°F) - extended
Size	8.15"H x 1.05"W x 3.17"D
Weight	0.24 kg (0.53 lbs.)

COMMUNICATION METHODS



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FlexDAQ Setup and Installation Manual

All efforts have been made to ensure the accuracy and completeness of the information contained in this document. RST Instruments Ltd reserves the right to change the information at any time and assumes no liability for its accuracy.

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REVISION TABLE

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1 INTRODUCTION

FlexDAQ data loggers are versatile, custom-made systems that provide precise and reliable data acquisition from various sensor types and gauges. They are all contained in a durable, rugged enclosures that are dust-tight and water-resistant (IP-66) (Figure 1-2). The enclosures can be exposed to the elements, such as rain, snow and splashes of water, but are not suitable for submersion.

FIGURE 1-1 AN EXAMPLE FLEXDAQ CONFIGURATION FEATURING THE CR6

FIGURE 1-2 RUGGED FLEXDAQ ENCLOSURE

Due to the high customizable and unique nature of each FlexDAQ system, the information provided in this document is general and is intended to be used as a guide only. Information that is specific to your individual system, including schematic diagrams and set up instructions, has been provided on a USB drive included with your shipment. Please refer to those documents when setting up the FlexDAQ. Contact RST Instruments with any questions or concerns that may arise.

CAUTION: **PLEASE USE THE DOCUMENTS SUPPLIED ON THE USB DRIVE INCLUDED WITH YOUR SHIPMENT AS THE PRIMARY RESOURCE WHEN SETTING UP THE FLEXDAQ. IT CONTAINS CUSTOM INFORMATION THAT IS HIGHLY SPECIFIC TO YOUR INDIVIDUAL SYSTEM. THE INFORMATION IN THIS DOCUMENT IS GENERAL AND WILL PROVIDE AN OVERVIEW ONLY.**

2 SAFETY

Normal safety precautions should be followed and proper personal protective equipment (PPE) should be worn when working in the field with this equipment, including safety glasses and high-visibility clothing.

Care should be taken to ensure the inside of the enclosure and the seal remain dry and free from dust and dirt. Should the FlexDAQ unit need to be opened, protect the electronics from the elements as much as possible and ensure the seal is clean before closing the cover and securing the latches.

3 COMMON COMPONENTS

The FlexDAQ components described below are some of the most typical components included in a single FlexDAQ enclosure. The type of datalogger included in a given enclosure depends on the required communication method, sensor type, and the required number of ports, switches and charging ports, among other considerations. Keep in mind that each enclosure in your system may contain different hardware. Consult the schematic drawings on the supplied USB drive (Section 5.1) to confirm the details of your specific system and each individual FlexDAQ unit.

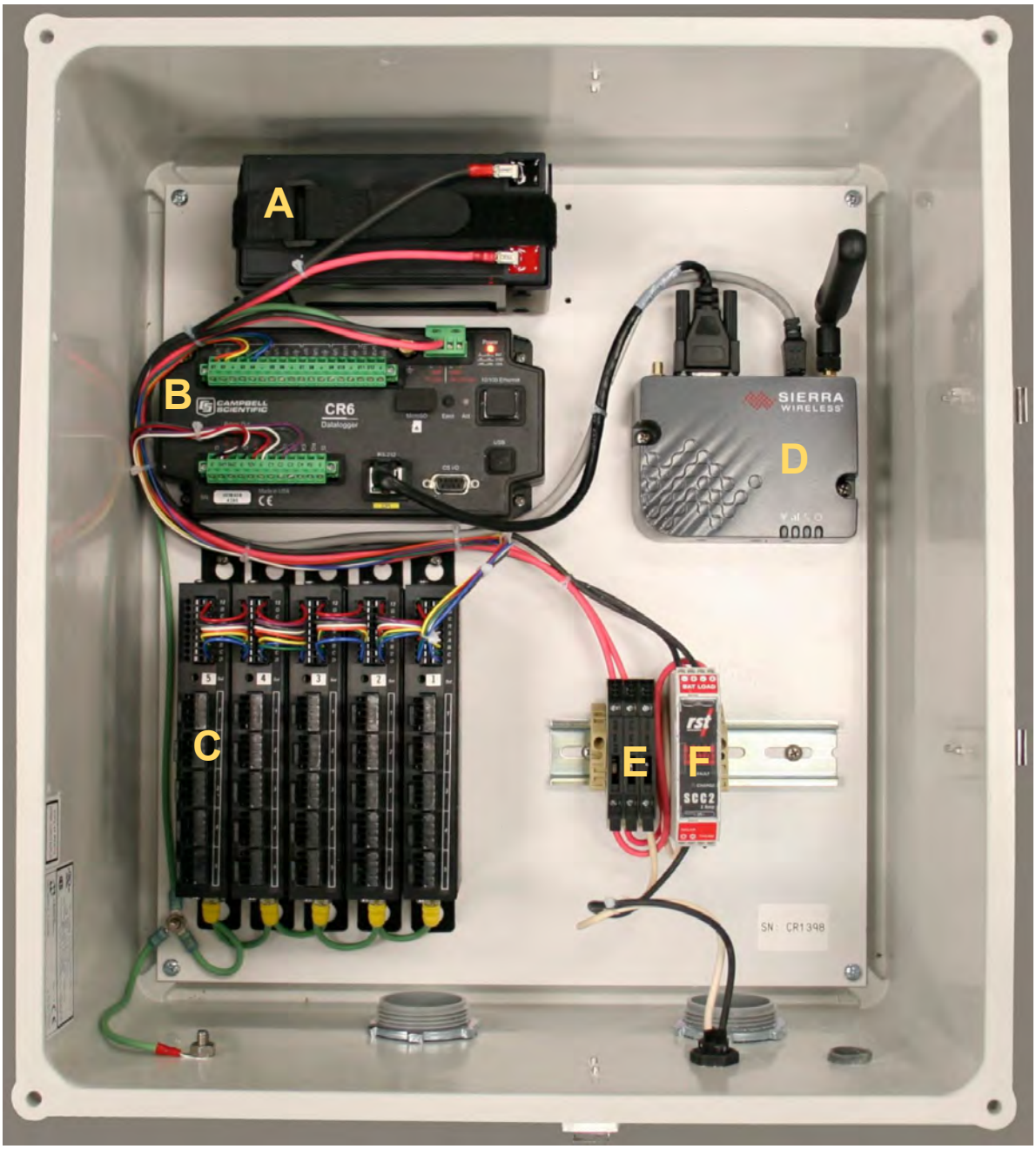

FIGURE 3-1 COMMON COMPONENTS OF THE FLEXDAQ SYSTEM

A Battery (see sections 3.1)

B Data logger (see section 3.2)

C Flexi-Mux (see section 3.3)

D Communications module (see section 3.4)

E Fuses (not covered in this document)

F Charger controller (not covered in this document)

3.1 POWER AND BATTERY

The FlexDAQ system is generally powered by 12V DC battery. The battery is charged by one of two methods:

- Solar power
- AC

The size and type of battery depends on many factors including the unit's consumptions and charger power source. Further information regarding the battery contained in your unit can be located on the USB drive included with your shipment.

3.2 DATALOGGER

The core of any FlexDAQ unit is its datalogger. It is pre-programmed in the factory, thus requiring minimal setup and configuration in the field. There are four commonly used models, each of which is briefly described in the sections below. The model in a particular unit is determined based on its application.

3.2.1 CR6

The CR6 datalogger (Figure 3-2) is a multi-purpose and low power datalogger that provides high accuracy and fast communication options such as Wi-Fi, cellular modem, ethernet, satellite, radio or USB connection to a PC. It features many different types of communication ports and its memory can be expanded with a microSD card.

FIGURE 3-2 THE CR6 DATALOGGER

3.2.2 CR300

The CR300 datalogger (Figure 3-3) is a compact, low-cost logger that features low power requirements and fast communications. This logger comes equipped with communication options such as Wi-Fi, cellular modem, radio or USB connection to a PC. With additional hardware, communication capabilities can be expanded to include ethernet and satellite.

FIGURE 3-3 THE CR300 DATALOGGER

3.2.3 CR800

The CR800 datalogger (Figure 3-4) is a simple logger ideal for situations where fewer sensors need to be monitored over long periods. It can communicate via radio or cellular modem, direct serial connection to a PC, and, with additional hardware, ethernet and satellite.

FIGURE 3-4 THE CR800 DATALOGGER

3.2.4 CR1000X

The CR1000X (Figure 3-5) is a versatile and robust datalogger. It is used in many diverse applications, can handle complex configurations and has communication options such as Wi-Fi, cellular modem, ethernet, satellite, radio or USB connection to a PC. It features many different types of communication ports and its memory can be expanded with a microSD card.

FIGURE 3-5 THE CR1000X DATALOGGER

3.3 FLEXI-MUX MULTIPLEXER

The Flexi-Mux Multiplexer (Figure 3-6) is included in many FlexDAQ systems to increase the number of sensors that can be measured by a single datalogger. It is a versatile unit that is compatible with many kinds of dataloggers and sensors. Multiple Flexi-Mux units may be used to dramatically increase the number of sensors measured by a FlexDAQ unit.

FIGURE 3-6 FLEXI-MUX MULTIPLEXER

3.4 COMMUNICATION

There are two main methods to communicate with your datalogger: wired connections and wireless. The communication method particular to your FlexDAQ will be defined upon purchase. Each method is described in the sections below.

3.4.1 Wireless

Wireless communication methods include Wi-Fi, radio, cellular modem and satellite modem. The type of communication module appropriate for a given system depends on a number of variables, including the intended location of the FlexDAQ, the type of datalogger used and customer preference. The communication method will be defined upon purchase. For generic setup instructions, see Section 4.2. For setup instructions specific to your individual system, please see the USB drive included in your shipment.

3.4.2 Wired Connections

The datalogger and any data stored in its memory can also be accessed through a wired connection. This is usually either ethernet or USB cable connected directly to the datalogger. Refer to the schematic diagram on the USB drive included in your shipment for exact configurations.

CAUTION: ENSURE THAT THE ELECTRONICS INSIDE THE RUGGED ENCLOSURE REMAIN PROTECTED FROM RAIN, SNOW, ICE, DIRT AND DUST. TO MAINTAIN THE INTEGRITY OF THE WEATHER PROTECTION OF THE ENCLOSURE AFTER OPENING, ENSURE THE SEAL REMAINS FREE FROM DUST AND DIRT BEFORE CLOSING THE COVER AND SECURING THE LATCHES.

4 INSTALLATION

The following section describes two common installation scenarios: mounting the FlexDAQ on a wall or pole. The location of the installation and relevant sizing information should be defined when ordering, and the appropriate hardware will be included with the shipment. Installation procedures may need to be adjusted based on the particular needs of a given site. Please read the following section and contact RST Instruments with any site-specific questions or concerns that may arise.

CAUTION: **INSTALLATION SHOULD BE HANDLED BY AT LEAST 2 PEOPLE. IF THE FLEXDAQ IS VERY LARGE, ADDITIONAL TECHNICIANS MAY BE USEFUL TO SUCCESSFULLY COMPLETE THE INSTALLATION.**

4.1 WALL MOUNT

The FlexDAQ can be mounted on a wall or any flat, secure, vertical surface. The tools and hardware required will depend on the type of wall selected. The FlexDAQ comes equipped with four steel feet (Figure 4-1) on the back of the unit to facilitate installation.

FIGURE 4-1 MOUNTING FOOT

4.1.1 Installation Tools and Materials

The following tools will be needed for installing the FlexDAQ on a wall:

- 4 bolts appropriate for the material of the wall.
- Drill.
- Drill bits appropriate for the material of the wall.
- Appropriate grounding stake and cable, if required.
- Flat-head screwdriver.

4.1.2 Installation Procedure

The following steps outline a general procedure for installing the FlexDAQ on a wall. Characteristics of individual site may require changes to the procedure. Please contact RST Instruments with any questions or concerns.

4.1.2.1 Preparation

1. Ensure the wall or vertical surface is sturdy and secure and capable of supporting the weight of the FlexDAQ.
2. Select the installation location. Ensure that the back of the wall is unobstructed, and installation of the unit will not interfere with important utilities.
3. Measure the spacing between the feet on the back of the FlexDAQ in both the vertical and horizontal direction.
4. Mark the spacing on the wall.

4.1.2.2 Installation

5. Drill guide holes into the wall, if necessary.
6. With one person holding the FlexDAQ unit in place, install the bolts through the holes in each foot into the wall.

4.1.2.3 Grounding (if required)

The unit should always be grounded. If the unit is charged using AC power, a grounding stake is not required so long as the AC power is properly grounded.

7. A grounding lug (Figure 4-2) is located on the lower side of each FlexDAQ enclosure.

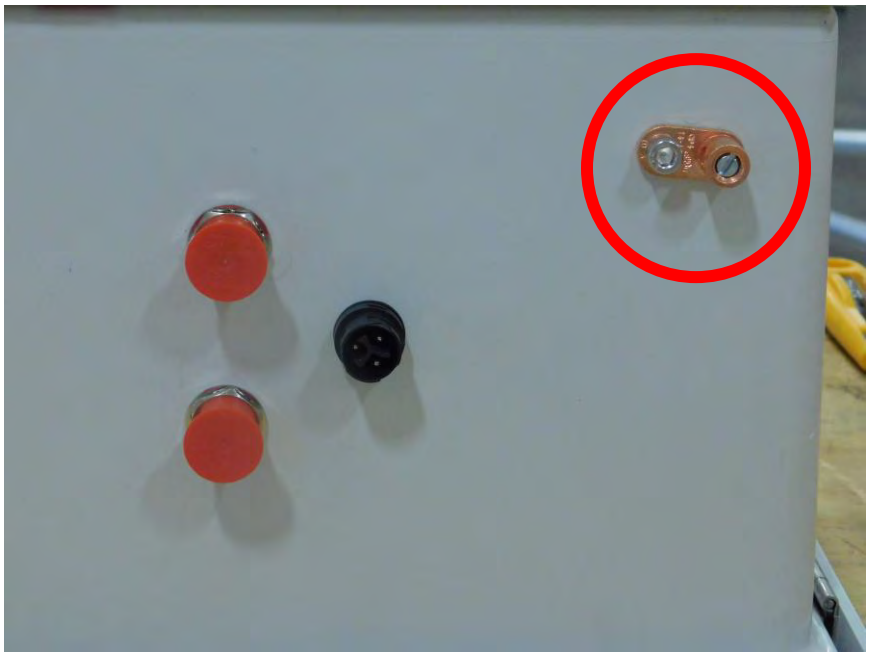

FIGURE 4-2 GROUNDING LUG (HIGHLIGHTED IN RED)

8 Attach an appropriate grounding cable to the grounding lug.

9 Run the cable from the FlexDAQ to a grounding stake. Ensure the grounding stake is firmly in the ground.

4.2 POLE MOUNT

The FlexDAQ unit may also be mounted on a pole or post. If this installation method is selected, two Unistrut channels will be added to the back of the enclosure to facilitate installation.

4.2.1 Installation Tools and Materials

- Cush-A-Clamps (supplied by RST Instruments).
- Wrench.
- An appropriate grounding stake and cable, if required.
- Flat-head screwdriver.

4.2.2 Installation Procedure

The following steps outline a general procedure for installing a FlexDAQ unit on a pole or post. Individual site requirements may necessitate changes to the procedure. Please contact RST Instruments with any questions or concerns.

4.2.2.1 Preparation

1 Ensure the pole or post is firmly and securely in the ground.

2 Ensure that the Cush-A-Clamp (Figure 4-3 and Figure 4-4) fits snugly around the pole.

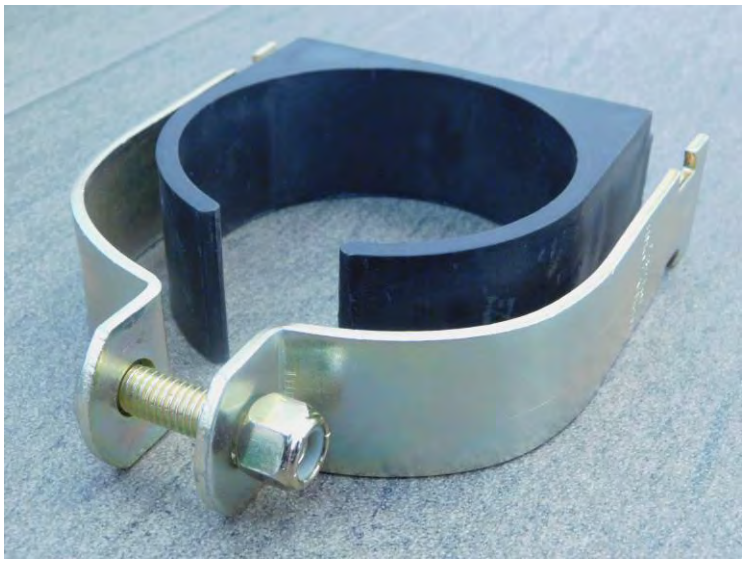

FIGURE 4-3 CUSH-A-CLAMP FOR SECURING FLEXDAQ TO POLE

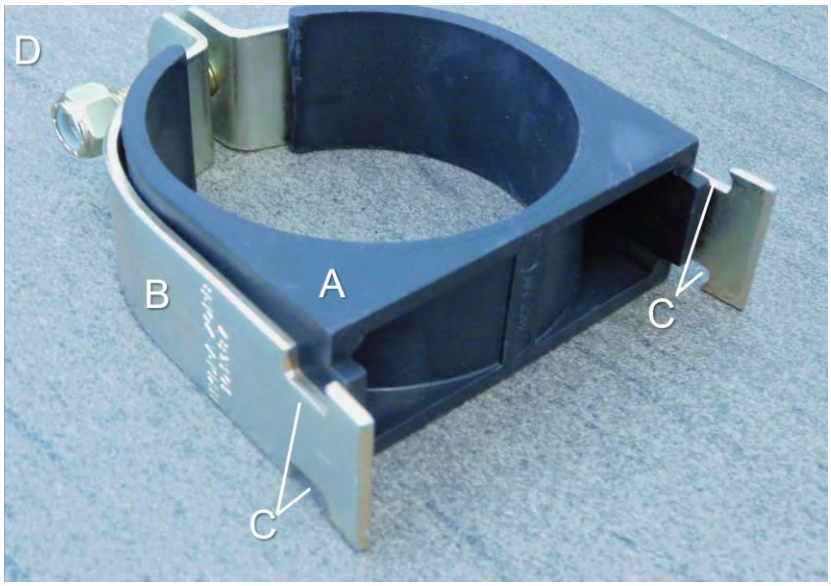

FIGURE 4-4 THE CUSH-A-CLAMP

A Thermoplastic cushion **B** Clamp

C Unistrut guide **D** Nut and bolt

NOTE: IF THE CUSH-A-CLAMP DOES NOT FIT SECURELY AROUND THE POLE, PLEASE CONTACT RST INSTRUMENTS.

3 Measure the vertical distance between the Unistrut bars on the back of the FlexDAQ.

4 Mark the distance on the pole, with the top mark corresponding to the approximate height of the FlexDAQ unit.

5 Place the black thermoplastic cushion around the pole at the markings. The flat side of the cushion should face the FlexDAQ.

6 Lift the FlexDAQ unit to the desired height.

7 Place the clamp around the thermoplastic cushion, with the bolt directly opposite from the flat edge of the cushion.

8 Thread the Unistrut guides through the Unistrut bars, as illustrated in Figure 4-5.

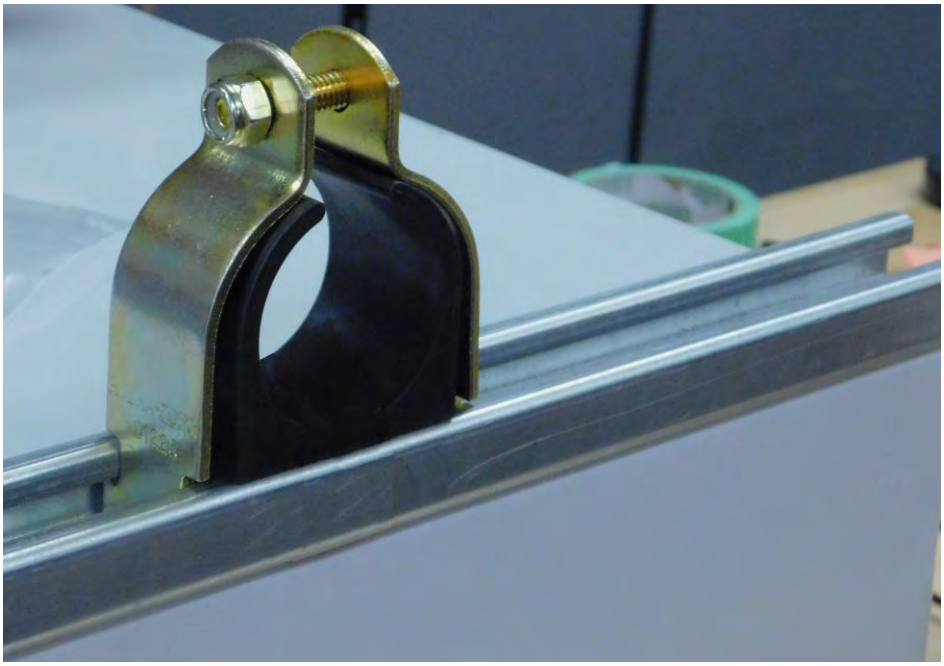

FIGURE 4-5 UNISTRUT AND CUSH-A-CLAMP ON BACK OF FLEXDAQ

9 Tighten the bolt. Final installation should resemble the example in Figure 4-6 and Figure 4-7.

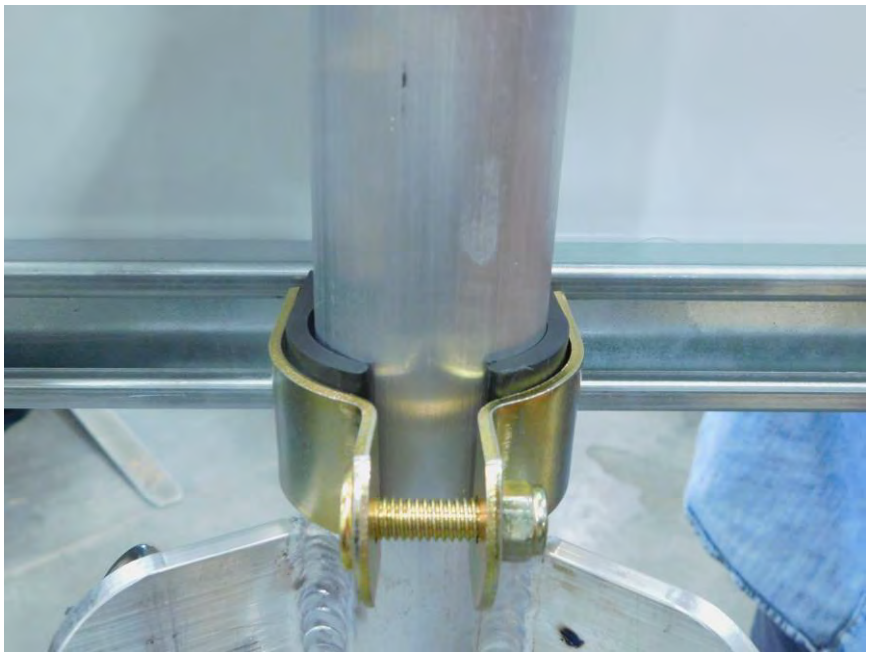

FIGURE 4-6 POLE MOUNT EXAMPLE, VIEW 1

FIGURE 4-7 POLE MOUNT EXAMPLE, VIEW 2

4.2.2.2 Grounding (if required)

The unit should always be grounded. If the unit is charged using AC power, a grounding stake is not required so long as the AC power is properly grounded.

10 A grounding lug (Figure 4-8) is located on the lower side of each FlexDAQ enclosure.

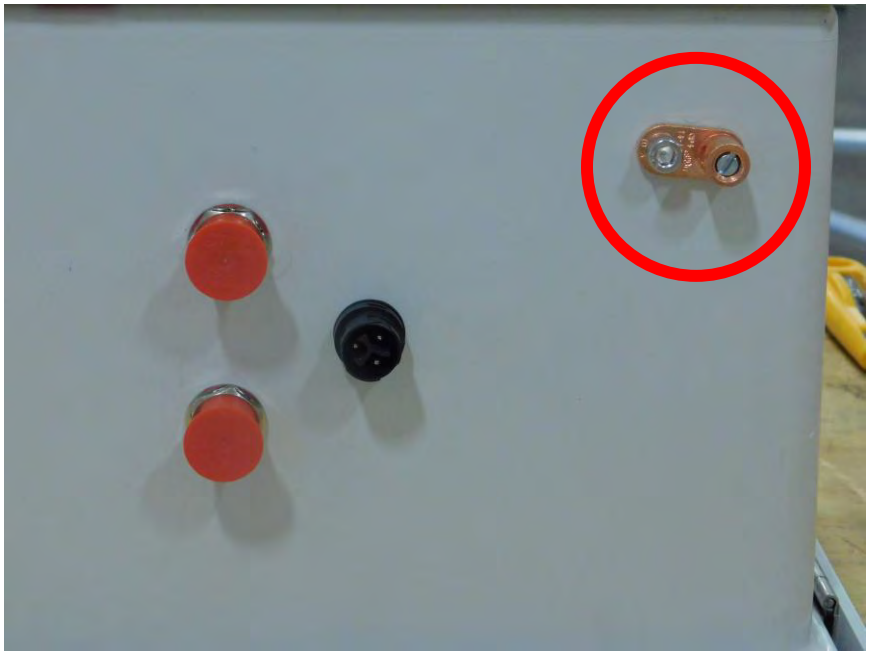

FIGURE 4-8 GROUNDING LUG (CIRCLED IN RED)

11 Attach the grounding cable to the grounding lug.

12 Run the cable from the FlexDAQ to a grounding stake. Plant the grounding stake firmly into the ground.

4.3 AUXILIARY COMPONENTS

Depending on the design specifications of a FlexDAQ unit, it may require the assembly and installation of some auxiliary components. The following section outlines two of the most common: the solar panel and the antenna.

4.3.1 Solar Panel (90W)

If the 12V DC battery is charged by solar power, a solar panel will need to be erected. The following instructions detail the best method for setting up a 90W solar panel.

4.3.1.1 Installation Tools and Materials

The solar panel comes with the hardware seen in Figure 4-9.

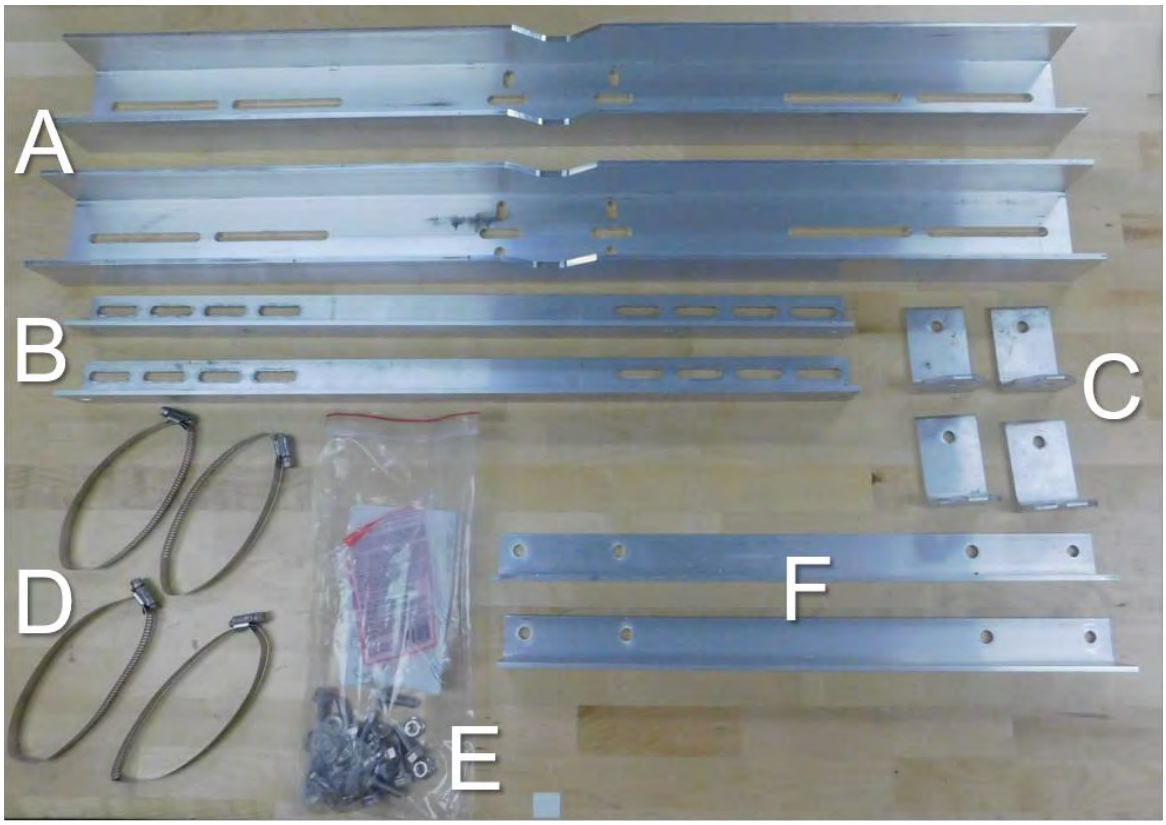

FIGURE 4-9 COMPONENTS TO MOUNT SOLAR PANEL

A Post brackets

B Panel brackets

C Foot brackets

D Pipe clamps

E Bolts, nuts, washers, Loctite

F Adjustment brackets

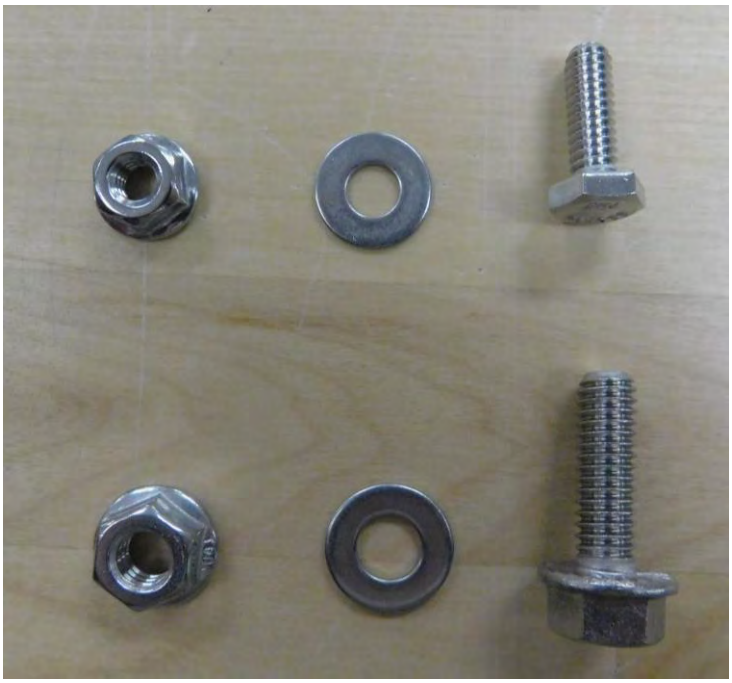

FIGURE 4-10 NUTS, WASHERS AND BOLTS
(TOP ROW: SMALL BOLT. BOTTOM ROW: LARGE BOLT)

4.3.1.2 Instructions

The following instructions detail the steps needed to correctly set up a solar power.

1 Place the panel brackets across the back of the solar panel, aligning the slots on the bracket with the inner holes on the back of the solar panel (Figure 4-11 and Figure 4-12, highlighted in red).

CAUTION: ENSURE THAT THE SLOTTED SIDES OF THE PANEL BRACKET ARE POINTING AWAY FROM THE EDGES OF THE PANEL (FIGURE 4-11).

FIGURE 4-11 PLACING THE PANEL BRACKETS ON THE BACK OF THE SOLAR PANEL

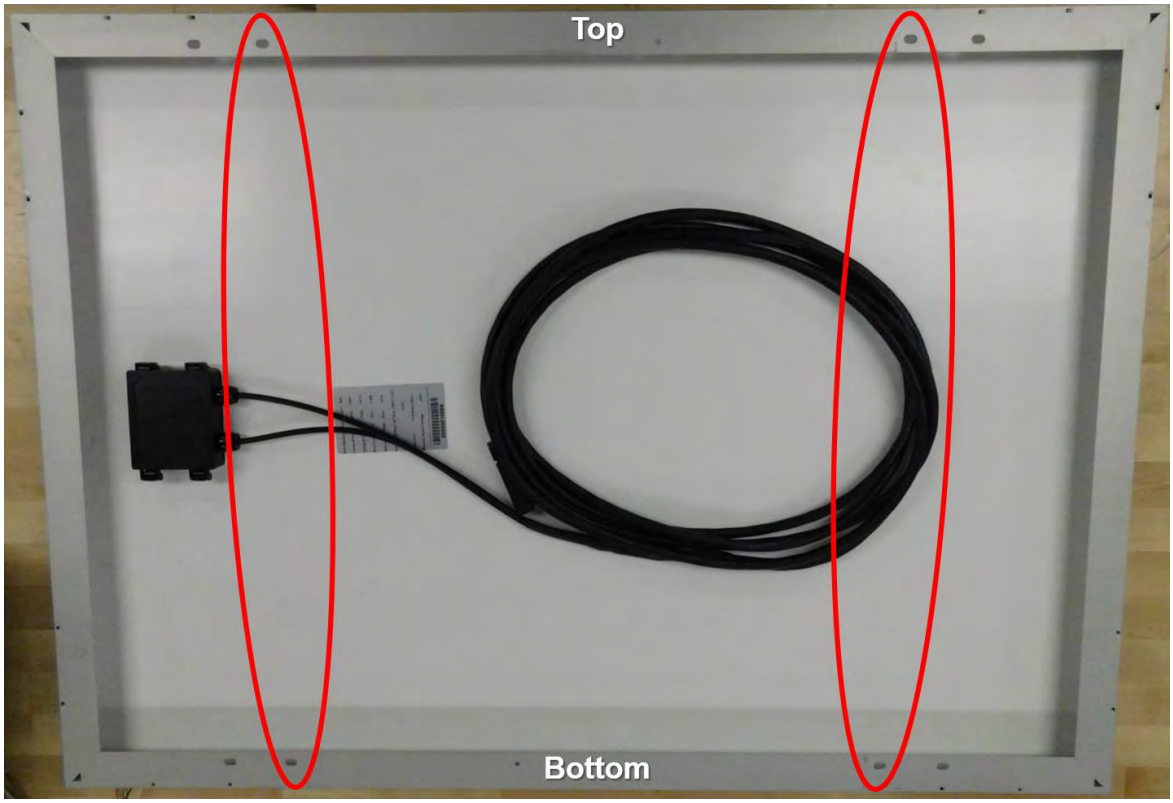

FIGURE 4-12 BACK OF THE SOLAR PANEL

2 Secure the panel bracket to the solar panel using the small bolt, washer and nut (Figure 4-13).

FIGURE 4-13 FASTENING THE NUT AND BOLT

3 Attach the foot brackets to panel bracket on the top side of the solar panel using the large bolt, washer and nut.

4 Attach the adjustment brackets to the bottom side of each panel bracket, as illustrated in Figure 4-14.

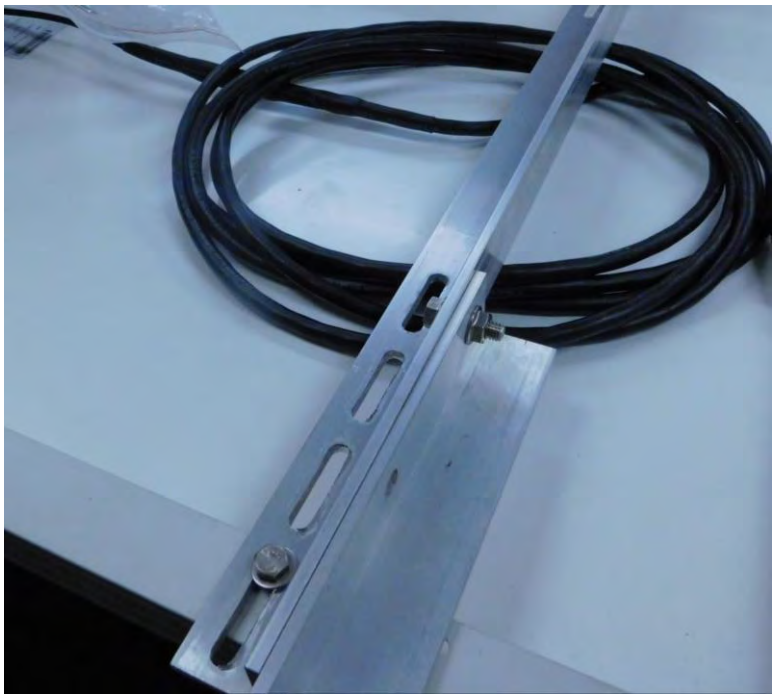

FIGURE 4-14 ADJUSTMENT BRACKETS ATTACHED TO BOTTOM SIDE OF THE PANEL BRACKETS

5 Secure a foot bracket to the free end of each adjustment bracket towards the top of the solar panel, as illustrated in Figure 4-15.

FIGURE 4-15 ATTACHING THE FOOT BRACKET TO THE END OF THE ADJUSTMENT BRACKET

6 Place a post bracket atop the foot brackets at both the top and bottom of the solar panel. Secure the post bracket with the small bolt, washer and nut (Figure 4-16).

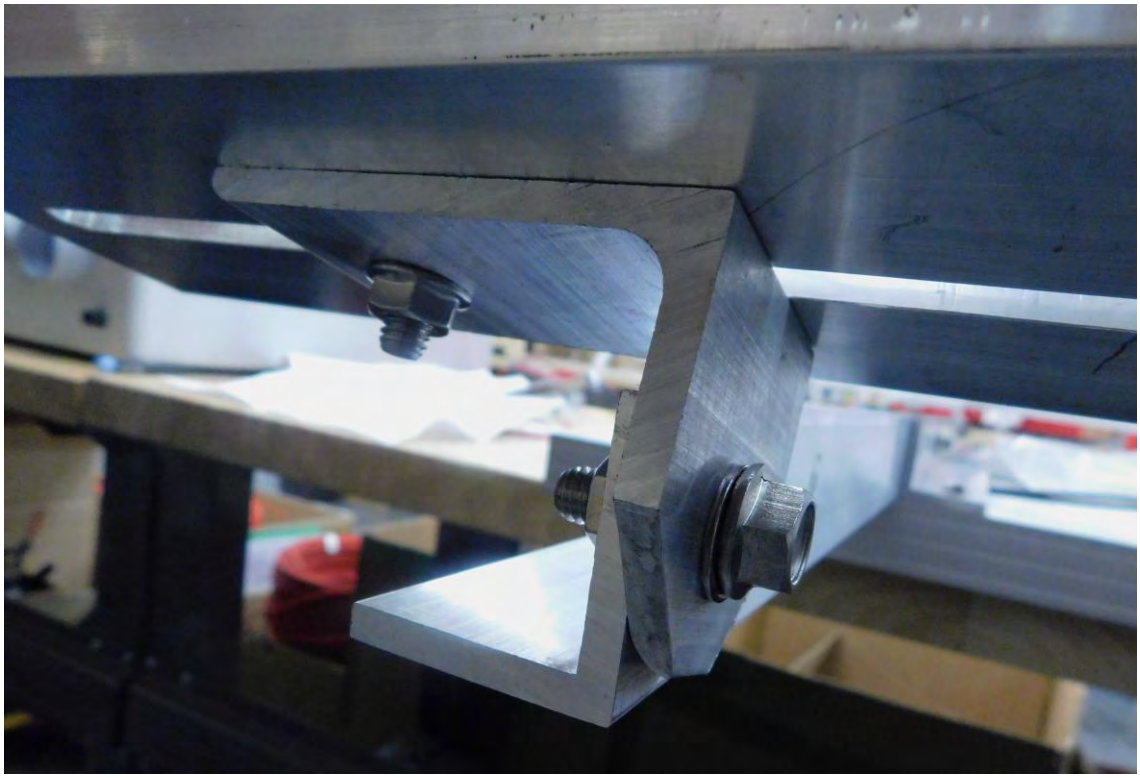

FIGURE 4-16 ATTACHING A POST BRACKET THE FOOT BRACKET AT THE END OF THE ADJUSTMENT BRACKET

7 The final solar panel assembly will resemble Figure 4-17.

FIGURE 4-17 FINAL ASSEMBLY

8 Select the correct orientation for the solar panel.

NOTE: ORIENT THE PANEL SO THAT IT RECEIVES DIRECT SUNLIGHT DURING DAYLIGHT HOURS. IF A LARGE VOLUME OF SNOW IS ANTICIPATED AT THE INSTALLATION SITE, ENSURE THE PANEL FACE IS MORE VERTICAL TO PREVENT ACCUMULATION OF SNOW. SNOW AND ICE WILL NEED TO BE REMOVED FROM THE PANEL FACE AS SOON AS POSSIBLE.

9 Open the pipe clamps and thread them through the vertical slots in the middle of each post bracket (on either side of the notches) (Figure 4-18).

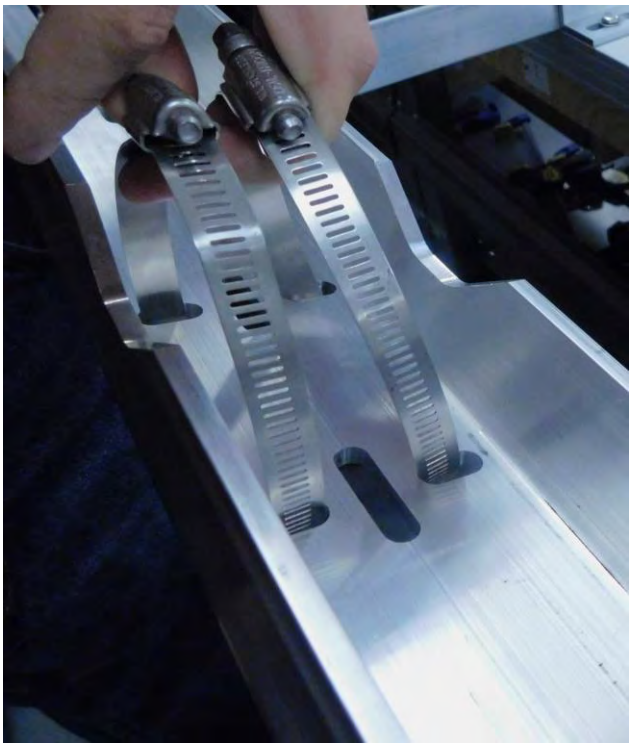

FIGURE 4-18 ATTACHING THE PIPE CLAMPS TO THE POST BRACKET

10 Wrap the pipe clamps around the pipe or post and secure. Tighten the bolt using a flathead screwdriver or a 5/16” socket.

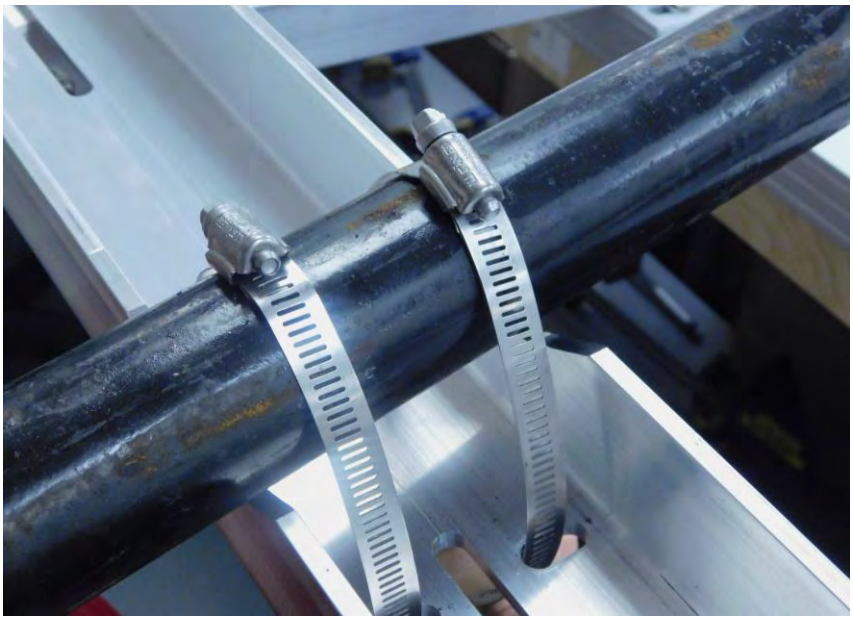

FIGURE 4-19 PIPE CLAMPS SECURED AROUND PIPE

11 Once the solar panel has been properly and securely mounted, connect it to the FlexDAQ.

4.3.2 Solar Panel (20 – 40W)

If the 12V DC battery will be charged by solar power, a solar panel will need to be erected. The following instructions detail the best method for setting up a 20 – 40W solar panel.

4.3.2.1 Components

The following components are required for the successful assembly of a 20 – 40W solar panel. Ensure that all components are present before proceeding with the assembly.

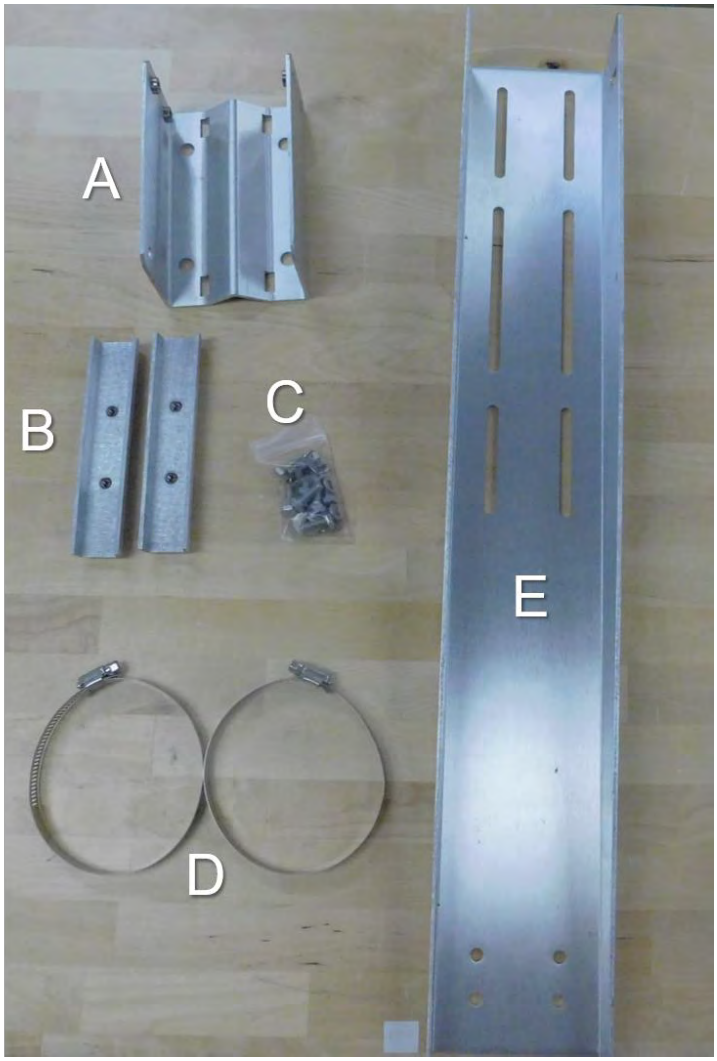

FIGURE 4-20 MOUNTING COMPONENTS

A Post bracket

B Clamping brackets

C Bolts, lock washers and washers

D Pipe clamps

E Panel bracket

4.3.2.2 Instructions

The following steps detail how to assemble the solar panel.

12 Loosely attach the clamping brackets to the back of the panel bracket (see Figure 4-21).

NOTE: DO NOT TIGHTEN THE BOLTS AT THIS TIME.

FIGURE 4-21 CLAMPING BRACKETS ON BACK OF PANEL BRACKET

13 Place the panel bracket across the short side of the back of the solar panel and slide the clamping brackets under the panel's lips (see Figure 4-22).

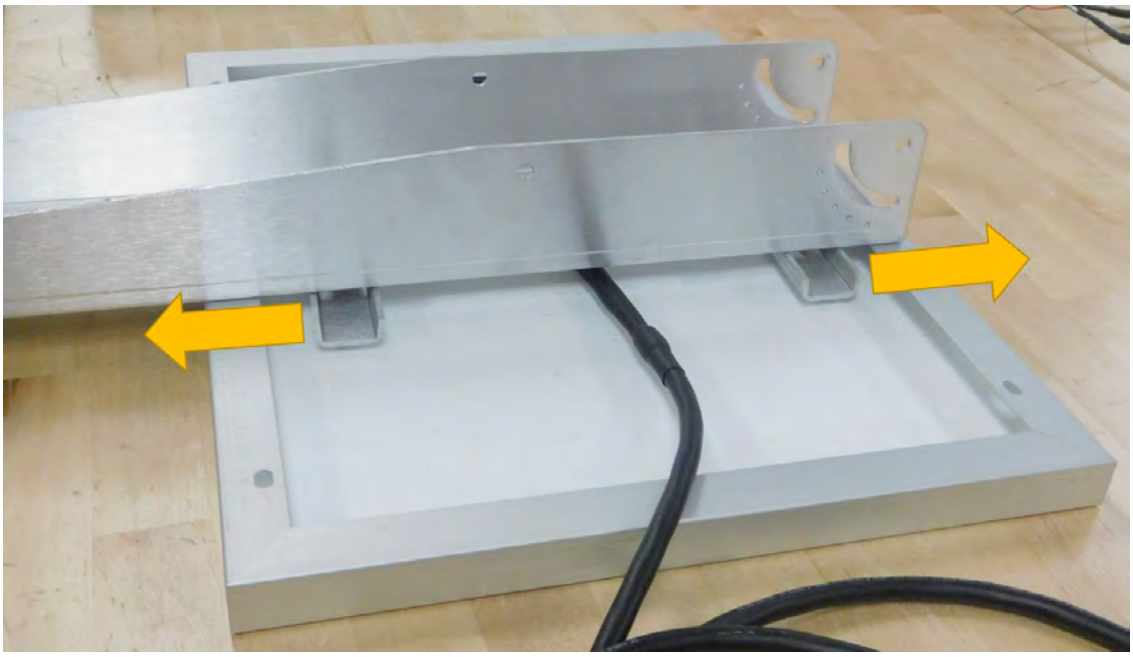

FIGURE 4-22 SECURING PANEL BRACKET TO PANEL WITH CLAMPING BRACKETS

14 Tighten the bolts on the panel bracket to secure (Figure 4-23).

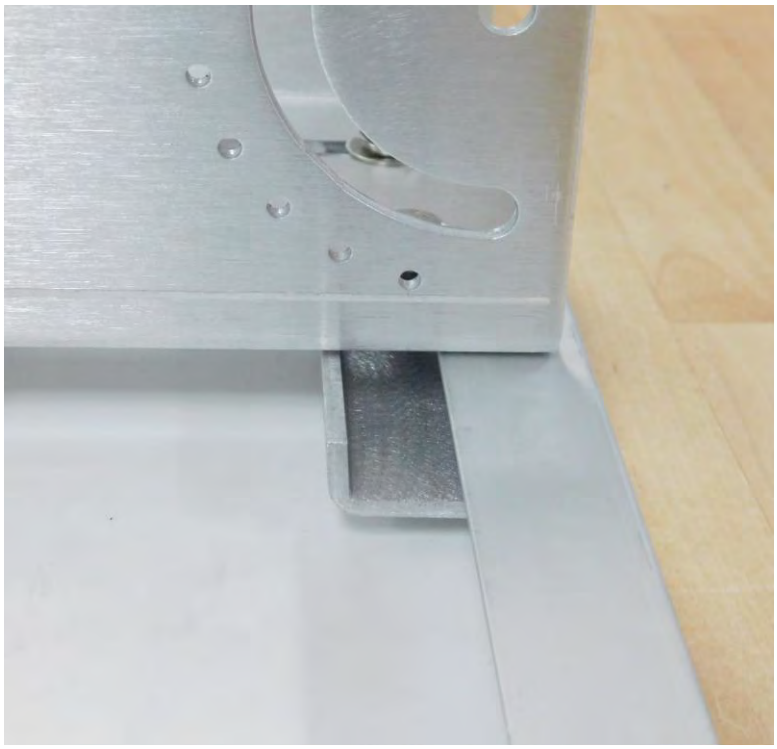

FIGURE 4-23 PANEL BRACKET ATTACHED

15 Place the post bracket in the top of the panel bracket and loosely bolt it into place, as illustrated in Figure 4-24.

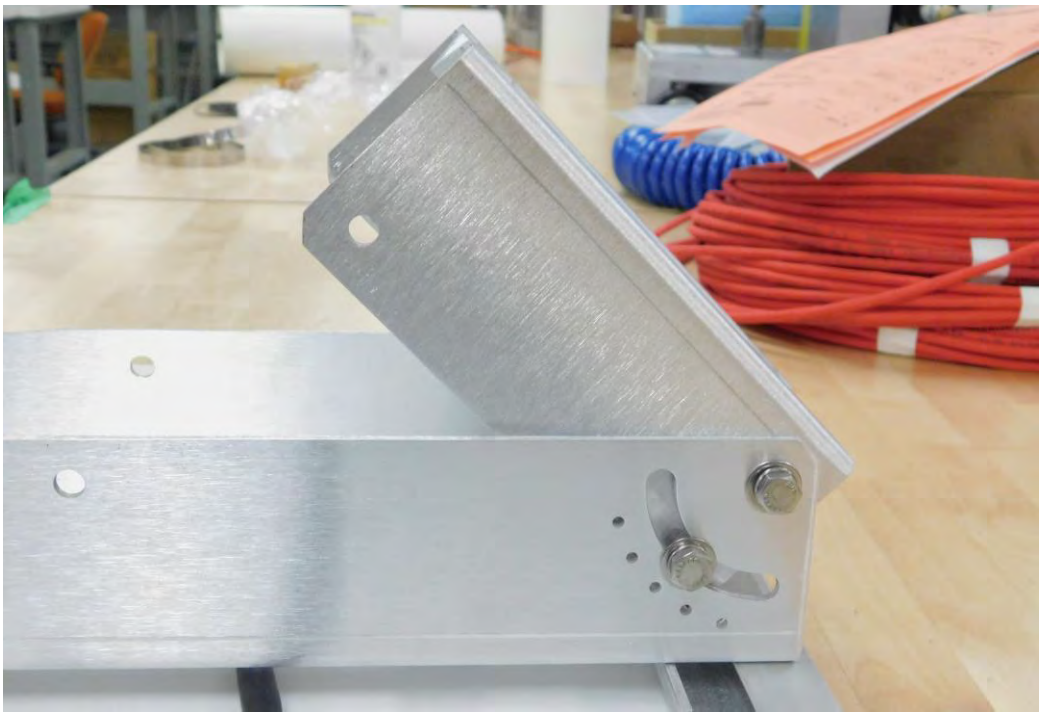

FIGURE 4-24 POST BRACKET IN PANEL BRACKET

16 Thread the pipe clamps through the slots on the post bracket (Figure 4-25).

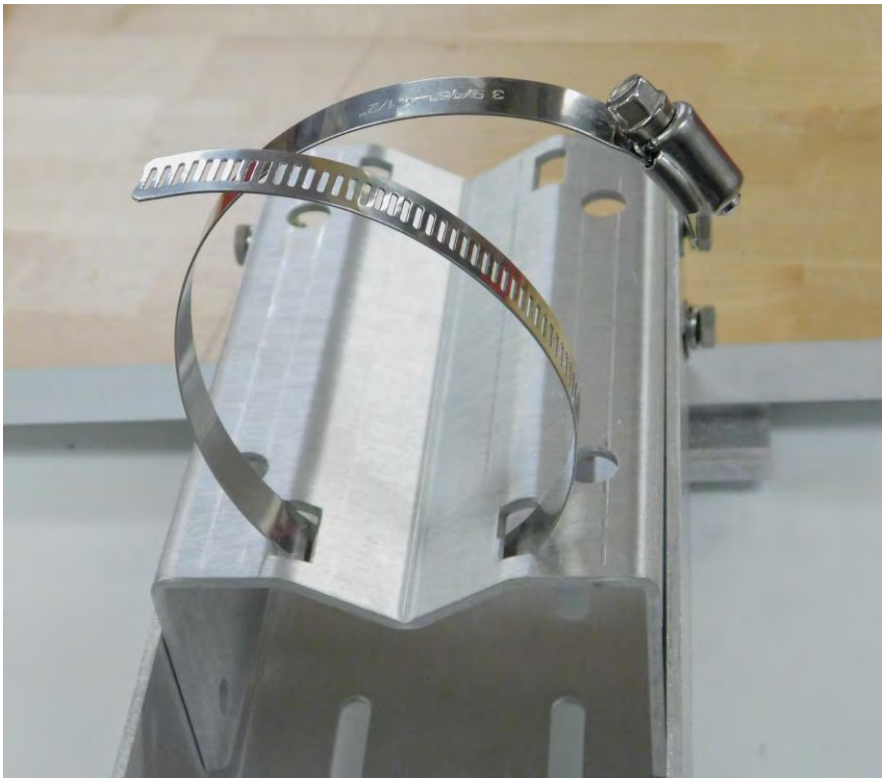

FIGURE 4-25 THREAD PIPE CLAMP THROUGH SLOTS ON POST BRACKET

17 Select the correct angle of orientation for the solar panel and tighten the bolts on the post bracket to lock it into place.

NOTE: ORIENT THE PANEL SO THAT IT RECEIVES DIRECT SUNLIGHT DURING DAYLIGHT HOURS. IF A LARGE VOLUME OF SNOW IS ANTICIPATED AT THE INSTALLATION SITE, ENSURE THE PANEL FACE IS MORE VERTICAL TO PREVENT ACCUMULATION OF SNOW. SNOW AND ICE WILL NEED TO BE REMOVED FROM THE PANEL FACE AS SOON AS POSSIBLE.

18 Wrap the pipe clamps around the pipe or post and tighten, as illustrated in Figure 4-26.

FIGURE 4-26 TIGHTEN PIPE CLAMP AROUND THE PIPE

19 Once the solar panel has been properly and securely mounted, connect it to the FlexDAQ.

4.3.3 Antennas

FlexDAQ systems may come equipped with two types of antennas. Though the Yagi and Omni antennas differ in appearance and function, the method for mounting each is similar. Please contact RST Instruments with any questions or concerns.

4.3.3.1 Components for a Yagi Antenna

The following hardware is needed to complete installation of a Yagi antenna:

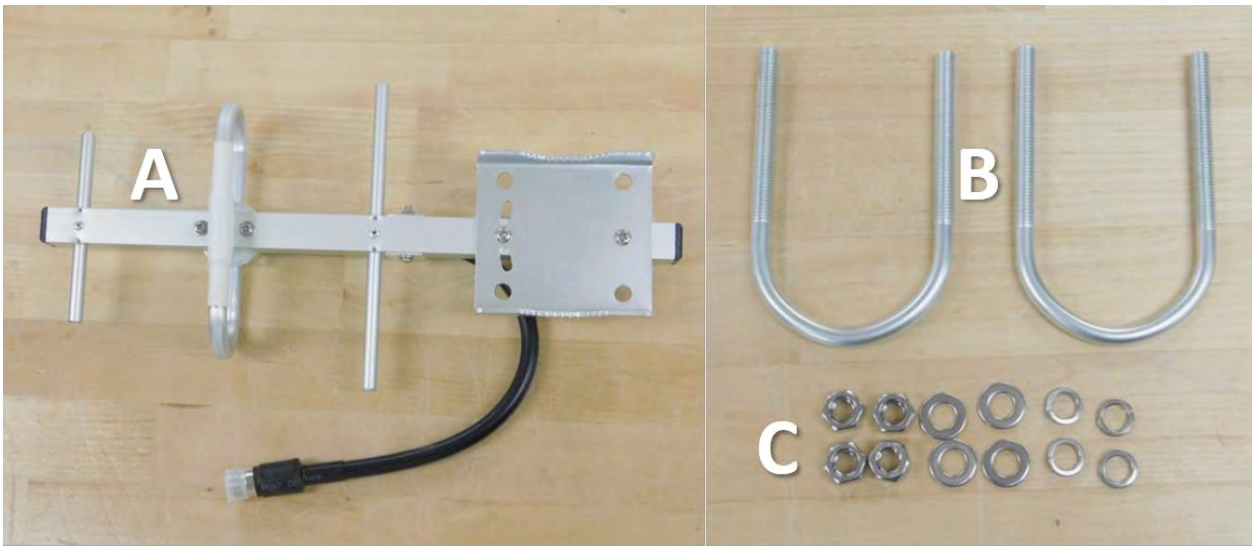

FIGURE 4-27 YAGI ANTENNA COMPONENTS AND HARDWARE

A Yagi antenna with pole bracket

B U-bolts

C Nuts, washers and lock washers

4.3.3.2 Mounting Instructions for a Yagi Antenna

The following instructions outline the steps requires for successfully mounting a Yagi antenna. One U-bolt has been installed for illustration purposes. Please be aware that both U-bolts will be needed to secure the antenna to the post.

1 Place the bracket of the antenna on the post or pole, with the post or pole resting in the serrated groove.

2 A Yagi antenna is directional, and direction of the antenna may need to be adjusted in order to receive the strongest signal. Referring to the screw highlighted in Figure 4-28, to adjust the direction of the antenna,

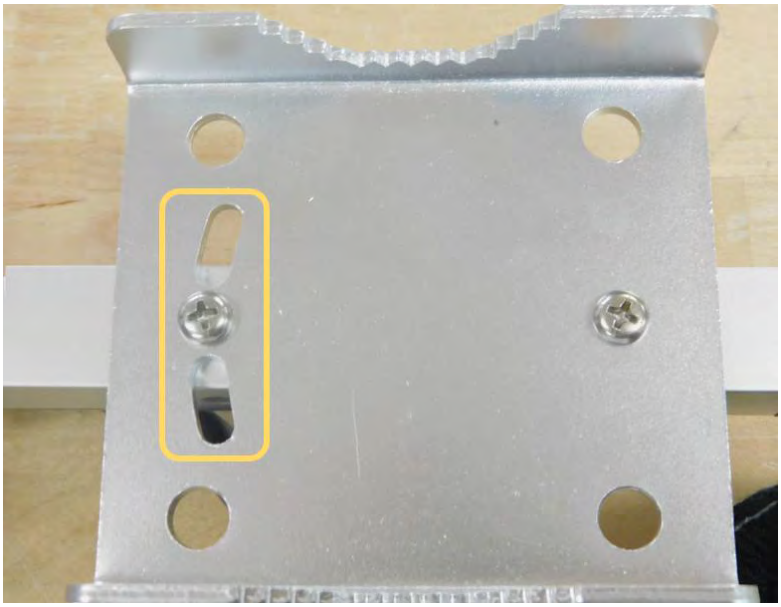

FIGURE 4-28 ADJUSTING THE DIRECTION

a. Hold the nut.

b. Remove the screw.

c. Adjust the angle of the antenna so it is oriented correctly.

d. Once the desired direction has been achieved, replace the screw to secure.

3 Place the U-bolt around the pole and feed the ends of the U-bolt through the holes in the bracket (highlighted in red in Figure 4-29).

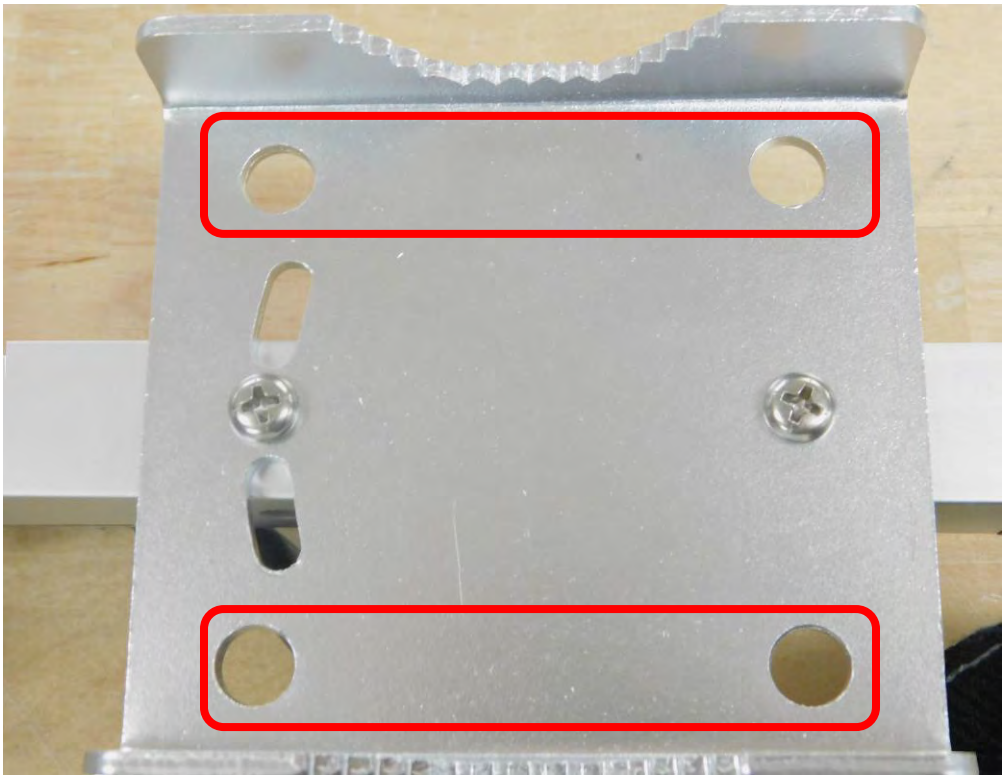

FIGURE 4-29 POST BRACKET

4 Once the U-bolt is in place, secure by placing a washer, lock washer and nut on the back of the bracket (Figure 4-30). Once both U-bolts have been secured, the installation is complete (Figure 4-31).

FIGURE 4-30 WASHER, LOCK WASHER AND NUT

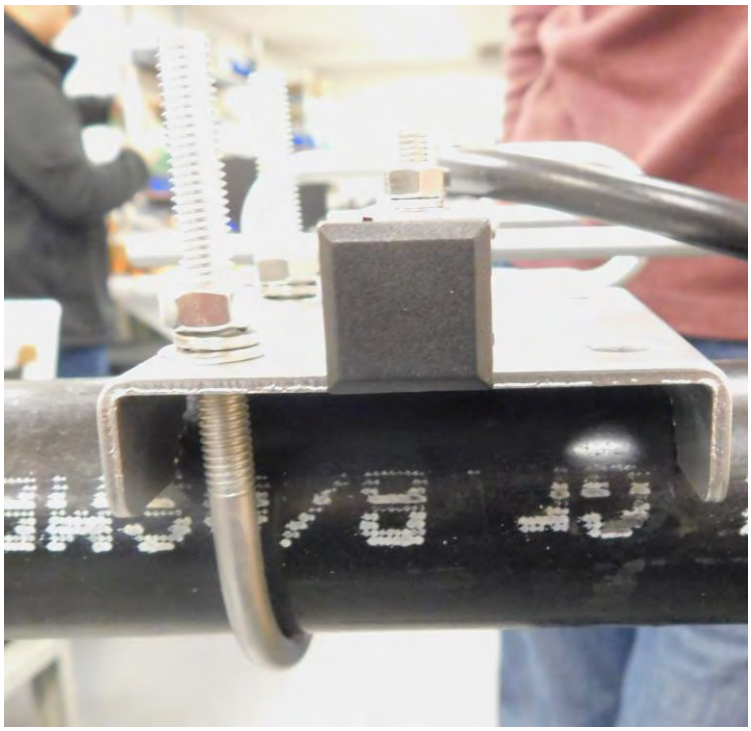

FIGURE 4-31 U-BOLT INSTALLED ON POST

5 Once the antenna has been properly and securely mounted, connect it to the FlexDAQ.

4.3.3.3 Components of an Omni Antenna

The following components are needed for the successful installation of an omni antenna:

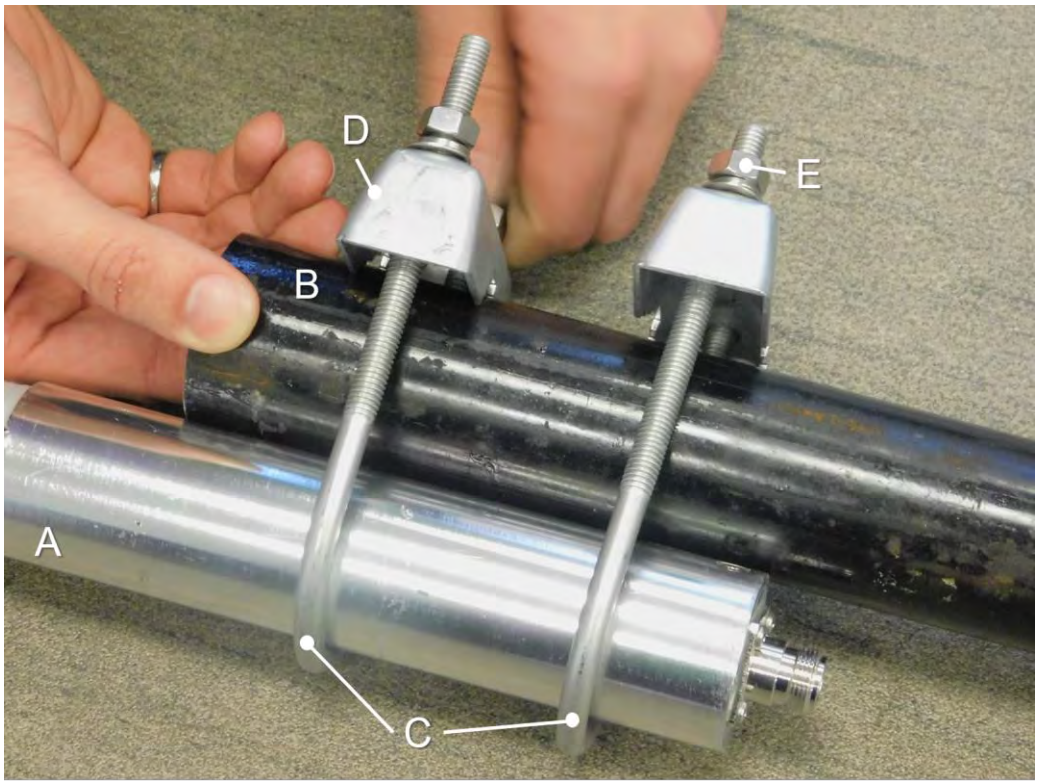

FIGURE 4-32 OMNI ANTENNA COMPONENTS

A Antenna

B Post

C U-bolts

D Post clamps

E Nut, washer and lock washer

4.3.3.4 Mounting Instructions for an Omni Antenna

The following instructions detail the steps required for successful installation of an Omni antenna:

1 Ensure that the post to which the antenna will be mounted is secured in the ground and is vertical.

CHECK: THE OMNI ANTENNA MUST BE VERTICAL AND MOUNTED ON A VERTICAL POST.

2 Place the antenna against the post, as illustrated in Figure 4-32.

3 Place the U-bolts around the metal base of the antenna, leaving 3 – 5 inches of space between them.

4 Place the post clamps on the U-bolts, as illustrated in Figure 4-33. Ensure that the serrated grooves (highlighted in yellow in Figure 4-33) on the clamps face the post.

FIGURE 4-33 OMNI ANTENNA CLAMPED TO POST

CAUTION: ENSURE THAT THE SERRATED GROOVES ON THE POST CLAMPS ARE FACING THE POST TO PREVENT DAMAGE TO THE ANTENNA OR ITS BASE.

5 Place a washer, lock washer and nut on the end of each side of each bolt to secure.

6 Once the antenna has been properly and securely mounted, connect it to the FlexDAQ.

4.3.3.5 Waterproofing the Connector

Both the Omni and Yagi antennas are connected to the FlexDAQ with an NxN cable. An O-ring inside the connection ensures that moisture does not enter the connection. If additional waterproofing to the connection of the antenna is desired, the connector may be wrapped in two layer of vulcanized rubber splicing tape, followed by two layers of electrical tape. The following instructions detail the steps to successfully apply these tapes.

1 Ensure the connection between the antenna and the FlexDAQ (Figure 4-34) is hand-tight.

FIGURE 4-34 THE CONNECTION BETWEEN THE ANTENNA AND THE FLEXDAQ

2 Beginning on one end of the connection, wrap the vulcanized rubber splicing tape around the connector, keeping it somewhat taut with a light pull (Figure 4-35). The tape is activated by stretching it during application.

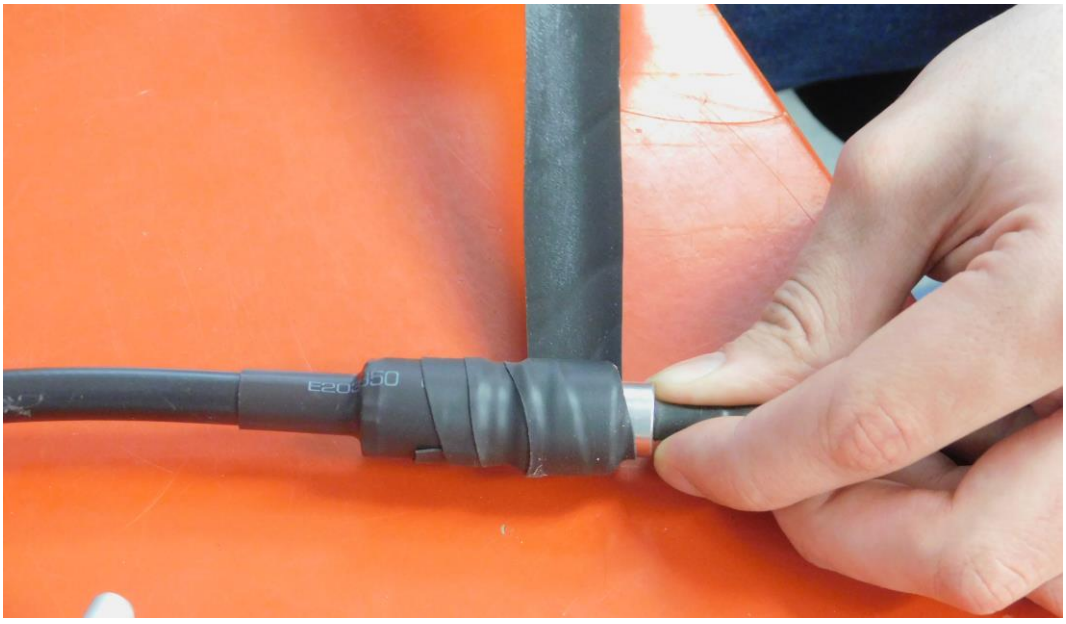

FIGURE 4-35 WRAPPING THE SPLICING TAPE AROUND THE CONNECTOR

3 Continue wrapping until two layers of tape have been applied to the connector and both ends of the connector have been sealed (Figure 4-36).

FIGURE 4-36 THE CONNECTOR WRAPPED IN TWO LAYERS OF SPLICING TAPE

4 Wrap electrical tape around the connector in the same manner. Ensure that the ends of the splice tape wrap are secured under the electrical tape.

FIGURE 4-37 WRAPPING ELECTRICAL TAPE AROUND THE SPLICE WRAP

5 The connection from the cable to the antenna should now be waterproof (Figure 4-38). The connector to the FlexDAQ does not need to be waterproofed but can be if required.

FIGURE 4-38 THE WATERPROOFED CONNECTION

5 SET UP

Due to the highly customizable nature of the FlexDAQ system, individual set up instructions have been included on a USB drive along with important information about the system. The following sections below contain generic information that may or may not be applicable to your system. Please read the information below and the information on the USB drive and contact RST Instruments with any questions or concerns that may arise.

CAUTION: **PLEASE USE THE DOCUMENTS SUPPLIED ON THE USB DRIVE INCLUDED WITH YOUR SHIPMENT AS THE PRIMARY RESOURCE WHEN SETTING UP THE FLEXDAQ. IT CONTAINS CUSTOM INFORMATION THAT IS HIGHLY SPECIFIC TO YOUR INDIVIDUAL SYSTEM.**

5.1 USB DRIVE

A USB drive with relevant information and files is included with your shipment. It contains schematic drawings, certificates, custom logger program files, setup and backup files. Please review these documents carefully.

5.2 DAQ SOFTWARE

RST Instruments recommends using the LoggerNet program to connect to the unit and access data. The program is supplied by RST and can be located on a CD included with your shipment. The software will need to be installed on a PC or laptop in order to complete the configuration of the FlexDAQ unit and access data in the future. Detailed instructions have been provided on the USB drive. For additional support, please contact RST Instruments.

6 MAINTENANCE

The FlexDAQ system will generally not require maintenance. However, a small desiccant packet has been included in the unit to assist in keeping the electrical components inside

the FlexDAQ enclosure dry. Upon receiving the unit, open the enclosure and locate the desiccant packets. Remove them from the plastic bag and place them inside the unit. The desiccant packets will need to be replaced periodically (approximately every 6 months to 1 year, depending on the humidity of the site).

CHECK: THE DESICCANT PACKET WILL NEED TO BE REPLACED EVERY 6 MONTHS TO 1 YEAR.

If the unit has a solar panel, the panel will need to be inspected for buildup of dirt, debris, ice and snow periodically and cleaned. The frequency of inspection will depend on the installation location and site weather conditions.

7 TROUBLESHOOTING

Due to the unique features and capabilities of each FlexDAQ system, please contact RST Instruments for any questions or concerns that arise.

8 SERVICE AND REPAIR

The product contains no user-serviceable parts. Please contact RST Instruments for product service or repair not covered in this manual.

Vibrating Wire Piezometer
Flexi-MUX Multiplexer

RST INSTRUMENTS LTD.

RST Flexi-Mux
Instruction Manual

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RST Flexi-Mux Instruction Manual

Although all efforts have been made to ensure the accuracy and completeness of the information contained in this document, RST Instruments reserves the right to change the information at any time and assumes no liability for its accuracy.

Product: RST Flexi-Mux
Instruction Manual

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Revision: 1.1
Date: March 23, 2012

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1 OVERVIEW

The RST Flexi-Mux is designed to increase the number of sensors that can be measured with a datalogger. The Flexi-Mux is located between the datalogger and the sensors and allows a single channel of a datalogger to be sequentially connected to numerous sensors. Each Flexi-Mux can sequentially multiplex 5 groups of 4 wire inputs or 10 groups of 2 wire inputs. Internal DIP switch settings permit the changing of these settings. The system can be expanded by chaining together multiple Flexi-Mux's allowing the signals to cascade through the system. This allows a virtually unlimited number of sensors to be connected to a single channel.

The datalogger program and control ports advance the Flexi-Mux through each sensor. An added feature of the RST Flexi-Mux is that it contains internal transient protection on each individual line. Unlike traditional multiplexers, this negates the need for external transient protection devices to be installed saving cost, wiring and time deploying the system.

2 FUNCTION

The RST Flexi-Mux allows a single channel of a datalogger such as a Campbell Scientific CR10x to be sequentially connected to numerous sensors. Each Flexi-Mux can sequentially multiplex 5 groups of 4 wire for a total of 20 wires. Alternatively, internal DIP switch settings permit the multiplexing of 10 groups of 2 wires.

The extremely slim and compact (8.15"H x 1.05"W x 3.07"D) vertical design permits the Flexi-Mux to occupy minimal space in the control box which allows for more Flexi-Mux units to be installed. By utilizing a unique cascade feature, there is theoretically no limit to the number of channels which can be connected to the datalogger.

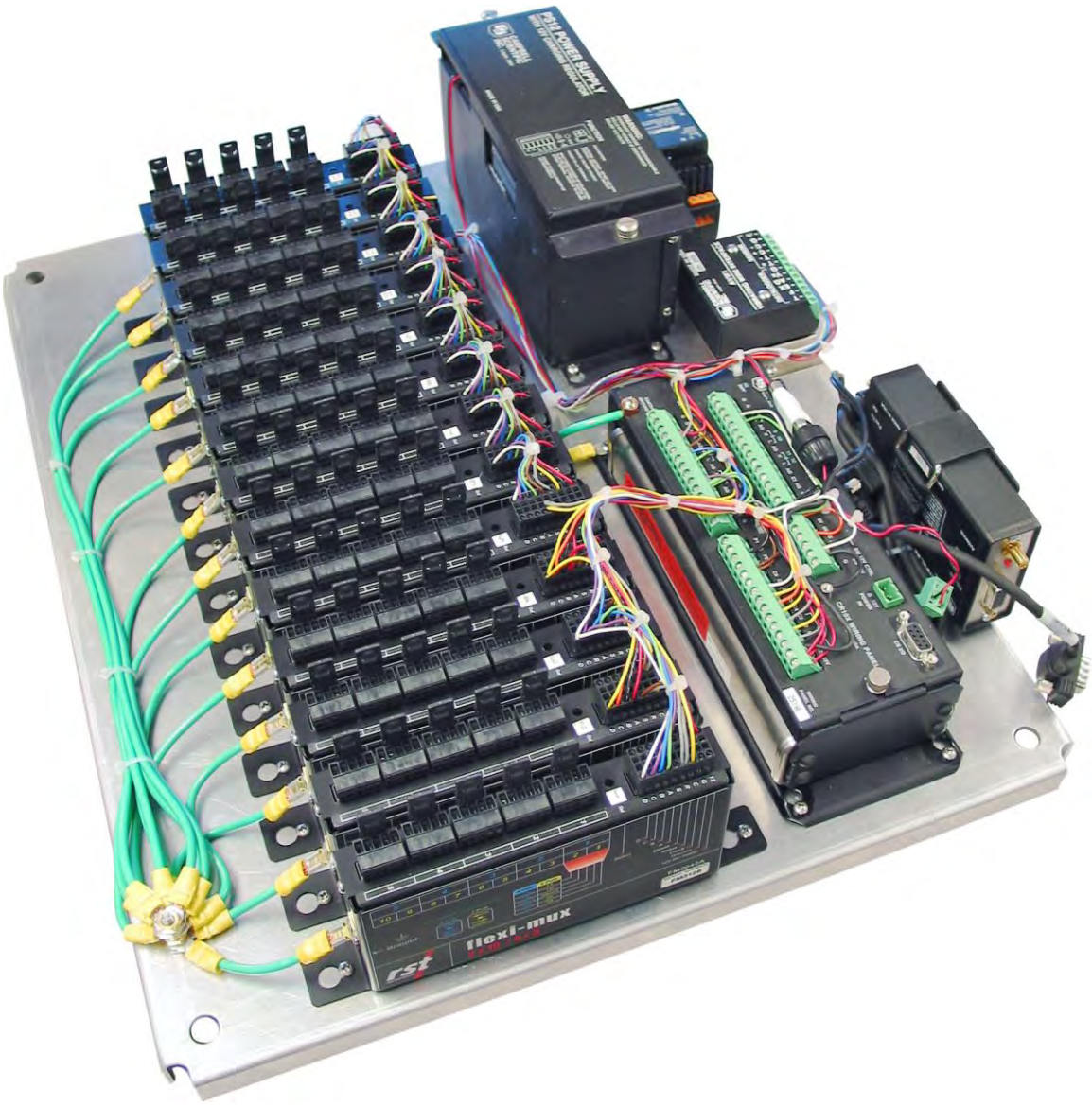


Figure 1 – Flexi-Mux Cascading Feature

Conveniently designed detachable screw terminals allow rapid wiring of large systems, with straightforward testing and substitution of both sensors and multiplexers. Built-in transient protection on every line safeguards against damaging power surges which can be caused by occurrences such as nearby lightning.

The Flexi-Mux requires only two datalogger control ports: One for “enable” (Reset Terminal), and a second for channel stepping (Clock Terminal). The Flexi-Mux is compatible with most sensors including load cells, pressure transducers, vibrating wire sensors, thermistors, potentiometers, tiltmeters, strain gauges, in-place inclinometers and tilt beams.

3 COMPATIBILITY

The Flexi-Mux is compatible with, but not limited to, Campbell's CR200, CR510, CR10(X), CR23X, CR5000 series dataloggers.

A wide variety of commercially available sensors are supported provided the current maximums are not exceeded on the relay contacts (section 6).

Using a single Flexi-Mux in combination with a Campbell AVW-1 Vibrating Wire Interface, up to 5 RST vibrating wire piezometers can be multiplexed. Cascading each Flexi-Mux permits a theoretically unlimited number of muxes to be chained together. Thus many vibrating wire sensors can be connected to a single vibrating wire interface.

4 PHYSICAL DESCRIPTION

4.1 LAYOUT

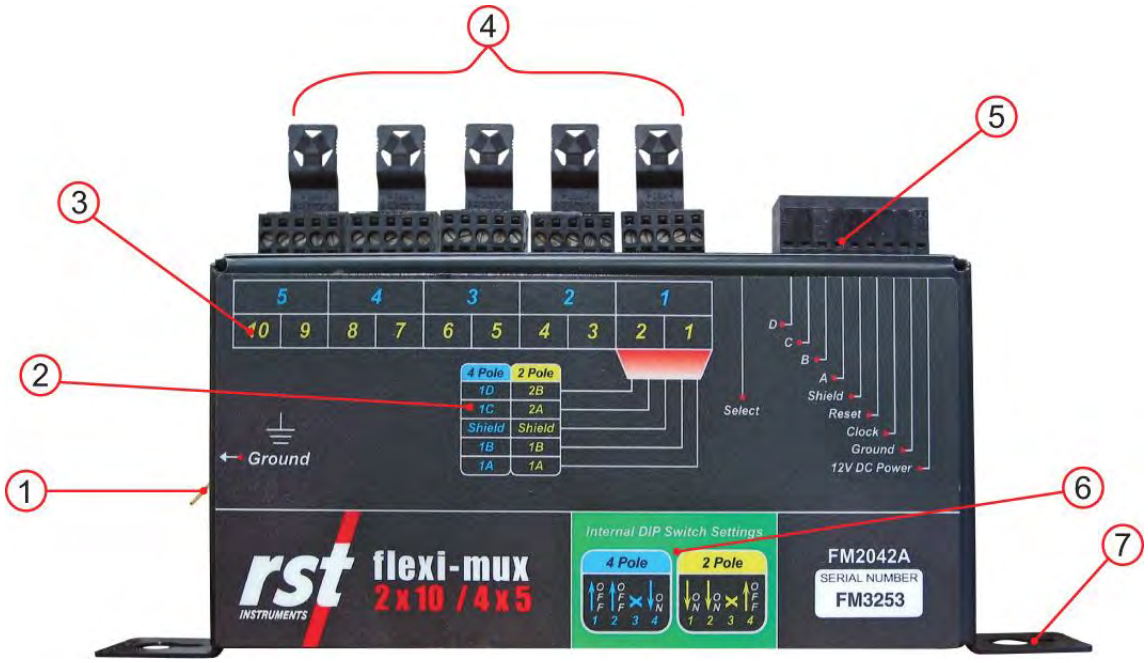


Figure 2 – Flexi-Mux Layout

1. Grounding spade terminal.
2. Channel Assignments
3. Multiplexed terminal channel assignments.
4. Modular 5-pole terminal blocks for multiplexed sensors.
5. Modular 18-pole Mux control terminal.
6. Graphical representation for internal DIP switch settings.
7. Mounting tabs.

4.2 DIMENSIONS

The Flexi-Mux is housed in a slim 15.6cm x 8.1cm x 2.7cm (6.15" x 3.17" x 1.05") aluminum case (Figure 3). Convenient mounting tabs extend 2.5cm (1") from each end and provide simple means of mounting the unit on any flat surface or base plate. The finished length including the mounting tabs is 20.7cm (8.15"). Mounting holes are 17.9cm (7.07") apart.

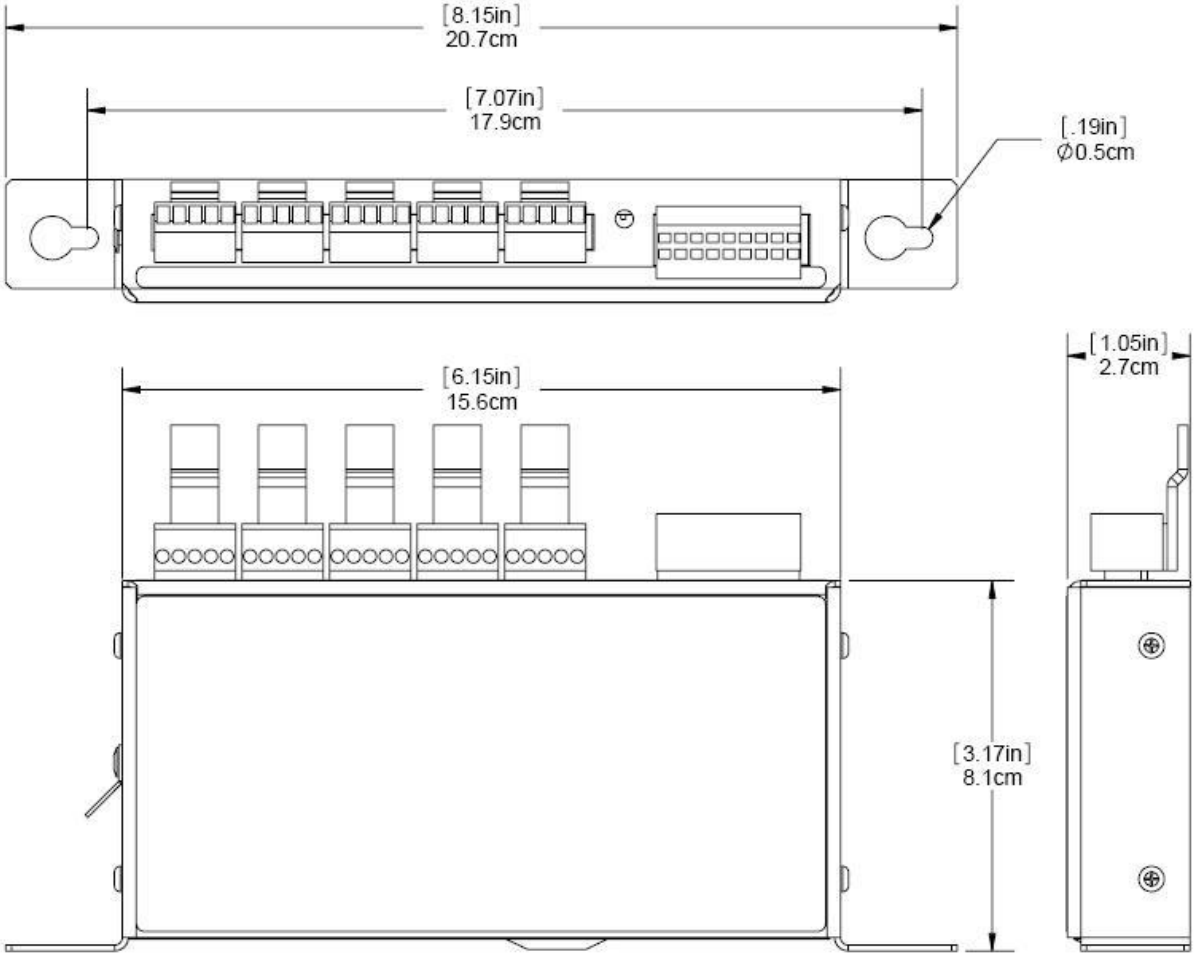


Figure 3 – Flexi-Mux Dimension

4.3 CONNECTION DETAILS

Connections to the Flexi-Mux are made on the top mounted modular terminal blocks. The removable 18-pin connector block is dedicated for connecting the datalogger power and control lines (section 5.1). This connector has a tension clamp which is rated to accept 14-28 AWG wire as shown below:

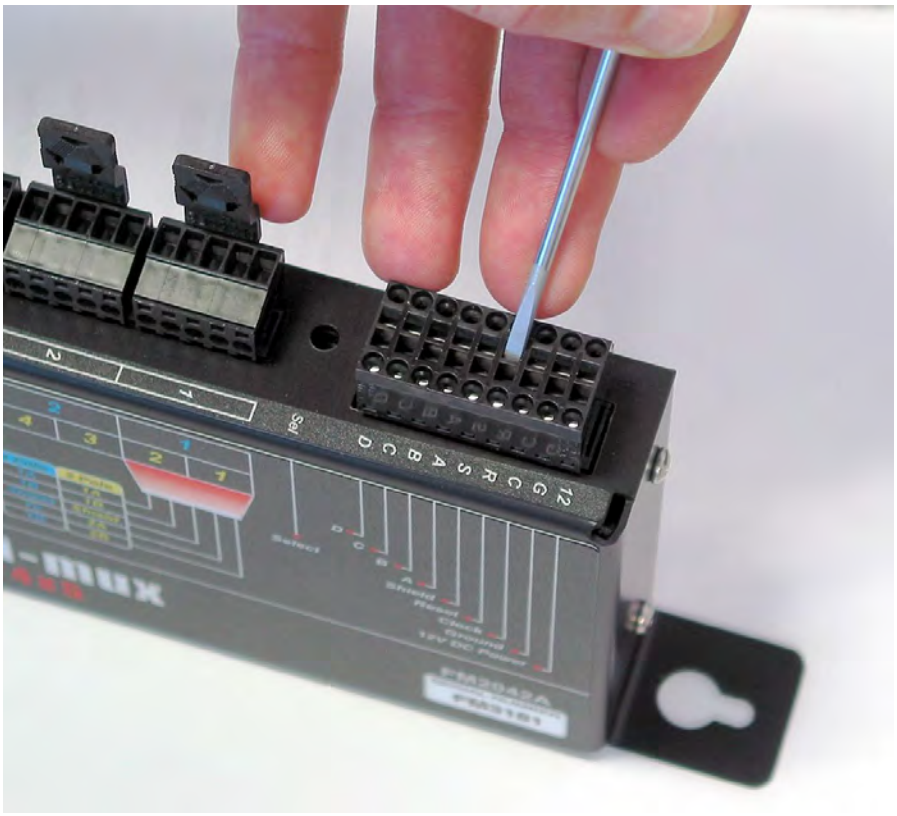


Figure 4 – Connector Detail

The cable grips are spring loaded, and require a small screwdriver to be inserted into the centre to retract the spring. Once retracted, insert the wire into the round hole and remove the screwdriver. The spring will grasp the wire.

The five, 5-pole terminal blocks are connection points for the shielded multiplexed sensor signals destined for the datalogger analog inputs (section 5.3). The 5-pole blocks have screw clamps and are rated to accept 14-28 AWG wire. Each sensor line is connected to a quick-connect terminal block with an integrated stress release system. The tab is designed to accommodate a tie-wrap which holds the lead wires. The connectors are designed to be easily disconnected, giving the flexibility to switch or move sensors. Lead wires are attached using a standard screw terminal on each block. Pin locations are numbered from the top down, with the shield being located in the centre. Ensure that connections are made in this order.

All terminal blocks are modular and socketed, allowing them to be unplugged. This provides the flexibility of being able to switch out and entire mux or switch the locations of instruments without having to rewire.

5 OPERATION

Section 5.1 describes the terminals that control the operation of the multiplexer. These terminals are located in the 18-pin terminal block labelled “5” in Figure 2. Section 5.2 discusses the use of the DIP switch settings which control the behaviour of the measurement terminals.

5.1 CONTROL TERMINALS

The CR10X datalogger (or other Campbell Scientific Datalogger) connects to the Flexi-Mux as shown in Figure 5. The power, ground, reset, and clock connections remain essentially the same unless the Flexi-Mux is being used with a CR510 Basic Datalogger (see note below).

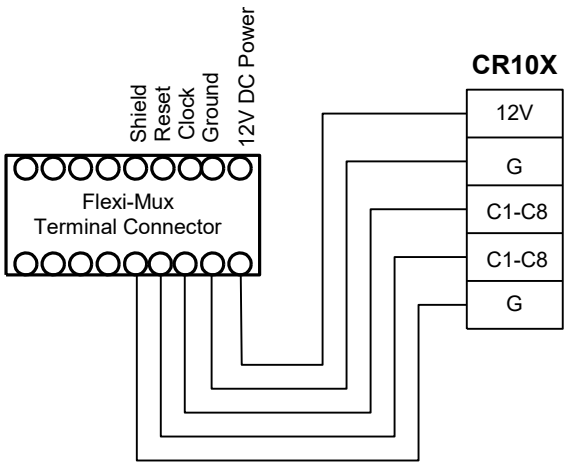


Figure 5 – Flexi-Mux to CR10x Datalogger Power/Control Hookup

With the CR10x, the Flexi-Mux connects to an available 12V port and a Ground terminal for power. One control port is used for *Reset* and another is used for *Clock*. If two control ports are not available (depending on the datalogger) a switched excitation channel can be used. The Flexi-Mux only requires 2 volts in order to be clocked.

Note

A control port is not always necessary to "clock" the Flexi-Mux. On basic dataloggers such as the Campbell Scientific CR510 which does not have a spare control port, a switched excitation channel can be used. This gives the RST Flexi-Mux more flexibility as compared to standard multiplexers.

5.1.1 RESET

The reset line is used to activate the Flexi-Mux. A signal in the range of +2.0V to +10VDC applied to the reset terminal activates the multiplexer. When this line drops lower than 0.9VDC, the multiplexer enters a quiescent, low current drain state. In the quiescent state the common terminals (A, B, C, D) are electrically disconnected from all the sensor input channels. Reset should always connect to a datalogger control port.

5.1.2 CLOCK

Pulsing the Flexi-Mux “clock” line high (with “reset” set high) advances the channel. Whether or not the Flexi-Mux advances 2 positions or 4 positions depends on the internal DIP switch settings (section 5.2). When the reset first goes high, the common terminals A, B, C and D are disconnected from all sensor input terminals. With the Flexi-Mux set in the 4-Pole mode, when the first clock pulse arrives the common terminals are switched to connect with the sensor input channel 1 (consists of 5 wires: A, B, C, D and shield). When a second clock pulse arrives the common lines are switched to connect to channel 2. The multiplexer advances along the leading edge of the positive going clock pulse. The voltage level must fall below 1.5VDC and then rise about 2.0VDC to clock the multiplexer. The clock pulse should be at least 1 ms long. A delay (typically 10 to 20 ms) is inserted in the datalogger program between the beginning of the clock pulse and the measurement instruction to ensure sufficient settling time for the relay contacts.

In general, a control port is used to clock the multiplexer. However, switched excitation for the sensors can also be used (as stated in section 5.1). See section 5.3 for more details on datalogger connections with the Flexi-Mux.

If several multiplexers are required, the Flexi-Mux allows a virtually unlimited number of units (limited by cable losses) to be connected in series because the Flexi-Mux boosts the clock and reset signals through its circuitry. Thus no control voltage is lost through the ports. An adequate 12VDC power source must be maintained through each multiplexer for this to function correctly.

5.1.3 GROUND

The Flexi-Mux “ground” terminal is connected to the datalogger power ground.

5.2 DIP SWITCH SETTINGS

Internal DIP switches on the Flexi-Mux control whether it switches 2 or 4 wires each time it is clocked. To change the DIP switch settings, remove the dust cover located on the base of the unit. The piano-key style DIP switches are accessed through this hole as shown in Figure 6. Adjust the DIP switches as outlined below. There is also a diagram on the Flexi-Mux itself which reflects these settings (item 6, Figure 2).

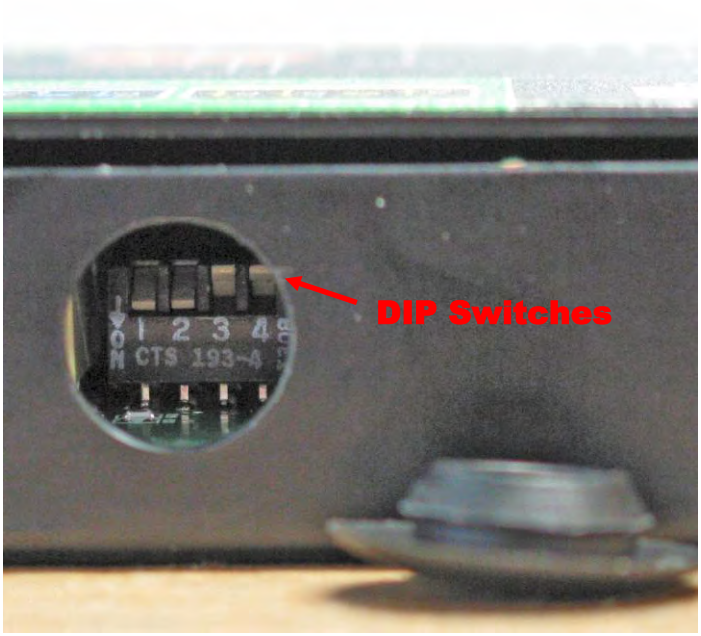


Figure 6 – DIP Switch Location

Switch No.	4-Pole	2-Pole
1	↑ (off)	↓ (on)
2	↑ (off)	↓ (on)
3	**X** (not used)	**X** (not used)
4	↓ (on)	↑ (off)

Figure 7 – DIP Switch Positions

5.3 CONNECTION EXAMPLES

The following illustrations depict some connection examples for using the RST Flexi-Mux in conjunction with Campbell Scientific CR10x dataloggers. Please note that the following sections are simply meant as an overview of the many ways an RST Flexi-Mux can be used. Many custom applications can be created. Contact RST Instruments Ltd. for more details.

5.3.1 2-WIRE SERIAL SWITCHING

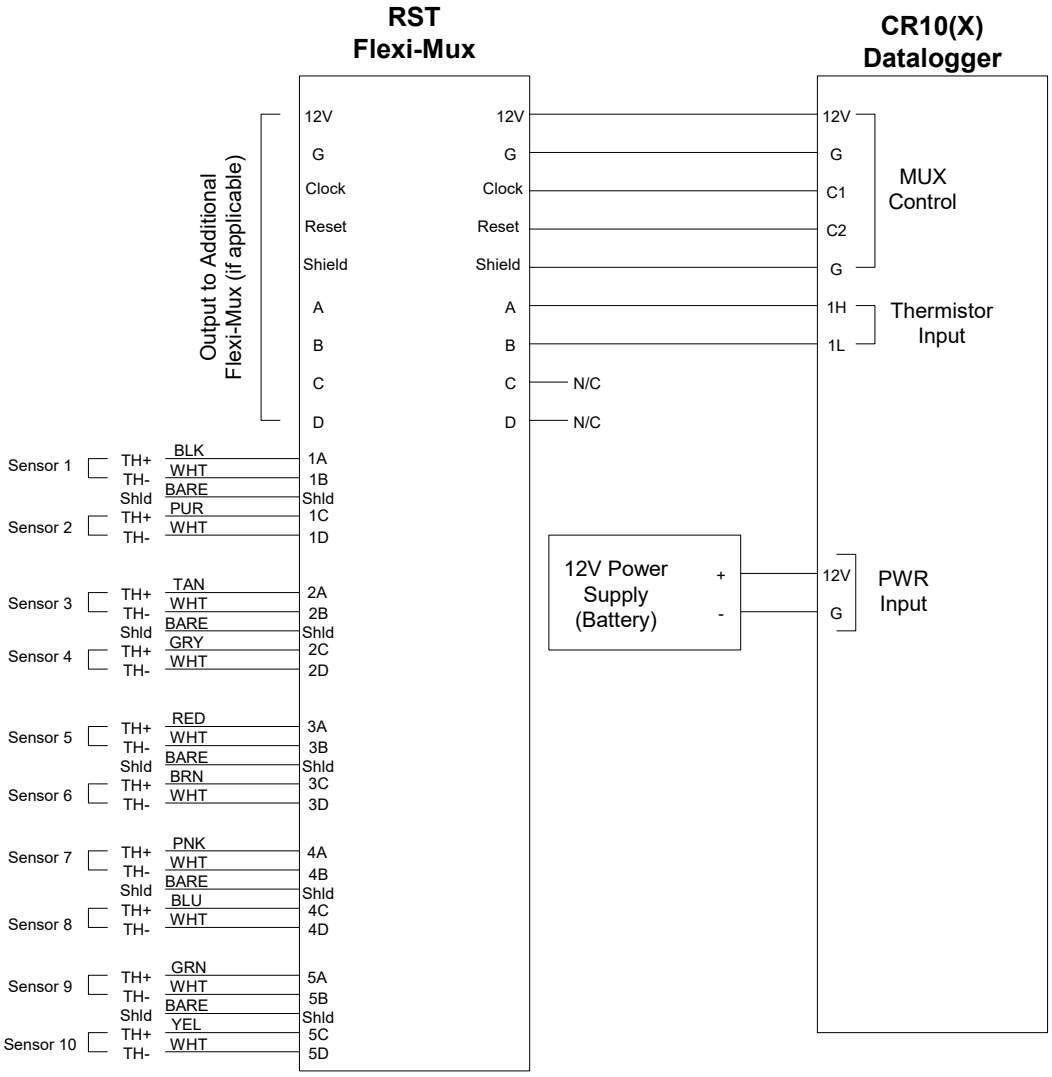


Figure 8 – Flexi-Mux Connected to a Thermistor String

5.3.2 4-WIRE SERIAL SWITCHING

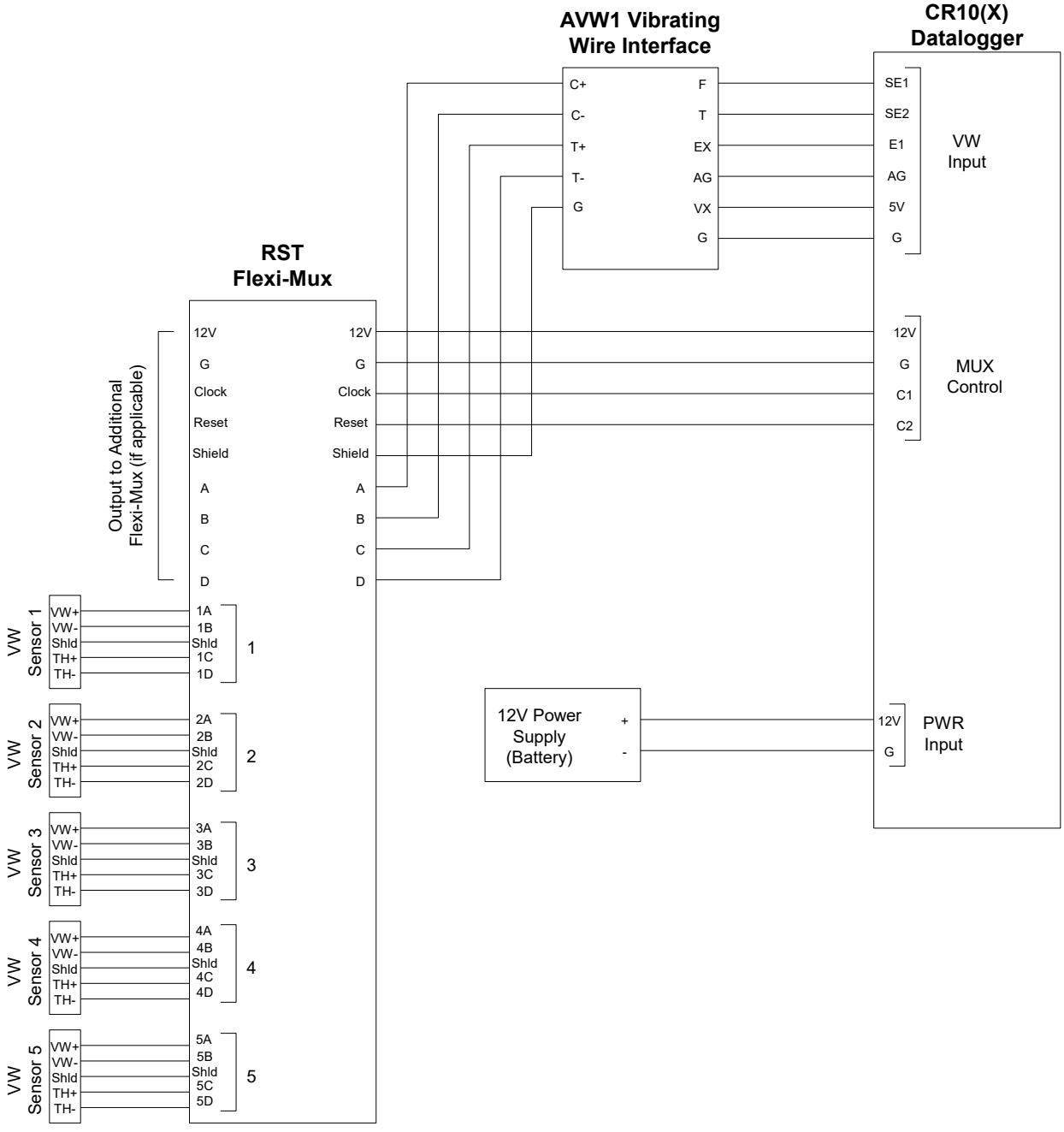


Figure 9 – Flexi-Mux with VW Instruments

5.3.3 4-WIRE SWITCHING WITH SEPARATE EXCITATION

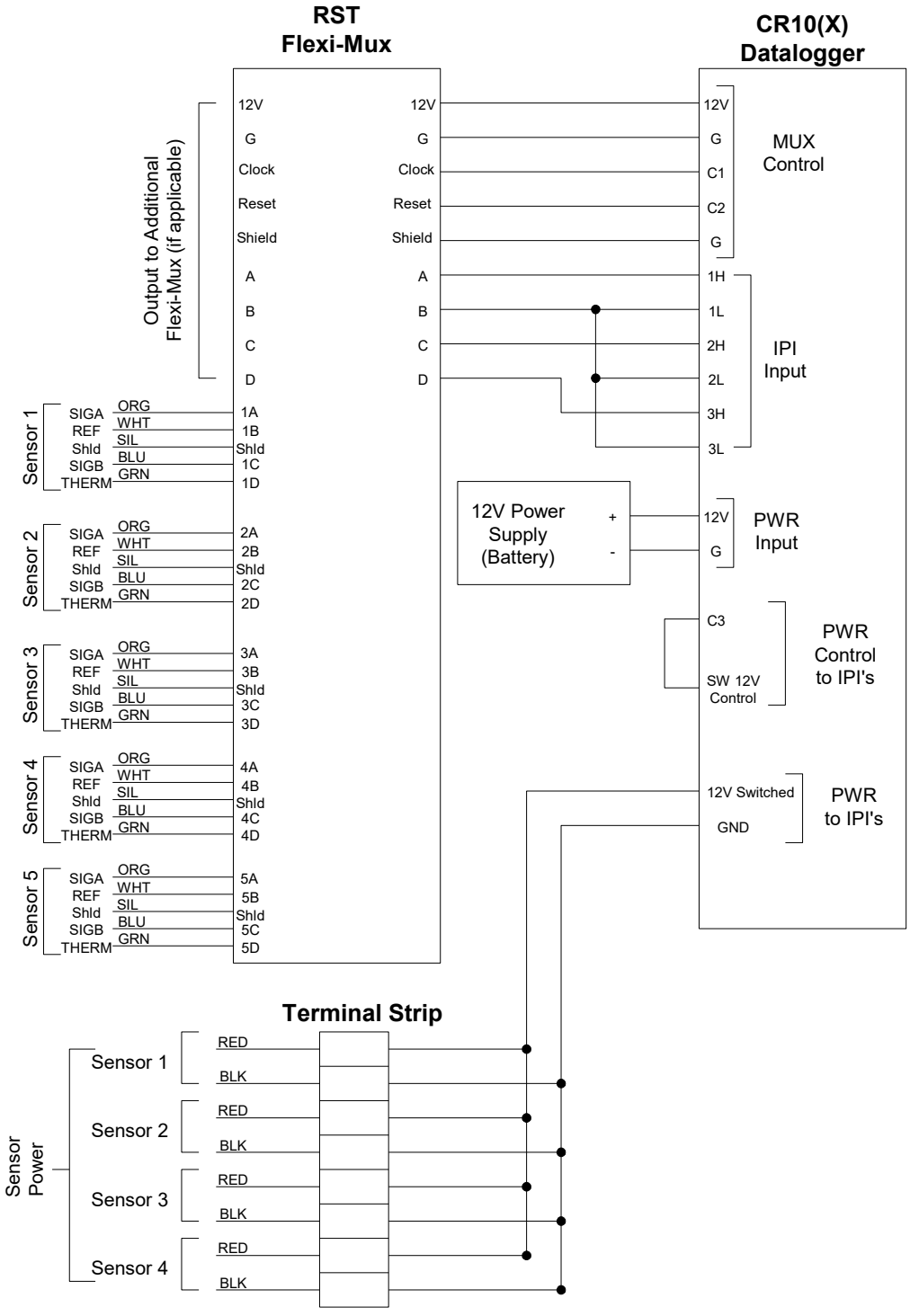


Figure 10 – Flexi-Mux with Biaxial In-Place Inclinometers

5.3.4 8-WIRE SERIES/PARALLEL SWITCHING

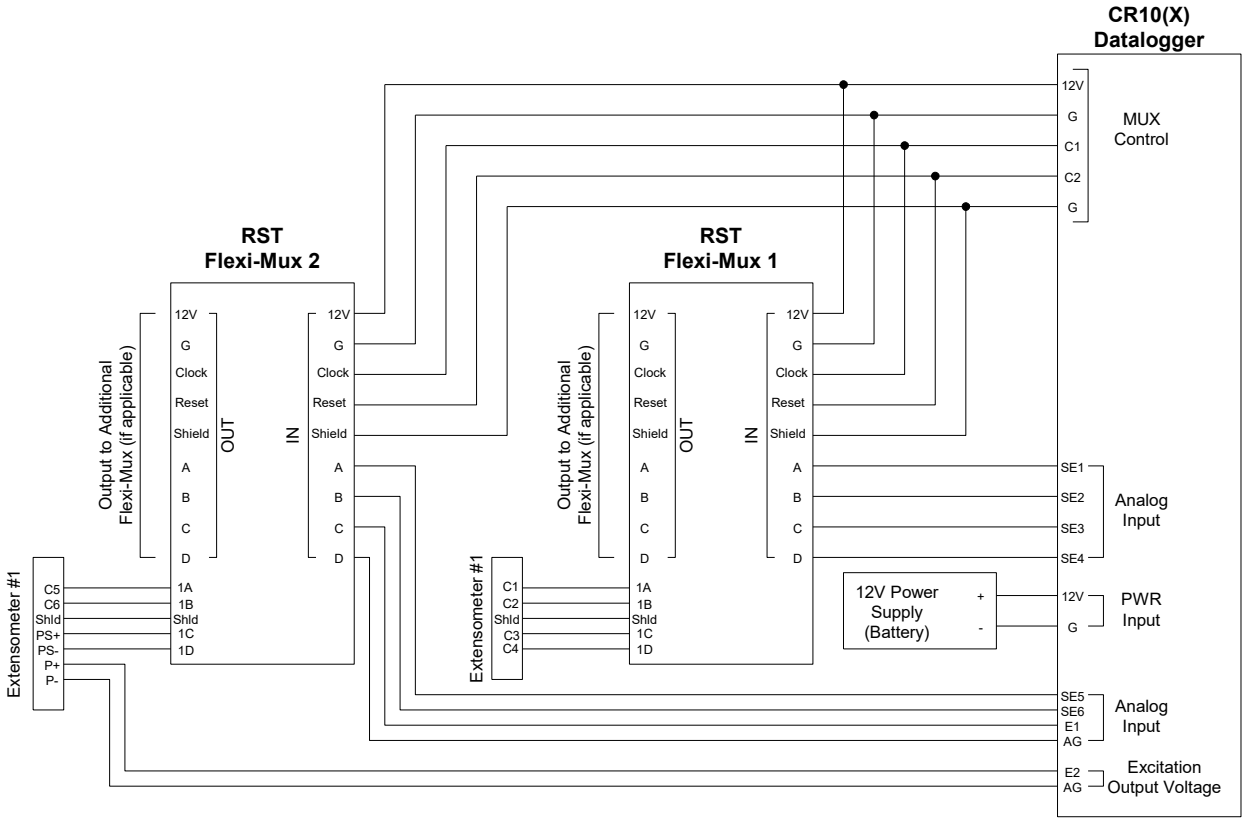


Figure 11 – Flexi-Mux wired in Parallel to Switch 8-wires

5.4 DATALOGGER PROGRAMMING

The following table outlines the basic program instructions which can be used to activate the RST Flexi-Mux and measure RST Vibrating Wire Piezometers with Campbell Scientific Dataloggers. Please note that this is a very basic example only, there are many options available.

```
 1:  Do (P86)
  1: 41       Set Port 1 High
;Turn on Multiplexer (reset)

 2:  Excitation with Delay (P22)
  1: 3        Ex Channel
  2: 5        Delay W/Ex (units = 0.01 sec)
  3: 0000     Delay After Ex (units = 0.01 sec)
  4: 0000     mV Excitation
;Delay

 3:  Beginning of Loop (P87)
  1: 0000     Delay
  2: 2        Loop Count

     4:  Do (P86)
      1: 72       Pulse Port 2
;1st Mux clock

     5:  Excitation with Delay (P22)
      1: 3        Ex Channel
      2: 0000     Delay W/Ex (units = 0.01 sec)
      3: 1        Delay After Ex (units = 0.01 sec)
      4: 0    0   mV Excitation
;delay for Mux

     6:  Vibrating Wire (SE) (P28)
      1: 1        Reps
      2: 1        SE Channel
      3: 1        Excite all reps w/Exchan 1
      4: 20       Starting Freq. (units = 100 Hz)
      5: 32       End Freq. (units = 100 Hz)
      6: 200      No. of Cycles
      7: 0        Rep Delay (units = 0.01 sec)
      8: 1     -- Loc [ VW_1      ]
      9: 1.0      Mult
     10: 0.0      Offset
;Read Vibrating Wire Model VW2100

     7:  Excite-Delay (SE) (P4)
      1: 1        Reps
      2: 15       ñ 2500 mV Fast Range
      3: 2        SE Channel
      4: 1        Excite all reps w/Exchan 1
      5: 1        Delay (units 0.01 sec)
      6: 2500     mV Excitation
      7: 17    -- Loc [ Therm_1   ]
      8: .001     Mult
      9: 0.0000   Offset
;Read 3K thermistors

     8:  Polynomial (P55)
      1: 1        Reps
      2: 17    -- X Loc [ Therm_1   ]
      3: 17    -- F(X) Loc [ Therm_1   ]
      4: -104.78  C0
      5: 378.11   C1
      6: -611.59  C2
      7: 544.27   C3
      8: -240.91  C4
      9: 43.089   C5
;Linearize 3K thermistors

 9:  End (P95)
;of loop

10:  Do (P86)
 1: 51       Set Port 1 Low
;turn off multiplexer
```

Figure 12 – Flexi-Mux Program Example

The above program example assumes that the Flexi-Mux DIP switches are set to 4-wire switching, therefore a pulse for the *reset* and *clock* lines will switch 4 wires (VW sensor and thermistor).

6 SPECIFICATIONS

Power	12 Vdc (under load), unregulated
Current Drain	10µA quiescent; 8mA active
Reset Active Levels, max.	2.0V
Clock Active Levels, max.	2.0V
Min. Clock Pulse Width	1 ms
Max. Actuation Relay Time	20 ms
Relay Operation	Break before make
Initial Relay Resistance, closed	0.1 Ohm
Max. Switching Current	1A
Min. Contact Life	10^7 closures
Operating Temp.	-40°C to 70°C (-40°F to 158°F) - extended
Size	20.7cm(8.15”H) x 8.5cm (3.17”W) x 2.7cm (1.05”D)
Weight	0.24kg (0.53lbs.)

Underdrain Flow Monitoring
Ultrasonic Transducers

Dynasonics®
Ultrasonic Flow Meters

iSonic 4000

Open-Channel Flow Meter

DESCRIPTION

An economical open-channel flow meter, iSonic 4000 measures level, flow rate and total volume of water flowing through weirs and flumes. The meter includes a non-contact ultrasonic level sensor to detect the water level and then calculates the flow rate and total volume using the Gauckler-Manning or other equations based on characteristics of the channel. All the measurements are available over Modbus RTU and can be logged for historical records.

BENEFITS

- Measure level, flow rate and total volume with a single device
- Simple setup for flumes and weirs
- Retain a historical log of all measurements
- Easily connect up to SCADA systems with Modbus RTU
- Rugged IP67 powder coated aluminum enclosure

OPERATION

Based on empirical formulas, the iSonic 4000 calculates the flow rate based on the geometry of the channel or primary element and water depth. The level sensor measures the depth of the water used in the calculation.

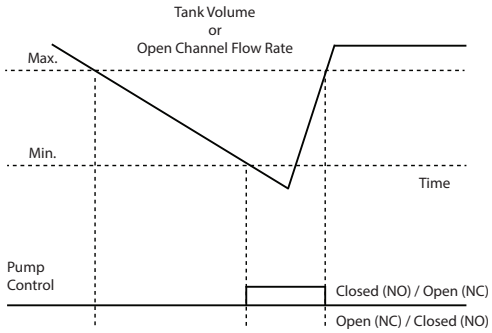
The iSonic 4000 includes a selection of primary elements with preprogrammed tables to simplify the setup, including:

- Parshall flumes
- Manhole flumes
- V-notch weirs

Additionally, you can enter custom tables using the Flow Meter Tool software.

PUMP CONTROL OPTION

The Pump Control option automatically starts and stops the pump based on water level.



PART NUMBER

- DK-1S-S
  - ◊ iSonic 4000 transmitter
  - ◊ Level sensor with 32 ft (10 m) cable
  - ◊ USB cable
  - ◊ Flow Meter Tool configuration software
- Optional bracket for level sensor

APPLICATIONS

Open channels with a primary element are a cost effective solution for managing varying flow rates in unpressurized systems. The iSonic 4000 flow meter performs best when used with a primary element, such as a flume or weir, and where the sediment does not build up.

- Flow into water treatment plants from reservoirs
- Storm and sanitary sewer systems
- Effluent from water resource recovery or wastewater treatment
- Industrial discharge
- Agriculture irrigation channels

Badger Meter®

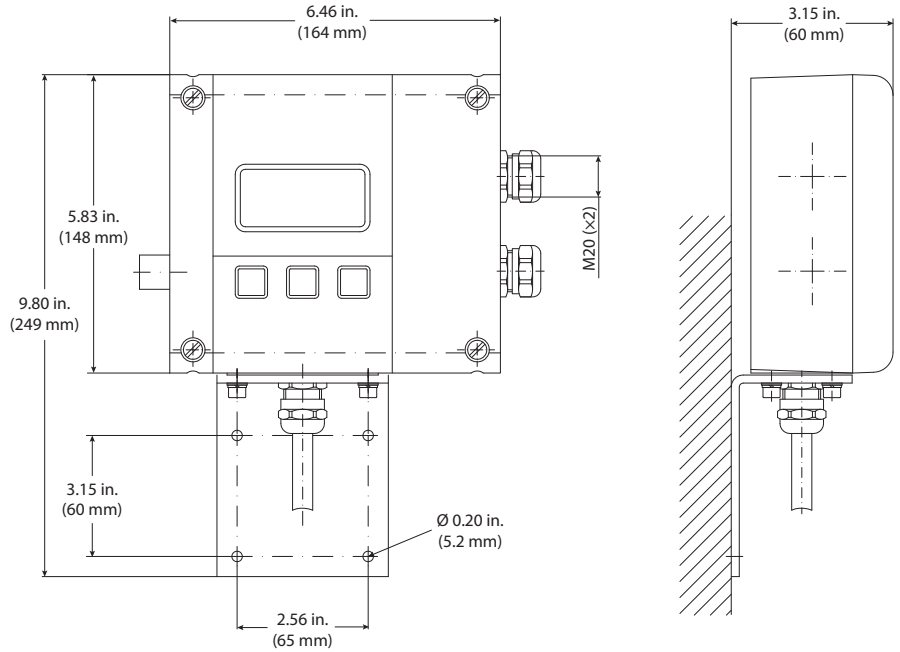
HYB-DS-02510-EN-03 (September 2019)

Product Data Sheet

SPECIFICATIONS

Type	iSonic 4000					
Auxiliary power	92…275V AC (50/60 Hz), < 14 VA					
Analog output	4…20 mA, 0…20 mA, 0…10 mA ≤ 800 Ohm, active or passive; Assigned parameter depends on flow meter mode					
Level sensor input	4…20 mA from level sensor					
Digital outputs	2 open collectors; passive: max. 32V DC, 0…100 Hz 100 mA, 100…10.000 Hz 20 mA; active: 24V DC, max. 20 mA; Select active pulse, min/max. alarm, error messages or pump control					
	Solid-state relay (n.o./n.c.) max. 230V AC, 500 mA, 1 Hz; Function is linked with open collector output 2					
Digital input	5…30V DC; totalizer reset, positive return zero, BEACON/AquaCUE connectivity					
Programming port	Mini USB, IP67					
Configuration	3 front-panel mounted push-buttons					
Communication	RS485 Modbus RTU, Modbus TCP/IP Ethernet, BEACON/AquaCUE connectivity					
Pulse length	Configurable up to 2000 msec					
Datalogger	2 MB capacity with 130,000 logged lines: date, level, flow rate, tank volume					
Display	Graphical LCD 64 × 128, backlight, actual flow rate, totalizers, status display					
Body	Die cast powder-coated aluminium, protection class IP67					
Cable inlet	Supply and signal cables 2 × M20; cable glands included					
Signal cable	From meter M20; cable gland included					
Ambient temperature	-20…60° C					
Sensors	**Measuring range**	**Offset**	**Beam width**	**Material**	**Accuracy**	**Deadband**
	0…49.21 in. (0…1250 mm)	2 in. (50 mm)	2 in. (50 mm)	PVDF	0.125 in. (3 mm)	2 in. (50 mm)
Security	Three level password					
Languages	English, Spanish, French, German, Italian, Czech, Russian					
Channel selection	Contracted rectangular weir, suppressed rectangular weir, Cipoletti weir; V-notch weir (30°, 45°, 60°, 90°); Parshall flume (1, 2, 3, 6, 9, 12, 18, 24, 36, 48 and 60 in.); Manhole flume (4, 6, 8, 10 and 12 in.); table entry, exponential equation, Manning rectangle flume, Manning pipe					

DIMENSIONS



Control. Manage. Optimize.

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EchoPod® DL10

Ultrasonic Liquid Level Transmitter

FLOWLINE™ LEVEL BEST

Application

The general purpose ultrasonic transmitter provides continuous level measurement up to 49.2” (1.25m) with a 4-20 mA signal output, and is configured via our free WebCal® software. This non-contact liquid level sensor is ideally suited for corrosive, sticky or waste liquids, and is selected for chemical feed, IBC or drum, skid or machine and cooling tower applications.

Features

- Continuous non-contact level measurement up to 49.2” (1.25m)
- 4-20 mA output for longer signal distances up to 1000’ (300m)
- Configuration is fast and easy via WebCal software and USB adapter
- Narrow 2” beam width and short 2” dead band optimized for small tanks
- PVDF transducer and 6P polycarbonate enclosure for corrosive liquids
- Automatic temperature compensation for accurate measurement

Success

Stormwater run-off from highways is a major source of pollution that degrades our clean water resources, negatively impacting both wildlife and people. This run-off carries high levels of lead, fuel, oil and chemicals which are commonly found on highways. State and federal agencies monitor run-off to determine its volume, content and risk to the local environment. Here, an EchoPod ultrasonic level sensor is installed over a V-Notch weir on the side of the highway. The continuous level sensor measures the volume of stormwater passing through the weir, and provides a 4-20 mA signal to the wireless telemetry system for remote data collection.

Compatible Products

LI23

DATALOOP™

Level Indicator

LI55

DATAVIEW™

Level Controller

LI40

PODVIEW™

Level Indicator

© 2019 Flowline | 10500 Humbolt Street, Los Alamitos, CA 90720 USA **p** 562.598.3015 **f** 562.431.8507 **w** flowline.com

EchoPod® DL10

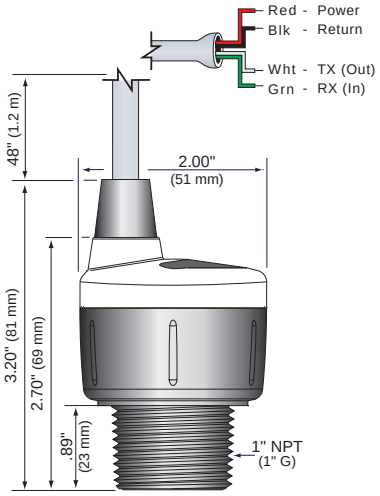
Ultrasonic Liquid Level Transmitter

FLOWLINE™ LEVEL BEST

Specifications

Range:	49.2” (1.25m)
Accuracy:	0.125” (3mm)
Resolution:	0.019” (0.5mm)
Dead band:	2” (5cm)
Beam width:	2” (5cm)
Configuration:	WebCal® PC Windows® USB 2.0
Memory:	Non-volatile
Supply voltage:	24 VDC (loop)
Consumption:	0.5W
Loop resist.:	400Ω max @ 24 VDC
Signal output:	4-20 mA, two-wire
Signal invert:	4-20 mA or 20-4 mA
Loop fail-safe:	4 mA, 20 mA, 21 mA, 22 mA or hold last
Process temp.:	F: 20° to 140° C: -7° to 60°
Temp. comp.:	Automatic
Ambient temp.:	F: -31° to 140° C: -35° to 60°
Pressure:	MWP = 30 PSI (2 bar)
Enclosure rating:	Type 6P, encapsulated, corrosion resistant & submersible
Encl. material:	Polycarbonate
Strain relief mat.:	Santoprene
Trans. material:	PVDF
Cable jacket mat:	Polyurethane
Cable type:	4-conductor, shielded
Cable length:	48” (1.2m)
Process mount:	1” NPT (1” G)
Mount gasket:	Viton®
Classification:	General purpose
Compliance:	CE, RoHS
Approvals:	cFMus

Dimensions



Configuration

LI99-1001

The level sensor is configurable via our free WebCal PC software and Fob USB adapter. The sensors are offered with and without Fobs. Fobs are universal and can be used to configure any WebCal compatible product. Download your free copy of WebCal in English or Chinese.

Fittings

For optimum performance, install the level sensor using the below recommended or direct equivalent fittings.

	P/N	DESCRIPTION
	LM52-1400	2” NPT x 1” NPT, PVC, schedule 40
	LM52-1800	2” NPT x 1” NPT, PVC, schedule 80
	LM52-1410	2” socket x 1” NPT, PVC, schedule 40
	LM52-1810	2” socket x 1” NPT, PVC, schedule 80
	LM52-1850	1” ANSI x 1” NPT, CPVC, schedule 80
	LM50-1001-1	1” NPT side mount bracket, PP

Ordering

DL10 - ☐ ☐

PROCESS MOUNT (1)

- **0** NPT (US)
- **1** G (Metric)

FOB USB ADAPTER (2)

- **0** Without Fob
- **1** With Fob

NOTES

1) Install the level sensor using Flowline installation fittings or equivalents.
2) The level sensor is configured via our WebCal software and one LI99-1001 Fob USB adapter. The level sensor is offered with and without a Fob. Fobs are universal and can be used to configure any WebCal compatible product. WebCal is a free download from our website.

Badger Meter

iSonic 4000

Open-Channel Flow Meter

HYB-UM-02509-EN-04 (November 2018)

User Manual

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SCOPE OF THIS MANUAL

This manual contains instructions for installing, operating and programming the iSonic 4000 flow meter.

IMPORTANT

Read this manual carefully before attempting any installation or operation. Keep the manual accessible for future reference.

SAFETY PRECAUTIONS AND INSTRUCTIONS

Some procedures in this manual require special safety considerations. In such cases, the text is emphasized with the following symbols:

Symbol	Explanation
⚠WARNING	Warning indicates the potential for severe personal injury, death or substantial property damage. Comply with the instructions and proceed with care.
⚠CAUTION	Caution indicates the potential for minor personal injury or property damage. Comply with the instructions and proceed with care.

Before installing or using this product, please read this instruction manual thoroughly. Only qualified personnel should install and/or repair this product. If a fault appears, contact your distributor.

Installation

- Do not place any unit on an unstable surface that may allow it to fall.
- Never place the units above a radiator or heating unit.
- Route all cabling away from potential hazards.
- Isolate from the mains before removing any covers.

Power Connection

- Use only the type of power source suitable for electronic equipment. If in doubt, contact your distributor. Ensure that any power cables are of a sufficiently high current rating.
- All units must be earthed to eliminate risk of electric shock. Failure to properly earth a unit may cause damage to that unit or data stored within it.

Protection Class

The device has protection class IP 67 and needs to be protected against dripping water, water, oils, etc.

Setup and Operation

Adjust only those controls that are covered by the operating instructions. Improper adjustment of other controls may result in damage, incorrect operation or loss of data.

Cleaning

Switch off all units and isolate from mains before cleaning. Clean using a damp cloth. Do not use liquid or aerosol cleaners.

Repairing Faults

Disconnect all units from power supply and have it repaired by a qualified service person if any of the following occurs:

- If any power cord or plug is damaged or frayed
- If a unit does not operate normally when operating instructions are followed
- If a unit exposed to rain/water or if any liquid has been spilled into it
- If a unit has been dropped or damaged
- If a unit shows a change in performance, indicating a need for service.

⚠ WARNING

FAILURE TO ADHERE TO THESE SAFETY INSTRUCTIONS MAY RESULT IN DAMAGE TO THE PRODUCT OR SERIOUS BODILY INJURY.

RoHs

Our products are RoHs compliant.

Battery Disposal

The batteries contained in our products need to be disposed of as per your local legislation, according to EU directive 2006/66/EG.

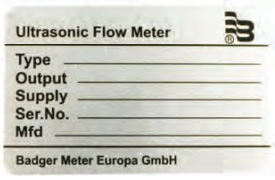
SYSTEM DESCRIPTION

The iSonic 4000 Ultrasonic flow meter is designated for flow measurements in open channels and partially filled pipes and volume measurements of liquids in tanks. You can connect one ultrasonic level sensor with 4…20 mA output to the unit. Flows are consequently calculated from measured levels using pre-programmed formulas for various primary flow elements (flumes, weirs) or from the Q/h table. The unit can also calculate flow rates in partially filled pipes and angular open channels using the Manning equation.

- The iSonic 4000 flow meter is an IP67 device in a robust wall-mounted metal case, with a large graphic display.
- The flow meter menu is operated with three front panel high endurance buttons.
- The flow meter is powered externally by 92…275V AC / 50…60 Hz. The DC version is powered externally by 9…36V DC (maximum 9 W).
- You can operate the flow meter via connection to a USB or Ethernet interface with Flow Meter Tool software, which can be used for parameter setup and datalogger download.
- The flow meter has an internal datalogger with 2 MB capacity for approximately 130,000 logged lines. You can download the logged data with the Flow Meter Tool software and save it in .csv format to a PC.
- USB, Ethernet, ADE, RS232, Modbus RS485/RS422 galvanic isolated interfaces are mounted on the board.
- The flow meter has one analog output (0…20 mA or 4…20 mA) and two galvanic isolated pulse outputs.

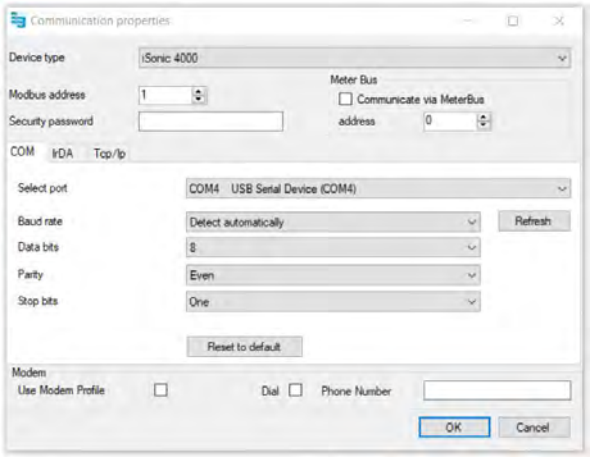
Nameplate

Look at the device nameplate to make sure the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.



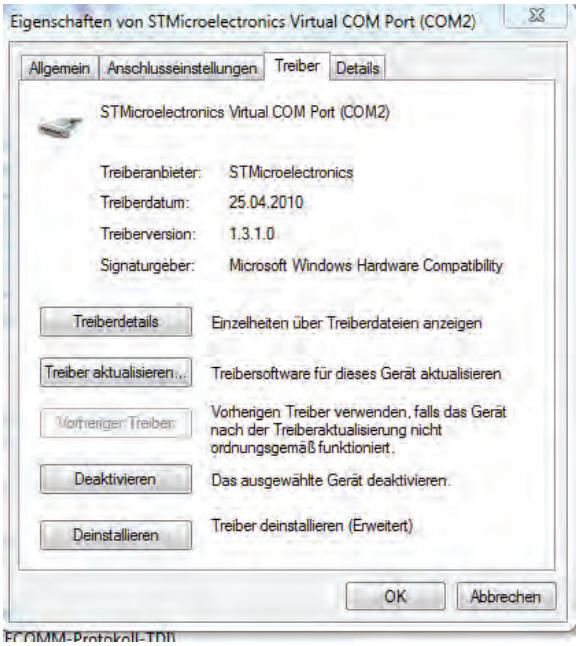
System Settings

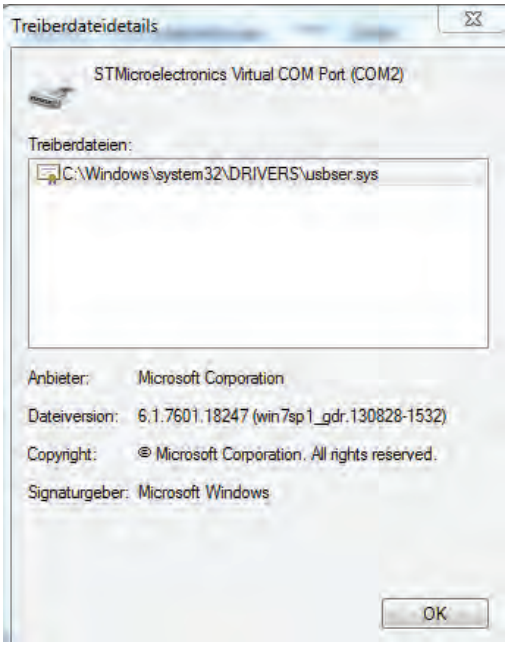
Flow Meter Tool Settings



Settings Control Panel

Driver Details



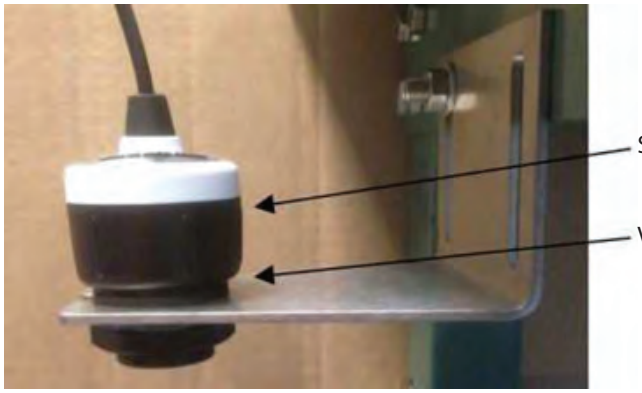


INSTALLATION

⚠ WARNING

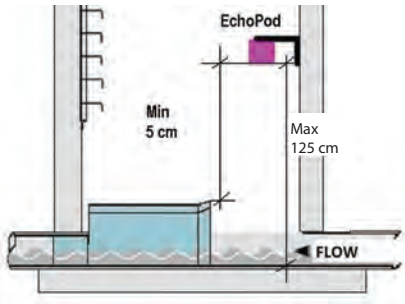
INSTALLATION INSTRUCTIONS GIVEN IN THE FOLLOWING ARE TO BE OBSERVED IN ORDER TO PROVIDE FUNCTIONALITY AND SAFE OPERATION OF THE METER.

Installation the EchoPod DL-10 Sensor

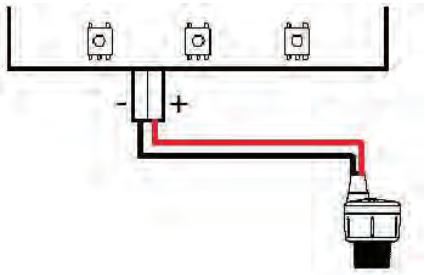


1. Insert the gasket onto the threaded end of the sensor.
2. Screw the sensor into the stainless steel mounting bracket.

NOTE: Install the sensor at a maximum of 49.21 in. (125 cm) above the flume bottom (minimal measured level) with a minimum of 1.97 in. (5 cm) distance above the maximal measured level.



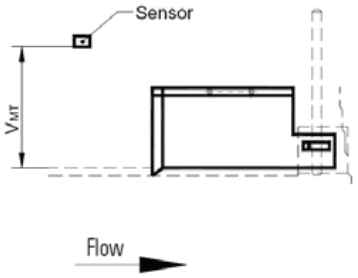
3. Connect the sensor to the 4…20 mA input terminal on the bottom side of display board.



Mounting Positions

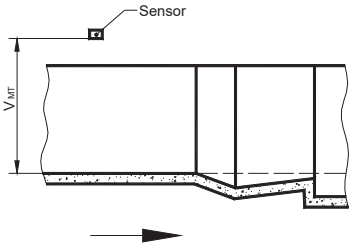
Manhole Flume

Size	Max. Flow	Max. Water Level	V-Mt	H-Mt
in. (DN)	g/sec (l/sec)	in. (mm)	in. (mm)	in. (mm)
4 (100)	1.32 (5)	5.83 (148)	23.62 (600)	5.75 (146)
6 (150)	4.23 (16)	8.94 (227)	23.62 (600)	7.75 (197)
8 (200)	9.25 (35)	12.28 (312)	23.62 (600)	9.76 (248)
10 (250)	16.64 (63)	15.55 (395)	27.56 (700)	11.73 (298)
12 (300)	24.83 (94)	18.00 (457)	27.56 (700)	13.74 (349)



Parshall Flume

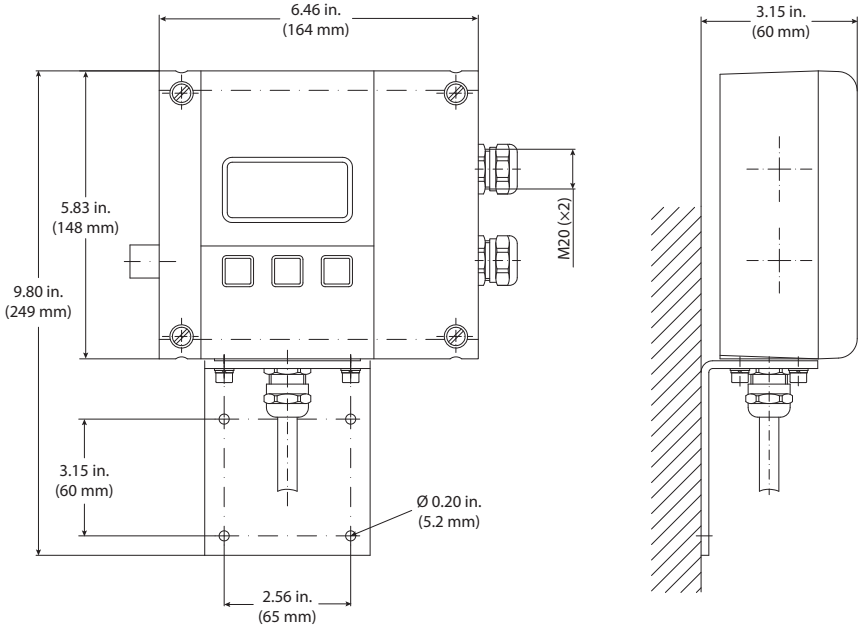
Size	Max. Flow	V-Mt	H-Mt
in. (DN)	g/sec (l/sec)	in. (mm)	in. (mm)
3 (75)	14.26 (54)	30.71 (780)	12.00 (305)
6 (150)	30.12 (114)	30.71 (780)	15.98 (406)
9 (230)	77.67 (284)	38.19 (970)	22.52 (572)
12 (305)	157.98 (598)	contact factory	contact factory
18 (455)	24.83 (94)	contact factory	contact factory



POWER CONNECTIONS

⚠CAUTION

FOR THE 2 × M20 CABLE INLETS, USE ONLY FLEXIBLE ELECTRIC CABLES. USE SEPARATE CABLE INLETS FOR AUXILIARY POWER, SIGNAL AND INPUT/OUTPUT CABLES.



Auxiliary Power

⚠ WARNING

- ***DO NOT CONNECT METER TO POWER SOURCE UNDER CONDITIONS THAT COULD CAUSE PERSONAL INJURY OR DAMAGE TO THE EQUIPMENT.***
- ***WIRING OF THIS EQUIPMENT MUST COMPLY WITH LOCAL AND NATIONAL CODES AND BE WITHIN THE VOLTAGE AND FREQUENCY RATING LISTED ON THE METER.***
- ***INSTALL EQUIPMENT WITH AN EXTERNAL MEANS FOR DISCONNECTING IT FROM POWER, SUCH AS A SWITCH OR A CIRCUIT BREAKER.***

1. Slightly loosen the lower cover screws.
2. Completely loosen both upper cover screws.
3. Open the cover to the lower side.
4. Push the auxiliary power cable through the upper cable inlet.
5. Connect the power as shown in *Figure 1* or *Figure 2*, depending on the version (AC or DC) of meter you have.
6. Close the cover and tighten the four screws.

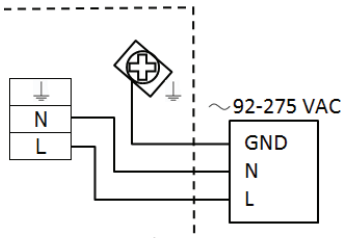


Figure 1: Power supply 92…275V AC (50/60 Hz); recommended cable size min. 0.3 sq. in. (0.75 mm²)

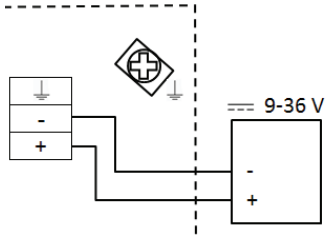
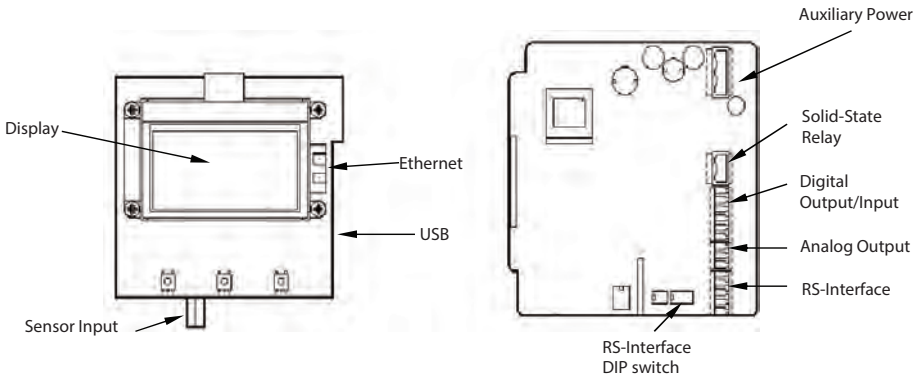
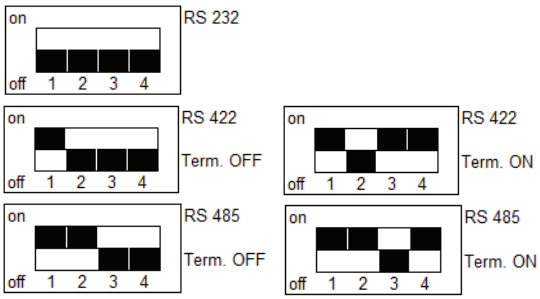


Figure 2: Power supply 9…36V DC (max. 9 W); recommended cable size min. 0.3 sq. in. (0.75 mm²)

Configuring Input/Outputs (I/O)



Input/Output		Description	Terminal
Analog output*		0…20 mA, 4…0 mA, RL < 800 Ohm, 0…10 mA	7 (+), 8 (-), 9 (GND)
Digital output	1*	Open collector max. 10 kHz, Passive max. 32V DC, <100 Hz 100 mA, >100 Hz 20 mA, Active 24V DC, 20 mA, (can be powered by analog output if not used)	3 (-),4 (+)
	2*	Open collector max. 10 kHz, Passive max. 32V DC, <100 Hz 100 mA, >100 Hz 20 mA, Active 24V DC, 20 mA, (can be powered by analog output if not used)	1 (-) 2 (+)
	3	Solid-state relays max. 230V AC, 500 mA, max. 1 Hz (function is linked to Output 2)	S1 and S2
Digital input*		5…30V DC	5 (-) and 6 (+)
RS interfaces*		RS232, RS485 and RS422 with Modbus RTU. Mode can be configured by DIP switches also termination ON or OFF. For the RS485, connect the A wire to the Y terminal and the B wire to the Z terminal. 	422 / 232 / 485 A / RxD / B / / Z / TxD / B Y / / A G (GND)
USB		USB Device CDC (Host Mass Storage)	Micro USB
Ethernet*		Ethernet Interface connection	RJ45 socket

* All marked inputs and outputs are according to safety data TNV-1 IEC 60950-1.

Input and Output Cable Connections

For the normal I/Os, use shielded cables. Connect the shield of the cable to one of the grounding screws. Recommended cable is LiYCY size min. 0.06 sq. in. (0.14 mm^2).

Solid-State Output
If using a second cable gland for the normal I/Os, use one cable and cable gland for the power supply and solid-state relay. Recommended cable size is min. 0.3 sq. in. (0.75 mm^2).

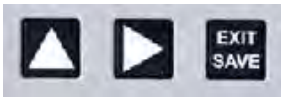
⚠CAUTION

- ***USE SEPARATE CABLE INLETS FOR CABLES CONNECTED TO THE SOLID-STATE RELAY OUTPUT AND CABLES CONNECTED TO THE OTHER INPUT/OUTPUTS.***
- ***WITH MULTIPHASE POWER, SOLID-STATE RELAY SHOULD HANDLE ONLY THE SAME PHASE THAT IS USED FOR POWERING THE METER.***

OPERATION

Function Buttons

All programming is accomplished using the three function buttons on the front of the unit. Screen navigation and digit and parameter selection is performed by a combination of these buttons.



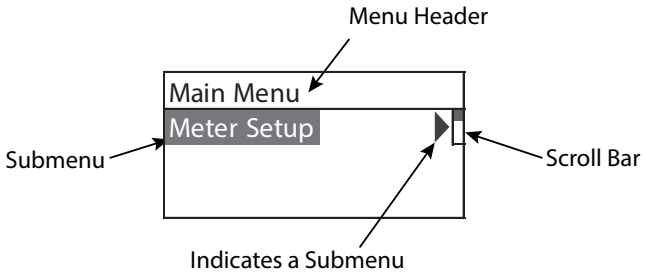
Use the **up-arrow** to scroll through the menu screens or to advance numerical digits to change values.

Use the **right-arrow** to select digits from left to right and allows or to enter a submenu.

Use **EXIT SAVE** to save changed values, return to a previous menu or toggle between *Measuring* mode and *Programing* mode.

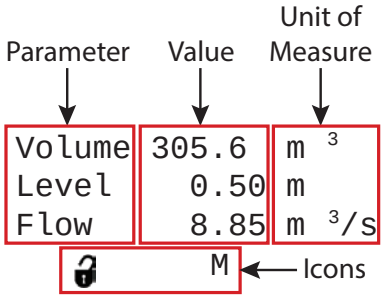
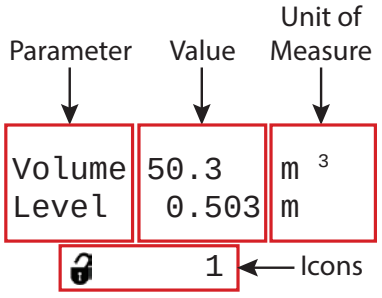
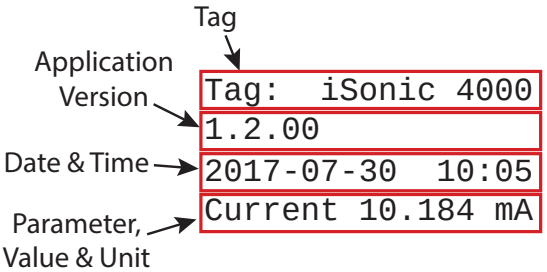
Display Icons

Minor battery power (Realtime clock)	**W**	Sensor warming
Device error	**0**	Sensor not connected
No keyword active	**M**	Sensor measuring
USB active	**S**	Simulation active



Initial Screens

From the *Main Menu*, press **EXIT SAVE** to display the current values and system information. The first screen to display depends on the application type (open channel or tank).

First screen for open channel applications:	First screen for tank applications:	Second screen for both applications.
		

Setting a PIN

The iSonic 4000 flow meter security feature allows the option to restrict access to the meter by way of a 6-digit Personal Identification Number (PIN). The system administrator can set up a single PIN for each of the three different levels of access:

- **Administration** – allows access to all iSonic 4000 flow meter menu configuration screens.
- **Service** – allows access to service-level and user-level menu configuration screens.
- **User** – allows access only to user-level menu configuration screens.

NOTE: For a lost PIN, Contact Badger Meter Technical Support at 800-456-5023 for a replacement PIN.

Not all levels of access need to be set. If no PINs are set up, any user will have access to all functions.

1. From the *Main Menu*, press the **right-arrow**.
2. From the *Meter Setup* menu, press the **up-arrow** until the *Pin* menu is displayed.
3. Press the **right-arrow** to display the PINS *Control* menu.
4. Press the **right-arrow** to highlight ON or OFF.
5. With either ON or OFF highlighted, press the **up-arrow** to display ON.
6. Press **EXIT SAVE** to save the ON setting.
7. With the *Control* menu highlighted, press the **up-arrow** to display the required security level (user, service, or admin).
8. With the required security level highlighted, press **EXIT SAVE** to display the first of six zeros (digits).
9. Press the **up-arrow** to change the first digit, followed by pressing the **right-arrow** to select the next digit.
10. Press the **EXIT SAVE** button to save the PIN number for that security level.

Logging In

To change any parameter, the PIN entered must provide the proper security privilege required by the parameter.

To enter a PIN, go to the *Login* menu and enter the PIN for the required security level.

Once you are properly logged in, the unlocked icon appears on the meter display.

NOTE: A ***PIN Error*** message displays if the incorrect PIN is entered.

Logging Out

To log out, follow steps 1 through 8 under *"Setting a PIN"*. At step 9, enter an invalid PIN, then press **EXIT SAVE**.

PROGRAMMING

Main Menu

From the *Main Menu*, you can access these submenus, each of which is described on the following pages:

- Meter Setup
- Measurements
- Input and Outputs
- Totalizer Reset
- Communication
- Miscellaneous
- Information
- Pin

The security levels are:

Administrative

Service

User

Parameters indicated by the battery icon, if changed, will affect battery performance.

To program the security levels, see *"Setting a PIN" on page 13*. No passwords were set at the factory.

Meter Setup Menu

Application	***Tank***	Select for a tank application.
	Open Channel	Select for an open channel application.
Sensor	***Interval***	Setup of time measurement interval(s); default value is 1 second; larger interval (for instance, 300 seconds) is set when unit is powered from battery
	WarmUpTime	Powering time of sensor(s) before measurement; larger interval is set when unit is powered from battery
	LowerRangeValue	The minimum level value of used sensor = 4 mA in selected level units
	UpperRangeValue	The maximum level value of used sensor = 20 mA in selected level units
	Offset	Level offset in selected level units, depends of sensor mounting position

Measurement Menu

Length

Establishes the unit of measure for the length

Display	*Length Unit*
ft	Feet
m	Meter
in.	Inch
cm	Centimeter
mm	Millimeter

DecimalPlaces – set of the decimal places of the Length values

Flow Rate

Establishes the unit of measure for the flow rate

Display	*Flow Unit*	*Display*	*Flow Unit*
L/s	Liters/Second	gal/s	Gallons/Sec.
L/min	Liters/Minute	gal/min	Gallons/Min.
L/h	Liters/Hour	gal/h	Gallons/Hour
m^3/s	Cubic Meters/Sec.	MG/d	MillionGallons/Day
m^3/min	Cubic Meters/Min.	IG/s	ImperialGallons/Sec.
m^3/h	Cubic Meters/Hour	IG/min	ImperialGallons/Min.
ft^3/s	Cubic Feet/Sec.	IG/h	ImperialGallons/Hour
ft^3/min	Cubic Feet/Min.	Bbl/min	Barrel/Min
ft^3/h	Cubic Feet/Hour.		

DecimalPlaces – set of the decimal places of the Flow Rate values

Volume

Display	*Volume Unit*	*Display*	*Volume Unit*
L	Liters	MG	MegaGallons
hL	HectoLiter	IG	Imperial Gallons
m^3	Cubic Meters	bbl	Barrel
Ft^3	Cubic Feet	Aft	Acre Feet
gal	US Gallons		

DecimalPlaces – set of the decimal places of the Volume values

Equation Selection

Q/h Table selection is possible only from the Flow Meter Tool software

Display	***Description***
Exponential Eq	Exponential Function Q = K h ^{exp}
Contract.Weir	Contracted Weir
Suppress.Weir	Suppressed Weir
CipolettiWeir	Cipoletti Weir
VNotchWeir30°	V Notch Weir 30°
VNotchWeir45°	V Notch Weir 45°
VNotchWeir60°	V Notch Weir 60°
VNotchWeir90°	V NotchWeir 90°
ManningRect.	Manning Rectangle Flume
ManningPipe	Manning Pipe
Pars.Flume1"	Parschall Flume 1"
Pars.Flume2"	Parschall Flume 2"
Pars.Flume3"	Parschall Flume 3"
Pars.Flume6"	Parschall Flume 6"
Pars.Flume9"	Parschall Flume 9"
Par.Flume12"	Parschall Flume 12"
Par.Flume18"	Parschall Flume 18"
Par.Flume24"	Parschall Flume 24"
Par.Flume36"	Parschall Flume 36"
Par.Flume48"	Parschall Flume 48"
Par.Flume60"	Parschall Flume 60"
Manh.Flume4"	Manhole Flume 4"
Manh.Flume6"	Manhole Flume 6"
Manh.Flume8"	Manhole Flume 8"
Manh.Flume10"	Manhole Flume 10"
Manh.Flume12"	Manhole Flume 12"

Equation Params

Exponent value in for equation (Q= K h exp)	Exponent
Coefficient value in for equation (Q= K h exp)	Coefficient
Measured profile width (Weirs, Manning equation)	Width
Rectangular profile slopes angle (Manning equation)	Angle
Measured pipe Radius (Manning equation)	Radius
Water Surface Slope (Manning equation)	WaterSurfaceSlope
Surface Roughness coefficient (Manning equation)	SurfaceRoughness
Maximum Water Level	MaximumWaterLevel
Flow Rate Upper Range Value	UpperRangeValue

Maximum Water Level /SetDefaultVal.
Set of the Maximum Water Level for the selected primary element – the value is possible to edit further.

Upper Range Value /Calculate
Is calculating the maximal Flow Rate value for Maximal Water Level - the value is possible to edit further – this parameter is used also for outputs (Upper Range Value=100% - full range)

Open Channel Calculation

Volumetric flow is calculated from actual water level. Actual water level is limited by the maximum water level.

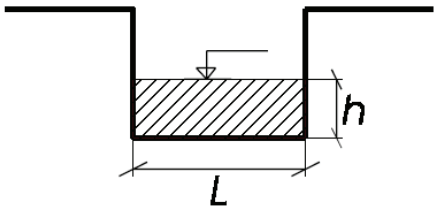
The Exponential Equation for general Parshall or Manhole flume: **$Q=K.Q^{exp}$**

Q – Volumetric flow [m^3/s]
K – Coefficient [$m^{(3-n)}/s$]
h – Water level [m]
exp – Exponent [-]

Predefined Flume	Equation [m^3/s, m]	Max. Water Level [m]
Parshall flume 1 in.	$Q = 0.0604 \cdot h^{1.55}$	0.230
Parshall flume 2 in.	$Q = 0.1207 \cdot h^{1.55}$	0.260
Parshall flume 3 in.	$Q = 0.1771 \cdot h^{1.55}$	0.667
Parshall flume 6 in.	$Q = 0.3810 \cdot h^{1.55}$	0.724
Parshall flume 9 in.	$Q = 0.5350 \cdot h^{1.55}$	0.876
Parshall flume 12 in.	$Q = 0.7050 \cdot h^{1.55}$	0.925
Parshall flume 18 in.	$Q = 1.0670 \cdot h^{1.55}$	0.925
Parshall flume 24 in.	$Q = 1.4290 \cdot h^{1.55}$	0.925
Parshall flume 36 in.	$Q = 2.1900 \cdot h^{1.57}$	0.925
Parshall flume 48 in.	$Q = 2.9600 \cdot h^{1.58}$	0.925
Parshall flume 60 in.	$Q = 3.7500 \cdot h^{1.59}$	0.925
Manhole flume 4 in.	$Q = 0.2343 \cdot h^{1.95}$	0.149
Manhole flume 6 in.	$Q = 0.3026 \cdot h^{1.95}$	0.227
Manhole flume 8 in.	$Q = 0.3424 \cdot h^{1.95}$	0.313
Manhole flume 10 in.	$Q = 0.3868 \cdot h^{1.95}$	0.396
Manhole flume 12 in.	$Q = 0.4345 \cdot h^{1.95}$	0.457

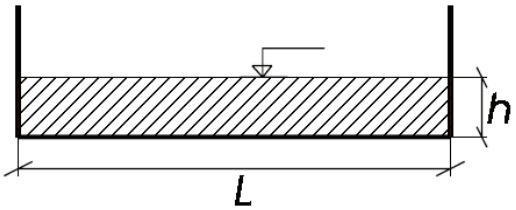
Contracted rectangular weir

Equation $Q = 1.84 \cdot (L - 0.2 \cdot h) \cdot h^{1.5}$
Q – Volumetric flow [m^3/s]
1.84 – Coefficient [$\sqrt{m}/s$]
L – Width [m]
h – Water level [m]



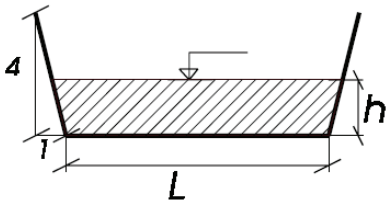
Suppressed rectangular weir

Equation $Q = 1.84 \cdot L \cdot h^{1.5}$
Q – Volumetric flow [m^3/s]
1.84 – Coefficient [$\sqrt{m}/s$]
L – Width [m]
h – Water level [m]



Cipoletti rectangular weir

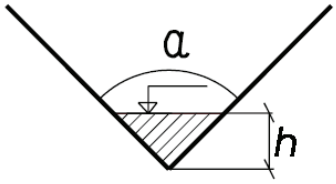
Equation $Q = 1.84 \cdot L \cdot h^{1.5}$
Q – Volumetric flow [m^3/s]
1.84 – Coefficient [$\sqrt{m}/s$]
L – Width [m]
h – Water level [m]



V-notch weir 30°

Equation $Q=\frac{8}{12}\sqrt{2 \cdot g} \cdot \tan\left(\frac{30^2}{2}\right) \cdot 0.586 \cdot (h + 0.0021)^{2.5}$

Q – Volumetric flow [m^3/s]
g – Standard gravity 9.80665 [m/s^2]
h – Water level [m]



V-notch weir 45°

Equation $Q=\frac{8}{12}\sqrt{2 \cdot g} \cdot \tan\left(\frac{45^2}{2}\right) \cdot 0.580 \cdot (h + 0.0015)^{2.5}$

Q – Volumetric flow [m^3/s]
g – Standard gavity 9.80665 [m/s^2]
h – Water level [m]

V-notch weir 60°

Equation $Q=\frac{8}{12}\sqrt{2 \cdot g} \cdot \tan\left(\frac{60^2}{2}\right) \cdot 0.577 \cdot (h + 0.0012)^{2.5}$

Q – Volumetric flow [m^3/s]
g – Standard gavity 9.80665 [m/s^2]
h – Water level [m]

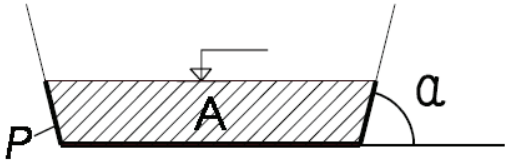
V-notch weir 90°

Equation $Q=\frac{8}{12}\sqrt{2 \cdot g} \cdot \tan\left(\frac{90^2}{2}\right) \cdot 0.578 \cdot (h + 0.0008)^{2.5}$

Q – Volumetric flow [m^3/s]
g – Standard gavity 9.80665 [m/s^2]
h – Water level [m]

Manning equation: $Q = 1/n\, R_h^{2/3}\, I^{1/2}\, A \qquad R_h = A/P$

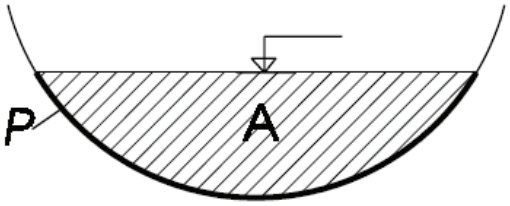
Manning rectangular



Equation $Q = \frac{1}{n}\left(\frac{h \cdot L + \frac{h^2}{tg\alpha}}{\frac{2 \cdot h}{\sin\alpha} + L}\right)^{2/3} \cdot \sqrt{I} \cdot h \cdot L + \left(\frac{h^2}{tg\alpha}\right)$

Q – Volumetric flow [m^3/s]
n – Gauckler-Manning coefficient [$s/\sqrt[3]{m}$]
L – Width [m]
h – Water level [m]
α – Angle [°]
I – Water surface slope [m/m]

Manning pipe



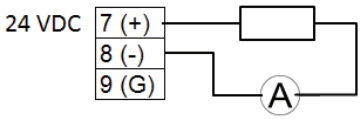
Equation $Q = \frac{1}{n}\left(\frac{(a - \sin\alpha) \cdot r}{2\alpha}\right)^{2/3} \cdot \sqrt{I} \cdot \left(\frac{(a - \sin\alpha) \cdot r^2}{2}\right)$ where

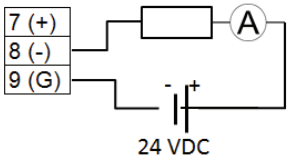
$$\alpha = \begin{cases} 2 \cdot \pi - 2 \cdot \arcsin\left(\sqrt{\frac{2 \cdot h \cdot r - h^2}{r}}\right) \mid h > r \\ 2 \cdot \arcsin\left(\sqrt{\frac{2 \cdot h \cdot r - h^2}{r}}\right) \mid h \le r \end{cases}$$

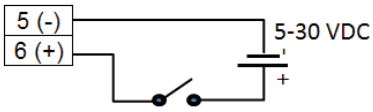
Q – Volumetric flow [m^3/s]
n – Gauckler-Manning coefficient [$s/\sqrt[3]{m}$]
L – Width [m]
h – Water level [m]
I – Water surface slope [m/m]

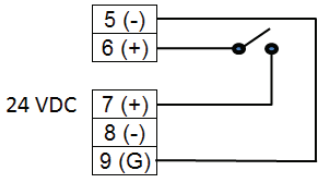
Material	n = $s/\sqrt[3]{m}$	**Material**	n = $s/\sqrt[3]{m}$	**Material**	n = $s/\sqrt[3]{m}$
Glass , PVC	0.010	Gravel, firm	0.023	Natural channels, poor	0.060
Cement, concrete, steel	0.011	Earth channel, gravelly	0.025	Floodplains, heavy brush	0.075
Brick	0.015	Earth channel, weedy	0.030	Floodplains, trees	0.150
Earth, smooth	0.018	Natural streams, clean	0.035		
Earth channel, clean	0.022	Floodplains, light brush	0.050		

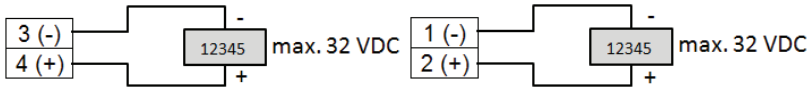
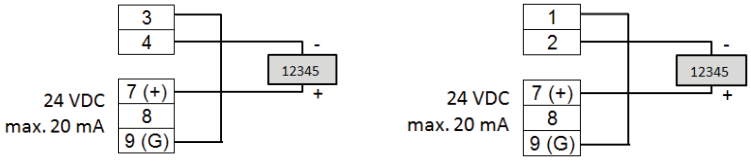
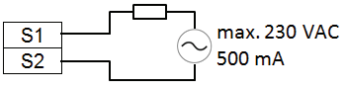
Input/Outputs Menu

<table>
<tr><td>Analog Output</td><td>Range
 </td><td>Establishes the range of the analog output signal: 0…100% (= full scale). The following current output ranges are available:
• 0…20 mA
• 4…20 mA
• 0…10 mA
Analog output active
 

Analog output passive
 

NOTE: If an error message displays, set the current according the programing of the Alarm Mode below. When you select bidirectional operation, you can signal the flow direction via digital outputs.</td></tr>
<tr><td></td><td>Alarm Mode
 </td><td>This parameter configures the behavior of the analog output during alarm conditions. The options are OFF, 3.5 mA and 23 mA.
• OFF: Analog signal is based on flow rate and always within the configured range.
• 3.5 mA: During alarm conditions, the analog signal is 3.5.
• 23 mA: During alarm conditions, the analog signal is 23 mA.
For example, if the analog range is 4…20 mA and the alarm mode is set to 23 mA, then during a full scale flow alarm condition, the analog output current will be 23 mA.</td></tr>
<tr><td></td><td>Compensation
 </td><td>Correction of the current value output.</td></tr>
<tr><td>Digital Input
 </td><td colspan="2">Digital input lets you reset totalizers (remote reset), interrupt flow measurement (PosZeroReturn) or ADE. Input switching is provided by applying an external potential of 5…30V DC
 

or by an internal voltage source of 24V DC (analog output if not used).
 
</td></tr>
</table>

Digital Outputs	You can configure functional operation of the 2 digital outputs. For example, you can select *Forward Pulse* for the digital output and define the pulses per totalizer unit via pulse scale.	
	Digital Outputs 1 and 2	The two outputs can be operated as open collector passively or actively. Passive output  Active output (if analog output is not used) 
	Solid-State Relay	The solid-state relay is functionally linked with *Output 2*. See *"Out 1 / 2 Function"* below. 

<table>
<tr><td rowspan="8">Digital Outputs</td><td>Pulse Width</td><td>This parameter establishes the ON duration of the transmitted pulse. The configurable range is from 0…2000 ms. If 0 ms is configured, pulse width is automatically adapted depending on pulse frequency (pulse/pause ratio 1:1).
During the configuration the program checks if pulses/unit and pulse width are in accordance with full scale defined. If not, an error alarm displays and scale, pulse width or full scale need to be adapted.</td></tr>
<tr><td>Pulse/Unit</td><td>The Pulses/Unit parameter lets you set how many pulses per unit of measure to transmit. The maximum output frequency of 10,000 pulses/sec. (10 kHZ) must not be exceeded.</td></tr>
<tr><td>Out 1 /2 Function</td><td>The following functions can be selected for the Output 1, Output 2 and the Solid-State Relay. The Solid-State Relay function is linked functionally with Output 2.
<table>
<tr><th>Function</th><th>Out1</th><th>Out2 / Solid-State Relay</th></tr>
<tr><td>Off</td><td>X</td><td>X</td></tr>
<tr><td>Forward pulse</td><td>X</td><td>X</td></tr>
<tr><td>Min/Max Alarm</td><td>X</td><td>X</td></tr>
<tr><td>Error alarm</td><td>X</td><td>X</td></tr>
<tr><td>Pump Control</td><td>X</td><td>X</td></tr>
<tr><td>Test</td><td>X</td><td>X</td></tr>
<tr><td>ADE</td><td>X</td><td></td></tr>
</table>

OFF: Digital output is switched off.
Forward pulse: Generates pulses during forward flow conditions.
Min/Max Alarm: Indicates when flow rate exceeds thresholds defined by Set Min. or Set Max. in % of full scale. See “Figure 3: Tank volume or open-channel flow rate” on page 23.
Error alarm: Indicates when the meter has error an condition.
Pump Control: Starts or stops the pump. See “Figure 3: Tank volume or open-channel flow rate” on page 23.
Test: Used only for the Verification Device.
ADE: Used for BEACON and AquaCUE connectivity.
</td></tr>
<tr><td>Output 1 /2 Type</td><td>The output type parameter lets you set the output switch to “normally closed“ or “normally open“.</td></tr>
<tr><td>Output 1 /2 Set Min</td><td>The flow Min Set Point establishes, as a percentage of full scale flow, the minimum threshold at which the output alarm activates. Select thresholds in 1% steps. Flow rates below or above the threshold activate the output alarm.</td></tr>
<tr><td>Output 1 /2 Set Max</td><td>The Flow Max Set Point establishes, as a percentage of full scale flow, the maximum threshold at which the output alarm activates. Select thresholds in 1% steps. Flow rates below or above the threshold activate the output alarm.</td></tr>
<tr><td>Flow Simulation</td><td colspan="2">Flow Simulation provides analog and digital output simulation based on a percentage of the full scale flow in cases where no real flow is occurring. The range of simulation includes 0…100% in steps of 10% of the full scale flow. This function remains active when you exit the menu. You must set it to Off to deactivate it. If the simulation is still active, a character “S” displays in the Measuring mode.</td></tr>
</table>

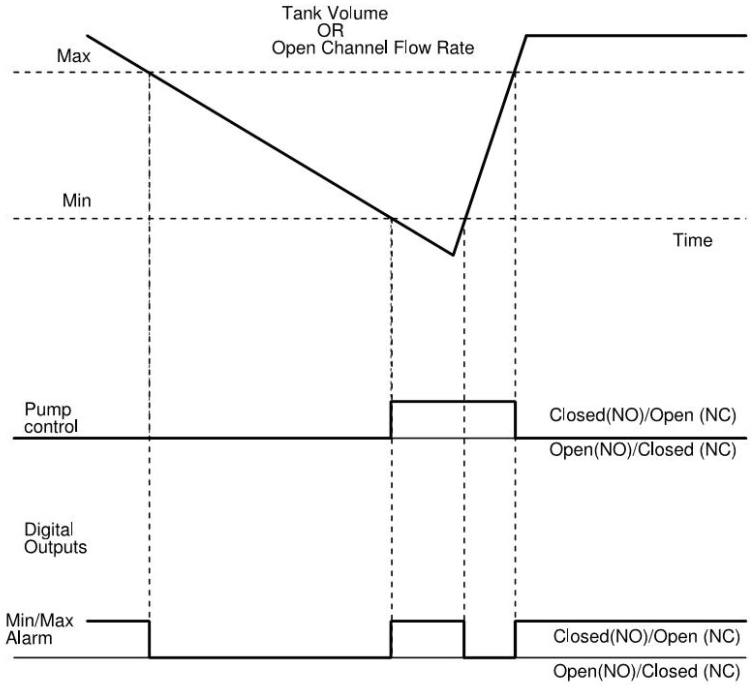
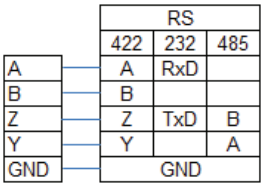
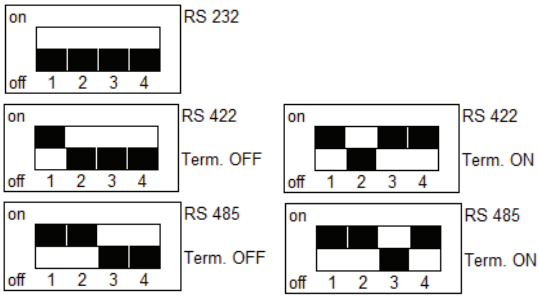


Figure 3: Tank volume or open-channel flow rate

Clear Total

Total	Resets the totalizer within the *ClearTot* item on the Flow Meter Tool software.

Communications Menu

Interfaces	Modbus® RTU	RS232, RS485 and RS422 with Modbus RTU.  Mode can be configured by DIP switches also if termination ON or OFF. 
Modbus	Address	Address available from 1…247
	RS232, RS422, RS485	Baudrate: 1200, 2400, 4800, 9600, 19200, 38400 Bd Parity: Even, Odd, Mark, Received Packets, Sent Packets
Ethernet	Modbus TCP/IP with MEAP-Header	
	IP Address	IPv4 address default 192.168.1.60
	IP Mask	IPv4 subnetting reference default 255.255.255.0
	IP Gateway	Gateway address default 192.168.1.1
	MAC Address	Media-Access-Control-Address
ADE	Control	ON or OFF
	Protocol	1 or 2
	Dial	4…9
	Resolution	0.001 / 0.01 / 0.1 / 1 / 10 / 100 / 1000 / 10,000

Miscellaneous

Power up	The number of times that the unit has been powered on.
Language	The unit supports these languages: English, German, Czech, Spanish, French, Russian
Date	Set the system date in the format [DD.MM.YY]; used for data logging.
Time	Set the system time in the format [HH.MM.SS]; used for data logging.
Contrast	The contrast of the display can be adjusted between 14 (low) and 49 (high).
Datalog Period	The data logging period can be adjusted to every 10 min / 20 min / 30 min / 1 h / 24 h. There is a 2 MB memory with about 130,000 data records for data logging available. The logging capacities (uni-directional mode) and durations are: 10 min up to 2.50 years 20 min up to 5 years 30 min up to 7.5 years 1 h up to 15 years 24 h up to 260 years The logging information can be downloaded by a PC program Flow Meter Tool.

Info Menu

Serial Number	Serial number of the electronic board.
Version	Software version of the device.
Compilation Date	Date of the software version.
Otp CRC	Checksum of software update
Application CRC	Checksum of application

PIN Menu

The menus and parameters can be secured via three password levels. See *"Setting a PIN" on page 13*.

- Administrator PIN
- Service PIN
- User PIN

The password protection is a 6-digit PIN [000000] and is deactivated at the factory.

The first time you use the unit, activate the password protection *Control* = *On* and enter login with the password 000000.

Then go back to the PIN again and enter [User], [Service] and [Admin] password.

Once the password protection has been activated, enter your PIN under *Login* and the *lock open* symbol appears.

The PIN grants you access to Administrator, Service or User levels with the respective access rights. You can now move to the menu and enter parameters.

Without a login, you can read all parameters, but cannot change them.

Control	Activate and deactivate the PIN
User	User logged in with this PIN can access all User levels, but do not have access to Service or Admin functions.
Service	User logged in with this PIN will have access to both service and user-level procedures. User at this level will not have access to administrative functions.
Admin	User logged in with this PIN will have access to both service and user-level procedures.
Random Number	In case of losing PIN read the random number. This number has to be sent to Badger Meter support, which is able to generate the Emergency PIN. Between reading random number and entering received emergency PIN, do no try to play with emergency PIN and do not restart the meter.
Emergency PIN	In case of losing PIN read the random number. This number has to be sent to Badger Meter support, which is able to generate the emergency PIN. Between reading random number and entering received emergency PIN, do no try to play with emergency PIN and do not restart the meter.

Login Menu

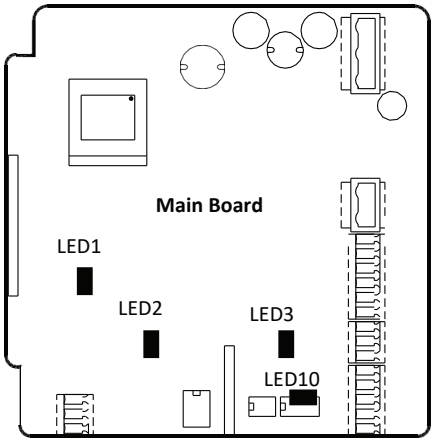
Login	Once the password protection has been activated, enter your PIN.

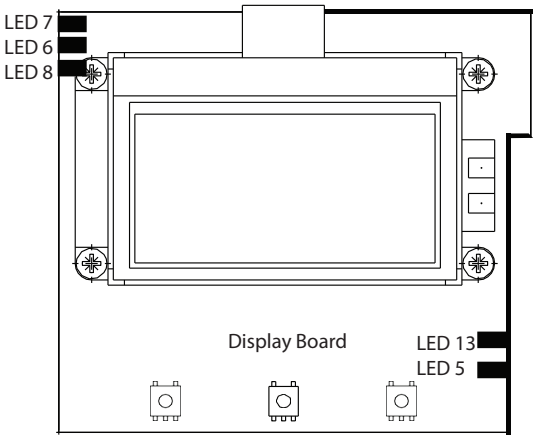
TROUBLESHOOTING

The following error messages may display:

Description	Possible Cause	Recommended Action
Pulse Output	Pulse rate exceeds the maximum	Reduce pulse scale (pulse/unit) and/or reduce pulse width configuration
EEPROM	Configuration file is missing	Contact support
Configuration	Configuration file is corrupted	Contact support
Low Battery	Low backup battery (memory)	Contact support
Measure Timeout	Measurement was not completed within specific time	Contact support

Control LED





The following LEDs on the board control the operation of the device:

LED1 No function attached
LED3 Communication – transmit (On = active)
LED5 Flash memory activity (DISK)
LED6 Digital output #1 (On = active)
LED7 Digital output #2 (On = active)
LED8 No function attached
LED10 Power ON (On = active)
LED13 USB, HOST mode (On = active)

Replace Meter's Electronics

⚠ WARNING

DISCONNECT AUXILIARY POWER BEFORE OPENING THE BODY COVER.

1. Pull out all the plugs.
2. Loosen screws S1-S4 and take out circuit board.
3. Insert the new circuit board and attach it by fastening the screws S1-S4.
4. Plug in all plugs.
5. If necessary, configure the new board.

SPECIFICATIONS

Type	iSonic 4000					
Auxiliary power	92…275V AC (50/60 Hz), < 14 VA optional 9…36V DC, < 4 W					
Analog output	4…20 mA, 0…20 mA, 0…10 mA ≤ 800 Ohm, active or passive; Assigned parameter depends on flow meter mode					
Level sensor input	4…20 mA from level sensor					
Digital outputs	2 open collectors; passive: max. 32V DC, 0…100 Hz 100 mA, 100…10.000 Hz 20 mA; active: 24V DC, max 20 mA; Select active pulse, min/max alarm, error messages or pump control					
	Solid-state relay (n.o./n.c.) max 230V AC, 500 mA, 1 Hz; Function is linked with open collector output 2					
Digital input	5…30V DC; totalizer reset, positive return zero, BEACON/AquaCUE connectivity					
Programming port	Mini USB, IP67					
Configuration	3 front-panel mounted push-buttons					
Communication	RS485 Modbus RTU, Modbus TCP/IP Ethernet, BEACON/AquaCUE connectivity					
Pulse length	Configurable up to 2000 msec					
Datalogger	2 MB capacity with 130,000 logged lines: date, level, flow rate, tank volume					
Display	Graphical LCD 64 × 128, backlight, actual flow rate, totalizers, status display					
Body	Die cast powder-coated aluminium, protection class IP67					
Cable inlet	Supply and signal cables 2 × M20; cable glands included					
Signal cable	From meter M20; cable gland included					
Ambient temperature	-20…60° C					
Sensors	**Measuring range**	**Offset**	**Beam width**	**Material**	**Accuracy**	**Deadband**
	4. 92 in. (0…1250 mm)	2 in. (50 mm)	2 in. (50 mm)	PVDF	0.125 in. (3 mm)	2 in. (50 mm)
Security	Three level password					
Languages	English, Spanish, French, German, Italian, Czech, Russian					
Channel selection	Contracted rectangular weir, suppressed rectangular weir, Cipoletti weir; V-notch weir (30°, 45°, 60°, 90°); Parshall flume (1, 2, 3, 6, 9, 12, 18, 24, 36, 48 and 60 in.); Manhole flume (4, 6, 8, 10 and 12 in.); table entry, exponential equation, Manning rectangle flume, Manning pipe					

DIMENSIONS

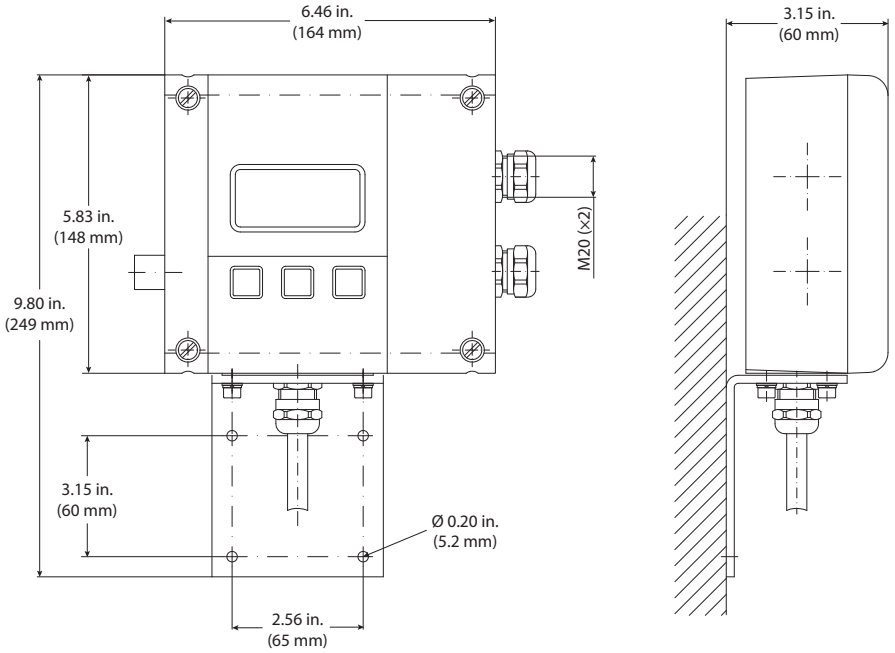


Figure 4: iSonic 4000 flow computer

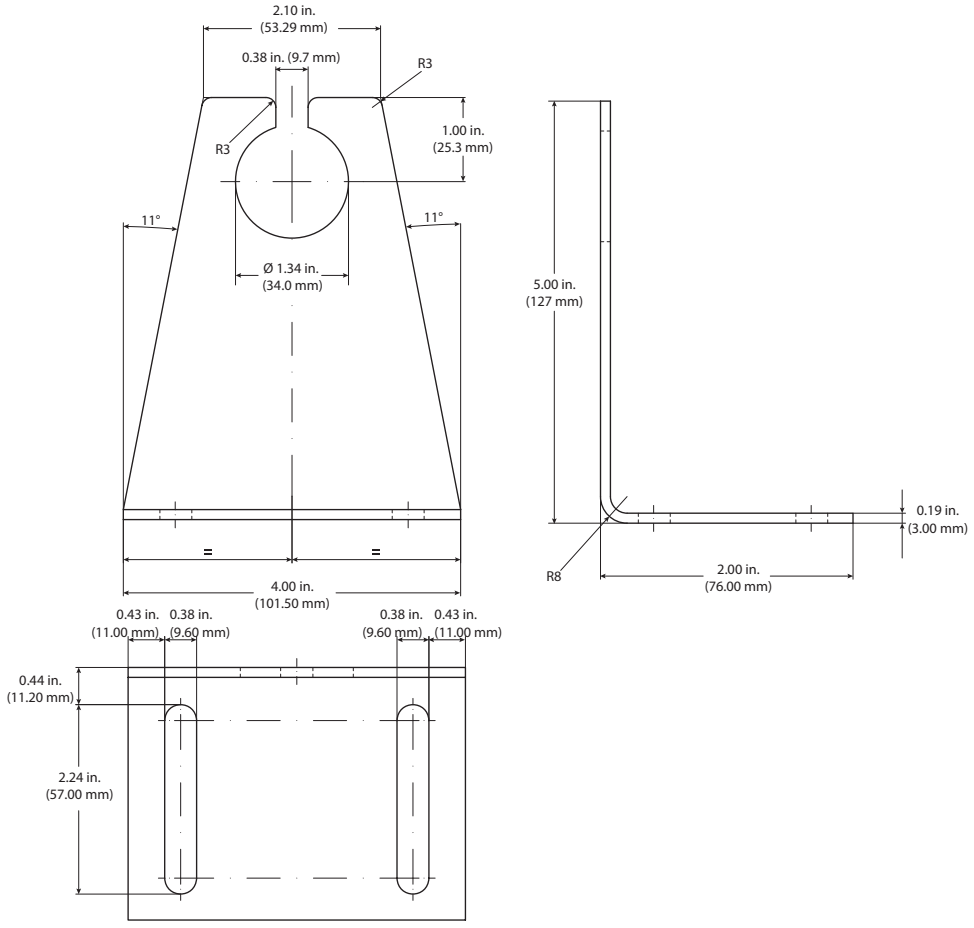


Figure 5: Sensor bracket

MAIN MENU PROGRAM STRUCTURE

Meter Setup

Application	Tank
	Open Channel
Sensor	Interval
	Warm Up Time
	Lower Range Value
	Upper Range Value
	Offset

Measurements

Length	Unit	ft
		m
		in
		cm
		mm
	Decimal Places	
Flow Rate	Unit	L/s
		L/min
		L/h
		m^3/s
		m^3/min
		m^3/h
		ft^3/s
		ft^3/min
		ft^3/h
		gal/s
		gal/min
		gal/h
		MG/D
		IG/s
		IG/min
		IG/h
		bbl/min
	Decimal Places	
Volume	Unit	L
		hL
		m^3
		ft^3
		gal
		MG
		IG
		bbl
		Aft
	Decimal Places	

Measurements (continued)

Equation Selection	Table	
	Exponential Eq	
	Contract. Weir	
	Suppress. Weir	
	Cipoletti Weir	
	V NotchWeir30°	
	V NotchWeir45°	
	V NotchWeir60°	
	V NotchWeir90°	
	Manning Rect.	
	Manning Pipe	
	Pars. Flume 1"	
	Pars. Flume 2"	
	Pars. Flume 3"	
	Pars. Flume 6"	
	Pars. Flume 9"	
	Par. Flume 12"	
	Par. Flume 18"	
	Par. Flume 24"	
	Par. Flume 36"	
	Par. Flume 48"	
	Par. Flume 60"	
	Manh. Flume 4"	
	Manh. Flume 6"	
	Manh. Flume 8"	
	Manh. Flume 10"	
	Manh. Flume 12"	
Equation Params	Exponent	
	Coefficient	
	Width	
	Angle	
	Radius	
	Water Surface Slope	
	Surface Roughness	
	Max. Water Level	SetDefaultVal.
		Exit
	Max. Water Level	
	Upper Range Value	Calculate
		Exit

Inputs/Outputs

Analog Output	Select Range	4…20 mA
		0…20 mA
		0…10 mA
	Alarm Mode	Off
		23 mA
		3.5 mA
	Compensation	
Digital Input	Off	
	Remote Reset	
	Pos Zero Reset	
	ADE	
Digital Output	Pulse Width	
	Pulse/Unit	
	Out 1 function	Off
		Forward Pulses
		Min/Max Alarm
		Error Alarm
		Test
		Pump Control
		ADE
	Out 1 Type	Normally Open
		Normally Close
	Out 1 Set Min	
	Out 1 Set Max	
	Out 2 Function	Off
		Forward Pulses
		Min/Max Alarm
		Error Alarm
		Test
		Pump Control
	Out 2 Type	Normally Open
		Normally Close
	Out 2 Set Min	
	Out 1 Set Min	
Simulation	Off	
	+100.0%	
	+90%	
	+80%	
	+70%	
	+60%	
	+50%	
	+40%	
	+30%	
	+20%	
	+10%	
	0.0%	

Total

Total	Clear Tot
	Exit

Communications

Modbus	MODBUS Address		
	RS-232/422/485	Baud Rate	1200
			2400
			4800
			9600
			19200
			38400
			115200
		Parity	Even
			Odd
Ethernet	Received Packets		
	Sent Packets		
	IP Address		
	IP Gateway		
	MAC Address		
ADE	Control	On	
		Off	
	Protocol	1	
		2	
	Dial	4…9	
	Resolution	0.0001…10000	

Miscellaneous

Power up			
Language	English	Español	Italiano
	Deutsch	Français	Türkçe
	Český	Русский	Polski
Date [DDMMYY]			
Time [HHMMSS]			
EEPROM	Format		
	Exit		
Contrast			
Datalog Period	10 min		
	20 min		
	30 min		
	1 h		
	24 h		

Info

Serial Number
Version
Compilat. Date
Otp CRC
Applicat. CRC

Pin

Control
User
Service
Admin
Random Number
Emergency PIN

Login

Login

FLOW METER MODBUS® REGISTER TABLE

Address	Registers	Rights	Name	iSonic
0x0000	U16	Read only	PRODUCT_CODE	7: iSonic
0x0001	8	Read only	PRODUCT_NAME	“iSonic 4000”
0x0009	16	Read only	FW_NAME	"iSonic_A_STM32F107RC"
0x0019	10	Read only	APP_VERSION	Version
0x0023	16	Read only	COMPILATION_DATE	Date of compilation
0x0033	16	Read only	COMPILATION_TIME	Time of compilation
0x0043	5	Factory	IDENTIFICATION_NUMBER	Unique number
0x0048	3	Read only	OTP_BOOT_CHECKSUM	Checksum
0x004B	3	Read only	FLASH_OS_CHECKSUM	Checksum
0x0081	U16	User	POWER_LINE_FREQUENCY	0: 50 Hz 1: 60 Hz
0x0095	U16	Service	ANALOG_OUTPUT_RANGE	1: 4…20 mA 2: 0…20 mA 3: 0…10 mA
0x00A1	U16	Service	OUT1_LOW	Digital Output setting
0x00A2	U16	Service	OUT1_HIGH	Digital Output setting
0x00A3	U16	Service	OUT1_MODE	0 normally open 1 normally closed
0x00A4	U16	Service	OUT1_OPERATION	0: Off 1: Comparator 3: Error alarm 4: Forward 10: Test 14: Pump
0x00AE	U16	Service	OUT2_LOW	Digital Output setting
0x00AF	U16	Service	OUT2_HIGH	Digital Output setting
0x00B0	U16	Service	OUT2_MODE	0 normally open 1 normally closed
0x00B1	U16	Service	OUT2_OPERATION	0 Off 1 Min/Max Alarm 3 Error alarm 4 Forward pulses 10 Test 14 Pump control
0x0114	U16	User	LANGUAGE	0 English 1 German 2 Czech 3 Spanish 4 French 5 Russian 6 Italian 7 Turkish
0x0115	Float	Read only	MEASURE	Dry calibration
0x0119	U16	Read only	MEASURE_COUNTER	Dry calibration

Address	Registers	Rights	Name	iSonic
0x0125	U16	Admin	COMMAND	1: save configuration 2: restore configuration 6: save totalizers 7: clear totalizers 8: clear totalizers 14: current loop calibration point A 15: current loop calibration point B 16: current loop calibration complete 22: default save 23: remote reset 24: default restore 26: make file system 34: press key up 35: press key right 36: press key save exit 38: print screen 41: open channel – calculate upper range 42: open channel – use default water level
0x0126	Float	Factory	CURRENTLOOP_POINTA	Dry calibration
0x0128	Float	Factory	CURRENTLOOP_POINTB	Dry calibration
0x012A	U16	Service	SIMULATION	Not stored in non-volatile memory 0: 0.0% 10: + 10.0% 20: + 20.0% 30: + 30.0% 40: + 40.0% 50: + 50.0% 60: + 60.0% 70: + 70.0% 80: + 80.0% 90: + 90.0% 100: +100.0% 65408: Off 65436: -100.0% 65446: - 90.0% 65456: - 80.0% 65466: - 70.0% 65476: - 60.0% 65486: - 50.0% 65496: - 40.0% 65506: - 30.0% 65516: - 20.0% 65526: - 10.0%
0x012B	U32	Read only	RANDOM	Security
0x012E	U16	Service	ALARM_MODE_OF_ ANALOG_OUTPUT	0: none 3: 23 mA 4: 3.5 mA
0x012F	U32	Write only	REMOTE_LOGIN	Security
0x0202	Float	Service	PULSE_PULSES_PER_M3	Digital Output setting
0x0204	U16	Service	PULSE_WIDTH	Digital Output setting
0x0205	U16	Service	OUT_LOW	OBSOLETE

Address	Registers	Rights	Name	iSonic
0x0206	U16	Service	OUT_HIGH	OBSOLETE
0x0226	6	Service	DATETIME	Date & Time
0x0232	U16	Read only	FAULT	Bit0: Low Battery Bit1: Measure Timeout Bit2: Table Error Bit6: Flow Overload Warning Bit7: Disk Error Bit8: Configuration Error Bit9: Pulse Overload Warning Bit10: Sensor Disconnected Error Bit11: Sensor Shorted Error
0x0233	8	Read only	PORT	Debug information
0x023D	U16	Admin	PASSWORD_CONTROL	Security
0x023E	4	User	PASSWORD_SET_USER	Security
0x0242	4	Service	PASSWORD_SET_SERVICE	Security
0x0246	4	Admin	PASSWORD_SET_ADMIN	Security
0x025B	U64	Read only	FS_TOT	Internal Disk Size [byte]
0x025F	U64	Read only	FS_FRE	Internal Disk Free Space [byte]
0x0263	U16	Service	DATALOGGER_PERIOD	10: 10 min 20: 20 min 30: 30 min 61: 1 hour 84: 24 hour
0x0267	U16	Service	MEDIAN	Filter setting
0x0268	U16	Service	MOVING_AVERAGE	Filter setting
0x0279	Float	Read only	ANALOG_OUTPUT_K	Dry calibration
0x0281	Float	Read only	ANALOG_OUTPUT_Q	Dry calibration
0x02B3	Float	Service	ANALOG_OUTPUT_ COMPENSATION	Analog Output Compensation
0x02E3	U32	Read only	POWER_UP_COUNTER	Power up counter
0x0300	U16	Admin	DATAPROCESSING_TANK_ OPENCHANNEL	0 Tank 1 Open Channel
0x0301	U16	User	UNITCODES_LENGTH	44 Feet 45 Meters 47 Inches 48 Centimeters 49 Millimeters
0x0302	U16	User	UNITCODES_ VOLUMETRICFLOW	15 Cubic Feet Per Minute 16 Gallons Per Minute 17 Liters Per Minute 18 Imperial Gallons Per Minute 19 Cubic Meter Per Hour 22 Gallons Per Second 23 Million Gallons Per Day 24 Liters Per Second 26 Cubic Feet Per Second 28 Cubic Meters Per Second 30 Imperial Gallons Per Hour 130 Cubic Feet Per Hour 131 Cubic Meters Per Minute 133 Barrels Per Minute 136 Gallons Per Hour 137 Imperial Gallons Per Second 138 Liters Per Hour

Address	Registers	Rights	Name	iSonic
0x0303	U16	User	UNITCODES_VOLUME	40 Gallons 41 Liters 42 Imperial Gallons 43 Cubic Meters 46 Barrels 112 Cubic Feet 236 Hectoliters 240 Mega Gallons 241 Acre Feet
0x0304	U16	User	DECIMALPLACES_LENGTH	Number of decimal places of length
0x0305	U16	User	DECIMALPLACES_ VOLUMETRICFLOW	Number of decimal places of volumetric flow
0x0306	U16	User	DECIMALPLACES_VOLUME	Number of decimal places of volume
0x0307	U16	Admin	OPENCHANNEL_EQUATION	0: Open Channel Table 3: Contracted Rectangular Weir 4: Suppressed Rectangular Weir 5: Cipoletti Weir 7: Manning Equation Rectangular Channel 8: Manning Equation Pipe 9: V Notch Weir 30° 10: V Notch Weir 45° 11: V Notch Weir 60° 12: V Notch Weir 90° 13: Parshall Flume 1" 14: Parshall Flume 2" 15: Parshall Flume 3" 16: Parshall Flume 6" 17: Parshall Flume 9" 18: Parshall Flume 12" 19: Parshall Flume 18" 20: Parshall Flume 24" 21: Parshall Flume 36" 22: Parshall Flume 48" 23: Parshall Flume 60" 24: Manhole Flume 4" 25: Manhole Flume 6" 26: Manhole Flume 8" 27: Manhole Flume 10" 28: Manhole Flume 12" 29: Exponential Equation
0x0308	Float	Admin	SENSOR_ UPPERRANGEVALUE	Sensor description [m]
0x030A	Float	Admin	SENSOR_ LOWERRANGEVALUE	Sensor description [m]
0x030C	Float	Factory	SENSOR_ DIVISIONTOCURRENT_K	Dry calibration
0x030E	Float	Factory	SENSOR_ DIVISIONTOCURRENT_Q	Dry calibration
0x0310	Float	Read only	SENSOR_WATERLEVEL	Actual water level
0x0312	Float	Read only	DATAPROCESSING_ OPENCHANNELFLOW	Actual volumetric flow
0x0314	Float	Read only	DATAPROCESSING_TANKVOLUME	Actual tank volume
0x0316	Float	Read only	TOTALIZER	Totalizer
0x0318	Float	Read only	SENSOR_CURRENT	Sensor actual current
0x031A	Float	Service	OPENCHANNEL_ UPPERRANGEVALUE	Open channel description
0x031C	Float	Service	TANK_ UPPERRANGEVALUE	Tank description
0x031E	U16	Service	MEASURE_WARMUPTIME	Sensor setting
0x031F	U16	Service	MEASURE_INTERVAL	Sensor setting

Address	Registers	Rights	Name	iSonic
0x0320	16	User	DESIGNATION_CURRENT	UTF-8 Designation of sensor current
0x0330	16	User	DESIGNATION_ WATERLEVEL	UTF-8 Designation of water level
0x0340	16	User	DESIGNATION_FLOW	UTF-8 Designation of flow
0x0350	16	User	DESIGNATION_VOLUME	UTF-8 Designation of volume
0x0360	32	User	DESIGNATION_TAG	UTF-8 Designation of device
0x0380	Float	Service	SENSOR_ WATERLEVELOFFSET	Offset
0x0388	Float	Admin	SENSOR_ UPPERRANGEVALUE_ ACTUALUNIT	Sensor description
0x038A	Float	Admin	SENSOR_ LOWERRANGEVALUE_ ACTUALUNIT	Sensor description
0x0390	Float	Read only	SENSOR_WATERLEVEL_ ACTUALUNIT	Actual water level
0x0392	Float	Read only	DATAPROCESSING_ OPENCHANNELFLOW_ ACTUALUNIT	Actual volumetric flow
0x0394	Float	Read only	DATAPROCESSING_ TANKVOLUME_ACTUALUNIT	Actual tank volume
0x0396	Float	Read only	TOTALIZER_ACTUALUNIT	Totalizer
0x0398	Float	Service	SENSOR_ WATERLEVELOFFSET_ ACTUALUNIT	Offset
0x039A	Float	Service	OPENCHANNEL_ UPPERRANGEVALUE_ ACTUALUNIT	Open channel description
0x039C	Float	Service	TANK_U PPERRANGEVALUE_ ACTUALUNIT	Tank description
0x0400	Float	Admin	OPENCHANNEL_ EXPONENT	Open channel calibration
0x0402	Float	Admin	OPENCHANNEL_ COEFFICIENT	Open channel calibration
0x0404	Float	Admin	OPENCHANNEL_WIDTH	Open channel calibration
0x0406	Float	Admin	OPENCHANNEL_ANGLE	Open channel calibration
0x040C	Float	Admin	OPENCHANNEL_RADIUS	Open channel calibration
0x040E	Float	Admin	OPENCHANNEL_ WATERSURFACESLOPE	Open channel calibration
0x0410	Float	Admin	OPENCHANNEL_ SURFACEROUGHNESS	Open channel calibration
0x0412	Float	Admin	OPENCHANNEL_ WATERLEVELMAXIMUM	Open channel calibration
0x0414	Float	Admin	OPENCHANNEL_ COEFFICIENT_ACTUALUNIT	Open channel calibration
0x0416	Float	Admin	OPENCHANNEL_ WIDTH_ACTUALUNIT	Open channel calibration
0x0418	Float	Admin	OPENCHANNEL_ RADIUS_ACTUALUNIT	Open channel calibration
0x041A	Float	Admin	OPENCHANNEL_ WATERLEVELMAXIMUM_ ACTUALUNIT	Open channel calibration
0x041C	Float	Admin	OPENCHANNEL_ SURFACEROUGHNESS_ ACTUALUNIT	Open channel calibration

iSonic 4000 Flow Meter Conversion Table

Address	Registers	Rights	Read	Write	Name	Note
0x0500	Float, Float	Admin	Yes	Yes	Conversion Table Point 0	Water Level [m], Volume [m^3] or Flow[m^3/s]
…					…	
0x08FC	Float, Float	Admin	Yes	Yes	Conversion Table Point 255	—

Points in conversion table have to be sorted in ascending order (higher address higher water level value).

Table can be shorter. First unused point has to contain NAN value.

Rights

1 User

2 Service

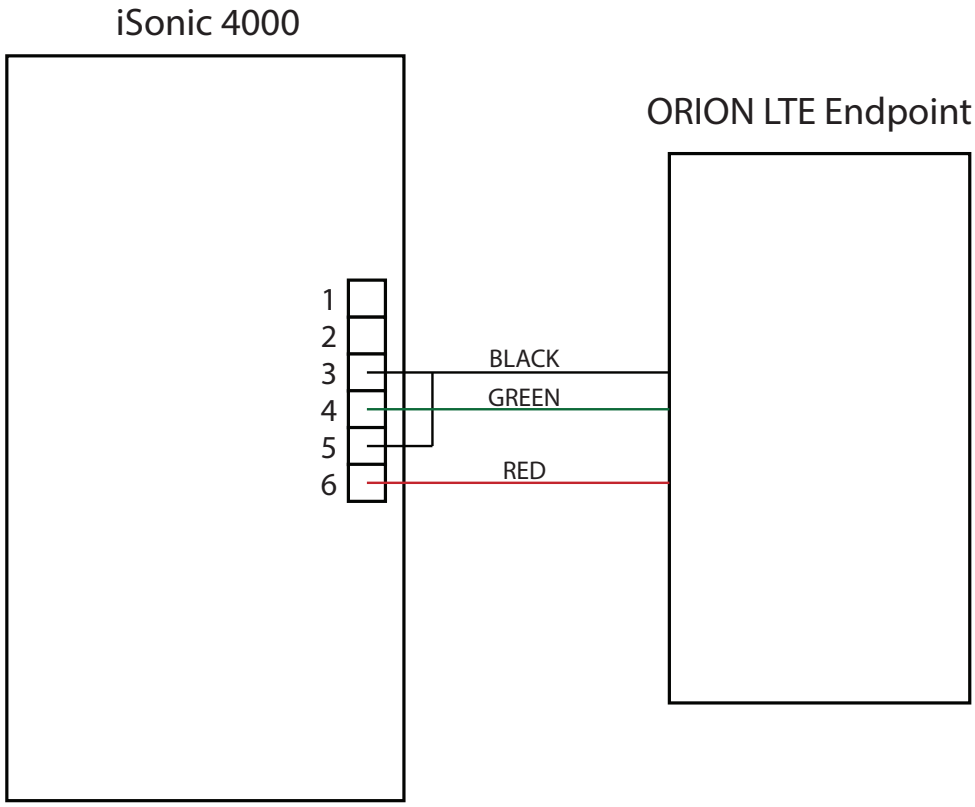
3 Admin

4 Factory

WIRING THE ISONIC 4000 METER TO AN ORION® CELLULAR LTE ENDPOINT

1. Connect the RED Encoder Clock signal wire from the endpoint to the Digital Input on the iSonic 4000.
2. Connect the GREEN Encoder Data signal wire from the endpoint to the Digital Output 1 positive signal on the iSonic 4000.
3. Connect the BLACK Encoder Ground signal wire from the endpoint to the Digital Output 1 negative signal on the iSonic 4000.
4. Jumper the iSonic 4000 Digital Output 1 negative signal to the Digital Input negative signal.

For detail information on installing and activating ORION Cellular LTE endpoints, see the *"ORION Water Endpoints User Manual"*, available on our website at *www.badgermeter.com*.



Control. Manage. Optimize.

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Survey Monuments

BRASS MARKERS

SURV-KAP offers a full line of brass survey markers for concrete. These survey markers are ideal for a wide variety of applications including highways, streets, cemeteries, landmarks and golf courses.

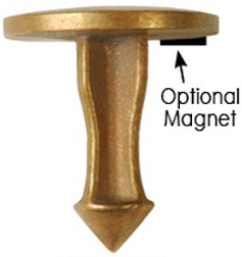
Brass survey markers for concrete are brass castings made to our design at our foundry. Many SURV-KAP brass survey markers for concrete are available in either flat or dome top.

Consecutive numbering is available on brass monument caps and survey markers. Magnets are also available as an option.

Pre-stamping is available on most SURV-KAP survey markers for concrete with flat tops. SURV-KAP survey markers can also be ordered without pre-stamping and can be hand-stamped in the field or in your office. There is no charge for pre-stamping if you order 25 or more survey markers with identical stamping.

Lettering patterns for brass survey markers with domed tops are part of the casting process. Please contact our Customer Service Team directly for pricing and lead times on your requirements for custom lettering on domed parts.

M/M-B2



M/M-3¼CBD

Model No.	Description	1-100	101-499	500+
M/M-B1 1/2	1-1/2" Flat Brass Monument Marker (Blank)	$ 14.55	$ 14.41	$ 14.26
M/M-B1 1/2S	1-1/2" Flat Brass Monument Marker (Stamped)	$ 19.59	$ 19.41	$ 19.22
M/M-B2	2" Flat Brass Monument Marker (Blank)	$ 12.45	$ 12.34	$ 12.21
M/M-B2S	2" Flat Brass Monument Marker (Stamped)	$ 16.77	$ 16.62	$ 16.45
M/M-B2D	2" Dome Brass Monument Marker (Blank)	$ 14.46	$ 14.33	$ 14.18
M/M-BCS-2 1/2F	2 1/2" Flat Brass M/M/Cast Corrugated Stem	$ 26.67	$ 26.41	$ 26.15
M/M-BCS-2 1/2FS	2 1/2" Flat Brass M/M/Cast Corrugated Stem (Stamped)	$ 30.86	$ 30.56	$ 30.26
M/M-BCS-2 1/2D	2 1/2" Dome Brass M/M/Cast Corrugated Stem	$ 27.62	$ 27.35	$ 27.08
M/M-B278F	2 7/8" Flat Brass M/M/Cast Corrugated Stem	$ 23.86	$ 23.62	$ 23.39
M/M-B278D	2 7/8" Dome Brass M/M/Cast Corrugated Stem	$ 23.86	$ 23.62	$ 23.39
M/M-BCS-3F	3" Flat Brass M/M/Cast Corrugated Stem	$ 26.67	$ 26.41	$ 26.15
M/M-BCS-3D	3" Dome Brass M/M/Cast Corrugated Stem	$ 30.43	$ 30.13	$ 29.84
M/M-B3F	3" Flat Brass M/M (or Inside 3/4" Pipe) Hex Stem	$ 29.02	$ 28.74	$ 28.46
M/M-B3D	3" Dome Brass M/M (or Inside 3/4" Pipe) Hex Stem	$ 29.02	$ 28.74	$ 28.46
M/M-BCS-3 1/4F	3 1/4" Flat Brass M/M/Cast Corrugated Stem	$ 26.67	$ 26.41	$ 26.15
M/M-BCS-3 1/4FS	3 1/4" Flat Brass M/M/Cast Corrugated Stem (Stamped)	$ 32.06	$ 31.75	$ 31.43
M/M-BCS-3 1/4D	3 1/4" Dome Brass M/M/Cast Corrugated Stem	$ 30.43	$ 30.13	$ 29.84
M/M-3 1/4CBF	3 1/4" Flat Brass M/M/Cast	$ 37.94	$ 37.57	$ 37.20
M/M-3 1/4CBD	3 1/4" Dome Brass M/M/Cast	$ 37.94	$ 37.57	$ 37.20
M/M-B3 1/4F	3 1/4" Flat Brass M/M (or Inside 3/4" Pipe) Hex Stem	$ 29.02	$ 28.74	$ 28.46
M/M-B3 1/4D	3 1/4" Dome Brass M/M (or Inside 3/4" Pipe) Hex Stem	$ 29.02	$ 28.74	$ 28.46
M/M-B3 1/4SPF	3 1/4" Flat Brass M/M/Cast Split-Stem	$ 28.55	$ 28.27	$ 27.99
M/M-B3 1/4SPD	3 1/4" Dome Brass M/M/Cast Split-Stem	$ 28.55	$ 28.27	$ 27.99
M/M-BTS-3 1/4F	3 1/4" Flat Brass M/M/Cast Tapered Stem	$ 28.08	$ 27.80	$ 27.53
M/M-BTS-3 1/4D	3 1/4" Dome Brass M/M/Cast Tapered Stem	$ 28.08	$ 27.80	$ 27.53
M/M-B3 1/2SPF	3 1/2" Flat Brass M/M/Cast Split-Stem	$ 28.55	$ 28.27	$ 27.99
M/M-B3 1/2SPD	3 1/2" Dome Brass M/M/Cast Split-Stem	$ 28.55	$ 28.27	$ 27.99
M/M-BCS-4F	4" Flat Brass M/M/Cast Corrugated Stem	$ 37.94	$ 37.57	$ 37.20
M/M-BCS-4D	4" Dome Brass M/M/Cast Corrugated Stem	$ 37.94	$ 37.57	$ 37.20
M/M-B4SPF	4" Flat Brass M/M/Cast Split-Stem	$ 41.70	$ 41.30	$ 40.89
M/M-B4SPD	4" Dome Brass M/M/Cast Split-Stem	$ 41.70	$ 41.30	$ 40.89

Inclinometer Casing

Monitor with Confidence

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Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

Glue and Snap Inclinometer Casing

Snap Seal Inclinometer Casing (showing internal "O-ring")

Standard Bottom Cap

Bottom Cap with Grout Valve

PRODUCT CATEGORY:
INCLINOMETERS + TILT SENSORS

Inclinometer Casing

RST's Inclinometer Casing is engineered to be assembled quickly and accurately for long and short term monitoring in the most adverse field conditions. It is suited to be installed in boreholes, embankments, piles, set into concrete or attached to structures.

The casing serves as an access tube to guide a MEMS-based inclinometer probe in the two orthogonal directions of measurement. Changes in the output of the probe caused by the deformation of the casing, is proportional to the sine of the angle of inclination of the long sensor axis from vertical. These displacements are incrementally summed to provide profiles of total displacement versus depth.

Key to quality inclinometer casing is not only the material, but the quality and shape of the grooves. The inclinometer probe utilizes grooves in the casing to control the azimuth of the inclinometer probe.

RST casing is manufactured from non-recycled virgin ABS resin. While more costly than common PVC resin, ABS is preferred due to superior flexibility, stability and low temperature impact resistance. Using recycled resin degrades the performance of casing. All RST casing is machined to insure the highest quality possible.

> THIS PRODUCT

Provides alignment and displacement measurements in numerous applications.

Is available in either 'Snap Seal" or "Glue & Snap" coupling styles.

> APPLICATIONS

Pilings.	Landslides and slope stability.
Subsidence control.	Under large storage tanks.
Embankment and dam stability.	Bridge pier, abutments deflection.
Areas next to large excavations.	

> FEATURES

High precision, machined guide grooves.	Low spiral ≤ 0.005 Rad/3 m (≤ 0.3 deg./10 ft.)
Meets or exceeds all applicable standards.	Easy assembly.
Self-aligning, water and grout tight couplings.	70 mm (2.75 in.) and 85 mm (3.34 in.) OD sizes.
Compatible with all commercial probe types and in-place inclinometer sensors.	
Integral coupling reduces assembly induced spiral by 50% over conventional separate coupling methods.	
Compatible with inductance, reed switch, magnetic, or mechanical settlement monitoring devices.	
Snap Seal and Glue & Snap integral flush couplings that minimze field installation time.	
Low temperature, impact, and corrosion resistant ABS plastic.	
External key provides visual and tactile confirmation of proper installation.	

> BENEFITS

✓ **Increase Safety**	✓ **High Accuracy**
✓ **Increase Productivity**	✓ **Upgradable**
✓ **High Reliability**	

Available for **IMMEDIATE DELIVERY** Info on reverse.

RST Instruments Ltd. reserves the right to change specifications without notice. ICB0001Q

Monitor with Confidence

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11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

Inclinometer Casing

PRODUCT CATEGORY:
INCLINOMETERS + TILT SENSORS

SPECIFICATIONS + ORDERING

CASING SPECS

DESCRIPTION	70 MM (2.75 IN.) OD	85 MM (3.34 IN.) OD
Casing OD (including coupling)	70 mm (2.75 in.)	85 mm (3.34 in.)
Casing ID	59 mm (2.32 in.)	73 mm (2.87 in.)
Casing Length	5 or 10 ft. (1.5 or 3 m)	5 or 10 ft. (1.5 or 3 m)
Casing Weight	1.27 kg/m (.85 lbs/ft.)	1.49 kg/m (1.0 lbs/ft.)
Material	ABS Plastic	
Groove Spiral	≤ 0.3 deg./10 ft.	
GLUE & SNAP SPECIFICATIONS - 70 MM		
Load Test	738 kg (1630 lbs.)	
Collapse Test	17.2 bar (250 psi)	

TELESCOPIC SECTION SPECS

DESCRIPTION	70 MM (2.75 IN.) CASING	85 MM (3.34 IN.) CASING
Telescopic Section OD	76.96 mm (3.03 in.)	91.44 mm (3.6 in.)
Compressed Length	457 mm (18 in.)	457 mm (18 in.)
Extended Length	609 mm (24 in.)	609 mm (24 in.)
Range	152 mm (6 in.)	152 mm (6 in.)
Weight	0.77 kg (1.7 lbs.)	0.9 kg (2 lbs.)

SNAP SEAL CASING

Snap Seal is the original O-ring sealed coupling system, which does not require glue, pop rivets, screws, or shear wires. This patented, innovative system allows casing sections to lock together while maintaining precise groove alignment and high collapse strength. The Snap Seal system is flush coupled for ease of installation in hollow stem augers and casing advancers.

GLUE + SNAP CASING

Glue & Snap provides the speed and convenience of a snap-together flush coupling combined with the low cost and high tensile/high torsional strength of a glue joint. Installation is simply done by applying a bead of glue to the male end, snap casing together and insert down hole.

ORDERING

Available for IMMEDIATE DELIVERY

Contact RST for Details

DESCRIPTION	GLUE & SNAP		SNAP SEAL	
	70 MM (2.75 IN.)	85 MM (3.34 IN.)	70 MM (2.75 IN.)	85 MM (3.34 IN.)
1.52 m length (5 ft.)	ICGC205	ICGC305	ICSC205	ICSC305
1.50 m length (4.92 ft.)	ICGC205M	ICGC305M	ICSC205M	ICSC305M
3.05 m length (10 ft.)	ICGC210	ICGC310	ICSC210	ICSC310
3 m length (9.84 ft.)	ICGC210M	ICGC310M	ICSC210M	ICSC310M
Top Cap	ICC2TC	ICC3TC	ICC2TC	ICC3TC
Bottom Cap	ICGC2BC	ICGC3BC	ICSC2BC	ICSC3BC
Casing Anchor	ICGC2CA	ICGC3CA	ICSC2CA	ICSC3CA
Casing Anchor with Grout Cap	ICGC2CG	ICGC3CG	ICSC2CG	ICSC3CG
Grout Cap	ICGC2CP	ICGC3CP	ICSC2CP	ICSC3CP
Repair Coupling	ICGC2RC	ICGC3RC	ICSC2RC	ICSC3RC
Alignment Tool for Coupling	IC1002	IC1003	IC1002	IC1003
ABS Solvent Cement (1/2 pint) (NOTE: cannot be air shipped)	IC1020			
Female Grout Adapter 3/4" NPT	IC1200			
Telescopic Section	ICGC2TS	ICGC3TS	ICSC2TS	ICSC3TS

Telescopic Section

Below: A top view of an Inclinometer Casing Anchor with its arms fully extended. Both Snap Seal (shown) and Glue & Snap coupling styles are available.

INCLINOMETER CASING ANCHOR

The Inclinometer Casing Anchor prevents buoyant uplift of inclinometer casing during installation. It is affixed to the bottom of the inclinometer casing prior to inserting it into the drill-rod/borehole. As soon as the anchor exits the bottom opening of the drill-rod/borehole, the spring loaded arms of the anchor are automatically extended to grip the borehole wall.

TELESCOPIC SECTION

When vertical heave or settlement is anticipated to exceed 1-2%, Inclinometer Casing Telescoping Sections must be used to allow axial movement of the casing while minimizing distortion due to vertical strain. Telescopic sections must be inserted appropriately extended or collapsed to accommodate the expected settlement/rebound. Settlement sections are available in 70 mm (2.75 in.) and 85 mm (3.34 in.) and each section can accommodate up to 150 mm (6 in.) of compression or heave.

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RST INSTRUMENTS LTD.

Installation Instructions for Snap Seal Inclinometer Casing

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Installation Instructions for Snap Seal Inclinometer Casing

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Product: Installation Instructions for Snap Seal Inclinometer Casing

Document number: ICM0011B
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Date: May 27, 2004

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1 Forward

Please note that these instructions are a general guideline for typical field practices, and may require modification to suit site-specific applications. This equipment should be installed, maintained, and operated by technically qualified personnel. Any errors or omissions in the installation, data or data interpretation, are not the responsibility of RST Instruments Ltd.

2 Advantages of RST Snap Seal Inclinometer Casing

Traditional Inclinometer Casing installation methods dictate that screws or pop rivets must be utilized to hold the coupling in place until the ABS cement cures. The requirements for rivets are increased in deep boreholes.

Snap Seal is the *original O-ring sealed coupling system*, which does not require glue, pop rivets, screws or shear wires. This patented, innovated system allows casing sections to lock together while maintaining precise groove alignment and high collapse strength.

The Snap Seal system is flush coupled for ease of installation in hollow stem augers and casing advancers.

3 RST Snap Seal Casing Part Numbers

70 mm (2.75 inch) Casing	**Part No.**
1.5 m Length	ICSC-205M
3 m Length	ICSC-210M
5 ft. Length	ICSC-205
10 ft. Length	ICSC-210
Top Cap	ICC-2TC
Bottom Cap	ICSC-2BC
Grout Cap	ICSC-2CP
Telescopic Section	ICSC-2TS

85 mm (3.34 inch) Casing	**Part No.**
1.5 m Length	ICSC-305M
3 m Length	ICSC-310M
5 ft. Length	ICSC-305
10 ft. Length	ICSC-310
Top Cap	ICC-3TC
Bottom Cap	ICSC-3BC
Grout Cap	ICSC-3CP
Telescopic Section	ICSC-3TS

4 Pre-Installation

Before beginning the installation, ensure that all equipment, accessories and spares are available:

- Casing and caps
- Spare bottom and top caps
- Spare casing length(s)
- Grout tremie line
- Grout valved bottom cap (if employing this method); c/w spare female grout valve
- Drill rods to weigh casing
- Safety line (if required)
- Clean water supply to ballast casing
- Repair Coupling and Alignment Tool (if required)
- Hand saw
- Casing collar protection (as required)
- Chain or casing clamps

Inspect casing lengths to insure that damage during transit has not occurred. Ensure that the inside of the casing is clean. To ensure the joint and casing interior will remain clean, only remove the protective end caps prior to installing the casing. Store the casing horizontally, fully supported, and out of the sunlight. Number each length, and assemble numerically to avoid errors, and to confirm correct depth.

Do not assemble the casing prior to insertion in the borehole.

Drill the borehole as vertical as possible, preferably within 1 degree. Flush the borehole clean, and verify that the borehole is fully open to the bottom.

5 Assembly of Snap Seal Casing

5.1 Snap Seal Casing Sections

Each section of casing has a male end with an alignment key, and a lock ring, and a female end with a keyway, O-ring, and lock ring (Figure 1). Casing is installed with the female end facing up. O-rings come greased from the factory, and are protected by a cap. In the field, remove the cap and ensure that that the O-ring is still greased. Take care to keep the casing ends clean to ensure a proper seal. Please note the female ends of the casing have three slots in them. These are stress relief cuts which facilitate the insertion of the male end of the subsequent casing section.

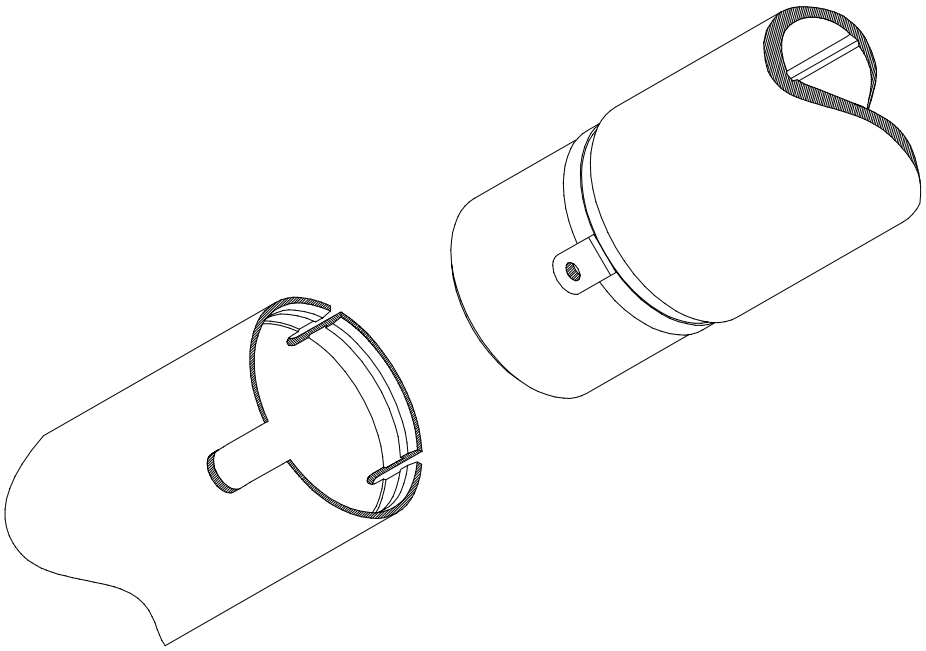


Figure 1 – RST Snap Seal Casing

5.2 Installing an End Cap

Before installing the first section of casing in the borehole, an end cap must be installed as indicated in Figure 2.

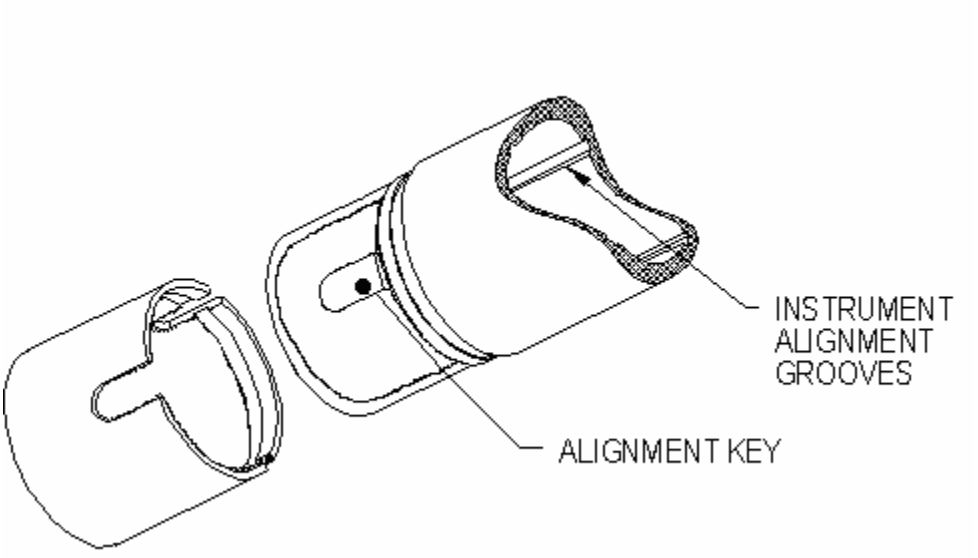


Figure 2 – End Cap Joint

Align the notch on the cap with the key on the casing. Slide the cap on to fully engage the notch and key (you will hear a “snap” as the lock ring is seated). Visually ensure proper assembly. Typically, a grout tube will be attached to the first section of casing. Additional grout tubes may be added during installation for multistage grouting. In some situations, a special grout cap will be required instead of the standard end cap. Installation is the same, except for the fact that the grout cap has a provision for a grout tube.

The casing, with attached cap, can then be lowered into the hole. If applicable, attach a safety line, and a grout tremie line.

5.3 Assembling Casing Sections

Subsequent casing sections in a borehole should be assembled in the same manner as the end cap (described above). Remove the protective caps and check that the O-ring and lock ring are greased. Align the key and the keyway of the two sections. Push the sections together until the joint snaps closed. In some cases, the user may find it easier to push the sections together using a twisting motion. In each case, the alignment button should be aligned with the notch in the female end (Figure 1).

Some practitioners use a 2-inch wide waterproof duct tape over the joint. Just a single wrap of this tape will improve the lateral strength of the joint by more than 100% and in tension by 50%.

5.4 Installing the Top Cap

After all the inclinometer sections have been installed, place a Top Slip Cap over the last piece of casing when finished and/or not in use. Do not cement into place. The cap is provided as a removable protective cover (Figure 3).

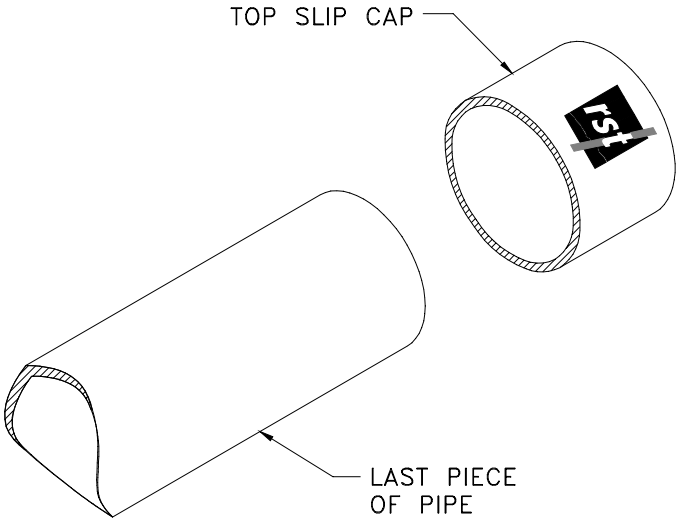


Figure 3 – Top Cap

5.5 Assembling Telescopic Sections

Each telescoping section is 2ft. (24”) in length and allows for six inches of compression or extension (Figure 4). Settlement sections may be inserted extended or collapsed, to accommodate the expected settlement/rebound. Typically, sections are shipped in the fully extended condition to accommodate settlement in the borehole. However, sections can be ordered in any configuration, depending on the site specific requirements. The telescopic section is equipped with Snap Seal ends, thus allowing it to be installed similar to a standard piece of casing (section 5.3).

If the telescoping sections are equipped with settlement rings, then lower the sensor into the casing and record the initial readings for each settlement ring. Contact RST Instruments Ltd for more information on Settlement Monitoring Systems.

The moving joint of the section is sealed by two O-rings (one at either end). Each telescoping section contains four set-screws two on each side (Figure 4), which are individually sealed with O-rings These screws are set in tracks which are blocked by a small web of ABS material. When sufficient force, >200lbs, is exerted on the casing (very small in a geotechnical setting), the material will break allowing the casing to compress (or extend). This design allows the telescopic section to bear the weight of the casing above it, and collapse under the force of ground settlement and/or rebound.

To prevent mis-tracking of the inclinometer probe as it passes through the telescoping section, the end of the grooves have a tapered “V-notch”. This notch ensures that the wheels of the probe re-establish themselves in the correct track.

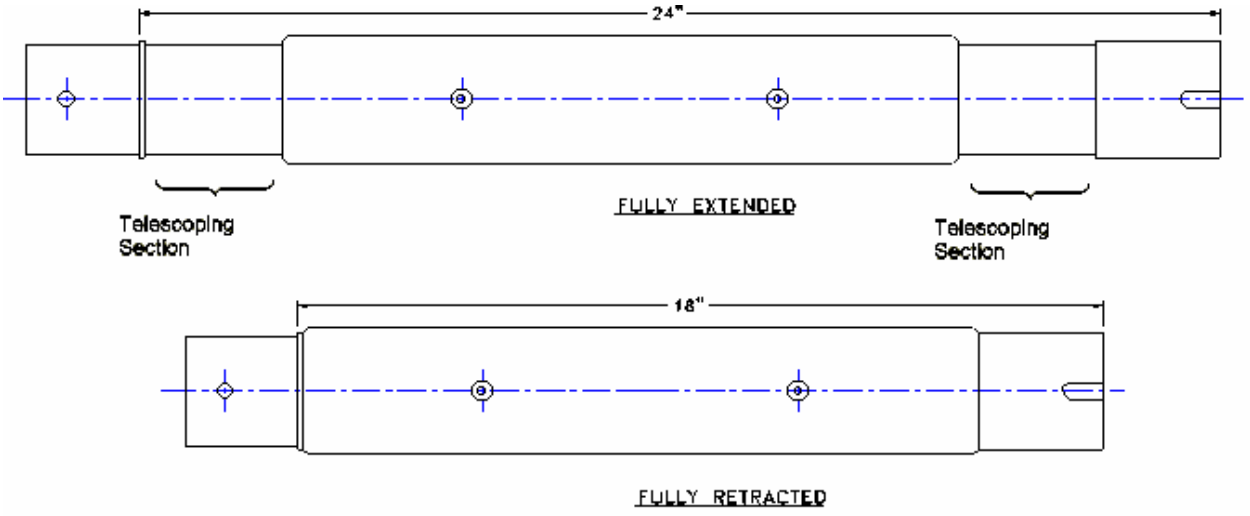


Figure 4 – RST Snap Seal Telescoping Section

6 Installing Snap Seal Casing

6.1 Installation Notes

Casing Storage

Casing should be stored horizontally and supported evenly so that it does not warp or bend. Whenever possible, casing should be stored in the shade since prolonged exposure to the heat of direct sunlight can cause deformation.

The Borehole

Drill the borehole as vertical as possible, preferably within 1 degree. Flush the borehole clean, and verify that the borehole is fully open to the bottom. Check the depth of the borehole before you begin installing the casing. Also consider that grout valves or external weights may be required for deeper boreholes.

Groove Alignment

It is important to have one set of grooves oriented down slope, in the direction of expected movement. If the direction cannot be determined, orient North/South. **Alignment must be maintained throughout the installation, to avoid introducing torsion to the casing, thereby causing spiraling of the grooves. Never push the casing from the top or twist the casing during installation.**

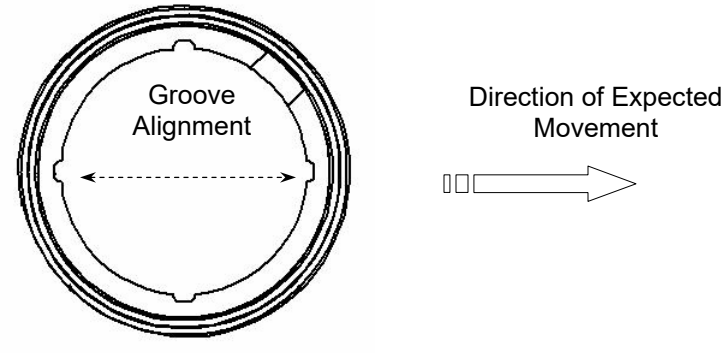


Figure 5 – Groove Alignment

6.2 Installation Methods

Pipe Clamp Method

This method involves using pipe clamps to hold the casing at the borehole collar while you add the next section of casing. Two pipe clamps are needed. In dry boreholes or in situations where down-hole problems seem likely, rig a safety line to provide extra security and a way to retrieve the casing if necessary.

1 Install an end cap on the first section of casing (section 5.2).

2 Attach one clamp to the top of the first section of casing. Lower the casing into the borehole until the clamp rests on the borehole collar.

3 Attach a second clamp to the top of the next section of pipe. Connect the two sections according to the instructions outlined in section 5.3. Remove the first clamp and lower the section into the borehole.

Repeat steps 2 and 3 until installation is complete. When to depth, verify the alignment of the grooves by running a dummy probe to the hole bottom. If the probe will not pass, jumps track, or returns in another set of grooves, pull the casing and rectify the problem.

In deep boreholes, it is advantageous to use a safety line to restrain the casing during installation. This can be used in conjunction with the casing clamps to lower the casing a controlled rate. Note that using the safety line *by itself* may induce spiraling due to the spiral lay of the rope, and is not recommended.

6.3 Casing Buoyancy

If the borehole is filled with water or mud, ballasting the casing with clean water can neutralize the casings' buoyancy. Exercise caution with this technique, as in dry boreholes, the differential pressure caused by the head of water may cause the casing to fail.

Casing also becomes buoyant during the process of grouting the borehole. The two following methods can be used to prevent the casing from floating out of the borehole during grouting:

1 Drill rods may be inserted inside the casing to hold the string from the bottom.

2 The bottom of the casing may be anchored in grout, then the balance of the borehole grouted.

> **Note**
>
> Applying a down-force to the top of the casing will likely distort the casing profile. Never use the drilling rig as a reaction force, or wedge the collar of the borehole. This will cause the casing to assume a large radius bend, making readings virtually useless.

In many cases, it is standard practice to attach a weight to the bottom of the casing to counteract the buoyancy effects of the casing. In situations where the casing is being inserted into a freshly grouted borehole, these buoyancy forces can be significantly large. RST cautions against using too large of a weight as it may fail the joint on the bottom cap or elsewhere in the casing.

6.4 Grouting

Properly mixed grout must be thin enough to pump, but thick enough to set in a reasonable amount of time. Ensure that the grout is free of lumps. If the mixture is too watery, it will shrink excessively, leaving the upper portion of the borehole un-grouted. Also, avoid the use of grouts that cure at high temperature since these may damage the casing.

Begin to tremie in grout as directed by the engineer. Grouting, via a high shear filtered grouting machine is recommended to avoid problems with lumps obstructing the tube.

Observe the water meniscus in the casing as an indication of casing collapse, or grout ingress (i.e. if the water in the casing rises, grout ingress can be assumed). Ensure that differential pressures are kept to a minimum, as the casing will collapse at 240 PSI differential.

Deeper boreholes will require a stage grouting procedure, with appropriate stages dependant on borehole water level, grout density, grout pump type, etc.

Note

Proper grouting of inclinometer casing is crucial to a successful inclinometer installation. The on-site engineer is required to have experience and can work with the drill crew on the proper mixture for the grout. Grout consistency is very important to ensure proper curing and to avoid separation of the solids and water. Grout must also have the proper viscosity which will enable it to be pumped easily.

In summary, grouting needs to be performed by experienced personnel, site conditions vary to the extent that each inclinometer installation is unique. Good judgment by on-site personnel and previous experience is the key to a successful installation.

7 Repairing Damaged Casing

Damaged Snap Seal Casing can be repaired using RST repair couplings. Most of the time, casing becomes damaged near the top of the borehole due to movement of heavy equipment etc. In any case, the damaged portion of the casing needs to be removed.

1. Cut off the damaged portion of the casing using a hacksaw. Be sure to make this cut as square as possible. Remove all burrs.
2. Apply ABS 771 Cement to the inclinometer casing (Figure 6). The repair coupler will slide over top and the alignment tool will be used.

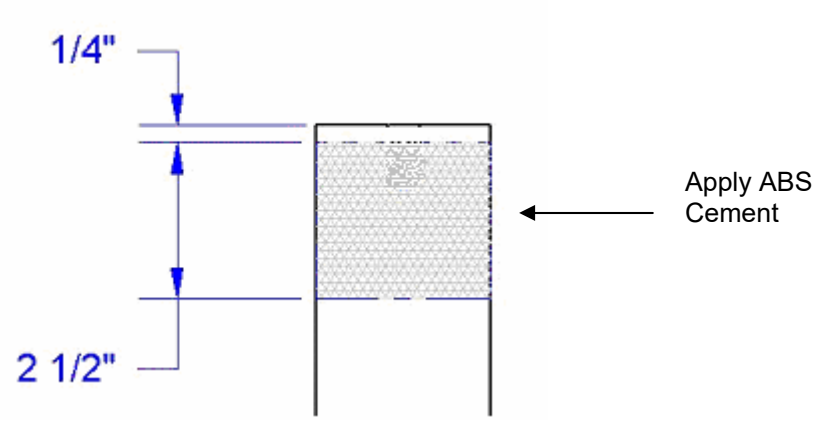


Figure 6 – Casing Preparation

3. Slide the RST repair coupling onto the casing and align the grooves using the RST Coupling Tool (Figure 7). Allow the cement to cure, according to the directions on the label.

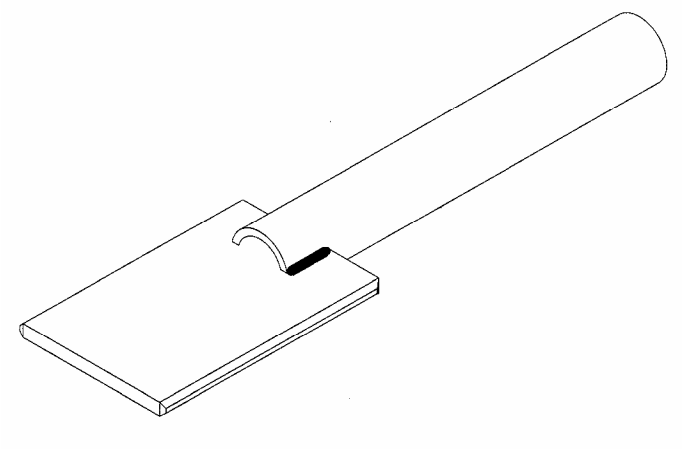


Figure 7 – RST Coupling Tool

4. Install the next section of Snap Seal casing as usual (section 5.3). Ensure that the keys and keyways are aligned.

8 Installing Corrugated Settlement Sheath Pipe

Another option to using Telescopic Sections is the use of Corrugated Settlement Sheath Pipe. This allows the inclinometer casing to remain in a static position while the ground moves around it. Settlement can thus be observed at the collar of the borehole. For example, if the ground settles, the casing will be observed to extend farther out of the ground than previously.

Installation Method:

1. Insert a weight into the bottom of the sheath with the groove side down, leaving room for the installation of the end cap.
2. Slide 2 band clamps over the sheath and tighten so that the clamps squeeze the sheath into the grooves locking the weight into place.
3. Install the End Cap onto bottom of the sheath.
4. Seal with Denso tape and Duct tape.
5. Lower Corrugated Settlement Sheath Pipe into the borehole.

Note: Ballasting the pipe with clean water may be necessary to counter the buoyancy encountered with wet bore holes.

6. Install Inclinometer casing inside the Corrugated Settlement Sheath Pipe.
7. Eliminate any slack by pulling on it by hand (hold in place while performing step 8).
8. Fill the void between the sheath and borehole with grout, ensuring that no grout gets into the sheath or casing.
9. If Corrugated Settlement Sheath is equipped with settlement rings, then lower the sensor into the casing and record the initial readings of each Settlement Ring. Refer to the RST Instruments Manual “Settlement Monitoring System”.

Inclinometer Digital MEMS System

VIEW THIS SYSTEM IN ACTION!

YouTube http://youtu.be/1nqpiQUzh4o

DIGITAL MEMS INCLINOMETER SYSTEM

MEMS TILT & INCLINATION SERIES

inclinalysis™
digital inclinometer analysis software

EVOLUTION + INNOVATION

INCLINOMETER SYSTEMS

WIRELESS COMMUNICATION | DIGITAL MEMS TECHNOLOGY

rst INSTRUMENTS

innovation in geotechnical instrumentation

WIRELESS COMMUNICATION | DIGITAL MEMS TECHNOLOGY

SINCE 2003

THE SHORTEST OVERALL LENGTH

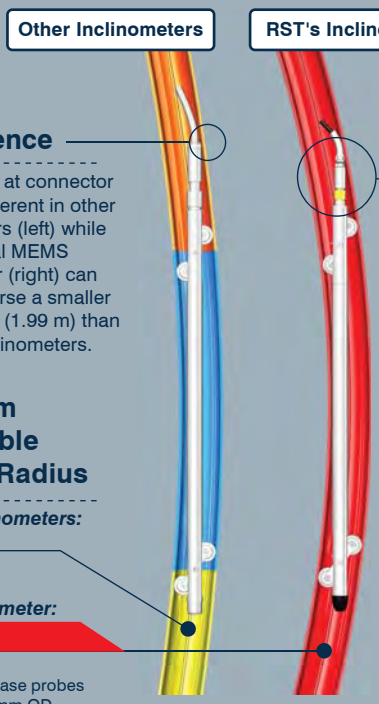
The RST Digital MEMS Inclinometer Probe with industry leading system accuracy of ±2 mm per 25 m, shown connected to the cable.

Since 2003, RST's Inclinometer systems have had the shortest overall length available for a given base length compared to competitive inclinometers. Undaunted, we've forged ahead and improved on our very own industry-leading specifications. With a new minimum negotiable casing radius of 1.99 m, RST's Digital MEMS Inclinometer can still traverse a smaller radius bend than all other inclinometers available in the industry. A local microcontroller in the probe manages data collection, applies precision digital calibration, and provides a fast settling time which results in very efficient data collection.

The Ultra-Rugged Field PC^2 functions as the data collector. It provides a high-level user interface, "at-the-borehole" data analysis and graphical comparison to previous data sets.

CONNECTOR COMPARISON

LEAST INTERFERENCE



Interference

Interference at connector is visibly inherent in other inclinometers (left) while RST's Digital MEMS Inclinometer (right) can clearly traverse a smaller radius bend (1.99 m) than all other inclinometers.

Minimum Negotiable Casing Radius

Other Inclinometers:
3.12 m

RST Inclinometer:
1.99 m

0.5 m wheelbase probes shown in 70 mm OD inclinometer casing.

RST Connector

Cable connector material made of 316 stainless steel.

Rating for underwater use, with wet connection at 5000 ft. (1524 m) in salt water.

Includes a spring strain relief to enhance cable durability at the connector entrance.

ULTRA-RUGGED Field PC^2

Rock solid and field ready for the most extreme environments. Wireless communication between the inclinometer control cable and the Ultra-Rugged Field PC^2 ensures ease of use and reliability since there is no concern with fragile connectors, cable related failure and reliability problems.

PROCESSOR OPERATING SYSTEM MEMORY

- 1.0GHz ARM Cortex A8 i.MX53 processor
- Microsoft® Windows Embedded Handheld 6.5.3
- Microsoft® Office Mobile 2010 (Word, Excel, PowerPoint, Outlook)
- Bluetooth® Wireless Communication
- Wi-Fi® 802.11b/g/n with extended range
- Internal solid state 512 MB Flash memory (2 million biaxial data sets)
- 8GB flash storage, user-accessible micro SD/SDHC slot
- Both USB Host and Client plus 9-pin RS-232
- Real-time clock keeps correct date & time, even without battery

DISPLAY

- Active viewing area of 109 mm (4.3 in.) diagonal
- WVGA LCD TFT (800x480) - portrait or landscape orientation
- High visibility backlit LCD - brilliant contrast in direct sunlight
- Projected capacitive touch interface, "optically bonded" to display for increased visibility.
- Scratch-resistant screen
- On-board stylus with tether

POWER

- Intelligent Li-Ion battery 3.7VDC @ 10600mAh, 38.16Whr
- 20 hour battery life on single charge (2 to 4 hrs. charge time)
- Battery easily changeable in field

ENVIRONMENTAL

- Operating temperature: -30 to 60°C (-22 to 140°F)
- Bluetooth® rated to -20°C (-4°F)
- IP68 waterproof and dustproof
- Shockproof (multiple drops from 1.5 m (5 ft.) on to concrete
- MIL-STD-810G: high/low temp., temp. shock, rain, humidity, sand & dust, immersion, vibration, altitude, shock.

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Bluetooth trademark is owned by Bluetooth SIG, Inc. © Bluetooth SIG, Inc. 2004.
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DIGITAL MEMS INCLINOMETER SYSTEM

THE FIRST

IN EVOLUTION + INNOVATION

For measuring any lateral movement down in the earth, via inclinometer casing, the Digital MEMS Inclinometer System from RST Instruments Ltd. was the first, and is still the best, Digital MEMS Inclinometer System available.

MEMS TILT & INCLINATION SERIES

The inclinometer reel can be charged without removing the battery and offers up to 30 hours of continuous use from a full charge. Its battery life can also be viewed with the Ultra-Rugged Field PC²

SPECIFICATIONS

INCLINOMETER	METRIC SYSTEM	IMPERIAL SYSTEM
Wheelbase	0.5 m	24 in
Probe diameter	25.4 mm	1.00 in
Probe length (including connector)	719 mm	32.6 in
Probe weight	1.06 kg	2.45 lbs
Probe material	Stainless steel	Stainless steel
Full-scale range (other ranges available)	±30 degrees	±30 degrees
Data resolution	0.005 mm per 500 mm	0.00002 ft per 2 ft
Memory	>1,000,000 readings	>1,000,000 readings
Repeatability	±0.002°	±0.002°
System Accuracy	±2 mm per 25 m	±0.1 in. per 100 ft
Axis alignment	Digitally nulled	Digitally nulled
Temperature rating	-40 to +70°C	-40 to +158°F
Sensor Type	MEMS Accelerometer, Biaxial	
CABLE		
Cable diameter	6.40 mm (±0.1 mm)	0.25 in
Cable weight	2.3 kg / 50 m	3.1 lbs / 100 ft
Cable breaking strength	5.90 kN	1325 lbs
Cable reinforcement	Kevlar® ‡	Kevlar® ‡
Cable jacket	Polyurethane	Polyurethane
Cable stretch (suspended in 50 m dry borehole)	7.0 mm	0.27 in
CABLE REELS		
Up to 75 m cable reel diameter	310 mm	12.2 in
100 to 200 m cable reel diameter	380 mm	15 in
+225 m cable reel diameter	460 mm	18 in
Reel weight with 50 m (100 ft.) cable	4.7 kg	8.4 lbs

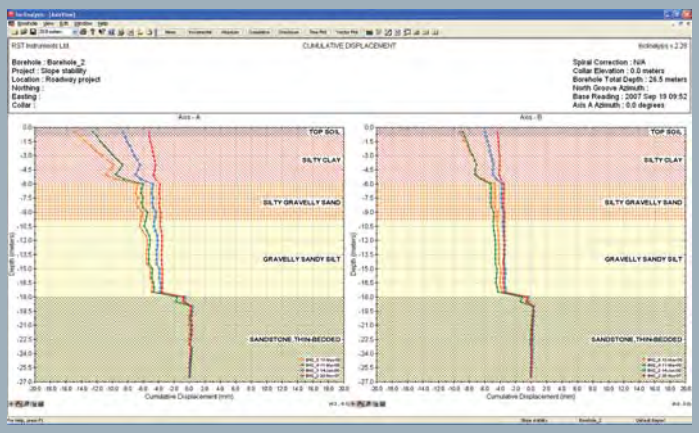
RST's newly developed connector is by far the industry leader for the least amount of connector interference.

RST also provides the most robust cable on the market with a breaking strength of 5.90 kN (1325 lbs.) Also, our new non-slip, swaged cable marks are unmatched in grip strength.

The compact reel system with 50 m cable weighs a very manageable 4.7 kg and can be easily held with one hand. A padded carrying case is included.

ANALYSIS SOFTWARE

THE PERFECT PAIR



RST Inclinalysis™ Software screen capture shows cumulative displacement of a borehole.

inclinalysis™

digital inclinometer analysis software

The RST Digital MEMS Inclinometer System and Inclinalysis™ Software offer a powerful combination for quick and efficient reduction of large volumes of inclinometer data. Data can be analyzed and presented quickly in a variety of formats.

RST Inclinalysis™ Software is powerful, yet easy to use. Plotting, manipulating data and printing are all only a few clicks away. Menu and plot functions are designed to be intuitive making the program very easy to learn. Designed to complement the Digital MEMS Inclinometer System, data is organized in a standard file structure which makes importing data seamless between Inclinalysis™ and the Ultra-Rugged Field PC^2.

Plot

Plot data at the click of a button. View several plots simultaneously across the screen. Ability to save multiple reports for a single borehole.

Customize

Create custom plot titles and change graph properties. Change reading units instantly to millimeters, metres, inches or feet. Specify top or bottom data reference. Correct for bias-shift.

Import

Import inclinometer data in a variety of formats from different manufacturers including spiral data.

Assess

Create vector plots displaying change in magnitude and direction, and time plots to assess the rate of movement at a particular depth or in a specific movement zone. Instant visual data validation by plotting checksum data.

Compare

Display data in tabular format and compare directly to plots. Take direct measurements off any plot.

Intuitive

Menu and plot functions are designed to be intuitive and easy to learn. Cascade windows to display multiple plots and tabular data on the same screen.

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ORDERING INFO

SYSTEMS - Metric	
IC32003	30 m complete system with 0.5 m probe
IC32005	50 m complete system with 0.5 m probe
IC32075	75 m complete system with 0.5 m probe
IC32010	100 m complete system with 0.5 m probe
125, 150, 200, 250, 300 m and longer systems available	
SYSTEMS - Imperial	
IC32110	100 ft complete system with 2 ft probe
IC32115	150 ft complete system with 2 ft probe
IC32120	200 ft complete system with 2 ft probe
IC32130	300 ft complete system with 2 ft probe
400, 500, 600, 800, 1000 ft and longer systems available	
OPTIONAL SYSTEM ACCESSORIES	
IC35805	Dummy Probe 0.5 m wheelbase - METRIC
IC35802	Dummy Probe 2 ft wheelbase - IMPERIAL
IC32705	Digital MEMS Inclinometer Spiral Sensor (see separate brochure)
IC35600	RST Inclinalysis™ - Digital Inclinometer Analysis Software
IC35650	Protective Aluminum Carrying Case - for Inclinometer Probe
Horizontal MEMS Inclinometer (probe available in custom lengths in Metric and Imperial units - view separate brochure or contact sales at RST Instruments).	

INCLUDED SYSTEM COMPONENTS
MEMS Digital Inclinometer probe with protective case
Cable Reel with Wireless Communication System
Cable Reel Carrying Case
Silicone spray for probe/cable connectors
Data collection & transfer software
70 & 85 mm cable grips
Ultra-Rugged Field PC^2 (with rechargeable Li-Ion battery)
AC Adapter for Ultra-Rugged Field PC^2
AC Adapter for Reel Battery Charger
USB cable for Ultra-Rugged Field PC^2
Quick start guide for Ultra-Rugged Field PC^2
Ultra-wide hand strap for Ultra-Rugged Field PC^2
Stylus with tether for Ultra-Rugged Field PC^2

rst INSTRUMENTS

innovation in geotechnical instrumentation

Certified System ISO 9001

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RST INSTRUMENTS LTD.

RST MEMS Digital Inclinometer
System Instruction Manual

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RST MEMS Digital Inclinometer System

Although all efforts have been made to ensure the accuracy and completeness of the information contained in this document, RST Instruments reserves the right to change the information at any time and assumes no liability for its accuracy.

Product: RST MEMS Digital Inclinometer System Instruction Manual

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Date: December 15, 2017

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1 GENERAL DESCRIPTION

The RST MEMS Digital Inclinometer System represents a breakthrough in inclinometer system technology, providing unprecedented accuracy, efficiency and ease of use. The system is comprised of a Digital Inclinometer Probe, Cable system, Reel with battery power, and an Ultra-Rugged Field PC running Mobile Microsoft Windows™ that functions as a readout, analysis, and data storage device.

Wireless communication between the inclinometer control reel and the Ultra-Rugged Field PC ensures ease of use and reliability, by removing two weaknesses inherent in conventional analog inclinometer systems. By removing the physical connection between the inclinometer control cable and the readout instrument there is no concern with fragile connectors, cable related failure and related reliability problems. The Achilles heel of any inclinometer control cable reel is the slip ring required to maintain electrical contact as the reel revolves. As the RST system is wireless from the control cable to the readout, a slip ring is not required, and there are no associated electrical continuity problems.

The RST digital inclinometer probe incorporates cutting edge MEMS (Micro Electro Mechanical Systems) technology providing high precision and durability. A highly accurate survey of the inclinometer casing is used to establish the initial position of the casing. Any subsequent deviations in the casing from this initial value (i.e. baseline reading) represent changes occurring in the subsurface. The RST MEMS Digital Inclinometer System can accurately measure the rate, depth and magnitude of these deviations.

The information included in this manual outlines the use and care of the RST MEMS Digital Inclinometer System. It provides examples of how to take readings and interpret the data. For more information on the installation of inclinometer casing, and other related issues, please contact RST Instruments Ltd.

Note

Proper care and maintenance of the MEMS Digital Inclinometer System will greatly extent the life of the instrument and accuracy of the readings. Please take the time to read this manual thoroughly. If any questions arise, do not hesitate to contact RST Instruments Ltd. Contact information is given in section 14. Proper maintenance of the probe ***after each use*** is outlined in section 12.

Functions:

- Measure lateral movement of earthworks or structures
- Landslides
- Embankment fills
- Stability adjacent to excavations or underground workings
- Deflection of piles, piers, abutments or retaining walls

Figure 1 – System Overview

1. Soft Shell Case
2. Digital Inclinometer Probe (w/ protective end cap)
3. 70mm/2.75” OD Cable Grip
4. 85mm/3.34” OD Cable Grip
5. Ultra-Rugged Field PC
6. Silicone Lubricant (for use on connectors)
7. Field PC stylus
8. USB Cable for Ultra-Rugged Field PC
9. AC Adapter for Ultra-Rugged Field PC
10. AC Adapter for Reel Battery Charger
11. Cable Reel with Wireless Communication System
12. Reel Carrying Case
13. Micro-fiber cleaning Cloth
14. Software Installation DVD

2 DIGITAL PROBE

In general terms, the new Digital Probe resembles that of the traditional analog probes sold by RST. The RST Digital Inclinometer has the smallest package available for a given wheel spacing, with the best ability to track deformed casings. This means that the Digital Probe can handle greater bends in the casing without fouling. The RST metric probe can negotiate a radius of 1.88m (74") in 70mm (2.75") OD inclinometer casing. The RST Digital Inclinometer will thus continue to provide readings past the limit for other probes on the market (see Figure 2).

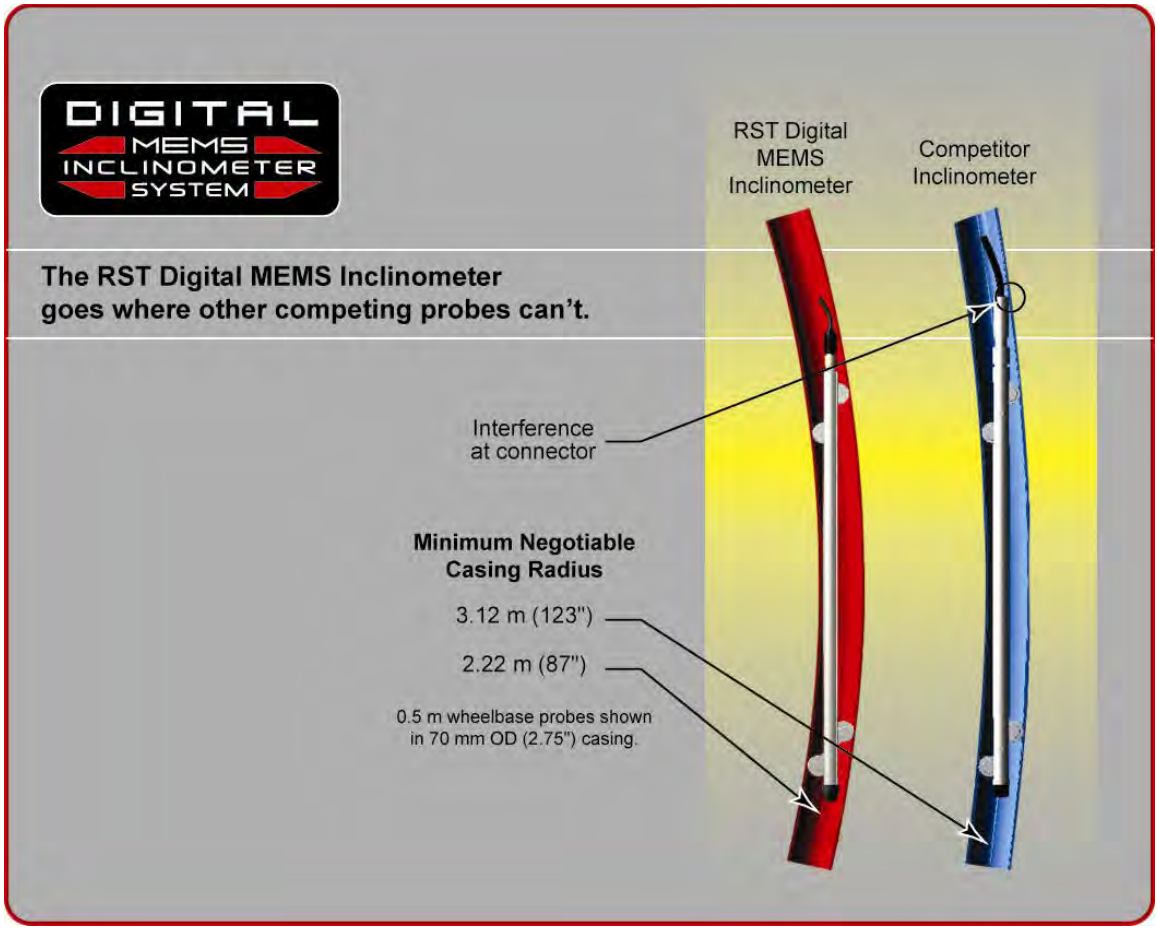

Figure 2 – Digital Probe Sizing

The connectors, wheels, and wheel carriages are the most precise and durable in the industry. The probe wheels are made of high grade hardened and heat-treated stainless steel. These are extremely durable and the most robust on the market.

The digital probe also incorporates shear pins on the wheel assemblies. In the event that the probe gets stuck in the inclinometer casing, a force of approximately 300 lbs is required to shear the shear pin. No damage to the probe or cable will result. Please contact RST Instruments Ltd. for further instructions on the replacement of shear pins.

2.1 DUMMY PROBE

Dummy inclinometer probes are available for purchase from RST for testing purposes in a borehole. RST encourages customers to try the new digital dummy probe in existing holes where the competitor's probes do not work. If it is found that the dummy probe passes through all areas of the casing, the RST MEMS Digital Inclinometer System will function. Therefore the existing hole will still be viable and a new hole will not need to be drilled.

The RST dummy probe has the exact same weight and dimensions as the standard probe. A ring is provided in place of the connector which allows the dummy probe to be lowered by a rope. For further information on purchasing a RST Dummy Probe, please contact RST Instruments Ltd (Section 14).

2.2 SIGN CONVENTION

The Digital Inclinometer Probe houses two MEMS accelerometers, which measure tilt in two axes. Proper installation of the inclinometer casing attempts to align one set of grooves in line with the axis of expected movement. This is called the *A axis*. The perpendicular set of grooves is the *B axis*.

When an inclinometer casing is surveyed for the first time (i.e. baseline readings), it is necessary to select a fixed direction reference for the probe so that each time a survey is repeated, the probe will always have the same orientation in the casing.

For example, in an area suspected of landslide activity, the first set of readings would be taken by placing the upper wheels of the probe in the casing groove closest aligned to the downslope direction. Figure 3 illustrates an inclinometer casing installed with a groove orientation in the general downslope direction.

In practice, it is often difficult to achieve exact orientation of grooves relative to some predetermined direction. The groove closest to the anticipated movement direction is usually chosen as the main reference direction. It is recommended that this direction (A+) be marked on the casing itself to ensure surveys are performed in the same manner each time.

The azimuth of this groove direction can be measured in a clockwise direction from the main reference direction (A+). All subsequent measured inclinometer movements would be referred to this direction.

Readings taken from the inclinometer probe (see Section 4.2.7) are actually deviations from the vertical over the distance between the upper and lower wheels (see Figure 4), calculated as:

$$D = L \times sine(\alpha)$$

Where: *L = inclinometer probe length (typically 0.5m for a metric probe or 2 ft for an imperial probe, as defined in Section 0)*

α = inclination angle of probe from vertical axis

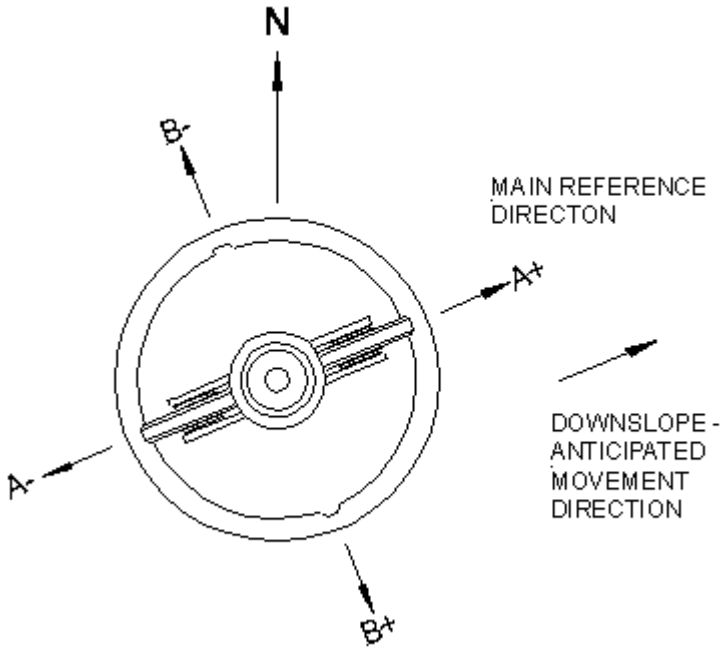

Figure 3 – Probe Orientation

The RST Digital Inclinometer System uses the industry standard sign convention, where tilt in the direction of the upper wheels results in a positive deviation and tilt in the direction of the lower wheels results in a negative deviation (Figure 4).

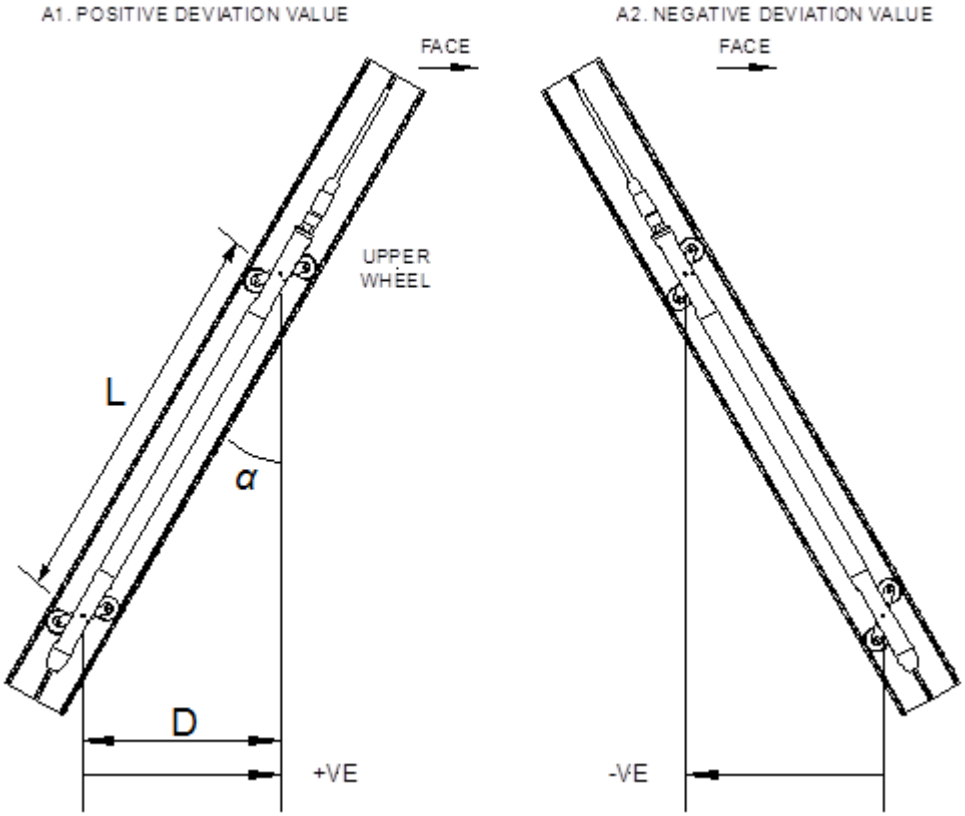

Figure 4 – Sign Convention in the A-axis and deviation D measured by inclinometer probe

Figure 5 shows the sign convention for the A and B axis.

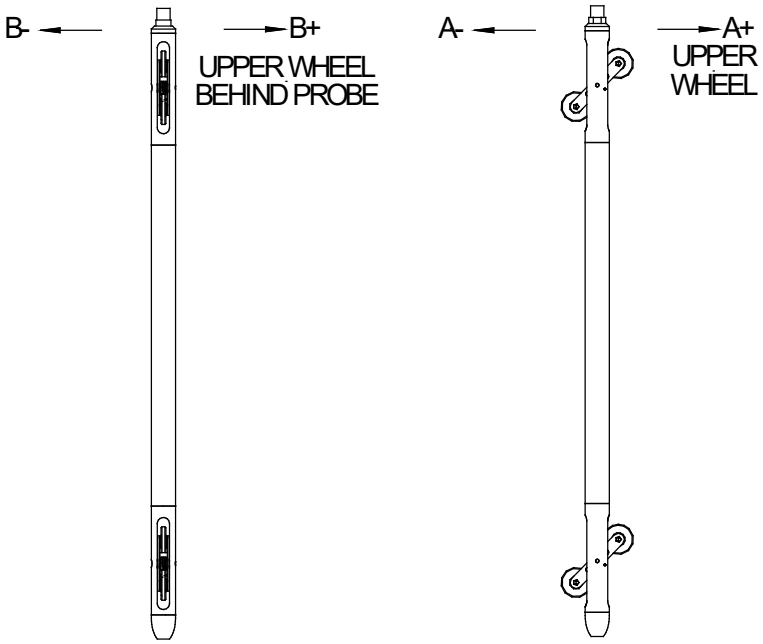

Figure 5 – Probe Axes

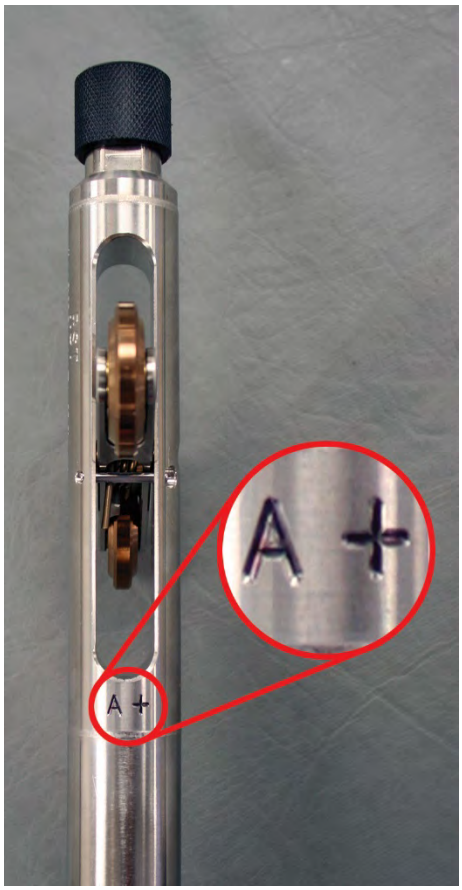

Figure 6 – A+ Marking on the Inclinometer Probe

2.3 TAKING READINGS

1. Upon arrival at the site, remove the protective caps from the casing, the probe and the control cable. Attach the probe to the reel by aligning the keyways and threading the connector onto the probe. Take care to only turn the threaded ring, not the cable itself. Do not over tighten the connector, make it hand tight.
2. Handle the inclinometer probe very carefully as the accelerometers are very susceptible to shock.
3. Once connected, turn on the power to the reel. This energizes the MEMS accelerometers and makes them less susceptible to shock.
4. Insert the probe into the borehole aligning the upper wheel in the direction of the A+ axis (see section 2.2).
5. Lower the probe to the desired depth *slowly* and as *smoothly* as possible. *Be extremely careful not to bounce the probe off the bottom of the hole.*
6. Once the desired location has been reached (i.e. base of the borehole), place the cable grip on the top of the casing and hang the cable by the aluminum crimps. The objective is placement repeatability within 5mm (0.25 inch). This is extremely important to ensure accurate and repeatable results.
7. Always pull the probe upwards to the desired location. If you accidentally pull the probe too far, lower the probe back down to the previous depth, and then pull it back to the intended depth. This procedure ensures that the readings will remain consistent.

> **Warning**
>
> Do not drop the cable marks onto the cable grip. The cable has very little stretch, especially near the top of hole, and the impact on the cable marks may “hammer” them out of position or break the cable. This effect has been demonstrated for drops as little at 70 mm

8. At each location allow the readings to stabilize. Reading stability can be gauged by both the noise bar and the standard deviation which are displayed on the Readings Screen (sections 4.2.7).
9. Once the readings have stabilized, press the *Accept* button and move the probe to the next interval as prompted by the software.
10. Continue logging the borehole until the top is reached, the software will then prompt you to turn the probe 180 degrees and repeat the survey, this time with the lower probe wheels in the A+ groove.

> **Warning**
>
> When the probe has reached the top of the casing, avoid allowing the wheel assemblies to snap out of the casing. As the wheels reach the top, grasp them with your hand and release the wheel assembly slowly until it reaches its stops. Failure to do so will damage the stops and subject the MEMS accelerometers to sudden shock which can damage them and affect the calibration of the probe.

11. Prior to lowering the probe for the second pass, remove the cable grip to avoid accidentally catching the marks on the cable grip, which would otherwise impact load the marks, cable, and probe. Once the probe is at the bottom of the hole, replace the cable grip and position the probe for the deepest reading.
12. During the second pass, checksum data will be displayed underneath each reading. Ensure that these remain small and consistent; however checksums can vary due to different site conditions. Large checksums can indicate errors in probe positioning

or fouling of the probe. Expect checksums to be slightly larger when the probe encounters an expansion coupling in the casing (if applicable).

13. The RST MEMS Digital Inclinometer has the ability to perform data reduction in the field, please refer to section 4.2.8 for information on viewing and validating the data.
14. Upon completion of the survey, close the inclinometer program, turn off the power to the reel, and disconnect the probe. Wipe off the probe and cable. Replace end-caps on the cable and probe. Replace the protective cap on the casing.
15. Upon returning to the office, clean the instrument and reel once more to remove any moisture from the instruments and the case. Recharge the batteries for the Reel and connect the power and USB communication cables to the Ultra-Rugged Field PC (Figure 7). Please refer to section 12 for proper care and maintenance of the system.
16. Transfer data to a desktop PC using Microsoft ActiveSync™ or Microsoft Mobile Device Center software (section 6).

3 INCLINOMETER CABLE AND REEL

The RST MEMS Digital Inclinometer System comes with a durable lightweight reel that is easy to handle. Since only a pair of conductors is needed in the cable, the weight and dimensions of the cable are drastically reduced as compared to a traditional analog cable. The reel is battery powered and houses the electronics used for wireless communication.

An important part to any inclinometer casing survey is the repeatability of the depth measurements. It is extremely important that measurements be consistently within 5mm (0.25in) of one another between subsequent surveys. To facilitate accurate repeatability, two aluminum seats are provided with the system, for 70mm (2.75") and 85mm (3.34") OD casing respectively. The seats provide a solid reference for the cable crimps to sit in. The result is that operator error is reduced, checksums will be smaller and surveys more accurate.

The thin, strong cable contains a Kevlar® strength member, allowing a long length of cable to fit on a small reel with no stretch. The aluminum sleeved measure marks are precision swaged to the cable and are not subject to tearing when handling. The measure marks are spaced at 0.5 metre or 2 feet intervals. The cable is marked with a red measure mark and a label every 5 metres or 10 feet depending on whether the metric or imperial system is being used. The urethane jacket is highly abrasion resistant, and maintains flexibility at low temperatures. It is good practice to avoid running the cable over sharp edges and to periodically clean it with a clean soft cloth. Be sure to keep the protective cap on the connector whenever the probe is not in use and avoid dropping or banging the cable end. Always keep the connectors and threads clean by rinsing them with water. Exercise care when connecting and removing the cable from the probe. Make sure to only turn the connector ring, not the entire cable.

Note

For reels with the serial number **under 2500**, refer to Appendix A for instructions on how to remove and recharge the battery. Only reels with a serial number under 2500 may be removed from the reel. Do not attempt to remove the battery from the reel if the serial number on the reel is 2500 or higher.

For reels with the serial number at 2500 or higher, refer to Section 3.1 for battery status and Section 3.2 for instructions on how to recharge the battery. Only reels with a serial number of 2500 or higher may be recharged. Do not attempt to remove the battery from the reel if the serial number of the reel is 2500 or higher.

3.1 INCLINOMETER REEL BATTERY

The battery is contained inside the inclinometer reel. The inside of the reel is inaccessible to the user and the battery is not removable. **Do not attempt to remove the battery.**

The inclinometer reel has a green LED light that will flash to indicate battery status. The LED light on the reel will flash when the power button is pressed.

Monitor the battery status. **Do not let the battery completely discharge**. A full charge will last around 30 hours.

LED Flash	Battery Status
1 flash, reel does not power on	Battery completely discharged
2 flashes, reel does not power on	Battery discharged below level required to connect
1 flash, reel powers on	Battery discharged below 25%
2 flashes, reel powers on	Battery discharged below 50%
3 flashes, reel powers on	Battery discharged below 75%
4 flashes, reel powers on	Battery is at full charge.

3.2 Charging the Battery (for reels with serial number of 2500 or higher)

Note

Refer to Appendix A if the reel serial number is under 2500. Do **not** proceed with the following instructions if the reel serial number is under 2500.

The following instructions are for reels with the serial number of 2500 or higher.

The battery will need to be recharged using the provided charger. The battery port may be accessed by unscrewing the cap on the reel. Refer to Figure 7 for the location of the battery cap.

Figure 7 – Unscrewing the Battery Cap

Unscrew the battery cap by turning it counter clockwise. The charger will plug into the port and begin charging the battery. Replace and tighten the cap to ensure debris does not enter the battery port.

3.3 Wireless Communication

Turn on the power to the reel by pressing the button located to the left of the battery housing on the Reel Hub. A solid green light indicates the reel has been powered on. After turning on the power to the reel, it automatically searches for a connection to the Ultra-Rugged Field PC. Once the Ultra-Rugged Field PC is powered up, and the RST Digital Inclinometer software is launched, it will automatically try and link to the reel. The light indicator will flash rapidly when the reel is communicating with the probe. During Ultra-Rugged Field PC wireless communication, the reel indicator light will blink with 1 second intervals. The status of the connection is also displayed on the status screen or on the bottom of the main menu screen (see section 4.2.6).

Note

The reel incorporates power saving feature. After 5 minutes of inactivity and lack of Ultra-Rugged Field PC wireless communication, the reel will power down automatically to save battery charge.

4 Ultra-Rugged Field PC

The RST MEMS Digital Inclinometer System comes with an Ultra-Rugged Field PC running Microsoft Mobile Windows™, which is the heart of the system. This hand-held device functions as a readout and data storage device. Data reduction can be performed “at-the-borehole” as soon as the survey is complete. The program has the ability to create plots of the data instantly. This is important if on-site personnel require immediate results to verify that data is accurate. No time is wasted by having to take the readout back to the office to download and process the data.

An overview of the Ultra-Rugged Field PC2 is provided in the following sections. The Field PC2 consists numerous features that may be omitted in this manual. A more thorough guide may be accessed here.

4.1 OVERVIEW

The Ultra-Rugged Field PC is well suited for use in the often demanding field conditions.

Figure 8 – Ultra-Rugged Field PC

4.2 USING THE ULTRA-RUGGED FIELD PC

Once the inclinometer probe is connected to the reel and the probe is ready to be placed in the borehole, turn on the power to the Ultra-Rugged Field PC by pressing the power button (Figure 9).

Figure 9 – Overview of Ultra-Rugged Field PC

Front Image

1. Elastomer overmold
2. Touchscreen
3. Buttons Control
4. Hold-to-Zoom
5. Pictures and Videos
6. Tab button
7. Home Screen
8. Shift Function
9. Microphone
10. Keypad buttons
11. LED Indicator
12. Power button
13. Enter button
14. Backspace
15. Context Menu Button
16. Right Soft Key

Back Image

17. Speaker
18. Battery Door
19. Hand Strap
20. Stylus
21. Stylus Tether

Bottom Image

22. USB client (micro USB)
23. Microphone/Headphones jack

24. 12V DC jack
25. USB host (full size USB)
26. 9-pin serial port

Note
DC charging is done through the 12V DC jack (barrel connector, bottom left of the unit).

Once the power is turned on, use the stylus to navigate through the operating environment. If you are unfamiliar with the Microsoft Mobile Windows™ operating environment, please refer to the "*Getting Started Guide*" which is supplied on CD-ROM with the Ultra-Rugged Field PC. From the *Start* menu, choose: *Digital Inclinometer* to launch the Digital Inclinometer Software. A screen similar to the following will appear:

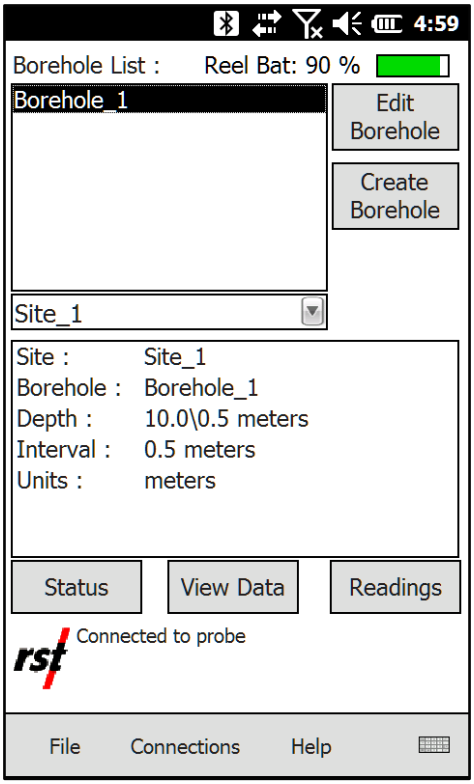

Figure 10 – RST Digital Inclinometer Software Main Menu

Upon start-up, the inclinometer will automatically begin searching for the Reel and Inclinometer Probe. This status is displayed at the bottom of the screen.

The opening screen (Figure 10) displays the current set-up and status of the system. The top menu provides a list of the current boreholes (a default site/borehole will appear, if none have been created). Underneath the borehole list is a drop-down dialog which is used to choose the site.

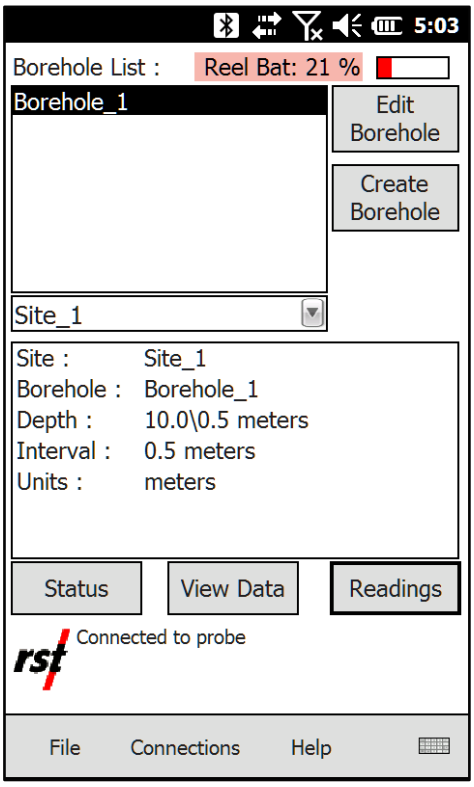

Figure 11 – RST Digital Inclinometer Software Main Menu

4.2.1 Battery Status

The reel battery status is located at the top right of the main menu screen. It shows the real-time status of the battery

Should the battery charge drop below 25%, the battery status will turn red (Figure 11). This indicates that the battery will not last more than a few more hours. The device should be plugged into a power source to recharge the battery.

4.2.2 Menu Items

The *File* menu allows the user to backup the current files to the Field PC non-volatile memory location and also Exits the Digital Inclinometer program. For more information on the backup function please refer to section 9.

The *Connections* menu allows the user to view the status of the Bluetooth (radio) connection and allows the user to disconnect and reconnect to the reel and probe manually. Should a new Reel be used (i.e. a replacement which was not supplied with the original system), the Ultra-Rugged Field PC needs to be made aware of this new instrument, and thus the Bluetooth Connections must be changed. For further information please refer to section 16.

4.2.3 Creating a Site and Borehole

To create a new borehole and site, click on the "*Create Borehole*" button on the Main Menu and the following screen will appear:

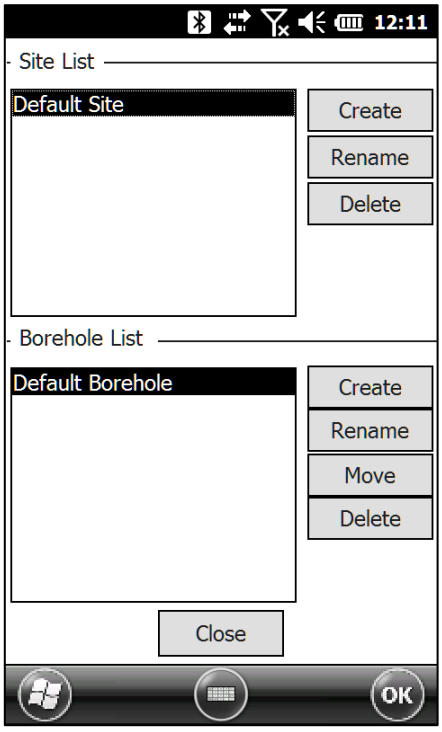

Figure 12 – Creating a Site and Borehole

First, create a new site by pressing the *Create* button under the *Site List* heading. This brings up the following screen:

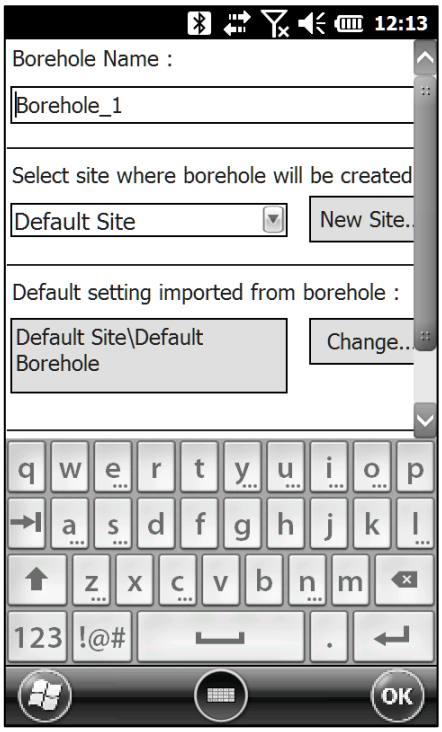

Figure 13 – Create Site

Please note that the remote keyboard automatically pops up when this screen is selected. Touching the keyboard icon in the bottom of the screen can hide the keyboard. Press *New Site…* and enter the new site name and borehole name in the appropriate dialog boxes. Once the new site and borehole is entered, press *OK*. Both site name and borehole names

can be edited, deleted, re-named and moved by pressing the appropriate options on this screen. To return to the main menu, press the *Close* button at the bottom of the screen (after hiding the remote keyboard), or press *OK* at the top right of the screen.

4.2.4 EDITING A BOREHOLE

Pressing the *Edit Borehole* button on the main menu screen invokes the following screen:

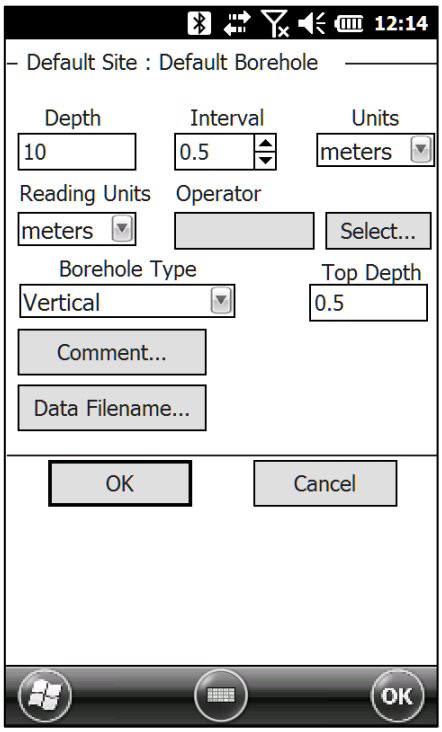

Figure 14 – Edit Borehole Screen

The site and borehole name appear at the top of the screen (in this case they are “default”) followed by *depth, interval, units* and *reading units.* Set *depth* to the depth of the borehole of the lowest reading you wish to take (match this to the cable marking). Choose the *interval* and *units* based on whether you are using a metric or imperial probe. In most cases this will be either 0.5 metres or 2 feet, which is equal to both the length of the probe and the divisions marked on the inclinometer cable.

The Horizontal Borehole checkbox should be used only when connecting horizontal probe. For all other probes, the Horizontal Borehole checkbox should be cleared.

Pressing the *Comment* button invokes a screen where comments can be made about the site, borehole information etc. Comments are entered using the remote keyboard.

Pressing the *Data Filename* button brings up the following screen:

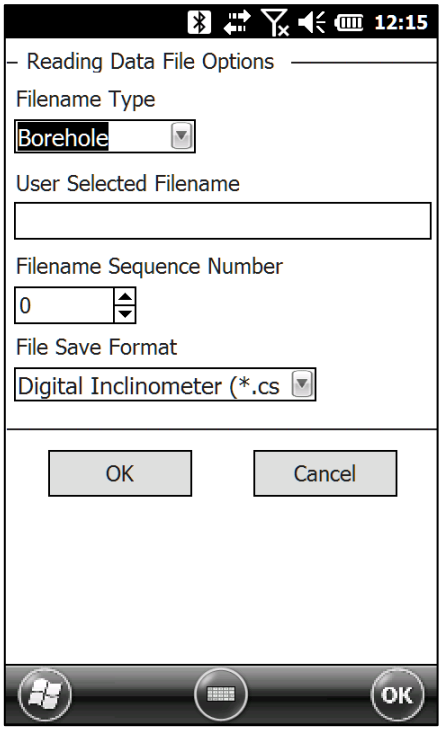

Figure 15 – Data Filename Screen

Filename Type can be chosen by the drop-down menu. Options under this menu include *User Selected, Borehole, Site* and *Site Borehole.* These options specify the name of the file to be written after the borehole is surveyed. If *User Selected* is chosen, enter the name in the dialog box under *User Selected Filename*. The *Filename Sequence Number* defines the numeric label of the file name. All subsequent files will be named in sequence. For instance, if you had a *User Selected File* named "Test", subsequent files will be named: Test(2), Test(3), etc. (incremented by 1).

Note

The default filename for an inclinometer survey is the *Borehole* name. If *User Selected* is chosen as the file format, and the *User Selected Filename* dialog box (Figure 15) is left blank, the software will default to the *Borehole* name. In most cases, it is recommended that the data files be managed using the *Borehole* name, as this will avoid confusion between multiple sets of data under a single *Site*.

4.2.5 FILE SAVE FORMATS

File Save Format enables the user to choose which format to save the inclinometer file in. To change the file save format choose the appropriate option from the drop-down list as shown in Figure 15. These are outlined below:

1. ***Digital Inclinometer (*.csv)*** format: Files are saved in a format which includes the probe serial number in the header file.
2. ***Standard RST(*.csv)*** format: This is the default file setting and is compatible with RST Inclinalysis™ software. Files are saved as *.csv (comma separated value). This data format also has the ability to be imported into most popular spreadsheet software. Files of this type can also be imported into GTilt (section 17.3).
3. ***RPP Format (*.rpp)***: This type of file can be imported into Inclinalysis™ and is also compatible with Slope Indicator's software including DMM for Windows and DigiPro. GTilt and GTilt Plus software also has the ability to import *.rpp file formats. If directly comparing data between two inclinometer systems, please ensure that the depth placement of the probe is identical between the surveys with the two different systems. For further reference on importing *.rpp files into Slope Indicator's software, please see section 17.1.
4. ***Standard RST (*.dty):*** File format designed to be imported directly into GTilt and GTilt Plus software. Please note however, that the other file types listed above can also be imported into GTilt.

Once the correct data file options have been chosen, exit the *Reading Data File Options* screen by pressing *OK*. If you want to exit without saving the changes, press *Cancel.* You will be returned to the *Edit Borehole* screen. If all the parameters in the *Edit Borehole* screen are correct press *OK*, else press *Cancel* and you will be returned to the *Main Menu*. The new borehole information will be displayed in the bottom half of the *Main Menu* screen. Verify that these settings are correct.

4.2.6 STATUS SCREEN

Navigate to the *Status Screen* by pressing the *Status* button on the main menu. The following screen will appear:

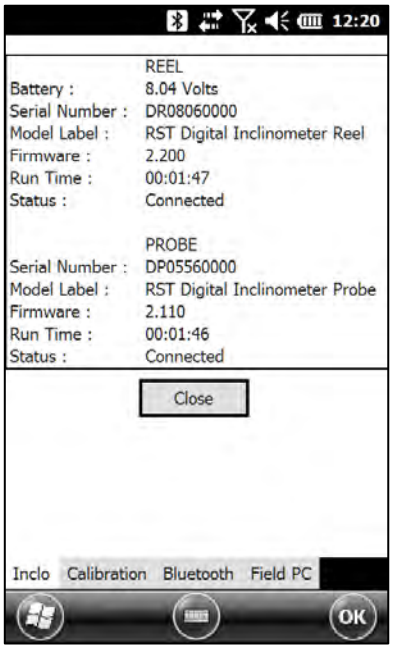

Figure 16 – Status Screen

If the Ultra-Rugged Field PC is connected to the Reel and the Probe, information will appear in the appropriate areas. If there is no connection the information fields will be blank (and the status will read *not connected*). Vital information for both the Reel and the Probe is displayed which includes: Battery Voltage, Serial Number, Model Label, Firmware Version, Run Time and Status.

Choosing the *Calibration* tab invokes the following screen:

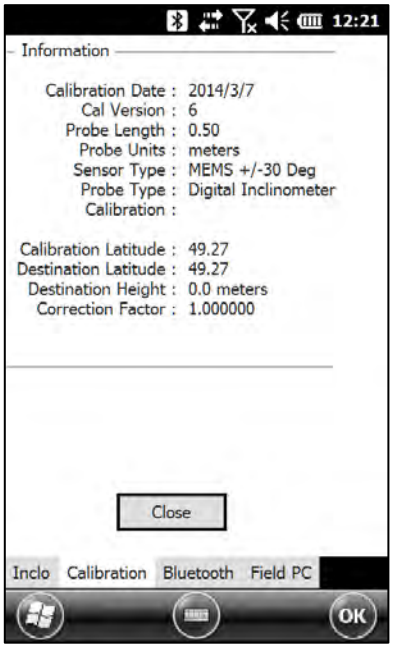

Figure 17 – Calibration Screen

The *Calibration Screen* provides information about the calibration date, calibration version, probe length and probe units (metric or imperial). Corrections can also be made to individual inclinometer probes to account for latitude and elevation changes.

Note

RST highly recommends that the inclinometer probe be calibrated on an annual basis. The probe should also be recalibrated if it has been exposed to any type of shock or shows high checksum values for no apparent reason.

Clicking on the *Bluetooth* tab brings up the following screen:

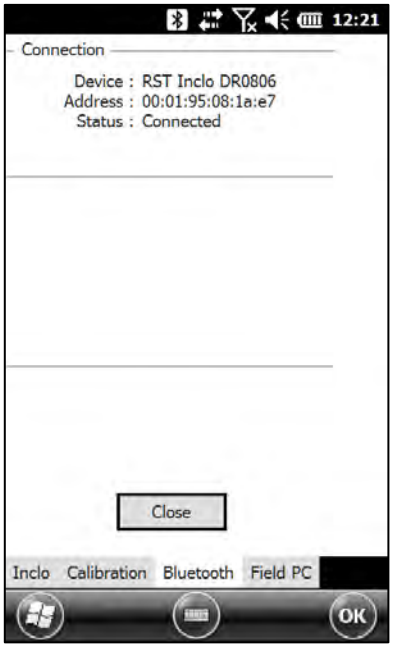

Figure 18 – Bluetooth Status Screen

The Bluetooth Status screen indicates which device is connected and the status of the connection. Please note that the range of the Bluetooth radio is approximately 10 metres and this distance may vary depending on objects and line of site.

The above two screens are used primarily to confirm that the Ultra-Rugged Field PC has established wireless communication with the Reel and Digital Probe and to display the hardware information. If communication has not been established, the hardware information will not display until a satisfactory connection has been made.

Pressing the *Field PC* tab brings up specific information about the Ultra-Rugged Field PC serial # as shown in the following screen:

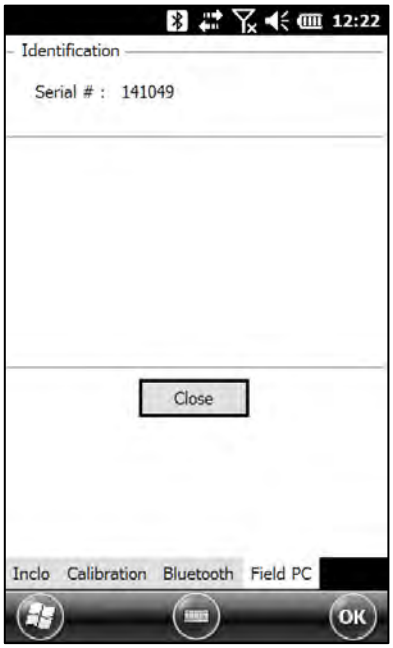

Figure 19 – Field PC Status Screen

4.2.7 READINGS

Once you have set up the Site Name, Borehole Name, Filename and the Ultra-Rugged Field PC has successfully connected to the Reel and Digital Probe (see *Status* Screen) you are ready to begin logging the borehole. This menu is only accessible once the readout is connected to both the Reel and the Digital Probe. From the *Main Menu*, pressing the R*eadings* button invokes the following screen:

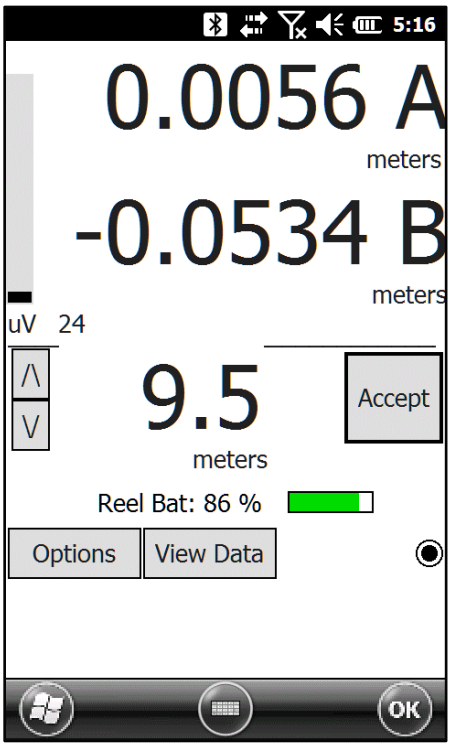

Figure 20 – Readings Screen

After a few seconds the real-time reading should appear as in Figure 20. This screen shows the real-time data in both the A and B axes. The units are displayed underneath both sets of readings. To the left of the readings is a dynamic bar which indicates the noise level (i.e. the difference, reported in microVolts, between subsequent readings). The user should wait until the noise level is at a minimum before taking a reading. This minimum can vary depending on the site conditions. In particularly noisy environments (i.e. heavy equipment is moving in the vicinity) the amount of averaging can be adjusted to help reduce the noise (for more info. please refer to the *Averaging Data* section in this manual, section 6.5 and Figure 21). The number displayed under the noise bar reports the microVolt change between successive readings. It should simply be used as a reference as to how noisy the readings are, this number does not correlate directly to the measurement units, it simply indicates the microVolt change between each subsequent measurement (1 measurement per 0.4 second).

The current depth of the instrument in this example is set to 10.0 metres. Pressing the *Accept* button will store the reading and the depth will move to whatever the next interval is set at (i.e. 9.5m). The arrow keys allow the user to scroll up and down the readings which permits re-taking readings if necessary.

Note

Be careful not to miss any data intervals when using the scroll feature as this can offset the data. At any time the user is able to view the data by pressing the *View Data* button to confirm that they have the probe in the correct location and the readings at that depth have been taken correctly.

The small black dot on the right hand side of the screen appears whenever data is being sent from the probe.

Once the top of the hole has been reached, the software will prompt the user to turn the probe 180° and lower it back to the bottom of the hole (unless the user specifically sets the software to only take a single set of readings, please see the *Advanced Options Menu,* Figure 22). The readings will automatically start at 10.0 metres once again (in this example). Check-Sum data will appear in a smaller font underneath the current readings. The real-time check-sums allow the user to monitor the second set of readings. If the check-sum is large or inconsistent, either the probe has fouled or the probe is not at the correct measurement depth. Continue logging until the top of the hole is reached. If the probe has been accidentally raised above the measurement point, lower the probe back down below the proper depth and then raise it slowly to the correct depth. This ensures consistent and accurate readings. Once the top is reached on the second pass, a dialog box will appear that says "Readings Complete". The software will then save the data to the filename which was specified in the *Reading Data File Options* screen.

Pressing the *Options* button on the readings screen brings up the *Readings Options* screen:

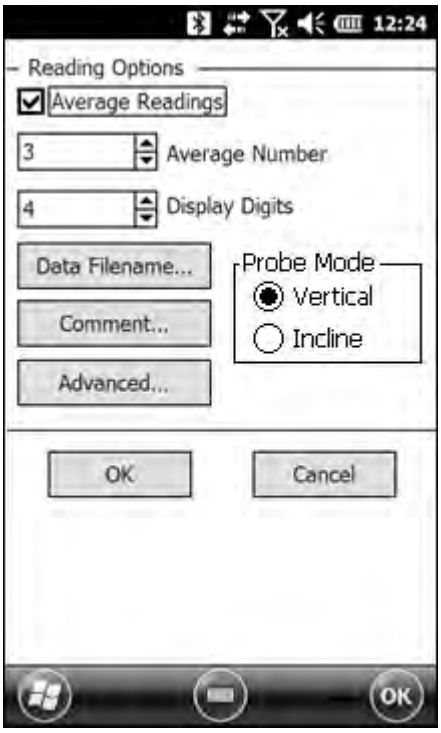

Figure 21 – Readings Options Screen

This option allows the user to specify whether or not the data from the probe is to be averaged. The number of readings to be averaged can be set in *Average Number* dialog box.

Note

Readings from the probe are taken once 0.4 second, therefore increasing the amount of averaging means that you increase the wait time between taking readings (i.e. if an averaging value of 5 is chosen, you must wait at least 2 seconds after moving the probe before taking a reading).

The number of decimals shown can be changed in the *Display Digits* dialog box. Pressing the *Comment* button permits the user to make any comments about the data set and the *Data Filename* allows the user to change the name of the data file the information is written

to upon completion of logging the borehole (for additional information please see section 4.2.3).

When the incline capable probe is connected, the Probe Mode settings allow switching between vertical mode and incline mode. The Probe Mode settings do not appear for single mode probes. For further info regarding Incline probe, refer to Section 5.3.

Pressing the *Advanced* button brings up the following screen:

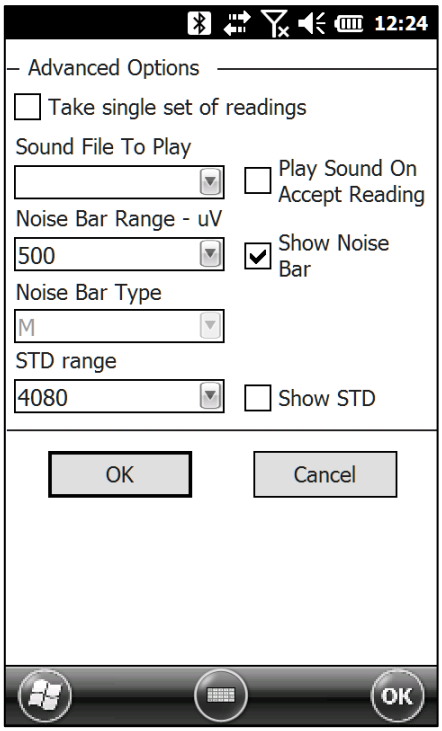

Figure 22 – Advanced Options Menu

The first check box allows the user to specify whether or not to take a single set of readings during a borehole survey. The inclinometer readout will save the data after a single pass of the borehole. A sound option allows the user to turn on/off the sound upon acceptance of a reading. User specified sound files (*.wav) can be placed in the following directory:

My Device\My Documents\Digital Inclinometer\SoundFiles\

This allows the user the option to have a custom sound played each time a reading is taken. The default sound is a simple beep.

The Noise Bar can be turned on and off and the drop-down menu provides a choice for the limit of the range of the Noise Bar. The numbers represent microVolt reading from the inclinometer probe. The last pull-down menu allows the option to display the standard deviation of the incoming data. This range can also be adjusted, depending on how noisy the readings are in the field. Measurements should be taken at the point of least noise whenever possible to obtain the most accurate readings.

4.2.8 VIEW DATA

By pressing the *View Data* button from the main menu, the following screen appears:

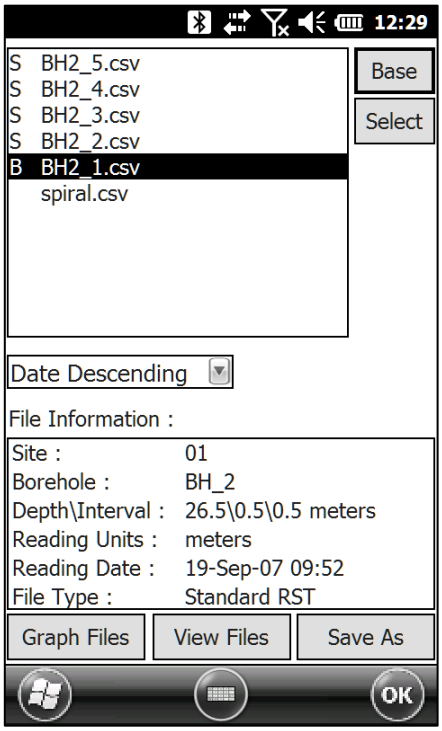

Figure 23 – View Data Screen

All borehole data files associated with the particular borehole that has been selected (from the Main Menu) will appear in the top dialog box. The detailed file information appears on the lower half of the screen and this includes: *site, borehole, depth/interval, reading units, reading date and file type*. Filenames can be sorted by date, type or name by selecting the appropriate option in the drop-down box.

In order to display the data, the appropriate files must be chosen from the list. To select a file, first highlight the file in the top dialog box and then press the S*elect* button. If the file has been selected, an "S" will appear to the left of that file. To choose a base file, highlight the appropriate file and press the *Base* button. A "B " will appear to the left of the file name confirming that this file is now the base file. Note that the *Base file* and the *Selected files* can be changed at any time by highlighting the file and pressing the *Base* or *Select* buttons. The software only allows the user to have a single *Base File*. To unselect any file, simply highlight that particular file and press either *select* or *base* a second time and the *B* or *S* to the left of the file will subsequently disappear.

The base file represents the original survey of the inclinometer hole, from which all other measurements are compared. Typically, a base file is chosen and kept the same throughout the life of the inclinometer hole in order to quantify any lateral displacements which occur.

Once the appropriate files are chosen, the user can choose to display the data in tabular format by pressing the *View Files* button, or in graphical format by pressing the *Graph Files* button.

Pressing the *Graph Files* button will bring up the following screen:

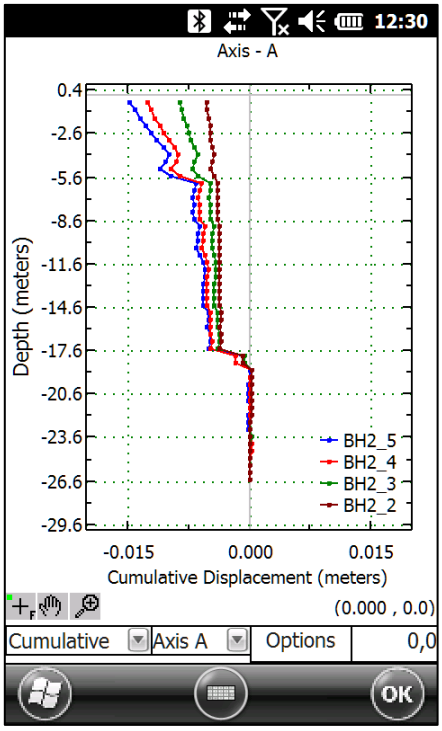

Figure 24 – Graphing Files

Several tools are available in the bottom pull-down menus to allow manipulation of the graph. The left-hand pull down allows the user to choose how the data is displayed, with Mean, Absolute, Cumulative or Checksum options. The centre menu allows the user to choose between plotting either the A or B axis. The third menu *Options*, allows the user to manipulate the cursor, zoom, pan, change the scale, move the legend, or change the appearance of the graph. Three icons also appear in the bottom left of the screen which allow further manipulation of the graph. These are self-explanatory and the user is encouraged to explore these options if required. The default setting for all plots is *auto-scale*.

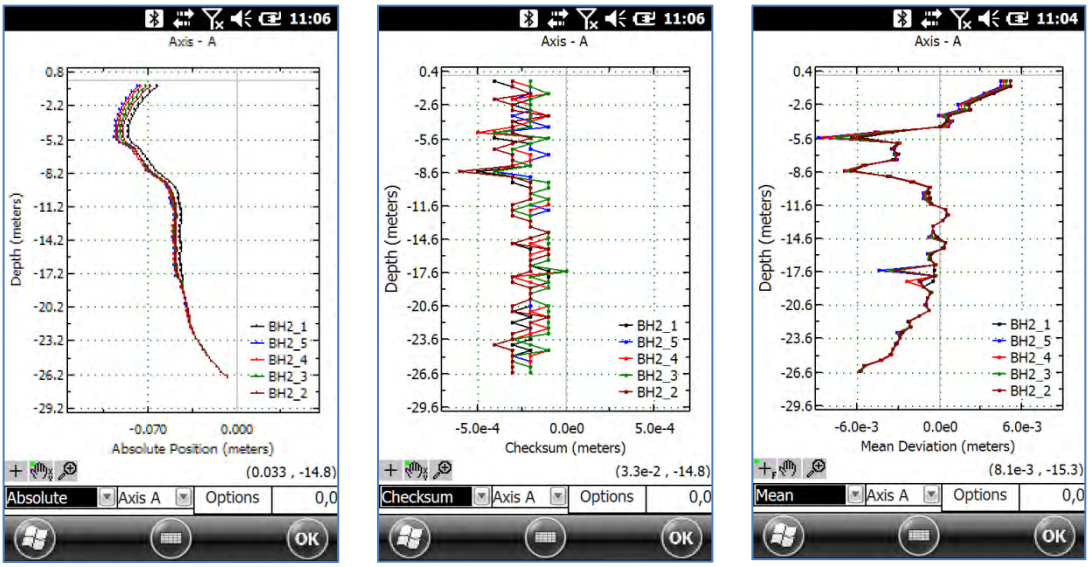

Figure 25 – Other Graph Types

To exit the graphical display, hit the *OK* button in the top right corner of the screen.

Pressing the *View Files* button invokes the following screen:

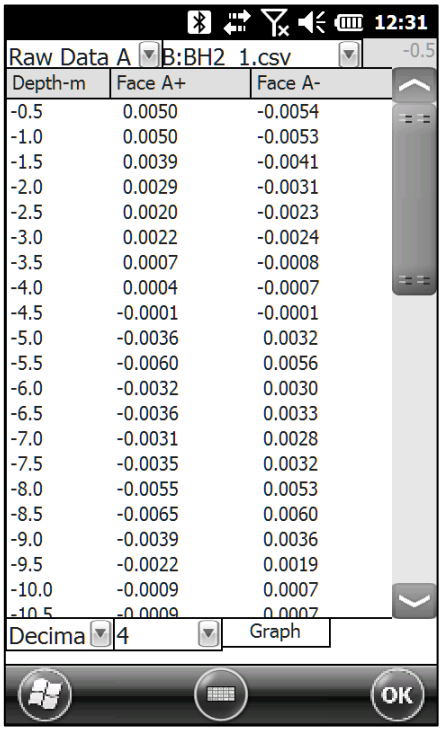

Figure 26 – Viewing Files

The top left pull-down menu allows the user to change the type of data that is reported in the table. The options include: Raw Data A, Raw Data B, Checksum, Mean, Absolute and Cumulative. The top right pull-down menu is used to choose which of the selected data files is currently being displayed. Please note that the base data file will contain the prefix "*B:"* so that it can be easily identified.

The bottom portion of the screen has three menus which allow the user to display the data in either decimal or scientific notation, change the number of decimal places displayed, and a *graph* button which takes you to the graph data screen. At any time you may exit from this screen by pressing *OK* in the top right corner of the screen.

Pressing the *Save As* button invokes the following screen:

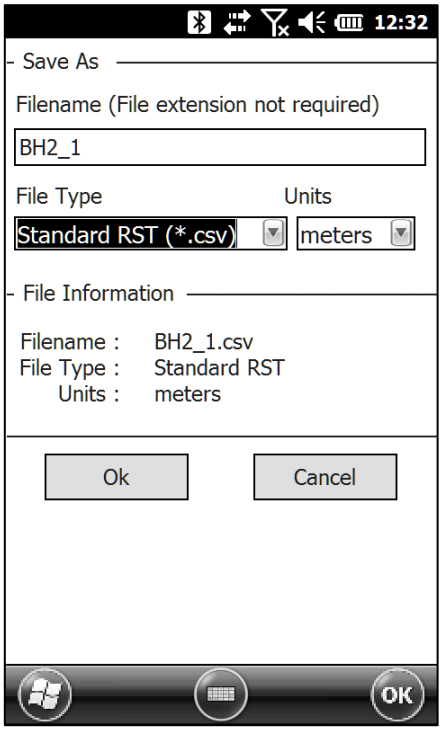

Figure 27 – Save As… Option

This function allows the user to edit the filename, file type and the measurement units. For more on file formats please refer to section 4.2.5.

5 PROBE TYPES

5.1 VERTICAL PROBE

Vertical probe collects data in A and B axis. It is the most commonly used probe. Readings taken from the inclinometer probe are actually deviations from the vertical over the distance between the upper and lower wheels. The probe is passed through the inclinometer casing, and every 0.5m (or 2ft.) a reading is taken. When the probe is at rest, MEMS accelerometers sense the inclination of the access tube in two planes. This inclination is displayed in terms of angular DEVIATION, which is recorded at that particular depth.

5.2 HORIZONTAL PROBE

The function of the MEMS Horizontal Inclinometer Probe is very similar to the standard biaxial (vertical) probe. Each individual survey requires the probe to be drawn or pulled through the casing, then reversed and passed through the casing again (probe is reversed end for end – not rotated axially 180° as in a vertical inclinometer survey). Measurements are collected at 0.5m intervals with the metric probe or 2 ft. intervals with the imperial probe. The readings taken represent the vertical displacement, defined by (½m)*(SIN (a)), where "a" is the angle between the horizon and the longitudinal axis of the probe.

5.3 INCLINE PROBE

Incline probe gives readings in borehole at 35 degree tilt.
There is one data set of interest, and that is axis A. Since there is only one pass, A- is filled up with A+ readings of opposite sign. A axis data represent displacements from 35 degree angle on the length of the probe.
B axis data is collected from other vertical sensor. Since that sensor is at an angle too big to read accurately, it is used here for a reference to show that the probe was inserted correctly. Data in B axis should be as close to zero as possible.
There is no need to edit data file to be able to display graphs in Inclinalysis. Graphs will be shown. Inclinalysis can be easily switched to A graph only to show important graph only.

5.4 COMPASS PROBE

Compass probe provides azimuth data for horizontal installations. The probe is passed through the inclinometer casing and compass sensors read azimuth at pre-set intervals.

5.5 SPIRAL PROBE

The RST Digital Spiral Probe is designed to complement the RST Digital Inclinometer System. In situations were excessive spiral is present in the inclinometer casing, it becomes important to correct for the spiral in order to have the correct magnitude of displacement in the A and B axes.

The software displays the spiral readings directly in degrees. Logging the spiral data is done in a similar manner as an inclinometer survey. To begin the survey, push *Start* button. The initial position is then measured. *Accept* button needs to be pressed when in manual mode. In *Auto Accept* mode, the probe will sense movements and the reading will be taken automatically without the need to press any buttons. The reading mode can be changed on Options screen

6 DOWNLOADING DATA TO A DESKTOP PC

The software used to transfer data will depend on the version of Microsoft Windows installed on a desktop PC.

For Windows XP versions, ActiveSync™ is required. Windows Vista, windows 7, 8,8.1, and Windows 10 needs Mobile Device Center 6.1. It is highly recommended to download and install the newest updates from Microsoft website.

6.1 INSTALLING MICROSOFT ACTIVESYNC™ ON WINDOWS XP

In order to communicate between the Ultra-Rugged Field PC and a desktop PC or laptop, Microsoft's ActiveSync™ software is required and is included with the Digital Inclinometer System. Communication between the two devices is achieved through an USB connection.

Note

Microsoft's ActiveSync™ software can be freely downloaded from Microsoft's website.

Important

Don't connect the USB cable before installing ActiveSync™ software. Doing so will result in installation of generic Windows USB drivers which will not work with Ultra-Rugged Field PC.

To install Microsoft ActiveSync™:

1. Insert the Ultra-Rugged Field PC Companion CD into the CD-ROM drive. On most systems, Windows will automatically launch the setup program. Minimum system requirements are outlined in the jacket of the CD-ROM. Once the CD is up and running, a graphical window will open. Press the *play* icon on this window.
2. Click the link marked *Start Here.*
3. Click *Install ActiveSync.* Note: When prompted to download the file, select *Run this program from its current location.* Installing Microsoft Outlook is **not** necessary, for the Digital Inclinometer System to function. If you wish to use the Ultra-Rugged Field PC for e-mail, install Outlook.
4. Follow the on-screen instructions until you reach the screen shown below, and then continue with Step 5.

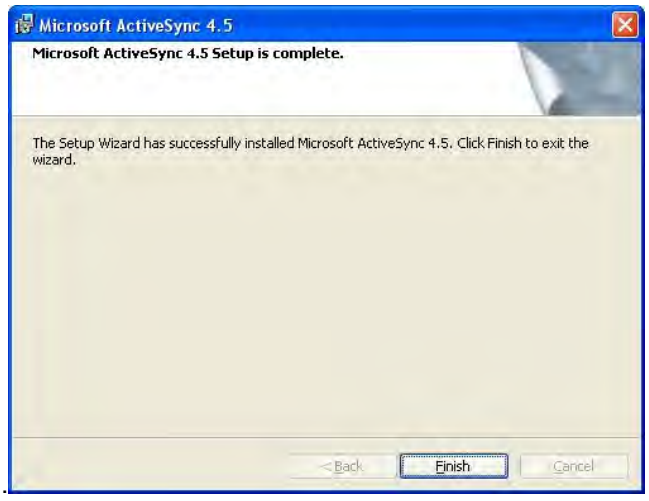

Figure 28 – ActiveSync Connection Screen

5. Click Finish button.

6. Insert the AC Adapter plug into an electrical outlet (Figure 1, item 10). Connect the AC connector barrel connection on the base of the Ultra-Rugged Field PC (Figure 9, item 24).
7. If you have not already done so, connect the micro USB connector to the connector on the base of the rugged case and the USB connector to the USB port on either the front or back of your personal computer.

Note

ActiveSync will automatically detect the Ultra-Rugged Field PC connection.

8. Continue to follow the ActiveSync instructions to establish a partnership. Eventually you will come to a screen like the one below:

Figure 29 – Setting Up a Partnership

In order to synchronize the data in real-time between the Ultra-Rugged Field PC and the desktop PC, you must set up a *sync partnership.* If you do not wish to synchronize data and simply use Windows Explorer to copy files to and from the Ultra-Rugged Field PC, click Cancel to leave the connection as *Guest Partnership* and skip the remaining instructions.

1. To set up a *sync partnership,* press *Next.*
2. Uncheck the option for synchronizing with Microsoft Exchange Server, press *Next.*
3. Decide what type of information you would like synchronized with the desktop computer. If you are only using the Ultra-Rugged Field PC for the purposes of transferring Digital Inclinometer information, uncheck all the options and place a check mark next to the *Files Folder* (see below).

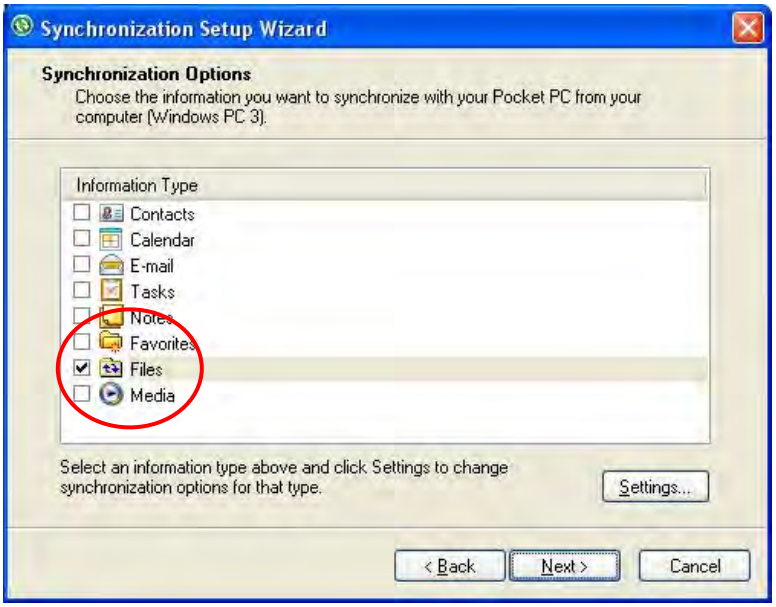

Figure 30 – Synchronization Settings

The software will notify you that it will create a folder on the desktop which links directly to the Ultra-Rugged Field PC (*press OK*). Click Next, and then Next on following dialog, then Finish the installation. Once the partnership is established, the PC will recognize and automatically synchronize to the Ultra-Rugged Field PC each time it is connected with the USB cable.

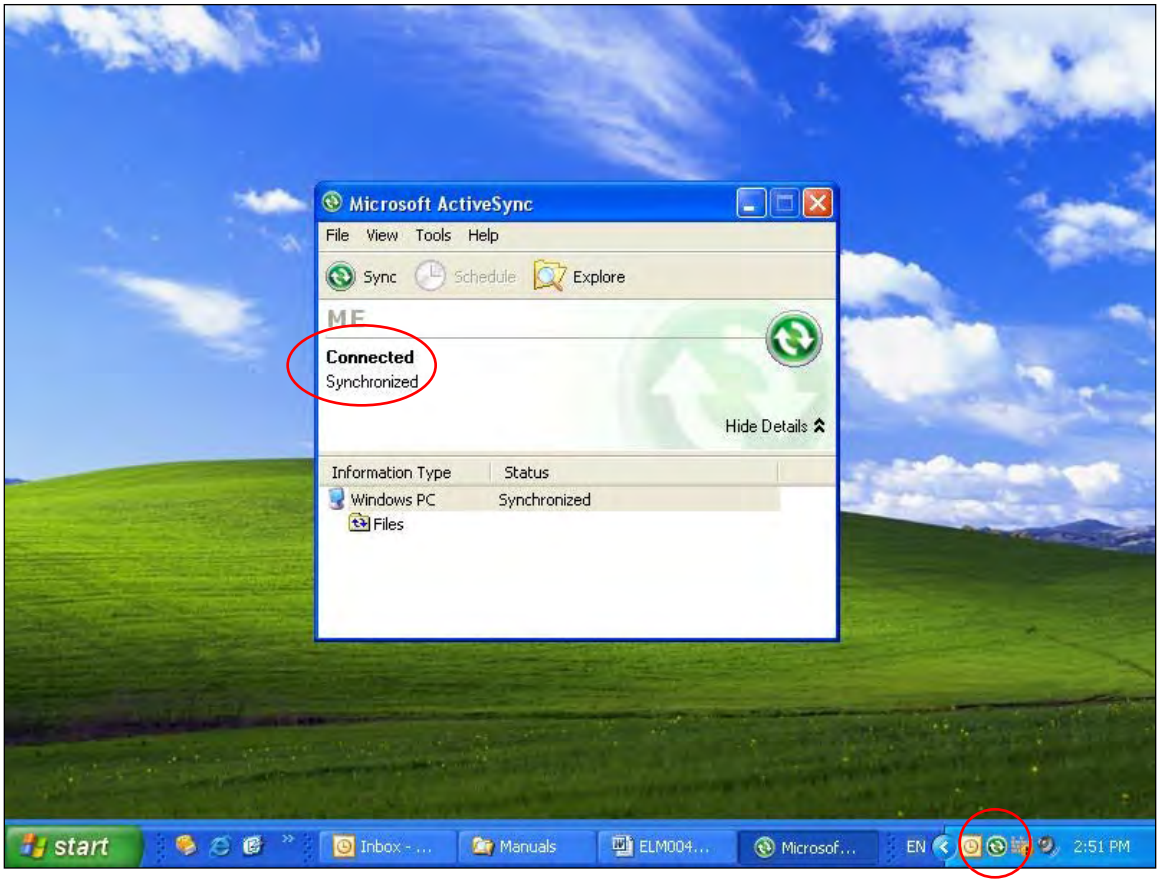

Figure 31 – ActiveSync Screen

Important

It is extremely important that the user realizes that the synchronized folder created on the desktop is an **active** link to the Ultra-Rugged Field PC. Any changes you make in that folder will be reflected on the Ultra-Rugged Field PC. For example, if you delete a file in the folder, the same file will be deleted on the Ultra-Rugged Field PC. If the Ultra-Rugged Field PC happens to be disconnected at the time, as soon as it is re-connected it will automatically see the missing file in the folder and the file will be deleted during the connection. It is therefore important to exercise good data management. Once the data is synchronized to the PC, move the inclinometer files to a safe location (i.e. a network server or hard drive).

For further instructions regarding synchronizing data between a PC and the Ultra-Rugged Field PC, please refer to the supplied documentation and software which comes with the Ultra-Rugged Field PC (CD-ROM).

6.2 SETTING UP MOBILE DEVICE CENTER ON WINDOWS VISTA, WINDOWS 7, 8, 8.1, 10

Before connecting to Ultra-Rugged Field PC, it should be verified that desktop PC or laptop contains current version of Microsoft Mobile Device Center™. Communication between the two devices is achieved through an USB connection.

Note

Microsoft's Mobile Device Center™ software can be freely downloaded from Microsoft's website. Choose 32 bit or 64 bit version depending on Windows Vista™, Windows 7 or Windows 8 operating system.

After Mobile Device Center™ is installed, connect the Ultra-Rugged Field PC to desktop or laptop computer using USB cable provided with the Digital Inclinometer System. Microsoft Windows ™ should detect new connection and display following dialog box.

Figure 32 – Mobile device Center Screen

In order to synchronize the data in real-time between the Ultra-Rugged Field PC and the desktop PC, you must click on *Set up your device.* If you do not wish to synchronize data and simply use Windows Explorer to copy files to and from the Ultra-Rugged Field PC, click *Connect without setting up your device.* Data files can be copied from Ultra-Rugged Field PC using File Management, as shown on Figure 34.

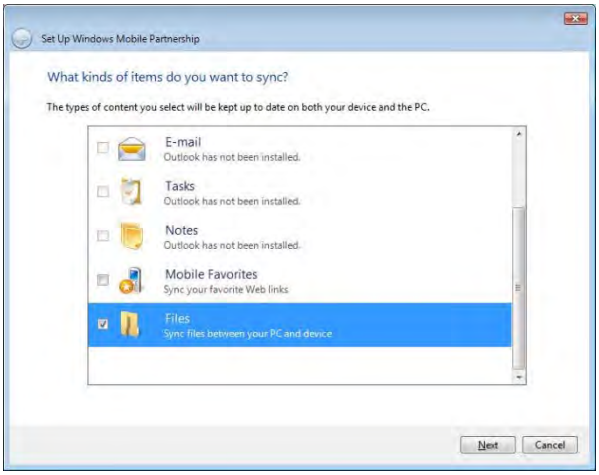

Figure 33 – Synchronization Settings on Windows Vista™, Windows™ 7, 8, 8.1, 10

If synchronizing files, decide what type of information you would like synchronized with the desktop computer. If you are only using the Ultra-Rugged Field PC for the purposes of transferring Digital Inclinometer information, uncheck all the options and place a check mark next to the *Files* (see above).

Figure 34 – Accessing Files on Windows Vista™, Windows™ 7 ,8, 8.1, 10

Important

It is extremely important that the user realizes that the synchronized folder created on the desktop is an **active** link to the Ultra-Rugged Field PC. Any changes you make in that folder will be reflected on the Ultra-Rugged Field PC. For example, if you delete a file in the folder, the same file will be deleted on the Ultra-Rugged Field PC. If the Ultra-Rugged Field PC happens to be disconnected at the time, as soon as it is re-connected it will automatically see the missing file in the folder and the file will be deleted during the connection. It is therefore important to exercise good data management. Once the data is synchronized to the PC, move the inclinometer files to a safe location (i.e. a network server or hard drive).

For further instructions regarding synchronizing data between a PC and the Ultra-Rugged Field PC, please refer to the supplied documentation and software which comes with the Ultra-Rugged Field PC (CD-ROM).

6.3 FILE MANAGEMENT

Once the Ultra-Rugged Field PC has been synchronized to a desktop computer, file management simply takes place using Windows Explorer. Files can be copied and/or deleted easily using drag and drop features. Using Windows Explorer is the easiest and most effective way of managing the Inclinometer Data on the Ultra-Rugged Field PC. File structure is straight forward and has the following format:

Figure 35 – File Structure

Where:

- RST = Site Name (user defined)
- Parking Lot = Borehole Data (user defined)

For additional information on the naming of sites and boreholes please refer to section 4.2.4.

Note

As with any modern digital peripheral device, data management is very important. In order to keep the system un-cluttered, it is extremely important to delete site and/or borehole data files off the Ultra-Rugged Field PC once the data is saved in a safe location on your PC and when the data is no longer required to reside on the Ultra-Rugged Field PC. Deleting files is simple with Microsoft ActiveSync™, because it creates an “active” connection. Any files which are deleted from the synchronized folder on the PC will be deleted on the Ultra-Rugged Field PC.

The Digital Inclinometer Software does not provide a means to delete the data files within the Ultra-Rugged Field PC. Data file management should be performed solely through the desktop PC. Once you have copied the data to a safe location, delete the necessary files/folders within the synchronized folder, and the corresponding files will be deleted on the Ultra-Rugged Field PC.

6.4 POST- PROCESSING THE DATA

The RST Digital Inclinometer system currently stores borehole survey data in a variety of formats, including *.csv format. Once the data has been downloaded/synchronized to a desktop PC or laptop (see section 6) it can be opened directly with RST Inclinalysis™ Software or Microsoft Excel™. If opened in MS Excel, the data will have a format similar to the one outlined below:

INCLINOMETER DATA
SITE CODE : RST Test
BOREHOLE CODE : Test Hole 1
FACES LOGGED : ABCD
TIME/DATE TAKEN : 12:12 ON 03/09/03
DEPTH OF TUBE : -15.0
READING INTERVAL : 1.0
OPERATING UNITS : meters

DEPTH meters	FACE A+ mm	FACE A- mm	FACE B+ mm	FACE B- mm
-0.5	-4.99404	5.01203	0.03442	-0.02147
-1.0	-5.00647	4.99654	0.01457	-0.00124
-1.5	-4.99182	5.02145	0.03603	-0.02984
-2.0	-5.00846	4.98021	0.04696	-0.03421
-2.5	-4.99441	5.01894	0.036	-0.03129
-3.0	-5.0068	5.01754	0.01508	-0.02913
-3.5	-4.99241	4.98564	0.03802	-0.04182
-4.0	-5.00809	5.00215	0.04617	-0.03191
-4.5	-4.99422	4.99412	0.0353	-0.0347
-5.0	-5.00706	5.01247	0.01538	-0.00897
-5.5	-4.99226	4.98542	0.03863	-0.02974
-6.0	-5.00885	5.00214	0.04342	-0.03487
-6.5	-0.0848	0.06547	4.94198	-4.98447
-7.0	-0.05701	0.06214	5.00787	-5.01914
-7.5	-0.07299	0.05237	4.93971	-4.95647

Figure 36 – Sample Data File

As shown in Figure 36, the header information is display followed by the data. In this example, the total hole depth is 7.5 metres, with readings taken at 0.5 metre intervals.

The units that the readings were taken in are displayed at the top of each column (in this case, millimetres). Readings are taking in two directions as outlined in section 2.3

6.5 DATA AVERAGING

The RST Inclinometer software automatically averages the real time inclinometer data streaming up from the probe every second. Pressing the *Options* button in the *Readings* screen allows averaging to be enabled and adjusted. While in the real time data display window, the current status of data averaging can be viewed on the left hand side of the screen (Figure 20). The bar indicates how stable the readings are. If the bar is full, averaging is being performed and the readings have not yet stabilized. The user should wait until this bar goes down before recording a reading for that section of the borehole. The number displayed under the averaging bar represents *bits*. They are simply there to give the user an indication of the change in bits between subsequent readings. Site conditions and the nature of the installation determine how noisy (or not noisy) the readings are. The software allows the flexibility of going back and re-taking readings if necessary.

The averaging is a running average of the previous readings. To change the amount of averaging that the software performs, simply change the *average number* (Figure 21). With the stylus, select the dialog box and enter in the value using the pop-up keyboard at the bottom of the screen.

7 WHAT DOES THE DATA MEAN

The system has been developed to measure accurately the lateral movement of earthworks and structures. The probe is passed through the inclinometer casing, and every 0.5m (or 2ft.) a reading is taken. When the probe is at rest, MEMS accelerometers sense the inclination of the access tube in two planes. This inclination is displayed in terms of angular DEVIATION, which is recorded at that particular depth.

A+ = Face A+ deviation
A- = Face A- deviation
B+ = Face B+ deviation
B- = Face B- deviation

The Checksum:

Checksum in A+/A- plane = A+ plus A-

Checksum in B+/B- plane = B+ plus B-

Checksum should be reasonably constant and of small magnitude, large and inconsistent Checksums may indicate that a problem exists. However, the consistency of checksums from survey to survey is more important than the actual value of the checksums. Checksum data should be monitored during the survey as a check on data integrity. Note that high checksums can be expected if a settlement coupling has been encountered, a checksum of the order of (+0.0045m and -0.0035m) or (+0.0147ft and –0.0114ft) would be reasonable at consecutive depths/couplings.

7.1 MEAN DEVIATION

A+/A- mean deviation in the A+/A- plane = (A+ minus A-)/2

B+/B- mean deviation in the B+/B- plane = (B+ minus B-)/2

This represents the mean deviation at each depth.

7.2 ABSOLUTE POSITION

An absolute position value at a particular depth is the summation of mean deviations starting from the bottom up to that particular depth. Absolute position is the profile of the access tube with respect to the vertical axis in a given plane. Absolute position can also be calculated from the top down if required using Inclinalysis™ software.

7.3 INCREMENTAL DISPLACEMENT

This is the difference in values of mean deviation between the base file, (first set of readings taken) and a compatible file, (usually the latest set of readings) at each depth. This plot can be generated using Inclinalysis™ software.

7.4 CUMULATIVE DISPLACEMENT

This is the result of comparing two sets of mean deviations, usually the base file and the latest or comparison file. The profile represents the actual movement (or displacement) which has occurred at all depths between the times that the two sets of readings were obtained.

Note:
The RST Digital Inclinometer Software has the ability to reduce the data in the field on the Ultra-Rugged Field PC itself. Please refer to section 4.2.8 (Viewing the Data) for additional information.

8 SYSTEM COMPATIBILITY

Regardless of the inclinometer system being used, it is imperative that the **probe wheels** be placed at the same locations during the profiling of the borehole (this is not necessarily the same depth marked on the inclinometer cable). Always use a consistent top reference, such as the aluminum cable grip which is provided with all RST Inclinometer systems.

The zero depth reference on the new RST Digital Inclinometer System is in reference to the midpoint of the probe (between the wheel assemblies). This is the industry standard. The old RST analog system is referenced to the uppermost set of wheels. Therefore, this *must* be taken into account if the customer wishes to directly compare the two sets of readings. It is very important that the data be within 4mm (0.25”). Otherwise, the data will not match and the comparison will not be valid.

Note

Those customers wishing to compare surveys between RST’s old analog system and the new digital system must ensure that the readings are taken at the same depths between the two systems (with the proper depth reference). If you are changing over to the new Digital Inclinometer System, as with any new system, it is good practice to survey the borehole with both systems. When it is determined that the data from the new Digital System is satisfactory, the user can stop using the older system and continue from that point forward.

Note

Some competitor’s inclinometers have different cable gripping/locating systems resulting in different depth locations. Therefore you must be aware of these differences when trying to directly compare data between the two different systems.

9 BACKING UP THE ULTRA-RUGGED FIELD PC INCLINOMETER DATA

Data file management between the Ultra-Rugged Field PC and a computer is handled by the mobile device communication software. On Windows XP based computers, ActiveSync software is used (see section 6.1). Windows Vista, Windows 7 and Windows 8 requires Mobile Device Center (section 6.2). Data files can be shared or mirrored on both the PC and the Ultra-Rugged Field PC. However, the normal synchronization process does not back up the data. An easy way to backup the data is to always copy synchronized information to a safe location on your desktop PC or network server.

The RST Digital Inclinometer software automatically backs up the most current data files upon returning to the main menu screen. Therefore, anytime the user returns to the main menu screen, the data will be automatically backed up to the non-volatile (Field PC) memory location. The Field PC storage folder is accessible through Windows Explorer when the Ultra-Rugged Field PC is connected to a peripheral computer

9.1 MANUAL BACKUPS

The RST Digital Inclinometer Software has provision for making manual backups of the data, in addition to automatic backups.

1. From the main menu of the Digital Inclinometer Software, under the *File* menu select *Backup…*

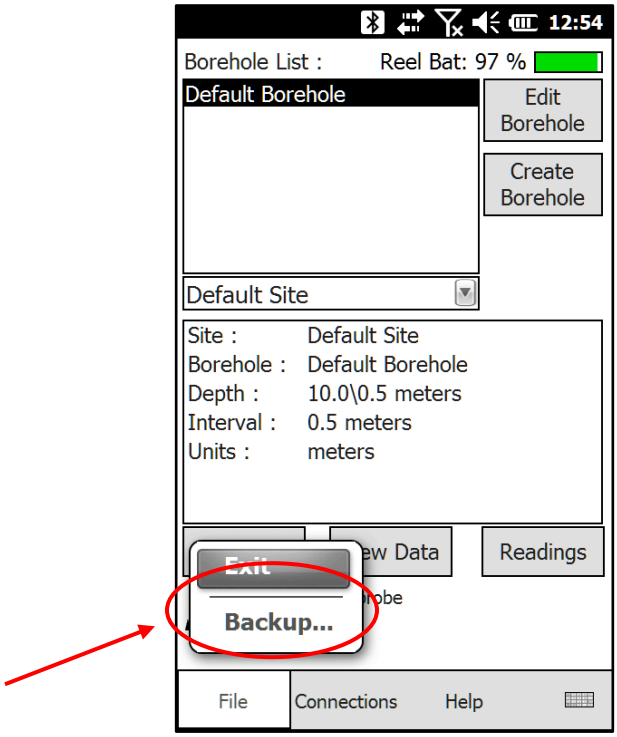

Figure 37 – File Backup

2. Once selected, the following screen will appear:

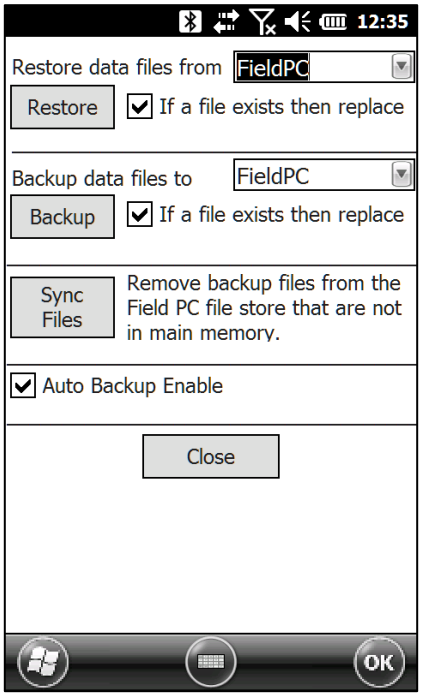

Figure 38 – File Backup Options

3. Using the drop-down box at the top of the screen, select the location in which you would like to restore the files from. All Ultra-Rugged Field PC's come with the Field PC storage location however, optional Flash™ Storage Cards are additional and are available through RST.
4. Choose from the several options whether you would like to *Restore*, *Backup* or *Synchronize* the files. Check boxes allow the options of overwriting files if desired.
5. Press the desired button to initiate the function.
6. Press *Close* to exit this screen.

Note

Proper data management is very important. The Ultra-Rugged Field PC, in conjunction with its onboard and optional non-volatile memory storage areas, and its ability to synchronize with a desktop PC, allows several options for backing up the data. At the same time, with all these options, data files can be confused with each other if not managed properly. After taking readings in the field it is always a good idea to back the files up in a safe location (i.e. network server etc…) back at the office using the ActiveSync software. Additional copies of this information will always be stored in the Field PC memory area should the main memory of the Ultra-Rugged Field PC become erased. Be sure to clear the Field PC memory of unneeded files on a regular basis to keep the files easily manageable.

Important

Because the Ultra-Rugged Field PC uses some power to maintain files in RAM and the clock, you need to recharge the battery regularly. Keep the Ultra-Rugged Field PC connected on AC or DC power while you are at your desk. The best policy is to keep the Ultra-Rugged Field PC connected to your computer when working at your desk and carry your AC adapter and DC adapter plug with you when traveling. Your Ultra-Rugged Field PC is shipped with a charge on the battery. You may want to ensure that it is fully charged before synchronizing. The Ultra-Rugged Field PC battery will provide approximately 20 hours of borehole survey time (when connected to the probe).

10 RESTORING FILES ON THE ULTRA-RUGGED FIELD PC

10.1 INSTALLATION THE RST DIGITAL INCLINOMETER PROGRAM

Use the following steps to reinstall the RST Digital Inclinometer Program:

1. Establish a connection to the Ultra-Rugged Field PC using Microsoft ActiveSync.
2. Using Windows Explorer, copy the file "Digital Inclinometer X.XX.CAB" to the folder on the Ultra-Rugged Field PC (My Documents for example). The "X.XX" will mean the software version.
3. On Ultra-Rugged Field PC, select *Start* and then *File Explorer* from pull down menu.
4. Navigate to the folder where the file "Digital Inclinometer X.XX.CAB" was copied to.
5. Click on the "Digital Inclinometer X.XX.CAB" file to begin installation.

Note

If an older version of the RST Digital Inclinometer Software is already present, uninstall the previous version by going to *Start*, then *Settings* and tapping on *Remove Programs* located in *System* tab. Highlight the program to be removed and tap *Remove*.
If the Digital Inclinometer entry is not present in the list, the program must be manually removed by deleting files in *Windows* directory and shortcut in *Start Menu*.

10.2 RESTORING THE INCLINOMETER DATA FILES

The inclinometer data files are backed up to the Field PC storage area of the Ultra-Rugged Field PC on a regular basis, each time the user returns to the Main Menu Screen of the Digital Inclinometer program. In order to restore the files, the user may navigate to the Field PC storage area using Windows Explorer. This is most easily accomplished when the Ultra-Rugged Field PC is ActiveSync'ed to the desktop PC. The following text explains this procedure:

Using *Windows Explorer,* navigate to*:*

Mobile Device: My Pocket PC\Field PC File Store\Digital Inclinometer

The files will be stored in directories according to their *Site Name*. If you need to restore all the files, simply copy the entire folder named "Digital Inclinometer" to the current directory.

The current folder resides in:

Mobile Device: My Pocket PC\My Documents

Else, you can copy the folder to the ActiveSync folder you created on your desktop. The files will automatically be sync'ed to the Ultra-Rugged Field PC.

Data file management between the Ultra-Rugged Field PC and a computer is handled by the supplied ActiveSync software (see section 6.1). This allows the mirroring of information on both the PC and the Ultra-Rugged Field PC. It makes file sharing easy and efficient between the two platforms. However, the normal synchronization process does not back up the data, it only reflects the current programs found on the Ultra-Rugged Field PC. An easy way to backup the data is to always copy synchronized information to a safe location on your desktop PC or network server.

11 ULTRA-RUGGED FIELD PC BATTERY

It is recommended that whenever the Ultra-Rugged Field PC is not being used in the field, it should be on charge. This ensures that the Ultra-Rugged Field PC is always ready to be used in the field. A flashing red light on the front of the Ultra-Rugged Field PC confirms that the battery is being charged. A solid red light indicates that the batteries are at full charge.

Battery status can be checked within Windows Mobile:

1. Under the *Start* menu, choose *Settings.*
2. Touch the *System* tab at the bottom of the screen.
3. Touch the icon labelled *Power*.

The *Power* screen indicates the status of the main battery and the current power settings. The backlight and auto turn-off can be adjusted to conserve power.

The Ultra-Rugged Field PC should be charged on a regular basis. Whenever not in use, the Ultra-Rugged Field PC should be on charge using one of the supplied chargers to maintain a full charge on its battery. The Ultra-Rugged Field PC will warn the user when its battery is getting low. In situations where AC power is not available, use the DC adapter (Figure 1, item 9) to charge the Ultra-Rugged Field PC in the field.

12 CARE AND MAINTENANCE

12.1 PROBE & REEL CONNECTORS

Proper care and maintenance of the digital probe and reel connectors will ensure trouble-free operation of the Digital Inclinometer System. The following guidelines should be strictly adhered to. Failure to adhere to these guidelines can result in premature connector wear, and ultimately connector failure.

- Ensure the keyway is aligned before threading the connector together.
- Never over-tighten the bulkhead connectors when mounting. Snug (hand-tight) is more than sufficient.
- Only twist the brass coupling on the connector, do not twist the signal cable itself.
- Avoid sharp bends at the cable entry to the connector.
- Clean the plugs and receptacles with a mild soap and fresh water on a regular basis. Do not allow the connectors to get excessively dirty.
- Rinse out with alcohol, allowing the connector to air dry. Replace dust caps, once the connector is dry.
- On a regular basis, lubricate the mating surfaces with the **supplied silicone spray**. The supplied product is *3M Silicone Spray part # 6204678-4930-3*. **DO NOT GREASE and avoid the use of any solvent based lubricants.**
- Amount of silicone spray used should be based on the frequency of use of the probe. One light spray to cover all contacts is enough after cleaning of the connector. Ensure the connector is clean and dry before applying the silicone spray.
- Elastomers contained in the connector can be seriously degraded if exposed to solvent, direct sunlight or high ozone levels for extended periods of time. Always replace dust caps once the connector is clean and dry.
- Always keep the dust caps clean and free of any foreign materials. Do not place the dust caps where they have the potential to become contaminated.
- Always use the dust caps and keep the connectors clean to prevent damage in storage and when in use.

Warning

In no case should solvent-based lubricants (such as WD-40) be used as a lubricant on the connectors. These products will damage the elastomers in the connectors resulting in loss of communication with the digital probe. **ONLY use the supplied silicon lubricant or RST approved equivalent.** If ever in doubt or any questions arise, do not hesitate to contact RST Instruments for further information.

12.2 INCLINOMETER PROBE

The digital inclinometer probe consists of high-grade stainless steel components and is completely sealed. After the survey is complete, wipe all moisture off the probe and replace the protective caps over the connectors. If required, rinse the probe in clean water and dry. If the probe is exceptionally dirty, use a mild soap and fresh water to clean. *Never use solvents to clean the probe and connectors*.

Always store the probe in its original case whenever it is not in use. The high precision accelerometers in the probe can be damaged if the probe is subjected to excessive shock or vibration. Keep both the probe and its case clean and dry. If the probe is not cleaned and dried in the field, be sure to clean and dry it (including the case) upon return to the office. It is good practice not to leave corrosive solutions (i.e. salt water) on the probe, connectors and cable, be sure to clean the parts if these conditions exist.

The probe wheels are made with high-grade hardened and heat-treated stainless steel. These are the most robust on the market and are extremely durable. The wheels contain sealed bearings which require no maintenance except keeping them clean and dry.

12.3 REEL AND CABLE

If required, wipe the cable with a clean rag to dry it off. The cable has a durable polyethylene jacket, simply use water and a mild soap to clean it off if necessary.

12.4 READOUT UNIT

To keep the Ultra-Rugged Field PC in good condition and working properly, please adhere to the following guidelines:

- Keep the Ultra-Rugged Field PC away from excessive moisture and extreme temperatures. Do not expose the Ultra-Rugged Field PC to liquids or precipitation. The supplied *Rugged Field PC* meets the IP54 standard for water and dust resistance, as well as being impact-resistant if dropped up to four feet from the ground.
- Do not place anything on top of the Ultra-Rugged Field PC to prevent damage to the screen.
- Clean the unit by wiping the screen and the exterior with a soft, damp cloth moistened only with water.
- Avoid exposing the Ultra-Rugged Field PC to direct sunlight or strong ultraviolet light for extended periods of time. Also avoid scratching the surface of the screen and banging it against hard objects.
- Only use the Ultra-Rugged Field PC stylus to prevent scratching the screen.

For further reference please see the supplied manufacturer's manuals for the Ultra-Rugged Field PC.

12.5 CALIBRATION

RST strongly recommends that the probe be sent in for calibration annually. Due to the high precision nature of the sensors and the sensitivity of the probe, calibration must be done to ensure quality results and continued performance of the probe. Heavy use in adverse conditions may require calibrations to be done more often.

Calibration should also be performed if the probe has been dropped or become damaged in any way. If checksums become significant and they are not due to errors in probe positioning or noise, the probe likely needs to be re-calibrated.

Calibration should also be performed after any wheel assembly replacement.

12.6 STORAGE & BATTERY LIFE

The Ultra-Rugged Field PC included with the Digital Inclinometer System has a limited battery life. In this regard, it is important to keep the unit charged, otherwise it loses any peripheral programs which are installed on it. This includes the RST Digital Inclinometer Program. Please refer to section 11 for more information on the Ultra-Rugged Field PC Battery.

Even if the Ultra-Rugged Field PC is turned off, it still consumes power. Therefore if left “on the shelf” and unused, it will eventually deplete its batteries. The Ultra-Rugged Field PC should be charged on a regular basis. Whenever not in use, the Ultra-Rugged Field PC should be on charge using one of the supplied chargers to maintain a full charge on its battery

13 TROUBLESHOOTING

Cannot connect to reel:

- Check the status of the Bluetooth Manager (see section 16). If the icon is not present on the desktop, launch the Bluetooth Manager software under the *Start* menu.
- Make sure that the Bluetooth radio is turned on (Figure 41).
- Exit the Digital Inclinometer software and cycle the power on the reel. Re-start the software and allow it to automatically make the connection to the probe. If this fails, repeat the procedure, this time giving the Ultra-Rugged Field PC a soft reboot (by pressing the power button for about 10 seconds until the screen goes dark).
- Follow the instructions outlined in section 16.1, Changing the Reel. This section outlines how to search for Bluetooth devices and establish a new connection.

Cannot connect to the Probe:

- Check the threaded electrical connection between the probe and the reel.
- Ensure that the connector is clean.
- Check the connector for damage.

Cannot connect a desktop PC to the Ultra-Rugged Field PC:

- Check physical connections between the PC and Ultra-Rugged Field PC.
- Microsoft ActiveSync only allows full synchronization between two different PC's and a single Ultra-Rugged Field PC. Ensure you are not trying to make more than two of these types of connections. However, manual data transfer can be accomplished on any PC running the ActiveSync Software. Simply choose not to sync to the Ultra-Rugged Field PC when prompted to do so (please refer to the Ultra-Rugged Field PC reference manual CD-ROM, for further information).

Readings fluctuate and/or are noisy:

- Ensure probe placement is within 4 mm (0.25") at each depth.
- Increase the averaging of the readings (section 4.2.6)
- Do not perform inclinometer surveys when heavy equipment is moving around the borehole. Choose "quiet" times.

Reset or turn off the Ultra-Rugged Field PC:

- Hold down the power button for about 10 seconds. A menu appears.
- Tap Reset or Power Off, then tap OK or Cancel if you are powering off.

Manually reset the Ultra-Rugged Field PC:

- In order to completely re-boot the Ultra-Rugged Field PC, hold down the power button for 10 seconds or until the screen goes dark. The Ultra-Rugged Field PC resets after a few seconds Refer to the Ultra-Rugged Field PC user manual for further information.

14 CONTACT US

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15 SYSTEM SPECIFICATIONS

Inclinometer	
Wheelbase	0.5 m (24 inches)
Probe Length Including Connector	710 mm (28 inches)
Probe Diameter	25.4 mm (1.00 inch)
Probe Weight	1.4 kg (3.0 lbs.)
Probe Material	Stainless Steel
Memory	> 1 000 000 readings
Displacement Error	±2 mm per 25m (±0.1 in. per 100 ft.)
Temperature Rating	-40 to +70°C (-40 to +158°F)
Data Resolution	0.005 mm per 500 mm (0.00002 ft. per 2 ft.)
Full Scale Range	±30 °
Repeatability	±0.002°
Axis Alignment	Digitally Nulled
Ultra-Rugged Field PC²	
Water Proof	IP68
Rugged Case	1.5 m or 5' drops onto concrete
Operating Temperature	Optimized for excellent performance in cold temperatures Operating temperature: –22F to 140F (–30C to 60C) Note: Bluetooth® wireless technology is rated to –4F (–20C)
Processor	1.0GHz ARM Cortex A8 i.MX53 processor
Memory	512 MB DDR2 RAM
Internal Flash Disk	8 GB
Operating System and Software	Microsoft® Windows Embedded Handheld 6.5.3 Microsoft Office Mobile 2010* (Word Mobile, Excel Mobile, PowerPoint Mobile, Outlook Mobile) Multiple languages (English, French, Spanish, German, Portuguese) Adobe Reader® LE
Battery	Intelligent Li-Ion battery 3.7VDC @ 10600mAh,38.7Whr Operates for up to 20 hours on one charge Charges in 2 to 4 hours Battery easily changeable in field
Wireless Connectivity Options	Bluetooth® wireless technology, 2.1 +EDR, Class 1.5, range greater than 100 feet (30m) Wi-Fi® 802.11b/g/n with extended range
Certifications and Standards	FCC Class B CE Marking (applicable EMC, R&TTE, and LVD directives) Industry Canada EN60950 Safety
Cable	
Cable Diameter	6.4 mm (0.25 inches)
Cable Weight	2.3 kg/50 m (3.1 lbs./100 ft.)
Cable Tensile Strength	5.9 kN (1325 lbs.)
Cable Jacket	Polyurethane
Cable stretch suspended in 30m dry borehole	4 mm (0.16 inches)
Cable Reel	
Up to 75 m cable reel diameter	310 mm (12.2 inches)
100 to 200m cable reel diameter	380 mm (15 inches)
+225m cable reel diameter	460 mm (18 inches)
Reel weight with 75m (246') cable	5 kg (11 lbs.)

16 BLUETOOTH COMMUNICATION

The Ultra-Rugged Field PC uses Bluetooth technology to establish a wireless radio link between the readout unit and the inclinometer reel. To verify the status of the Bluetooth connection, touch the Bluetooth icon located on the opening screen of the Ultra-Rugged Field PC desktop. Please note that the Ultra-Rugged Field PC is continually undergoing updates and the Bluetooth configuration screens may vary slightly from those shown.

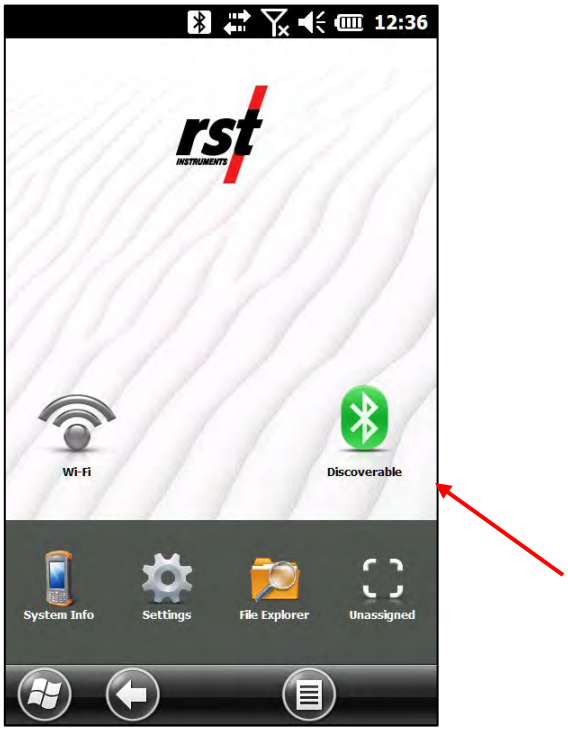


Figure 39 – Field PC Wireless Icon

Clicking on the Field PC Wireless icon opens the following screen:

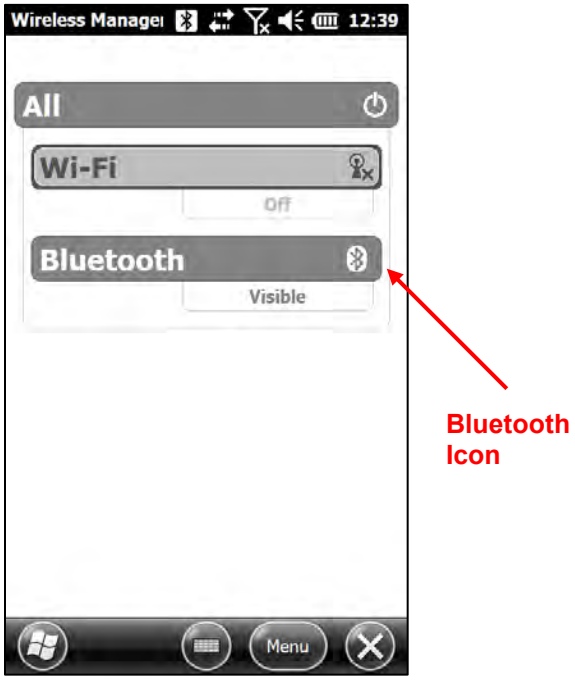


Figure 40 – Field PC Wireless Main Menu

Press the Bluetooth icon to turn on the Bluetooth Radio. Clicking on the *Bluetooth Settings* under *Menu* opens the following screen:

Figure 41 – Bluetooth Options

The user has the option of turning the Bluetooth radio on and off and can use the Devices tab to view the current Bluetooth devices within the vicinity of the Ultra-Rugged Field PC. In general, the user is not required to edit any of these settings because the RST Digital Inclinometer software will automatically search and connect to the reel and probe supplied with the system.

16.1 CHANGING THE REEL

Should the situation arise where the reel needs to be changed, the inclinometer software and the Bluetooth radio need to be reconfigured to recognize the new reel. To change which device the inclinometer software connects to, launch the RST digital Inclinometer software. From the *Main Menu Screen* (Figure 10) touch the *Connections* menu and choose *Bluetooth…* The following screen will appear:

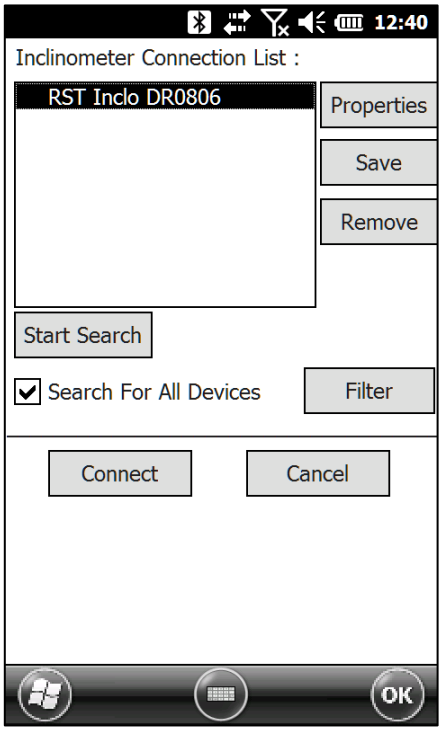


Figure 42 – Inclinometer Connection List

The current inclinometer connection list that the software recognizes is displayed. To search for any new devices, press the *Search* button. The window gives the option of searching for all Bluetooth devices, or filtering for only certain types of devices. Press the *Filter* button to specify which devices to search for (i.e. filter by name). Once a device is discovered (this may take a few moments) an "F" will appear to the left of the device if it is currently in the existing list, indicating that it was found. An "N" will appear if a new device is found.

If the user wishes to add a new inclinometer reel to the list, search for this device first and then press the *Save* button once the device is discovered. This saves the new reel in the list so that the software recognizes it the next time the Digital Inclinometer software is launched. To specify which device the software connects to, simply highlight which one you would like in the list and press *Connect*. You can remove any devices from the list by pressing the *Remove* button.

Pressing the *Properties* button invokes the following screen:

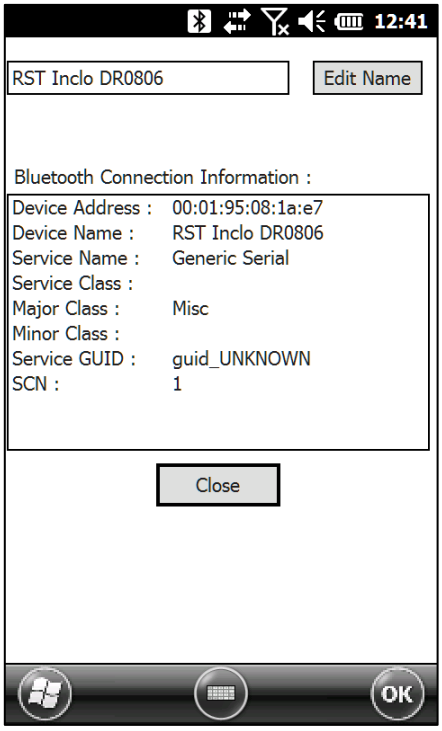


Figure 43 – Inclinometer Reel/Bluetooth Properties

This option allows the user to change the name of Reel if desired. This is simply an identification name that the software uses to distinguish between different devices. The Bluetooth Connection Information is detailed information for use by RST and in most cases is not important for the user.

17 IMPORTING AND EXPORTING FILES

17.1 SAVING AND IMPORTING INCLINOMETER DATA INTO SLOPE INDICATOR SOFTWARE

The RST Digital Inclinometer Program has the ability to save data in the *.rpp format which is able to be imported into Slope Indicator's Management software (DMM for Windows). This allows the user to compare data sets taken with the Digitilt System and RST's Digital Inclinometer.

Note

Whenever comparing data between two different systems it is **Extremely Important** that the probe be placed at the same depth for both systems. RST and SINCO instruments use a different reference at the collar of the borehole. You must ensure that placement of the probe is within 5mm (0.25") or the data will be difficult to compare. Please also refer to section 8.

To ensure that the survey is being saved in the correct format, select **RPP Format** from the data filename options screen (see Figure 15). This Data Filename Options screen is found by navigating through *Edit Borehole>Data Filename…* For further information regarding editing a borehole please refer to section 4.2.4.

Once the survey of the borehole is complete, return to the office and connect the Ultra-Rugged Field PC to your desktop computer using Microsoft ActiveSync. Using Windows Explorer, copy the data to a safe location.

Importing a *.rpp file into DMM for Windows:

1. Launch the DMM for Windows application.
2. Either create a new project database or open an existing database in which you would like to place the inclinometer data.
3. Under the *File* menu, select *Import* and then choose *Import RPP File*.
4. Navigate to the location in which you saved the *.rpp file created by the RST Digital Inclinometer Program. Click *Open.*

DMM for Windows will then bring the *.rpp into the database. The database can now be saved as a *.mdb (Microsoft Access) file. The new *.mdb file can also be accessed by Slope Indicator's DigiPro software.

For additional information on DMM for Windows and DigiPro software, please consult the appropriate documentation provided with Slope Indicator's software.

17.2 USING SLOPE INDICATOR DATA WITH INCLINALYSIS

Slope Indicator files (in *.rpp format) can be directly imported into RST Inclinalysis Software. Please refer to the Inclinalysis Manual for further information (included on the Digital Inclinometer Support CD).

17.3 IMPORTING INCLINOMETER DATA INTO GTILT

Standard RST Format Inclinometer files (*.csv) and Standard RST (*.dty) files (section 4.2.5) can be imported into GTilt by performing the following steps:

1. Start GTilt
2. Select *File - New*
3. Select *File - Import - DT/DTY or DT and DTX Data*
4. Navigate to the directory containing the RST data files
5. Change *List File Types* to *All Files (*.*)* from *DT & DTY (*.DT)*
6. Select data file to import (*.csv or *.dty format)
7. Repeat steps 3 to 6 until all files for this borehole have been imported
8. Select *File - Save As* Input file name for this site and borehole
9. Select *Edit - Main header* - Insert 0.5 into Shallowest rdg Depth
10. Select *Edit - Main header* - Insert 2500 into Probe Sensitivity

Note

The *.csv files can also be opened directly in Excel, however, **do not save the files in *.csv format from Excel.** This will change the format of the file and you will no longer be able to import the file into GTilt. Always backup your data.

Note

The inclinometer program also allows the option to save the files in *.rpp format (section 4.2.5). GTilt also recognizes this format and the files are imported in a similar fashion as described above.

Appendix A CHANGING THE BATTERY (FOR REELS WITH SERIAL NUMBERS UNDER 2500)

Batteries inside reels with serial numbers under 2500 may be removed for recharging. The reel uses a 7.4V lithium-ion camcorder battery. The system comes with a battery housed inside the reel and a charger. Adapters are supplied to allow the charger to function in a vehicle (12V DC), or 110-240V AC power (see Figure 1). It is also highly recommended that the Reel batteries be kept at a state of full charge whenever the probe is not in use.

To remove the battery, simply unscrew the cap off the reel hub by turning it counter-clockwise (Figure 44).

Figure 44 – Battery Removal / Installation

Remove the battery and place on the Mach 1™ Speed Charger.

Mach 1 Speed Charger Operating Instructions

Status LED's

Together, the three LED's on the front of the Mach 1 charger will indicate the status of the battery and the charger. The descriptions and diagrams included in the following sections describe the various indicators and their meaning.

Standby Mode

Without any battery installed, the charger will flash the LED on the left, marked *MED*, indicating that the charger is standing by and waiting for a battery to be connected.

STANDBY	FLASHING	OFF	OFF
	MED	HI	MAX

Figure 45 – Standby Mode

Once a battery has been properly connected to the charger, it will determine the status of the battery and begin the proper phase of the charging cycle. There are 3 phases to the charge cycle. The battery may be removed during any of the charging phases without harm to the battery or charger unit.

Phase I – Initial Charge

All 3 LED's flashing in sequence from *MED* (left) to *MAX* (right). If the battery is low, this will be the first charge phase. With high capacity batteries, this phase can sometimes be the longest of the 3 phases. Similarly, with some low capacity batteries and batteries reaching the end of their life, this phase can be very short.

	MED	HI	MAX
LED's Phase I	Sequential Flashing	Sequential Flashing	Sequential Flashing

Figure 46 – Initial Charge

Note: When the battery is first connected, the LED's may instantly indicate *MED, HI* or *MAX* charge depending on the charge status of the battery. The process will continue normally from that point forward.

Note: It is normal for the charger, AC adapter, or the battery to become warm during charging.

Phase II – MED Charge

The *MED* LED is on continuously and the other LED's are flashing in sequence. At this point the battery is typically about 50% charged. Some very small capacity batteries (650mAh) and worn out batteries can be as low as 10% charged.

	MED	HI	MAX
LED's Phase II	ON	Sequential Flashing	Sequential Flashing

Figure 47 – MED Charge

Phase III – HI Charge

The *MED* and *HI* LED's are on and the *MAX* LED is flashing. At this point the battery is typically about 70% charged.

	MED	HI	MAX
LED's Phase II	ON	Sequential Flashing	Sequential Flashing

Figure 48 – HI Charge

Charge Complete – MAX Charge

All three LED's are on at the same time. Charging has completed and the battery is fully charged. It is recommended to remove the battery at this time.

	MED	HI	MAX
Charge Complete	ON	ON	ON

Figure 49 – MAX Charge

Error Condition – Charge Terminated

If the battery is removed before a complete charge has been reached, **the charger will continue indicating the last complete charging phase for up to 1 minute.** After that time, an "Error" indication will appear on the LED's, shown by the *MED* and *MAX* LED's coming on together while the *HI* LED is off.

	MED	HI	MAX
Error Condition	ON	OFF	ON

Figure 50 – Error in Charging

The Error Condition will also be indicated if the charger senses and problem with the battery being charged. To reset the error condition, unplug the charger from the power adapter for a few seconds, and then reconnect it. If the Error occurs again, there may be a defect in the battery that will prevent safely charging.

Charging Time

The 7.4V 2200mAh Lithium-Ion batteries supplied with the inclinometer system will take approximately 80 minutes to fully charge if they are depleted.

Note
RST strongly recommends that all batteries should be taken out into the field fully charged at the beginning of each day.

Be aware that cold temperatures can also have an effect on the performance of the batteries. Expect a somewhat shorter operation in extremely cold temperatures. Under adverse conditions, it is recommended that extra batteries be taken to the field, where one can be charging in between readings of several boreholes. The reel batteries are a standard camcorder battery and are readily available.

Note
The batteries will self discharge when not in use whether they are installed in the inclinometer reel or not. Batteries can be kept fresh if recharged on a regular basis.

Upon replacement of the battery, ensure to align the battery contacts with the contacts in the Reel hub to allow proper operation. Installation is the exact opposite of removal. Please ensure that the battery contacts line up with the contacts contained within the hub for correct operation.

Battery Life

A single Reel battery has the ability to last for up to 1 week on standby mode (i.e. no connection to the Ultra-Rugged Field PC). However, it is a good practice to turn off the Reel power whenever the survey is complete, as leaving the power on will eventually drain the battery. At room temperature, while taking readings, battery life is approximately 30 hours. In extreme environmental conditions (extreme cold or hot temperatures) fully expect useable battery life to decrease. Therefore it is always a good practice to take 2 or more fully charged batteries out in the field before performing inclinometer survey work.

APPENDIX B

Instrumentation Data Sheet Examples

Vibrating Wire Piezometers

PIEZOMETER ID:	PZ-XX-XX	**COORDINATES (ft):**	**Northing:**	XX,XXX,XXX	**LOCATION NOTES:**
DATE INSTALLED:	DD/MM/YYYY		**Easting:**	X,XXX,XXXX	
DEPTH (ft, bgs):	10.0	**GROUND SURFACE ELEVATION (ft):**		3600.0	
MANUFACTURER:	RST	**ELEVATION CORRECTION (psi):**		1.90	
MANUFACTURER PART #:	VW2100	**MANUFACTURER SN:**		XXXXXX	**RANGE (psi):** 100

MANUAL ABC FACTORS: A = -0.000019305 B = 0.01007729 C = 118.67

TEMPERATURE CORRECTIONS: m = 0 b = 0 offset = 0

Reading Date (MM/DD/YY)	Measured HZ	Measured Temp.	Pressure psi	Temp Correction	Altitude Correction	Corrected Pressure psi	Head on Piezo. ft	Piezometric Elev. ft	Notes
1/1/2021	2782.2	26.6	-2.729	0.000	1.899	-0.830	-1.92	3588.1	Intital Reading On-ground
									Reading after burial - install check
									Initial w/ Portable Readout - install check
									Initial w/ Datalogger

Survey Monuments

MONUMENT ID: SMX-XX
DATE INSTALLED: DD/MM/YYYY

MONUMENT COORDINATES (ft): **Northing:** XX,XXX,XXX
Easting: X,XXX,XXXX
Elevation: 3600.0

LOCATION NOTES:

Survey Data				Elapsed Time		East Movement (in)		North Movement (in)		Vert. Movement (in)		Horiz. Movement (in)		Movement Vector: XYZ (in)		Movement Vector: Bearing (°)		Movement Vector: Dip (°)		Velocity		
DATE	East	North	Elev.	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative	Daily	Cumulative	Inverse Cumulative
44,197.00	15,866,537.00	1,544,596.00	3,593.40	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000	0	0.000	90	0.000	0.00	0.00

Inclinometers

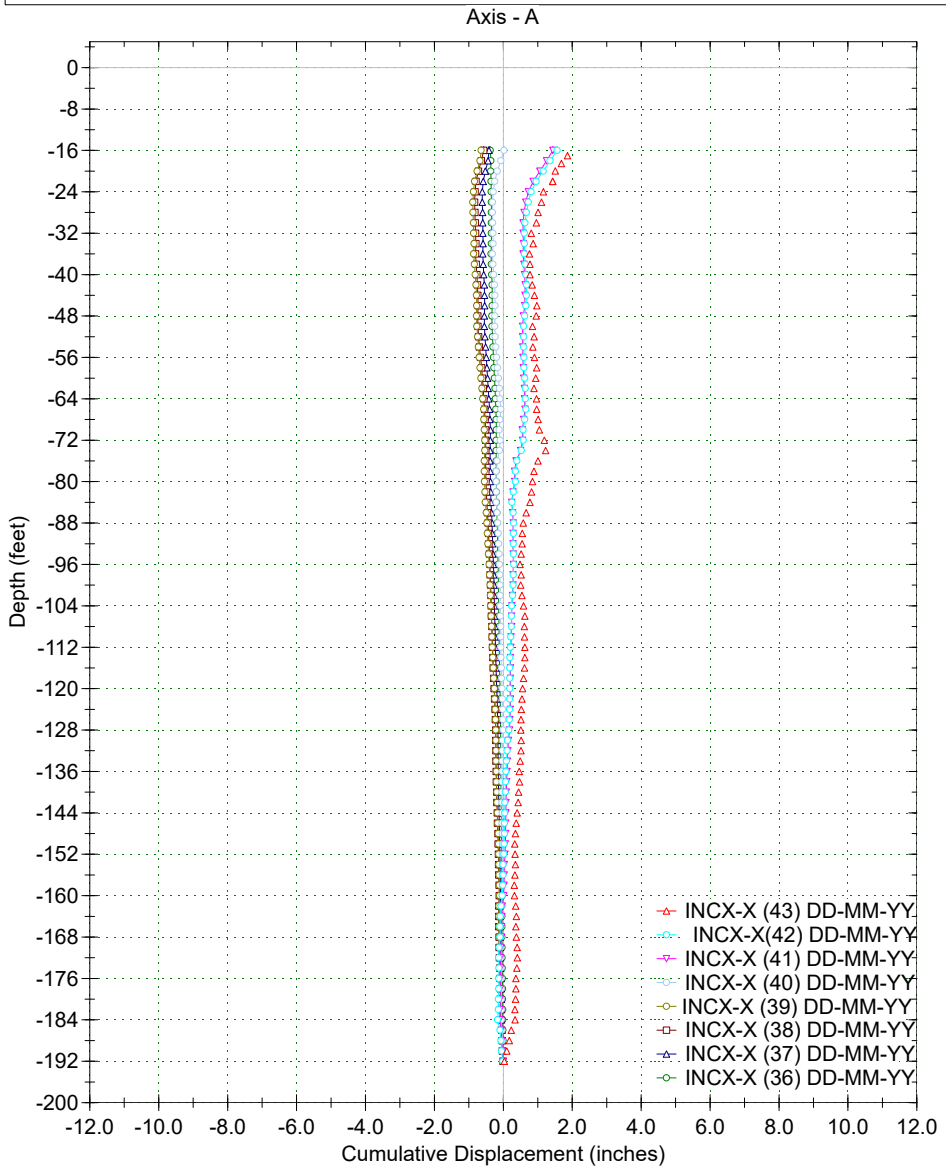
RST Instruments Ltd.

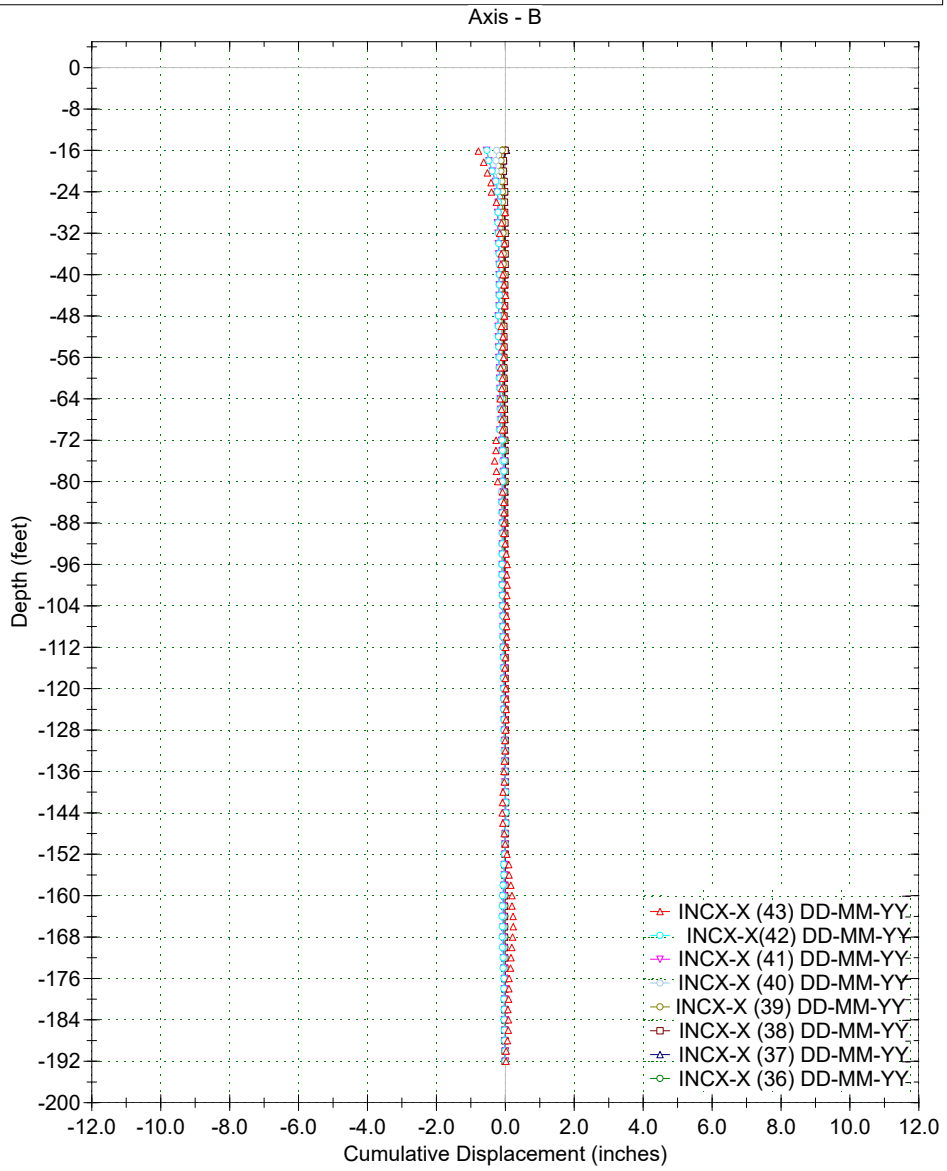
CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.48.4

Borehole : INCX-X
Project : Grassy Mountain TSF
Location : Embankment Crest
Northing : XX,XXX,XXX
Easting : X,XXX,XXX
Collar : -

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : XX.X feet
A+ Groove Azimuth : XXX
Base Reading : YYYY MMM DD mm:ss
Applied Azimuth : 0.0 degrees





Visual Inspection Checklist Example

CHECK LIST FOR SITE INSPECTOR

FORM 1 – GENERAL INFORMATION

(This page must be completed by the inspector before entering project area)

1. General Information

Inspector Name: _____ Employee ID: _____

Date: _____ Expected Start Time: _____

Weather: _____ Temperature: _____

Location of Inspection: _____

_____

2. Equipment

- ■ Safety Equipment: ☐ Safety Boots ☐ Hard Hat ☐ Safety Glasses
- ■ ☐ First-Aid Kit ☐ Others (specify)_____
- ■ Communication: ☐ Radio (Channel_____ Emergency No.: ____) ☐ Battery Checked
- ■ ☐ Others (specify)_____
- ■ Transportation: ☐ 4WD Vehicle ☐ Gas Checked
- ■ Monitoring Equipment: ☐ For Monument ☐ For Inclinometer ☐ For Piezometer / Settlement Cell
  ☐ Tape Measure ☐ Others (specify)_____

3. Job Functions/Tasks

☐ Check the condition of monitoring equipment and monitoring points

☐ Observe surface water conditions (if any)

☐ Inspect for changes in ground surface and slope features

☐ Report the findings to the superintendent

☐ Others (specify)_____

Signature:_____ Time:_____ Date:_____

CHECK LIST FOR SITE INSPECTOR

FORM 2 - VISUAL INSPECTION SHEET FOR INSTRUMENTS AND SLOPE FEATURES

Check Point	Observation		Explanations	Action Taken		Notes
	Yes	No		Notification	Measure	
a. Is the investigation and instrumentation site accessible?	☐	☐	If "No", describe problem	☐	☐	Optional
b. Large scale change of topography?	☐	☐	If "Yes", describe location and magnitude	☐	☐	Optional
c. New cracks, bulges, or sag ponds on the ground?	☐	☐	If "Yes", describe location, direction and size	☐	☐	Optional
d. Tilting of structures or trees?	☐	☐	If "Yes", describe location and tilting degree	☐	☐	Optional
e. Malfunction of TSF?	☐	☐	If "Yes", describe location and magnitude	☐	☐	Optional
f. New seeps or springs?	☐	☐	If "Yes", describe location and/or direction	☐	☐	Optional
g. Disturbance of animals?	☐	☐	If "Yes", describe the phenomena	☐	☐	Optional
h. Disturbance / Damage of Instruments?	☐	☐	If "Yes", describe the ID and phenomena	☐	☐	Optional
i. Suspicious Readings of Instruments?	☐	☐	If "Yes", describe the ID and phenomena	☐	☐	Optional
j. Silting or Sedimentation of Underflow monitoring?	☐	☐	If "Yes", describe the ID and phenomena	☐	☐	Optional

Other Information

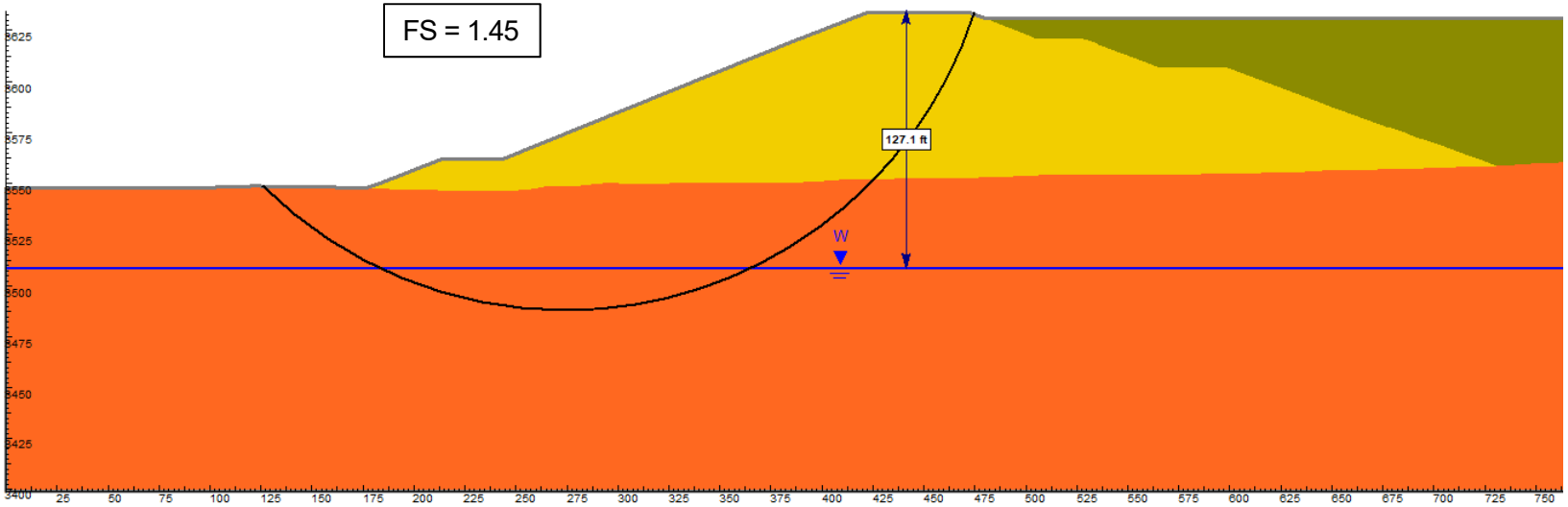
_____

_____

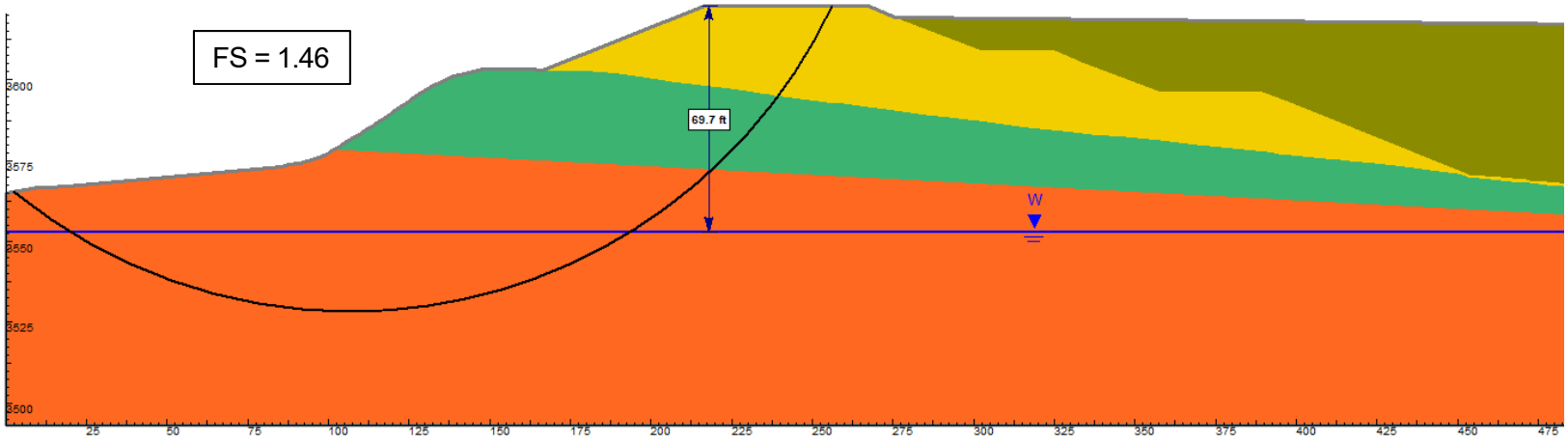
Signature: _____ Date: _____

APPENDIX C

VW Foundation Piezometer Trigger Level Stability Analyses



NORTH EMBANKMENT – TRIGGER LEVEL 1



WEST EMBANKMENT – TRIGGER LEVEL 1

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		125	Mohr-Coulomb	0	32
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

CLIENT
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

YYYY-MM-DD	2019-10-29
PREPARED	JRP
DESIGN	MDB
REVIEW	CJM
APPROVED	RAB

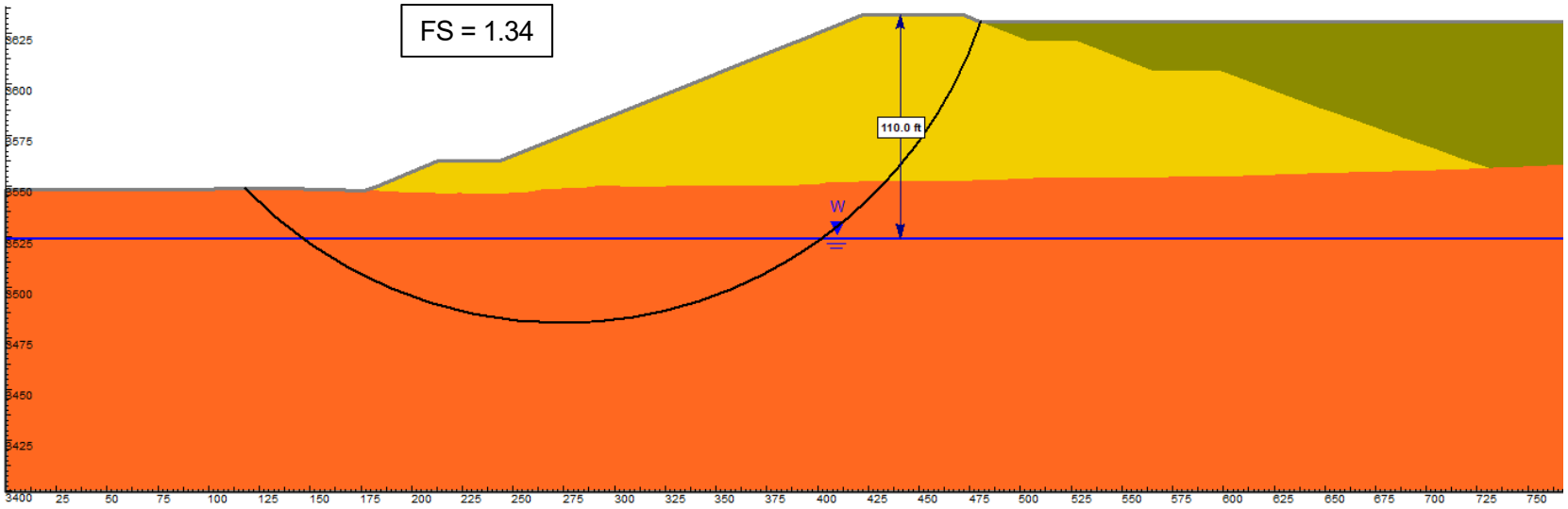
PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL MONITORING PLAN
APPENDIX C – STABILITY ANALYSIS
TRIGGER LEVEL 1

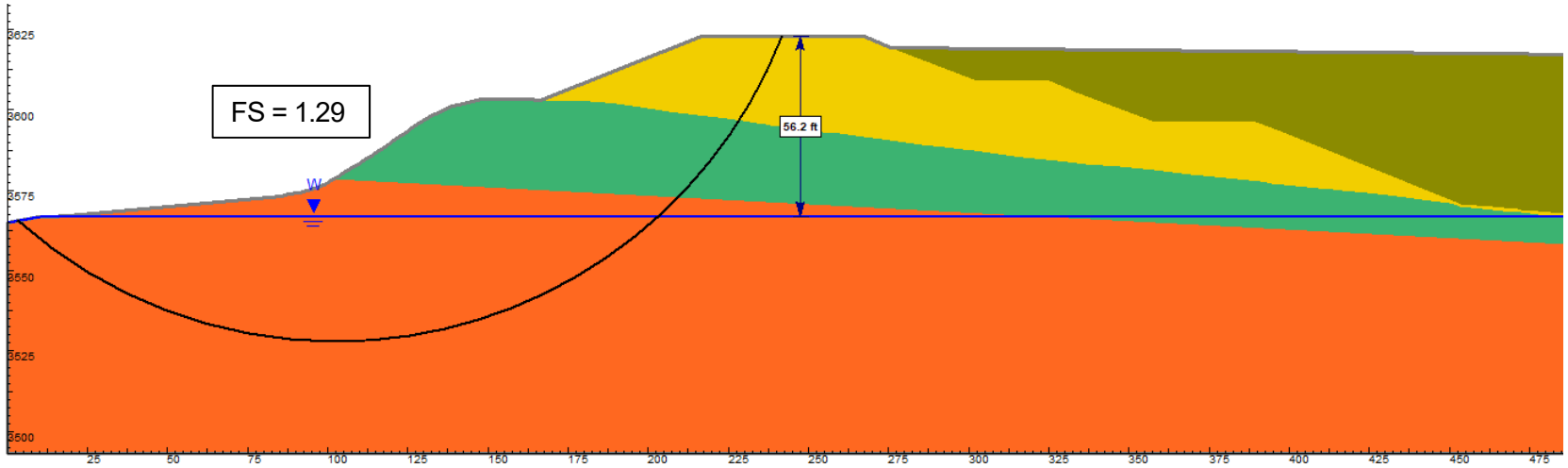
PROJECT No.
1663241

FIGURE
1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0



NORTH EMBANKMENT – TRIGGER LEVEL 2



WEST EMBANKMENT – TRIGGER LEVEL 2

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		125	Mohr-Coulomb	0	32
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

CLIENT
CALICO RESOURCES USA CORP
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MALHEUR COUNTY, OREGON

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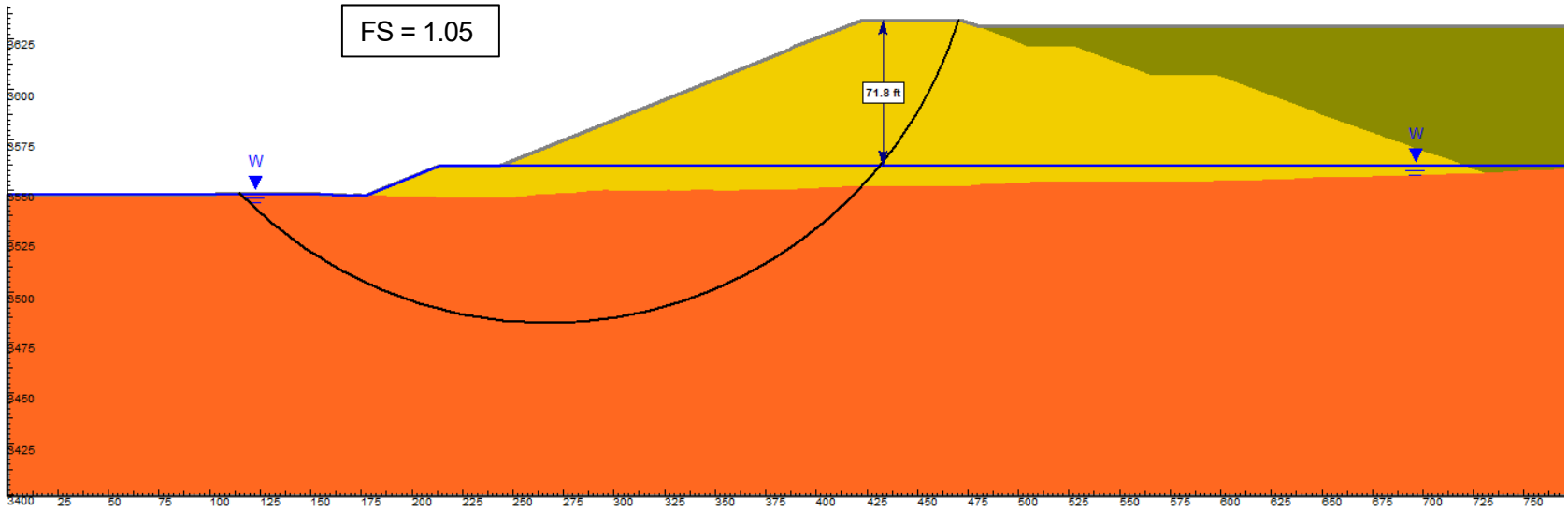
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL MONITORING PLAN
APPENDIX C – STABILITY ANALYSIS
TRIGGER LEVEL 2

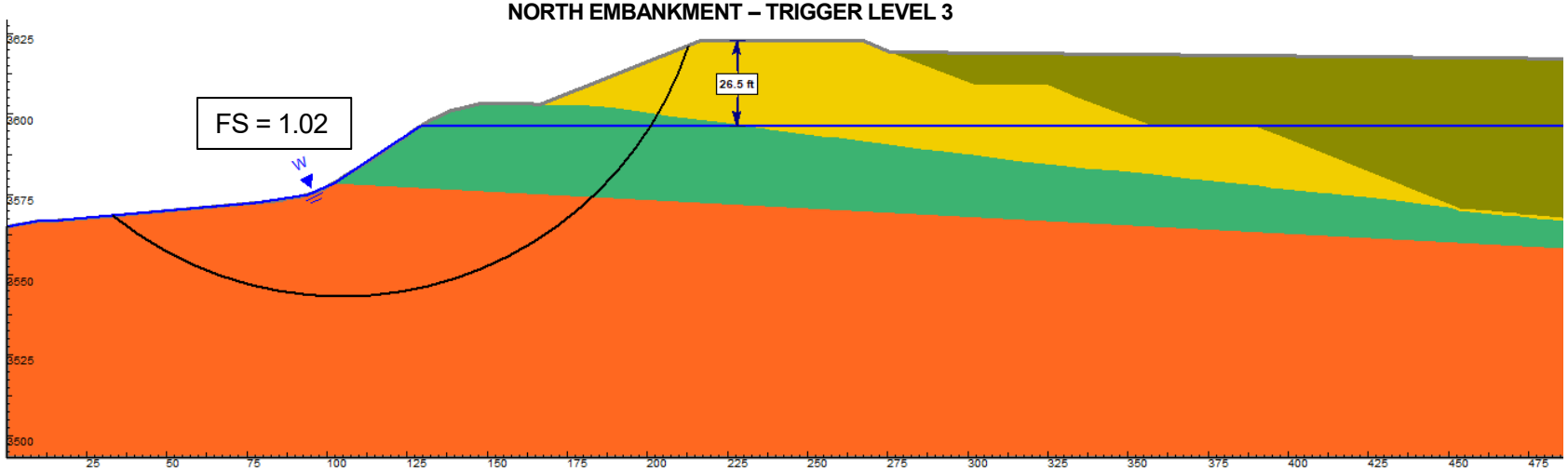
PROJECT No.
1663241

FIGURE
2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0



NORTH EMBANKMENT – TRIGGER LEVEL 3



WEST EMBANKMENT – TRIGGER LEVEL 3

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		135	Mohr-Coulomb	0	40
Alluvium		125	Mohr-Coulomb	0	32
Clay		120	Mohr-Coulomb	315	14
Tailings		95	Mohr-Coulomb	0	15

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CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

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PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY AND WASTE ROCK DUMP
DETAILED DESIGN

TITLE
GEOTECHNICAL MONITORING PLAN
APPENDIX C – STABILITY ANALYSIS
TRIGGER LEVEL 3

PROJECT No.
1663241

FIGURE
3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
1 in
0

golder.com

APPENDIX L

Dam Breach Modeling

November 6, 2019 Project No. 1663241-051-L-Rev0

Ms. Nancy Wolverson
Calico Resources USA Corp
665 Anderson St.
Winnemucca, Nevada 89445

DAM BREACH INUNDATION ANALYSIS
TAILINGS STORAGE FACILITY (TSF)
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

Dear Ms. Wolverson,

This letter presents the results of the dam breach inundation analysis performed by Golder Associates, Inc. (Golder) for Calico Resources USA Corp.'s (Calico's) proposed tailings storage facility (TSF) at the Grassy Mountain Project located in Malheur County in southeastern Oregon.

Golder has completed a detailed engineering design for the Grassy Mountain TSF which is included in the Consolidated Permit Application as Appendix C. The purpose of this inundation analysis is to evaluate the failure consequence, not probability of failure. This simulated dam breach scenarios presented is considered a worst-case scenario and is not a reflection of TSF embankment stability or integrity of the TSF.

1.0 INTRODUCTION

The dam breach inundation analysis was completed in accordance with the Water Resources Department, Oregon Administrative Rules, Section 690-020-0120. The results of this analysis will be incorporated into a facility-specific Emergency Action Plan (EAP) prepared prior to construction of the facility.

It is important to note that the purpose of this study is to evaluate the consequence of failure, and not the probability of failure. The simulated dam breach scenario presented is hypothetical and is not a reflection of the embankment integrity or stability of the TSF.

The dam breach flood from a potential failure of the TSF would travel to the north for approximately 12 miles, along Rock Canyon Road as shown in Figure 5. There are no known major water tributaries by which the flood route would be controlled, the flow path will be controlled by sloping topography.

This letter presents the following:

- TSF configuration at the time of the simulated breach.
- Dam breach flood routing from the TSF embankment towards the north.

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Reno, Nevada, USA 89521
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- Dam breach flood inundation mapping along the study reaches.
- Summary of the study assumptions, results, findings, and recommendations.

2.0 TSF CONFIGURATION

Development of the Grassy Mountain TSF is currently in the permitting process, with engineering support and design provided by Golder. The TSF will have an ultimate capacity of 3.67 million tons of tailings solids and has been designed as a valley fill facility with embankments constructed within the natural drainages bounding the northern side of the TSF and within saddles along the western ridge. The embankments will have a maximum overall upstream slope of 3H:1V with a downstream slope of 2.5H:1V. The upstream slope of the embankments will be geomembrane-lined to maintain a continuous lining system within the facility. The TSF will be constructed in three stages utilizing downstream construction techniques.

The hypothetical dam breach simulated for this analysis focused on the TSF configuration when Stage 3 has been completely filled. Golder assumed that if the TSF were to breach, it would occur within the northern embankment along the critical stability and deepest dam section. A stability analysis was performed on the TSF as part of the detailed design and shows the location of this section (Golder 2019). The breach location for the TSF is shown in Figure 1.

The configuration of the embankment at the end of Stage 3 is summarized in Table 1.

Table 1: Configuration of TSF at the Modeled Breach Location – Stage 3 (Ultimate Configuration)

Parameters	Value at Ultimate Configuration (Stage 3)
Embankment Crest Elevation	3622 ft
Tailings Elevation	3619 ft
Crest Height[1]	82 ft
Released Tailings Volume at Ultimate Elevation[2]	986,920 yd^3
Supernatant Pool	52,500 yd^3
500-yr, 24-hr Storm Volume	32,640 yd^3
Minimum Crest Width Along Northern Embankment	50 ft
Northern Embankment Crest Length	1888 ft

Note: 1. Crest height is measured from the elevation of the embankment toe (breach bottom elevation), to the embankment crest elevation.
2. Includes the maximum volume of tailings, with a full operating pool and the additional volume of water generated by the 500-yr, 24-hour storm event.

3.0 DAM BREACH MODELING

3.1 Data Sources

The following data sources and information were used in this study:

- 2-foot topographic contour data from the 2017 flyover of the Grassy Mountain project site (provided by MDA on March 29, 2017 in an electronic file titled “contours_2ft_expanded_project_area.dxf”)
- 30-meter (100 foot) topographic contour data from 1998 as digital elevation model (DEM) files of the *Grassy Mountain, Sourdough Spring, Double Mountain and Kane Spring Gulch* 7.5-minute quadrangle United States

Geological Survey (USGS) maps downloaded from WebGIS. This data was used for the topography downstream of the TSF where current flyover data was unavailable

- Geo-image TIFF files from 2013 of the *Grassy Mountain, Sourdough Spring, Double Mountain and Kane Spring Gulch Quads* downloaded from the USGS
- Tailings rheology data (SGS Mineral Services 2018)
- Tailings geotechnical data (Golder 2019)
- TSF Design Report (Golder 2019)

3.2 MODELING APPROACH

The dam breach flood simulation was performed using two hydrodynamic models, FLDWAV and FLO-2D. Summary descriptions of these models are provided below.

- FLDWAV is a dam breach and flood routing model developed by the U.S. National Weather Service (Version 2-0-0, dated June 2000). This model is widely used in North America for dam breach flood inundation studies. The model offers empirically-based formulations for characterizing a dam breach. The FLDWAV model was used in this study to simulate the potential breach of the north side of the TSF and to generate dam failure flood hydrographs at the breach location.
- The FLO-2D model (FLO Pro Model, December 2018), developed by Dr. Jim O'Brien with FLO-2D Software Inc., was used to route the non-Newtonian tailings dam breach flood hydrographs from the TSF along the downstream study reaches. FLO-2D is a two-dimensional hydraulic model with an unsteady-state flow routing component. FLO-2D has been approved by the U.S. Federal Emergency Management Agency (FEMA) for riverine studies and unconfined flood analyses. FLO-2D can be applied to a number of complex flood problems including mud and debris consisting of non-homogenous, non-Newtonian flows. The high solids content of a tailings flow categorizes it as a non-Newtonian flow; therefore, FLO-2D is considered an appropriate method for tailings flood routing and has gained wide acceptance for routing of tailings.

3.2.1 TSF Breach Scenario

A tailings dam breach analysis is generally more complicated than a water dam breach analysis. Depending on the solid content of the released tailings and water, the slurry flow can behave as Newtonian flow (i.e., water flood) or non-Newtonian flow (i.e., mud flood). Section 3.5 presents the tailings flow properties used in this analysis.

Golder evaluated the following critical scenario in a dam breach analysis:

- Full Capacity Breach: The TSF is filled to the ultimate capacity at the end of Stage 3 with a maximum operating pool.
- Rainy Day Breach Event: The breach would occur concurrent with the addition of water from the Inflow Design Flood generated from the 500-year, 24-hour storm event (storm depth of 2.91 inches) during operation of the facility.

- Full-Depth Breach: To justify use of a full-depth breach from an engineering view, Golder assumed that the embankment breach would occur due to piping failure at a location along the downstream toe of the north embankment corresponding to the location of the maximum embankment height.

A dam break that occurred after the TSF has been reclaimed would result in a smaller downstream inundation area. Reclamation will shape the surface of the TSF to shed water to prevent ponding, so would eliminate the volume of the supernatant pool and the volume of the storm event from the model.

Tailings dam failures result from a variety of causal mechanisms e.g. overtopping, liquefaction, piping or a combination. Overtopping is caused by fluids spilling over the top of a dam due to inadequate spillway design or settlement of the dam crest. At maximum operating level, the TSF is designed to accommodate runoff from the 500-yr, 24-hr storm event with a storm depth of 2.91 inches within the design freeboard without overtopping. Based on the design requirements for the breach, an overtopping failure of Stage 3 TSF at its maximum operating levels is considered an unlikely failure mechanism.

Due to the TSF being constructed using downstream raise techniques, the embankment does not rely on the tailings to provide embankment stability. Liquefaction of the tailings during a seismic event, or statically, would not jeopardize the stability of the embankment. The foundation conditions below the TSF have been determined to not be susceptible to liquefaction. Therefore, a liquefaction-induced failure mechanism is considered unlikely.

Piping failures occur when the initial breach formation take place at some point below the top of the dam due to erosion of an internal channel through the dam by the escaping water. As erosion proceeds, a larger opening is formed and is eventually hastened by caving-in of the top portion of the dam. Based on the TSF design including a fully geomembrane-lined upstream slope and basin, this is considered an unlikely failure mechanism.

The dam breach flood from a potential failure of the north side of the TSF would travel to the north, along Rock Canyon Road, as shown on Figure 5. There are no known major water tributaries by which the flood could be routed; the flow path would be routed by sloping topography only.

The domain boundary, presented on Figure 1, was based on a review of the site topography and potential flow path in the event of a breach. The domain boundary was refined after preliminary model runs to confirm that the domain coverage was sufficient to minimize the boundary effects on the modeling results. The selected model domain includes the Project Site, and *Sourdough Spring, Kane Spring Gulch, Double Mountain and Grassy Mountain* 7.5-minute USGS quadrangle topographic maps.

3.3 Dam Breach Release Volume Estimate

3.3.1 Methods for Estimating Release Volume

Studies of historic tailings dam failures indicate that released tailings volumes are governed by the impoundment construction method and history, tailings dam height, geotechnical properties of tailings, and geometries of tailings ponds and downstream floodway.

Golder reviewed three methods for estimating the released tailings volume:

- Azam and Li (2010)
- Rico et al. (2008)

- Ishihara (1996)

A review of over 200 historic tailings dam failures around the world indicates that, on average, about 20 percent of the tailings contained within the tailings storage facilities is lost as part of the breach events (Azam and Li, 2010). Rico M. et al. (2008) developed an empirical relationship between the tailings storage volume and the quantity of tailings released in the event of a tailings dam failure based on the available information for the 29 historic tailings dam failures with tailings dam heights ranging from 5 meters (16 feet) to 66 meters (217 feet). This relationship is provided below:

$$V_F = 0.354\ V_T^{1.01}$$

Where: V_F = tailings release volume

V_T = total tailings volume contained in the pond

This equation suggests that, on average, about one-third of the tailings volume and the entire water volume of tailings ponds is released during dam failures. This is slightly higher than estimates developed by Azam and Li (2010).

An analytical approach to breach volume estimates involves a mechanism that creates a geometry into the tailings starting at the outflow location at the base of the dam centerline that extends up into the tailings in the shape of a cone until the cone daylights back in the basin at the top of the tailings. Under this scenario, tailings and water above this cone would leave the impoundment, while tailings beneath the cone would remain.

This failure mechanism, referred to as the “cone failure” assumes that the breach of the dam will cause static liquefaction of the tailings, reducing the undrained shear strength (s_u/p) ratio. Based on empirical relationships developed by Ishihara (1996) for non-plastic tailings, the liquefied undrained shear strength of the tailings can be conservatively modeled with an s_u/p of 0.06. Stability models based on this shear strength result in a cone slope of approximate eight percent grade (five degrees). Using this method, the total volume released is highly dependent on the height and shape of the facility. It should be noted that this failure mechanism refers to the upstream tailings and is used to estimate the volume of tailings released during a breach only.

For the Grassy Mountain TSF, Golder estimated the released tailings volumes considering both the relationship proposed by Rico M. et al. (2008) and the cone failure method.

3.3.2 Modeled Release Volume

The TSF is designed to contain approximately 3.2 million cubic yards of consolidated tailings. An additional fluid volume of 52,500 cubic yards is included in the impoundment volume; this accounts for the volume of the supernatant pool with a depth of 5 feet. For estimating the dam breach volume, it was assumed that failure would be preceded by accumulation of run-on from the 500-yr, 24-hr storm event. In the event of the 500-yr, 24-hr storm event, an additional water volume of 32,600 cubic yards for Stage 3 is introduced in the impoundment above the supernatant pool.

Golder estimated the tailings released volume using the methods described in Section 3.3.1. The relationship proposed by Rico M. et al. (2008) estimates 41 percent of the total tailings volume in the Stage 3 impoundment will be released in the event of the embankment breach (corresponding to 1.22 Myd^3). The cone failure method estimates that approximately 24 percent of the tailings would be mobilized due to an embankment failure

(corresponding to 0.71 Myd^3) as well as the embankment fill within the cone failure and the breach width downstream (corresponding to 0.28 Myd^3). It was assumed that this embankment fill will be displaced and carried away by the tailings mass and was modeled with the tailings flow characteristics

For selecting a tailings release volume for the Grassy Mountain TSF, Golder considered the estimate from both methods, along with the geometry of the impoundment. A value of 33 percent of the total material release volume (corresponding to 0.99 Myd^3) was chosen to accommodate the embankment fill that will be carried away as a part of the tailings mass as described in the above paragraph. This is a conservative approach when compared to the proposed estimated volume released of about one-fifth of the total TSF volume proposed by Azam and Li (2010), which considers a much larger dam failure database than Rico M. et al (2008).

Additionally, all the water from the combined operational supernatant pool and the 500-yr, 24-hr storm (0.08 Myd^3) would be mobilized. The total released volume is estimated as 1.07 Myd^3. The tailings, water, and total release volumes for the analyzed breach scenario are summarized in Table 2.

Table 2: Estimates of Released Tailings Volumes

Breach	Dam Breach Volume (Myd^3)			
	Tailings Volume Released	**Supernatant Pool Volume**	**500-yr, 24-hr Storm Event**	**Total Volume Released**
Full Depth of Stage 3 TSF	0.99	0.05	0.03	1.07

3.4 Dam Breach Model Parameters

The dam breach outflow hydrograph was generated by FLDWAV and is presented as the rate of tailings flow vs time at the toe of the dam along the failure surface. The dam breach outflow hydrograph is a function of the dam breach model parameters that are related to the breach mechanism and embankment geometry. Table 3 presents the dam breach outflow input parameter values that were used in FLDWAV. These values are based on the recommendations by the U.S. Federal Energy Regulatory Commission (FERC 1994) and empirical formulations developed by Fread (2001), and in consideration of historical dam failures, as well as site-specific characteristics of the TSF.

Table 3: Dam Breach Model Parameters

Breach Scenario	Failure Mode	Average Breach Width (BR) (ft)	Breach Side Slope	Time to Failure (TFH) (hour)	Elevation of Tailings at Dam Failure (HFDD) (ft)	Breach Bottom Elevation* (ft)
Stage 3 Rainy Day	Full Depth	102.4	1H:1V	0.2	3619	3534

* Bottom breach elevation is the elevation of the embankment toe at the assumed breach location, assuming the failure extended from the native ground to the crest of Stage 3.

The basis for the selected modeling parameter values is provided below.

- The average breach width (BR) was selected using the empirical relationship suggested by Fread (2001):

$$BR = 9.5\ k_0\ (V_r\ H)^{0.25}$$

Where: BR = average breach width (ft)

k_0 = a coefficient (equal to 0.7 and 1.0 for piping and overtopping failures respectively)

V_r = water volume (acre-ft)

H = height of water over the breach bottom (feet); measured from the elevation of the embankment toe to the elevating of the tailings and/or water.

Fread (2001) indicates the range for BR should be 0.5HD ≤ BR ≤ 8HD; where HD is the total height of the dam embankment. This relationship suggests that the selected BR value is reasonable for modeling breach of the TSF.

- Time to failure (TFH) was estimated to be 0.2 hours for a piping failure of the Stage 3 embankment. This value is within the recommended range by FERC for engineered earthen dams (0.1 ≤ TFH ≤ 1.0). The following empirical relationship is suggested by Fread (2001) for estimating TFH:

$$TFH = 0.3\ V_r^{0.53}/H^{0.9}$$

- For the breach modeling, the horizontal component of the side slope of the breach opening (Z) was selected to be 1, which is at the higher end of the normal range (1/4 ≤ Z ≤ 1) recommended for engineered earthen dams by FERC. The simulated downstream maximum flood levels are not expected to be sensitive to this parameter.

3.5 Tailings Flow Properties

In the event of a breach, viscous tailings slurry would leave the Grassy Mountain TSF and would travel downstream as a mudflow. This would constitute a non-homogeneous, non-Newtonian, transient flood event. Mudflow behavior is a function of the fluid matrix properties as well as floodway geometry, slope and roughness. The fluid would consist of water and fine solids (tailings). At sufficiently high concentrations, fine solids are expected to alter properties of the fluid including density, viscosity and initial yield stress.

The properties of the outflow resulting from a tailings dam breach are likely to vary over the mudflow duration. The solids in the outflow are expected to have significant effects on the hydraulics of the resulting flow, which would be highly turbulent. Therefore, the fluid flow from the failure was simulated as non-Newtonian flow. The model assumed that the outflow would comprise a mudflow represented by a blended mixture of the materials that will be released from the tailings impoundments (tailings, embankment fill and water). The material properties that FLO-2D uses to model the flow are yield stress (remolded strength), dynamic viscosity of the breach outflow, and solids volume content.

The following empirical relationships are used within the FLO-2D model to compute the yield stress (τ_{YS}) and dynamic viscosity (η) coefficients α and β of the mudflow during model simulation:

$$\tau_{YS} = \alpha_{YS} e^{\beta_\eta C_v} \quad \text{and} \quad \eta = \alpha_\eta e^{\beta_\eta C_v}$$

Where: α and β = empirical coefficients defined by laboratory testing results.

Laboratory results for the yield stress (τ_{YS}) and dynamic viscosity (η) of the tailings slurry are plotted against the different solids volume content (Cv) for which each test was performed. From these plots the empirical coefficients α and β are estimated. Site-specific laboratory data that was not developed for the target Cv can still be extrapolated parameters using the laboratory relationships.

SGS Mineral Services (SGS) performed laboratory testing to measure the rheological properties of pilot tailings slurry samples for the Grassy Mountain Project (SGS, 2018). The measured specific gravity (SG) of the tailings slurry averaged at 2.64. Tailings rheological properties were measured at six solids contents and the collected data sets are presented in Table 4.

Table 4: Tailings Slurry Rheological Testing Results (SGS, 2018)

Solids Content, Cw (by weight)	Solids Content, Cv (by volume)	Dynamic Viscosity (poises)	Yield Stress (dynes/cm^2)
67.0%	43.5%	0.77	160
64.6%	40.9%	0.62	130
62.2%	38.4%	0.33	100
59.2%	35.5%	0.22	58
55.6%	32.2%	0.15	40
51.6%	28.8%	0.23	10

The dynamic viscosity and yield stress for the tailings were obtained at solids volume content (Cv) values that ranged from 28.8 percent to 43.5 percent; this represents a tailings solids content range appropriate for the Cv value developed for the tailings during a breach of 48.6 percent (see Section 3.6). The dynamic viscosity and yield stress were plotted to estimate the α and β coefficients needed for input into FLO-2D. Figures 2 and 3 show the plot of the dynamic viscosity and yield stress test results, respectively, along with their estimated α and β coefficients.

Table 5 presents the tailings mudflow properties used as input for the FLO-2D model.

Table 5: Tailings Slurry Mudflow Properties

Viscosity Coefficients		Yield Stress Coefficients		Specific Gravity	Laminar Flow*
α_η	β_η	α_{YS}	β_{YS}		
0.008054	10.13	0.091257	17.78	2.64	2000

*Laminar flow resistance was estimated using the range for “sparse vegetation” listed in the FLO-2D PRO

3.6 Tailings Solids Content

To simulate a flood model, the flood hydrographs (as predicted by the FLDWAV model) input into the FLO-2D program are assumed to represent the outflow of water at the breach location. However, the volume released from the TSFs includes a mixture of the tailings slurry and water from the supernatant pool and the 500-yr, 24-hr storm event, and is expected to behave as a mudflow. To simulate a mudflow in FLO-2D, the flood hydrographs for each breach scenario must be adjusted to represent the total volume of the mixture of water and tailings. This can be determined by multiplying the water volume by the bulking factor (BF):

$$BF = 1/(1-Cv)$$

Where: Cv = assumed solids content of the mudflow mixture by volume.

The estimated tailings volumes released for the dam scenario (described in Section 3.3.2 and listed in Table 2) are assumed to consist of a well-mixed slurry of tailings solids and water. The dry density of the tailings solids is estimated be 80 pounds per cubic foot (Golder 2019) and the tailings solids SG is 2.64. Using this data, Golder estimated the Cv in the dam breach tailings slurry to be 48.6 percent.

Table 6 lists the estimated Cv values and bulking factor for the breach scenario.

Table 6: Grassy Mountain Mudflow Solids Content and Bulking Factor

Dam Failure Mode	Tailings Volume Released (Myd^3)	Tailings Solids Volume (Myd^3)	Tailings Water Volume (Myd^3)	Storm and Pool Water Volume (Myd^3)	Total Volume Released (Myd^3)	Cv (%)	BF
Rainy Day Full Depth	0.99	0.48	0.51	0.08	1.07	48.6	1.94

3.7 Initial Hydraulic Conditions and Manning's Roughness Coefficient

The assumed initial hydraulic conditions for routing the dam breach flood are estimated to have negligible effects on the modeling results, particularly on the resulting flood peak levels. However, a reasonable approximation of the initial hydraulic conditions is required for numerical computation and to represent the likely hydraulic conditions during the potential dam breach flood events.

Presented below are the considerations and assumptions made in this study for specifying the initial hydraulic conditions at the TSF and the downstream flood way:

- initial tailings surface Elevation 3619 ft in the impoundment.
- initial supernatant pool surface Elevation 3610 ft in the impoundment (1 foot of freeboard).
- downstream hydraulic boundary conditions for FLO-2D modeling assumed to be normal flow conditions.
- there are no known major water tributaries by which initial flow may be introduced into the impoundments. Stormwater would be diverted around the facility and only stormwater runoff falling below the permanent diversion channel contributes to the TSF in the 500-yr, 24-hr storm event.

The selection of a Manning's roughness coefficient, *n,* value was based on Golder's interpretation of the available Google Earth images, site-visit photographs, relevant project experience and judgement of Golder's team and consideration of the vegetation cover and the overland form roughness. The Manning's *n* value was estimated as 0.15 for downstream areas with short prairie grass.

3.8 2-D Model Domain and Mesh Resolution

A FLO-2D model domain was defined based on the TSF design surface, 2017 aerial survey within the Project Boundary, and 7.5-minute DEM files obtained from USGS to cover the areas of interest downstream of the breach location. The domain and associated boundaries were refined after preliminary model runs to minimize the boundary effects on the modeling results and to confirm that the available quad DEM's and the domain coverage

were sufficient to cover the maximum possible flood extents. A rectangular mesh system was used for the domain, and the final model run was based on a 50-foot mesh resolution.

4.0 MODELING RESULTS

The outflows from a potential breach of the Stage 3 TSF embankment would contain tailings solids, water from the supernatant pool, and additional water from the 500-yr, 24-hr storm event. In the case of a full-depth dam breach on the north side of the embankment, the total volume of materials (1.07 Myd^3) to be released from the failure of the ultimate TSF would include 0.48 Myd^3 of tailings solids (45 percent of the total material volume), 0.51 Myd^3 of slurry water (47 percent of the total material volume), 0.03 Myd^3 of additional runoff water during the 500-yr, 24-hr storm event (3 percent of the total material volume) and 0.05 Myd^3 of supernatant pool water (5 percent of the total material volume).

FLDWAV software, Version 1.0.0, developed by the National Weather Service (FLDWAV, 1998) was used in this study to model the potential breach of the north side of the TSF using the dam breach model parameters presented in Section 3.4. Figure 4 presents the simulated dam breach flood hydrograph at the breach location generated in FLDWAV. The simulated peak discharge is 75,500 cubic feet per second (cfs).

The FLDWAV and FLO-2D models were used to generate the dam breach flood inundation mapping downstream of the Grassy Mountain TSF. Figures A-1 through A-4 in Attachment A present the FLO-2D modeling results along the study reach. The inundation area was ended when the Flood Hazard Intensity (depth x velocity) fell below 0.04 m^2/sec, lower than the commonly-accepted level of about 0.4 m^2/sec. The results of the dam breach scenario modelled for this analysis indicate that:

- The TSF flood flows would follow an existing ephemeral drainage running adjacent to Rock Canyon Road;
- The total tailings slurry deposition area inundated would be approximately 834 acres;
- Golder reviewed aerial imagery, and it is our understanding that there are no occupied structures within the tailings slurry inundation area;
- The modeled maximum tailings runout distance from the TSF is approximately 12 miles, beyond which flows would not pose a significant risk to human life; and
- The peak flood travel time from the TSF to the maximum tailings runout distance (12 miles) would be approximately 48 hours.

4.1 Flood Inundation Maps

The flood inundation map was prepared at a scale of 1 inch:2000 feet for the dam breach modeling scenario to show the flood delineation on the base map consisting of contours, roads and other mapping features with the aerial imagery as a background. Figure 5 presents the map, which includes the following information:

- The tailings runout extents delineated based on the simulated maximum tailings deposition levels, which were simulated using the FLO-2D model
- Mile marker locations and labels used in the FLDWAV and FLO-2D models

Depending on the local terrain slopes, the accuracy of contour interval leads to various levels of horizontal accuracy. However, the delineation provides a sufficiently accurate definition of the areal extents of the tailings dam breach flood.

4.2 Potentially Impacted Areas

4.2.1 General

The key flooding information downstream of the TSF is summarized at mile markers on Figure 5. The areas potentially impacted by the simulated tailings dam breach floods are discussed in the following section.

4.2.2 Project Site

The primary access roads to the Grassy Mountain Mine site will be flooded in the event of a full-depth breach on the north side of the TSF embankment. The flood arrival time is immediate with a maximum tailings runout velocity and maximum tailings deposition depth of 20.6 ft/s and 37.7 feet, respectively.

4.2.3 Rock Canyon Road and Twin Springs Road

Lower lying portions of the Rock Canyon Road and the Twin Springs Road would likely be flooded in the event of a full-depth breach on the north side of the TSF embankment. The flood arrival time to the Rock Canyon Road is approximately 41 minutes with a maximum tailings runout velocity and maximum tailings deposition depth of approximately 8.0 ft/s and 13.0 feet, respectively.

5.0 CONCLUSIONS

The purpose of this study is to evaluate the consequence of failure, and not the probability of failure, for the dam breach scenario. The results of this study support the following conclusions:

- Potential piping failure of the TSF embankment under the 500-yr, 24-hr storm inflow conditions, provides a mechanism for a breach of the full depth of the dam, and represents a ‘reasonable worst-case’ scenario for analyzing the downstream impact of a potential dam breach for delineating a runout inundation area.
- In the event of a full-depth breach at the north side of the TSF under the ‘reasonable worst-case’ scenario:
  - While the inundation area just downstream of the breach is broad, it quickly narrows to a thin flow constrained in the walls of a relatively narrow drainage feature.
  - The maximum tailings deposition levels are, on average, about eight feet above the ground surface and range from about 38 feet immediately downstream of the reach to about 1½ feet at the end of the inundation map.
  - Within approximately 41 minutes of the initial dam breach, Rock Canyon Road would be inundated with tailings to a maximum depth of approximately 13 feet where it crossed the drainage.
  - The tailings runout distance would be approximately 12 miles from the dam breach location and would be reached in approximately 48 hours. Flows may extend beyond this distance, depending on base flow in the drainage along the reach of the inundation area, but the depth and velocity of flow would be sufficiently low beyond this point to pose minimal risk to human life.
- No habitations or lifelines would be impacted by a piping failure of the TSF under the conditions evaluated.

- Public access to the project site and areas south along Rock Canyon Road and Twin Springs would either be inaccessible or access limited in the event of a piping failure of the TSF, until tailings solids could be removed. Alternative public access routes would remain operational.

6.0 CLOSING

Golder is pleased to present this breach analysis of the tailings storage facility at the Grassy Mountain Mine. If you have any questions or comments regarding the information presented herein, please contact the undersigned at (775) 828-9604.

Respectfully,

Golder Associates Inc.

Christopher J. MacMahon, PE
Associate, Engineer of Record

Russell A. Browne, PE (NV)
Principal, Senior Tailings Practice Leader

MDB/CJM/RAB/vk

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Figure 9: Modeling Output – Time to Maximum Tailings Deposition Depth

7.0 REFERENCES

DOGAMI, 2018. *Technical Review Memorandum, Conceptual Design – Tailings Storage Facility (TSF)*, prepared by Tetra Tech for Cardno, Inc. and State of Oregon, Department of Geology and Mineral Industries (DOGAMI). December 19, 2017.

FLDWAV, 1998. FLDWAV, Version 1.0.0. Developed by Nation Weather Service. 1998.

FLO-2D Software, Inc. FLO-2D PRO Reference Manual, Version 2009.

Fread, D.L. 2001. Some Existing Capabilities and Future Directions for Dam-Breach Modelling/Flood Routing, Proceedings FEMA Workshop on Issues, Resolutions, and Research Needs Related to Embankment Dam Failure Analysis, Oklahoma City, Oklahoma.

Golder, 2017. *Conceptual Design, Tailings Storage Facility, Grassy Mountain Project, Malheur County, Oregon.* Prepared for Calico Resources USA Corp. by Golder Associates Inc. August 22, 2017. 1663241.Doc018.L.Rev0.

Golder, 2018. *Report, Pre-feasibility Design Tailings Storage Facility, Grassy Mountain Project.* Prepared for Calico Resources USA Corp. by Golder Associates Inc. June 29, 2018. 1663241.36.R.Rev0.

Ishihara, 1996. *Soil Behavior in Earthquake Geotechnics*.

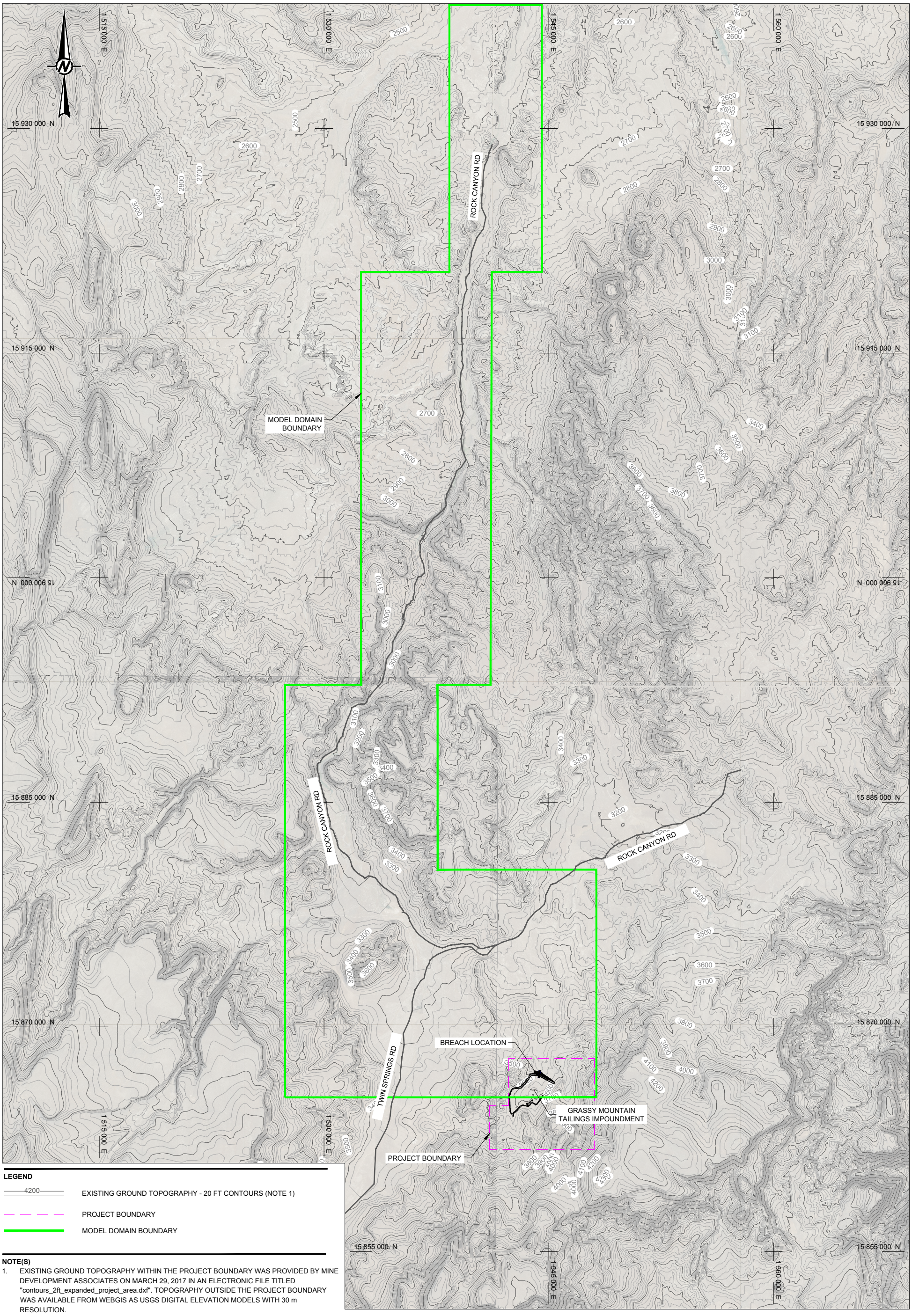
Tetra Tech 2017. *Calico Grassy Mountain – Conceptual Tailings Design (8/22/17),* prepared by the Department of Geology & Mineral Industries. February 21, 2018.

Rico, M., Benito, G., and Díez-Herrero, 2008, Floods from Tailings Dam Failures, Journal of Hazardous Materials, vol.154, pp.79-87.

Shahid Azam and Qiren Li, 2010, Tailings Dam Failures: A Review of the Last One Hundred Years Geotechnical News, December 2010.

WebGIS, Lakes Environmental Software <http://www.webgis.com/index.html>

FIGURES



LEGEND

- 4200 — EXISTING GROUND TOPOGRAPHY - 20 FT CONTOURS (NOTE 1)
- PROJECT BOUNDARY
- MODEL DOMAIN BOUNDARY

NOTE(S)

1. EXISTING GROUND TOPOGRAPHY WITHIN THE PROJECT BOUNDARY WAS PROVIDED BY MINE DEVELOPMENT ASSOCIATES ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf". TOPOGRAPHY OUTSIDE THE PROJECT BOUNDARY WAS AVAILABLE FROM WEBGIS AS USGS DIGITAL ELEVATION MODELS WITH 30 m RESOLUTION.
2. GEOIMAGE TIFF FILES FROM 2013 OF THE GRASSY MOUNTAIN, SOURDOUGH SPRING, DOUBLE MOUNTAIN AND KANE SPRING GULCH QUADS WERE AVAILABLE FROM THE USGS.
3. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".

0 3000 6000
1" = 3000' FEET

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CONSULTANT
GOLDER

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REVIEWED	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
MODEL DOMAIN BOUNDARY

PROJECT NO.	REV.	FIGURE
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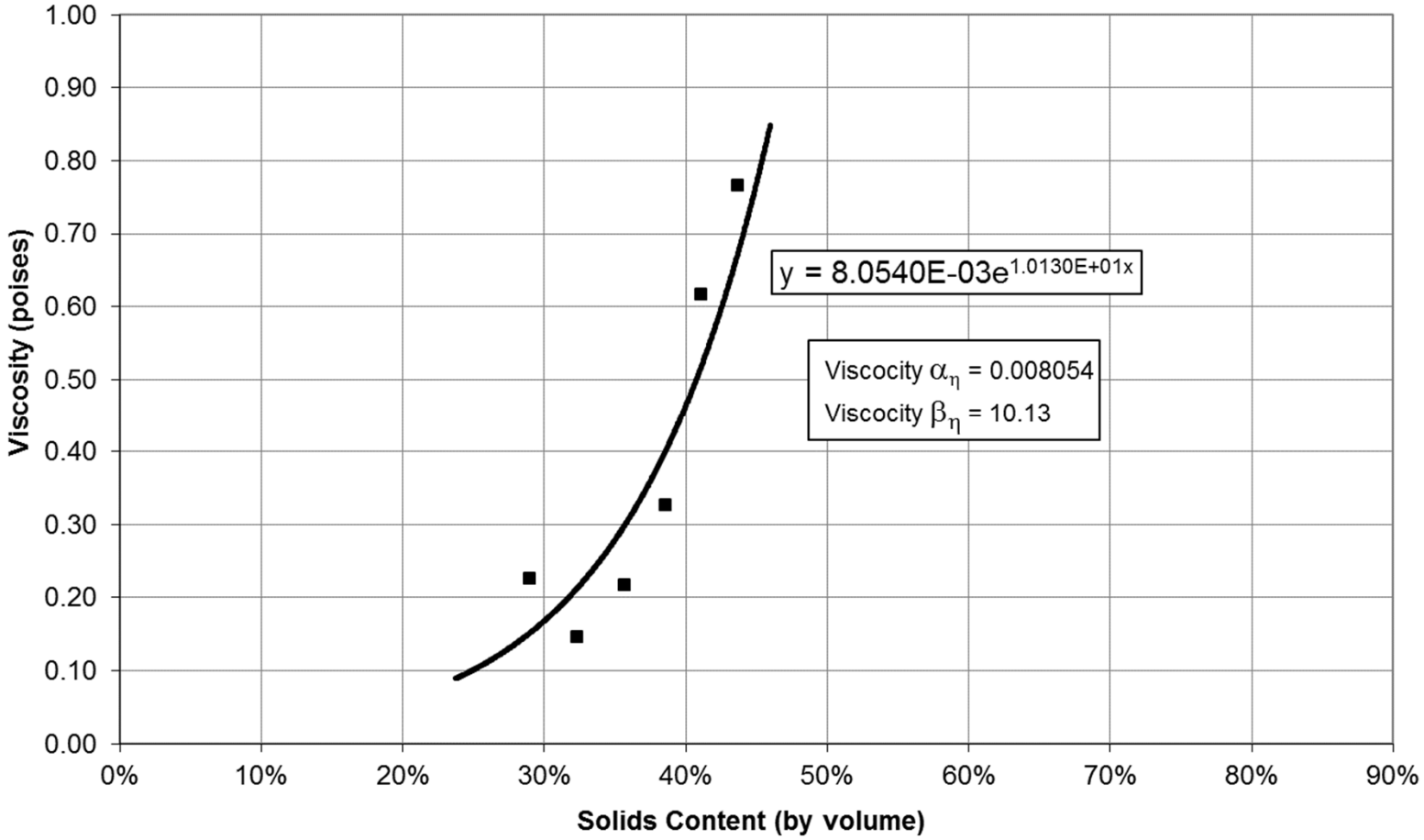

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DETAILED DESIGN

TITLE
TAILINGS PARAMETERS
DYNAMIC VISCOCITY

PROJECT No.	Rev.	FIGURE
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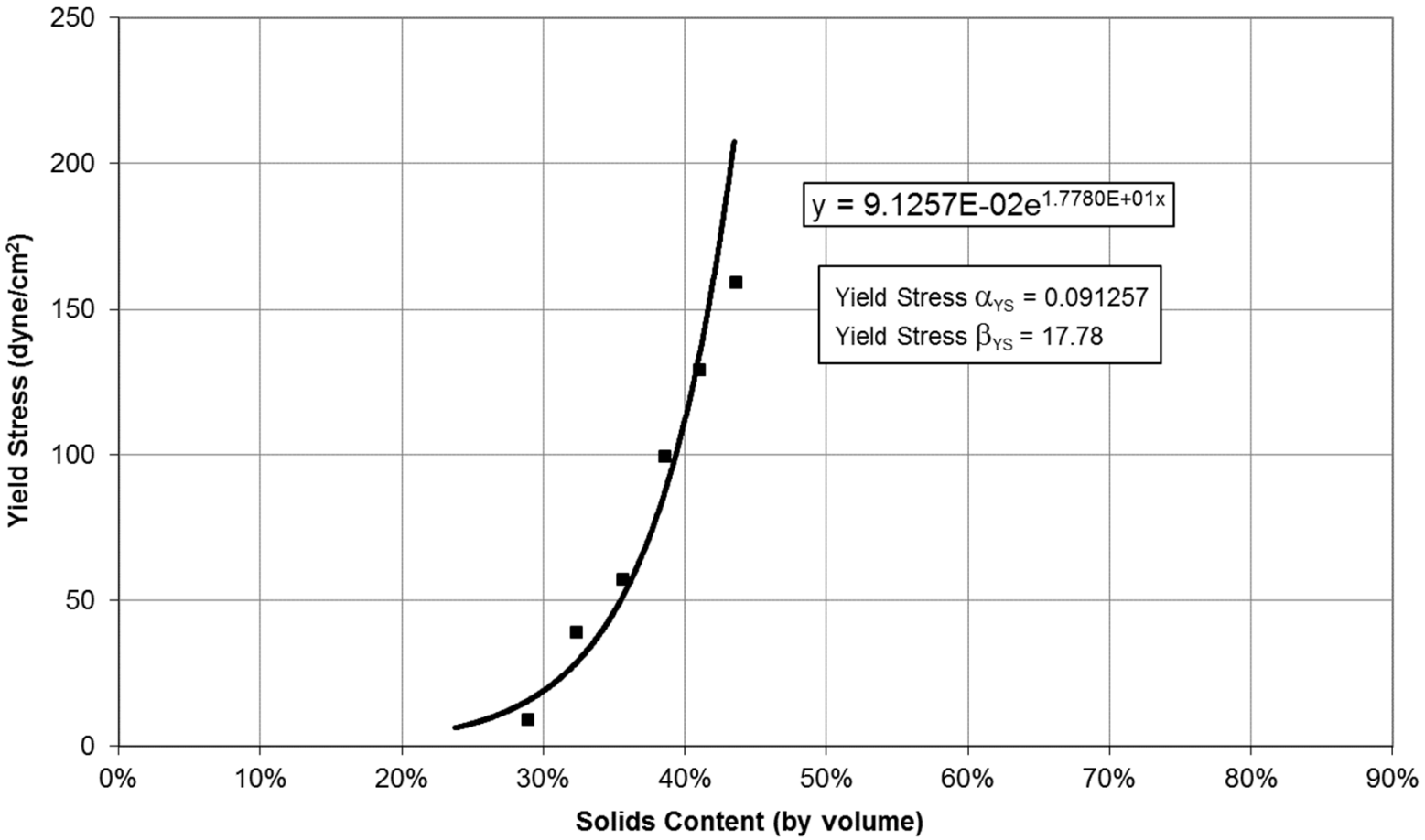

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TAILINGS PARAMETERS
YIELD STRESS

PROJECT No. 1663241 | Rev. 0 | FIGURE 3

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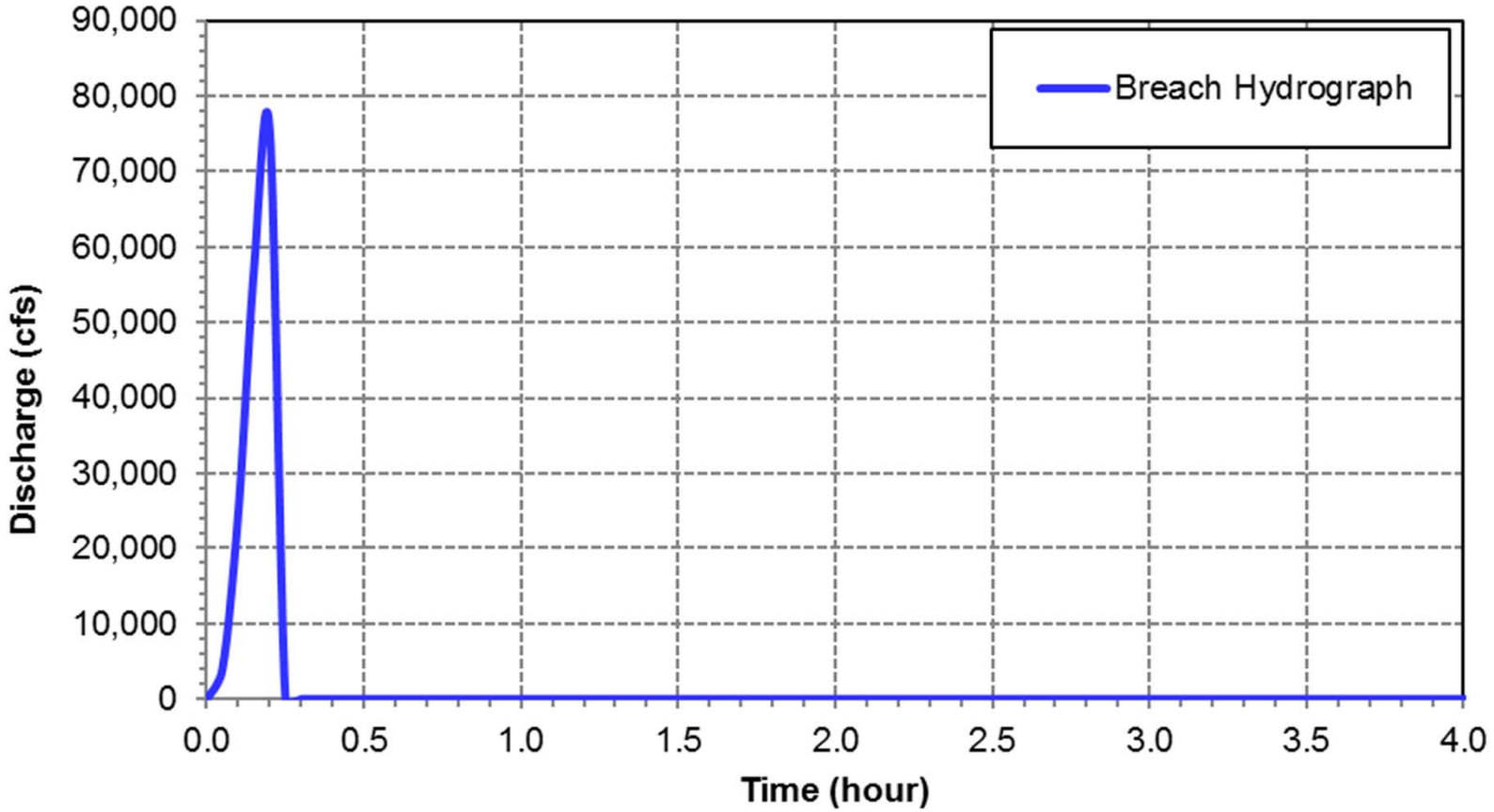

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TAILINGS OUTFLOW HYDROGRAPH

PROJECT No. 1663241 | Rev. 0 | FIGURE 4

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LEGEND

- 4200 — EXISTING GROUND TOPOGRAPHY - 20 FT CONTOURS (NOTE 4)
- INUNDATION AREA
- PROJECT BOUNDARY

NOTE(S)

1. EXISTING GROUND TOPOGRAPHY WITHIN THE PROJECT BOUNDARY WAS PROVIDED BY MINE DEVELOPMENT ASSOCIATES ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf". TOPOGRAPHY OUTSIDE THE PROJECT BOUNDARY WAS AVAILABLE FROM WEBGIS AS USGS DIGITAL ELEVATION MODELS WITH 30 m RESOLUTION.
2. GEOIMAGE TIFF FILES FROM 2013 OF THE GRASSY MOUNTAIN, SOURDOUGH SPRING, DOUBLE MOUNTAIN AND KANE SPRING GULCH QUADS WERE AVAILABLE FROM THE USGS.
3. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".
4. INUNDATION MAP PRESENTED IS BASED ON 2019 BREACH ANALYSIS OF THE STAGE 3 GRASSY MOUNTAIN DAM PERFORMED FOR THE EAP DATED JULY, 2019.
5. ARRIVAL TIMES WERE ESTIMATED USING THE FLO-2D MODEL. THESE ESTIMATES ARE APPROXIMATE AND THEREFORE ALL PERSONNEL SHOULD EVACUATE THE INUNDATION AREAS AS SOON AS POSSIBLE AS THE FLOODWAVE MAY ARRIVE QUICKER THAN INDICATED ON THIS MAP.
6. THE DAM BREACH WAS MODELED WITH THE 500-YEAR 24-HOUR STORM VOLUME (APPLIED OVER THE ENTIRE TAILINGS SURFACE AREA), AND THE ENTIRE SUPERNATANT POOL VOLUME (ASSUMING A DEPTH OF 5 FT) INTEGRATED INTO THE TOTAL BREACH OUTFLOW.

0 2000 4000
1" = 2000' FEET

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DETAILED DESIGN

TITLE
STAGE 3 INUNDATION MAP

PROJECT NO.	REV.	FIGURE
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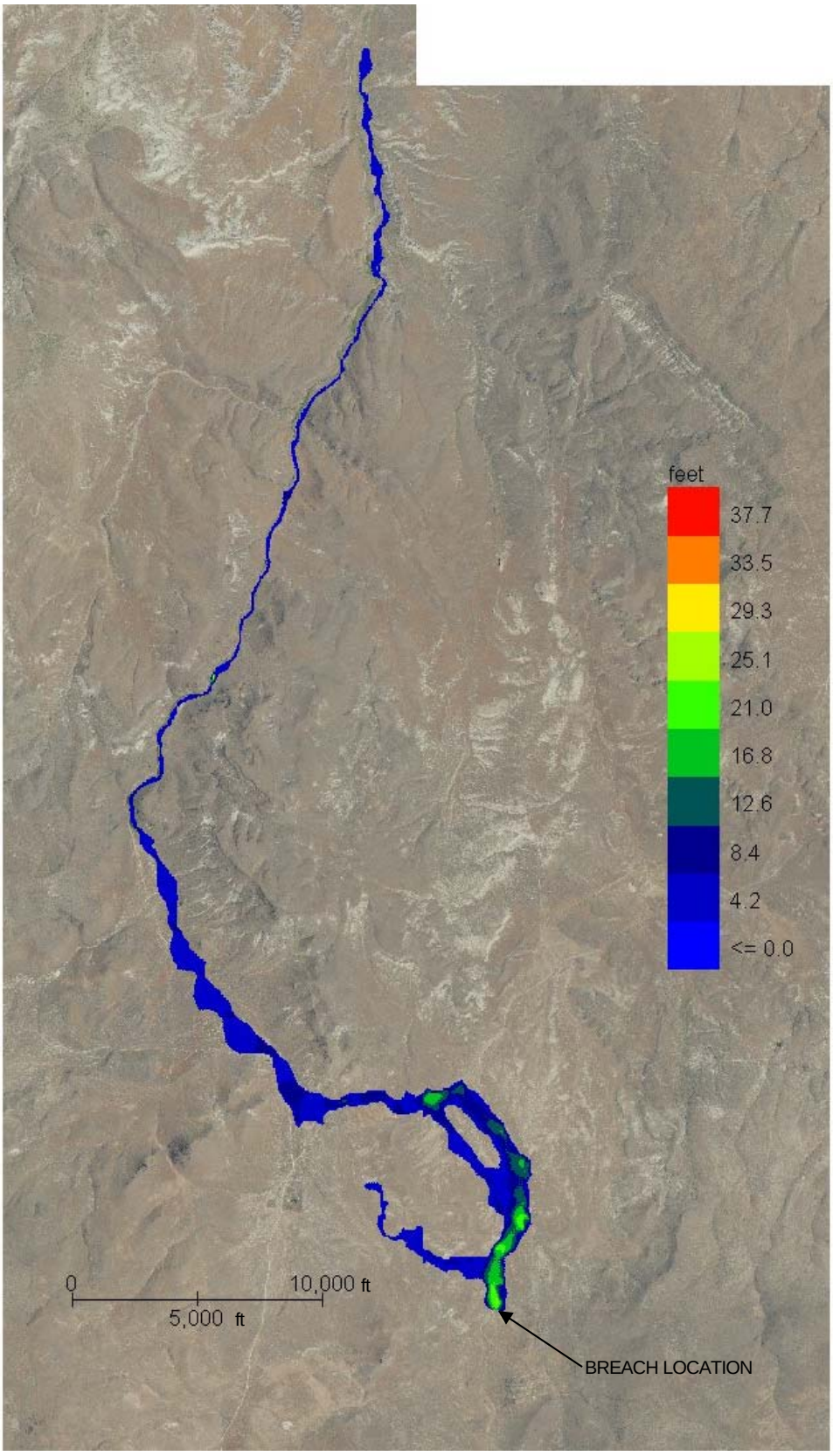

NOTE(S)

1. GEOIMAGE TIFF FILES FROM 2013 OF THE GRASSY MOUNTAIN, SOURDOUGH SPRING, DOUBLE MOUNTAIN AND KANE SPRING GULCH QUADS WERE AVAILABLE FROM THE USGS.

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TITLE
MODELING OUTPUT
MAXIMUM TAILINGS DEPOSITION DEPTH

PROJECT No. 1663241 | Rev. 0 | FIGURE 6

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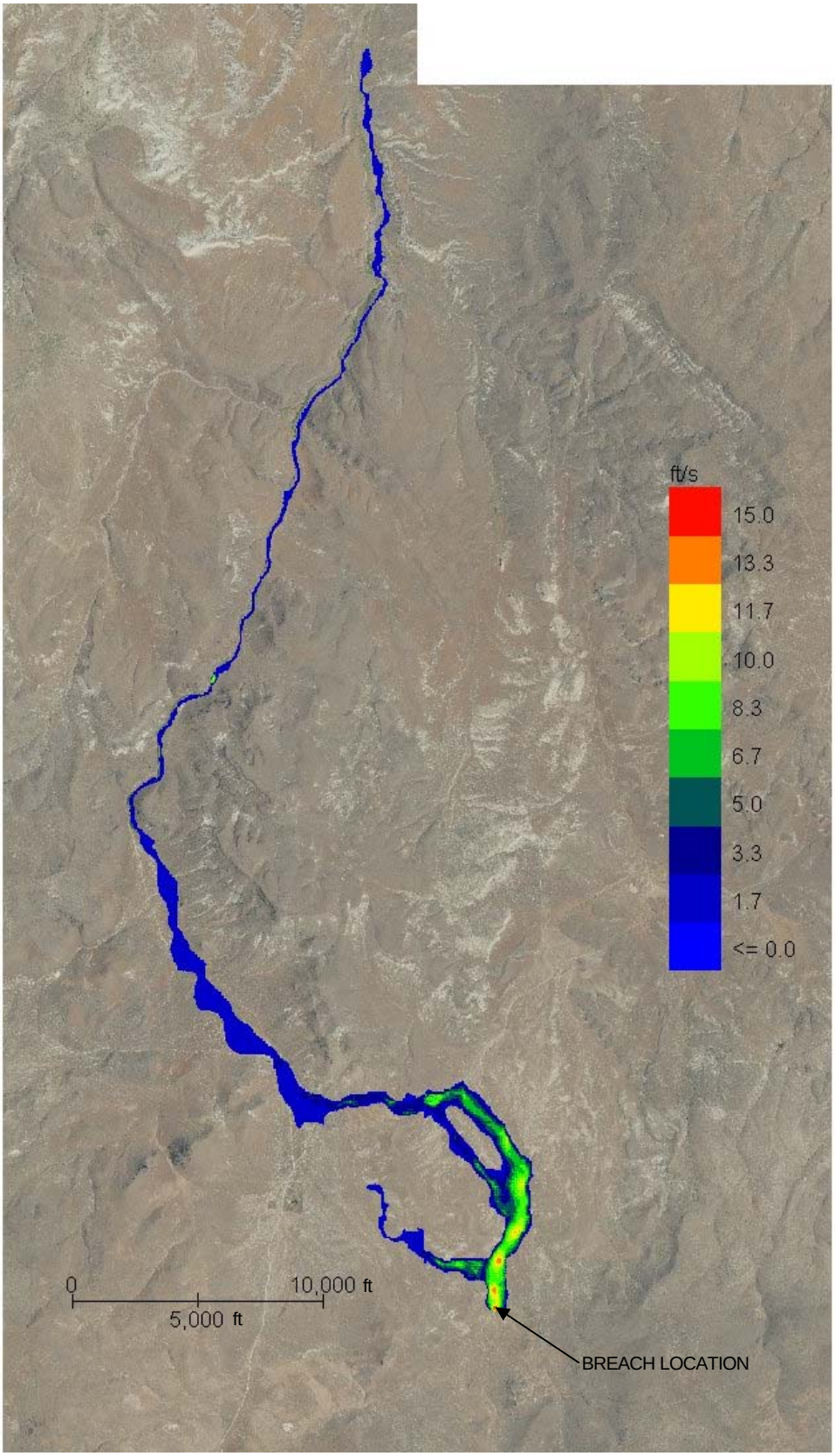

NOTE(S)

1. GEOIMAGE TIFF FILES FROM 2013 OF THE GRASSY MOUNTAIN, SOURDOUGH SPRING, DOUBLE MOUNTAIN AND KANE SPRING GULCH QUADS WERE AVAILABLE FROM THE USGS.

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APPROVED	RAB

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DETAILED DESIGN

TITLE
MODELING OUTPUT
MAXIMUM TAILINGS RUNOUT VELOCITY

PROJECT No. 1663241 | Rev. 0 | FIGURE 7

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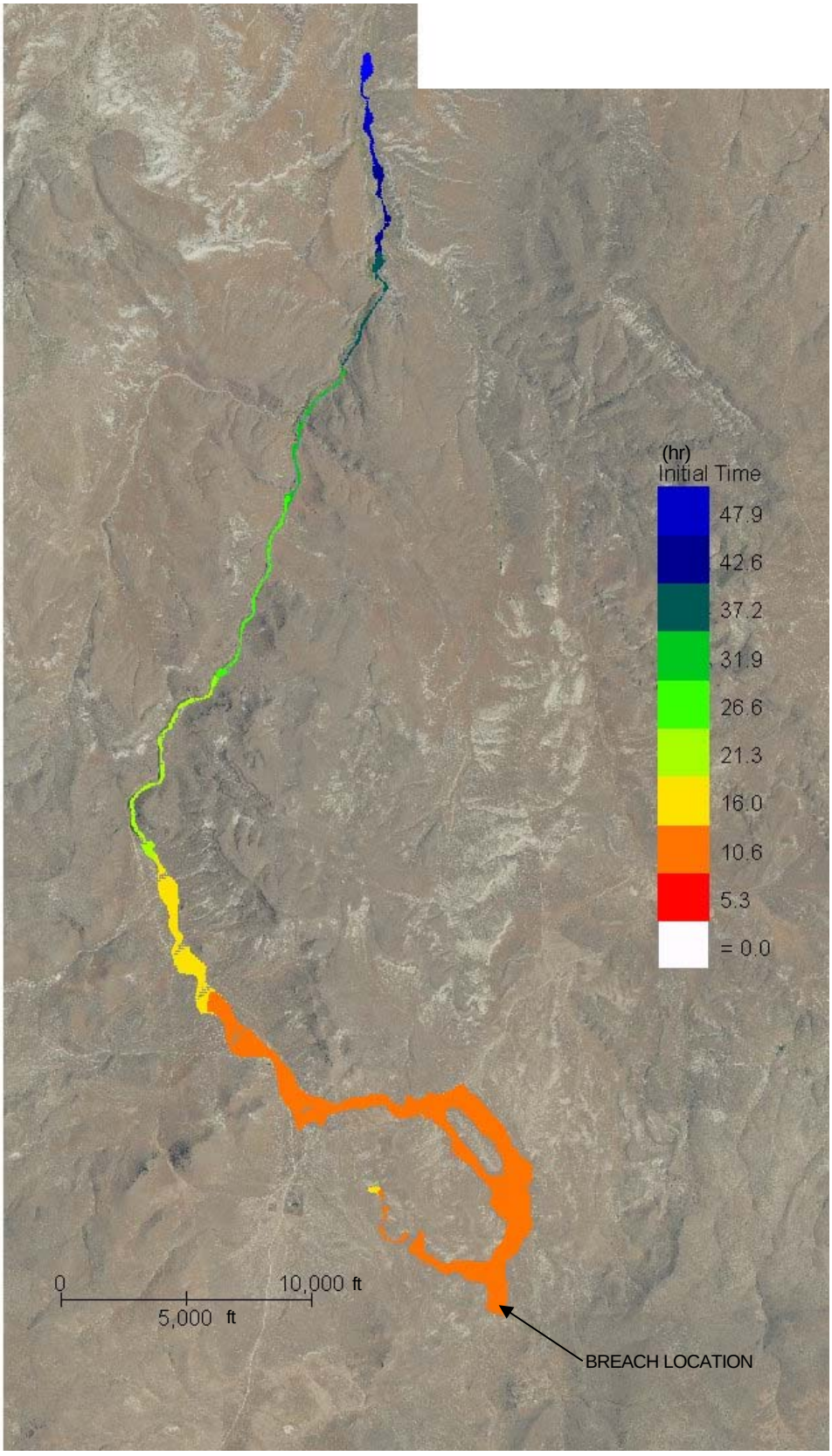

NOTE(S)

1. GEOIMAGE TIFF FILES FROM 2013 OF THE GRASSY MOUNTAIN, SOURDOUGH SPRING, DOUBLE MOUNTAIN AND KANE SPRING GULCH QUADS WERE AVAILABLE FROM THE USGS.

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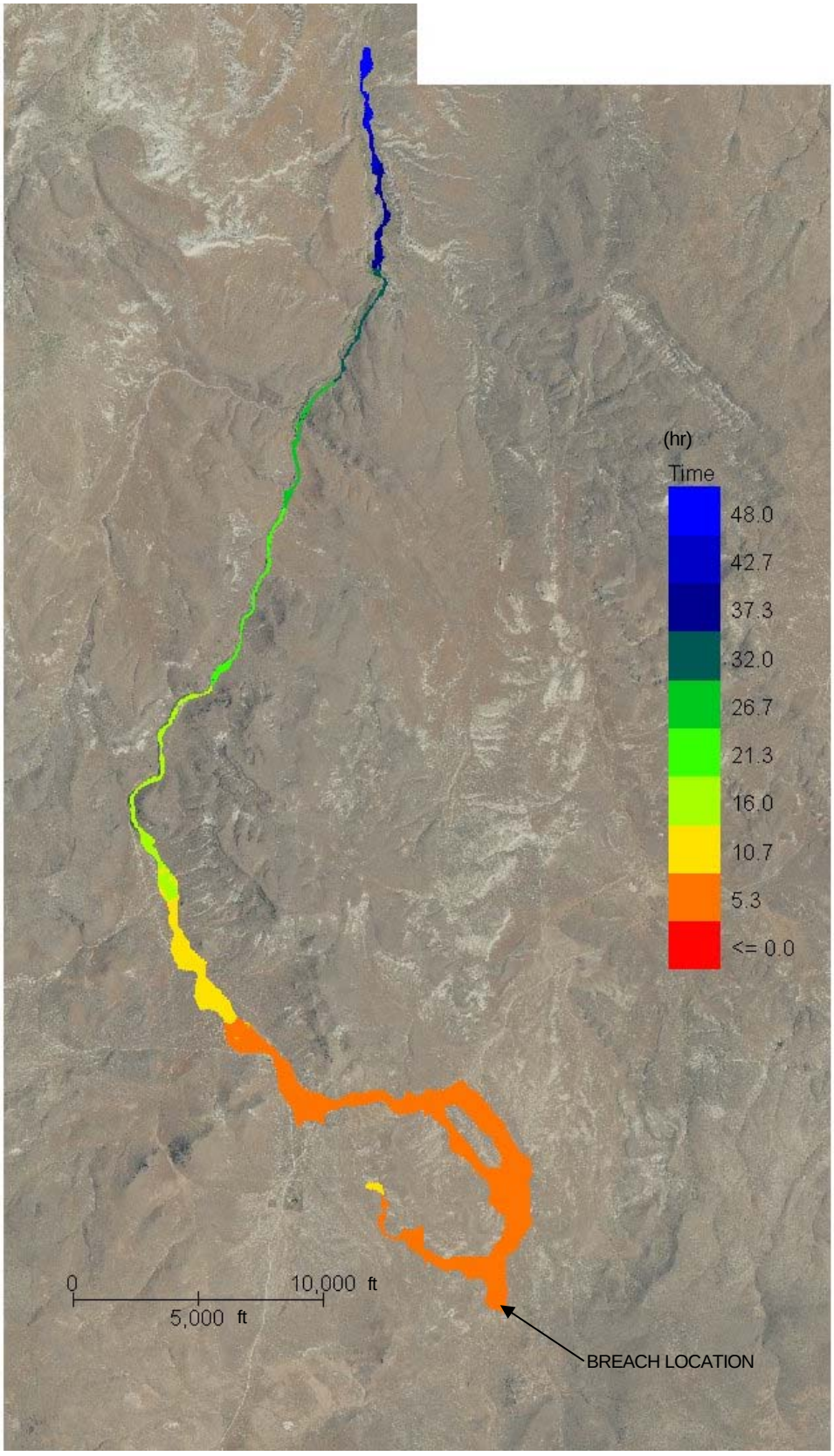
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
MODELING OUTPUT
FLOOD ARRIVAL TIME (1 FT MINIMUM)

PROJECT No. 1663241 | Rev. 0 | FIGURE 8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A



NOTE(S)

1. GEOIMAGE TIFF FILES FROM 2013 OF THE GRASSY MOUNTAIN, SOURDOUGH SPRING, DOUBLE MOUNTAIN AND KANE SPRING GULCH QUADS WERE AVAILABLE FROM THE USGS.

CLIENT
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT
GOLDER

YYYY-MM-DD	2019-09-30
PREPARED	MCJ
DESIGN	MDB
REVIEW	CJM
APPROVED	RAB

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
MODELING OUTPUT
TIME TO MAXIMUM TRAILINGS DEPOSITION DEPTH

PROJECT No. 1663241 | Rev. 0 | FIGURE **9**

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Appendix D: Mill Design Report

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CALICO RESOURCES

101768-RPT-0002
Revision Number 0

Calico Resources USA Corp. Grassy Mountain Gold Project, Malheur County, Oregon, USA

Mill Design Report June 2019

June 24 2019

Ausenco

CALICO RESOURCES

Revision Status

Revision	Date	Description	Author		Approver	
			FirstName LastName	Position Title	FirstName LastName	Position Title
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1 Introduction

Paramount Gold Nevada Corporation (Paramount), a gold mining company based in Nevada, USA, is continuing to develop the Grassy Mountain Project in Malheur County, Oregon. The site is located in eastern Oregon, approximately 70 miles west of Boise, Idaho and 22 miles south of Vale, Oregon.

The project includes an underground mine, process plant, and associated infrastructure, with a capacity to process 255,500 short tons of ore per year resulting in approximately 44,200 ounces of gold annually. The process plant will produce gold doré bars to be sold to local gold refiners.

The crushing plant consists of primary and secondary crushing producing a crushed ore product, which is then conveyed to feed the process plant. The carbon-in-leach (CIL) circuit cyanide is used to recover gold from the ore and activated carbon is used to adsorb the extracted gold from solution. Following the CIL circuit, the carbon is collected and treated in the elution circuit which separates the gold from the carbon. The carbon is regenerated and reused in the CIL circuit, while the gold is removed from solution in the integrated electrowinning plant. The stripped gold is then smelted in a gold room to produce gold doré bars. Leached tails are detoxified in an INCO™ Air/SO_2 cyanide destruction circuit. Detoxified tails are pumped to a tailings storage facility (TSF) for final deposition and recovery of decant water.

The crushing and process plant consists of:

- Crushing and screening plant
- Ball mill grinding circuit
- Gravity and intensive cyanidation circuit
- Pre-aeration & CIL circuit
- Elution circuit
- Gold room
- Carbon regeneration
- Cyanide detoxification
- Reagent and air services
- Water services (raw water, process water, potable water)

A depiction of the key unit operations involved in the process is shown in Figure 1.

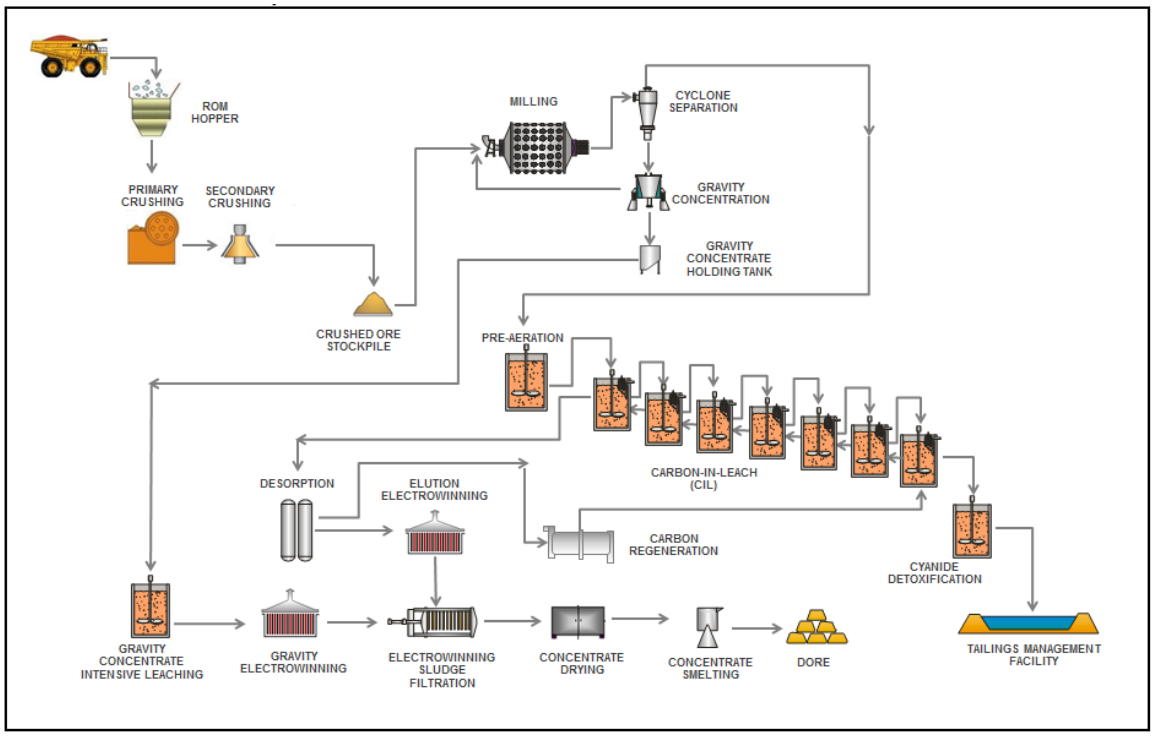


Figure 1: Grassy Mountain Process Flowsheet

The intent of the Mill Design Report is to address the following items from Chapter 340, Division 43 - Chemical Mining by the Department of Environmental Quality of the State of Oregon:

- Description of the facilities to be constructed, including tanks, pipes and other storage and conveyance means for processing chemicals, solutions, and wastewaters;
- Description of all chemical process and facilities for mixing, distribution, and application of chemicals associated with on-site mining operations, ore preparation, and beneficiation facilities;
- Description of all chemical conveyances (ditches, troughs, pipes, etc.) and the requisite equipment with secondary containment and leak detection means for preventing and detecting release of chemicals to surface water, groundwater and soils.

1.1 Plant Design Basis

The key criteria selected for the plant design are:

- Average plant treatment rate of 700 st/d on a solids basis
- Design crushing plant operating time of 70% (crushing / screening / conveying)
- Design process plant operating time of 91.3% (milling / leaching & adsorption / detoxification / elution / refining).

1.2 Throughput & Availability

An overall crushing plant availability of 70% and a process plant availability of 91.3% over the course of the year yield total crushing plant operating time of 6,132 h/y and a total process plant operating time of 7,998 h/y.

1.3 Key Design Criteria

The major process design criteria developed for the Grassy Mountain Project are outlined in Table 1.

Table 1: Grassy Mountain Process Design Criteria

Description	Units	Value
Ore Throughput	st/y	255,500
Design Grade - Au	oz/st	0.22
Design Grade - Ag	oz/st	0.35
Operating Schedule		
Crusher Availability	%	70
Plant Availability	%	91.3
Throughput, Daily - average	st/d	700
Plant capacity, Hourly	st/h	32
Crushing (Two Stage)		
Primary Crusher	type	Single Toggle Jaw Crusher
Secondary Crusher	type	Cone Crusher
Fine Ore Stockpile Residence Time - Live	d	1
Grinding		
Circuit Type		Ball mill
Bond Ball Mill Work Index	Hp/st	25.8
Ball Mill, Dimensions	ft x ft	11 x 14
Ball Mill Power	hp	1072
Feed Particle Size, F80	in	0.394
Product Particle Size, P80	U.S. mesh	100
Gravity Concentration		
Overall Gravity Gold Recovery	%	10
Carbon-in-Leach		
Total Leach Time	h	24
Number of Tanks	#	1 pre-aeration + 7 leach / adsorption
Cyanide Addition	lb/st	0.82
Lime Addition	lb/st	2
Carbon Concentration	lb/ft^3	1.56

Description	Units	Value
Carbon Loading (Au + Ag)	oz/st	175
Desorption		
Carbon batch size	st	3.3
Elution CIL strips per week	#	7
Gravity strips per week	#	7
Cyanide Destruction		
Method	-	Air / SO_2
Residence time	h	2
CN_{WAD} not-to-exceed value	ppm	30

1.4 Overall Site Process Flow Diagram

Drawing Overall Site Process Flow Diagram (101768-0000-F-001) shows the basic process design circuits and the selection of major equipment for the process plant. This drawing can be found in Appendix A.

The descriptions in the following sections include references to Process Flow Diagrams (PFDs) which are included in Appendix B.

2 Area 3110 – Crushing

Overview:

Run-of-mine (ROM) ore is transported by haul truck from the underground mining operation to the crushing plant area, and fed either directly to the ROM hopper or to the coarse ore stockpile. Ore is received by the ROM hopper at the crushing plant before being discharged onto the vibrating grizzly feeder and fed to the primary crusher for the first crushing stage. The crushed ore is then collected onto the coarse ore conveyor which conveys the reduced ore to the coarse ore screen. The undersize from the screen is suitable for ball mill feed while the oversize is fed to the secondary crusher included in the crushing plant. The secondary crusher product is received by the coarse ore conveyor and is returned to the coarse ore screen along with new crushed product from the primary crusher, initiating the closed-circuit loop within the crushing plant. This process repeats itself to ensure that the ore has enough time to be reduced before moving on for further downstream processing.

Reference PFDs:

101768-0000-F-002 Crushing, Screening, and Reclaim Area

2.1 Crushing Plant

The crushing plant operates 7 days per week for the entire year with an availability of 70%. The nominal throughput is 42 short ton per hour. The crushing plant consists of one of each of the following: ROM hopper, vibrating grizzly feeder, primary crusher, coarse ore screen, and secondary crusher. The ROM ore is received at a ROM hopper having a capacity 353 ft^3, filled either directly by

the dump truck or by using a front-end loader (FEL) that draws from the ROM ore stockpile. The ROM hopper is equipped with a static grizzly, and particles larger than the grizzly can be removed for individual breakage. The ore passes over a vibrating grizzly feeder leaving the ROM hopper before is fed to the primary crusher. The vibrating grizzly feeder allows for smaller material to pass directly though the feeder and onto the coarse ore conveyor, allowing for more efficient crushing in the primary crusher. The ore passing over the vibrating feeder then is reduced by a primary crusher and discharged onto the coarse ore conveyor as well.

The coarse ore conveyor transports the crushed ore to the coarse ore screen, where the undersize is collected and conveyed for mill feed, while the oversize is sent to the secondary crusher to be reduced further. The secondary crusher discharge is recirculated to the coarse ore screen to repeat the size classification step. A metal detector is included in the crushing plant to recognize any metal debris that could potentially cause damage to the crushing equipment.

The product from the crushing plant is conveyed to the crushed ore stockpile to be sent to the grinding circuit in the process plant. The stockpile conveyor is fitted with a weightometer to monitor crushing plant throughput and assist with operational and metallurgical accounting. The fine ore stockpile has a live capacity of 1 day, the equivalent of 750 short tons of live material. This material is collected with a front-end loader which deposits the fine ore into the fine ore reclaim hopper.

3 Area 3200 – Grinding

Overview:

The grinding circuit receives the fine ore product at the ball mill feed conveyor which then deposits the material at the mill feed chute. The ore is ground to a desired product size with the addition of process water and steel ball grinding media. The ground ore slurry is discharged to the cyclone feed pumpbox and pumped to the cyclone cluster pack to be classified into cyclone overflow stream, dominated by fine particles, and cyclone underflow stream, dominated by coarse particles. The overflow stream is sent to leaching process while the underflow is split into two streams, which one reports back to the ball mill and the other one reports to the gravity concentration and intensive leaching circuit.

Reference PFDs:

101768-0000-F-002 Crushing, Screening & Reclaim Area Process Flow Diagram

101768-0000-F-003 Grinding & Gravity Process Flow Diagram

3.1 Ball Mill

The fine ore stockpile allows for over 24 hours of continuous milling operation at the nominal feed rate of 31.9 short tons per hour. A front-end loader is used to transport the fine ore from the stockpile to the fine ore reclaim hopper, which has sufficient capacity to provide the grinding circuit with 1 hour of feed. The fine ore is fed to a 11.0 ft x 14.0 ft (d x EGL) overflow ball mill, which is operated at 75% of the critical speed and with a normal operating ball mill charge of 35% on a volumetric basis. Ore addition to the ball mill is supplemented with process water to achieve a milling density of 72% solids (by weight). The ball mill also receives a nominal circulating load of 350% from the underflow portion of the cyclone cluster. To avoid damage to the cyclone feed pumps and cyclone cluster, the ball mill

discharge is screened through a trommel to scalp off oversized particles and broken grinding media. The scalped off materials are then stored in the scats bunker. The aperture size of the ball mill trommel is the same as the product size leaving the crushing plant. The oversize material will be manually removed periodically.

The trommel screen undersize slurry from the ball mill is discharged to the cyclone feed pumpbox, diluted to 61% solids with process water, and pumped to two classification cyclones (1 duty / 1 standby).

3.2 Cyclone Classification

The cyclone cluster operates in a closed-circuit with the ball mill and is configured to achieve a target cyclone overflow product size. The cyclone cluster has one operating and one standby unit with pneumatically actuated valves that allow automated feed pressure control, as well as manually actuated isolation valves.

The slurry from the cyclone cluster underflow launder flows to the manual splitter box which splits approximately 33% of the cyclone underflow to the gravity concentrator via a scalping screen to remove particles larger than 10 mesh (0.08”). The remaining portion is recirculated back to the ball mill for further grinding.

The cyclone overflow slurry from the cyclone clusters gravity flows to a trash screen distributor where the slurry is distributed over the trash screen to remove any plastic, steel, wood and organic refuse coming from the mine. The overflow slurry density is nominally 42% solids.

A sump pump is installed in the grinding area to facilitate clean-up. The pump discharges into the cyclone pumpbox. Maintenance activities in the grinding and classification area are serviced by the mill area crane (33 st) and the grinding area hoist (3.3 st) which will be used for ball mill charging duties and minor lifts.

4 Area 3300 – Gravity Circuit and Intensive Cyanidation

Overview:

The gravity circuit included in the process plant receives a portion of the cyclone cluster underflow slurry that is passed through the gravity scalping screen. The slurry is treated by the gravity concentrator to recover free gold from the slurry into gravity concentrate. The concentrate is transported to the intensive leach reactor system by fluidization water. During this stage, the gravity concentrate is exposed to cyanide leaching resulting in high gold extraction. The pregnant solution is pumped to the electrowinning area while the tailings is recirculated back to the ball mill for further grinding.

Reference PFDs:

101768-0000-F-003 Grinding & Gravity Process Flow Diagram

101768-0000-F-004 Intensive Cyanidation Process Flow Diagram

4.1 Process Background

The gravity concentration and intensive leaching reactor circuit offers several advantages by:

- Reducing the exposure and accumulation of gold in grinding equipment
- Reducing the quantity of loaded carbon to be eluted
- Reduces the chances of losing gold to tailings from the CIL circuit either from:
    - Incomplete leaching of gold, or
    - operational fluctuations causing inefficiencies in carbon adsorption.

The concentrating portion of the process allows for free gold to be separated from the gangue material through the principal of a centrifuge, where the heavier gold particles are collected in the bowl of the concentrator while the lighter gangue material overflows and are removed back to the ball mill. This allows the free gold to be recovered with minimal processing, reducing the risk of losing gold to tailings and grinding circuit. Once the gold concentrate has reached its specified loading, fresh water is used to move the concentrate to the intensive leaching area without exposing it to any contaminants in the process water. The size and number of gravity concentrators required depends on the throughput and rate at which free gold is collected.

The intensive leaching reactor circuit is typically a packaged system designed to receive a concentrated coarse gold bearing ore product from the gravity concentrator. These systems, as well as all other gold leaching circuits, rely on the fundamental leaching reaction seen below, known as the Elsner Equation.

$$4Au(s) + 8NaCN(aq) + O_2(g) + 2H_2O(l) \rightarrow 4NaAu(CN)_2(aq) + 4NaOH(aq)$$

From this equation it can be observed that the reaction relies heavily on sodium cyanide and oxygen to complete the gold leaching reaction. Dissolved oxygen oxidizes the gold resulting in the formation of the soluble gold complexes. Sodium hydroxide is added to provide a basic pH environment required to prevent cyanide ions from reacting with hydrogen cations to form hydrogen cyanide. As such the reagents and dosages supplied to the intensive leaching reactor must be able to satisfy these requirements. Oxygen is supplied through a hydrogen peroxide tote and dosing pump located in the ILR area. Adequate concentration of oxygen is essential for the cyanidation reaction, and its absence will prevent the reaction from occurring. Additional reagents can also be included depending on the specific process or a specific operational objective.

After the addition of the initial levels of reagents along with the required water and gravity concentrate, the agitator is started, and the leaching reaction begins. Dosing rates of reagents are calibrated to optimize the process, depending on the ore in question. The leaching reaction lasts several hours before the gold is leached into the pregnant leaching solution and transferred to the electrowinning area for gold plating. Tailings from the reactor typically are collected and recirculated to the grinding area. Gold recoveries using this process are typically above 95%.

4.2 Scalping Screen and Gravity Concentrator

A portion of the cyclone underflow slurry is directed to one gravity circuit scalping screen where oversized material is subsequently sent back to ball mill, while the undersize is supplied to a single gravity concentrator. Nominally 90% of the slurry received by the screen passes and is received by the gravity concentrator, while the remaining 10% is oversized and recirculated back to the ball mill. Process water is added to the screen feed stream to reduce the percent solids from 76% to 55%, allowing for improved screening efficiency.

The centrifugal gravity concentrator is an automated batch process. Feed is received from the cyclone underflow for a specified time. When one concentration cycle is finished, the feed stream is paused and the bowl stops spinning to allow the concentrate that has been built up in the bowl to be flushed to the concentrate holding tank. After the flushing, a new concentration cycle starts again. Gravity concentrator tails flow back to the ball mill during the feeding portion of the cycle. Cycle times are 45 minutes each and about 46lb of concentrate is expected from each cycle of the selected unit. Cycle time is manually adjusted based on the head grade and circuit performance.

Flushing water rinses the gravity concentrate to a gravity concentrate holding tank located beneath the concentrator. Water is continually decanted as the gravity recoverable gold concentrate accumulates in the hopper. Access to the gravity concentrator holding tank is restricted, and only authorized personnel are allowed access.

Once per day the concentrate accumulated in the gravity concentrate holding tank is pumped to the intensive leach reactor where it is dosed with sodium hydroxide and high levels of sodium cyanide.

4.3 Intensive Leach Reactor

Following gravity concentration, the concentrate is held by the gravity concentrate holding tank before being supplied to one intensive leach reactor. The agitated reactor is dosed with sodium hydroxide, sodium cyanide, hydrogen peroxide and flocculant/leach aid to facilitate the high-cyanide gold extraction reaction. A complete cycle for the concentrate to be fully leached will take 24 hours and is operated daily. The gold bearing pregnant solution is then pumped to the gravity electrolyte tank for the electrowinning process. Tailings from the reactor are collected and pumped back to the ball mill feed chute.

Given the nature of the process, cyanide specific design considerations are implemented for both personnel safety, equipment integrity and operational performance. Control valves and alarm interlocks are utilized to ensure the operation is performed within an acceptable pH range and will also monitor the presence of hydrogen cyanide, a toxic gas evolved from cyanide bearing solution when pH values are lowered out of the operating range. The area will be equipped with hydrogen cyanide monitors, and operators will wear hydrogen cyanide badges to alert them of any potential evolution of cyanide gas in the area. The sodium cyanide solution is monitored by operator titration, ensuring that the dosing concentration is suitable for the intensive leaching reaction. Piping providing cyanide solution is socket welded stainless-steel connection, with double block and bleed isolation valving. The area is also designed to account for complete containment of all process vessels. Standard operating procedures are developed to accurately describe the methods and equipment required to achieve these tasks safely.

5 Area 3400 – Carbon-in-Leach

Overview:

The overflow slurry from the cyclone cluster is initially screened by the trash screen to prevent any debris that could impact the gold extraction or recovery to reach the CIL circuit. After passing through the screen the slurry reports to the pre-aeration tank where the slurry is pre-treated with air to ensure optimal gold extraction and minimize cyanide consumption. Following pre-treatment, the slurry flows through the leaching tanks. During this stage the slurry and activated carbon flow counter-currently throughout the CIL tanks. Carbon is added to the last tank and sequentially pumped to the first tank, while slurry is added to the first tank and flows to the last. Most of the metal extraction from ore to solution occurs at the front end of the circuit, while adsorption from solution to the carbon primarily occurs towards the end of the circuit. The slurry exits the final tank and is sent to the carbon safety screen before being treated for tailings storage. The loaded carbon exiting the first CIL tank is pumped to the loaded carbon screen in the elution circuit to be prepared for acid washing and elution.

Reference PFDs: 101768-0000-F-005 Pre-Leach & CIL Area Process Flow Diagram

5.1 Process Background

The CIL circuit is responsible for the gold leaching and carbon adsorption of the main slurry stream coming from the grinding circuit. It utilizes a counter-current flow of activated carbon in reference to the slurry flow to optimize the gold extraction and recovery. After the grinding circuit the ore particle size should be sufficiently reduced so that the gold in the ore is exposed allowing for the leaching reaction to occur.

In the presence of sulphide species native to the ore, the leach rate of gold into solution can be influenced by the amount of dissolved sulphur and the oxygen concentration in solution. A pre-aeration tank is used to oxidize and precipitate soluble species such as sulphides to prevent them from consuming oxygen during the process. A pre-aeration tank can also prevent a passivation layer from forming over the ore that hinders the leaching process. This passivation layer is often caused due to sulphide species forming sulphur monolayers on the surface of the exposed gold in the ore.

In this circuit the leaching reaction follows the same reaction shown in the intensive leaching reaction.

$$4Au(s) + 8NaCN(aq) + O_2(g) + 2H_2O(l) \leftrightarrow 4NaAu(CN)_2(aq) + 4NaOH(aq)$$

Sodium cyanide is dosed into the front end of the circuit along with air additions to facilitate the dissolution of gold into solution. The rate of the gold extraction is highest in the first tank where the reaction begins and rapidly decreases as the gold in the ore becomes scarcer. The extraction eventually reaches a plateau point where all the recoverable gold has been leached into solution in the form of a soluble and stable cyanide-gold species. With the gold in solution, the adsorption process will then recover the dissolved gold onto activated carbon to be recovered in the elution circuit.

The availability of free cyanide in solution is dependent on the pH of the solution. At a lower pH less cyanide ions are retained in solution while more are evolved as hydrogen cyanide molecules. From this relationship we can determine that the desired result is to have the free cyanide ions stay in solution at high pH. This is true for both safety and operation, as hydrogen cyanide gas is toxic to operators and cyanide must be in solution to perform the leaching reaction. For this reason, the CIL circuit is operated in a basic environment maintained through the addition of hydrated lime.

In solution the sodium-gold-cyanide complex dissociates into a negative gold-cyanide anion and a positive sodium cation. The negative gold-cyanide ion in solution preferentially pairs with a positive ion found in solution based on reduced activation energy. The addition of lime in the CIL circuit ensures sufficient calcium is available to produce an ionic pair between the gold-cyanide anion and the calcium cation resulting in a stable pair with neutral charge. The importance of this lies in the fact that the surface of activated carbon has a neutral charge and for species to adsorb to it they also require a neutral charge.

$$2Au(CN^-)_2^- + Ca^{2+} \leftrightarrow Ca\,(Au(CN_2))_2\,(ion\ pair)$$

As both the ion-pair and the surface of the carbon are neutral, no reaction occurs between the two items and the adsorption process is dependent on process parameters. Key parameters include mixing efficiency, slurry density, particle size of carbon, cyanide concentration, slurry pH and gold concentration among others used to design the adsorption process of a specific operation.

With the activated carbon being introduced in the last tank and moving towards the first tank the greatest gold recovery occurs in the last tank of the CIL circuit and progressively diminishes as the carbon advances through the tanks with increasing gold loading. After the fully loaded carbon is reaches the first tank of the circuit, the final transfer pump transports the loaded carbon to the next stage for the acid wash and elution stages.

Testwork determined that the gold is leached to completion with a residence time of 24 hours. Carbon management modelling determined that 7 leach stages were required, the optimum carbon concentration is 1.56 lb/ft3 and advance rate to minimize solution losses is 3 tonnes per day.

5.2 Pre-Aeration and Carbon-in-Leach Tanks

The leach feed slurry from the cyclone cluster overflow reports to the pre-aeration and CIL circuit. The slurry will first reach one pre-aeration tank where low-pressure air addition is added prior to the introduction of cyanide. Lime is added to adjust the solution to a pH of 10-10.5. Following the pre-aeration step the slurry will then flow to a series of 7 open top CIL tanks.

In the CIL tank train, the gold bearing slurry is brought into contact with cyanide and dissolves the gold from the ore into solution by forming stable gold-cyanide complexes in the presence of sparging air. The pH of slurry in the tanks is monitored and lime is added as necessary at several points in the CIL circuit to maintain target (10-10.5 pH typical). Low pressure compressed air is blown into slurry in the tank through blowers and dispersed using dispersion cones located at the bottom of the agitator.

Slurry exiting each tank flows by gravity to the next through an up-comer inside the tank to an overflow launder. Each tank is connected to the next two tanks via overflow launders with knife gate valves for tank isolation on each discharge point. This arrangement will allow the slurry to bypass the next tank in the series if one of the downstream tanks must be taken out of service for maintenance. Once the slurry discharges at the final tank, the slurry gravity flows to the carbon safety screen.

The purpose of the activated carbon is to recover gold from leached slurry. The gold is recovered by bringing the leached slurry, containing gold in solution, in contact with the carbon so that the dissolved gold can be loaded onto it through the process of adsorption. Each CIL tank is equipped with an agitator, an inter-stage screen to retain the carbon and a carbon advance transfer pump. Slurry in the first tank flows through the inter-stage screen to the next tank via an overflow launder while the screen holds back the carbon from moving to the next tank. Each subsequent tank in the series sends slurry to the next tank until the slurry reaches the last tank which then gravity flows out to the cyanide

destruction circuit by the carbon safety screen. Carbon flows through the circuit in the opposite direction, through carbon advance pumps in a batch process. The carbon is transferred once per day and is retained in the tanks by the inter-stage screens. Once the carbon has been transferred through all CIL tanks to the first tank in the train, the loaded carbon recovery pump will transfer the loaded carbon to the loaded carbon screen before being treated in the elution circuit.

As the nature of the process is similar to that of intensive leaching, similar safety considerations are implemented. Cyanide monitors will be installed at the top of the tanks and at ground level. Control valves, and alarm interlocks are utilized to ensure the operation is performed within an acceptable pH range and will monitor the presence of hydrogen cyanide. Operators are also equipped with hydrogen cyanide badges to alert them of any potential generation of cyanide gas. The sodium cyanide solution will be monitored by operator titration, ensuring that the dosing concentration is suitable for the leaching and adsorption reactions. Standard operating procedures are developed to accurately describe the methods and equipment required to achieve these tasks safely.

6 Area 3500 – Acid Wash and Elution

Overview:

Carbon containing slurry from the CIL circuit is transferred by the loaded carbon recovery pump to the loaded carbon screen in preparation for the acid wash and elution steps. The undersize slurry from the screen is sent back to the pre-aeration tank while the carbon retained in the oversize fraction reports to the acid wash column. During the acid wash stage, acid soluble contaminants that were adsorbed onto the surface of the loaded carbon are removed using a dilute hydrochloric acid stream followed by a rinse water cycle to clean the acid washed carbon before moving onto the elution step. The acid rinsed carbon is then transferred from the acid wash column to the elution column. During this step a strip solution of sodium hydroxide and cyanide is heated and is passed through the carbon in the elution column. This process reverses the kinetics of the gold loading onto the carbon and brings the gold into solution. The gold bearing solution also known as the pregnant solution then flows to the gold room where the gold will be recovered in the electrowinning process. Once the loaded carbon has been stripped of gold it is considered barren carbon and is transferred to the carbon regeneration area.

Reference PFDs:

101768-0000-F-006 – Desorption Area Process Flow Diagram

6.1 Process Background – Elution

Loaded carbon will undergo the desorption process where the loaded carbon is acid washed and eluted. The underlying principle during these stages is that the stable gold complexes loaded on the carbon must be changed so that they separate from the carbon.

The loaded carbon is initially received from the adsorption stage to a loaded carbon screen, where the carbon and slurry are separated. The carbon is then fed to one acid wash tank where a dilute hydrochloric acid solution is passed through. This process removes undesirable contaminants such as calcium carbonate from the surface of the carbon that would otherwise move forward to the elution column. The acid wash cycle is done at ambient conditions. Rinse water is passed through to remove residual acid and protect downstream equipment from low pH conditions.

Once the loaded carbon is acid washed it is transferred from the acid wash column to one elution column. In the elution stage a solution of sodium hydroxide and sodium cyanide, called the strip solution, is heated under pressure and flows up through the elution column. During elution the adsorption kinetics that initially bonded the gold complexes to the carbon are reversed and the gold is brought back into solution. This solution flows from the elution column to the electrowinning cells.

After the stripping of the pregnant solution by the electrowinning cell, the solution has trace amounts of gold remaining that will not be recoverable in electrowinning. Due to need for new reagent additions and water top ups, a certain portion of the barren solution will be bled to the CIL circuit, where the gold has the potential to be re-adsorbed.

6.2 Loaded Carbon Screening

Once the carbon in the first CIL tank is completely loaded, carbon slurry is pumped to the loaded carbon screen where the loaded carbon is screened and separated from the slurry under water spray. Water sprays on the vibrating screen decks wash off process slurry from the loaded carbon. The loaded carbon gravity flows to the acid wash column ahead of the elution cycle, and the slurry returns to the pre-aeration tank.

6.3 Acid Wash

The loaded carbon from CIL tanks recovered on the loaded carbon screen is directed to an acid wash column. Acid soluble foulants which have loaded onto the carbon are dissolved during the acid washing stage. Hydrochloric (HCl) acid is diluted with fresh water to provide the required acid wash solution concentration of 3% HCl and injected into the acid wash column. The solution will soak in the acidic solution for 30 minutes.

Following acid solution contact, the carbon is rinsed with fresh water to remove residual acid of the liquor in the carbon column at a rate of two bed volumes (BVs) per hour. The neutralized acid solution is drained back to the acid solution circulation tank. Washed carbon is then hydraulically transferred to the elution column using pressurised transport water supplied by a transport water pump.

6.4 Elution

The elution system comprises an elution column, strip solution tank, strip solution pump and an elution heater package. Strip solution (eluate) is made up in the strip solution tank using raw water dosed with 2% sodium hydroxide and 0.2% cyanide to form an electrolyte for the electrowinning process. The eluate flows upwards through a stationary bed of loaded carbon at a flow rate of about two BVs per hour at 275°F. The elution system is pressurized to keep the solution from flashing to steam in the heater or elution column. At this temperature gold that was previously adsorbed on the carbon is desorbed from the carbon by a reversal of the adsorption kinetics.

The direct electric strip solution heater is designed to increase the temperature of the strip solution up to 275ºF (135°C) for the stripping cycle. Additionally, an elution recovery heat exchanger ensures that the nominal temperature of the pregnant solution directed to the electrowinning cells is below boiling to prevent flashing.

Following the elution process, gold is recovered from the pregnant strip solution with a single electrowinning cell located inside the gold room (the gravity circuit has its own electrowinning cell). The pregnant and barren solution streams will be pumped between the elution plant and electrowinning cell in a dual contained pipe with flow meters positioned at both ends for leak detection.

The gold depleted solution from electrowinning is then re-heated and recycled to the elution column for additional stripping.

Given the use of sodium cyanide during the elution of the loaded carbon, additional steps are included to ensure safe and efficient operation. The pH of the solution will be properly buffered using sodium hydroxide, utilizing control valve interlocks to ensure the process is operating at the designed operating parameters.

7 Area 3500 – Carbon Regeneration and Management

Overview:

After the completion of the elution stage, the barren carbon is transported to the carbon regeneration area to treat the used carbon to be recycled for the adsorption process. The carbon is first screened through the kiln dewatering screen, where the oversize will report to the horizontal kiln while the undersize carbon and water are collected in the carbon fines clarifier. The carbon in the kiln is exposed to elevated temperatures to remove any remaining foulants that could impact the adsorption process. The carbon is then received by the quench tank for cooling before being sent to the carbon sizing screen in the CIL circuit. The fine carbon reporting to the clarifier is collected with the use of a filter press for further off-site processing, while the process water from the clarifier overflow is received by the transfer water tank for application in the elution circuit.

Reference PFDs: 101768-0000-F-007 Carbon Regeneration Process Flow Diagram

7.1 Carbon Regeneration

After completion of the elution process, barren carbon is hydraulically transferred from the elution column to a kiln dewatering screen. The screened carbon is fed into the kiln feed hopper then metered into a carbon regeneration kiln. The carbon regeneration kiln is a horizontal, rotary, electrically heated unit and reaches a temperature of at least 1400°F (750°C) to regenerate the stripped carbon.

Regenerated carbon discharges by gravity from the kiln to a quench tank to cool down and is then transferred via recessed impeller transfer pump to the carbon sizing screen. The barren carbon is then screened and reports to the last tank in the CIL adsorption train.

Fine carbon is received by the carbon fines clarifier, which then settles to the bottom of the tank while water overflows out of the top. The underflow of the clarifier is batch fed to the carbon fines filter, which removes additional water allowing the fines to be bagged and may be sold for further gold recovery at an offsite location.

7.2 Carbon Pre-attrition

Bags of new carbon are processed in a pre-attrition tank before being sent to the leach circuit. This process breaks off the corners of the angular coconut shell-based carbon particles, and the fine particles are collected. The fine particles are too small to be retained by the leach tank inter-stage screens and would therefore pass through to leach tails. Without this step the sharp corners of the loaded carbon particles would be broken off in the leach circuit and these carbon fines would flow to tails carrying the gold they had adsorbed causing gold losses.

The new carbon is charged to the pre-attrition tank via a bag breaker where water is added to produce an effective solids density of about 50% carbon. A high intensity agitator stirs the carbon slurry vigorously to break off the sharp corners, reducing the angular particles to a more rounded shape. Once complete, the new carbon is pumped to the regeneration kiln quench hopper where it is stored before being added to the leach circuit. Fresh and regenerated carbon passes over a barren carbon sizing screen, which also separates and removes fines.

7.3 Carbon Transport Water

All carbon movements in the elution and regeneration circuits are accomplished using carbon transport water. A transport water tank and pump are provided to supply transport water to carbon movement demands as needed.

As an example; when moving carbon from the acid wash column to the elution column, the carbon is drained into a venturi with transport water passing through it in sufficient quantity and velocity to carry it to the next destination at an effective solids density of about 20%. As the carbon arrives at the elution column, strainers in the column discharge ports allow the transport water to exit the column while retaining the carbon.

Transport water picks up fines when moving carbon from one place to another as a result of both the previous process and the attrition associated with the carbon movement itself. Once the movement is complete, strained or decanted transport water reports to a carbon fines clarifier where flocculant settles the fines and the overflow water recharges the transport water tank. Process water is added as necessary to maintain the level in this tank. The carbon fines are removed from the clarifier underflow periodically and shipped to the refinery to recover contained precious metal values.

8 Area 3650 – Electrowinning and Gold Room

Overview:

The elution circuit and the intensive leach reactor circuit both produce a gold bearing solution that will flow through electrowinning cells to remove the gold from solution and onto cathodes. The flow of pregnant solution and the electrical current is controlled for operation under optimal gold plating parameters. The plated gold is removed from the cathodes with the use of a high-pressure cleaner and the gold sludge is collected in the electrowinning sludge filter feed tank. The sludge is pumped through a filter and then moved by hand to the drying oven. The smelting of the dried sludge is then completed by hand and ultimately produces the final doré bars.

Reference PFDs:

101768-0000-F-008 Gold Room Process Flow Diagram

The gold room houses the electrowinning cells, smelting furnace, and associated support equipment within a security envelope which limits access to authorized gold room personnel only. Access and egress are controlled by security personnel at both a man door and a vehicle access roll up door for the armoured car. The armoured car door is enclosed by a fence with an automated gate controlled by security personnel. The exception to this is an emergency exit door which sets off alarms when opened from the inside.

8.1 Electrowinning

Two electrowinning sludging cells are located on the upper floor within the gold room. One electrowinning cell is dedicated to the intensive cyanidation circuit and the other to the elution circuit. The rectifiers associated with the electrowinning cells back onto the gold room wall, allowing easy access for operations and maintenance outside the secure area of the gold room.

The electrowinning cell dedicated to the intensive cyanidation circuit is fed eluate via a fixed speed centrifugal pump from the gravity eluate storage tank. Eluate is pumped to the electrowinning cell and then gravitates back into the gravity eluate storage tank in a closed loop until suitable gold recovery is achieved. The electrowinning cell dedicated to the elution circuit operates in a closed loop with the elution column and associated equipment. Eluate flows directly from the top of the elution column to the electrowinning cell after cooling through heat exchangers. The eluate flows through the electrowinning cell and then gravitates back to the strip solution tank and is pumped to the elution column in a continuous closed loop. Both cells extract gold by passing a current through the liquid solution, resulting in metal extraction through electroplating onto the cathodes within the cell.

Periodically, high pressure spray dislodges sludge from the cathodes and cell floor to a sludge hopper. A positive displacement pump feeds a plate and frame filter from the sludge hopper where the moisture content of the sludge is reduced. The pressed filter cake (gold sludge) is loaded from the plate and frame filter into trays on the electrowinning sludge trolley. The trays slide into the gold room drying oven, which heats the sludge to remove the entrained moisture.

8.2 Smelting

The dried and cooled sludge is combined with fluxes (silica, nitre, borax and sodium carbonate) in the flux mixer. The fluxes are manually added to the flux mixer after they are weighed. The sludge-flux mix is direct smelted in an electric furnace. The fluxes react with base metal oxides to form a low viscosity, free flowing slag, whilst the gold and silver remains as a molten metal.

The gold doré is poured into a cascade pouring table of doré moulds. The slag (non-precious metal compounds) is separated from the precious metal and collected in slag trays at the bottom of the cascade tables. The doré bars solidify and are quenched in water, cleaned to remove slag, weighed, stamped for identification, sampled for analysis and stored in a safe while awaiting dispatch.

9 Area 3600 – Cyanide Detoxification

Overview:

Tailings from the CIL circuit that no longer contains economically recoverable gold will flow to the carbon safety screen prior to reaching the cyanide detoxification stage. The slurry contains cyanide species that are not suitable for release from the process plant, and therefore a detoxification process is completed. In this circuit reagents are added to facilitate the breakdown of cyanide species to acceptable levels before reporting to the tailings pumpbox and sent to the TSF.

Reference PFDs:

101768-0000-F-009 Cyanide Detoxification & Tailings Disposal Area Process Flow Diagram.

9.1 Process Background

The cyanide detoxification stage of a gold processing operation is the location where the process slurry reports prior to tailings storage to reduce the level of Weak Acid Dissociable (WAD) cyanide and in turn the total cyanide released from the plant.

WAD cyanides are described as weak metal complexes that form during the leaching stage of the operation. Typical metals seen in these complexes include copper, zinc and nickel. The concern with these complexes is that they dissociate in solution to produce an environmentally significant concentration of free cyanide that could pose a risk to the environment and wildlife, or persist on a longer term basis due to a resistance to natural degradation.

The detoxification circuit receives all of the slurry from the upstream processes with the addition of acid rinse solution from the elution circuit and sump slurry on an intermittent basis from several areas within the plant. During the detoxification process the reaction will convert the free cyanide in solution to the less toxic cyanate ion. This is achieved through the SO_2/Air reaction utilizing a copper catalyst, and the reaction is shown below.

$$CN^- + SO_2 + O_2 + H_2O \rightarrow OCN^- + H_2SO_4$$

The free cyanide and WAD cyanide are oxidized during the reaction to form cyanate and sulphuric acid. The reaction typically operates in the pH range of 8 to 9 therefore requires the addition of lime to counteract the acid production.

Sodium metabisulphite ($Na_2S_2O_5$), also known as SMBS, is the source for SO_2 in the Air/SO_2 process. The reaction also requires a soluble copper catalyst to achieve the cyanide reduction. The copper is typically administered in the form of a soluble copper sulphate pentahydrate solution.

Iron cyanide removal is initiated by the reduction of iron from the ferric to the ferrous state. Following this step, the reaction will then react with a soluble metal cation to produce a precipitate. The same will be the case for trace metals that will be precipitated as their hydroxides. The remaining thiocyanate and cyanate are reduced by means of oxidation and hydrolysis respectively.

Through this process the key cyanide species of interest are converted into chemical species acceptable for discharge to the tailing's storage facility.

Once in the tailing's management facility processes such as photodegradation by UV light and biodegradation will also contribute to the minimization of cyanide species in a lined TSF where precautions are implemented to minimize the impact to wildlife.

9.2 Carbon Safety Screen

Tailings from the CIL circuit flows by gravity to a carbon safety screen. The safety screen retains any carbon that has reported with the slurry due to a leak in inter-stage screen mesh or seals in the CIL circuit. Water sprays are used on the vibrating screen deck to wash off process slurry from the carbon particles before reporting to a tote box. Screen underflow flows to the cyanide detoxification tanks.

9.3 Cyanide Detoxification Tanks

The cyanide detoxification circuit provides sufficient residence time for the detoxification reaction. In addition to leach tails, the tanks receive acid wash effluent from the acid wash column and the area sump pump discharge on an intermittent basis.

The cyanide detoxification circuit reduces weak acid dissociable cyanide (CN_{WAD}) to a target value. Air supply for the detoxification reaction is supplied to each cyanide destruction tank via a dispersion cone mounted to the bottom of each tank to maintain a high redox potential, maximizing oxidation of cyanide. The tanks utilize dual-impeller high shear agitators to enhance air dispersion and dissolution in the slurry to meet the oxygen demand of the cyanide destruction process. A sodium metabisulphite solution (the source of SO_2) is added to the slurry in the tanks. Copper sulphate solution, when needed, is dosed as catalyst for the cyanide detoxification process while lime slurry is added from a ring main into each tank to maintain a desired pH between 7.0 and 9.0. pH monitoring and HCN gas monitors will be interlocked with control valves to prevent detect the evolution of HCN gas. Operators will also wear personal HCN badges or monitors. The slurry will be reduced from a CN_{WAD} concentration of 100 ppm from the CIL circuit to below the not-to-exceed limit of 30 ppm. The final CN concentration will be monitored by operator titration to ensure compliance with the target discharge limit and the not-to-exceed regulatory limit of 30 ppm.

9.4 Tailings Discharge

Detoxified slurry overflows the second detoxification tank to the final tailings pump box, where it is then pumped to the TSF by two final tailings pumps (1 duty / 1 standby). The tailing slurry flows through a tailings discharge pipeline and will have dual containment initially provided through a buried pipe-in-pipe configuration, before daylighting to an HDPE lined containment trench. At the TSF the tailings are deposited using spigotting manifolds positioned along the rim of the impoundment to create low angle deposition beaches.

The position of the spigotting manifolds are moved periodically to produce an even beach head and push decant water towards the decant water pool. A pontoon mounted decant return water pump is provided to pump decant water back to the process water tank plant for re-use in the plant.

10 Area 3800 – Reagents and Services

Overview:

Given the properties of the reagents and their interactions with each other, design of the reagent preparation area will largely focus on the isolation of the cyanide. The cyanide preparation area is located away from incompatible reagents and in a low traffic area of the process plant. The cyanide preparation area will also be separated from the acidic reagents preparation area by the alkaline reagents. In this configuration the basic chemicals act as a buffer to prevent the exposure of acidic reagents and sodium cyanide, which would lead to the generation of cyanide gas.

Reference PFDs:

101768-0000-F-010 Alkaline Reagents Process Flow Diagram

101768-0000-F-011 Acidic Reagents Process Flow Diagram

101768-0000-F-012 Reagents General Process Flow Diagram

101768-0000-F-013 Plant Services – Air Process Flow Diagram

10.1 Hydrated Lime

Preparation of the hydrated lime will require:

- A bulk storage silo
- A mixing tank
- Dosing pumps feeding a ring main
- Automatically controlled dosing points from the ring main.

Hydrated lime is used in leaching and detoxification for pH control. The hydrated lime is delivered to site by bulk tanker and blown into a bulk storage silo.

When the mixing tank level is low, hydrated lime is added to the tank via a rotary valve and screw feeder. Process water is added at the same time to maintain the mixture strength of 20% forming a milk-of-lime suspension.

Milk-of-lime is distributed to the various dosing points using a ring main that provides constant flow to various destinations. Dosing is accomplished with drop lines off the ring main with automated on-off valves that open when pH is low and close when the operator specified target is reached.

10.2 Sodium Hydroxide

Preparation of Sodium hydroxide will require:

- Dosing pumps.

Sodium hydroxide (NaOH), also known as caustic soda, is used as a pH modifier in the intensive cyanidation and in the elution circuit to prepare the stripping solution used to recover the gold from

the loaded carbon. The reagent will be delivered in a 1,000 L tote received by truck and unloaded near sodium hydroxide area. The solution is supplied at a concentration of 50 percent by weight basis. Three positive displacement pumps will then each provide the required dosages of sodium hydroxide to their dedicated area. These areas include the intensive leach area, the elution circuit and the sodium cyanide preparation area.

10.3 Sodium Cyanide

Preparation of sodium cyanide will require:

- A bulk handling system
- Mixing and holding tanks
- Dosing pumps.

Sodium cyanide is used in leaching as a lixiviant and in elution as a carbon stripping aid. Cyanide is delivered to site in 1-ton bulk bags contained within wooden boxes and is stored in a separate area of the plant from the other chemicals.

When the storage tank level is low, a cyanide mix batch is started by removing a cyanide bulk bag from its box and dropping it onto a bag breaker, which discharges cyanide into the mix tank. The mix tank has been previously filled with sufficient raw water and buffered with sodium hydroxide to pH 12 to produce a cyanide mixture strength of 28%. Once mixing is complete and there is sufficient room in the holding tank, the mixed cyanide solution is pumped to the holding tank by a sodium cyanide transfer pump.

Sodium cyanide is dosed from the storage tank to dosing points via dedicated positive displacement metering pumps. The discharge piping is arranged such that the infrequently utilized pumps can be used as back-up spares for the leach dosing pump. For additional information on the equipment and procedures for the handling of cyanide, reference the Cyanide Management Plan in Appendix F of the Consolidated Permit Application.

10.4 Sodium Metabisulphite

Preparation of Sodium metabisulphite (SMBS) will require:

- A bulk handling system
- Mixing and holding tanks
- Dosing pumps.

Sodium metabisulphite ($Na_2S_2O_5$), also known as SMBS, is the source for SO_2 in the Air/SO_2 process and will be supplied in 2000 lb bulk bags with a minimum quality of 67 percent SO_2. It will be shipped by road to site, offloaded by forklift, and stored in the reagents storage area.

When the storage tank level is low a SMBS mix is started by dropping a bulk bag of SMBS onto a bag breaker which discharges SMBS into the mix tank. The mix tank has been previously filled with sufficient process water to produce a mixture strength of 20%. Once mixing is complete, and there is sufficient room in the holding tank, the mixed SMBS solution is pumped to the holding tank by a sodium metabisulphite transfer pump.

SMBS is dosed from the storage tank to the detoxification circuit via dedicated positive displacement metering pumps for each stage. A third pump is provided as an installed spare for the detoxification dosing pumps.

10.5 Copper Sulphate (Pentahydrate)

Preparation of Copper Sulphate will require:

- A bulk handling system
- A combined mixing/storage tank
- Dosing pumps.

Copper sulphate (pentahydrate) ($CuSO_2.5H_2O$) is supplied in 2000lb bulk bags at a purity of 98 percent on a weight basis. It will be shipped by road to site, offloaded by forklift and stored in the reagents storage area adjacent to the reagents mixing facility. Copper sulphate is mixed and stored in a combined mixing/storage tank laid out such that the mixing tank is directly above the storage tank and mixed solution drops by gravity into the storage tank.

When the storage tank level is low copper sulphate is added to the mixing tank by dropping a bulk bag of onto a bag breaker which discharges copper sulphate into the mix tank. The mix tank has been previously filled with sufficient process water to produce a mixture strength of 15%. Once mixing is complete, and there is sufficient room in the holding tank, the mixed copper sulphate solution is transferred by gravity to the holding tank.

Copper sulphate is dosed from the storage tank to the detoxification circuit via duty / standby positive displacement metering pumps.

10.6 Hydrochloric Acid

Hydrochloric Acid (HCl) is used in the elution circuit and is supplied in 275-gallon totes in liquid form at 32 percent concentration on a weight basis. The acid will be dosed directly to the acid wash column through the use of a metering pump.

10.7 Flocculant

Flocculant will be used in the carbon fines clarifier and intensive leach reactor to assist in solids settling. The flocculant will be supplied in 1,000L totes and dosed directly through two metering pumps.

10.8 Blower Air

The blowers will supply low pressure process air to the CIL tanks and the cyanide detoxification circuits. Both the CIL and cyanide detoxification trains will have a dedicated blower fan, with one common standby fan, able to supply process air to any of the four usage points.

10.9 Plant & Instrument Air

An air compressor will provide high pressure compressed air operating in lead-lag mode, to meet the demand for plant and instrument air requirements.

Plant air will be stored in the plant air receivers to account for variations in demand prior to being distributed throughout the plant. Instrument air will be dried in an instrument air dryer before being stored in the instrument air receivers and distributed throughout the plant.

10.10 Assay and Metallurgical Laboratory and Quality Control

The plant is equipped with automatic samplers to collect shift and routine samples for aqua regia digestion, atomic absorption, and fire assays. Those samples include plant feed, intermediate products, tailings, and final products. The data obtained will be used for product quality control and routine process optimization.

The metallurgical laboratory will perform metallurgical tests for quality control and process flowsheet optimization. The laboratory will include equipment such as laboratory crushers, ball mill, sieve screens, laboratory flotation cells, balances, and pH meters.

11 Area 3920 – Water Services

Overview:

The overall process has a negative water balance and requires raw water makeup from site wells. The raw water is used for gland water, makeup water, and treated to produce potable water. Raw water that has entered the process becomes part of the process water circuit and may be eventually discharged to the TSF. Decanted water from the TSF is recycled back to the process plant for reuse in the process water circuit.

Reference PFDs:

101768-0000-F-014 Plant Services – Water (Sheet 1 of 2)

101768-0000-F-015 Plant Services – Water (Sheet 2 of 2)

11.1 Tailings Storage Facility

The TSF receives the treated tails from the process plant and allows for material to settle while water is decanted and recovered at the process water tank for re-use in the process plant. Two centrifugal pumps (1 duty / 1 standby) located on a barge at the TSF return water through a decant water pipeline, which runs in the same containment trench used for the tailings discharge pipeline.

The TSF also allows for the natural degradation of remaining trace cyanide. Degradation is achieved through exposure to ultraviolet light received from the sun and metabolic processes from micro-organisms native to the environment in the water of the tailings pond.

11.2 Raw Water

Raw water will be pumped from site wells to the raw water tank for distribution throughout the operation.

Raw water in the tank is used to supply the following services:

- Reagent preparation water
- Slurry pumps gland seal water
- Intensive cyanidation
- Make-up water for the process water system
- Fire Water
- Potable water treatment plant, potable water is then sent to the potable water tank for safety showers and eyewash stations.

11.3 Gland Water

Water for the gland water system is supplied by fresh water from the raw water tank and distributed to each slurry pump by the gland seal water pumps in a duty/standby configuration.

11.4 Process Water

Process water is comprised of decant water from the TSF and raw water additions. Process water is stored in the process water storage tank and distributed by the Process Water Pumps, in a duty/standby configuration, to the circuits throughout the process plant, select reagent preparation areas and the truck washing station.

12 Process Solution Containment

The containment strategy associated with the process plant can be divided between the containment of process flows and reagents, and the collection and containment of surface contact water.

12.1 Process Flows and Reagents

There are eight primary areas which require containment at the plant site. Each area is located on a cast in-situ concrete slab, which will have curbs providing the required containment volume. The required volume is determined by the equipment located in the area, and in each case this has been determined to be 110% of the volume of the largest vessel plus allowance for adequate freeboard for precipitation. Adequate precipitation freeboard is defined as the height required to provide a volume capable to contain a 25-year 24-hour storm event. The containment areas have been summarized in the following table:

Location	Required Containment Volume (m^3)	Total Containment Volume (m^2)	Reference Drawing
Grinding Area	18.1	21.9	101768-1200-C-101
CIL Area	324.2	326.5	101768-1200-C-102
Goldroom – Refining Area	0.8	5.5	101768-1200-C-103
Goldroom – ILR Area	6.6	9.5	101768-1200-C-103

Location	Required Containment Volume (m^3)	Total Containment Volume (m^2)	Reference Drawing
Desorption and Regeneration – Acid Wash Area	13.3	13.7	101768-1200-C-104
Desorption and Regeneration – Elution Area	27.2	76.3	101768-1200-C-104
Reagents Area – Alkaline Containment	12.7	16.4	101768-1200-C-105
Reagents Area – Acidic Containment	12.7	15.5	101768-1200-C-105
Air Services Area	3.2	16.1	101768-1200-C-106

The concrete bund for the air services area is mainly for housekeeping purposes, and the required volume is only related to the 25-year 24-hour storm event for the catchment area.

12.2 Surface Contact Water

For a detailed description of contact water management and the design of water management structures, reference Appendix Y of the Consolidated Permit Application.

Diversion ditches will be constructed above plant infrastructure where required to prevent runoff from entering the process plant areas. Precipitation that falls directly on the pad will be collected in a system of ditches and culverts and directed by gravity towards the collection pond.

The contact collection pond is sized to contain the runoff from a 100-year 24-hour storm event and includes other allowances such as sediment deposition and freeboard. The pond will be double lined with a fluid evacuation zone between the liners.

13 Dust Suppression and Collection

Considerations for the design of the dust suppression and collection facilities is intended to comply with applicable federal and state regulations for air quality, including the Cleaner Air Oregon objectives.

13.1 Summary of Applicable Regulations

Regulations applicable to the Grassy Mountain project include, but are not limited to:

Table 2 - Applicable Air Quality Regulations

Regulation	#	Description
Oregon Permitting Rules	OAR 340-216	Air Contaminant Discharge Permits
	OAR 340-218	Title V Operating Permits

Oregon Air Quality Standards	OAR 340-202	Ambient Air Quality Standards and Prevention of Significant Deterioration
	OAR 340-245	Cleaner Air Oregon
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	40 CFR Part 63 Subpart EEEEEEE	Gold Ore Processing
	40 CFR Part 63 Subpart CCCCCC	Gasoline Tanks
New Source Performance Standards (NSPS)	40 CFR Part 60 Subpart LL	Metallic Mineral Processing Plants
	40 CFR Part 60 Subpart OOO	Non-Metallic Mineral Processing
	40 CFR Part 60 Subpart IIII	Emergency Generators

13.2 Dust Generating Sources and Controls

The key dust generating sources and identified control methods for the plant site are identified as follows:

Table 3 - Selected Air Quality Controls

Dust Source	Control Method
Unpaved Roads	Dust suppression chemicals and water application
Stockpiles (ROM and Crushed Ore)	Inherent moisture content of the ore
Primary and Secondary Crushing Unit	Inherent moisture content of the ore
Ball Mill Feed Conveyor	Inherent moisture content of the ore
Carbon Kiln	Wet dust scrubber
Barring Furnace	Baghouse
Lime Silo	Bin ventilation baghouse

Additional information pertaining to the identification and control of air emissions can by found in Appendix M of the Consolidated Permit Application.

14 Reclamation Plan

The reclamation of the process facilities and ancillary infrastructure is described below. The reclamation of the entire project (including these facilities) will be described in other sections of the DOGAMI Consolidated Permit Application and associated documents.

14.1 Reclamation Objective

The goal of this reclamation plan is to minimize environmental damage through the use of best available, practicable, and necessary technology and provide protection measures that are consistent with the policies of the permitting agencies.

14.1.1 Scope of Reclamation

The scope of this reclamation plan includes the process plant and facilities, ancillary infrastructure, and water management structures including the water collection pond.

14.1.2 Conceptual Plan

The general concept for reclaiming the project site is to remove all buildings and facilities that can be dismantled. Non-movable physical aspects such as the plant site itself will be contoured to match the original site topography and re-vegetated.

Removal of facilities and remediation of the site, including re-vegetation, will take approximately two years. Monitoring of site conditions will be undertaken on a quarterly and annual basis for the first five years with maintenance and remedial action taken on an as-required basis to ensure that the results of reclamation are sustainable.

14.1.3 Final Topography

All man-made slopes on the project site will be reduced to 3:1 (h:v) or less as required. Re-sloping is intended to create contours in disturbed areas that blend into the surrounding terrain, flatten the landscape as much as possible to prevent erosion and enable easy access by wildlife and humans. Where exceptions to the above grade are required, they will comply with the requirements of OAR 632-030-0027.

14.2 Reclamation Requirements

The reclamation plan is designed to satisfy the requirements of The Mined Land Reclamation Act of 1971, comply with OAR 632-030-0025 Requirements for an Operating Permit and Reclamation Plan, and OAR 632-030-0027 Minimum Standards for a Reclamation Plan. Reclamation performance standards as stated by the State of Oregon Department of Geology and Mineral Industries include:

- Ensure protection of human health and safety (also livestock, fish, and wildlife)
- Ensure environmental protection
- Require certification to the Oregon Department of Fish and Wildlife and Oregon Department of Agriculture of a self-sustaining ecosystem comparable to undamaged ecosystems in the area
- Include backfilling or partial backfilling on a case-by-case basis
- Ensure adequate, long-term environmental monitoring
- Provide adequate financial security

14.3 Removal of Infrastructure

The majority of buildings and structures erected on site during the mining operation will be decommissioned and removed as part of the reclamation process, unless otherwise agreed to remain after the mine's closure.

14.3.1 Buildings

Buildings at the plant site will be dismantled during the first year of reclamation and sold or re-used elsewhere. These buildings will include:

- Administration building
- Laboratory
- Plant Workshop/Warehouse
- Mine Offices
- Truck Workshop/Warehouse
- Mill Building and Structures

The administration, laboratory, and mine office buildings will be modular structures that will break down into their component parts and can be hauled away and re-used. The Plant and Truck Workshop/Warehouses are steel frame, fabric covered structures that can be similarly dismantled and re-used elsewhere. The process facility is a steel frame non-enclosed structure containing process equipment, which will be removed before the frame is dismantled and removed.

14.3.2 Surface Water Management Structures

The reclamation of the contact water collection pond will be in accordance with the Water Pollution Control Facility (WPCF) permit as required by the Oregon Department of Environmental Quality.

Reclamation of lined ditches and other water management structures will be in accordance with the Stormwater Management Plan in Appendix Y of the Consolidated Permit Application.

14.3.3 Other Infrastructure

Other structures to be remediated and removed include:

- Truck Wash Pad
- Crushing Area

The Truck Wash Pad is a concrete slab that will be broken up, have the rebar removed, and disposed of offsite. The crushing area consists of a series of portable units mounted on chassis that can be towed away for use elsewhere.

14.3.4 Electrical Infrastructure

Electrical infrastructure that will be removed or disconnected includes:

- Plant site distribution powerlines
- Main substation

14.3.5 Pipelines

Pipelines will be removed and disposed of offsite:

- Tailings distribution pipeline
- Tailings reclaim water pipeline

14.3.6 Roads

Roads that will be reclaimed include:

- Plant site roads

All road surfaces will be ripped and then capped with overburden, topsoil, and seeded. The timing to reclaim roads will depend on the necessity to access a particular area during reclamation. For example, plant site roads will be reclaimed once the process plant area is dismantled and removed.

14.3.7 Removal/Burial of Foundations

All foundations remaining from decommissioned structures, made from inert materials such as concrete, will be broken up and removed to an approved construction material disposal facility or another approved site. This includes concrete slabs. Any broken concrete or complete foundations (below 0.5m grade) left on the reclaimed site will be buried a minimum of 0.5m below the final site grade. Before burial, all exposed rebar, that has a potential to protrude through the completed backfill, will be cut off level with the remaining concrete.

Concrete that may be contaminated through exposure to process reagents will be excavated and disposed of in the TSF.

14.4 Material Management

14.4.1 Topsoil and Overburden

Refer to Section 3.5.3.3 and 4.1 of the Consolidated Permit Application.

14.4.2 Waste Rock

Refer to Section 3.3.4 and Section 4.6.3 of the Consolidated Permit Application.

14.4.3 Contaminated Materials

Soil, waste rock, or concrete that have been exposed to hydrocarbons or process reagents on a frequent basis during the life of the project may have become contaminated. Hydrocarbon contaminated soils will be excavated and transported to an approved dump site. This procedure also applies to any soil contaminated with hydrocarbons from leaking fuel oil storage tanks discovered during the removal from site.

Soil, rock, or concrete contaminated by process reagents will be excavated and disposed of in the TSF. Pre-existing soil contamination, resulting from historic mining activity, will be further delineated by sampling, either through drilling or the digging of test pits. Risk assessment based on the degree of contamination and likelihood of remobilization of contaminants will determine if the material is left in place or excavated and disposed of in the TSF or offsite.

14.5 Re-Vegetation

Refer to Section 4.2 of the Consolidated Permit Application.

14.6 Site Drainage

Site drainage will be managed with the objective of:

1. Preventing contamination of surface and groundwater flows
2. Preventing erosion and sedimentation
3. Protection of natural watercourses and wetlands

Site grading will facilitate drainage such that runoff disperses from the area in a manner which reflects natural flows. Ditches will be rip-rapped where necessary to prevent erosion. All slopes will be reduced to 3:1 (h:v) or less to minimize the velocity of runoff.

14.7 Monitoring

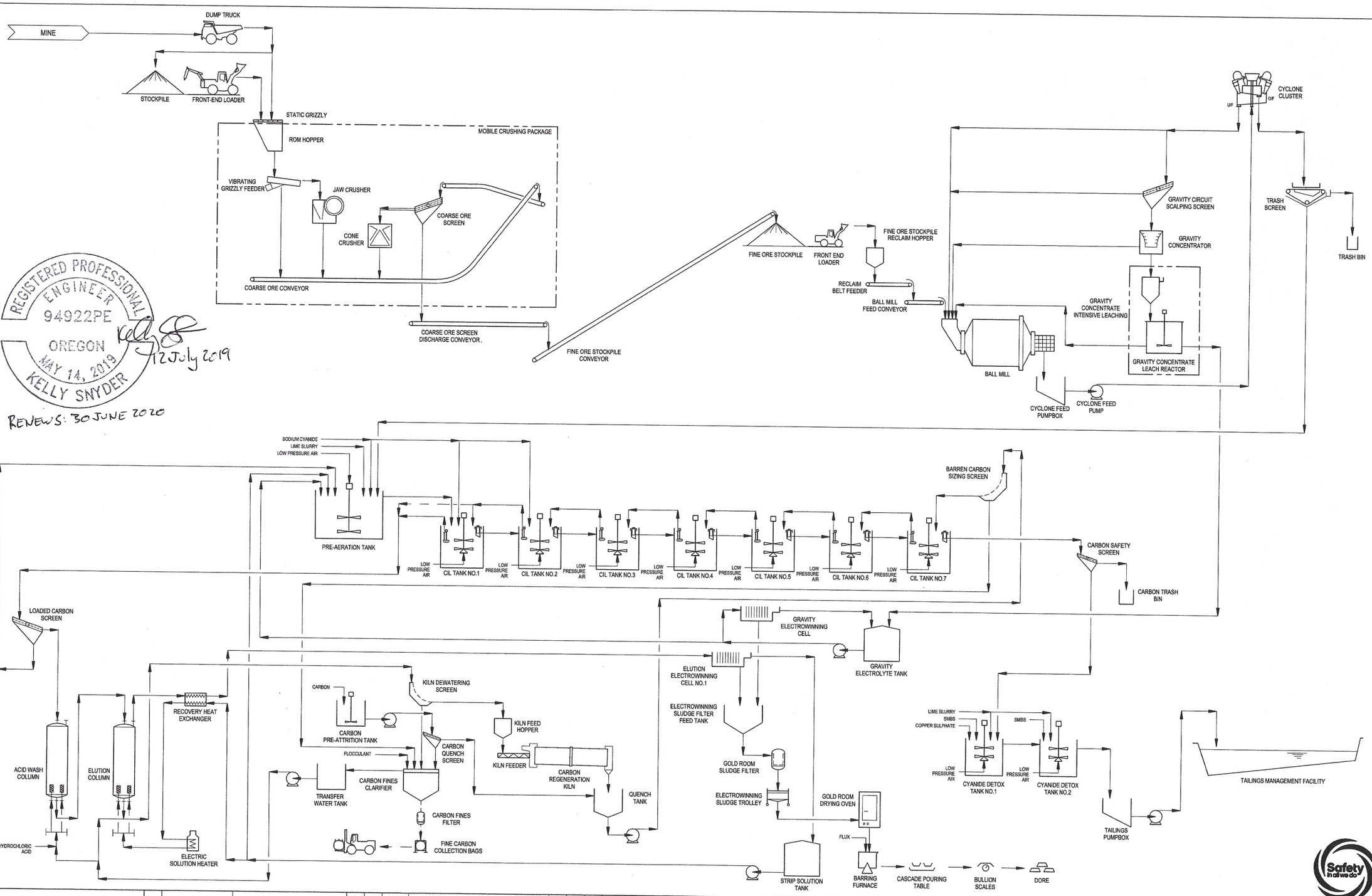
The primary goal of post-mining monitoring activities will be to determine the progress being made in restoring the site and to make adjustments, if required, that lead to a successful conclusion of site reclamation.

Monitoring after mining ceases will initially be an extension of the monitoring programs that were used to support production activities. These will include monitoring physical and chemical parameters for air, surface and ground water, soil and sediments. In addition, routine surveys and field observations will be conducted with regard to flora and fauna on and around site. The status of various VECs (valued ecological components) such as woodlands, wetlands, and watercourses will be assessed.

Post-mining monitoring will ensure, through inspection, that decommissioned structures such as the re-contoured plant pad are not subject to damage from erosion or settlement and that spillways and ditches remain functional. The monitoring program will be linked to remedial action plans in the event that reclamation measures require enhancement.

The specific monitoring requirements will be defined and described in the Water Pollution Control Facility Permit (WPCF) which is required under OAR 340-043 and will be submitted as part of the DOGAMI Consolidated Permit Application.

Appendix A – Overall Process Flow Diagram



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94922PE
OREGON
MAY 14, 2019
KELLY SNYDER

12 July 2019

RENEWS: 30 JUNE 2020

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OVERALL
PROCESS FLOW DIAGRAM

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PROJECT No.	SCALE	SIZE
101768	NTS	A1

DRAWING No.	REV
101768-0000-F-001	E

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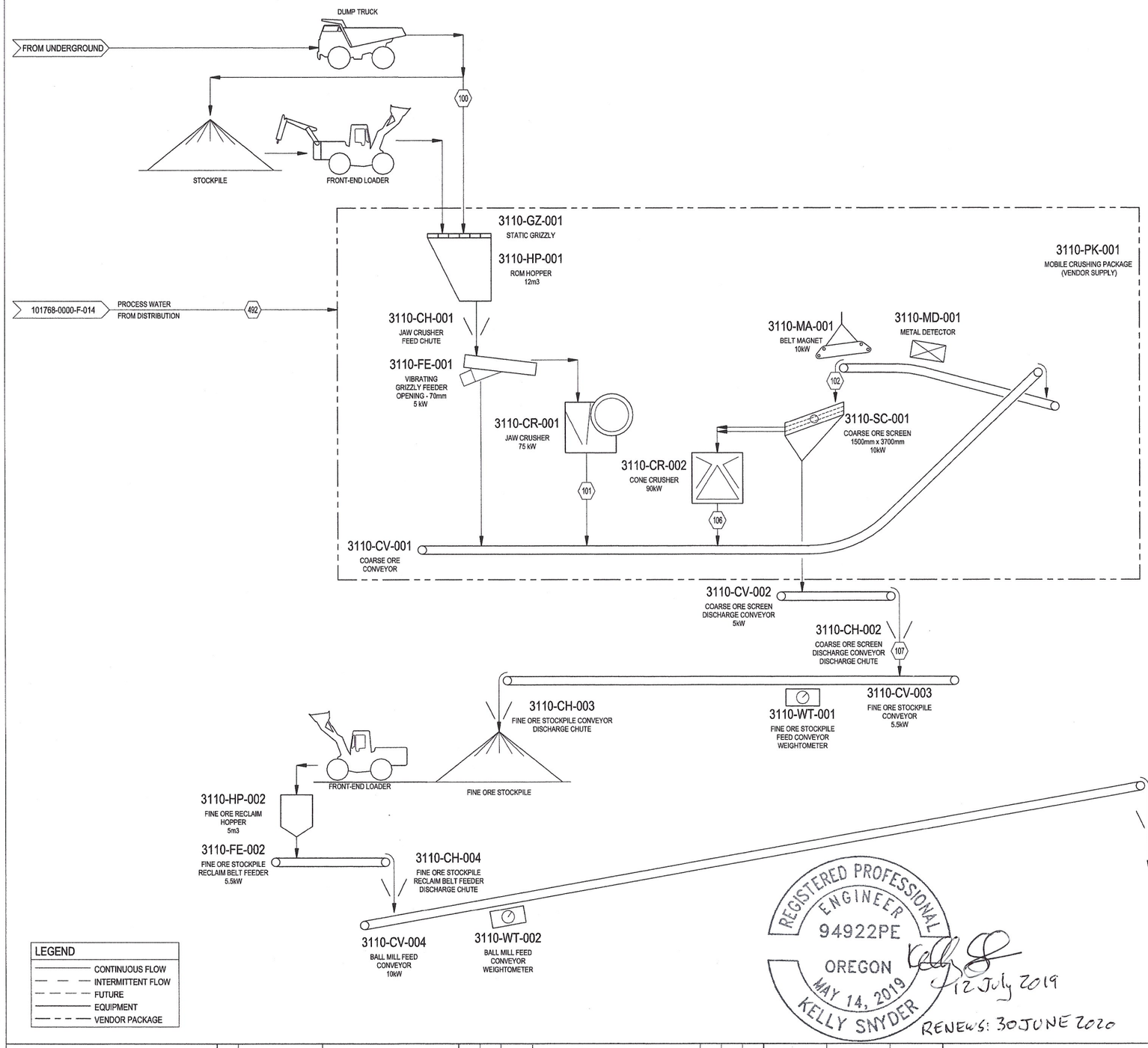
Appendix B – Process Flow Diagrams



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OREGON
MAY 14, 2019
KELLY SNYDER
12 July 2019
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TITLE: GRASSY MOUNTAIN-PROCESSING PLANT
CRUSHING, SCREENING & RECLAIM AREA
PROCESS FLOW DIAGRAM

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PROJECT No. 101768 | SCALE NTS | SIZE A1

DRAWING No. 101768-0000-F-002 | REV E

101768-0000-F-014 PROCESS WATER FROM DISTRIBUTION

3200-HT-001
MILL AREA CRANE
32 kW
30 t

3200-CY-001
CYCLONE CLUSTER

3200-HT-002
GRINDING AREA
HOIST
3 t

3300-DI-002
CYCLONE CLUSTER
UNDERFLOW WEIR BOX

3300-SC-002
TRASH SCREEN
600 X 1850
1.5 kW

3300-DI-001
TRASH SCREEN
FEED BOX

3300-SC-001
GRAVITY CIRCUIT
SCALPING SCREEN
2 x 8.5 kW
1220 x 3660

3300-CH-003
GRAVITY CIRCUIT
SCALPING SCREEN
OVERSIZE CHUTE

3300-CH-002
TRASH SCREEN
UNDERSIZE CHUTE

3300-CH-001
TRASH SCREEN
OVERSIZE CHUTE

3300-CH-004
GRAVITY CIRCUIT
SCALPING SCREEN
UNDERSIZE CHUTE

3300-BN-001
TRASH BIN

BALL BUCKET

3200-HP-001
BALL FEED
HOPPER

3200-CH-001
BALL CHARGING
CHUTE

CYCLONE OVERFLOW
TO PREAERATION TANK
101768-0000-F-005

3300-SA-001
PLANT FEED
SAMPLER

PLANT FEED
SAMPLER
CONTAINER

101768-0000-F-004 INTENSIVE LEACH REACTOR TAILS FROM INTENSIVE LEACH TAILS PUMP

101768-0000-F-002 CRUSHED ORE FROM BALL MILL FEED CONVEYOR

3300-GC-001
GRAVITY
CONCENTRATOR
18 kW

GRAVITY CONCENTRATE
TO INTENSIVE CYANIDATION
101768-000-F-004

3200-CH-002
MILL FEED
CHUTE

3200-CH-005
SCATS CHUTE

3200-ML-001
BALL MILL
3200 DIA x 5250 EGL
600 kW

3200-CH-003
BALL MILL TROMMEL
DISCHARGE CHUTE

SCATS BUNKER

3200-HP-002
CYCLONE FEED
PUMPBOX

3200-PU-002 / 003
CYCLONE FEED
PUMP NO.1 / NO.2
23 kW

101768-0000-F-015 GLAND WATER FROM DISTRIBUTION

3200-PU-001
GRINDING AREA
SUMP PUMP
5 kW

LEGEND
- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER 94922PE OREGON MAY 14, 2019 KELLY SNYDER

12 July 2019

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TITLE: GRASSY MOUNTAIN-PROCESSING PLANT
GRINDING & GRAVITY AREA
PROCESS FLOW DIAGRAM

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PROJECT No. 101768 | SCALE NTS | SIZE A1

DRAWING No. 101768-0000-F-003 | REV E

101768-0000-F-003 GRAVITY CONCENTRATE FROM GRAVITY CONCENTRATOR 21

3450-PK-001
VENDOR PACKAGE
INTENSIVE LEACH REACTOR

25 O/F

3450-TK-001
GRAVITY CONCENTRATE HOLDING TANK
2.5 m³

3450-PU-001
GRAVITY CONCENTRATE TRANSFER PUMP
7.5 kW

101768-0000-F-014 RAW WATER FROM DISTRIBUTION 425

101768-0000-F-010 SODIUM HYDROXIDE FROM DISTRIBUTION 601

101768-0000-F-010 SODIUM CYANIDE FROM DISTRIBUTION 600

101768-0000-F-012 FLOCCULANT FROM DISTRIBUTION 24

HYDROGEN PEROXIDE TOTE

3450-PU-005
HYDROGEN PEROXIDE DOSING PUMP
0.5 kW

3450-TK-002
INTENSIVE LEACH REACTOR
4.3 m³

3450-AG-001
INTENSIVE LEACH REACTOR AGITATOR
5.6 kW

3450-PU-002
INTENSIVE LEACH PREGNANT SOLUTION PUMP
5 kW

3450-PU-004
INTENSIVE LEACH TAILS PUMP
7.5 kW

26 PREGNANT SOLUTION TO GRAVITY ELECTROLYTE TANK 101768-00000-F-008

27 INTENSIVE LEACH REACTOR TAILS TO BALL MILL 101768-0000-F-003

28 ILR SUMP WASHING TO LEACH TANK / CIL TANKS 101768-0000-F-005

3450-PU-003
INTENSIVE LEACH AREA SUMP PUMP
5 kW

LEGEND
- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER 94922PE OREGON MAY 14, 2019 KELLY SNYDER

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PROCESS FLOW DIAGRAM

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PROJECT No. 101768 | SCALE NTS | SIZE A1

DRAWING No. 101768-0000-F-004 | REV E

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3400-HT-001
CIL TANK
MAINTENANCE CRANE
7.5 / 3 x 0.75 kW
5 t

101768-0000-F-007 BARREN CARBON FROM QUENCH TANK 45
101768-0000-F-003 CYCLONE OVERFLOW FROM TRASH SCREEN UNDERSIZE 30
101768-0000-F-004 INTENSIVE LEACH SUMP WASHING FROM INTENSIVE LEACH AREA SUMP PUMP 28
101768-0000-F-010 LIME SLURRY FROM DISTRIBUTION 612
101768-0000-F-008 BARREN ELUATE FROM STRIP SOLUTION TANK 60
101768-0000-F-008 ILR BARREN SOLUTION FROM GRAVITY ELECTROLYTE TANK 53
101768-0000-F-006 LOADED CARBON SCREEN UNDERSIZE FROM LOADED CARBON SCREEN 40
101768-0000-F-013 LOW PRESSURE AIR FROM DISTRIBUTION 800
101768-0000-F-014 PROCESS WATER FROM PROCESS WATER TANK 463
36
101768-0000-F-010 SODIUM CYANIDE FROM DISTRIBUTION 610

3400-TK-001
PRE-AERATION TANK
196 m³

3400-AG-001
PRE-AERATION TANK
AGITATOR
37 kW

LEACH AREA ANALYZER
LEACH AREA HCN DETECTOR 1
LEACH AREA HCN DETECTOR 2

3500-DI-003
BARREN CARBON
SIZING SCREEN
FEED BOX

3500-SC-003
BARREN CARBON
SIZING SCREEN
900 x 2000
5 kW

3500-CH-006
BARREN CARBON
OVERSIZE CHUTE

3500-CH-007
BARREN CARBON
UNDERSIZE CHUTE

43
44
BARREN CARBON UNDERSIZE TO CARBON FINES TANK 101768-0000-F-007

41
38 LOADED CARBON TO LOADED CARBON SCREEN FEED BOX 101768-0000-F-006

101768-0000-F-006 DESORPTION SUMP WASHING FROM DESORPTION AREA SUMP PUMP

37 CIL TANK OVERFLOW TO CARBON SAFETY SCREEN 101768-0000-F-009

3400-AG-002	3400-TK-002	3400-AG-003	3400-TK-003	3400-AG-004	3400-TK-004	3400-AG-005	3400-TK-005	3400-AG-006	3400-TK-006	3400-AG-007	3400-TK-007	3400-AG-008	3400-TK-008
CIL TANK NO.1 AGITATOR 37 kW	CIL TANK NO.1 196 m³	CIL TANK NO.2 AGITATOR 37 kW	CIL TANK NO.2 196 m³	CIL TANK NO.3 AGITATOR 37 kW	CIL TANK NO.3 196 m³	CIL TANK NO.4 AGITATOR 37 kW	CIL TANK NO.4 196 m³	CIL TANK NO.5 AGITATOR 37 kW	CIL TANK NO.5 196 m³	CIL TANK NO.6 AGITATOR 37 kW	CIL TANK NO.6 196 m³	CIL TANK NO.7 AGITATOR 37 kW	CIL TANK NO.7 196 m³
3400-PU-002	3400-SC-001	3400-PU-002	3400-SC-002	3400-PU-003	3400-SC-003	3400-PU-004	3400-SC-004	3400-PU-005	3400-SC-005	3400-PU-006	3400-SC-006	3400-PU-007	3400-SC-007
LOADED CARBON RECOVERY PUMP 1.25 kW	INTERTANK SCREEN NO.1 3.7 kW	CARBON TRANSFER PUMP NO.1 1.25 kW	INTERTANK SCREEN NO.2 3.7 kW	CARBON TRANSFER PUMP NO.2 1.25 kW	INTERTANK SCREEN NO.3 3.7 kW	CARBON TRANSFER PUMP NO.3 1.25 kW	INTERTANK SCREEN NO.4 3.7 kW	CARBON TRANSFER PUMP NO.4 1.25 kW	INTERTANK SCREEN NO.5 3.7 kW	CARBON TRANSFER PUMP NO.5 1.25 kW	INTERTANK SCREEN NO.6 3.7 kW	CARBON TRANSFER PUMP NO.6 1.25 kW	INTERTANK SCREEN NO.7 3.7 kW

CIL SUMP WASHING TO CIL DETOX TANK No.1 101768-0000-F-009

3400-PU-008
CIL AREA
SUMP PUMP NO.1
5 kW

3400-PU-009
CIL AREA
SUMP PUMP 2
5 kW

LEGEND
- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER 94922PE OREGON MAY 14, 2019 KELLY SNYDER

12 July 2019
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PRE-LEACH & CIL AREA
PROCESS FLOW DIAGRAM

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PROJECT No.	SCALE	SIZE
101768	NTS	A1

DRAWING No. 101768-0000-F-005 REV E

101768-0000-F-005 LOADED CARBON FROM LOADED CARBON RECOVERY PUMP (38)

101768-0000-F-014 PROCESS WATER FROM DISTRIBUTION (440)

3500-DI-001
LOADED CARBON SCREEN FEED BOX

3500-SC-004
LOADED CARBON SCREEN
900 x 2000
2 x 0.4 kW

3500-PU-008
SULPHAMIC ACID DRUM PUMP

(39)

3500-CH-001
LOADED CARBON SCREEN DISCHARGE CHUTE

3500-CH-002
LOADED CARBON SCREEN UNDERSIZE CHUTE

(40) LOADED CARBON SCREEN UNDERSIZE TO PREAERATION TANK 101768-0000-F-005

3500-XM-001
ACID WASH DISCHARGE STRAINER NO.1

3500-XM-002
ACID WASH DISCHARGE STRAINER NO.2

(616) ACID RINSE SOLUTION TO CYANIDE DETOX TANK 1 101768-0000-F-009

3500-XM-003
ELUTION STRAINER NO.1

3500-XM-004
ELUTION STRAINER NO.2

(50)

(52) PREGNANT ELUATE TO GOLD ROOM 101768-0000-F-008

3500-HP-001
ACID WASH FEED HOPPER

3500-HX-001
RECOVERY HEAT EXCHANGER

TO ATMOSPHERE

3500-HE-001
ELECTRIC SOLUTION HEATER
600 kW

3500-CM-001
ACID WASH COLUMN
3.5 m³

3500-CM-002
ELUTION COLUMN
3.5 m³

(51) BARREN CARBON TO CARBON REGENERATION 101768-0000-F-007

101768-0000-F-011 HYDROCHLORIC ACID FROM HYDROCHLORIC ACID DOSING PUMP (615)

101768-0000-F-007 TRANSFER WATER FROM TRANSFER WATER TANK (445)

101768-0000-F-008 STRIP SOLUTION FROM STRIP SOLUTION TANK

(54) ACID WASH AREA SUMP WASHING TO CYANIDE DETOX TANK 1 101768-0000-F-009

DESORPTION AREA SUMP WASHING TO CIL 101768-0000-F-005

3500-PU-001
ACID WASH AREA SUMP PUMP
3.7 kW

3500-PU-002
DESORPTION AREA SUMP PUMP
3.7 kW

LEGEND
- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER 94922PE OREGON MAY 14, 2019 KELLY SNYDER

12 July 2019

RENEWS: 30 JUNE 2020

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DESORPTION AREA
PROCESS FLOW DIAGRAM

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DRAWING No. 101768-0000-F-006 | REV E

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101768-0000-F-006 BARREN CARBON FROM ELUTION COLUMN (51)

101768-0000-F-014 PROCESS WATER FROM DISTRIBUTION (452)

101768-0000-F-012 FLOCCULANT FROM DISTRIBUTION

101768-0000-F-005 BARREN CARBON UNDERSIZE FROM BARREN CARBON SIZING SCREEN (44)

101768-0000-F-014 PROCESS WATER FROM DISTRIBUTION (493)

101768-0000-F-013 PLANT AIR FROM PLANT AIR DISTRIBUTION

101768-0000-F-015 GLAND WATER FROM GLAND WATER DISTRIBUTION (464)

(445) TRANSFER WATER TO ACID WASH COLUMN 101768-0000-F-006

(450)

(451)

(497)

(56)

(42)

(45) BARREN CARBON TO BARREN CARBON SIZING SCREEN FEED BOX 101768-0000-F-005

(57) CARBON REGENERATION SUMP WASHINGS TO TAILINGS PUMP BOX 101768-0000-F-009

TO OFFSITE PROCESSING

FINE CARBON COLLECTION BAGS

TO ATMOSPHERE

3500-DI-002 KILN DEWATERING FEEDBOX

3500-SC-001 KILN DEWATERING SCREEN 5 kW

3500-CH-003 KILN DEWATERING SCREEN UNDERPAN CHUTE

3500-CH-004 KILN DEWATERING SCREEN OVERSIZE CHUTE

3500-HT-001 CARBON BULK BAG HOIST 5 kW 1 t

CARBON BULK BAG

3500-XM-005 CARBON BULK BAG BREAKER

3500-CH-005 CARBON PRE-ATTRITION FEED CHUTE

3500-TK-001 CARBON PRE-ATTRITION TANK 1500 DIA x 1700 H

3500-AG-001 CARBON PRE-ATTRITION TANK AGITATOR 5 kW

3500-PU-003 CARBON PRE-ATTRITION TRANSFER PUMP 3.7 kW

3500-SC-002 CARBON QUENCH SCREEN 1500 x 3200 5 kW

3500-TH-001 CARBON FINES CLARIFIER 1500 DIA x 2000 H

3500-PU-004 TRANSFER WATER PUMP 5.5 kW

3500-TK-002 TRANSFER WATER TANK 2300 DIA x 2800 H

3500-FL-001 CARBON FINES FILTER 1.1 kW

3500-HP-002 KILN FEED HOPPER

3500-KN-001 CARBON REGENERATION KILN 190 kW

3500-FE-001 KILN SCREW FEEDER 3.7 kW

3500-FA-001 KILN EXHAUST FAN 3.7 kW

3500-TK-004 KILN SCRUBBING TANK

3500-TK-003 QUENCH TANK 2300 x 2550

3500-PU-005 / 006 BARREN CARBON TRANSFER PUMP NO.1 / NO.2 3.7 kW

3500-PU-007 CARBON REGENERATION AREA SUMP PUMP 3.7 kW

LEGEND
- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER 94922PE OREGON MAY 14, 2019 KELLY SNYDER

Kelly 12 July 2019

RENEWS: 30 JUNE 2020

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TITLE: GRASSY MOUNTAIN-PROCESSING PLANT
CARBON REGENERATION AREA
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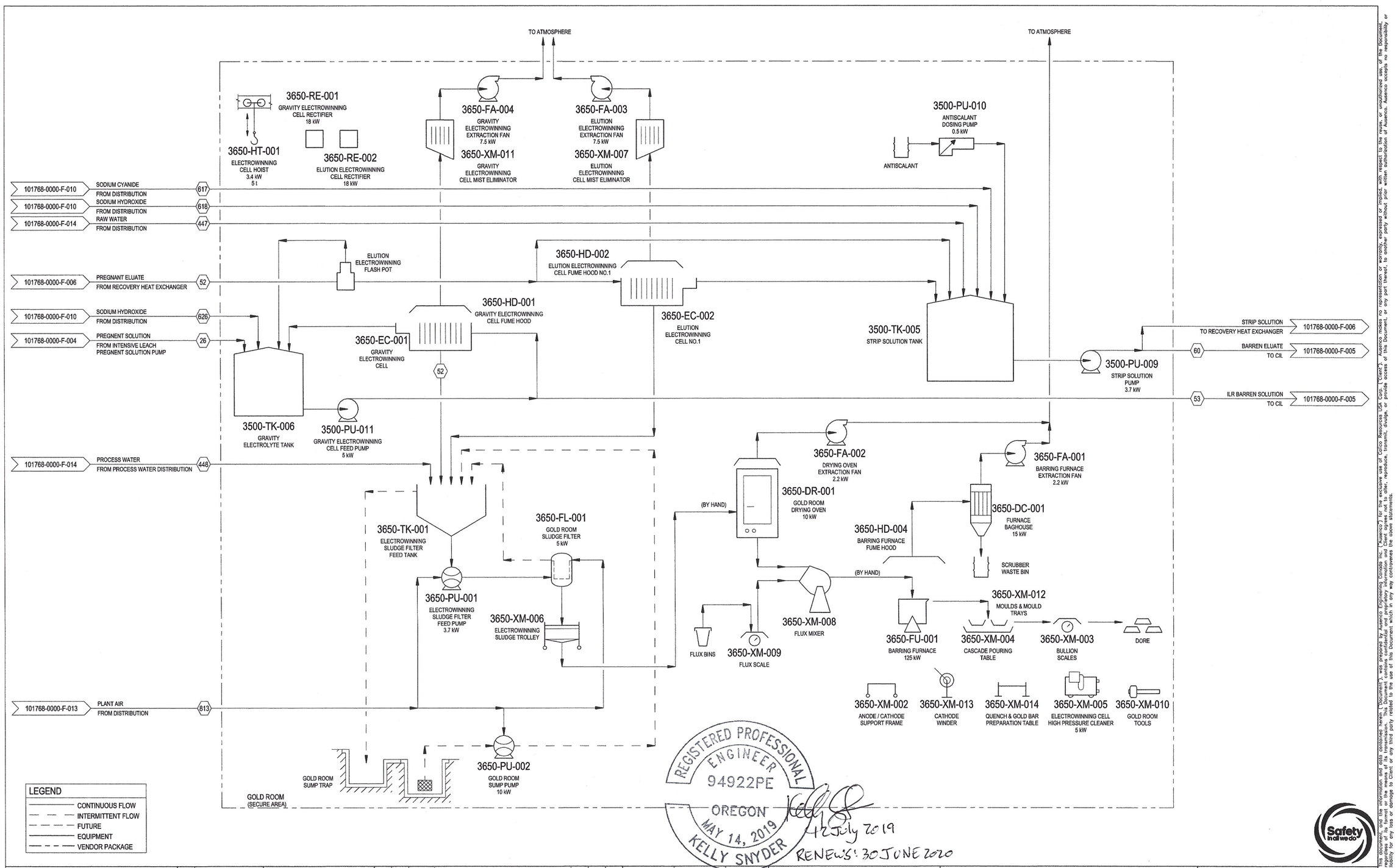
PROJECT No.	SCALE	SIZE
101768	NTS	A1

DRAWING No. 101768-0000-F-007 REV E



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12 July 2019

RENEWS: 30 JUNE 2020

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GOLD ROOM AREA
PROCESS FLOW DIAGRAM

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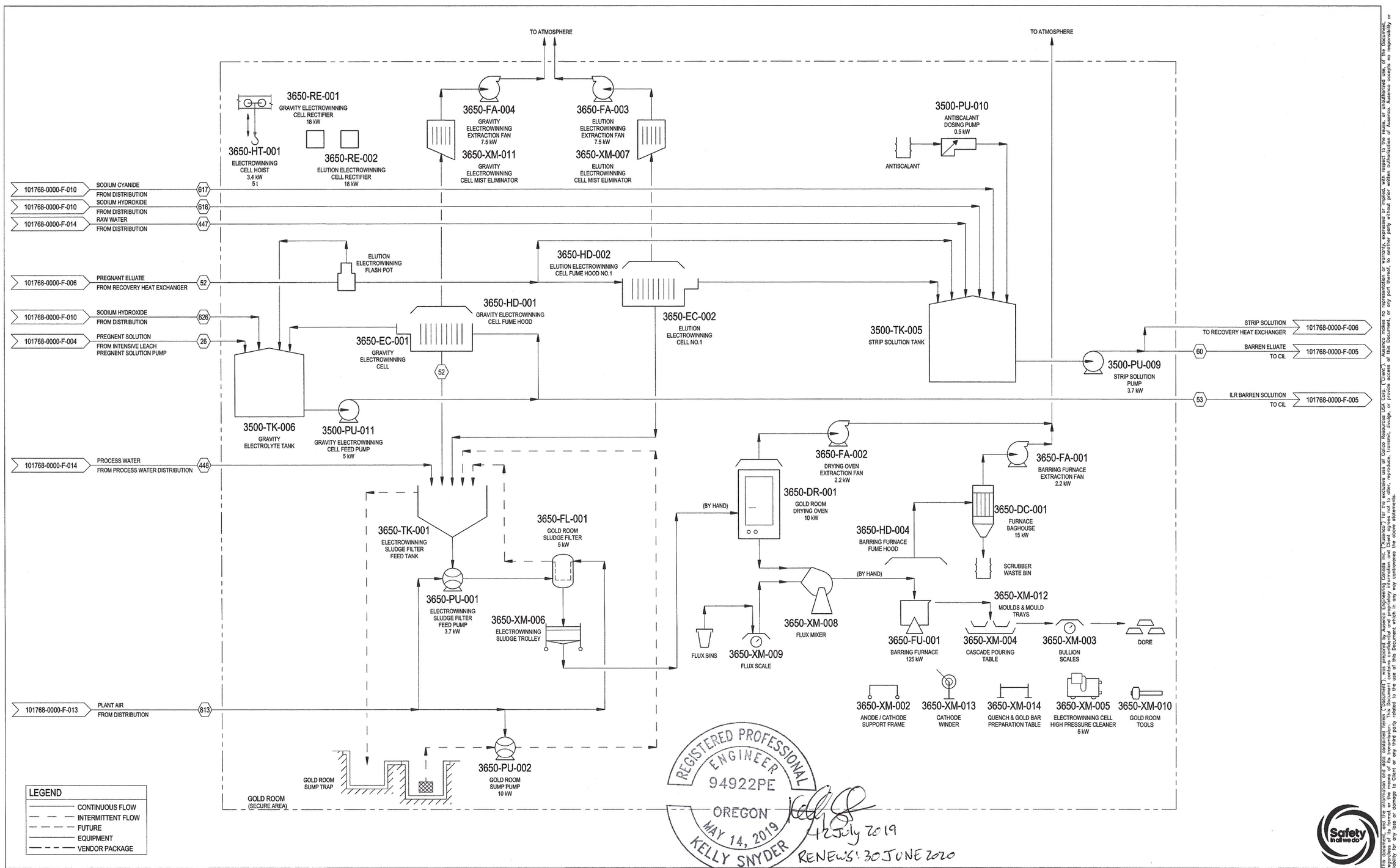

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101768-0000-F-014 PROCESS WATER FROM DISTRIBUTION (454)

101768-0000-F-005 CIL TANK OVERFLOW FROM CIL TANK 7 (37)

3710-DI-001
CARBON SAFETY SCREEN FEED BOX

3710-SC-001
CARBON SAFETY SCREEN
900 x 1800
2.2 kW

3710-CH-002
CARBON SAFETY SCREEN UNDERSIZE CHUTE

3710-CH-001
CARBON SAFETY SCREEN OVERSIZE CHUTE

3710-BN-001
CARBON TRASH BIN

3710-PU-003
TAILINGS AREA SUMP PUMP
5 kW

101768-0000-F-005 CIL AREA SUMP WASHING FROM CIL AREA SUMP PUMP

101768-0000-F-010 LIME AREA SUMP WASHING FROM LIME AREA SUMP PUMP

101768-0000-F-010 ALKALINE REAGENT SUMP WASHING FROM ALKALINE REAGENT AREA SUMP PUMP

101768-0000-F-011 SODIUM METABISULPHITE FROM DISTRIBUTION

101768-0000-F-010 LIME SLURRY FROM DISTRIBUTION (627)

101768-0000-F-011 COPPER SULPHATE FROM COPPER SULPHATE DOSING PUMPS (629)

101768-0000-F-006 ACID RINSE SOLUTION FROM ACID WASH CLOUMN (616)

101768-0000-F-011 SODIUM METABISULPHITE FROM DISTRIBUTION

101768-0000-F-011 ACIDIC REAGENT SUMP WASHING FROM ACIDIC REAGENT AREA SUMP PUMP

101768-0000-F-006 ACID WASH SUMP WASHING FROM ACID WASH AREA SUMP PUMP (54)

101768-0000-F-011 COPPER SULPHATE SUMP WASHING FROM COPPER SULPHATE SUMP

DETOX CYANIDE ANALYZER

3600-TK-001
CYANIDE DETOX TANK NO.1
73 m³

3600-AG-001
CYANIDE DETOX TANK NO.1 AGITATOR
33 kW

DISPERSION CONE

3600-AG-002
CYANIDE DETOX TANK NO.2 AGITATOR
33 kW

DISPERSION CONE

3600-TK-002
CYANIDE DETOX TANK NO.2
73 m³

3710-SA-001
TAILINGS SAMPLER

TAILINGS SAMPLE CONTAINER

(65)

101768-0000-F-013 LOWER PRESSURE AIR FROM DISTRIBUTION (805)

101768-0000-F-007 CARBON REGENERATION SUMP WASHING FROM CARBON REGENERATION AREA SUMP PUMP (57)

101768-0000-F-015 GLAND WATER FROM DISTRIBUTION (461)

3710-HP-001
TAILINGS PUMPBOX

3710-PU-001 / 002
TAILINGS PUMP NO.1 / NO.2
19 kW

(69) PROCESS SLURRY TAILINGS TO TAILINGS MANAGEMENT FACILITY 101768-0000-F-014

LEGEND
- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER 94922PE OREGON MAY 14, 2019 KELLY SNYDER

12 July 2019
RENEWS: 30 JUNE 2020

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CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN-PROCESSING PLANT
CYANIDE DETOXIFICATION & TAILINGS DISPOSAL AREA
PROCESS FLOW DIAGRAM

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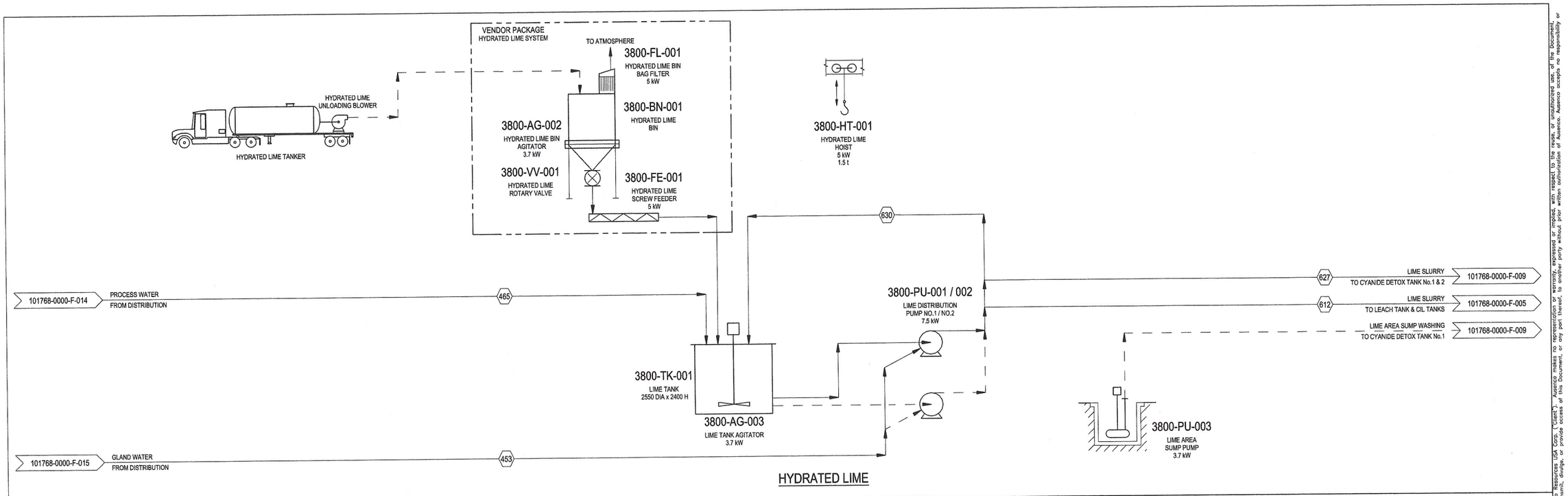

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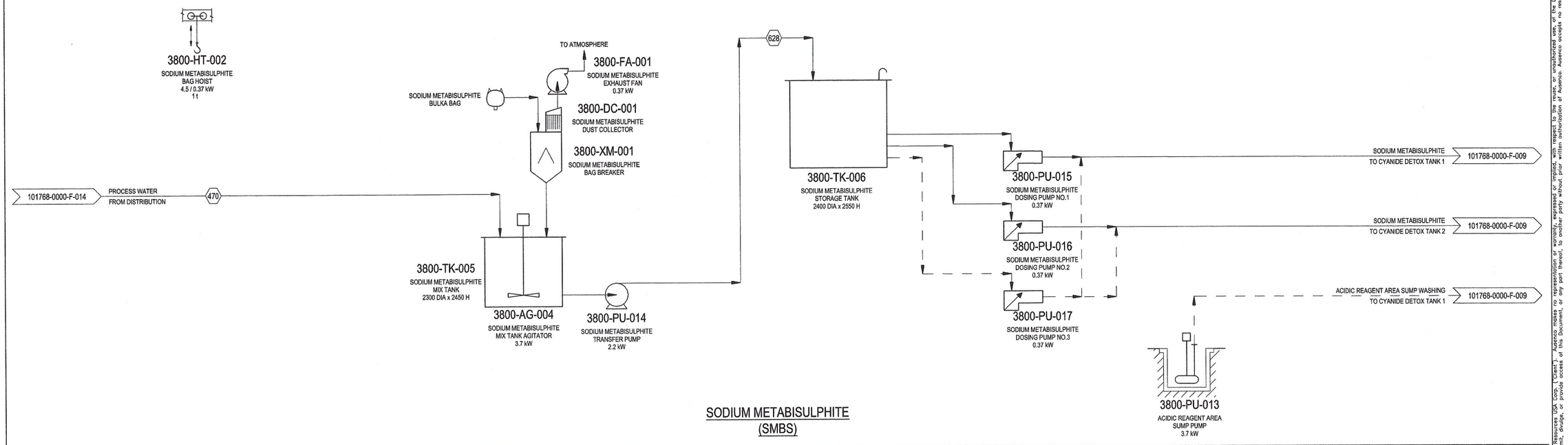

REGISTERED PROFESSIONAL ENGINEER 94922PE OREGON MAY 14, 2019 KELLY SNYDER

12 July 2019
RENEWS: 30 JUNE 2020

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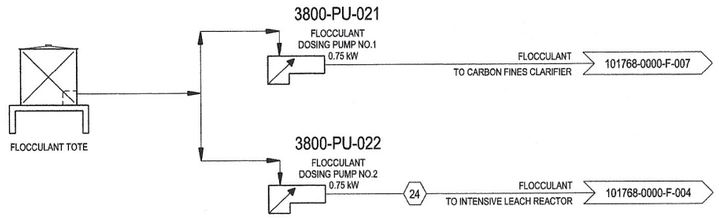

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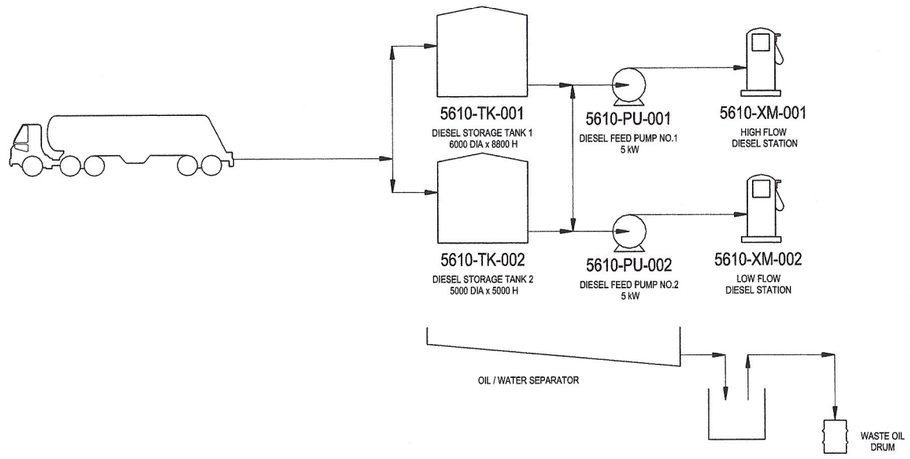

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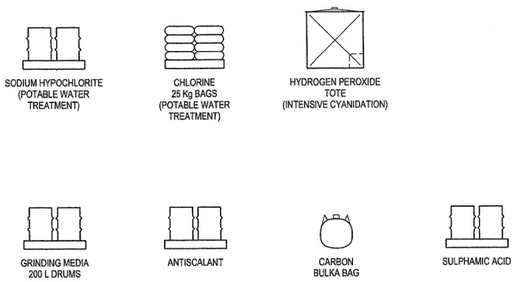

LEGEND

- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER
94922PE
OREGON
MAY 14, 2019
KELLY SNYDER

12 July 2019
RENEWS: 30 JUNE 2020

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TITLE: GRASSY MOUNTAIN-PROCESSING PLANT
REAGENTS GENERAL
PROCESS FLOW DIAGRAM

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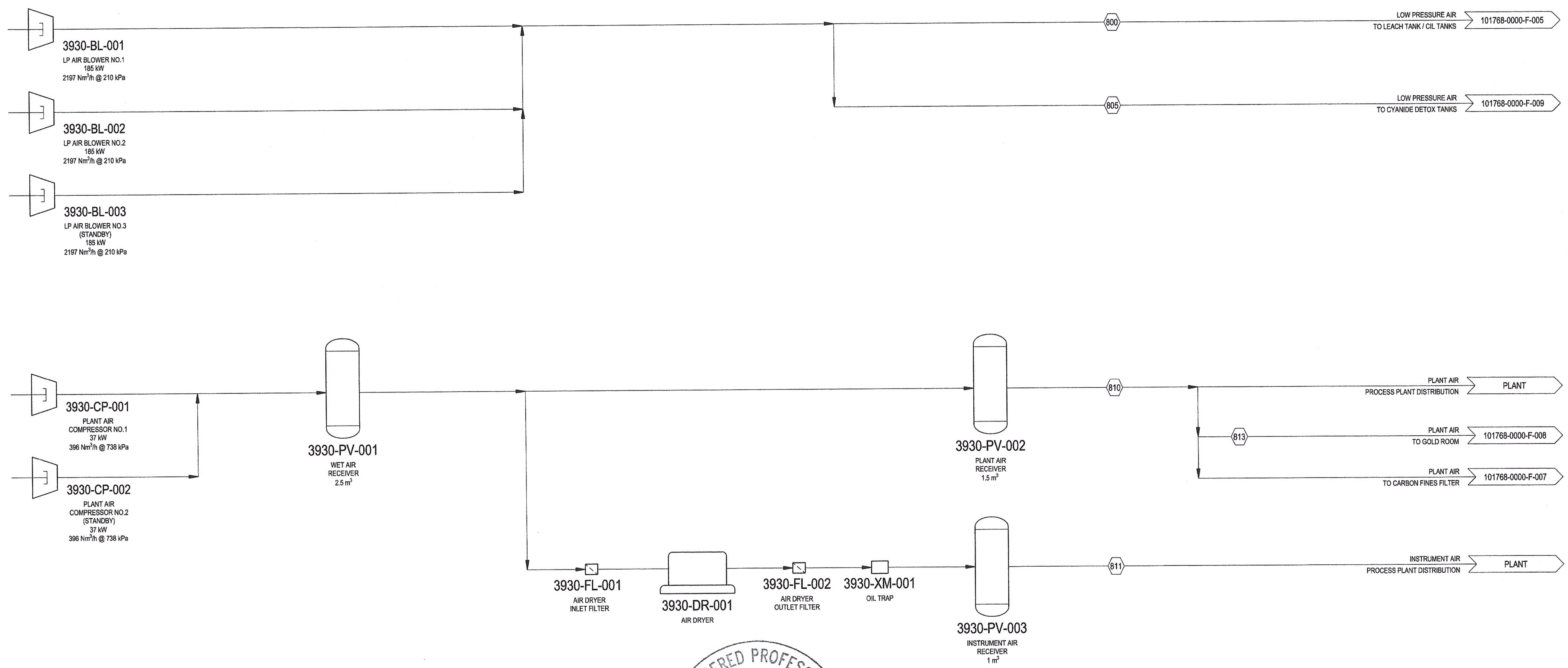

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OREGON
MAY 14, 2019
KELLY SNYDER

12 July 2019
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LEGEND

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PLANT SERVICE- AIR
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DRAWING No. 101768-0000-F-013 | REV E

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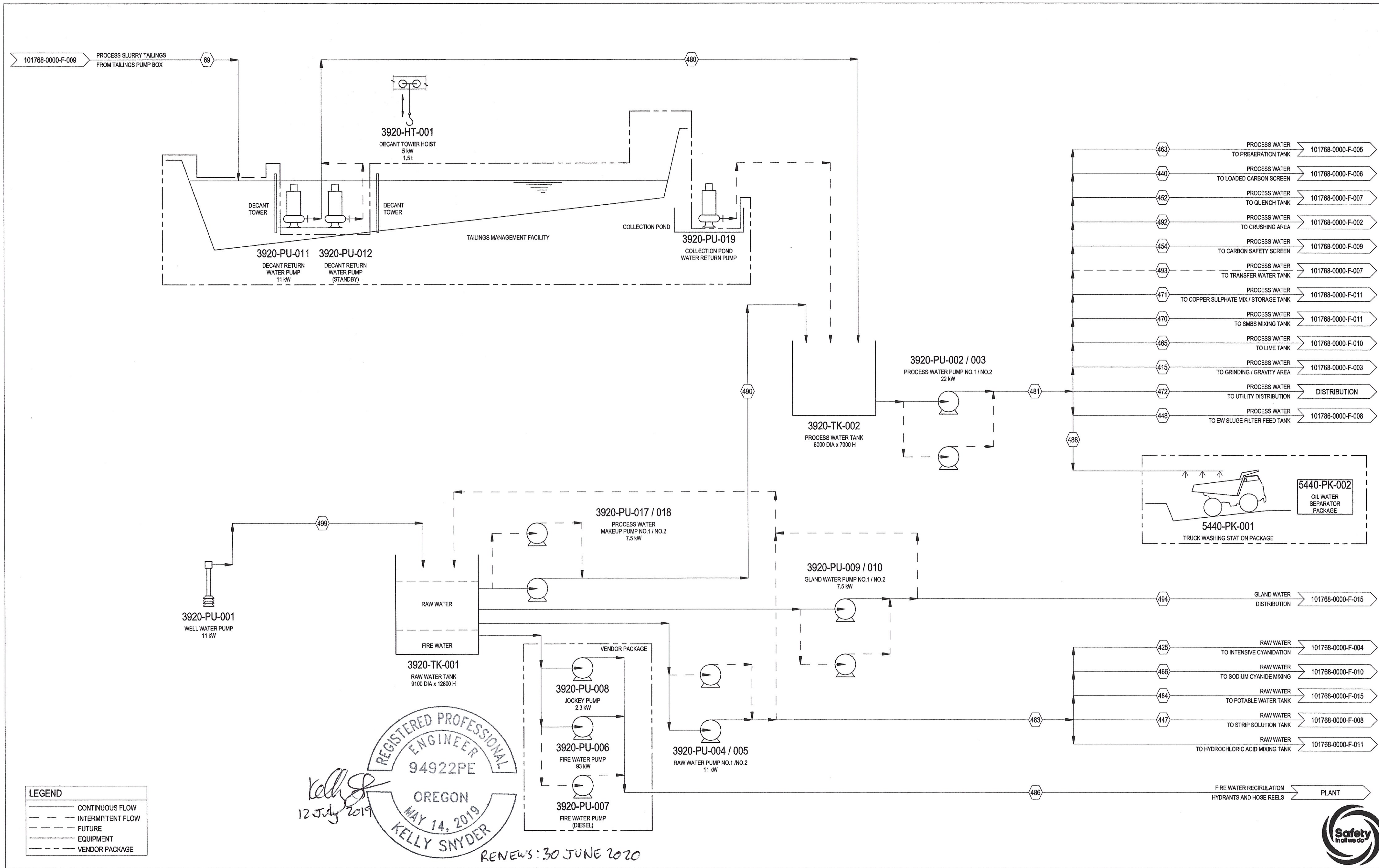

CALICO RESOURCES

REF.	DRAWING No.	REFERENCE DRAWING	No.	BY	DATE	REVISION DETAILS	CHKD	ENG	APPR
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			D	KL	04MAY2018	RE-ISSUED FOR PREFEASIBILITY STUDY	MW	TM	RA
			C	BM	23MAR2018	ISSUED FOR PREFEASIBILITY STUDY	MW	TM	RA
			B	BM	16MAR2018	RE-ISSUED FOR INTERNAL REVIEW	MW	TM	RA
			A	SS	02FEB2018	ISSUED FOR INTERNAL REVIEW	DI	MF	RA

DRAWN	SS	02FEB2018
DWG. CHECKED	DI	02FEB2018
DESIGNED	MF	02FEB2018
DES. APPR.	RA	02FEB2018
PROJ. APPR.	GD	16MAR2018

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CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN-PROCESSING PLANT
PLANT SERVICE-WATER (SHEET 1 OF 2)
PROCESS FLOW DIAGRAM

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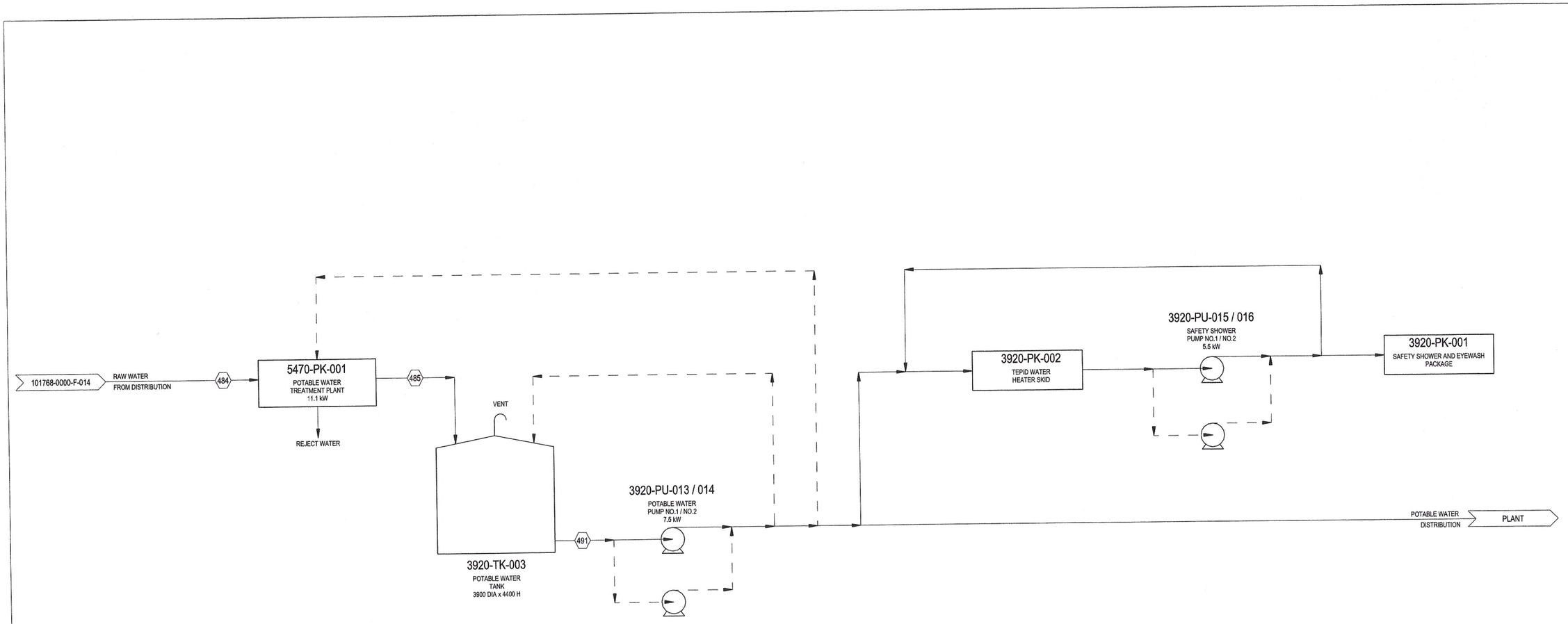

LEGEND

- CONTINUOUS FLOW
- INTERMITTENT FLOW
- FUTURE
- EQUIPMENT
- VENDOR PACKAGE

REGISTERED PROFESSIONAL ENGINEER
94922PE
OREGON
MAY 14, 2019
KELLY SNYDER

12 July 2019

RENEWS: 30 JUNE 2020

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CALICO RESOURCES

REF.	DRAWING No.	REFERENCE DRAWING

No.	BY	DATE	REVISION DETAILS	CHK'D	ENG	APPR
E	LT	24JUN2019	ISSUED FOR PERMITTING	TM	TM	SG
D	KL	04MAY2018	RE-ISSUED FOR PREFEASIBILITY STUDY	MW	TM	RA
C	BM	23MAR2018	ISSUED FOR PREFEASIBILITY STUDY	MW	TM	RA
B	BM	16MAR2018	RE-ISSUED FOR INTERNAL REVIEW	MW	TM	RA
A	SS	02FEB2018	ISSUED FOR INTERNAL REVIEW	DI	MF	RA

DRAWN	SS	02FEB2018
DWG. CHECKED	DI	02FEB2018
DESIGNED	MF	02FEB2018
DES. APPR.	RA	02FEB2018
PROJ. APPR.	GD	16MAR2018

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TITLE: GRASSY MOUNTAIN-PROCESSING PLANT
PLANT SERVICE-WATER (SHEET 2 OF 2)
PROCESS FLOW DIAGRAM

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Appendix C – General Arrangements

SEPTIC TANK
CULVERT
DITCH
PARKING
PLANT OFFICES & CHANGE HOUSE
LABORATORY
ADMINISTRATION BUILDING
PLANT WORKSHOP & WAREHOUSE
COLLECTION POND VOL: 110,000 ft³
CULVERT
CULVERT
DITCH
TP-B1
TP-B2
TP-B3
TP-B4
TP-B5
TP-B6
TP-A1
TP-A2
TP-A3
TP-A4
TP-A5
TP-A6
TP-C1
TP-C2
TP-C3
TP-C4
TP-C5
TP-C6
TP-C7
TP-C8
STOCKPILE & RECLAIM AREA
GOLDROOM
ELUTION AREA
REAGENT AREA
WATER SERVICE AREA
PAD EL. 3710' (NOM.)
GRINDING AREA
CIL AREA
DITCH
CRUSHING AREA
PAD EL. 3730' (NOM.)
TRUCK WASH
SUMP
ROM STOCKPILE
FUEL STORAGE
FUEL STORAGE
TRUCK WORKSHOP & WAREHOUSE
MINE OFFICE & CHANGE HOUSE
TO UG PORTAL

PRELIMINARY

50' 0 50' 100' 150' 200'
SCALE: 1"=50'

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PARAMOUNT GOLD Nevada

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			C	LB	10APR2019	ISSUED FOR CLIENT REVIEW	LK		
			B	RK	05APR2019	ISSUED FOR CLIENT REVIEW	JTR		
			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

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PROJ. APPR.		

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CLIENT PARAMOUNT GOLD NEVADA

TITLE GRASSY MOUNTAIN PROJECT
PLANT SITE
GENERAL ARRANGEMENT PLAN

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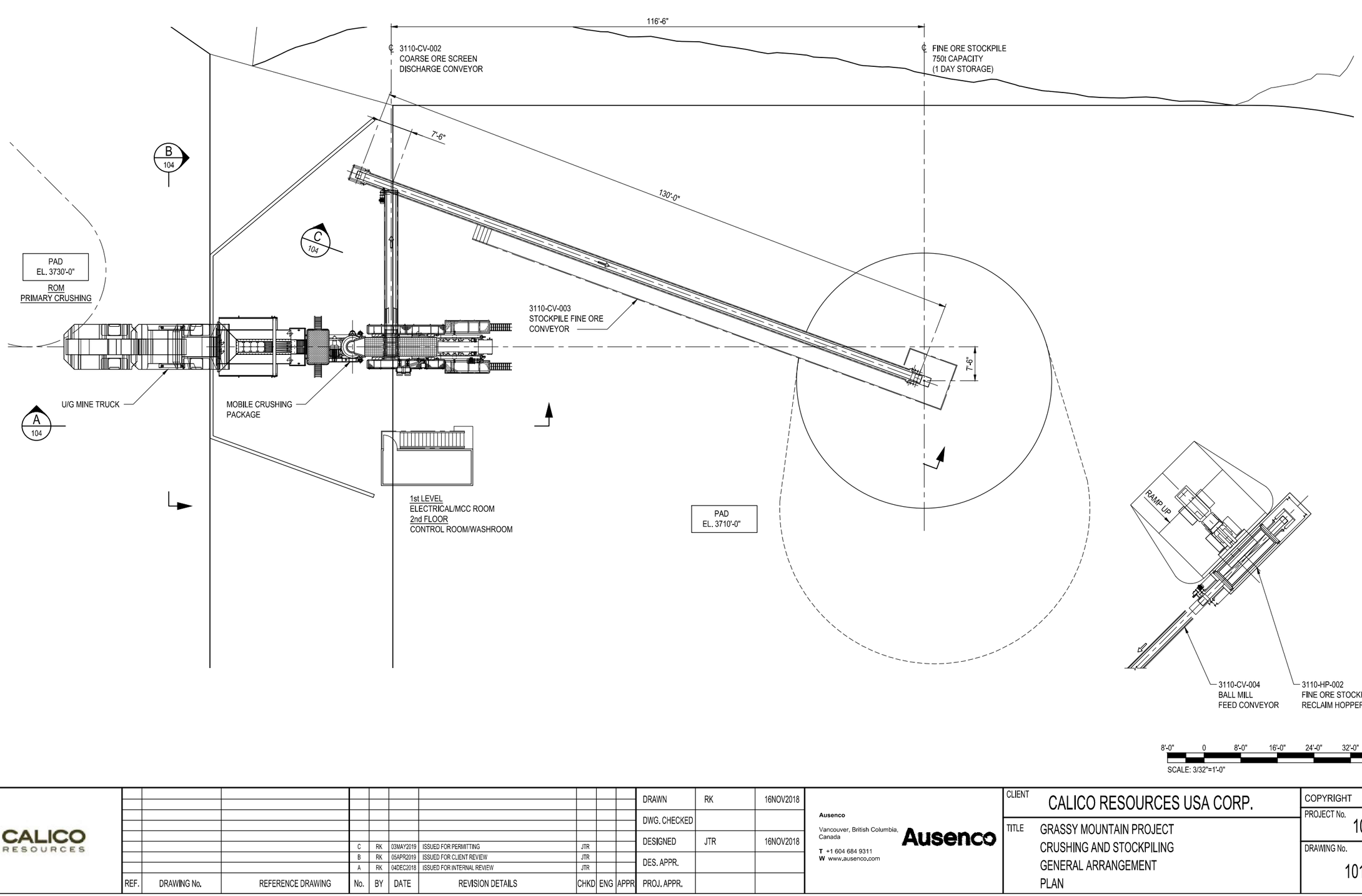
PROJECT No.	SCALE	SIZE
101768	1" = 50'	D

DRAWING No. 101768-0000-G-102 REV E



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CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN PROJECT
CRUSHING AND STOCKPILING
GENERAL ARRANGEMENT
PLAN

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PROJECT No.	SCALE	SIZE
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DRAWING No.	REV
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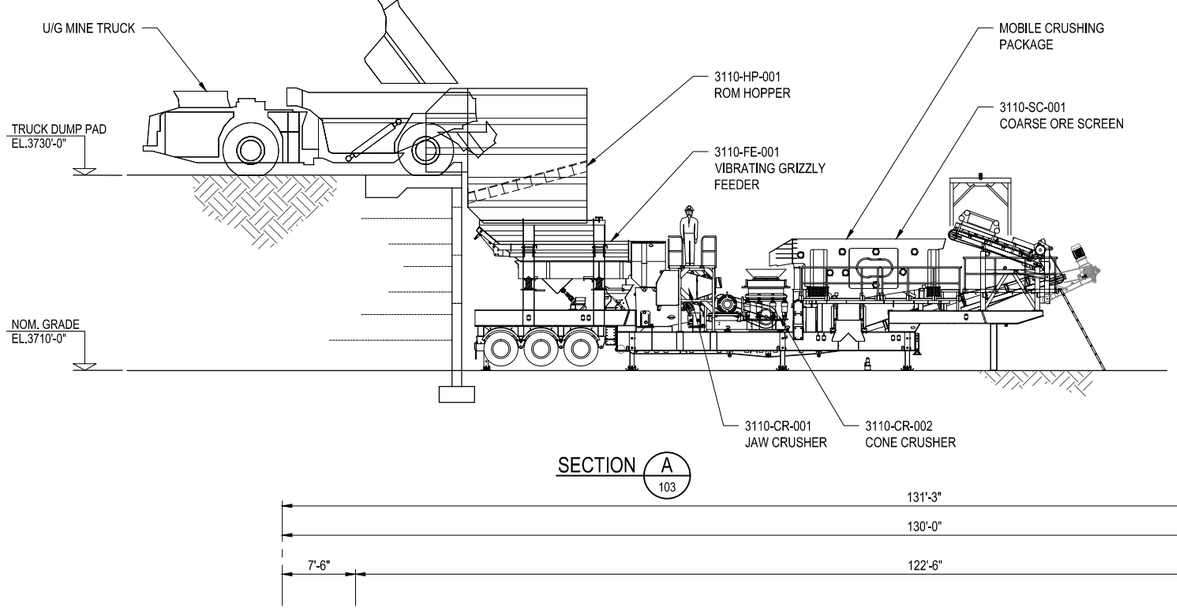

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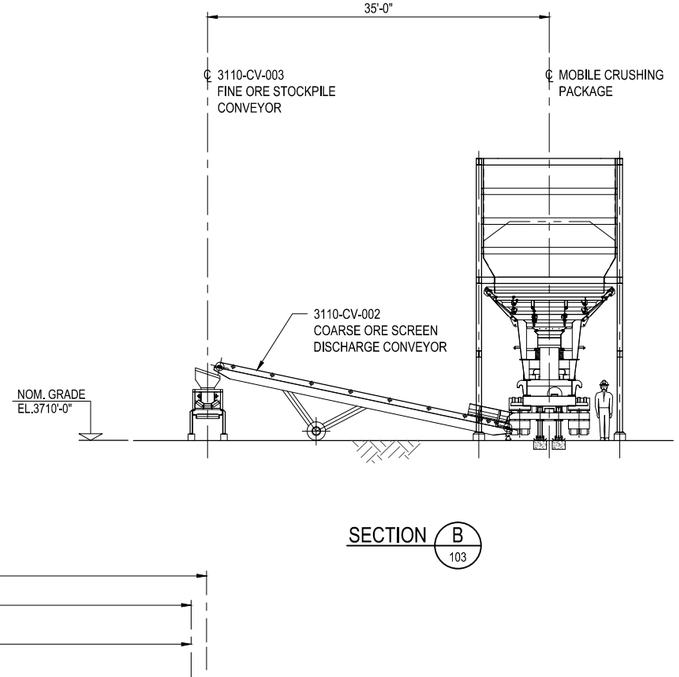

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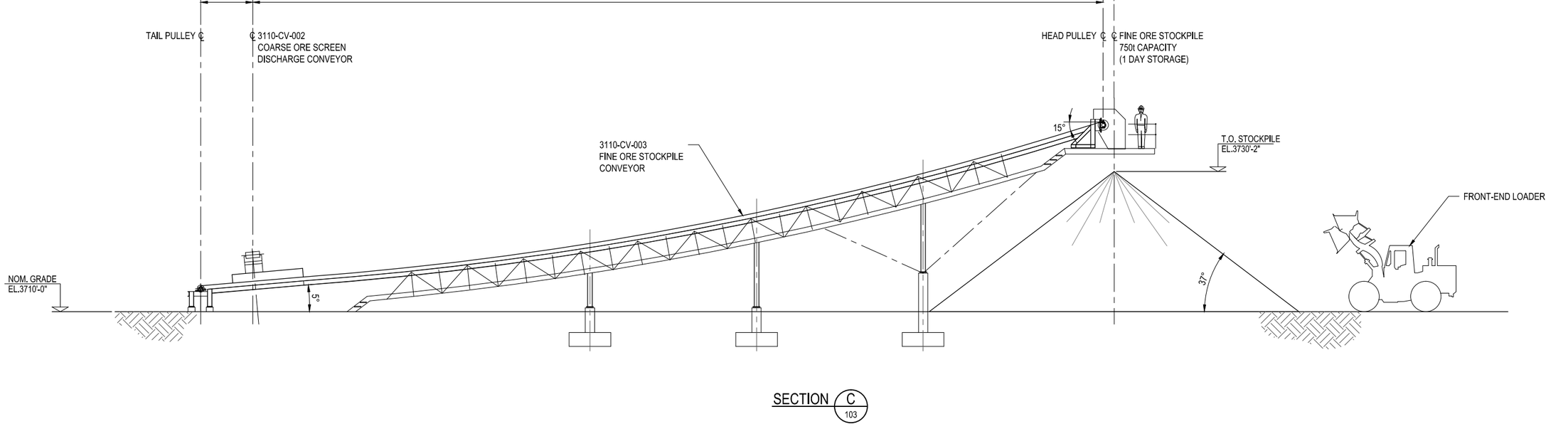

SECTION C 103

5'-0" 0 10'-0" 20'-0" 30'-0"

SCALE: 1/8"=1'-0"

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PROJ. APPR.		

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CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN PRE-FEASIBILITY STUDY
CRUSHING AND STOCKPILING
GENERAL ARRANGEMENT
SECTIONS

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PROJECT No.	SCALE	SIZE
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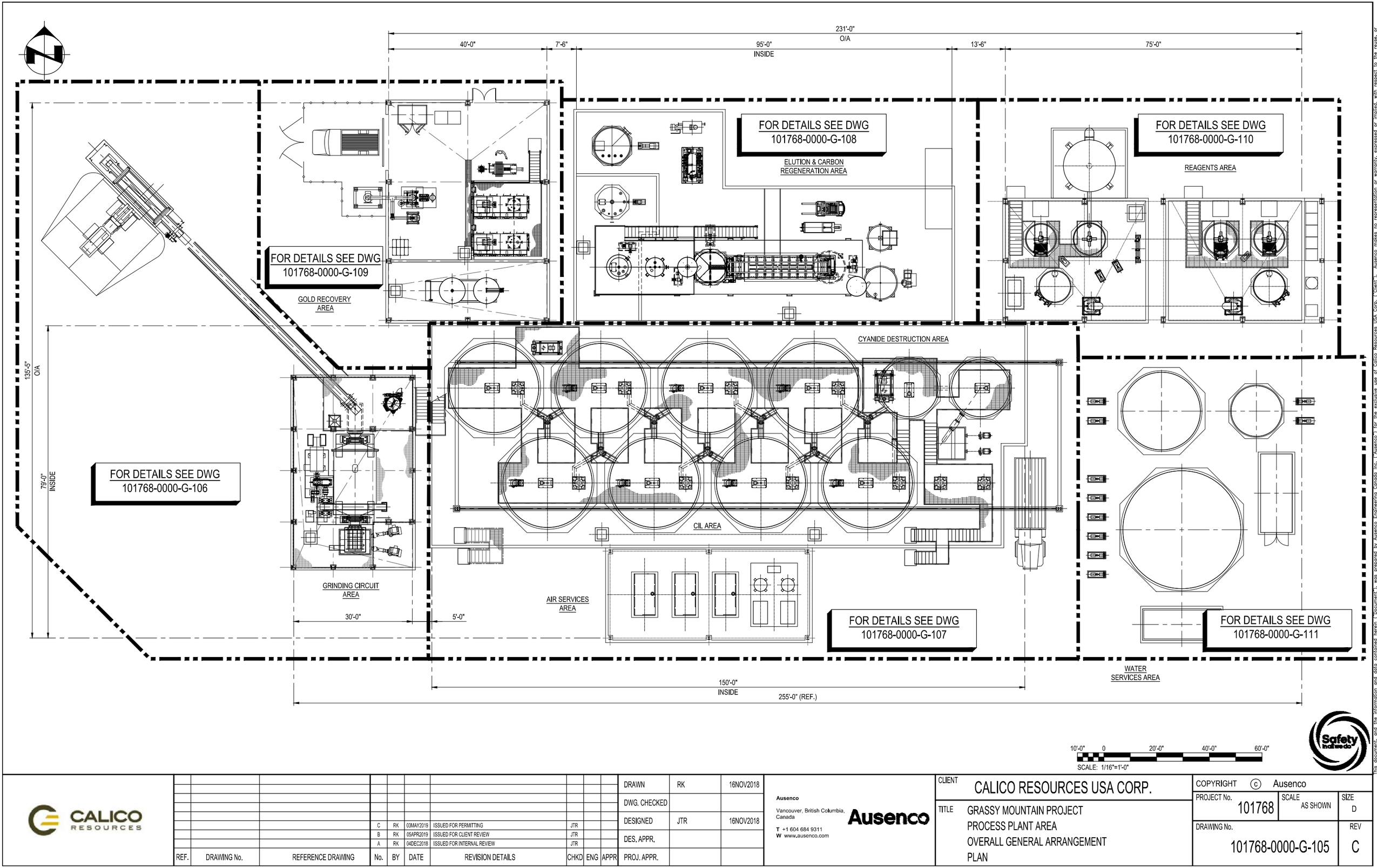
DRAWING No.	REV
101768-0000-G-104	C



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DESIGNED	JTR	16NOV2018
DES. APPR.		
PROJ. APPR.		

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CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN PROJECT
PROCESS PLANT AREA
OVERALL GENERAL ARRANGEMENT
PLAN

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PROJECT No.	SCALE	SIZE
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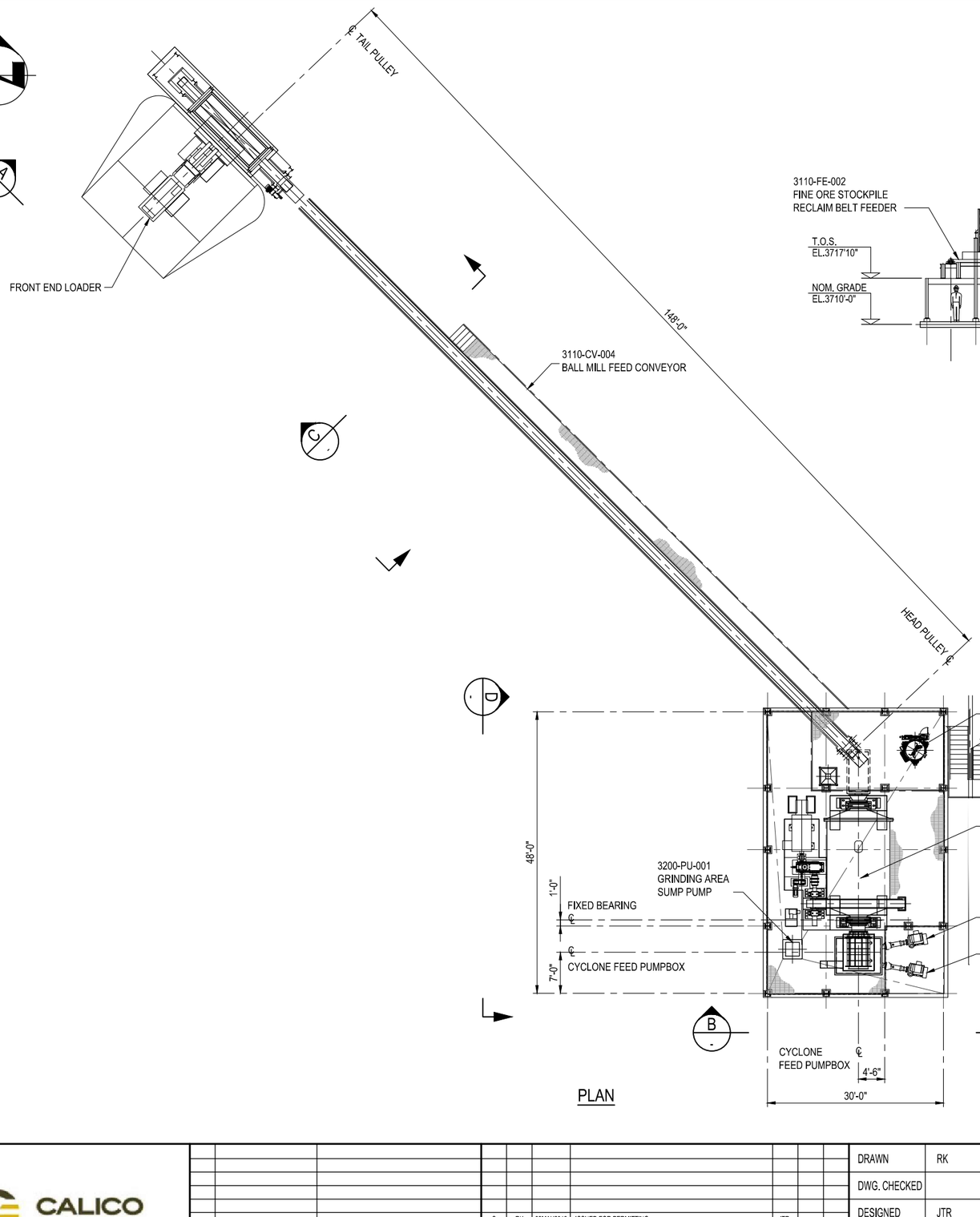

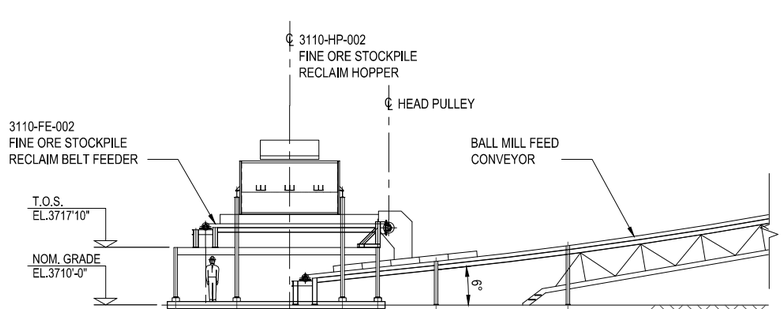

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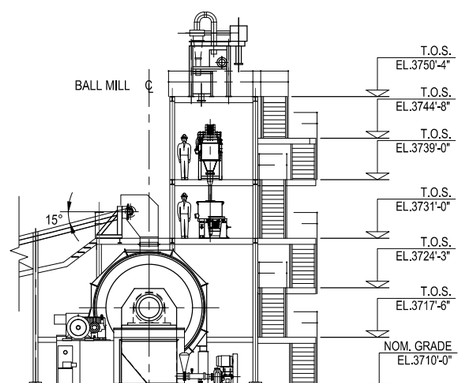

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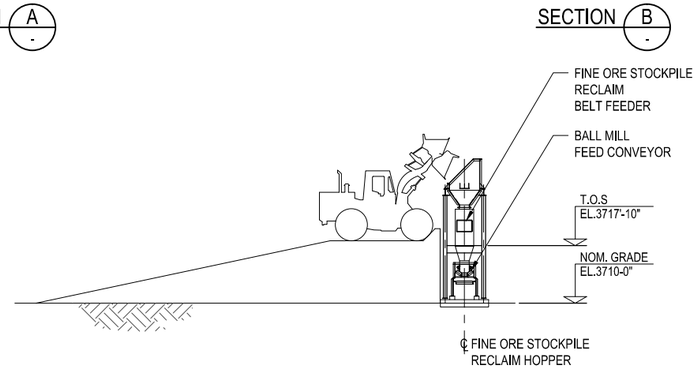

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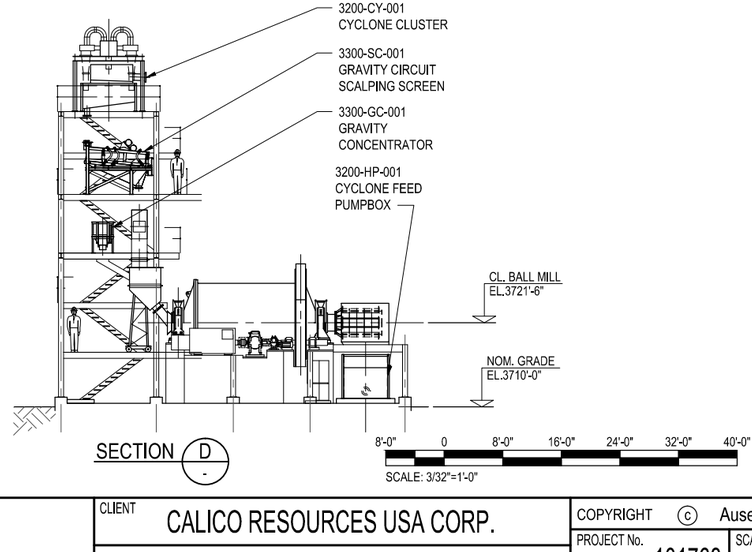

SECTION D

8'-0" 0 8'-0" 16'-0" 24'-0" 32'-0" 40'-0"

SCALE: 3/32"=1'-0"

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TITLE GRASSY MOUNTAIN PROJECT
GRINDING AREA
GENERAL ARRANGEMENT
PLAN & SECTIONS

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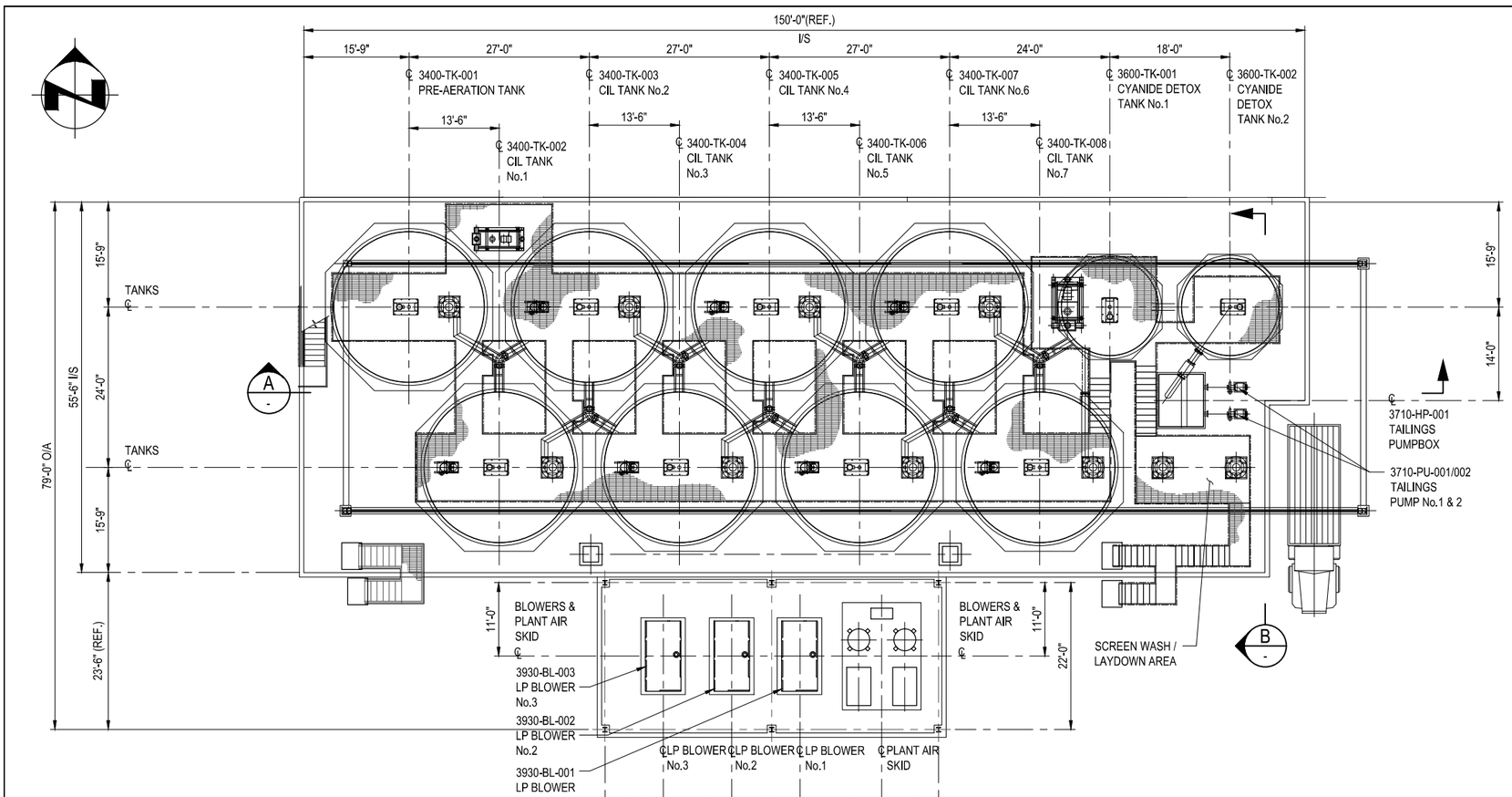
PROJECT No. 101768 | SCALE AS SHOWN | SIZE D

DRAWING No. 101768-0000-G-106 | REV C



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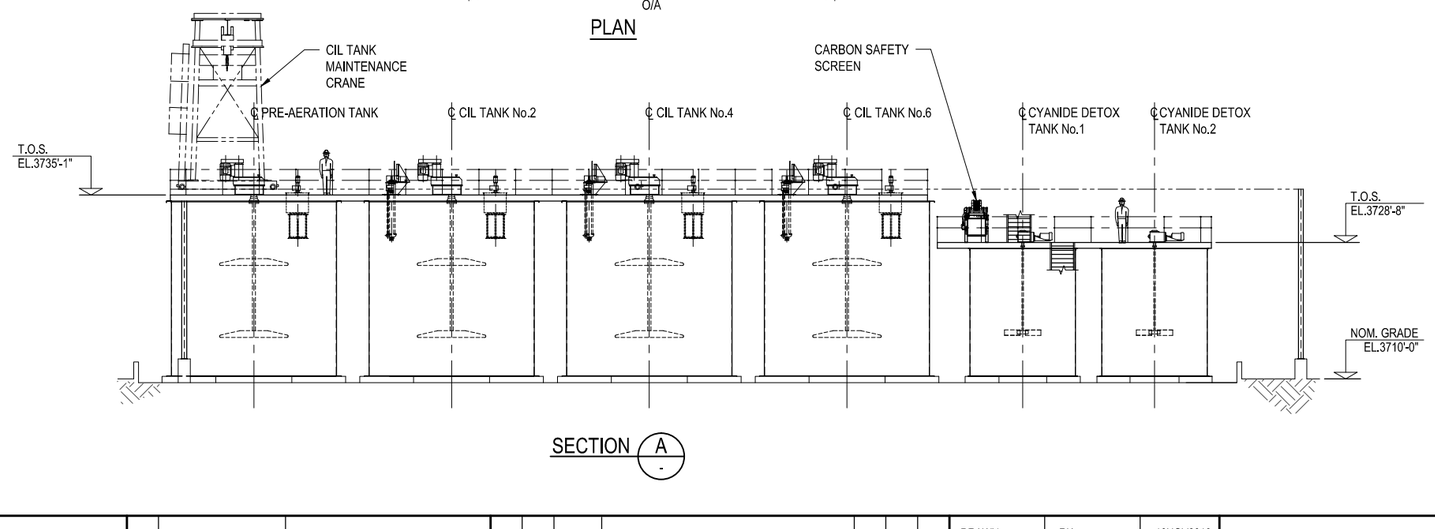

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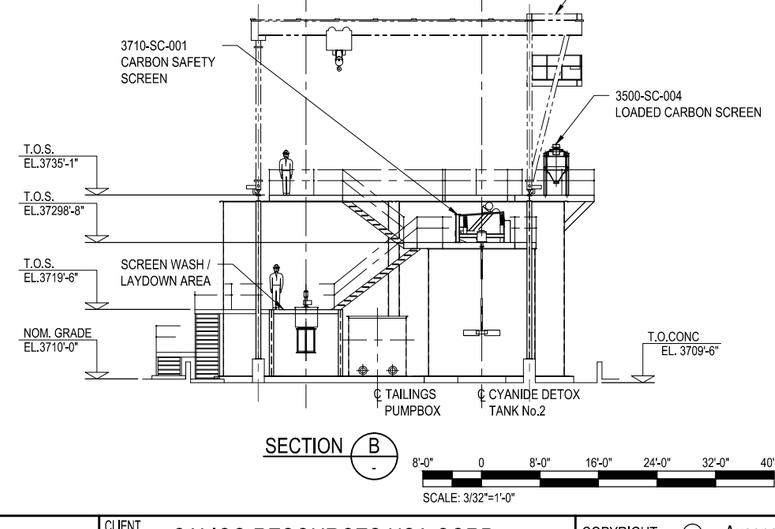

SECTION B -

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SCALE: 3/32"=1'-0"

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TITLE GRASSY MOUNTAIN PROJECT
CIL AREA
GENERAL ARRANGEMENT
PLAN & SECTIONS

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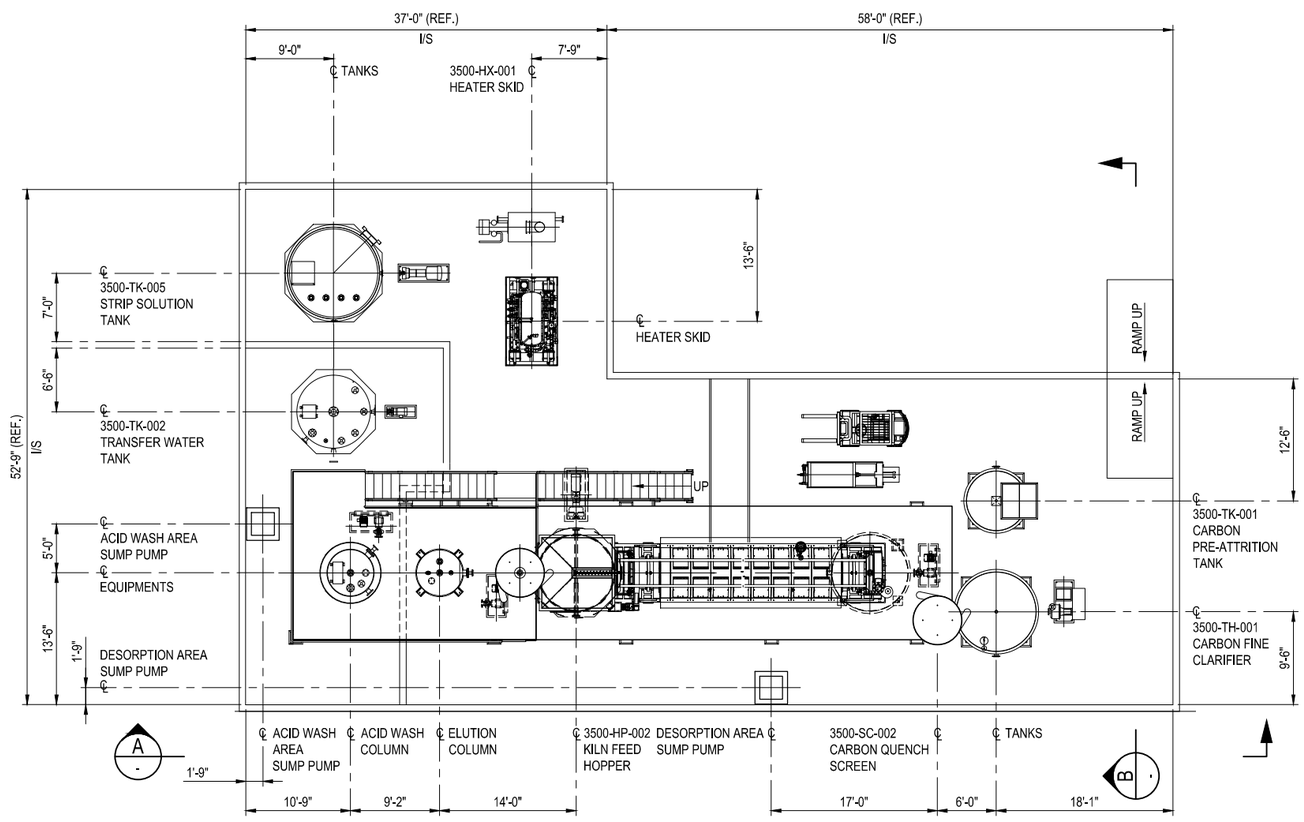
101768	AS SHOWN	D

DRAWING No.	REV
101768-0000-G-107	C



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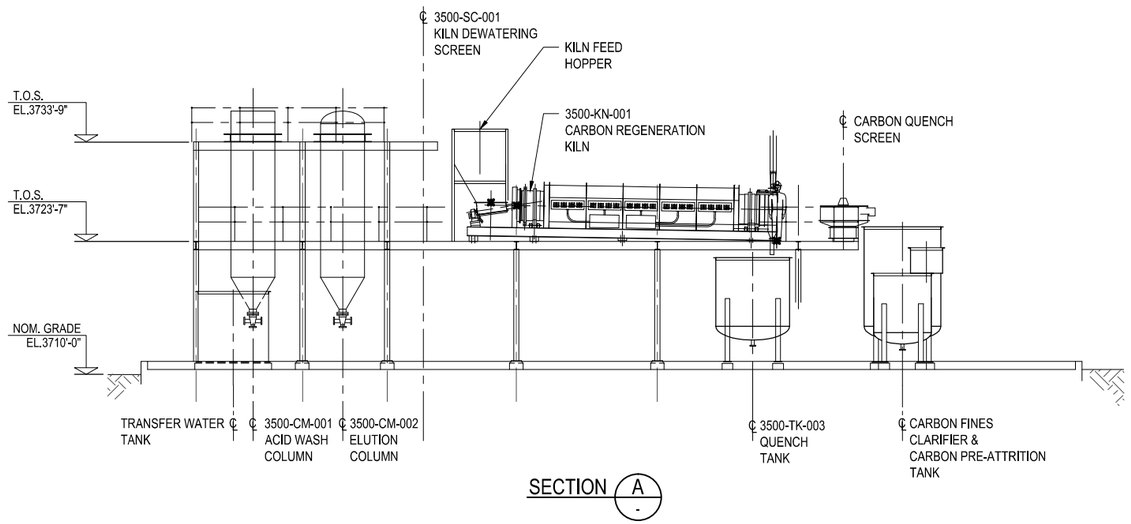

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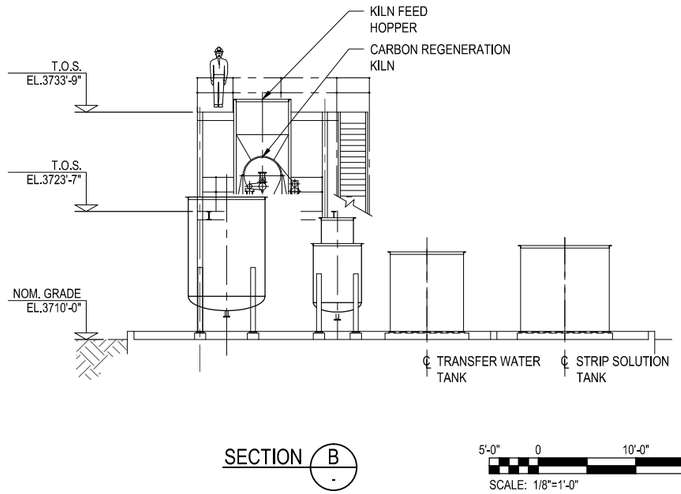

SECTION B
-

5'-0" 0 10'-0" 20'-0" 30'-0"
SCALE: 1/8"=1'-0"

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TITLE GRASSY MOUNTAIN PROJECT
DESORPTION & REGENERATION AREA
GENERAL ARRANGEMENT
PLAN & SECTIONS

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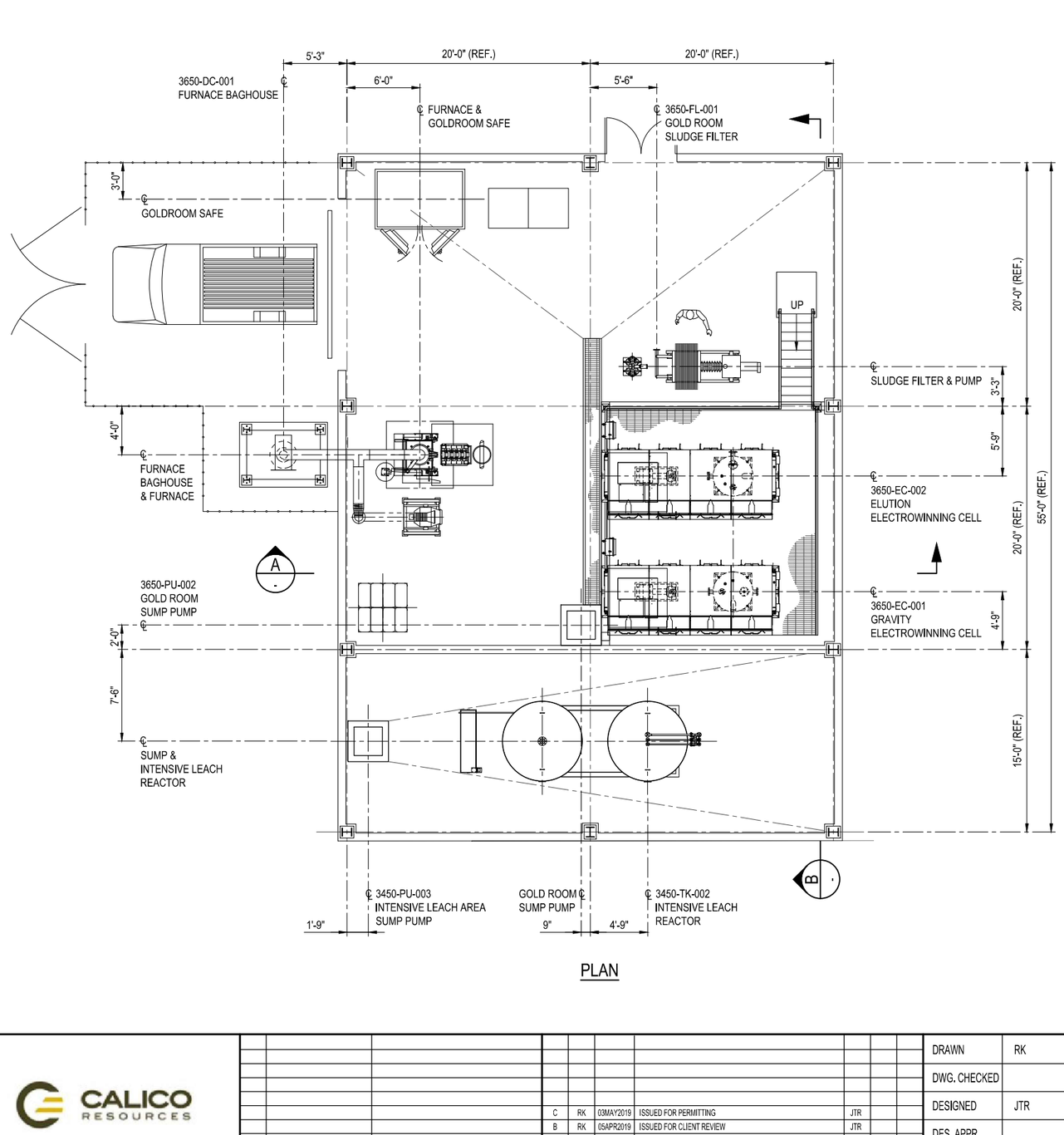
DRAWING No. 101768-0000-G-108 | REV C



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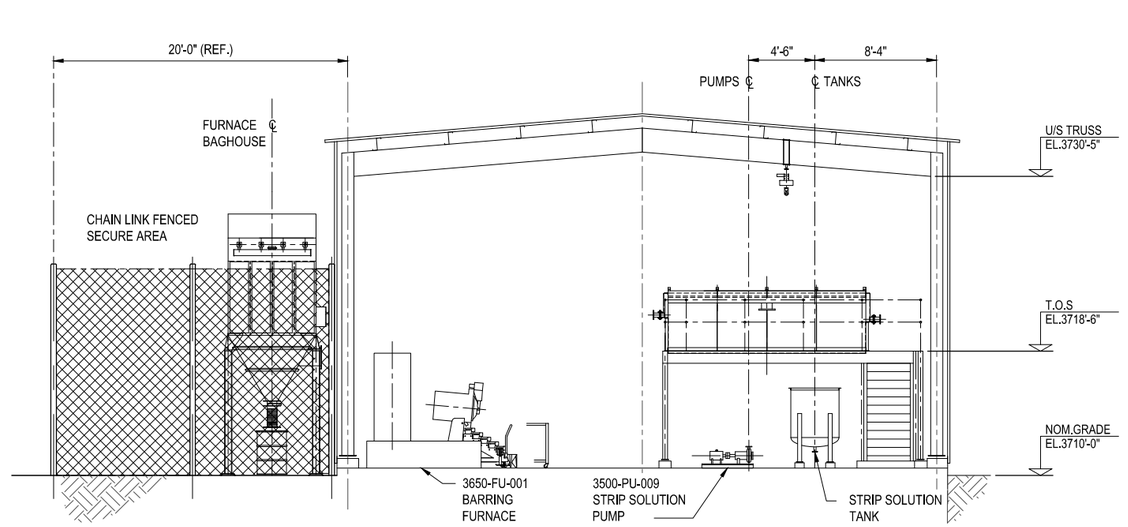

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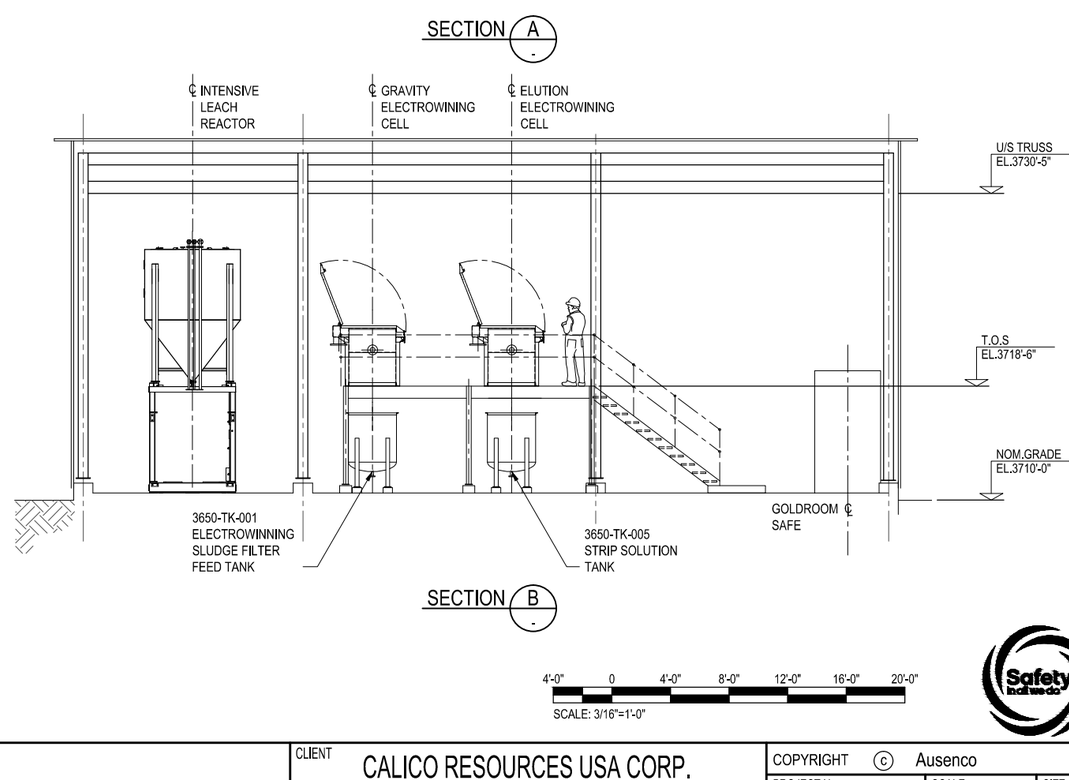

SECTION B

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SCALE: 3/16"=1'-0"

REF.	DRAWING No.	REFERENCE DRAWING	No.	BY	DATE	REVISION DETAILS	CHKD	ENG	APPR
			C	RK	03MAY2019	ISSUED FOR PERMITTING	JTR		
			B	RK	05APR2019	ISSUED FOR CLIENT REVIEW	JTR		
			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

DRAWN	RK	16NOV2018
DWG. CHECKED		
DESIGNED	JTR	16NOV2018
DES. APPR.		
PROJ. APPR.		

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CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN PROJECT
GOLDROOM AREA
GENERAL ARRANGEMENT
SECTIONS

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PROJECT No. 101768 | SCALE AS SHOWN | SIZE D

DRAWING No. 101768-0000-G-109 | REV C

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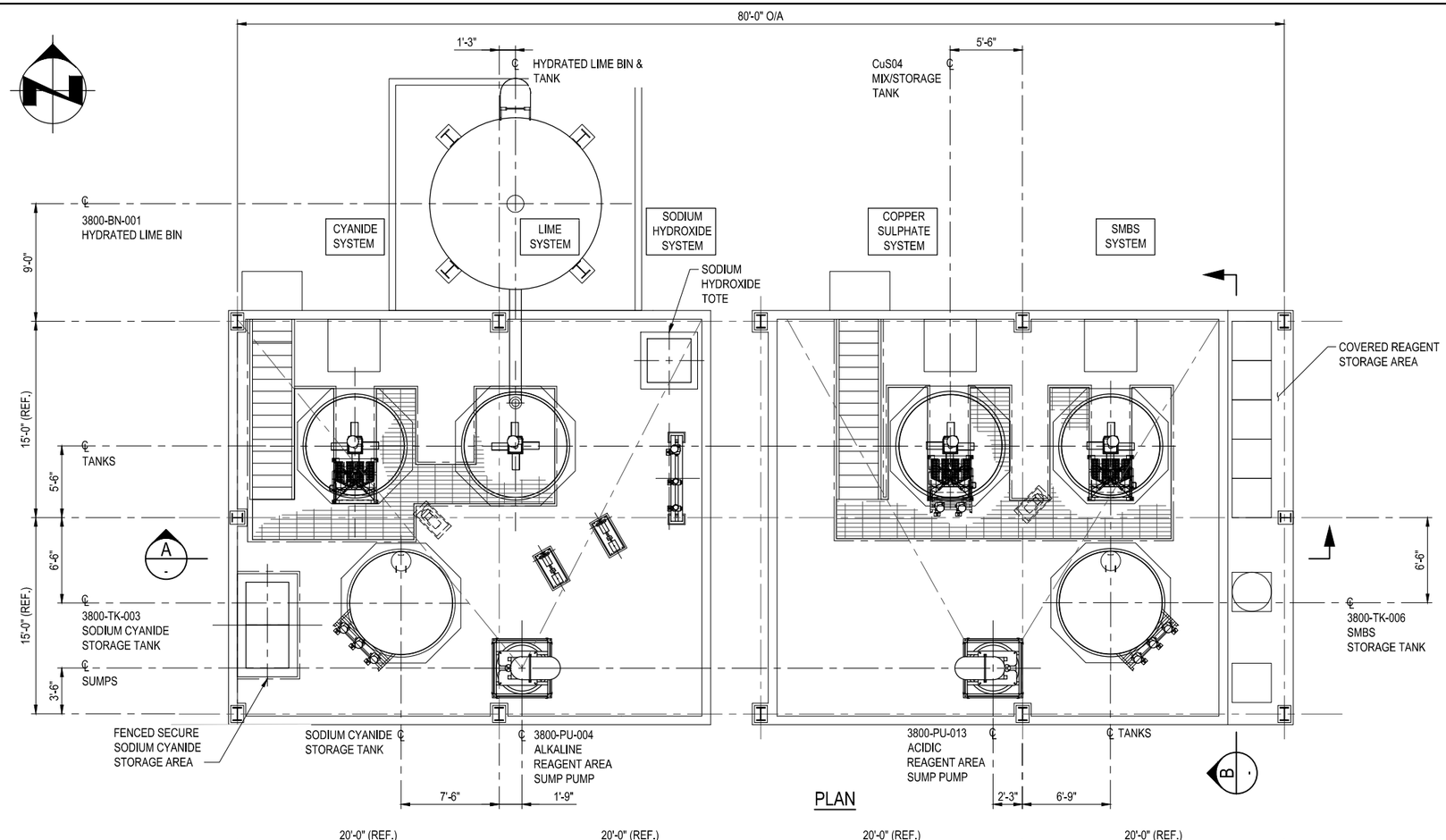

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			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

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DESIGNED	JTR	16NOV2018
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TITLE: GRASSY MOUNTAIN PROJECT
REAGENTS AREA
GENERAL ARRANGEMENT
PLAN & SECTIONS

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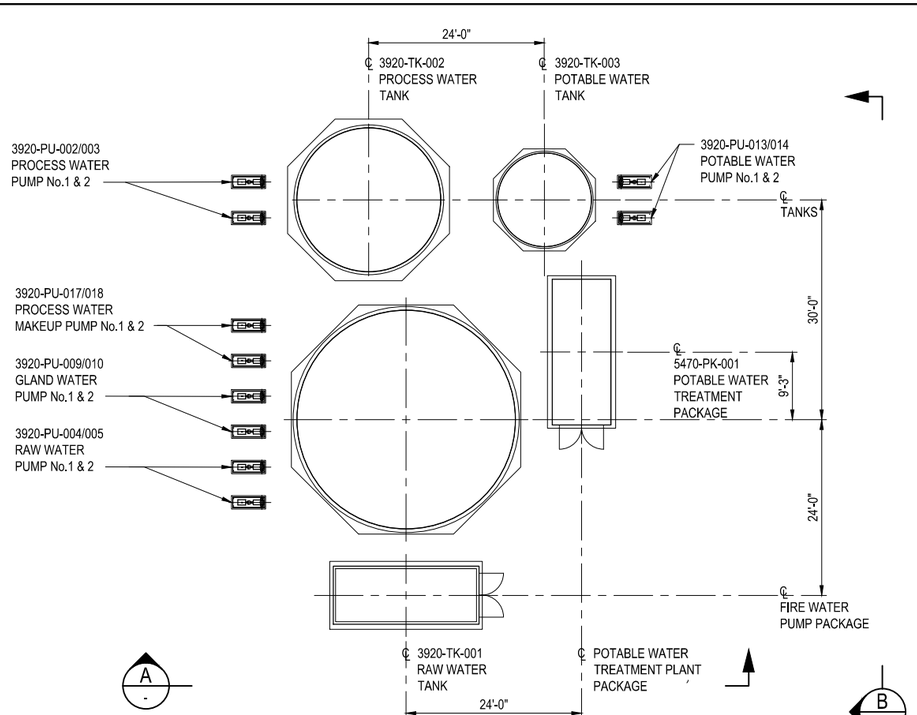
PROJECT No.	SCALE	SIZE
101768	AS SHOWN	D

DRAWING No.	REV
101768-0000-G-110	C



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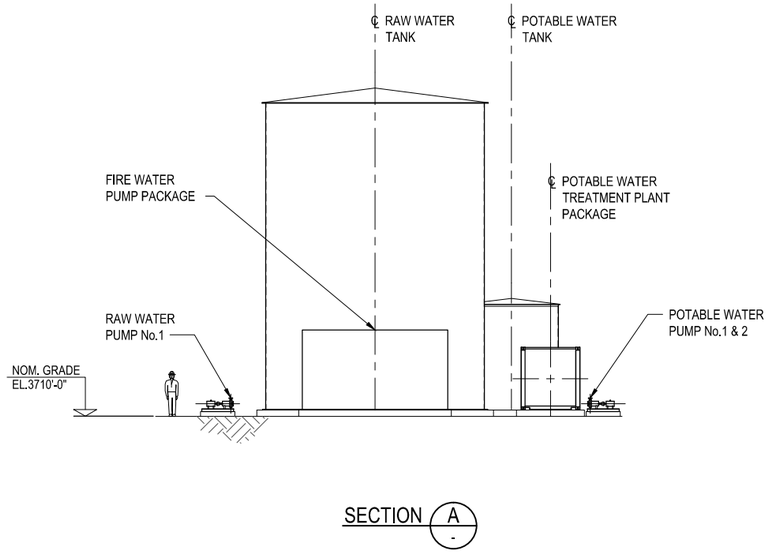
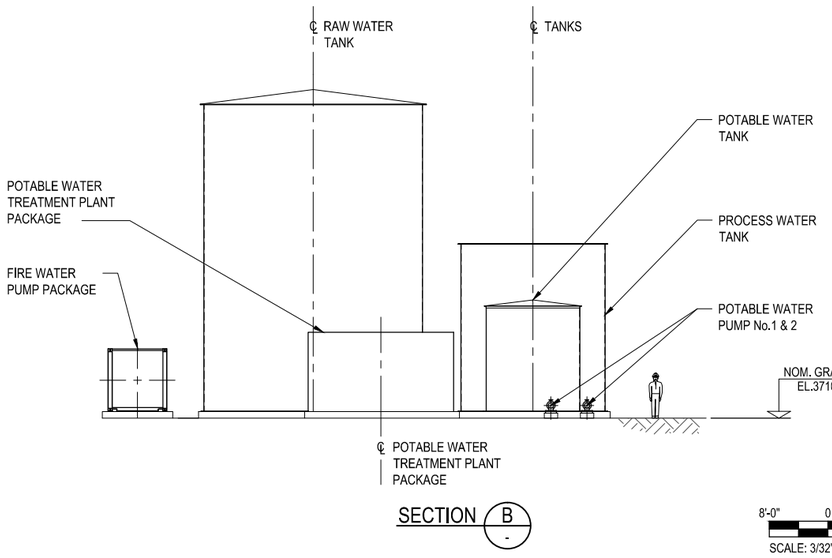


SECTION A
-



SECTION B
-

8'-0" 0 8'-0" 16'-0" 24'-0" 32'-0" 40'-0"

SCALE: 3/32"=1'-0"

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WATER SERVICES
GENERAL ARRANGEMENT
PLAN & SECTIONS

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PROJECT No.	SCALE	SIZE
101768	AS SHOWN	D

DRAWING No.	REV
101768-0000-G-111	C

Appendix D – Concrete Containment Drawings

REVIEWED AS NOTED

PETERSON STRUCTURAL ENGINEERS
9400 SW BARNES RD., SUITE 100
PORTLAND, OR 97225
PHONE: 503-292-1635

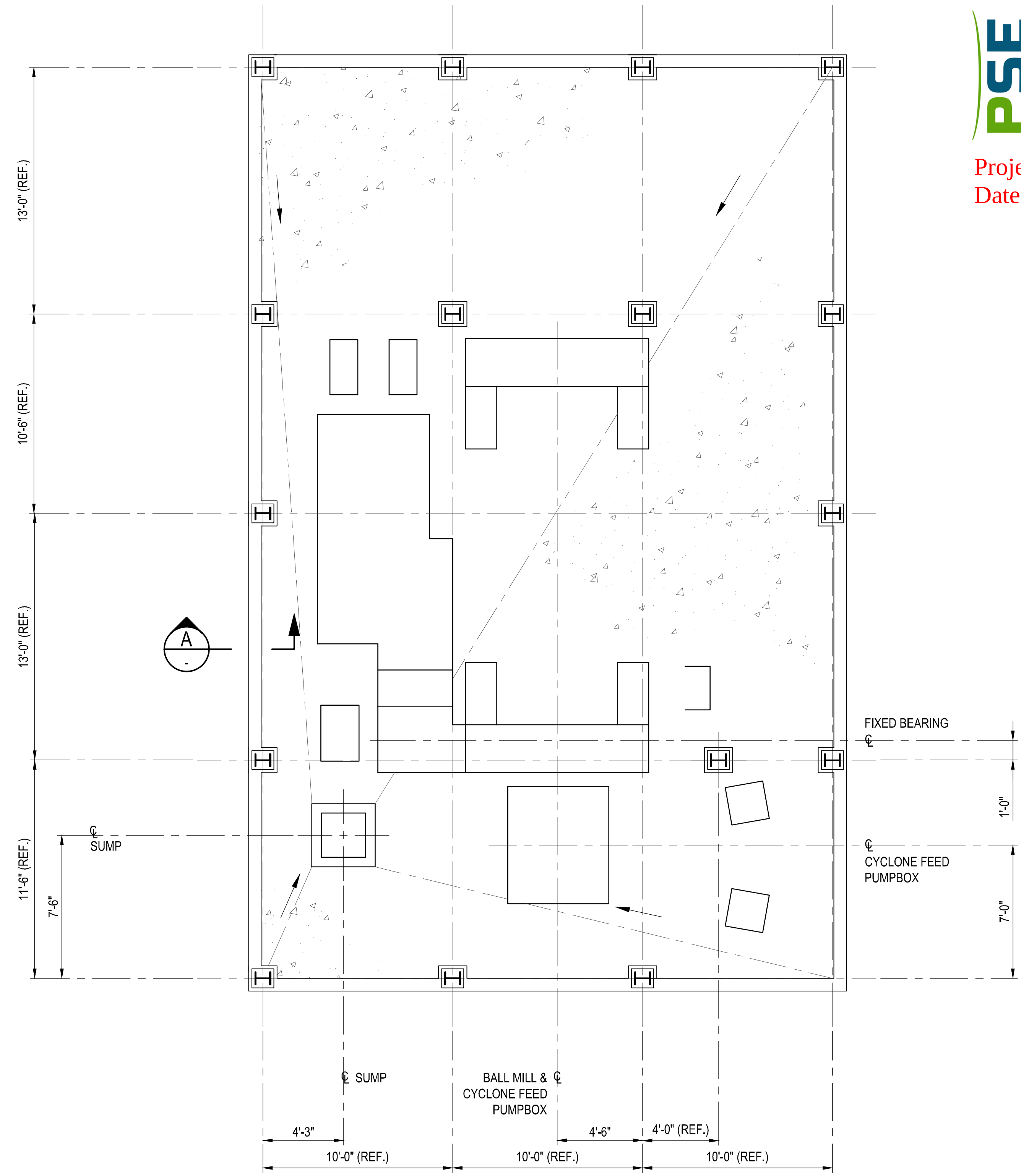
Project No.: 1901-0033
Date: 5/8/19

REGISTERED PROFESSIONAL ENGINEER
82232PE
OREGON
JAN. 15, 2015
EDWARD FON-HON LING
EXPIRES 12 / 31 / 20

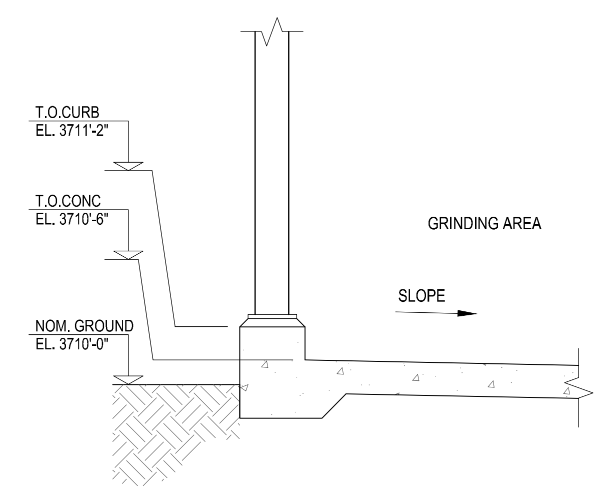
Seal applies to sizing of secondary containment volumes for compliance with International Cyanide Management Code only.

NOTES:

1. TOTAL CONTAINMENT VOLUME: 773ft³.
2. VOLUME OF LARGEST VESSEL (110%) : 493ft³.
3. DESIGN CURB HEIGHT: 8".
4. THE BUNDED AREA IS SIZED TO CONTAIN 110% OF THE LARGEST TANK VOLUME PLUS A 25 YEAR 24 HOUR STORM EVENT.
5. REFERENCE CALCULATION: 101768-0000-MX-CALC-0004.



PLAN
SCALE:1/4" =1'-0"



SECTION A
1/2"=1'-0"

SCALE: 1/2"=1'-0"

SCALE: 1/4"=1'-0"

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REF.	DRAWING No.	REFERENCE DRAWING	No.	BY	DATE	REVISION DETAILS	CHKD	ENG	APPR
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			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

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DESIGNED	JTR	16NOV2018
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GRINDING AREA
CONTAINMENT-GENERAL ARRANGEMENT

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101768	AS SHOWN	D

DRAWING No.	REV
101768-1200-C-101	C

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9400 SW BARNES RD., SUITE 100
PORTLAND, OR 97225
PHONE: 503-292-1635

Project No.: 1901-0033
Date: 5/8/19

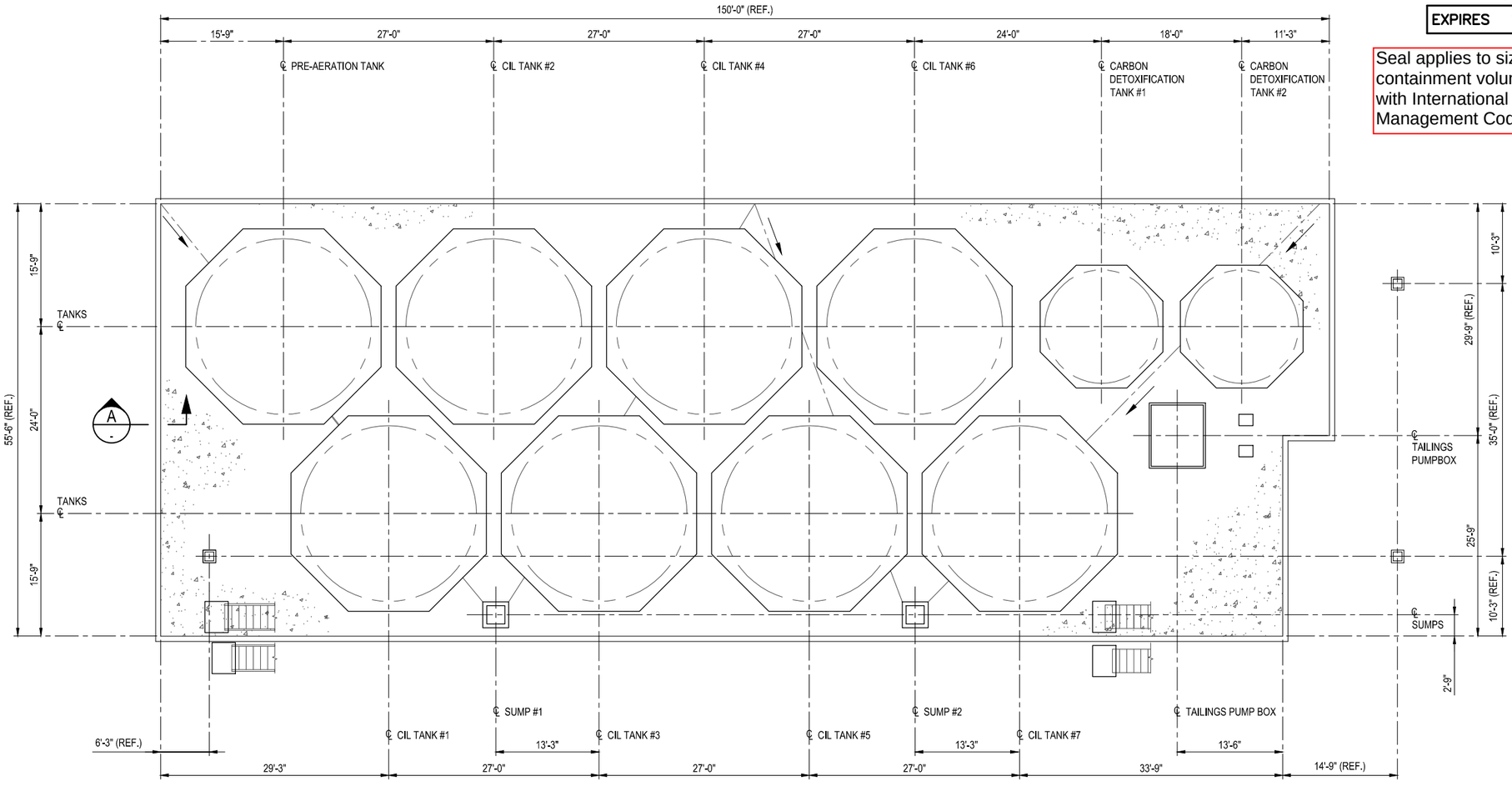
REGISTERED PROFESSIONAL ENGINEER
82232PE
OREGON
JAN. 15, 2015
EDWARD FON-HON LING

EXPIRES 12 / 31 / 20

Seal applies to sizing of secondary containment volumes for compliance with International Cyanide Management Code only.

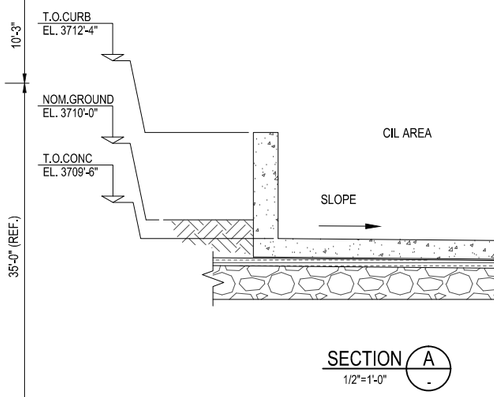
NOTES:

1. TOTAL CONTAINMENT VOLUME: 11548ft³
2. VOLUME OF LARGEST VESSEL (110%) : 10605ft³
3. DESIGN CURB HEIGHT: 34"
4. THE BUNDED AREA IS SIZED TO CONTAIN 110% OF THE LARGEST TANK VOLUME PLUS A 25 YEAR 24 HOUR STORM EVENT.
5. REFERENCE CALCULATION: 101768-0000-MX-CALC-0001



PLAN

SCALE: 1/8"=1'-0"



SECTION A
1/2"=1'-0"

1'-0" 0 2'-0" 4'-0" 6'-0" 8'-0"
SCALE: 1/2"=1'-0"

5'-0" 0 10'-0" 20'-0" 30'-0"
SCALE: 1/8"=1'-0"

Safety Inclusive

REF.	DRAWING No.	REFERENCE DRAWING	No.	BY	DATE	REVISION DETAILS	CHKD	ENG	APPR.
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			B	RK	05APR2019	ISSUED FOR CLIENT REVIEW	JTR		
			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

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DESIGNED	JTR	16NOV2018
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PROJ. APPR.		

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CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN PROJECT
PROCESS PLANT
CIL AREA
CONTAINMENT-GENERAL ARRANGEMENT

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PROJECT No. 101768 | SCALE AS SHOWN | SIZE D

DRAWING No. 101768-1200-C-102 | REV C

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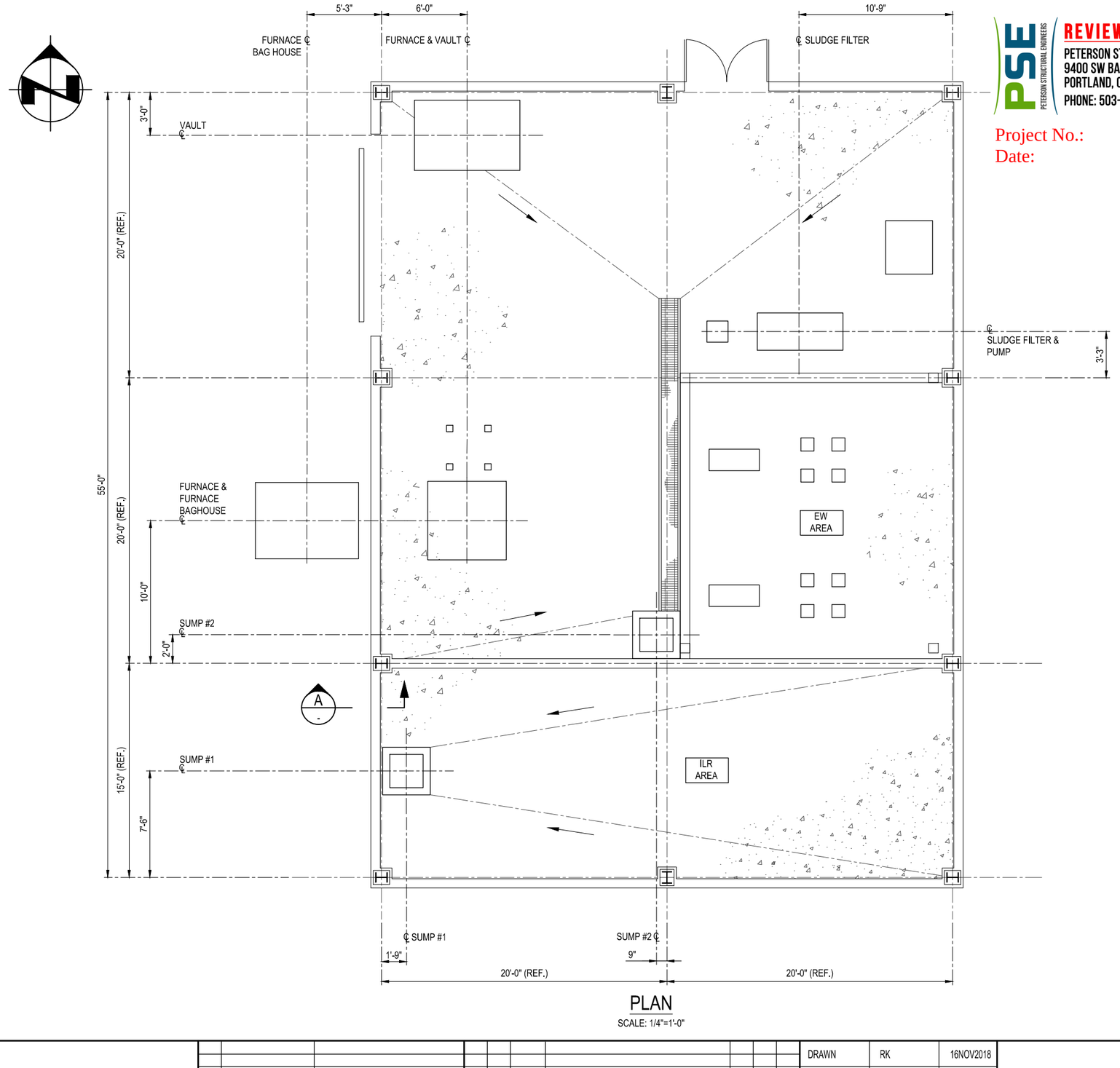


PLAN

SCALE: 1/4"=1'-0"

PSE PETERSON STRUCTURAL ENGINEERS

REVIEWED AS NOTED

PETERSON STRUCTURAL ENGINEERS
9400 SW BARNES RD., SUITE 100
PORTLAND, OR 97225
PHONE: 503-292-1635

Project No.: 1901-0033
Date: 5/7/19

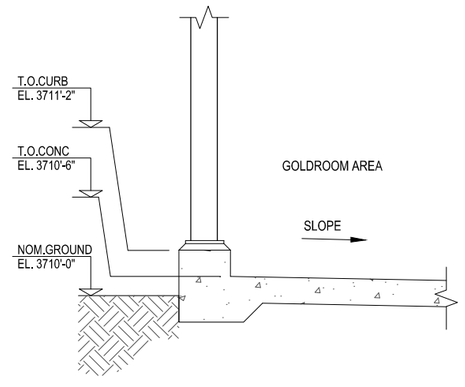
REGISTERED PROFESSIONAL ENGINEER 82232PE OREGON JAN. 15, 2015 EDWARD FON-HON LING

EXPIRES 12 / 31 / 20

Seal applies to sizing of secondary containment volumes for compliance with International Cyanide Management Code only.

NOTES:

1. TOTAL CONTAINMENT VOLUME FOR ILR AREA: 335ft³.
2. VOLUME OF LARGEST VESSEL IN ILR AREA (110%): 233ft³.
3. TOTAL CONTAINMENT VOLUME FOR EW AREA: 195ft³.
4. VOLUME OF LARGEST VESSEL IN EW AREA (110%): 30ft³.
5. DESIGN CURB HEIGHT: 8".
6. THE BUNDED AREA IS SIZED TO CONTAIN 110% OF THE LARGEST TANK VOLUME.
7. REFERENCE CALCULATION: 101768-0000-MX-CALC-0005.



SECTION A
1/2"=1'-0"

1'-0" 0 2'-0" 4'-0" 6'-0" 8'-0"
SCALE: 1/2"=1'-0"

2'-0" 0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE: 1/4"=1'-0"

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			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

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DESIGNED	JTR	16NOV2018
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CLIENT CALICO RESOURCES USA CORP.

TITLE GRASSY MOUNTAIN PROJECT
PROCESS PLANT
GOLDROOM AREA
CONTAINMENT-GENERAL ARRANGEMENT

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PROJECT No.	SCALE	SIZE
101768	AS SHOWN	D

DRAWING No.	REV
101768-1200-C-103	C

REVIEWED AS NOTED

PETERSON STRUCTURAL ENGINEERS
9400 SW BARNES RD., SUITE 100
PORTLAND, OR 97225
PHONE: 503-292-1635

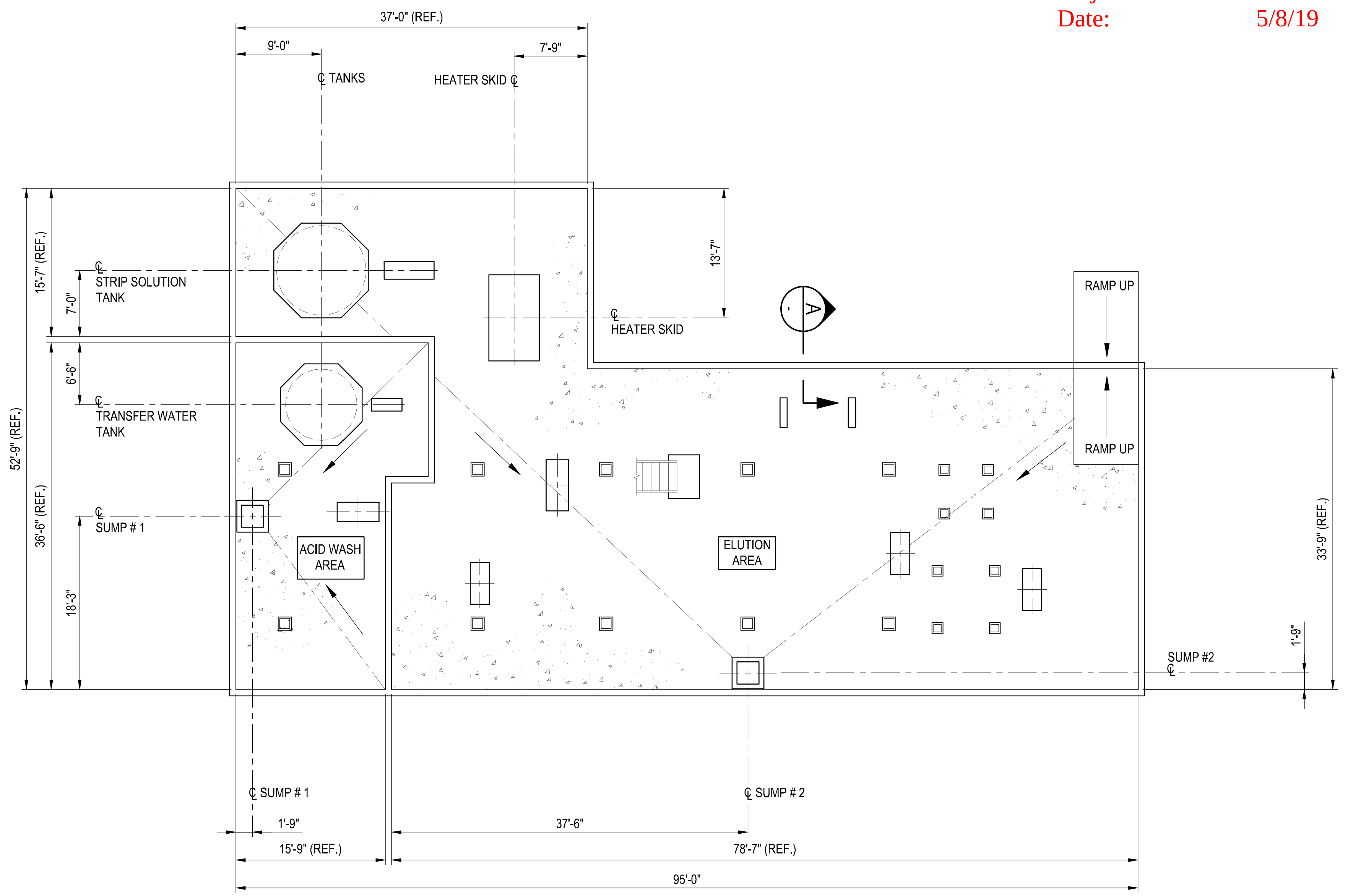
Project No.: 1901-0033
Date: 5/8/19

REGISTERED PROFESSIONAL ENGINEER 82232PE
OREGON
JAN. 15, 2015
EDWARD FON-HON LING
EXPIRES 12 / 31 / 20

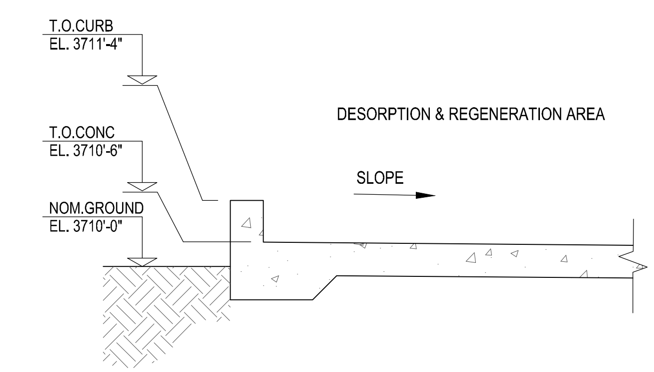
Seal applies to sizing of secondary containment volumes for compliance with International Cyanide Management Code only.

NOTES:

1. TOTAL CONTAINMENT VOLUME FOR ELUTION AREA: 2622ft³.
2. VOLUME OF LARGEST VESSEL IN ELUTION AREA (110%): 633ft³.
3. TOTAL CONTAINMENT VOLUME FOR ACID WASH AREA: 484ft³.
4. VOLUME OF LARGEST VESSEL IN ACID WASH AREA (110%): 404ft³.
5. DESIGN CURB HEIGHT: 10".
6. THE BUNDED AREA IS SIZED TO CONTAIN 110% OF THE LARGEST TANK VOLUME PLUS A 25 YEAR 24 HOUR STORM EVENT.
7. REFERENCE CALCULATION: 101768-0000-MX-CALC-0003.



PLAN
SCALE: 1/8"=1'-0"



SECTION A
1/2"=1'-0"

1'-0" 0 2'-0" 4'-0" 6'-0" 8'-0"
SCALE: 1/2"=1'-0"

5'-0" 0 10'-0" 20'-0" 30'-0"
SCALE: 1/8"=1'-0"

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			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

DRAWN	RK	16NOV2018
DWG. CHECKED		
DESIGNED	JTR	16NOV2018
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TITLE GRASSY MOUNTAIN PROJECT
PROCESS PLANT
DESORPTION & REGENERATION AREA
CONTAINMENT-GENERAL ARRANGEMENT

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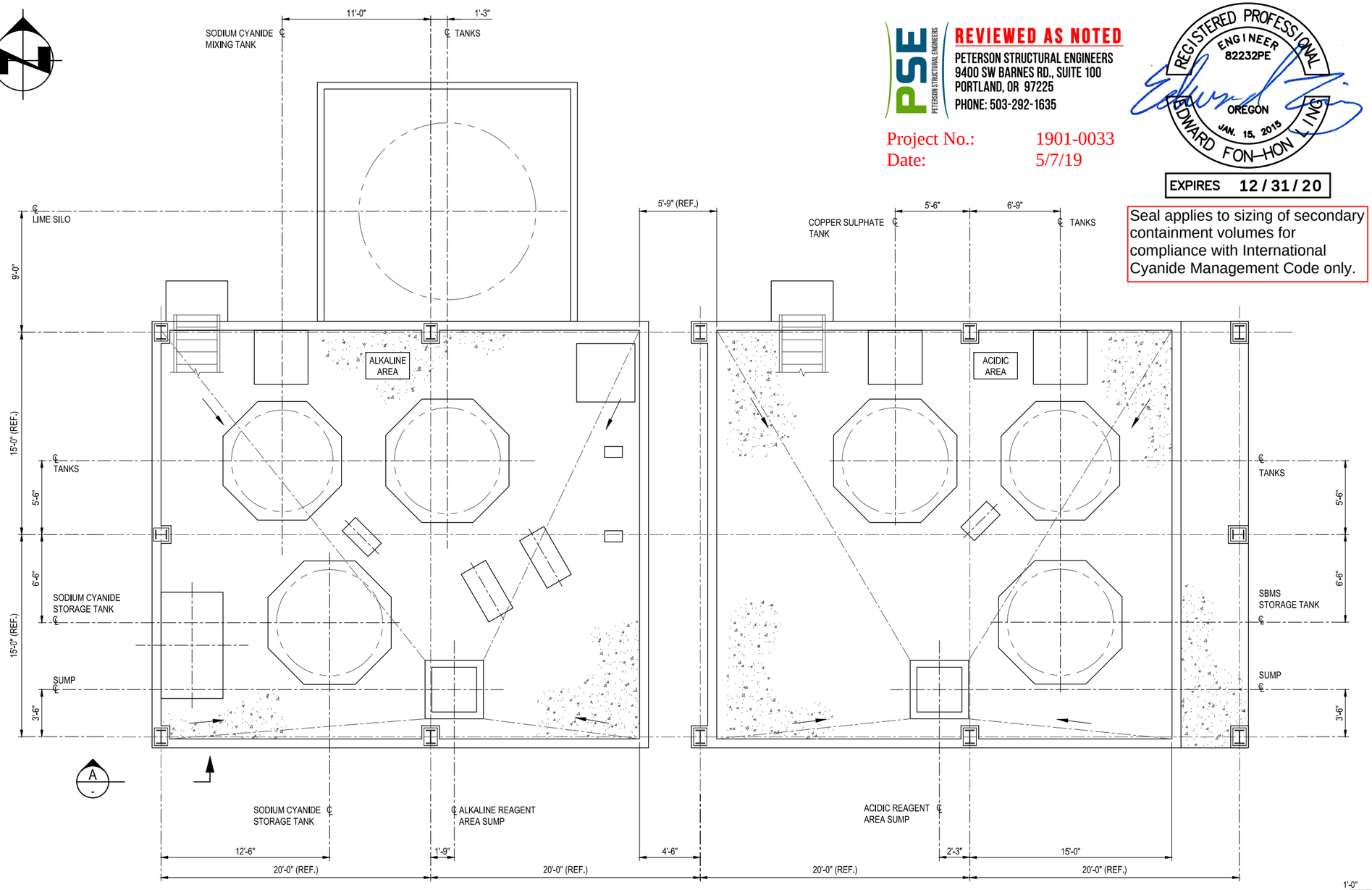
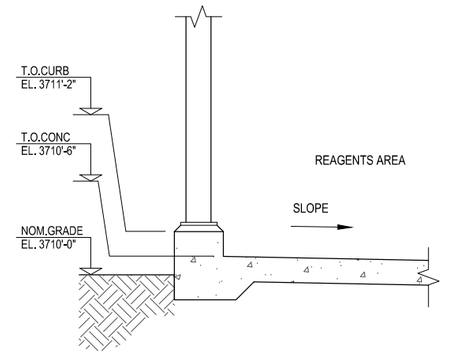
DRAWING No. 101768-1200-C-104 | REV C



PLAN

SCALE:1/4" =1'-0"



SECTION A
1/2"=1'-0"

1'-0" 0 2'-0" 4'-0" 6'-0" 8'-0"
SCALE: 1/2"=1'-0"

2'-0" 0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE: 1/4"=1'-0"

PETERSON STRUCTURAL ENGINEERS

REVIEWED AS NOTED

PETERSON STRUCTURAL ENGINEERS
9400 SW BARNES RD., SUITE 100
PORTLAND, OR 97225
PHONE: 503-292-1635

Project No.: 1901-0033
Date: 5/7/19

REGISTERED PROFESSIONAL ENGINEER 82232PE OREGON JAN. 15, 2015 EDWARD FON-HON LIN

EXPIRES 12/31/20

Seal applies to sizing of secondary containment volumes for compliance with International Cyanide Management Code only.

NOTES:

1. TOTAL CONTAINMENT VOLUME FOR ALKALINE AREA:580ft³.
2. VOLUME OF LARGEST VESSEL IN ALKALINE AREA (110%): 467ft³.
3. TOTAL CONTAINMENT VOLUME FOR ACIDIC AREA: 548ft³.
4. VOLUME OF LARGEST VESSEL IN ACIDIC AREA (110%): 467ft³.
5. DESIGN CURB HEIGHT: 8".
6. THE BUNDED AREA IS SIZED TO CONTAIN 110% OF THE LARGEST TANK VOLUME.
7. ALKALINE AND ACIDIC REAGENTS ARE STORED AND CONTAINED SEPARATELY.
8. REFERENCE CALCULATION: 101768-0000-MX-CALC-0002.

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DESIGNED	JTR	16NOV2018
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PROJ. APPR.		

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TITLE: GRASSY MOUNTAIN PROJECT
PROCESS PLANT
REAGENTS AREA
CONTAINMENT-GENERAL ARRANGEMENT

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PROJECT No.	SCALE	SIZE
101768	AS SHOWN	D

DRAWING No.	REV
101768-1200-C-105	C

PSE PETERSON STRUCTURAL ENGINEERS

REVIEWED AS NOTED

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9400 SW BARNES RD., SUITE 100
PORTLAND, OR 97225
PHONE: 503-292-1635

Project No.: 1901-0033
Date: 5/8/19

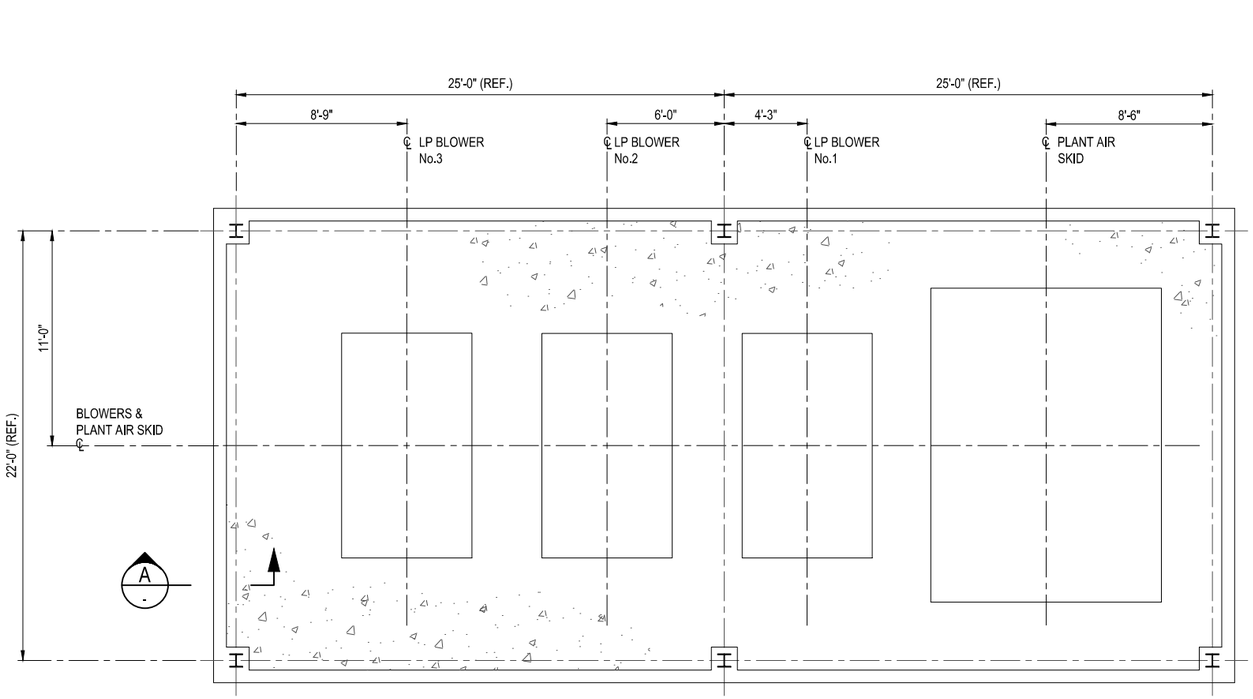
REGISTERED PROFESSIONAL ENGINEER
82232PE
OREGON
JAN. 15, 2015
EDWARD FON-HON LING

EXPIRES 12 / 31 / 20

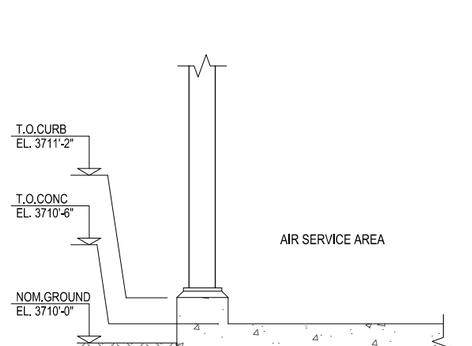
Seal applies to sizing of secondary containment volumes for compliance with International Cyanide Management Code only.

NOTES:

1. TOTAL CONTAINMENT VOLUME FOR AIR SERVICE AREA: 459ft³
2. VOLUME OF LARGEST VESSEL IN AIR SERVICE AREA (110%): THERE ARE NO TANKS IN AIR SERVICE AREA
3. DESIGN CURB HEIGHT: 8"
4. THE AIR SERVICE AREA HAS SUFFICIENT VOLUME TO CONTAIN A SINGLE 25 YEAR STORM EVENT
5. REFERENCE CALCULATION: 101768-0000-MX-CALC-0006



PLAN
SCALE: 1/4"=1'-0"



SECTION A
1/2"=1'-0"

1'-0" 0 2'-0" 4'-0" 6'-0" 8'-0"
SCALE: 1/2"=1'-0"

2'-0" 0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE: 1/4"=1'-0"

Safety is all we do

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CALICO RESOURCES

REF.	DRAWING No.	REFERENCE DRAWING	No.	BY	DATE	REVISION DETAILS	CHKD	ENG	APPR
			C	RK	03MAY2019	ISSUED FOR PERMITTING	JTR		
			B	RK	05APR2019	ISSUED FOR CLIENT REVIEW	JTR		
			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

DRAWN	RK	16NOV2018
DWG. CHECKED		
DESIGNED	JTR	16NOV2018
DES. APPR.		
PROJ. APPR.		

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Ausenco

CLIENT: CALICO RESOURCES USA CORP.

TITLE: GRASSY MOUNTAIN PRE-FEASIBILITY STUDY
PROCESS PLANT
AIR SERVICE AREA
CONTAINMENT-GENERAL ARRANGEMENT

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PROJECT No. 101768 | SCALE AS SHOWN | SIZE D

DRAWING No. 101768-1200-C-106 | REV C

PETERSON STRUCTURAL ENGINEERS

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CIL Area Containment Calculations

Grassy Mountain Mine Containment
Malheur County, OR

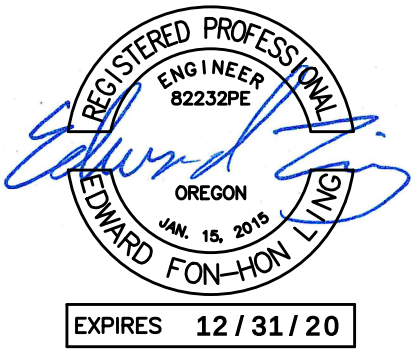
Client Information
Thomas Mills
Ausenco Minerals and Metals
Vancouver, British Columbia
Canada

Project Site
Grassy Mountain
Malheur County, OR

Scope: Review of containment volume calculations for conformance with applicable cyanide codes. Sealing of documents for volume calculations only. All other elements including construction of containment curbs are by others. Review based on tank and equipment volumes provided by client.

Review By:
Peterson Structural Engineers
May 7, 2019
Job No. 1901-0033

Endorsement



Calculation

1200 - CIL Area Containment	**Calculation No:** 101768-0000-MX-CALC-0001

Project Title:	Grassy Mountain	**Project No:**	101768-01
Area/Code:			
Equipment Description:	Containment of CIL area to cyanide code requirements		
Equipment No:			

Design Inputs	**References**
Containment Volume Requirement = 110% Volume of largest tank + one design storm event	International Cyanide Code of Practice Section 4.7
25 Yr Storm event = 31mm (1.22 inches)	Boise, Idaho - Record Rainfall - 1.22in https://www.wunderground.com/history/daily/KBOI/date/2009-5-12
Containment Area	from 101768-1200-C-102

Design Asumptions and Basis

Assumes process plant containment pond is suitably lined

Calculation Summary and Outcome

The CIL containment area will require a minimum curb height of 864mm (34 inches).

Other calculations if this calculation is revised:

Rev	Date	Description	Prepared	Checked	Approved
A	2019-03-28	Issued for Internal Review	JT	TM	
B	2019-04-11	Issued for Peer Review	JT	JTR	
C	2019-04-22	Issued for Permitting	JT	TM	

Calculation

1200 - CIL Area Containment	**Calculation No:** 101768-0000-MX-CALC-0001

Project Title:	Grassy Mountain	**Project No:**	101768-01
Rev: C			

GENERAL INPUTS			**Comments**
TANK SIZE AND VOLUME			
Leach Tank Diameter	n/a	m	no Leach Tanks
Leach Tank Plinth Diameter	n/a		
Leach Tank Height	n/a	m	
Number of Leach Tanks	n/a	No	
CIL Tank Diameter	6.9	m	
CIL Tank Plinth Diameter	7.2	m	
CIL Tank Height	7.3	m	
Number of CIL Tanks	8	No	
Detox Tank Diameter	4.7	m	
Detox Tank Plinth Diameter	4.9	m	
Detox Tank Height	5.3	m	
Number of Detox Tanks	2	No	
Volume of largest tank	273	m^3	CIL Tank
BUND DIMENSIONS			
CIL / Detox			
CIL Bund Length	45.7	m	
CIL Bund Width	16.9	m	
CIL Area for rainfall catchment	774	m^2	
CIL Tank Area	299	m^2	
Detox Tank Area	35	m^2	
CIL Area Tank Plinth Area (Divide is middle of detox tanks)	326	m^2	
Detox Area Tank Plinth Area (Divide is middle of detox tanks)	38	m^2	
Equipment Deductions	2	m^2	
Notched Area Deduction	49	m^2	SW corner of containment
CIL Containment Catchment Area below top of plinth	359	m^2	
CIL Containment Catchment Area above top of plinth	391	m^2	
Containment CALCULATION			
Bund Wall Height (from 101768-1200-C-102)	0.864	m	
CIL and Detox Average Tank Plinth height	0.35	m	
Volume below top of plinth	126	m^3	
Volume above top of plinth to Bund Wall	201	m^3	
Total Volume Designed	**327**	**m^3**	
STORMWATER			
24 Hour 25 Year Storm Event Cover	30.988	mm	1.22 in
CIL/Detox Stormwater Catchment	24	m^3	
Total Stormwater Catchment Volume	24	m^3	
CONTAINMENT REQUIRED			
110% One Largest Tank Volume + One Storm Event	**324**	**m^3**	

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Reagents Area Containment Calculations

Grassy Mountain Mine Containment
Malheur County, OR

Client Information
Thomas Mills
Ausenco Minerals and Metals
Vancouver, British Columbia
Canada

Project Site
Grassy Mountain
Malheur County, OR

Scope: Review of containment volume calculations for conformance with applicable cyanide codes. Sealing of documents for volume calculations only. All other elements including construction of containment curbs are by others. Review based on tank and equipment volumes provided by client.

Review By:
Peterson Structural Engineers
May 7, 2019
Job No. 1901-0033

Endorsement

Calculation

1200 - Reagents Area Containment	**Calculation No:** 101768-0000-MX-CALC-0002

Project Title:	Grassy Mountain	**Project No:**	101768-01
Area/Code:			
Equipment Description:	Containment of Reagents Area		
Equipment No:			

Design Inputs	**References**
Containment Volume Requirement = 110% Volume of largest tank	International Cyanide Code of Practice Section 4.7
Largest tank volume = 12 m³	101768-MEL-0001 Rev B
Containment General Arrangement	from 101768-1200-C-105

Design Assumptions and Basis

No storm containment required as this area is covered.

Calculation Summary and Outcome

The containment in the Alkaline area will require a minimum curb height of 160mm (6.3in) to satisfy the containment requirements, but has been raised to 203mm (8in) for consistency throughout the area.

The containment in the Acidic area will require a minimum curb height of 170mm (6.7in) to satifsy the containment requirements but has been raised to 203mm (8in) for consistency throughout the area.

Other calculations if this calculation is revised:

Rev	Date	Description	Prepared	Checked	Approved
A	2019-03-28	Issued for Internal Review	JT	TM	
B	2019-04-11	Issued for Peer Review	JT	JTR	
C	2019-04-22	Issued for Permitting	JT	TM	

Calculation - Alkaline Area

1200 - Reagents Area Containment	**Calculation No:** 101768-0000-MX-CALC-0002

Project Title:	Grassy Mountain	**Project No:**	101768-01		
Rev: C					
GENERAL INPUTS					**Comments**
TANK SIZE AND VOLUME					
Lime Tank Diameter			2.4	m	
Lime Tank Plinth Diameter			2.8		
Lime Tank Height			2.55	m	
Number of Lime Tanks			1	No	
CN Mix Tank Diameter			2.4	m	
CN Mix Tank Plinth Diameter			2.8	m	
CN Mix Tank Height			2.55	m	
Number of CN Mix Tanks			1	No	
CN Storage Tank Diameter			2.4	m	
CN Storage Tank Plinth Diameter			2.8		
CN Storage Tank Height			2.55	m	
Number of CN Storage Tanks			1	No	
Volume of largest tank			12	m^3	
BUND DIMENSIONS					
Alkaline Area					
Bund Length			10.8	m	
Bund Width			9.1	m	
Area for rainfall catchment			99.0	m^2	
Lime Tank Area			4.5	m^2	
CN Mix Tank Area			4.5	m^2	
CN Storage Tank Area			4.5	m^2	
Lime Area Tank Plinth Area (Divide is middle of detox tanks)			6.2	m^2	
CN Mix Area Tank Plinth Area (Divide is middle of detox tanks)			6.2	m^2	
CN Storage Area Tank Plinth Area (Divide is middle of detox tanks)			6.2	m^2	
Containment Catchment Area below top of plinth			81	m^2	
Containment Catchment Area above top of plinth			85	m^2	
CONTAINMENT CALCULATION					
Bund Wall Height (from 101768-1200-C-105)			0.203	m	
Average Tank Plinth height			0.20	m	
Volume below top of plinth			16	m^3	
Volume above top of plinth to Bund Wall			0.02	m^3	
Total Volume Designed			**16.4**	**m^3**	
STORMWATER					
24 Hour 25 Year Storm Event Cover			0	mm	
Stormwater Catchment			0	m^3	
Total Stormwater Catchment Volume			0	m^3	
CONTAINMENT REQUIRED					
110% One Largest Tank Volume			**12.7**	**m^3**	

Calculation - Acidic Area

1200 - Reagents Area Containment	**Calculation No:** 101768-0000-MX-CALC-0002

Project Title:	Grassy Mountain	**Project No:**	101768-01		
Rev: B					
GENERAL INPUTS					**Comments**
TANK SIZE AND VOLUME					
SMBS Tank Diameter			2.4	m	
SMBS Tank Plinth Diameter			2.8		
SMBS Tank Level			2.55	m	
Number of SMBS Tanks			1	No	
SMBS Mix Tank Diameter			2.3	m	
SMBS Mix Tank Plinth Diameter			2.7	m	
SMBS Mix Tank Level			2.45	m	
Number of SMBS Mix Tanks			1	No	
CuSO4 Mix/Storage Tank Diameter			2.4	m	
CuSO4 Mix/Storage Tank Plinth Diameter			2.8		
CuSO4 Mix/Storage Tank Level			2.55	m	
Number of CuSO4 Mix/Storage Tanks			1	No	
Volume of largest tank			12	m^3	
BUND DIMENSIONS					
Acidic Area					
Bund Length			10.3	m	
Bund Width			9.1	m	
Area for rainfall catchment			94.1	m^2	
SMBS Storage Tank Area			4.2	m^2	
SMBS Mix Tank Area			4.5	m^2	
CuSO4 Mix/Storage Tank Area			4.5	m^2	
SMBS Storage Area Tank Plinth Area (Divide is middle of detox tanks)			5.7	m^2	
SMBS Mix Area Tank Plinth Area (Divide is middle of detox tanks)			6.2	m^2	
CuSO4 Storage Area Tank Plinth Area (Divide is middle of detox tanks)			6.2	m^2	
Containment Catchment Area below top of plinth			76	m^2	
Containment Catchment Area above top of plinth			81	m^2	
CONTAINMENT CALCULATION					
Bund Wall Height (from 101768-1200-C-105)			0.203	m	
Average Tank Plinth height			0.20	m	
Volume below top of plinth			15	m^3	
Volume above top of plinth to Bund Wall			0.02	m^3	
Total Volume Designed			**15.5**	**m^3**	
STORMWATER					
24 Hour 25 Year Storm Event Cover			0	mm	covered containment
Stormwater Catchment			0	m^3	
Total Stormwater Catchment Volume			0	m^3	
CONTAINMENT REQUIRED					
110% One Largest Tank Volume			**12.7**	**m^3**	

PETERSON STRUCTURAL ENGINEERS

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Desorption and Regeneration Area Containment Calculations

Grassy Mountain Mine Containment
Malheur County, OR

Client Information
Thomas Mills
Ausenco Minerals and Metals
Vancouver, British Columbia
Canada

Project Site
Grassy Mountain
Malheur County, OR

Scope: Review of containment volume calculations for conformance with applicable cyanide codes. Sealing of documents for volume calculations only. All other elements including construction of containment curbs are by others. Review based on tank and equipment volumes provided by client.

Review By:
Peterson Structural Engineers
May 7, 2019
Job No. 1901-0033

Endorsement

REGISTERED PROFESSIONAL ENGINEER
82232PE
OREGON
JAN. 15, 2015
EDWARD FON-HON LING
EXPIRES 12/31/20

Calculation

1200 - Desorption and Regeneration Containment	**Calculation No:** 101768-0000-MX-CALC-0003

Project Title:	Grassy Mountain	**Project No:**	101768-01
Area/Code:			
Equipment Description:	Containment of Desorption and Regeneration Area		
Equipment No:			

Design Inputs	**References**
Containment Volume = 110% Volume of largest tank + 24hr Storm Event	International Cyanide Code of Practice Section 4.7
25 Yr Storm event = 31mm (1.22 inches)	Boise, Idaho - Record Rainfall - 1.22in https://www.wunderground.com/history/daily/KBOI/date/2009-5-12
Largest tank volume Acid Wash Area = 10 m³	101768-0000-G-108
Largest tank volume Elution Area = 16 m³	101768-0000-G-108
Containment General Arrangement	101768-1200-C-104

Design Asumptions and Basis

Calculation Summary and Outcome

The acid wash area will require a minimum curb height of 254mm (10in).

The elution area containment will require a minimum curb height of 86mm (3.4in) but will be raised to 254mm (10in) to match the curb height of the acid wash area.

Other calculations if this calculation is revised:

Rev	Date	Description	Prepared	Checked	Approved
A	2019-03-28	Issued for Internal Review	JT	TM	
B	2019-04-11	Issued for Peer Review	JT	JTR	
C	2019-04-22	Issued for Permitting	JT	TM	

Calculation - Acid Wash Area

1200 - Desorption and Regeneration Containment	**Calculation No:** 101768-0000-MX-CALC-0003

Project Title:	Grassy Mountain	**Project No:**	101768-01		
Rev: C					
GENERAL INPUTS					**Comments**
TANK SIZE AND VOLUME					
Transfer Water Tank Diameter			2.3	m	
Transfer Water Tank Plinth Diameter			2.7		
Transfer Water Tank Height			2.5	m	
Number of Transfer Water Tanks			1	No	
Acid Wash Column Tank Diameter			1.4	m	
Acid Wash Column Tank Plinth Diameter			0.0	m	no plinths
Acid Wash Column Tank Height			5.2	m	
Number of Acid Wash Column Tanks			1.0	No	
Volume of largest tank			10.4	m^3	
BUND DIMENSIONS					
Acid Wash Area					
Bund Length			11.1	m	
Bund Width			4.8	m	
Additional Bund Length			4.0	m	
Additional Bund Width			1.5	m	
Area for rainfall catchment			59.5	m^2	
Transfer Water Tank Area			4.2	m^2	
Acid Wash Column Tank Area			0.0	m^2	not mounted on ground
Transfer Water Area Tank Plinth Area (Divide is middle of detox tanks)			5.7	m^2	
Acid Wash Column Area Tank Plinth Area (Divide is middle of detox tanks)			0.0	m^2	not mounted on ground
Containment Catchment Area below top of plinth			54	m^2	
Containment Catchment Area above top of plinth			55	m^2	
CONTAINMENT CALCULATION					
Bund Wall Height (as designed)			0.254	m	
Average Tank Plinth height			0.25	m	
Volume below top of plinth			14	m^3	
Volume above top of plinth to Bund Wall			0	m^3	
Total Volume Designed			**13.7**	**m^3**	
STORMWATER					
24 Hour 25 Year Storm Event Cover			30.988	mm	
Stormwater Catchment			2	m^3	
Total Stormwater Catchment Volume			2	m^3	
CONTAINMENT REQUIRED					
110% One Largest Tank Volume + One Storm Event			**13.3**	**m^3**	

Calculation - Elution Area

1200 - Desorption and Regeneration Containment	**Calculation No:** 101768-0000-MX-CALC-0003

Project Title:	Grassy Mountain	**Project No:**	101768-01		
Rev: C					
GENERAL INPUTS					**Comments**
TANK SIZE AND VOLUME					
Strip Solution Tank Diameter			2.77	m	from GA drawing
Strip Solution Tank Plinth Diameter			3.17		
Strip Solution Tank Height			2.71	m	
Number of Strip Solution Tanks			1	No	
Elution Column Tank Diameter			1.3	m	
Elution Column Tank Plinth Diameter			0.0		no plinths
Elution Column Tank Height			4.8	m	
Number of Elution Column Tanks			1	No	
Carbon Fine Clarifier Diameter			2.4	m	
Carbon Fine Clarifier Plinth Diameter			0.0		no plinths
Carbon Fine Clarifier Height			3.5	m	
Number of Carbon Fine Clarifiers			1	No	
Volume of largest tank			16.3	m^3	
BUND DIMENSIONS					
Elution Area					
Bund Length			24.0	m	small notches between the two rectangular areas assumed to be similar and cancelled out
Bund Width			10.3	m	
Additional Bund Length			11.3	m	
Additional Bund Width			4.8	m	
Area for rainfall catchment			300.2	m^2	
Strip Solution Tank Area			0.0	m^2	
Carbon Fine Clarifier Area			0.0	m^2	not mounted on ground
Strip Solution Tank Plinth Area (Divide is middle of detox tanks)			7.9	m^2	
Elution Column Area Tank Plinth Area (Divide is middle of detox tanks)			0.0	m^2	
Containment Catchment Area below top of plinth			292	m^2	
Containment Catchment Area above top of plinth			300	m^2	
CONTAINMENT CALCULATION					
Bund Wall Height (as designed)			0.254	m	
Average Tank Plinth height			0.254	m	
Volume below top of plinth			74.25	m^3	
Volume above top of plinth to Bund Wall			0.0	m^3	
Total Volume Designed			**74.25**	**m^3**	
STORMWATER					
24 Hour 25 Year Storm Event Cover			30.988	mm	
Stormwater Catchment			9	m^3	
Total Stormwater Catchment Volume			9	m^3	
CONTAINMENT REQUIRED					
110% One Largest Tank Volume + One Storm Event			**27.2**	**m^3**	

PETERSON STRUCTURAL ENGINEERS

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Grinding Area Containment Calculations

Grassy Mountain Mine Containment
Malheur County, OR

Client Information
Thomas Mills
Ausenco Minerals and Metals
Vancouver, British Columbia
Canada

Project Site
Grassy Mountain
Malheur County, OR

Scope: Review of containment volume calculations for conformance with applicable cyanide codes. Sealing of documents for volume calculations only. All other elements including construction of containment curbs are by others. Review based on tank and equipment volumes provided by client.

Review By:
Peterson Structural Engineers
May 7, 2019
Job No. 1901-0033

Endorsement

Calculation

1200 - Grinding Area Containment	**Calculation No:** 101768-0000-MX-CALC-0004

Project Title:	Grassy Mountain	**Project No:**	101768-01
Area/Code:			
Equipment Description:	Containment of Grinding Area		
Equipment No:			

Design Inputs	**References**
Containment Volume = 110% Volume of largest tank + one design storm event	International Cyanide Code of Practice Section 4.7
25 Yr Storm event = 31mm (1.22 inches)	Boise, Idaho - Record Rainfall - 1.22in https://www.wunderground.com/history/daily/KBOI/date/2009-5-12
30% of Mill Volume - 3.2m dia x 5.25 m EGL	
Containment General Arrangement	from 101768-1200-C-101

Design Assumptions and Basis

Calculation Summary and Outcome

The grinding area will require a minimum curb height of 168mm (6.6in) to satisfy the minimum containment requirements, but has been designed with 203mm (8in) curb height for consistency throughout the plant.

Other calculations if this calculation is revised:

Rev	Date	Description	Prepared	Checked	Approved
A	2019-03-28	Issued for Internal Review	JT	TM	
B	2019-04-11	Issued for Peer Review	JT	JTR	
C	2019-04-22	Issued for Permitting	JT	TM	

Calculation

1200 - Grinding Area Containment	**Calculation No:** 101768-0000-MX-CALC-0004

Project Title:	Grassy Mountain	**Project No:**	101768-01
Rev: C			

GENERAL INPUTS			**Comments**
TANK SIZE AND VOLUME			
Volume of Grinding Mill	12.7	m^3	30% of 3.2m x 5.25m EGL
BUND DIMENSIONS			
Grinding Area			
Bund Length	14.6	m	
Bund Width	9.1	m	
Additional Bund Length	0.0	m	
Additional Bund Width	0.0	m	
Area for rainfall catchment	133.8	m^2	
Tank Area	0.0	m^2	no tanks
Deductions for other equipment	26.0	m^2	mill foundations (20m2) and cyclone feed hopper (6m2)
Tank Plinth Area (Divide is middle of detox tanks)	0.0	m^2	
Containment Catchment Area below top of plinth	0	m^2	
Containment Catchment Area above top of plinth	107.8	m^2	
CONTAINMENT CALCULATION			
Bund Wall Height (as designed)	0.203	m	
Average Tank Plinth height	0.00	m	
Volume below top of plinth	0	m^3	
Volume above top of plinth to Bund Wall	22	m^3	
Total Volume Designed	**21.9**	**m^3**	
STORMWATER			
24 Hour 25 Year Storm Event Cover	30.988	mm	
Stormwater Catchment	4	m^3	
Total Stormwater Catchment Volume	4	m^3	
CONTAINMENT REQUIRED			
110% One Largest Tank Volume + One Storm Event	**18.1**	**m^3**	

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Gold Room Containment Calculations

Grassy Mountain Mine Containment
Malheur County, OR

Client Information
Thomas Mills
Ausenco Minerals and Metals
Vancouver, British Columbia
Canada

Project Site
Grassy Mountain
Malheur County, OR

Scope: Review of containment volume calculations for conformance with applicable cyanide codes. Sealing of documents for volume calculations only. All other elements including construction of containment curbs are by others. Review based on tank and equipment volumes provided by client.

Review By:
Peterson Structural Engineers
May 7, 2019
Job No. 1901-0033

Endorsement

Calculation

1200 - Gold Room Containment	**Calculation No:** 101768-0000-MX-CALC-0005

Project Title:	Grassy Mountain	**Project No:**	101768-01
Area/Code:			
Equipment Description:	Containment of Gold Room		
Equipment No:			

Design Inputs	**References**
Containment Volume = 110% Volume of largest tank	International Cyanide Code of Practice Section 4.7
Largest Tank - ILR Area = 6m3	from 101768-0000-G-109
Largest Tank - EW Area = 0.78m3	from 101768-0000-G-109
Containment Area	from 101768-1200-C-103

Design Asumptions and Basis

Assumes process plant containment pond is suitably lined
The gold room will be covered, so therefore no requirement to design for a 25 year storm event.

Calculation Summary and Outcome

The ILR area containment requires a minimum of 140mm (5.6in) to satisfy the minimum requirements. The EW Area requires a minimum of 30mm (1.25in). The area has been designed with curb height of 203mm (8in).

Other calculations if this calculation is revised:

Rev	Date	Description	Prepared	Checked	Approved
A	2019-03-28	Issued for Internal Review	JT	TM	
B	2019-04-11	Issued for Peer Review	JT	JTR	
C	2019-04-22	Issued for Permitting	JT	TM	

Calculation - ILR Area

1200 - Gold Room Containment	**Calculation No:** 101768-0000-MX-CALC-0005

Project Title:	Grassy Mountain	**Project No:**	101768-01		
Rev: C					
GENERAL INPUTS					**Comments**
TANK SIZE AND VOLUME					
Intensive Leach Reactor Diameter			2.01	m	
Intensive Leach Reactor Plinth Length			4.27	m	
Intensive Leach Reactor Plinth Width			2.13	m	
Intensive Leach Reactor Height			1.88	m	
Number of Intensive Leach Vessels			2.00	No	
Volume of largest tank			5.98	m^3	
BUND DIMENSIONS					
ILR Tank Area					
Bund Length			12.20	m	
Bund Width			4.57	m	
Area for rainfall catchment			55.77	m^2	
ILR Plinth Area			9.11	m^2	
Total Catchment Area			46.66	m^2	ILR tanks at grade
CONTAINMENT CALCULATION					
Bund Wall Height (from 101768-1200-C-102)			0.20	m	
Average Plinth Height			0.25	m	
Volume around ILR below ILR Plinth			9.48	m^3	
Total Volume Designed			**9.48**	**m^3**	
STORMWATER					
24 Hour 25 Year Storm Event Cover			0.00	mm	area covered by a roof
CIL/Detox Stormwater Catchment			0.00	m^3	
Total Stormwater Catchment Volume			0.00	m^3	
CONTAINMENT REQUIRED					
110% One Largest Tank Volume			**6.57**	**m^3**	

Calculation - EW Area

1200 - Gold Room Containment	**Calculation No:** 101768-0000-MX-CALC-0005

Project Title:	Grassy Mountain	**Project No:**	101768-01		
Rev: C					
GENERAL INPUTS					**Comments**
TANK SIZE AND VOLUME			**N/A - old option**		
Sludge Filter Feed Tank Diameter			0.99	m	
Sludge Filter Feed Tank Plinth Diameter			0.00		no plinths
Sludge Filter Feed Tank Level			0.99	m	
Number of Sludge Filter Feed Tanks			1.00	No	
Strip Solution Tank Diameter			0.99	m	
Strip Solution Tank Plinth Diameter			0.00		no plinths
Strip Solution Tank Level			0.99	m	
Number of Strip Solution Tanks			1.00	No	
Volume of largest tank			0.76	m^3	
BUND DIMENSIONS					
EW Area					
Bund Length			6.10	m	
Bund Width			6.10	m	
Area for rainfall catchment			37.18	m^2	
Sludge Filter Feed Tank Area			0.77	m^2	
Strip Solution Tank Area			0.77	m^2	
Sludge Filter Area Tank Plinth Area (Divide is middle of detox tanks)			0.00	m^2	no plinths
Strip Solution Area Tank Plinth Area (Divide is middle of detox tanks)			0.00	m^2	no plinths
Equipment Area Deductions			10.00	m^2	
Containment Catchment Area below top of plinth			27.18	m^2	
Containment Catchment Area above top of plinth			37.18	m^2	no plinths
CONTAINMENT CALCULATION					
Bund Wall Height (from 101768-1200-C-103)			0.20	m	
Volume floor to Bund Wall			5.52	m^3	
Total Volume Designed			**5.52**	**m^3**	
STORMWATER					
24 Hour 25 Year Storm Event Cover			0.00	mm	
CIL/Detox Stormwater Catchment			0.00	m^3	
Total Stormwater Catchment Volume			0.00	m^3	
CONTAINMENT REQUIRED					
110% One Largest Tank Volume			**0.84**	**m^3**	

PETERSON STRUCTURAL ENGINEERS

PORTLAND OFFICE
9400 SW Barnes Rd.
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Portland, OR 97225
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Air Services Area Containment Calculations

Grassy Mountain Mine Containment
Malheur County, OR

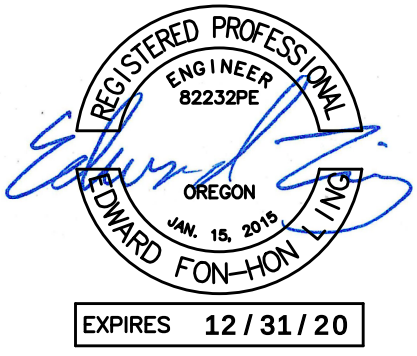
Client Information
Thomas Mills
Ausenco Minerals and Metals
Vancouver, British Columbia
Canada

Project Site
Grassy Mountain
Malheur County, OR

Scope: Review of containment volume calculations for conformance with applicable cyanide codes. Sealing of documents for volume calculations only. All other elements including construction of containment curbs are by others. Review based on tank and equipment volumes provided by client.

Review By:
Peterson Structural Engineers
May 7, 2019
Job No. 1901-0033

Endorsement



Calculation

1200 - Air Services Area Containment	**Calculation No:** 101768-0000-MX-CALC-0006

Project Title:	Grassy Mountain	**Project No:**	101768-01
Area/Code:			
Equipment Description:	Containment of Air Services Area		
Equipment No:			

Design Inputs	**References**
Containment Volume Requirement = Volume of largest tank + one design storm event	International Cyanide Code of Practice Section 4.7
25 Yr Storm event = 31mm (1.22 inches)	Boise, Idaho - Record Rainfall - 1.22in https://www.wunderground.com/history/daily/KBOI/date/2009-5-12
Containment Area	101738-1200-C-106

Design Asumptions and Basis

There are no tanks in this area.

Calculation Summary and Outcome

The air services area has sufficient volume to contain a single 25 year storm event.

Other calculations if this calculation is revised:

Rev	Date	Description	Prepared	Checked	Approved
A	2019-03-28	Issued for Internal Review	JT	TM	
B	2019-04-11	Issued for Peer Review	JT	JTR	
C	2019-04-22	Issued for Permitting	JT	TM	

Calculation

1200 - Air Services Area Containment	**Calculation No:** 101768-0000-MX-CALC-0006

Project Title:	Grassy Mountain	**Project No:**	101768-01
Rev: C			

GENERAL INPUTS			**Comments**
TANK SIZE AND VOLUME			
Tank Diameter	n/a	m	
Tank Plinth Diameter	n/a		
Tank Height	n/a	m	
Number of Tanks	n/a	No	
Volume of largest tank	n/a	m^3	no tanks in this area
BUND DIMENSIONS			
Air Service Bund Length	15.2	m	
Air Service Bund Width	6.7	m	
Air Service Area for rainfall catchment	102	m^2	
Equipment Deductions	39	m^2	3 Blowers + Air Skid
Air Service Area for containment volume	63	m^2	
Containment CALCULATION			
Bund Wall Height (from 101768-1200-C-106)	0.203	m	
Total Volume Designed	**13**	**m^3**	
STORMWATER			
24 Hour 25 Year Storm Event Cover	30.988	mm	1.22 in
Air Service Area Stormwater Volume	3.2	m^3	
CONTAINMENT REQUIRED			
One Storm Event	**3.2**	**m^3**	

Appendix E: Emergency Response Plan

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT
MALHEUR COUNTY, OREGON

EMERGENCY RESPONSE PLAN

June 2019

Submitted to

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation & Reclamation
229 Broadalbin Street SW
Albany, Oregon 97321-2246

Prepared for

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
EMERGENCY RESPONSE PLAN

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1 INTRODUCTION

This Emergency Response Plan (Plan) has been prepared in support of the Grassy Mountain Mine Project (Project) located in Malheur County, Oregon, and has been included as part of the Consolidated Permit Application.

1.1 Resource Study Area

The Project is located approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 2). The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or re-routing, and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be approximately 30 feet wide, which includes a 20-foot wide road travel width (ten feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

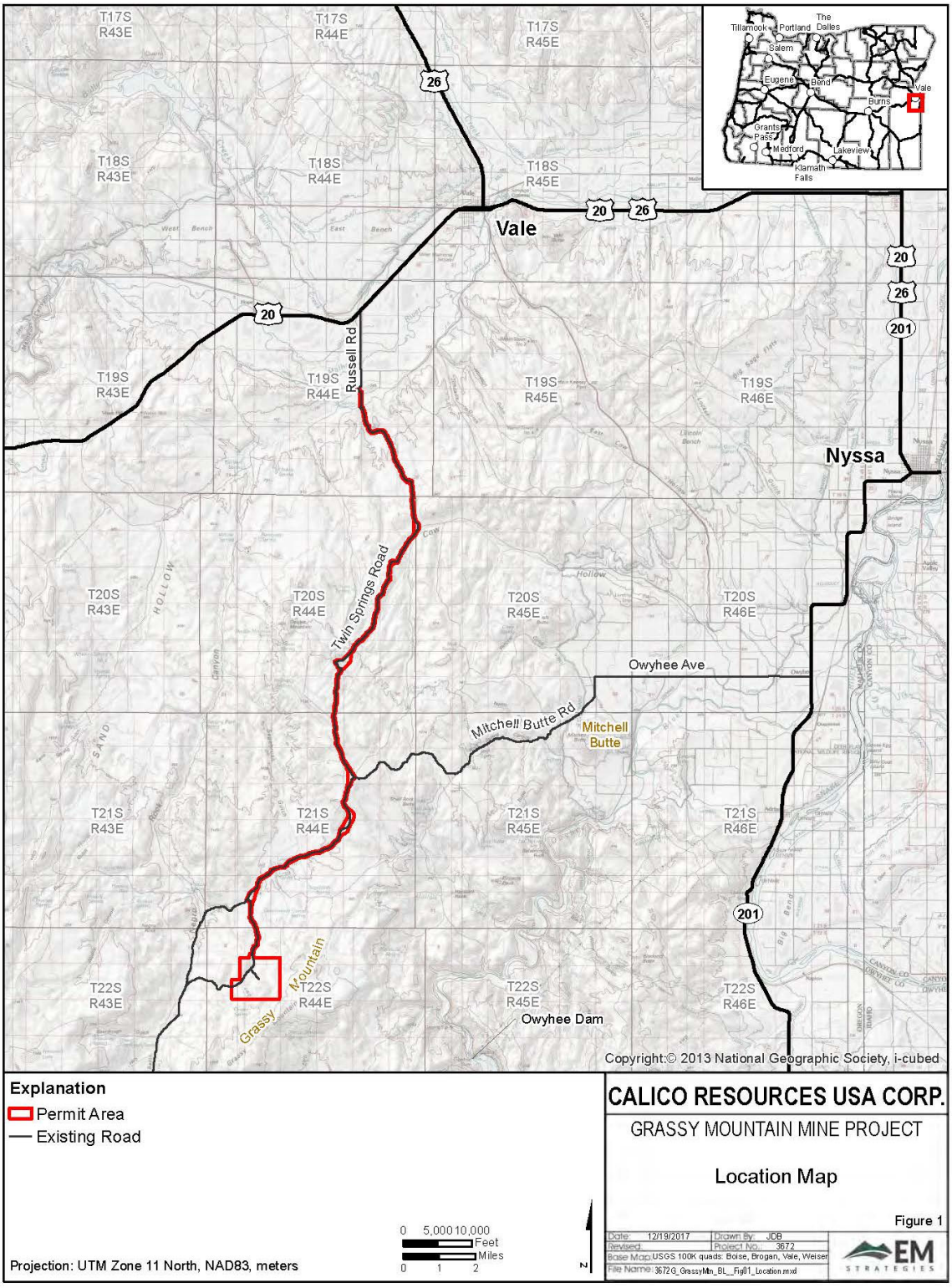

Figure 1: Location Map

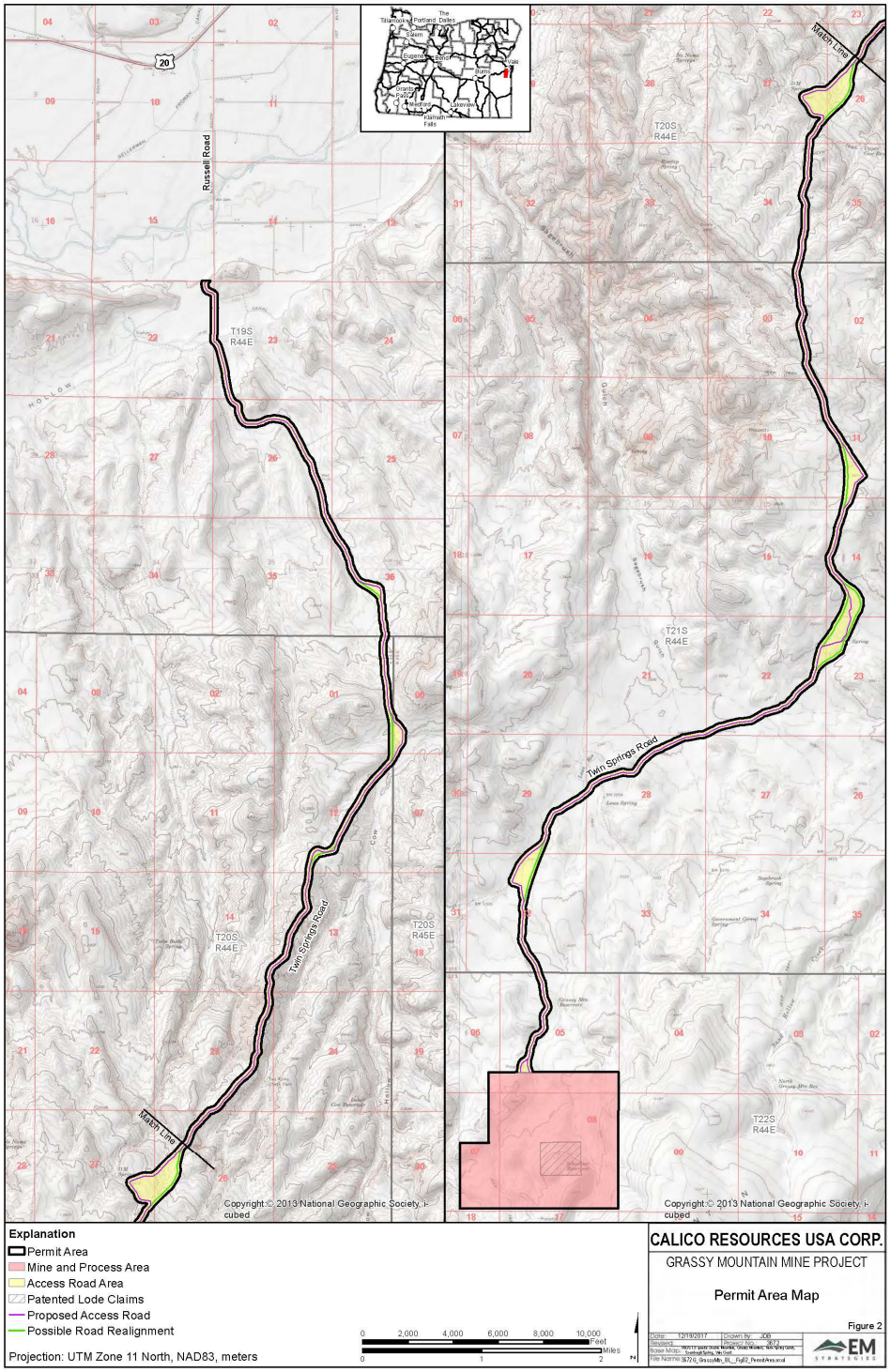

Figure 2: Permit Area Map

2 PLAN PURPOSE

The purpose of this Plan is to establish responsibilities and guidelines for actions to be taken by mine personnel in the event of a process fluid spill at the mine. These guidelines are intended to assist personnel and responsible parties in making timely decisions and taking positive actions toward a successful resolution of the problem. In addition, this plan has been prepared in support of the application for a new Water Pollution Control Facility (WPCF) Permit for the Project.

This Plan identifies potential sources of process fluid spills, establishes measures of prevention, and defines control, cleanup, and reporting procedures, including instructions for what should be done in the event of a hazardous material spill, petroleum release, or natural disaster.

This Plan does not currently provide the names and contact numbers of site-specific personnel, as they have not been finalized. However, this will be done by the time operations begin and Calico will revise this document to reflect the complete information.

The objectives of this Plan are to:

1. Reduce the potential for accidental spills and environmental degradation by taking precautionary measures and being prepared for potential emergencies;
2. Provide the operating facility with the necessary information to properly respond to a hazardous material emergency;
3. Define personnel roles for emergencies involving hazardous conditions; and
4. Include a self-audit program to ensure that the Plan and related response activities meet environmental protection objectives.

2.1 Plan Review

This is a preliminary version of the Plan. As the Project proceeds and final information concerning permit requirements, construction, operations, and site personnel is developed, the Plan will be revised prior to Project commissioning.

This Plan will be reviewed and updated on a regular basis during operations to ensure it remains applicable to the hazards associated with the operation and the responsible parties who will be assigned to respond to a spill. Modifications or changes should be made at any time if conditions pertaining to this Plan change at the site.

3 PROJECT DESCRIPTION

3.1 Project Activities

Calico Resources USA Corp (Calico) plans to construct, operate, reclaim, and close an underground mining and precious metal milling operation. In general, the proposed mining and precious metal processing operations will consist of an underground mine and ore processing facilities, including a conventional mill and tailings storage facility (TSF) and a waste rock storage

area (WRSA), as well as other support facilities. The Project will include the following major components:

- One underground mine;
- One WRSA;
- One carbon-in-leach (CIL) processing plant;
- One borrow pit area;
- One TSF;
- Run-of-mine ore stockpile;
- One reclaim pond;
- A water supply well field and pipeline, associated water delivery pipelines, and power;
- A power substation and distribution system;
- One ventilation shaft;
- Access and haul roads;
- Ancillary facilities that include the following: haul, secondary, and exploration roads; truck workshop; warehouse; stormwater diversions; sediment control basins; reagent and fuel storage; storage and laydown yards; explosive magazines; fresh water storage; monitoring wells; meteorological station; an administration/security building; borrow areas; growth media stockpiles; a landfill; and solid and hazardous waste management facilities to manage wastes; and
- Reclamation and closure, including the potential development of an evaporation cell for the TSF.

3.2 Chemical Use

Calico will transport, store, and use a variety of fuels and reagents for operation of the Project. A summary of these materials is provided in Table 3-1. These fuels and reagents will be transported, used, and stored in accordance with applicable federal, state, and local regulations and guidelines, including the United States Department of Transportation, Oregon Department of Transportation, Bureau of Alcohol, Tobacco, Firearms and Explosives, Department of Homeland Security, and Mine Safety and Health Administration (MSHA). The on-site storage containerization and units may vary according to vendor availability.

Table 1: Fuels and Reagents Volumes and Shipments

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Mill Ore Processing				
Sodium Cyanide – Mixed to 25% Sodium Cyanide (NaCN)	10,000 gal	10,000 gal		1
Lime - Dry pebble at 90% Calcium Oxide (CaO)	25-ton truckload	100-ton silo	30 tons/day	4

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Anti-Scalant (liquid surfactant)	240 lb carboy	2 carboys	30 lbs/day	
Carbon Acid Wash & Neutralization				
Hydrochloric Acid (HCL) - Liquid 30%	HDPE totes	3,000 gal	10 lbs/day	7
Acid Wash Vessel	2,320 working gal			
Acid Mix Tank	282 working gal			
Caustic Soda - Sodium Hydroxide (NaOH) - Liquid	4,887 working gal	5,000 gal	5 lbs/day	7
Fluxes				
Borax (pentahydrats) - Dry	50 lb sacks	20 sacks	20 lbs/day	*
Silica (SiO2) - Dry	50 lb sacks	10 sacks	10 lbs/day	
Niter (NaNO3) - Dry	50 lb sacks	5 sacks		
Feldspar - Dry	50 lb sacks	5 sacks		
Mercury Control				
Sulfide-impregnated Carbon - Dry	50 lb sacks	40 sacks	25 lbs/day	*
Mercury Recovered				
Mercury	80 lb flask		5 lbs/day	*
Electrolytes				
Sodium Hydroxide (NaOH) – Dry	20 lb sacks	10 sacks	15 lbs/day	*
Assay and Met Lab				
Sulfuric Acid (H_2SO_4) Reagent Grade	1 gal	6 gal		
Nitric Acid (HNO_3) Reagent Grade	1 gal	10 gal	1lb/day	
Hydrofluoric Acid (HFI) Reagent Grade	1 gal	2 gal		
Hydrochloric Acid (HCL) Reagent Grade	1 gal	4 gal		
NaCN Reagent Grade – Dry	5 lb box	10 boxes	1 lb/ day	*
Buffer Solution Reagent Grade - Dry	5 lb box	10 boxes		
Lead Nitrate ($PbNO_3$)- Dry	20 lb bag	1 bag		
Acetylene	Size 45 industrial Acetylene Cylinder	3 in lab/15 in shop	2 cylinders per week	
Fluxes				
Borax Penta - Use Plant Source			18 lbs/day	*
Silica - Use Plant Source				
Lead Oxide - Reagent Grade	80 lb pail	1 pail	2 lbs/day	*

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Methyl Ethyl Ketone (MEK)	5 gal pail	1 pail		
Silver Inquart	10 lb package	1 pkg		
Fuel/Lube/Oil				
Diesel- Truck Shop	30,000 gal	Up to 30,000 gal	6,000 gal/day	1
Ammonium Nitrate/Fuel Oil (ANFO)	60 ton silo	Up to 60 tons	8 tons/day	
Gasoline	10,000 gal	Up to 10,000 gal	250 gal/day	
30WT Motor Oil	4,000 gal	Up to 4,000 gal	15-20 gal/day	
Used Motor Oil	4,000 gal	Up to 4,000 gal	15-20 gal/day	
Antifreeze	2,000 gal	Up to 2,000 gal	1-15 gal/day	
Hydraulic Fluid	2,000 gal	Up to 2,000 gal	10-15 gal/day	
90WT Gear Lube	2,000 gal	Up to 2,000 gal	10-15 gal/day	
Waste Antifreeze	2,000 gal	Up to 2,000 gal	10-15 gal/day	
Grease bins	4 x 120 gallon totes, 4 x 30 gallon drums	Up to 4 totes, up to 4 drums	5-10 gal/day	

lb = pound
gal = gallons

3.3 Organization and Personnel

The Project will be operated by Calico. Key site personnel and their respective classifications are summarized in Table 3-2. The primary contact for the project is the General Manager.

Table 2: Facility Personnel Summary

Personnel Classification	Name
General Manager	To Be Determined
Mine Superintendent	To Be Determined
Process Superintendent	To Be Determined
Maintenance Superintendent	To Be Determined
Environmental Manager	To Be Determined
Safety Officer	To Be Determined

4 SPILL PREVENTION

4.1 Inspections

Tanks, pipelines, and process components will be inspected for leaks and/or damage on a routine basis. Employees, contractors, and other workers on site will be instructed to immediately report leaks and damage to the working supervisor and the Environmental Department for assessment. The working supervisor will be responsible for scheduling and implementing necessary repairs as soon as possible. If a discharge has occurred or will occur, the working supervisor will inform the Environmental Department, in writing, of the intended schedule and manner of repair.

4.2 Transfer of Petroleum Products

Employees, contractors, and other workers responsible for the transfer of petroleum products are required to remain at the fill point until fill procedures are completed and the transfer line is placed back in the proper storage location. Spillage will be reported to the maintenance supervisor and the Environmental Department, and cleanup will be scheduled and implemented.

4.3 Preventive Maintenance

Preventive maintenance will be performed to maintain the integrity of the systems. Faulty valves, joints, elbows, and other fixtures or fittings that could result in the release of possible contaminants outside a containment structure will be repaired or replaced immediately upon identification.

4.4 Spill Containment Structures

Hydrocarbon products, including lubricants, oils, antifreeze, and used oil will be stored at the truck workshop (Figure 3). Reagents will be transported, stored, and used in accordance with federal, state, and local regulations. Diesel fuel and hydrocarbon products will be stored in primary (tanks, tote bins, barrels) and secondary containment to prevent release to the environment. Spill containment will be designed for 110 percent of the largest tank or tanker within the containment.

5 EMERGENCY PREPAREDNESS

5.1 Personal Protective Equipment

Mine and process personnel will be required to wear personal protective equipment (PPE), including hardhats, steel-toed and steel-shanked boots, leather gloves, eye protection, safety vests, and hearing protection (where necessary), as required by MSHA. Process personnel will also be provided with chemical-resistant gloves, aprons, coats, pants, face shields, and dust masks or air-purifying respirators, depending on the particular task being performed at a given time. Eye wash stations will be placed at all locations where hazardous chemicals are stored.

5.2 First Aid

A first aid clinic will be housed in the administration and security offices. First aid kits will be maintained in the administration building, security office, maintenance shop and warehouse, assay laboratory, and process building, in addition to vehicles and heavy equipment as required by MSHA. Personnel will be trained and certified in CPR (cardiopulmonary resuscitation) and basic first aid on an annual basis.

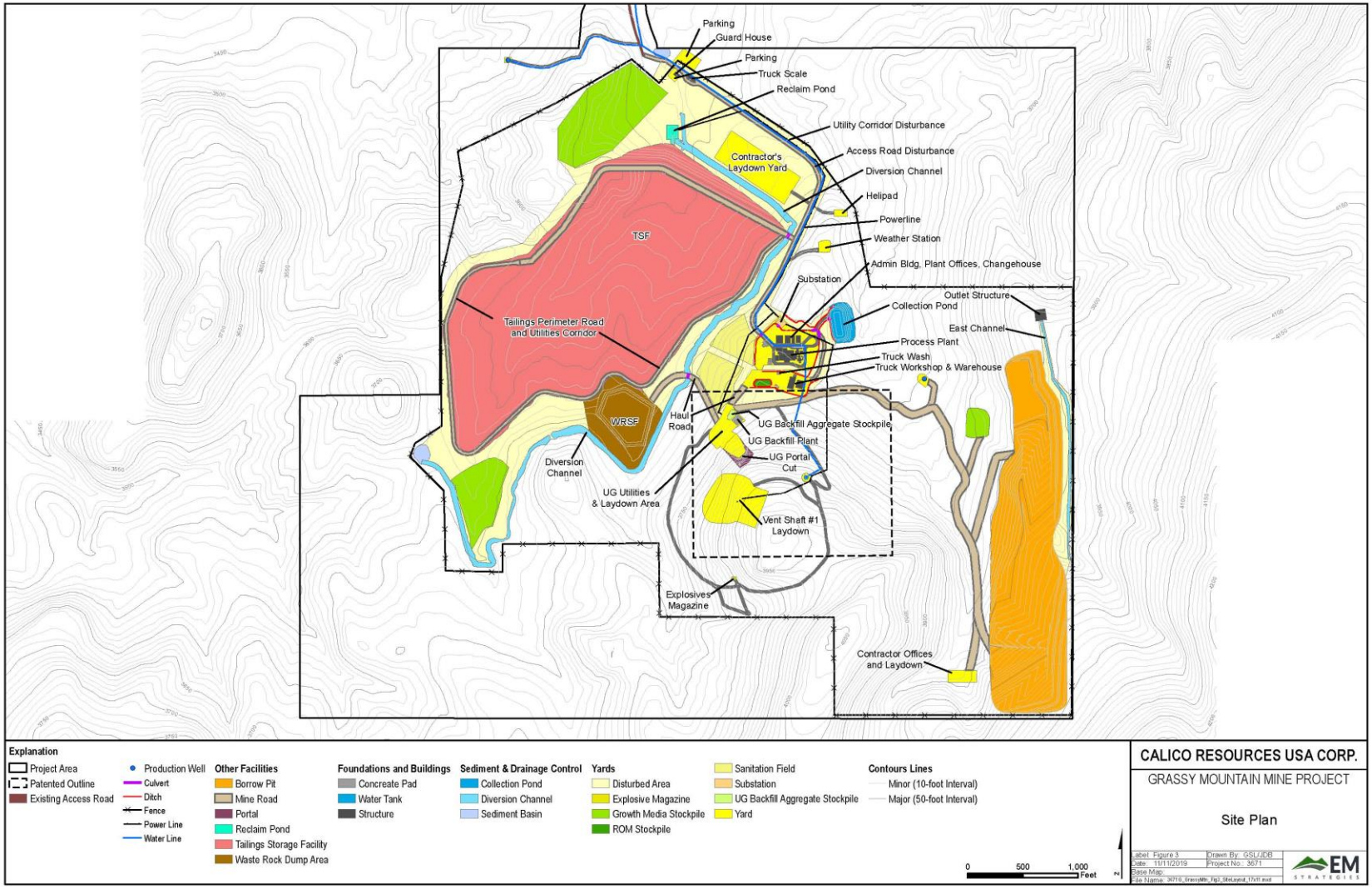

Figure 3. Site Layout Map

5.3 Fire Extinguishers

Fire extinguishers will be placed in buildings, equipment storage yards, vehicles, and heavy equipment, as required by MSHA. Fire extinguishers will be of the type required to address the reasonably anticipated class of fire at a given location. Fire extinguishers will be serviced regularly to ensure their proper functioning.

Locations and proper use of fire extinguishers will be reviewed with personnel on an annual basis, at a minimum, and upon assignment for new personnel.

5.4 Additional Fire Suppression Measures

Water for fire protection will be distributed from the fire water tank located on Grassy Mountain via a network of piping and will be maintained under a constant pressure with a jockey pump. The piping will be looped and sectionalized to minimize loss of fire protection during maintenance. Where located outside buildings, fire water piping will be buried below the ground surface to eliminate the potential of pipes freezing.

Yard hydrants will be limited to the fuel storage tank area. Wall hydrants will be used in lieu of yard hydrants and will be located on the outside walls of the buildings in cabinets that will be heated during winter months.

Fire protection within buildings will include standpipe systems, sprinkler systems, and portable fire extinguishers. Standpipe systems will be provided in all structures that exceed 46 feet in height, as well as where required by building code, local authorities, or the insurance underwriter.

Sprinklers will be provided at the following locations or to protect the following items: truck workshop; assay laboratory; over hydraulic or lube packs that contain more than 120 gallons of fluid; lube-storage rooms; any conveyor belts that are within tunnels or other enclosed spaces which would be hazardous to fight fires manually; transformers; and warehouse.

5.5 Hazardous Materials Identification

A variety of chemicals and reagents will be used in the mining and ore processing activities at the mine. Hazardous materials are defined by 49 Code of Federal Regulations (CFR) 172 according to the following characteristics:

- Toxicity;
- Explosive properties;
- Corrosiveness;
- Flammability;
- Oxidizing properties; and
- Potential for violent or chemical reaction when mixed.

Safety Data Sheets (SDS) for hazardous materials used in mine operations will be maintained in strategic locations at the mine. The SDS provide relevant information on physical characteristics, hazardous reactivity, fire and explosion data, and health hazard information, including safety precautions, first aid, and medical treatment.

Tanks and other containers will be clearly labeled as to their contents.

5.6 Hazardous Material Spill Prevention and Countermeasures

A variety of hazardous materials will be used at various locations at the mine and process facilities. They will be stored at the most efficient location according to their place of use. Small quantities of chemicals will be stored in secure, fire-proof cabinets adjacent to the area of their use. ln areas where corrosive materials are stored or used, the concrete floor will be covered with an impermeable compound, resistant to corrosive chemicals. Only chemical groups compatible with one another may be stored together. Incompatible materials will not be stored in proximity to one another (i.e., same room or cabinet).

A fuel storage depot will be located near the Processing Facilities (Figure 3). It will include separate diesel above-ground tanks for fueling of light/intermediate and heavy vehicles. Gasoline will also be stored in an above-ground tank in the fuel storage depot at the contractor yard. Spill containment will be designed for 110 percent of the largest tank or tanker within the containment. Camlock fittings or other appropriate fittings will be located within the containment to collect any spilled fuels. A sump will be located at one end of the containment so that any spilled fuels can be pumped for appropriate disposal from the containment using a portable pump.

Hydrocarbon products, including lubricants, oils, antifreeze, and used oil will be stored at the truck workshop (Figure 3). Reagents will be transported, stored, and used in accordance with federal, state, and local regulations. Diesel fuel and hydrocarbon products will be stored in primary (tanks, tote bins, barrels) and secondary containment to prevent release to the environment.

Spill containment and cleanup equipment maintained at strategic locations throughout the mine include the following:

- Oil absorbent rolls;
- Oil absorbent pads;
- Oil absorbent booms;
- Oil absorbent pillows;
- Spill kits;
- Backhoe or excavator;
- Motor graders; and
- Bulldozers.

If the spill is of significant size and/or duration, special cleanup efforts such as those provided by environmental contractors will be used as necessary.

5.7 Fluid Management System

Calico will adhere to a Fluid Management Plan (FMP) and Monitoring Plan developed for the WPCF Permit Application. The FMP will describe the containment and monitoring of process solutions, and will address components associated with process solutions, including the CIL plant and reclaim ponds. Response and reporting requirements specific to the process solution will be addressed in the FMP. The FMP will be updated periodically to incorporate improvements identified during implementation.

5.8 Communications System

On-site communications will comprise of inter-connected mobile and fixed systems, including a land-line or cable telephone network, portable two-way radios, and internet. Access for internet and corporate network connections will be made via satellite connections or a cable line.

The primary means of communication between the underground and the surface will be via a leaky-feeder very high frequency radio system.

5.9 Alarm System

A fire alarm system will be installed in the following surface facilities (per MSHA regulations 30 CFR 57.4330): administrative/security building; truck workshop; warehouse; assay laboratory; and CIL process building. A fire alarm system will be provided and maintained in operating condition in the underground mine area, per MSHA regulations 30 CFR 57.4360. These systems will be used to initiate evacuations and alert personnel of emergency situations.

5.10 Evacuation Plans

Evacuation plans will be developed for structures including the administrative/security building, truck workshop, warehouse, assay laboratory, CIL process building, and other structures that might require evacuation during an emergency. Evacuation plans will outline the procedures that should be followed in the event of a fire or other emergency requiring evacuation and will define the responsibilities of key personnel. Evacuation maps showing suggested evacuation locations and emergency response routes will be posted at appropriate locations throughout the Project site.

Two emergency refuge stations are considered to be necessary in case of fire or rockfalls that would block access and prevent full evacuation of personnel. These refuges will allow the staff to remain safe in an underground mine for 48 hours. The refuges are mobile, each can accommodate up to 20 people within the protected chamber, and they will be arranged so that they are always no more than 650 feet from the areas where the mine operation personnel are located.

5.11 Ancillary Power Systems

Electrical power will be supplied to the mine via an Idaho Power overhead powerline. The power demand will be approximately five megawatts throughout the life of the mine. The Idaho Power powerline will connect to the Project substation, located near the processing facility.

One emergency diesel generator capable of producing 2,000 kilowatts will be located at the process facility. This generator will provide sufficient emergency power to operate critical components at the facility in the event of a power outage.

At the start of mining, an underground 480 volt (V) transformer will be placed near the entrance to the portal. This will supply power to electrical equipment used to develop the main decline and portable fans. Once development has advanced far enough that carrying power at 480 V becomes too inefficient, a main powerline will be installed along the rib of the decline to carry 4.16 kilovolts and will be connected to the transformer which will be moved underground.

Upon completion of the decline to the 3,224-foot level, and the initiation of production-mining activities, a second underground transformer will be purchased for use in the lower areas of the mine.

Line power will also be carried up the hill to the location of the ventilation shaft to supply power to the ventilation fan.

6 SPILL RESPONSE ACTIVITIES

6.1 Emergency Response Procedures

The following emergency response procedures (ERPs) are to be followed in the event of a hazardous materials release:

1. The first responder reports the incident and notifies the supervisor;
2. The supervisor notifies the General Manager and Environmental Manager;
3. The Environmental Manager contacts off-site emergency response teams at the General Manager's direction;
4. Gather information about the incident;
5. Complete preliminary information on an incident report form;
6. Contact and transmit information to the emergency response team;
7. An emergency response team is dispatched to the incident;
8. Contact additional emergency units if necessary;
9. Contain spill material and control release;
10. Contact off-site specialists/contractors as required by circumstances;
11. Remove and secure contaminated material;
12. Arrange for proper disposal of contaminated material;
13. Supervisor completes an incident report form;

14. Verbally notify agencies of spill if the amount is greater than or equal to the reportable quantity;
15. Follow up incident with debriefing; and
16. Evaluate emergency response procedures and modify as necessary.

6.2 Duties of Mine Personnel

6.2.1 General Manager

The General Manager or his designate will be notified as soon as possible when a reportable spill or release occurs. The General Manager will direct all public statements made to the media, if required.

6.2.2 Emergency Response Team

The Emergency Response Team (ERT) will include employees who have been specially trained to work with hazardous materials in a safe and proper manner. The team will be trained in the use of all safety gear and will promote and demonstrate safe remediation practices. The prime responsibility of the team is to assess a scene for hazards, act professionally and conduct cleanup procedures as outlined in the previous section.

6.2.3 Environmental Manager

The Environmental Manager will determine and verify pertinent facts about the incident, including the amount and location of the spill or release, probable direction and time of travel of the spill, resources required at the scene, and the property that may be affected. The Environmental Manager may advise, instruct, and/or direct containment, countermeasures, and cleanup of the release. The Environmental Manager will assess the area to determine the effect and extent of the spill or release and report the information to the General Manager.

6.2.4 Safety Officer

The Safety Officer will ensure the safety of all persons involved with a spill or release. Once on the scene of the spill, the Safety Officer will evaluate the area for dangers and will ensure that all persons involved are equipped with the appropriate safety gear and have received the proper training. The Safety Officer may also determine if tests for toxic gases are required prior to handling of the spilled material.

6.2.5 Supervisor

The foreman of an area where a spill or release occurs is responsible for coordinating the initial containment. The Supervisor is responsible for determining if the spill will require the ERT. Once the spill or release is controlled, the Supervisor must coordinate with the Environmental and Safety Departments to determine if the spill is or is not a reportable spill.

6.3 Emergency Response for Chemical Spills

Calico will receive, store, use, and transport a variety of chemicals for use at the mine and process facilities. These chemicals will be handled according to standard industry practices which will include the use of PPE, task training, and preventive maintenance of equipment, tanks, pipes, and fittings. Unplanned events may occur that require rapid response to protect worker health, prevent or reduce releases to the environment, and reduce damage to equipment.

6.3.1 Lime – Calcium Oxide

Specifications

Lime is shipped by trailer truck and consists of white, odorless, solid pebbles or powder that will be pneumatically transferred from the truck to a lime silo. It is an alkali, highly corrosive, and highly exothermic when in contact with water.

Personal Safety

1. Wear an approved dust respirator, work gloves, goggles, and a full covering of clothing.
2. Do not use water.

Immediate Response

Follow ERPs as outlined in **Section 6.1**.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Scoop or sweep up spilled lime and place in a suitable container.
3. Excavate contaminated soil and place within a secured area.
4. Reclaimed lime may be placed into the process circuit with approval from the Process Supervisor.

6.3.2 Antiscalant

Specifications

Antiscalant properties may vary by manufacturer. Antiscalant is generally a straw-colored liquid with a slight ammonia odor. Antiscalant will be trucked to the site in barrels or other containers.

Personal Safety

Recommended PPE includes gloves and eye/face protection.

Immediate Response

1. Secure area to prevent contact and slipping.
2. Absorb with an inert material and scoop up into an appropriate container. Avoid use of iron, copper, or aluminum containers or equipment. Wash area thoroughly with water and scrub to remove slip hazard.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Contact the Environmental or Safety Departments for disposal options.

6.3.3 Hydrochloric Acid

Specifications

Hydrochloric acid will be shipped to the site in 220-pound drums. Hydrochloric acid is a clear, colorless, or slightly yellow fuming liquid with a pungent, biting odor. It is acidic, highly corrosive, and on reacting with other materials may give off chlorine gas which is highly toxic.

Personal Safety

Wear a self-contained breathing apparatus or an approved respirator, goggles, rubber suit, rubber gloves, and boots.

Avoid contact with metals and sulfides as these will produce hydrogen gas, which is highly flammable and may cause fire or explosion; it is an asphyxiant. Stay upwind as a respirator will not provide protection from hydrogen gas.

Immediate Response

1. Notify the Environmental and Safety Departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the ERPs as outlined in **Section 6.1**.
3. Evacuate and isolate the immediate area to avoid personnel exposure.
4. For a pipeline leak, adjust appropriate valves to isolate the system and stop further leakage.
5. Dike the area to contain the spill.

Containment, Countermeasures, and Cleanup

1. Neutralize all pooled solution with water, soda ash, or lime. Verify that the solution is neutralized with a pH tester.
2. lf possible, place any neutralized solution back in the process circuit.
3. Excavate the contaminated soil and mix with lime. Contact the Environmental or Safety Departments for disposal options.
4. Neutralized material may be placed in previously approved areas.

6.3.4 Sodium Hydroxide

Specifications

A sodium hydroxide solution will be shipped to the site dry in five-pound boxes. Sodium hydroxide is an alkali, is highly corrosive, and may give off hydrogen gas which is highly inflammable and potentially explosive and is an asphyxiant.

Personal Safety

1. Wear an approved respirator, face shield, suit, gloves, and boots. A self-contained breathing apparatus should be worn in the case of large spills.
2. Provide ventilation to the area.
3. Use water spray to divert or reduce vapors.

Immediate Response

1. ln the case of a small spill, dilute with water and mop up or absorb with inert dry material.
2. ln the case of a large spill, absorb with dry earth, sand, or other non-combustible material.
3. Stop leak if safe and dike if needed.
4. Neutralize residue with a dilute solution of acetic acid.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Neutralize residue with a dilute solution of acetic acid.
4. Excavate the contaminated soil. Contact the Environmental or Safety Departments for disposal options.

6.3.5 Sodium Cyanide

Specifications

Sodium cyanide in aqueous solution will be shipped to the site in a tanker truck and transferred to and stored in a 10,000-gallon tank. Sodium cyanide is odorless when dry and emits an almond-like odor when damp. Sodium cyanide is highly toxic and may give off hydrogen cyanide gas which is highly toxic. It is more likely to give off hydrogen cyanide gas when in contact with an acid.

Personal Safety

1. Wear an approved respirator for vapors and dust, goggles, rubber suit, rubber, gloves, and boots. A self-contained breathing apparatus should be worn in the case of large spills.
2. Eliminate all ignition sources and use water spray to reduce vapors.
3. Avoid contact with acids and acid fumes.

Immediate Response

1. Notify the Environmental and Safety Departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the ERPs as outlined in **Section 6.1**.
3. Evacuate and isolate the immediate 50-foot area to avoid personnel exposure.
4. Dike the area to contain the spill. Prevent entry into confined areas.

Containment, Countermeasures, and Cleanup

1. Use appropriate tools to put the spilled solid in a waste disposal container.
2. Follow ERPs as outlined in **Section 6.1**.
3. Excavate the contaminated soil. Contact the Environmental or Safety Departments for disposal options.

6.3.6 Carbon

Specifications

Carbon will be delivered to the site by truck in containers. Carbon can be granular, pelletized, or powdered. Carbon is neither toxic nor corrosive.

Personal Safety

1. Ventilate area.
2. Wear a dust mask, gloves, and eye protection.

Immediate Response

1. Shovel and sweep material into an appropriate container.
2. Wash area with water if necessary.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Contact the Environmental or safety Department for disposal options.

6.3.7 Gasoline and Diesel Fuel

Specifications

Gasoline and diesel fuel are shipped to the site by tanker truck in large amounts. Gasoline liquid and vapor are toxic and highly flammable

Personal Safety

1. Stay upwind, out of fumes, and keep out of low areas.
2. Wear rubber gloves and boots.
3. No smoking or open flames near gasoline or diesel fuel.

Immediate Response

1. Notify the Environmental and Safety Departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the ERPs as outline in **Section 6.1**.
3. Remove all sources of ignition.
4. Evacuate and isolate the immediate area to avoid personnel exposure.
5. Stop the leak without personal safety risks.
6. Dike the area to contain the spill.

Containment, Countermeasures, and Cleanup

1. Remove all diesel-contaminated soil and place in a designated area for removal and disposal.
2. Gasoline-contaminated soil will be temporarily stored on a synthetic liner and will be covered to prevent volatilization. Contact the Environmental Department for appropriate disposal options.
3. All diesel or gasoline liquids recovered from a spill will be placed in drums or dumpsters for proper disposal.

6.3.8 Propane

Specifications

Propane will be shipped to the site by tanker truck. Propane is a gas which is an asphyxiant and highly flammable.

Personal Safety

1. Stay upwind, out of fumes, and keep out of low areas.
2. Wear rubber gloves and boots.
3. No smoking or open flames near propane.

Immediate Response

1. Notify the Environmental and Safety Departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the ERPs as outline in **Section 6.1**.
3. Remove all sources of ignition.
4. Evacuate and isolate the immediate area to avoid personnel exposure.
5. Stop the leak without personal safety risks.
6. For a pipeline leak, adjust appropriate valves to isolate the system and stop the leak.
7. Dike the area to contain the spill.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Remove propane-contaminated soil and place in designated area for removal and disposal.
3. All propane liquid recovered from a spill will be placed in drums or dumpsters for proper disposal.

6.3.9 Automatic Transmission Fluid

Specifications

Automatic transmission fluid (ATF) is shipped to the site by tanker truck. It is a red, transparent-colored liquid. It is toxic, corrosive, and flammable.

Personal Safety

1. Provide adequate ventilation.
2. Wear rubber gloves, goggles, boots, and an approved respirator when necessary.

3. No smoking or open flames near ATF.

Immediate Response

1. Notify the Environmental and Safety Departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the ERPs as outlined in **Section 6.1**.
3. Remove all sources of ignition.
4. Isolate the spill area and stop the leak without personal safety risks.
5. For a pipeline leak, adjust appropriate valves to isolate the system and stop the leak.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Contact the Environmental Department for appropriate disposal options.
3. Recover free product for recycling or disposal.
4. Use sand, earth, or absorbent material to absorb from spill area.
5. Remove contaminated soil and place in designated area for removal and disposal.

6.3.10 Bulk Oils

Specifications

Bulk oils are shipped to the site in 55-gallon drums or in bulk by tanker truck. Oils are toxic and flammable.

Personal Safety

1. Wear rubber gloves and boots.

Immediate Response

1. Follow the ERPs as discussed in **Section 6.1**.
2. Remove all sources of ignition.
3. Stop the leak.
4. Dike the area if the spill is large.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Pump pooled oil into 55-gallon drums. Contact the Environmental Department for additional instruction.
3. Remove contaminated soil and place in a designated area for removal and disposal.

6.3.11 Ethylene Glycol (Antifreeze)

Specifications

Shipped in tanker trucks at 50 percent ethylene glycol, the material has a distinctive green color and a pH of 9. It is toxic.

Personal Safety

1. Wear rubber gloves, eye protection, and self-contained breathing apparatus.
2. ln the event of fire, avoid contact with strong acids, bases, and oxidizers.
3. Thoroughly wash contacted skin and clothing.

Immediate Response

1. Follow the ERPs as discussed in **Section 6.1**.
2. Safely stop the source of a leak or spill and contain.
3. Properly flag and mark the spill area. Isolate the spill from exposure to wildlife.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Reclaim free solution.
3. Excavate contaminated soils and place on a synthetic liner. Contact the Environmental Department for appropriate disposal options. Do not mix hydrocarbon and ethylene glycol contaminated soils.

6.3.12 Hydraulic Fluid

Specifications

Hydraulic fluid is a blend of ingredients which may vary slightly by manufacturer. lt is a clear fluid with a slight odor. Shipments will be delivered to the site in containers or tanks. Hydraulic fluid is corrosive, toxic, and flammable.

Personal Safety

No particular safety equipment is required, although gloves are recommended.

Immediate Response

1. Dike area if needed.
2. Remove contaminated soils and use dry materials to soak up spills.

Containment, Countermeasures, and Cleanup

1. Follow ERPs as outlined in **Section 6.1**.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Excavate the contaminated soil. Contact the Environmental or Safety Departments for disposal options.

6.3.13 Ammonium Nitrate

Specifications

Shipped in tanker trucks, ammonium nitrate is white in color and consists of small round pearl-like granules. It is toxic, corrosive, and flammable.

Personal Safety

1. Wear an approved dust respirator, gloves, and boots.

2. Ammonium nitrate is not compatible with wood, sulfur, chlorides, phosphorus, fine metals, acids, organics, or solvents.

Immediate Response

1. Follow the ERPs as outlined in **Section 6.1**.

Containment, Countermeasures, and Cleanup

1. If the ammonium nitrate is spilled on an area that has hydrocarbon contamination, DO NOT REMOVE. Contact the Environmental Department.
2. Follow ERPs as outlined in **Section 6.1**.
3. If spilled on clean ground, then contain the spill and scoop or sweep up the spilled material and place in a clean plastic container marked with the new contents. The container must not have any traces of petroleum products prior to use.
4. Place the marked container by the ammonium nitrate silo and notify the Environmental Department.

7 EXTERNAL EMERGENCY SERVICES AND CONTACT INFORMATION

In addition to the internal ERPs described in Sections 6.1 and 6.2, responding mine personnel will first contact external emergency services via two-way radios installed in vehicles and heavy equipment or by phone. A separate radio frequency will be established for emergency use, and emergency response and communication protocols will be established. Once the emergency has been stabilized, the Sheriff's Department and additional regulatory agencies as required will be contacted.

Due to the remote location of the site, fire response will be handled by mine staff until the appropriate agency can respond.

The closest major medical center to the mine is Saint Alphonsus Medical Center in Ontario, Oregon, located approximately 37 road miles from the Project site. This has an emergency room and other facilities to handle injuries that may occur. If immediate care is necessary that cannot be provided at Saint Alphonsus Medical Center in Ontario, the Life Flight Air Ambulance out of Ontario, Oregon, is equipped to provide rapid air transportation of critically injured/ill persons. For less critical incidences, a clinic is available in Vale, Oregon, located approximately 22 miles from the Project.

Calico will have medical staff on site to treat minor incidents and to try to stabilize any major medical incidents until the Life Flight Air Ambulance out of Ontario, Oregon, is dispatched and can reach the Project site.

Emergency contact information for site personnel, first responders, medical care, and local and federal agencies is provided in Table 7-1.

Table 3: Emergency Contact Information

Position or Agency		Contact	Location	Phone Number(s)	Radio or Cell Phone Number
Calico Emergency Contacts	General Manager	TBD	TBD	TBD	TBD
	Mine Superintendent	TBD	TBD	TBD	TBD
	Process Superintendent	TBD	TBD	TBD	TBD
	Maintenance Superintendent	TBD	TBD	TBD	TBD
	Environmental Manager	TBD	TBD	TBD	TBD
	Safety Officer	TBD	TBD	TBD	TBD
	Off-Site Emergency Contact	TBD	TBD	TBD	TBD
Northwest Interagency Coordination Center		On-Duty Personnel	150 SW Harrison Street, Suite 400 Portland, OR 97201	(503) 808-2720	n/a
Malheur County Sheriff's Office		On-Duty Personnel	151 "B" Street West Vale, OR 97918	(541) 473-5126	n/a
BLM Vale District Office		On-Duty Personnel	100 Oregon Street Vale, OR 97918	(541) 473-3144	n/a
Vale Fire and Ambulance		On-Duty Personnel	950 Hope Street Vale, OR 97918	(541) 473-3796	n/a
Saint Alphonsus Medical Center Ontario		On-Duty Personnel	351 SW 9th Street Ontario, OR 97914	(541) 881-7000	n/a
Life Flight Air Ambulance		On-Duty Personnel	599 SW 33rd Street Ontario, OR 97914	(800) 232-0911 (509) 678-4364	n/a

TBD = to be determined
n/a = not applicable

8 REPORTING AND NOTIFICATION

Reportable environmental incidents will be conveyed to the appropriate agencies by Calico within 24 hours of incident stabilization. Calico's Environmental Manager or designee will be responsible for incident reporting. lf the release is determined to be a reportable quantity, the incident will be reported as required by telephone no later than 5:00 p.m. of the next regular work day from the time of the incident to the following:

- Oregon Department of Environmental Quality's 24-hour emergency notification number at 1-800-452-0311;
- Local Emergency Planning Committee – to be determined;
- National Response Center at 1-800-424-8802;
- BLM – Vale District Office at (541) 473-3144; and
- Transportation incidents should be reported to 911.

Reporting is generally required within 24 hours, or the next business day if the release occurs on a weekend. Reporting to MSHA is immediate in the case of certain events including, but not limited to, fire and fatality.

Calico will also be responsible for obtaining special authority for emergency operations where equipment, personnel, or materials are required for the containment of spills or removal of hazardous material.

8.1 Incident Reporting Forms

Incident reporting forms and checklists that may be developed prior to initiation of operations and made available to personnel include, but are not limited to, the following: site safety plan; checklist for person identifying emergency; emergency response team leader checklist; incident scene checklist; operator checklist; safety specialist checklist; site access control checklist; and hazardous material checklist.

These forms will be used to document incidents that occur as well as assist mine personnel during an emergency.

9 TRAINING

Employees will be trained at least annually on the details of this Plan prepared for the Project. Training records will be retained in employee personnel files and in the facility operating record.

Appendix F: Cyanide Management Plan

MEMORANDUM

DATE: September 19, 2019

TO: File

FROM: EM Strategies, Inc.

SUBJECT: Grassy Mountain Mine Project; Cyanide Transportation

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Cyanide transporters are expected to comply with the International Cyanide Management Code (ICMC) for transport, as well as in the event of a release or spill, and with the Federal Motor Carrier Safety Administration's regulations for routing of hazardous materials on public highways (49 CFR Part 397). Cyanide will be delivered to the Project in dry form by truck from Winnemucca, Nevada. The ICMC's principle for cyanide transportation is to protect communities and the environment during cyanide transport. The ICMC also establishes the following standards of practice for cyanide transportation: 2.1) Establish clear lines of responsibility for safety, security, release prevention, training and emergency response in written agreements with producers, distributors and transporters; and 2.2) Require that cyanide transporters implement appropriate emergency response plans and capabilities, and employ adequate measures for cyanide management (International Cyanide Management Institute [ICMI] 2019).

Additional information on cyanide management is in the attached Cyanide Management Plan.

Reference

International Cyanide Management Institute (ICMI). 2019. *International Cyanide Management Code*. https://www.cyanidecode.org/about-cyanide-code/cyanide-code. Accessed September 19, 2019.

Reno: 1650 Meadow Wood Lane, Reno, Nevada 89502 **Phone:** 1.775.826.8822 **Fax:** 1.775.826.8857
Elko: 835 Railroad Street, Elko, Nevada 89801 **Phone:** 1.775.753.9496 **Fax:** 1.775.826.8857

Ausenco

CALICO RESOURCES

101768-RPT-0003
Revision Number C

Calico Resources USA Corp. Grassy Mountain Project

Cyanide Management Plan May 2019

14 May 2019

Revision Status

Revision	Date	Description	Author		Approver	
			FirstName LastName	Position Title	FirstName LastName	Position Title
A	November 1, 2018	Issued for Internal Review	Paul Seguin	Process Engineer	Thomas Mills	Project Engineer
B	May 8, 2019	Re-Issued for Internal Review	Thomas Mills	Project Engineer	Ruth Sherrit	Director, Process and Commissioning
C	May 14, 2019	Issued for Client Review	Thomas Mills	Project Engineer	Ruth Sherrit	Director, Process and Commissioning

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Appendix 1 – Reagent Mixing and Storage Area

1 Introduction

The International Cyanide Management Code 2009 (Code) is an industry voluntary program for cyanide producers and cyanide consumers, such as mining companies. It focuses on the safe management of cyanide and cyanidation mill leach solutions and tailings. Companies that adopt the Code must have their mining operations that use cyanide audited by an independent third party to determine the status of Code implementation. Those operations that meet the Code requirements can be certified and a unique trademark symbol can then be utilised by the certified operation. Audit results are made public to inform stakeholders of the status of cyanide management practices at the certified operation.

The objective of the Code is to improve the management of cyanide used in gold mining, assist in the protection of human health and the reduction of environmental impacts. The Code is structured along nine Principles each with standards of practice. The Principles are:

Principle 1:	Production
Principle 2:	Transportation
Principle 3:	Handling and Storage
Principle 4:	Operations
Principle 5:	Decommissioning
Principle 6:	Worker Safety
Principle 7:	Emergency Response
Principle 8:	Training
Principle 9:	Dialogue

For the Grassy Mountain PFS, preliminary plant layout designs have been developed. The design of cyanide facilities is aligned with the guidelines of the cyanide code. However, given the preliminary nature of the study, it is recognised that many of the specific cyanide code compliance actions will require further definition in subsequent phases of the project. Further, in line with the natural progression of project development it is required that project specific cyanide handling and storage design criteria as well as the specific operating procedures required by the cyanide code are developed during future phases of the project.

2 Battery Limits

The battery limits of Ausenco's scope on the Grassy Mountain PFS for the process and engineering design for the cyanide systems are:

- receipt of cyanide from the supplier into the cyanide storage area at site
- detoxification and discharge of tailings into the Tailings Storage Facility

The process and engineering design within the battery limits is impacted mainly by the following principles from the Code, and their accompanying standards of practice:

- Principle 3: Handling and Storage
- Principle 4: Operations

This report section deals with the implementation of elements in Principles 3 and 4 of the Code and describes the aspects from the Code which have been incorporated in the preliminary plant design.

3 Principle 3: Handling and Storage

3.1 General

The objective of Principle 3 in the Code is to "protect workers and the environment during cyanide handling and storage." Two standards of practice and accompanying guidelines are provided; the standards are:

Standards of Practice:

3.1 the design and construction of unloading, storage and mixing facilities

3.2 the operation of the unloading, storage and mixing facilities

The delivery of bulk cyanide is expected to be in dry form and will be supplied as 1 tonne bulk bags packed in wooden crates. The crates will be stored in a fenced and secured area. The cyanide is dissolved in water in an agitated mix tank after which the solution gravitates into a storage tank.

3.2 Reagent Receipt, Mixing and Storage – Application of the Code

"Standard of Practice 3.1 Design and construct unloading, storage and mixing facilities consistent with sound, accepted engineering practices and quality control and quality assurance procedures, spill prevention and spill containment measures."

Sodium cyanide is delivered to site in solid form (briquettes) packed in 1T bulk bags, with each bag packed in a wooden crate. The crates will be stored on site at the cyanide mix and storage area, which will be completely fenced and secured. The nominal amount of cyanide stored on site will be 8 tonnes, which will supply a 2-4 week operational reserve. This is the only area where cyanide is stored. The reagent area will be covered, but open to the air providing adequate ventilation to prevent the potential build-up of HCN vapours. The cyanide mixing and storage area is placed on an impervious concrete slab with bund walls providing 110% containment to prevent any potential seepage, giving due consideration to the potential reduction of containment volume form pumps or other equipment installed within the containment. A hydrogen cyanide (HCN) analyser is located in the mixing and storage area. The HCN analyser will activate local audible and visual alarms and alarms on the control system in the event that HCN gas is present.

The cyanide mix and storage area is a relatively "low- traffic" part of the site with respect to personnel movements. The mix area is readily serviced from a perimeter plant site road. Compatible reagents, sodium hydroxide and lime slurry, will share the same mixing area and containment structure (alkaline reagent area).

Incompatible reagents on the site include hydrochloric acid, sodium metabisulphite (SMBS), and copper sulphate. These reagents are potentially hazardous if mixed with cyanide as it may result in the evolution of hydrogen cyanide gas. Cyanide and incompatible reagent lines will not intersect or pass over each other and will not run over or through incompatible areas.

The copper sulphate and SMBS mixing and storage area (acidic reagent area) is separate from the alkaline reagent area, placed on an impervious concrete slab, and contains adequate bunding for 110% containment.

The HCL system is limited to a tote and dilute acid mixing tank, and the resulting solution is dosed directly into the acid wash column. The acid was column and HCL system are in a dedicated bunded acid wash area with an acid wash area sump pump. Cyanide lines will not pass through or over this area, and HCL lines will not extend beyond the bunded area.

Reference: 101768-0000-G-108 Desorption and Regeneration Area General Arrangement

101768-0000-G-110 Reagents Area General Arrangement (See Appendix 1)

101768-0000-F-010 Alkaline Reagents Process Flow Diagram

"Standard of Practice 3.2 Operate unloading, storage and mixing facilities using inspections, preventive maintenance and contingency plans to prevent or contain releases and control and respond to worker exposures."

Prior to removing cyanide from storage and performing the mixing process, operators will be fully trained and equipped with the minimum following PPE:

- Hardhat
- Full face respirator
- Rubber gloves
- Chemical resistant suit
- Rubber boots
- Personal HCN gas monitor
- Hearing protection

Cyanide solution is prepared in a semi-automated system that consists of a bag breaker chamber, agitated mix tank and storage tank. Prior to the start of the mixing procedure the area will be roped off and appropriate warning signage will be in place. Due to the sensitivity of the operation, a second operator will be assigned to monitor the operator performing the mixing procedure to provide assistance in the event of an emergency. The operator hoists the bulk bag into a bag breaker chamber from where the briquettes gravitate into an agitated mix tank. A dust collector maintains a negative pressure during the bag breaking process to control any cyanide dust generated, and water is used to dissolve the briquettes. As a safety precaution a provision is made in the design to increase the pH by dosing sodium hydroxide in the mix tank thus preventing HCN evolution. The tank levels will be monitored via the control system, and a level alarm will be installed to prevent overfilling of the tank. The water addition to the mix tank and transfer of the mixed cyanide solution to the storage tank will be controlled via the control system. A level alarm will be installed on the sump to indicate any spillage. All valves associated with mixing and storage will be automated and fail in the safe position. A safety eyewash/shower station will be installed in bund area and mixing platform.

After completion of bag cutting and emptying operations, the bag will be rinsed using a water spray arrangement integrated with the bag cutter, and all rinseate will report directly to the mix tank. Empty

rinsed bags and all associated packing materials will be collected and transported to a securely fenced area for disposal. Recycling or re-use of any cyanide packaging materials will be prohibited and will be removed and disposed of by the reagent supplier. Following mixing, the cyanide solution will flow via a transport pump to the cyanide stock tank. All piping will be socket weld stainless steel, with double block and bleed isolation.

4 Principle 4: Operations

4.1 General

The objective of Principle 4 in the Code is to "manage cyanide process solutions and waste streams to protect human health and the environment". Nine standards and accompanying guidelines are provided; the standards are summarised below:

Standards of Practice:

4.1 Set-up and management of an operating system and its controls

4.2 Systems to minimise the use of cyanide

4.3 Water management system to protect against unintentional releases

4.4 Protection of avian and land-based wildlife, and livestock

4.5 Protection of aquatic wildlife

4.6 Manage seepage and influence on groundwater

4.7 Spill prevention and containment measures

4.8 QC/QA procedures on construction of facilities and standards and specifications adopted

4.9 Monitoring programmes for wildlife and system waters

Cyanide process solutions and slurries are defined where the weak acid dissociable (WAD) cyanide concentration is greater than 0.5 mg/L.

4.2 Operations - Applications of the Code

"Standard of Practice 4.1 Introduce management and operating systems to minimize cyanide use, thereby limiting concentrations of cyanide in mill tailings."

In the leach train cyanide solution is added to the first two tanks to ensure efficient use of the cyanide, mitigating the risk of overdosing cyanide. Vendor supplied cyanide analysers (titrator type) measure the free cyanide concentration in the first and last CIL tank, and alarms if outside of target range. The cyanide analyser controls sodium cyanide addition to the first CIL tank. Further addition of trim cyanide addition to the second tank is by manual adjustment, by the leach area process operator, if the free cyanide concentration is manually measured to be below target.

"Standard of Practice 4.2 Implement management and operating systems designed to protect human health and the environment including contingency planning and inspection and preventive maintenance procedures."

Lime is added to the pre-aeration tank to achieve a suitable pH level in the pulp and to minimise the potential hydrolysis of sodium cyanide to form unacceptable levels of hydrogen cyanide gas (HCN). A pH control system is installed on each circuit (pre-aeration and leach) with interlocked control valves. The pH of the slurry in the first two tanks is measured with dual in-line pH meters. The output signals from the pH transmitters feedback to a PID controller which regulates the lime dose rate to the pre-aeration tank to achieve a pre-set pH value in the leach tank. Separate manual valves off the lime ring main will be available for manually dosing in the leach tanks from the field.

Hydrogen cyanide (HCN) analysers will be located in the CIL area. The HCN analysers will activate local audible and visual alarms and alarms on the control system in the event that HCN gas is present. Personal cyanide monitoring devices will be provided to personnel working in the leach and CIL area. Clear and unambiguous signs and safety eye-wash/shower stations will be provided at key locations in areas of regular worker activities.

"Standard of Practice 4.3 Implement a comprehensive water management program to protect against unintentional releases."

All cyanide containing vessels will be located on impervious concrete slabs and bunded to provide 110% containment of the largest vessel. In the event that a spill or release occurs outside the bunded catchment areas, site grading and ditching has been designed such that all contact water flows to a collection pond. The collection pond will be double lined to prevent any seepage to the environment and will be reclaimed back to the process when necessary. Additional information on the water management plan can be found in Appendix C of the Consolidated Permit Application.

"Standard of Practice 4.4 Implement measures to protect birds, other wildlife and livestock from adverse effects of cyanide process solutions."

Reference Appendix I – Wildlife Mitigation Plan.

"Standard of Practice 4.5 Implement measures to protect fish and wildlife from direct and indirect discharges of cyanide process solutions to surface water."

Reference Appendix I – Wildlife Mitigation Plan.

"Standard of Practice 4.6 Implement measures designed to manage seepage from cyanide facilities to protect the beneficial uses of ground water."

All cyanide storage, mixing, leach, CIL and detox tanks will be installed on cast in-situ concrete slab-on-grade (impervious to prevent seepage). All CIL tailings will be treated in the cyanide destruction circuit before the tailings slurry is pumped to the TSF. In accordance with the Code, the discharge of detoxified slurry complies with the "not to exceed 50 mg/L (ppm) CNwad" criteria at the point of discharge into the TSF. It is recognized that the "not to exceed" limit for Oregon is 30 mg/L (ppm). The proven and effective air/SO_2/Cu^{2+} process is selected for this cyanide destruction duty.

The CIL tails overflow the last CIL tank and pass through a carbon safety screen before entering the cyanide detox tank where sodium metabisulphite (SMBS) and copper sulphate will be added. Low-pressure air is sparged to aid the oxidation of cyanide to cyanate, and lime is dosed to maintain the pH. Detoxified slurry overflows the detoxification reactor through a tailings sampler before gravitating to the tailings pumpbox. The tailings discharge line out of the process plant bund will be double contained with leak detection to alert pipeline failure or spillage.

Reference: 101768-0000-G-107 CIL Area General Arrangement

"*Standard of Practice 4.7 Provide spill prevention or containment measures for process tanks and pipelines*."

The CIL tanks will be installed on cast in-situ concrete slab-on-grade (impervious to prevent seepage). The slab supporting the tanks is part of the containment slab but 300 mm higher, in octagonal shape and placed monolithically with the containment slab. The slab has the same construction as the typical slab-on-grade, with 50 mm Styrofoam underside to provide insulation, 150 mm drain rock underneath the Styrofoam, and structural fill below down to the firm load bearing strata. The CIL area bunded volume is sufficient to contain 110% of the live volume of the largest tank, giving due consideration to rainfall and to the potential reduction of containment volume form pumps or other equipment installed within the containment. Floor sump pumps in the area return any spillage to the circuit for re-processing. Cyanide piping will be socket welded stainless steel, with double block and bleed isolation.

Reference: 101768-1200-C-102 CIL Area Containment General Arrangement

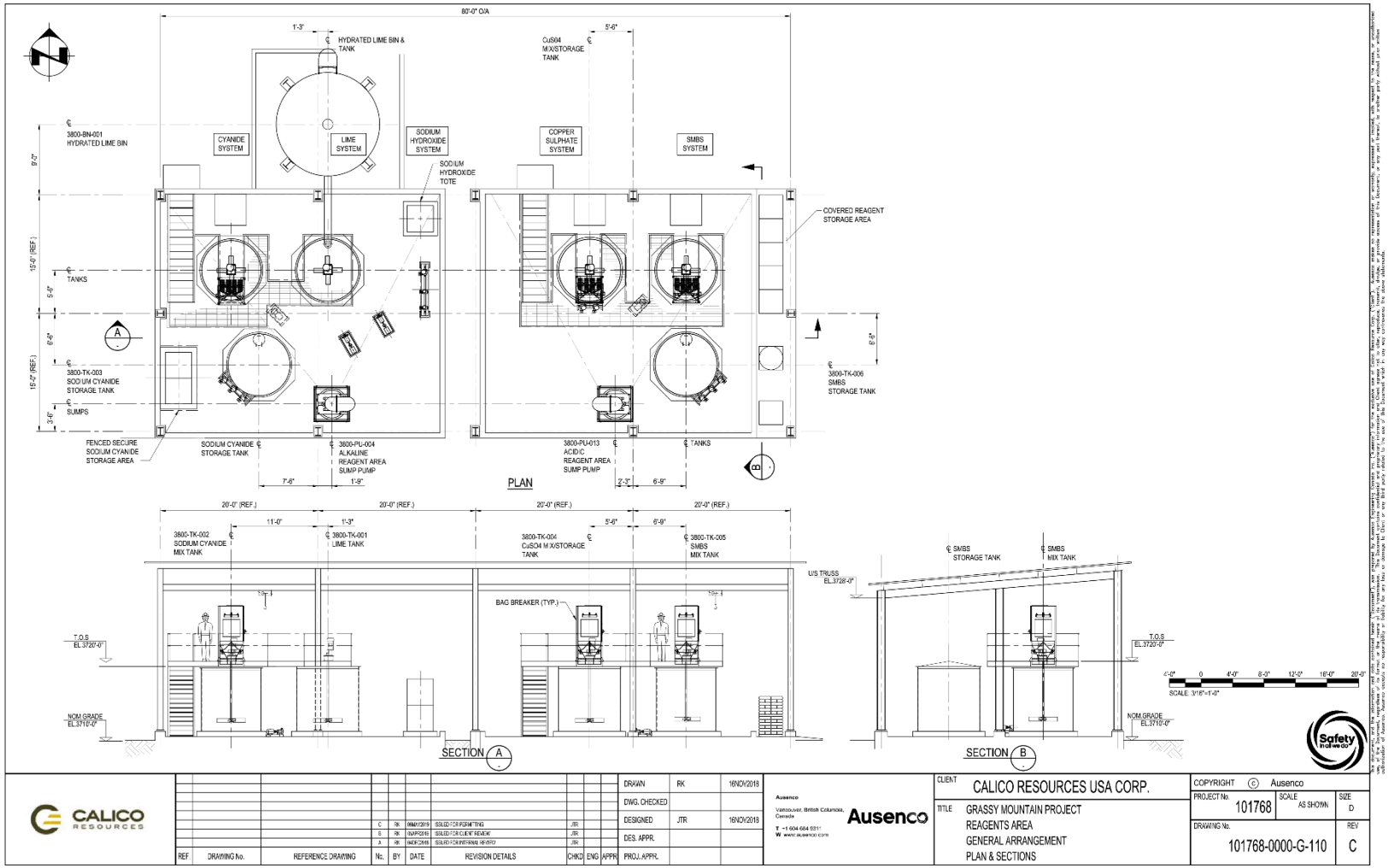
"Standard of Practice 4.8 Implement quality control/quality assurance procedures to confirm that cyanide facilities are constructed according to accepted engineering standards and specifications."

Reference: Appendix AA – Quality Assurance Plan

"Standard of Practice 4.9 Implement monitoring programs to evaluate the effects of cyanide use on wildlife, surface and ground water quality."

Reference: Appendix G – Monitoring Plan

Appendix 1 – Reagent Mixing and Storage Area



Appendix G: Monitoring Plan

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT
MALHEUR COUNTY, OREGON

MONITORING PLAN

November 2019

Submitted to

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation & Reclamation
229 Broadalbin Street SW
Albany, Oregon 97321-2246

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
MONITORING PLAN

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
MONITORING PLAN

1 INTRODUCTION

This Monitoring Plan has been prepared in support of the Grassy Mountain Mine Project (Project) located in Malheur County, Oregon, and has been included as part of the Consolidated Permit Application (CPA).

The Project is located approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 2). The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The Access Road Area totals approximately 876 acres.

1.1 Regulatory Requirements

1.1.1 Federal Regulations

Pursuant to 43 CFR 3809.401(b)(4), a plan for monitoring the effect of the proposed operations must accompany the Plan of Operations. Monitoring plans may incorporate existing state or other federal monitoring requirements to avoid duplication. The monitoring plan must meet the following objectives:

- Demonstrate compliance with the approved plan of operations and other federal or state environmental laws and regulations;
- Provide early detection of potential problems, and to supply information that would assist in directing corrective actions should they become necessary; and
- Provide details on type and location of monitoring devices, sampling parameters and frequency, analytical methods, reporting procedures, and procedures to respond to adverse monitoring results.

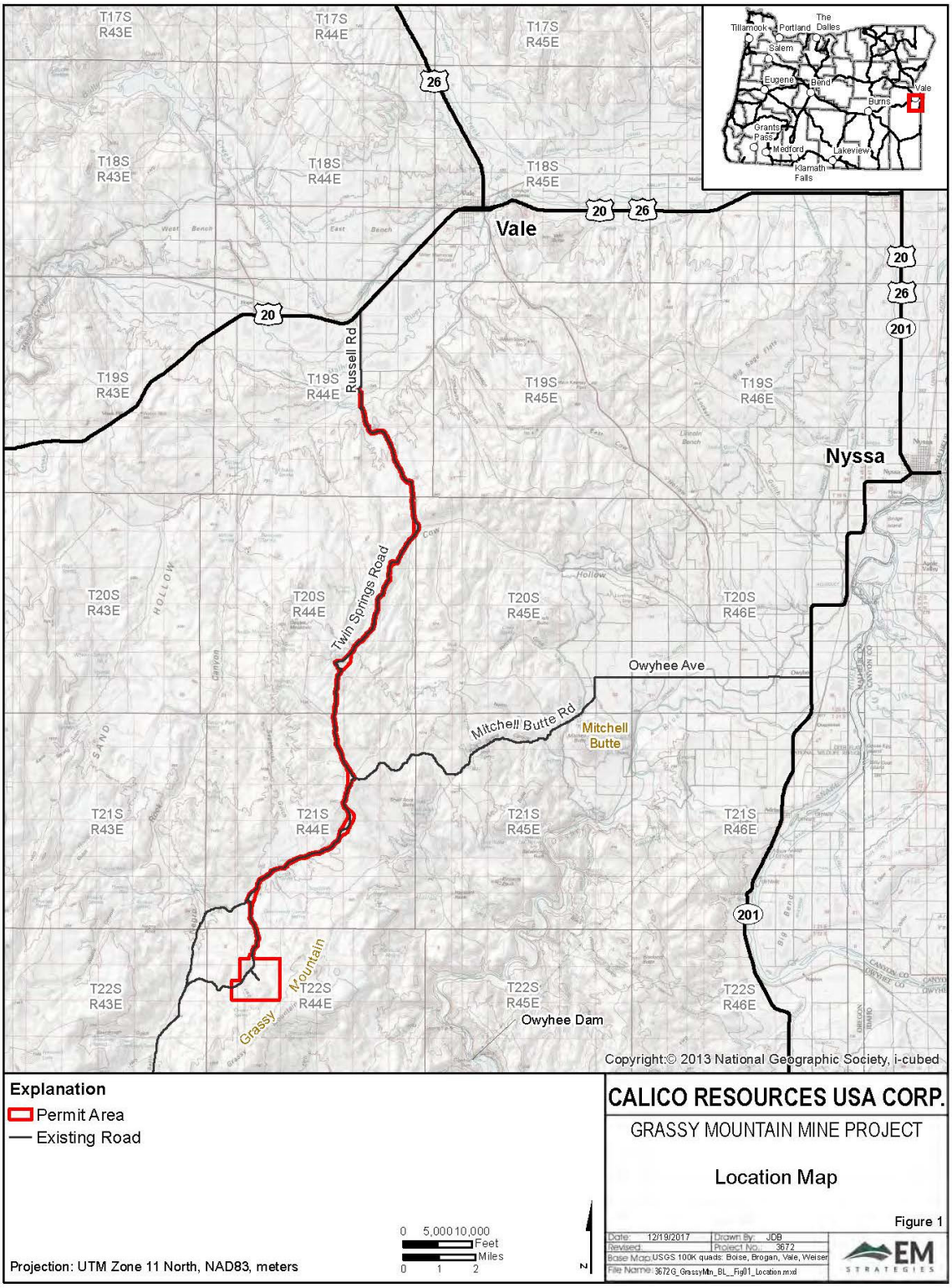

Figure 1: Location Map

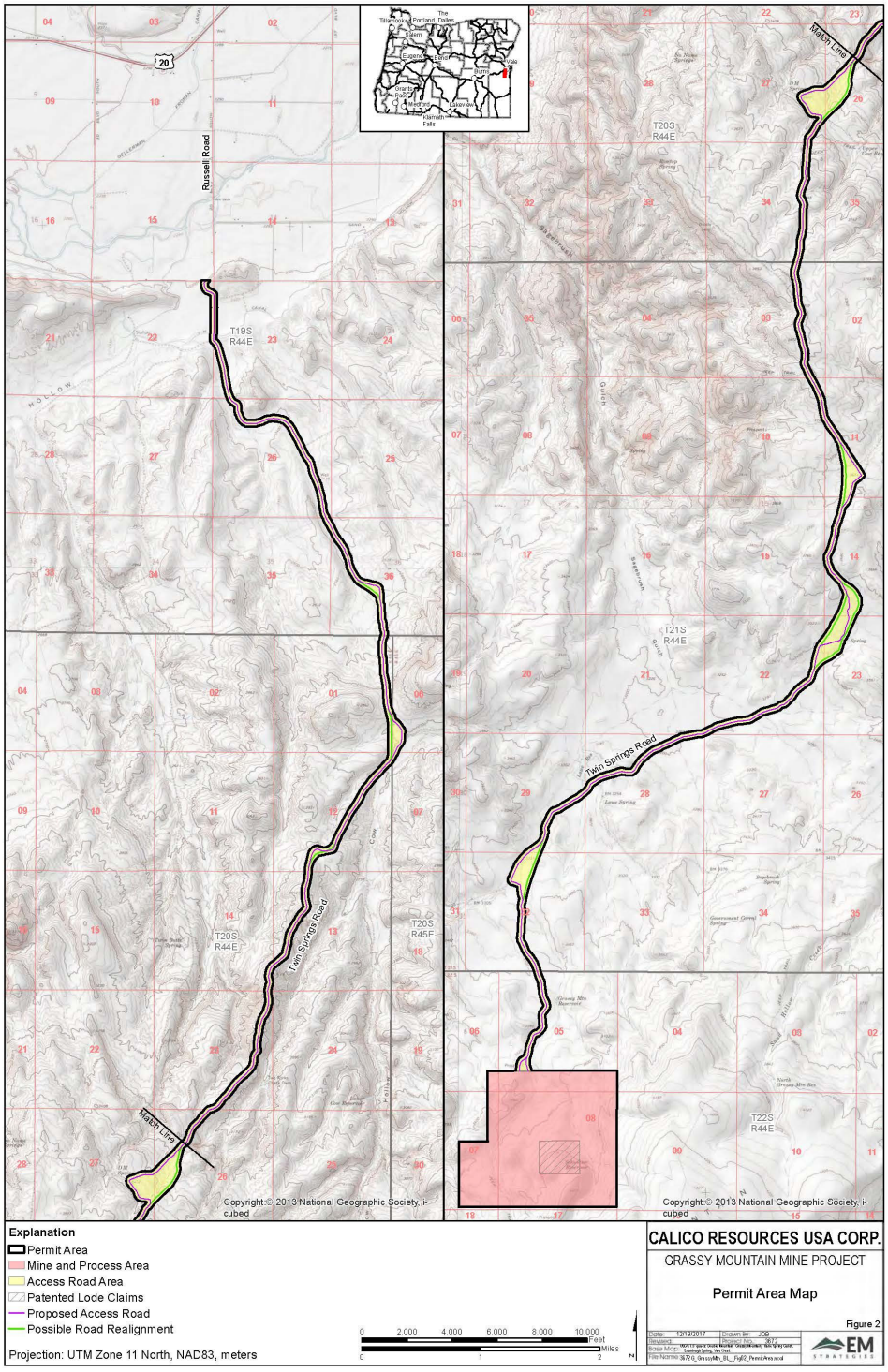

Figure 2: Permit Area Map

1.1.2 State Regulations

Oregon Administrative Rule (OAR) 632-037-0060 states that operational monitoring and reporting programs must be developed. Item 7 provides an example of the items to be included in the monitoring plan:

- Surface and groundwater monitoring systems within and outside of the Permit Area and reporting frequency;
- Water balance of the process system and leak detection systems and reporting frequency;
- Biological monitoring and reporting procedures and frequency; and
- Fish and wildlife injury and mortality monitoring and reporting frequency developed according to standards adopted by the Oregon Department of Fish and Wildlife (ODFW).

2 MONITORING PLAN

As part of the site-wide operating plan, Calico Resources USA Corp. (Calico) will monitor the following components in compliance with state permits and other plans: air quality; waste rock storage areas and stockpiles; reagent and diesel storage; sediment controls; groundwater; process solution containment; reclamation; noxious weeds; and wildlife. The major relevant permits/plans associated with each monitoring component are summarized in Table 1.

Table 1: Major Permits and Authorizations Required for Project Development

Permit/Approval	Granting Agency	Areas Addressed
Chemical Process Mining Permit	Oregon Department of Geology and Mineral Industries (DOGAMI), Mineral Land Regulation & Reclamation	Surface disturbance, reclamation
Plan of Operations/Record of Decision	Bureau of Land Management	Surface disturbance, reclamation
Air Quality Permit	Oregon Department of Environmental Quality (ODEQ)	Fugitive dust, air emissions
Storm Water Permit	ODEQ	Storm water
Water Pollution Control Facility (WPCF) Permit	ODEQ	Process solution containment

2.1 Air Quality

Calico anticipates the issuance of a Standard Air Contaminant Discharge Permit (ACDP) for the Project by the Oregon Department of Environmental Quality (ODEQ). As per ODEQ regulations, the Project ACDP must be authorized by the ODEQ prior to Project commissioning. Appropriate emission control equipment will be installed and operated in accordance with the construction and operating air permits. Where required, pollution control devices installed by equipment manufacturers will control combustion emissions. Pollution control equipment will be installed,

operated, and maintained in good working order to minimize emissions. Fugitive dust will be monitored and controlled as described in the ACDP.

2.2 Waste Rock Storage Areas and Ore Stockpiles

Monitoring of the waste rock and ore stockpiles will be performed in accordance with the Water Pollution Control Facility (WPCF) Permit, and the rock characterization program in coordination with the ODEQ and the BLM.

There are two ore stockpiles on the Project site: the run-of-mine stockpile and the crushed ore stockpile. Both ore stockpiles will be lined in compliance with the OAR 640.43 Chemical Mining guidelines. The liner design, from subgrade through to the filter layer in contact with the ore, is as follows:

- Prepared Subgrade (as required)
- Geosynthetic Clay Liner
- HDPE Double Sided Textured Geomembrane (3.1")
- 18" Drainage Layer
- 6" Filter Fill

Run-off contact water will be collected in a dedicated sump within the lined stockpile area. When required, water will be transferred to the surface water collection pond using portable submersible pumps or vacuum trucks.

2.3 Reagent and Diesel Storage

Monitoring of the reagent and diesel storage areas will be in accordance with the WPCF Permit.

Diesel storage tanks will be clearly labelled, and their locations will be made well-known to all on-site personnel. Diesel will only be stored in designated areas with secondary containment, which will be impermeable and sized to contain 110 percent of the volume stored.

The primary process reagents are characterized as either alkaline or acidic as follows:

- Alkaline Reagents
    - Hydrate Lime
    - Sodium Hydroxide
    - Sodium Cyanide

- Acidic Reagents
    - Sodium Metabisulphite (SMBS)
    - Hydrochloric Acid
    - Copper Sulphate

Reagents will be stored in the covered reagent storage area. The exception to this is sodium cyanide, which will be stored in the fenced secure cyanide storage area. Both storage areas are located on an impervious concrete slab, and the cyanide area is also bunded to provide 110 percent containment of the largest vessel. Additional information on the management and storage of cyanide can be found in Appendix F of the CPA.

2.4 Sediment Controls

Calico will monitor disturbed areas for signs of erosion, sediment accumulation, and potential off-site discharges; and the chemical storage, dispensing, and processing areas for signs of spillage or potential equipment failure. Inspections of facilities that could result in impacts to receiving surface waters include the activities outlined below.

- All areas that contain materials, chemicals, or soils that could adversely impact surface waters will be inspected, cleaned and maintained to prevent discharge. These areas are designed to provide containment of contaminants through the use of berms, lined channels, swales, or secondary containment facilities. Outlets to these areas will be properly maintained to perform as designed at all times.

- Calico will regularly inspect, clean, maintain, and repair all equipment, systems, and material handling/storage areas that have the potential to impact receiving surface waters. All management control measures including stormwater structures, catch basins, treatment facilities will be repaired and maintained in proper working order to perform as designed at all times.

2.5 Groundwater Monitoring

Groundwater monitoring will be undertaken in accordance with the WPCF Permit and other permits as required.

2.6 Process Solution Containment Monitoring

All process solutions will be located within impervious concrete containments sized in accordance with the ODEQ to contain 110 percent of the largest tank volume plus freeboard for precipitation. Any discharge to the containment will be returned to an appropriate vessel through sump pumps and will not be released to the environment.

The process facility tailings sent to the Tailings Storage Facility will be monitored as part of the WPCF Permit and tailings flow and quality will be measured and reported to the ODEQ on a regularly scheduled basis.

2.7 Reclamation Monitoring

Calico will monitor for revegetation success according to the plans set forth in Section 4.9, Post Reclamation Monitoring and Maintenance, of the CPA. Areas to be monitored will include revegetation success, groundwater quality, and presence of erosion. Calico will also monitor

disturbed sites for noxious weeds as set forth in Section 3.6.11, Noxious Weeds and Invasive Nonnative Species, of the CPA. Following site closure, Calico will conduct site maintenance, site inspections, and any other necessary monitoring for the period of reclamation responsibility.

2.8 Noxious Weeds

Calico will monitor for the presence of noxious weeds in accordance with the *Grassy Mountain Mine Project, Malheur County, Oregon, Noxious Weed Monitoring and Control Plan*. Periodic monitoring of the Permit Area will be conducted to identify new infestations while they are small so they can be effectively eliminated.

2.9 Wildlife Monitoring

Wildlife monitoring will include:

- Fences and netting installed to prevent access by avian species, livestock, and other large wildlife will be monitored on a routine schedule to check for breaches;
- Surveys conducted for proposed facilities as necessary to determine the presence and/or use by special status species; and
- The reclaim and collection ponds and process water tanks will be monitored on a daily basis for the condition of wildlife exclusion features and the presence of mortalities.

Mortalities will be reported on a quarterly basis according to the ODFW's standard reporting forms.

Appendix H: Noxious Weed Monitoring and Control Plan

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT
MALHEUR COUNTY, OREGON

NOXIOUS WEED MONITORING AND CONTROL PLAN

October 2019

Submitted to

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation & Reclamation
229 Broadalbin Street SW
Albany, Oregon 97321-2246

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
NOXIOUS WEED MONITORING AND CONTROL PLAN

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
NOXIOUS WEED MONITORING AND CONTROL PLAN

1 INTRODUCTION

This Noxious Weed Monitoring and Control Plan (Plan) has been prepared in support of the Grassy Mountain Mine Project (Project) located in Malheur County, Oregon, and has been included as part of the Consolidated Permit Application.

The purpose of this Plan is to document baseline noxious weed conditions and develop a noxious weed management program for the Project. The short-term objective of this Plan is to facilitate compliance with 43 Code of Federal Regulations (CFR) 3809 regarding undue and unnecessary degradation of public lands; Chapter 603 of the Oregon Administrative Rules (OAR); and stipulations in National Environmental Policy Act (NEPA) decisions. The long-term objective of this Plan is to provide a systematic program for identifying, preventing, and treating noxious weeds with the goal of promoting sustainable and productive plant communities. Post-mining land use objectives include forage for livestock, forage and habitat for wildlife, dispersed recreation, and mineral exploration/development. Implementation of the Plan will manage the noxious weeds which pose a threat to the environmental and economic value to the Project.

1.1 Resource Study Area

The Project is located approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 2). The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or re-routing, and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be 30 feet wide, which includes a 20-foot wide road travel width (ten feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum

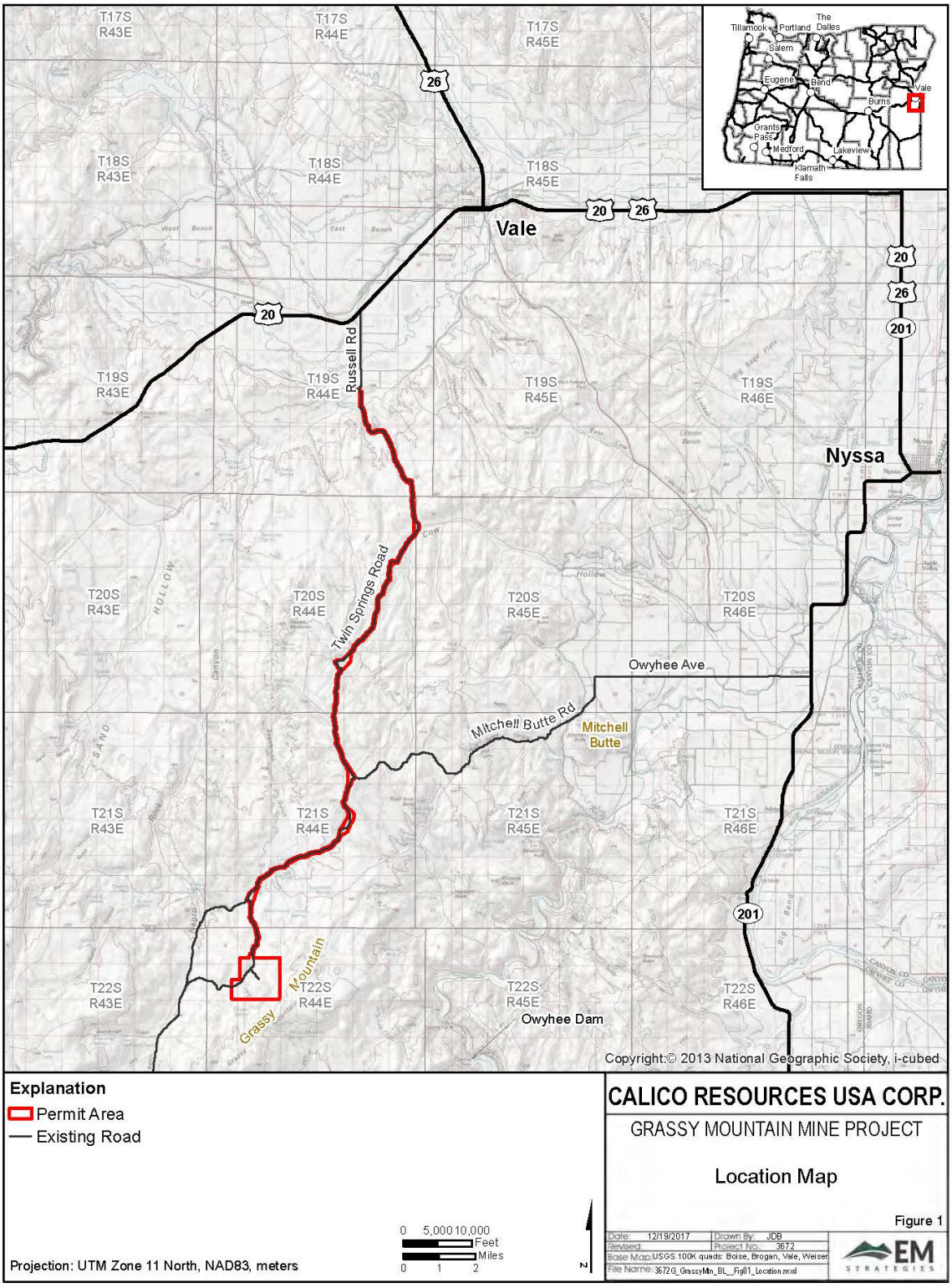


Figure 1. Location Map

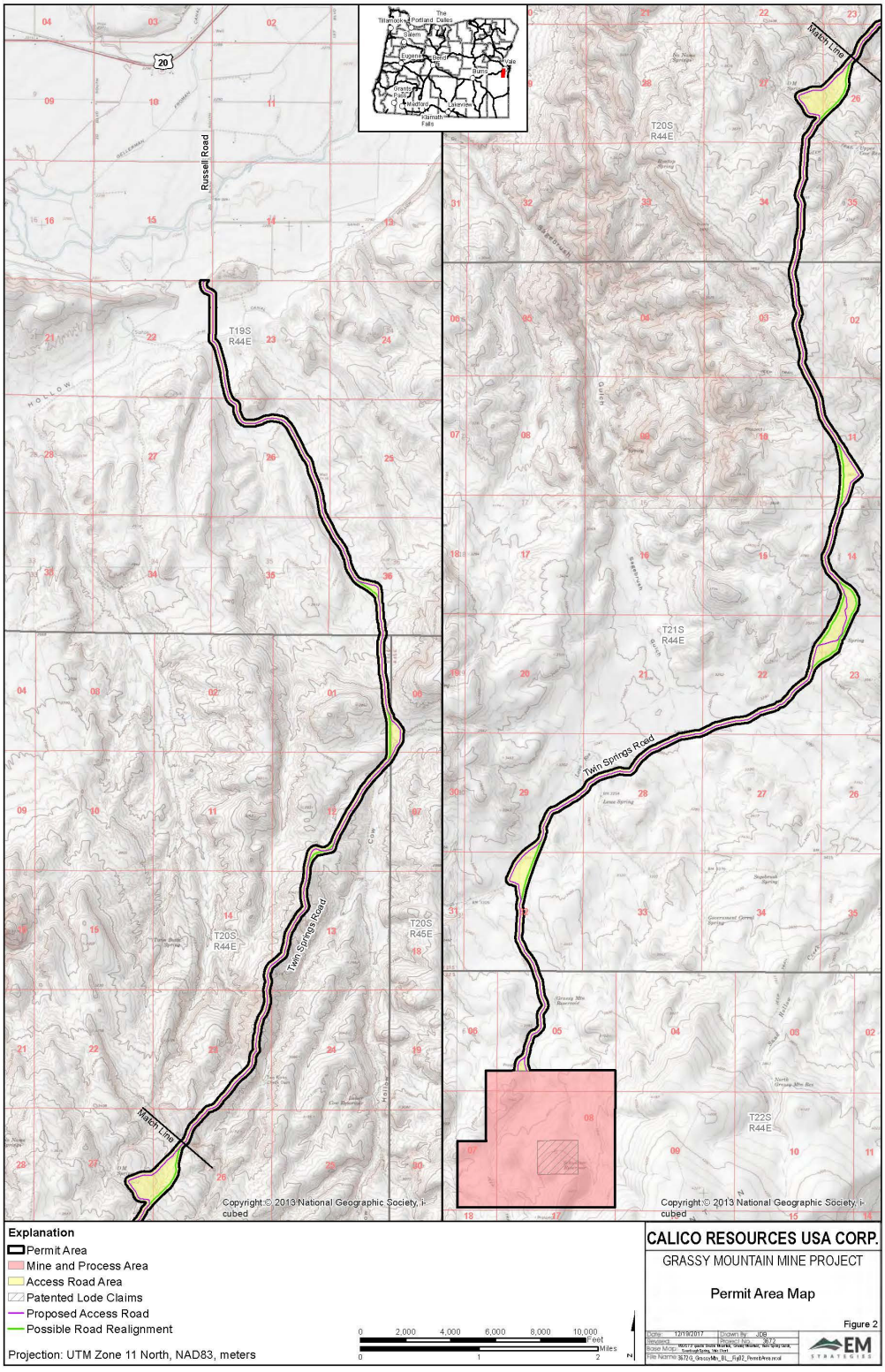


Figure 2. Permit Area Map

one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

2 REGULATORY FRAMEWORK

2.1 Federal Regulations

The Federal Noxious Weed Act of 1974 (7 United States Code [U.S.C.] 2801-2813) as amended by Sec. 15, Management of Undesirable Plants on Federal Lands 1990, requires that each federal agency: 1) designate a lead office and person trained in the management of undesirable plants; 2) establish and fund an undesirable plant management program; 3) complete and implement cooperative agreements with State agencies; and 4) establish integrated management systems to control undesirable plant species.

The BLM defines a noxious weed as "any plant designated by a federal, state or county government as injurious to public health, agriculture, recreation, wildlife or property," and "invasive plants include not only noxious weeds, but also other plants that are not native to this country or to the area where they are growing" (BLM 2011). The BLM has identified noxious weed management as a priority problem affecting public lands, and as such, has developed a policy relating to the management and coordination of noxious weed activities. This policy is set forth in *BLM Manual 9015 – Integrated Weed Management* and requires that all ground-disturbing projects and any projects that alter plant communities be assessed to determine the risks of introducing and spreading noxious weeds (BLM 1992). If the risk is moderate or higher, a weed management program needs to be established. Noxious weeds have been added as one of the critical elements of the human environment, and therefore need to be addressed in all NEPA-compliant documents.

2.1.1 State Regulations

The Oregon Department of Agriculture (ODA) has responsibility for jurisdiction, management, and enforcement of the State of Oregon's noxious weed law. Oregon defines "noxious weeds" as those that represent "the greatest public menace" and are "a top priority for action by weed control programs" (Oregon Revised Statutes [ORS] 569-350). State noxious weed laws pertain to both private and public land. The ODA maintains and updates the list of Oregon noxious weeds (Appendix A; ODA 2018a) under OAR 603-052-1200. The Oregon noxious weeds listed in OAR 603-052-1200 are further divided into the following classifications: A; B; and T.

- A Listed Weed: a weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent. Recommended action: Infestations are subject to eradication or intensive control when and where found (ODA 2018a).
- B Listed Weed: a weed of economic importance which is regionally abundant, but which may have limited distribution in some counties. Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management

plan is not feasible, biological control (when available) shall be the primary control method (ODA 2018a).

- T Designated Weed: a designated group of weed species that are selected and will be the focus for prevention and control by the Noxious Weed Control Program. Action against these weeds will receive priority. T designated noxious weeds are determined by the Oregon State Weed Board and directs ODA to develop and implement a statewide management plan. T designated noxious weeds are species selected from either the A or B list (ODA 2018a).

2.1.2 County Regulations

The entire Malheur County is a weed control district known as the Malheur County Weed District. The weed district is governed by the Malheur County Court upon recommendations from the Malheur County Weed Advisory Board. Pursuant to ORS 570.575, Malheur County has prioritized control and/or eradication of these noxious weeds by A, B, and C classes, with Class A having the highest priority (Appendix B; Malheur County 2018).

- Class A Weed: a weed of known economic/environmental importance known to occur in the county in very small numbers to make eradication practicable, or not known to occur but its status in surrounding counties makes future occurrence seem imminent. Action: Infestations are subject to eradication or intensive control when and where found (Malheur County 2018).
- Class B Weed: a weed of known economic/environmental importance and of moderate to wide distribution and highly invasive, subject to intensive control or eradication where feasible at the county level. Action: Infestations are subject to control where found, with possible county assistance when funds are available. All Class B weeds are required to be controlled within 50 feet of all property lines, easements and rights-of-way, pursuant to ORS 570.525 (Malheur County 2018).
- Class C Weed: a weed of known economic/environmental importance and of general distribution, that is subject to control or eradication as local conditions warrant. Action: Infestations are treated at landowner's discretion (Malheur County 2018).

3 PROJECT DESCRIPTION

3.1 Project Activities

Calico Resources USA Corp (Calico) plans to construct, operate, reclaim, and close an underground mining and precious metal milling operation. In general, the proposed mining and precious metal processing operations will consist of an underground mine and ore processing facilities, including a conventional mill and tailings storage facility (TSF) and a waste rock storage area (WRSA), as well as other support facilities. The Project will include the following major components:

- One underground mine;
- One WRSA;

- One carbon-in-leach processing plant;
- One borrow pit area;
- One TSF;
- Run-of-mine ore stockpile;
- One reclaim pond;
- A water supply well field and pipeline, associated water delivery pipelines, and power;
- A power substation and distribution system;
- One ventilation shaft;
- Access and haul roads;
- Ancillary facilities that include the following: haul, secondary, and exploration roads; truck workshop; warehouse; stormwater diversions; sediment control basins; reagent and fuel storage; storage and laydown yards; explosive magazines; fresh water storage; monitoring wells; meteorological station; an administration/security building; borrow areas; growth media stockpiles; a landfill; and solid and hazardous waste management facilities to manage wastes; and
- Reclamation and closure, including the potential development of an evaporation cell for the TSF.

3.2 Previous Surveys

Botanical surveys conducted in 2012, 2013, and 2015 by HDR Engineering, Inc. (HDR) (HDR 2012, 2014, 2015) and 2017 by EMS (EMS 2017) characterized vegetation within the Permit Area as a desert-rangeland type where sagebrush and grasses are the dominant species. The area has been extensively grazed for many years, and portions of the Permit Area appear to have been re-seeded at one time with a crested wheatgrass (*Agropyron cristatum*) dominated seed mix. Six plant communities were identified within the Permit Area: 1) Agricultural; 2) Bluebunch Wheatgrass/Cheatgrass/Annual; 3) Burned Yellow Rabbitbrush/Bluebunch Wheatgrass; 4) Crested Wheatgrass Seeding; 5) Wyoming Big Sagebrush/Bluebunch Wheatgrass; and 6) Wyoming Big Sagebrush/Crested Wheatgrass.

3.3 Environmental Setting

The Permit Area is in the Sourdough and Grassy Mountains at elevations ranging between 3,250 and 4,800 feet above mean sea level (amsl). According to the Western Regional Climate Center (WRCC), the average maximum temperature recorded at the Owyhee Dam, Oregon field station, located approximately five miles east of the Permit Area, is 93.6 degrees Fahrenheit (°F) in July, and the average minimum temperature is 22.4°F in January. The average annual precipitation is 9.12 inches and tends to peak in May (WRCC 2016).

3.4 Noxious and Invasive Weed Inventory

Ten noxious weed species listed on Oregon's noxious weed list were observed within the Permit Area during the 2019 botanical survey (Siskiyou Biosurvey LLC 2019). These species are listed in Table 1 below and shown on Figure 3. Cheatgrass, a Malheur County listed noxious weed, was also observed in the Permit Area, but was not mapped.

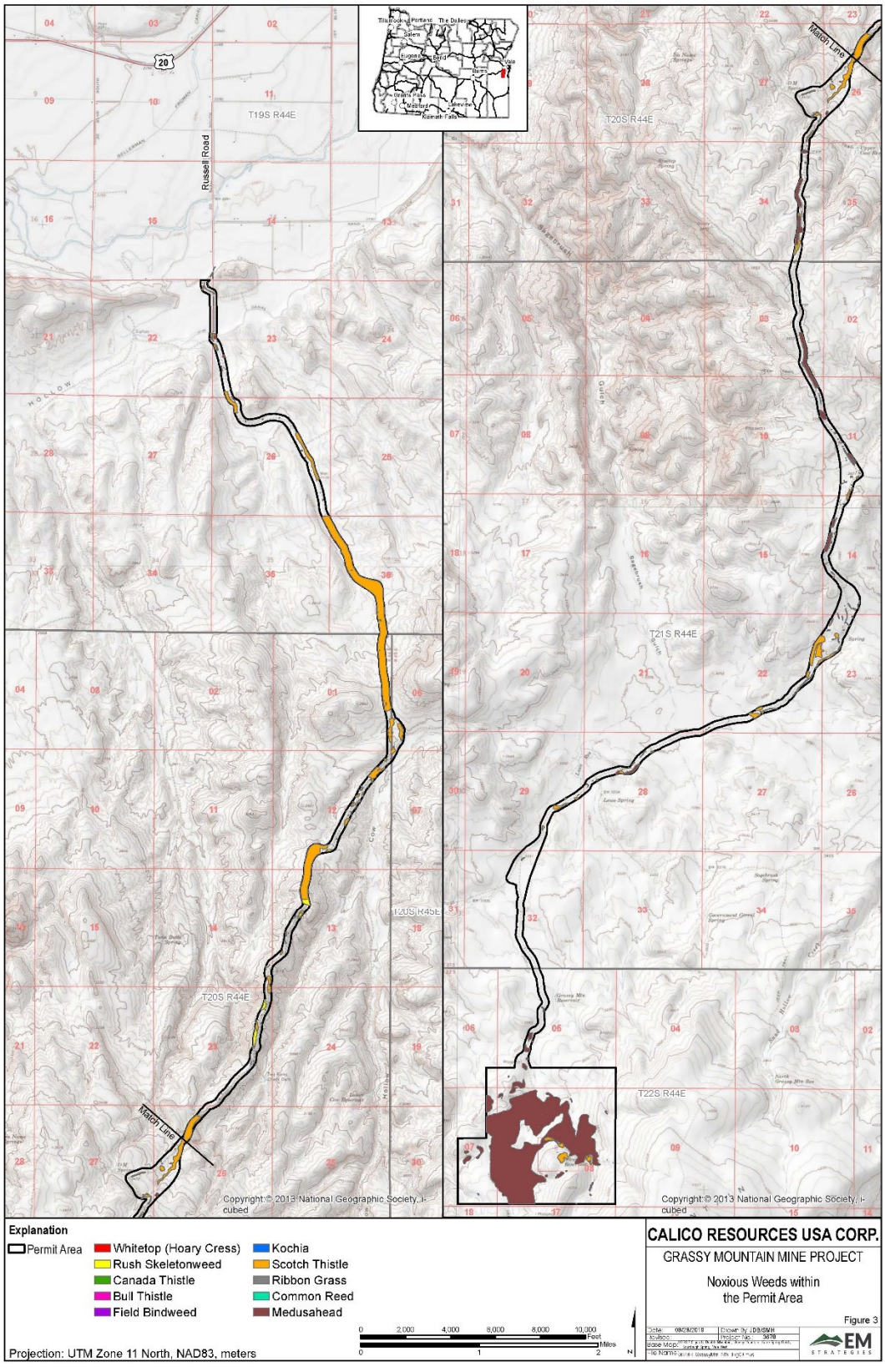


Figure 3: Noxious Weeds within the Permit Area

Table 1: Status of Noxious Weed Species in the Permit Area

Common Name	Scientific Name	Malheur County Status	Oregon Status
Cheatgrass	*Bromus tectorum*	C	n/a
Whitetop (hoary cress)	*Cardaria draba (Lepidium draba)*	B	B
Rush skeletonweed	*Chondrilla juncea*	A	B
Canada thistle	*Cirsium arvense*	B	B
Bull thistle	*Cirsium vulgare*	C	B
Field bindweed	*Convolvulus arvensis*	n/a	B
Kochia	*Kochia scoparia*	C	B
Scotch thistle	*Onopordum acanthium*	B	B
Ribbon grass	*Phalaris arundinacea*	n/a	B
Common reed	*Phragmities australis*	n/a	B
Medusahead	*Taeniatherum caput-medusae*	C	B

4 WEED MANAGEMENT STRATEGIES

Due to the presence of noxious weeds within the Permit Area and the amount of surface disturbance associated with the Project, the risk of introducing or spreading weed infestations is high, and a management program is required. The components of a noxious weed management program are prevention, treatment, and monitoring. Each component will be implemented until the final reclamation release for revegetation. Implementation of weed management techniques will be conducted in consultation with the ODA, the BLM, and/or the Malheur County Weed Inspector, as appropriate. The following sections help define how these major components will be implemented; however, site-specific methods will continue to be adapted that are appropriate to the situation, species and environment, and limitations of the Project.

4.1 Prevention

Prevention of new noxious weed infestations is the most cost-effective means of noxious weed control. Prevention, or more accurately, reduction of the potential for noxious weed establishment involves several approaches: weed management as an assigned duty; awareness and education; and implementation of cultural practices.

4.1.1 Weed Management as an Assigned Duty

The implementation of this Plan will be included in the assigned duties of Calico's Environmental Department staff. The staff will be responsible for regular monitoring of the Permit Area and developing the appropriate action for the eradication of new weed infestations. By implementing early detection followed by rapid response, the spread of noxious weeds is minimized, and eradication is achievable. In addition, the Environmental Department staff will be the repository for noxious weed observations and will be responsible for enforcement of all weed management strategies.

4.1.2 Awareness and Education

Identification and eradication of the first noxious weed to establish in an area translates into major cost savings over treatment of large or multiple patches of weeds. The first weed can only

be detected if mine personnel can identify the plant as a noxious weed. Not every employee is required to be able to identify noxious weeds; however, key mine personnel will have training in noxious weed identification on an as-needed basis. Noxious weed identification training will occur during late winter or early spring, and an annual refresher course will be conducted if needed. As noxious weeds are detected, these trained individuals will visit the infestations to reinforce the noxious weed identification training. Therefore, the purpose of the noxious weed training is for personnel to be able to identify common, local invasive plants, incorporate simple techniques to prevent new infestations or prevent the spread of noxious weeds, and monitor the progress of treated infestations.

The Malheur County Weed Advisory Board offers information on identifying weeds and how to prevent their spread: https://www.malheurco.org/weed-inspector/weeds/. In addition, the ODA provides the Western US Invasive Plant EDRR [Early Detection and Rapid Response] Guide to Oregonians to aid in EDRR to noxious weed infestations: https://www.oregon.gov/ODA/shared/Documents/Publications/Weeds/WesternUSInvasivePlantEDRRWeedIDGuide.pdf.

4.2 Protective Management Practices

Protective management practices are changes in land management practices from practices that create favorable conditions for weed establishment to practices that reduce the potential for weed establishment. They reduce the potential for weed invasion and increase the effectiveness of other weed prevention or control methods. One or more of these practices will be implemented if monitoring indicates that these measures are necessary:

- Interim seeding of long-term disturbance. Road berms, sediment basins, growth media stockpiles, and other sites that will have exposed soil for more than one growing season will be seeded with an interim seed mix. The interim seed mix will be certified pure live seed and weed free and include bluebunch wheatgrass (*Pseudoroegneria spicata*) and bottlebrush squirreltail (*Elymus elymoides*), which are two aggressive native perennial grass species capable of competing with invasive annual plants. The establishment of native vegetation on these sites will reduce the potential for noxious weeds and other nonnative and invasive species to establish.

- Road maintenance. The Environmental Department staff will be responsible for overseeing road maintenance activities so that areas infested with weeds are not bladed. Road maintenance activities can spread seeds or weed parts that can establish in new locations. If necessary, weed infestations will be treated manually and removed before any road maintenance activity is conducted.

- Minimize disturbance to existing vegetation. Vehicles will be confined to existing roadways and not permitted to conduct cross-country travel, unless involved in approved activity (e.g., mining), to reduce the potential for new weed establishment.

- Maintain desired plant communities. Resistance to weed establishment is greatly increased by maintaining vegetation communities with native and desirable species.

- Effective reclamation. Whenever feasible, earthwork and reclamation seeding will occur within the same year to allow the seeded species to establish before non-native, invasive species and noxious weeds can dominate the reclaimed surfaces. Using species in a seed mix that have been successful in previous reclamation efforts, and seed suited for site conditions, will also reduce the potential for noxious weed establishment by providing a dense perennial plant cover. Reclamation seed mixes will be certified pure live seed and weed free. Plantings may serve as an additional option or in conjunction with reclamation seeding and will be determined on an as needed basis. Noxious weeds will not be counted towards vegetative cover during evaluations of re-vegetation bond release.

- Certified weed-free materials. Seed and mulch used in reclamation and straw bales used for sediment control will be certified weed free.

- Apply seed to treated areas. Any location that has been treated for noxious weeds will be seeded with either the interim seed mix or reclamation seed mix during the fall after treatment. Leaving the area fallow after treatment increases the risk that either the same species or another species of noxious weed or non-native, invasive species will establish on the site.

- Avoid travel through infested areas. Ensure that personnel and contractors avoid, as much as possible, travel through areas which are identified as containing noxious weeds to prevent their spread to uncontaminated areas.

- Decontaminate vehicles. Personnel or contractors, who transport equipment on site, or those that must travel through identified noxious weed areas, are required to power wash vehicles and equipment to ensure that the spread of noxious weed seeds are minimized. Prior to mine site access, all contractors are required to check-in at the mine site administrative offices. Contractors will be expected to wash vehicles locally prior to accessing the site, or when this is not possible, on-site decontamination procedures will use high pressure water hoses to spray down all areas of the vehicle and equipment which have the potential to collect noxious weeds or noxious weed seeds. A vehicle wash bay facility will be located adjacent to the truck workshop and warehouse. The main areas on vehicles that will be decontaminated will include, but are not limited to, the equipment tracks, tires, undercarriage, axles, wheel wells, running boards, bumpers, and brush guard assemblies.

- Segregate topsoil. In areas that are to be cleared and where noxious weeds have been identified, Calico will ensure that the topsoil contaminated with noxious weeds will be cleared first and will be encapsulated in the TSF.

- Disposal. Noxious weeds that are mechanically removed will be disposed of in a location and manner acceptable to the ODA.

4.3 Treatment

Noxious weed treatment identifies how areas infested with noxious weeds will be handled to prevent the spread of the infestation and control or eliminate noxious weeds within the Permit Area. The goal of noxious weed treatment is to reduce infestations below the level at which they cause failure to achieve reclamation revegetation success criteria or displace native species. The treatment methods used, and the timing of treatment will be determined on a species-specific basis to be most effective. Generally, treatment will occur prior to seed production. The general types of treatment methods that Calico has outlined as potentially useful for the Project are described in the following subsections. Specific treatment recommendations for the five noxious weeds known to occur within the Permit Area (Section 3.4) are included in Appendix C (DiTomaso 2013).

4.3.1 Mechanical Treatment

Mechanical eradication is a technique in which physical methods or equipment is used to damage or destroy the target plant (USFWS 2009; Donaldson 2013). Mechanical treatments include any form of physical destruction of the plant (e.g., pulling, mowing, cutting, and grazing). However, mechanical treatment may cause favorable conditions for some weeds' reproductive mechanisms and should therefore be considered carefully prior to initiation (USFWS 2009).

Pulling is most effective in controlling the spread of new infestations by neutralizing the weed prior to seed dispersal. This treatment works best for the following: small infestations; annual or biennial plants; shallow-rooted plant species that do not sprout from residual roots; plants that grow on sandy or gravelly soils; difficult areas to access that prevent the use of chemical, motorized equipment, or livestock; or small infestations that will reduce or eliminate seed production. Weed species that are good candidates for the pulling method include: bull thistle (*Cirsium vulgare*); medusahead rye (*Taeniatherum caput-medusae*); musk thistle (*Carduus nutans*); puncturevine (*Tribulus terrestris*); scotch thistle (*Onopordum acanthium*); and yellow starthistle (*Centaurea solstitialis*) (Donaldson 2013).

Mowing and cutting employ mechanical or hand tools to separate the plant from its roots. Mowing works best for large, relatively flat and dry areas with minimal safety concerns; large-scale restoration sites where weeds need to be controlled during the first or second growing season; and areas where repeated mowing will weaken weed plants by depleting root and rhizome reserves. Cutting can be utilized for small infestations of fleshy-stemmed biennial thistles or for tall biennial weed species prior to seed dispersal, in combination with herbicide treatments, and for weed species that spread seeds through a "tumbling action" (i.e. diffuse knapweed [*Centaurea diffusa*]) (Donaldson 2013).

The use of grazing animals is sometimes considered a form of mechanical treatment, since the plants are generally physically damaged which minimizes growth. Horses, cattle, sheep, and goats can be used to selectively overgraze certain weed species. Overgrazing results in a weakened state whereby the efficacy of herbicide treatments is increased. However, noxious weeds vary greatly in their palatability to different types of livestock and implementation should be carefully

weighed against the transfer of weed seed by the livestock, scale of the infestation, potential damage to desirable species, and livestock behavior response (Davison et al. 2006).

4.3.2 Prescribed Burning

Prescribed burning entails planning, setting, and managing controlled fires. A controlled burn will only eradicate noxious weeds and will not likely have any effect on noxious weed seeds. Controlled burns should only be used if a favorable vegetative species can repopulate an area without the noxious weed reappearing. This type of treatment does not treat already felled seeds in the plant bed and is only successful if the treated area is reseeded with a favorable seed mix. Prescribed burning typically requires a permit and is limited to certain times of the year. Rarely will prescribed burning provide adequate control of most invasive plant species (USFWS 2009).

4.3.3 Chemical Treatment

Chemical treatment involves using herbicides to efficiently and effectively suppress or kill noxious weed species. Chemical treatment may be a necessary technique when treating a large noxious weed infestation as an effective way to reduce weed populations prior to secondary treatment. This is also a common technique when complete eradication is the land management goal. There are many types of herbicides; some are derived from plants (e.g., nicotine-based herbicides) or are manufactured synthetically (e.g., 2,4-D). Herbicides can be classified in terms of their mode of action and include growth regulators, amino acid inhibitors, grass meristem destroyers, cell membrane destroyers, root and shoot inhibitors, and amino acid derivatives which interfere with plant metabolism in a variety of ways (Donaldson 2013). The choice of which herbicide is best for a situation depends on the target weed species, the presence of other desirable plant species, soil texture, depth, distance to water, and environmental conditions (Bussan and Dyer 1999). When using herbicides, considerations should be given to the safety of the environment and the individuals applying the herbicide, costs to apply, and the effectiveness of the material used.

Any chemical weed control efforts on public lands will be coordinated and approved by the Malheur County Weed Inspector and/or the BLM as needed. Appendix C includes a list of Oregon Pesticides of Interest and Oregon Pesticides of Concern. Appendix D includes the list of BLM-approved herbicides. Herbicide application will conform to all federal and state regulations and herbicides will be applied by certified applicators, or under the direct supervision of a certified applicator (BLM Manual 9011). Not all herbicides have been approved for use on public lands; therefore, the choice of treatments on public lands may be limited. The following subsections describe techniques to be utilized during the lifetime of the Project with respect to certain areas of concern.

Selective Site Sterilization

Federal mine safety standards require areas surrounding facilities such as fuel storage tanks and power transformers to remain free of vegetation (30 CFR 56.4130). These areas will be treated annually, or as needed with an approved soil sterilant. This spray will be conducted by a licensed pesticide contractor. The selection, use, storage, and disposal of chemicals used as a function of

this Plan will be conducted according to manufacturer's recommendations and applicable state and federal laws.

Biennial Weed Spraying

Biennial weed spraying will help control or eradicate existing infestations. Additional weed treatment will be performed on an as needed basis to supplement biennial efforts. Weed treatments for infestations within the Permit Area and selected areas adjacent to the Permit Area will be conducted by a licensed pesticide contractor. This task will be directed and managed by the Project's Environmental Department staff. These treatment efforts are usually performed in early spring for herbaceous species such as Canada thistle, hoary cress (*Cardaria draba*), perennial pepperweed (*Lepidium latifolium*), and Russian knapweed (*Acroptilon repens*) and in mid to late summer for woody species such as salt cedar (*Tamarix* spp.) (Bussan and Dyer 1999). The selection, use, storage, and disposal of chemicals used as a function of this Plan will be conducted according to manufacturer's recommendations and applicable laws or regulations.

Any application of herbicide over, in, or within three feet of waters of the state (as defined in ORS 468B.005) would require compliance with the Pesticide General Permit (2300A). Waters of the state within the Permit Area include two wetlands totaling 0.2 acre and the J-H Canal (EMS 2018). Calico will avoid spraying herbicides over, in, or within three feet of the two wetland features and J-H Canal. If weed eradication becomes necessary within three feet of the two wetland features or J-H Canal, Calico will utilize mechanical treatment techniques using hand tools.

4.3.4 Biological Treatment

Biological treatment often involves using insects or livestock to control weed populations and reduce their abundance to acceptable levels (Wilson and McCaffrey 1999). Other biological organisms that specifically target the weed species of concern may also be used and can include fungi or diseases. Biological treatment is often used in conjunction with another treatment method. Depending on the severity of the noxious weed infestation, biological treatment can sometimes be used as the sole control measure. Biological treatments often only reduce infestations to manageable sizes for secondary treatment or can often reduce a population to the point where native species can overgrow the noxious species. The ODA provides information on biological treatment for specific species on their website: http://www.oregon.gov/ODA/programs/Weeds/Pages/BiologicalControl.aspx.

The ODA's Noxious Weed Program has been utilizing biological treatment for the control of invasive weeds since 1947 and currently manages over 120 biocontrol projects (weed/biological agent combinations) (ODA 2018b). They have demonstrated success in controlling targeted invasive weeds, including tansy ragwort (*Senecio jacobaea*), St. Johnswort (*Hypericum perforatum*), musk thistle, Mediterranean sage (*Salvia aethiopis*), purple loosestrife (*Lythrum salicaria*), yellow starthistle, Dalmatian toadflax (*Linaria dalmatica*), and diffuse knapweed.

4.3.5 Protection of Wildlife Habitat Areas

It is important, when determining a treatment mechanism, to recognize potential environmental parameters that may require specific considerations. Some areas within the Permit Area may require special treatment because of the habitat requirements for some wildlife species. This may include proximity to waterways, migration habitats, grazing habitats, and other wildlife specific requirements.

5 WEED MONITORING

Continued monitoring is an integral part of management and elimination of noxious weeds. The two main objectives of monitoring for noxious weeds are to identify new infestations and to evaluate the effectiveness of noxious weed treatments. Two types of weed surveys will be performed regularly at the Project. An informal survey will be carried out annually by Environmental Department staff. Specific areas of the Permit Area will be inspected such as roads, berms, WRSAs, process facilities, laydown yards, reclaimed areas, stormwater diversions, and growth media stockpiles, since these are often areas susceptible to weed establishment. The results of the annual surveys will be used to direct weed management efforts for the year and be the basis for updating the Plan.

Formal weed surveys will be performed on a biennial basis, until the final reclamation release of revegetation. The results of these surveys will be documented in a report, which will be provided to the BLM. Areas of noxious weed infestations noted during the annual and biennial surveys will be recorded with a GPS unit, and documented on area maps and with photographs. Notes regarding the size of the infestation, vigor of the plants, density of the plants, success of establishment of desired species seeded after treatment, and recommendations for follow-up treatment will be taken. This information provides a record of the noxious weed control that has been conducted and the effectiveness of the treatment program. This information will also document whether the cultural practice of post-treatment seeding, if implemented, is successful in reducing the potential of the reestablishment of noxious weeds. It is important to note, from year to year, if the infestation areas are increasing or decreasing in size and to track the phenology stages of the weed species. The monitoring frequency required for effective noxious weed management, for different areas within the Project, will vary, as will the treatment methodology.

Any new noxious weed infestations identified during weed monitoring efforts will also be reported to ODA using the Report and Identification Form provided online at: https://data.oda.state.or.us/fmi/webd/WebSubmissions?script=RedirectWebSubmissions&param=Invasive. The reports are filled out and submitted online.

Calico will monitor the effectiveness of previous years' treatment methodologies to determine if alternate measures should be taken to reduce or eliminate existing infestations, reduce seed production, and prevent future infestations. Infestations treated previously or found after the growing season will be monitored in the spring to determine if the treatment has been effective and to include the sites in the biennial treatment plan, as necessary. Seeds of noxious weeds can

remain viable in the soil for several years; therefore, treated areas will be monitored for a period of several years after eradication to ensure new plants do not establish.

6 CONCLUSIONS

Calico will utilize prevention and treatment techniques as described in the Plan and approved by the ODA and/or the BLM to reduce the risk of introduction or spread of noxious weeds in the Permit Area. If monitoring identifies additional noxious weed species, the treatments outlined above will be implemented as necessary. This Plan is considered preliminary and will be updated for suitability and adequacy as the Project progresses.

7 REFERENCES

Bureau of Land Management (BLM). 1991. *Chemical Pest Control.* BLM Manual 9011.

_____. 1992. *Integrated Weed Management.* BLM Manual 9015. December 2, 1992.

_____. 2011. U.S. Department of the Interior web site. June 27, 2011. *What are Noxious and Invasive Weeds?* www.blm.gov/wo/st/en/prog/more/weeds/weed_definition.html.

Bussan, A.J., and W.E. Dyer. 1999. *Herbicides and Rangeland*. Biology and Management of Noxious Rangeland Weeds. Oregon State University, Corvallis, Oregon. Pages 116-132.

Davison, J.C., E. Smith, and L.M. Wilson. 2006. *Livestock Grazing Guidelines for Controlling Noxious Weeds in the Western United States*. A Western Region Sustainable Agriculture, Research and Education Project Report. http://www.unce.unr.edu/publications/files/Ag/2006/ebo605.pdf. Accessed October 30, 2014.

DiTomaso, J. 2013. *Weed Control in Natural Areas of the Western United States.* Weed Research and Information Center, University of California. 544 pages.

Donaldson, S. 2013. *Weed Warriors Curriculum*. University of Nevada Cooperative Extension. May 2013. Pp. 319.

EM Strategies, Inc. (EMS) 2017. Baseline Vegetation Survey of the Grassy Mountain Exploration Project Expansion Area. Finalized 2018.

_____. 2018. Wetland Delineation Report for Grassy Mountain Mine Project Malheur County. Finalized 2018.

HDR Engineering, Inc. 2012. Draft Terrestrial Vegetation Report, Grassy Mountain Exploration Project. July 2012. Unpubl. 40 pp.

_____. 2014. Draft Terrestrial Vegetation Baseline Study, Grassy Mountain Exploration Project. May 2014. Unpubl. 84pp.

_____. 2015. Draft Terrestrial Vegetation Baseline Study, Addendum 1, Grassy Mountain Exploration Project. July 2015. Unpubl. 44pp.

Malheur County. 2019. *Public Notice: Malheur County Noxious Weed Control*. https://www.malheurco.org/wp-content/uploads/Departments/Weed/MalheurWeedList.pdf. Accessed February 6, 2019.

Oregon Department of Agriculture (ODA). 2018a. *Noxious Weed Policy and Classification System 2018*. https://www.oregon.gov/ODA/shared/Documents/Publications/Weeds/NoxiousWeedPolicyClassification.pdf. Accessed February 6, 2019.

_____. 2018b. Invasive Noxious Weed Control Program 2017 Annual Report. Available online at https://www.oregon.gov/ODA/shared/Documents/Publications/Weeds/NoxiousWeedProgramAnnualReport.pdf. Accessed February 6, 2019.

Siskiyou Biosurvey LLC. 2019. *Botanical Survey & Vegetation Community Mapping Report, Grassy Mountain Mine Project, Malheur County, Oregon*. June 2019.

United States Fish and Wildlife Service (USFWS). 2009. *Managing Invasive Plants: Concepts, Principles, and Practices*. Available online at: https://www.fws.gov/invasives/stafftrainingmodule/. Accessed February 6, 2019.

Western Regional Climate Center (WRCC). 2016. *Western U.S. Climate Historical Summary for Owyhee Dam Oregon*. https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?or6405. Accessed February 6, 2019.

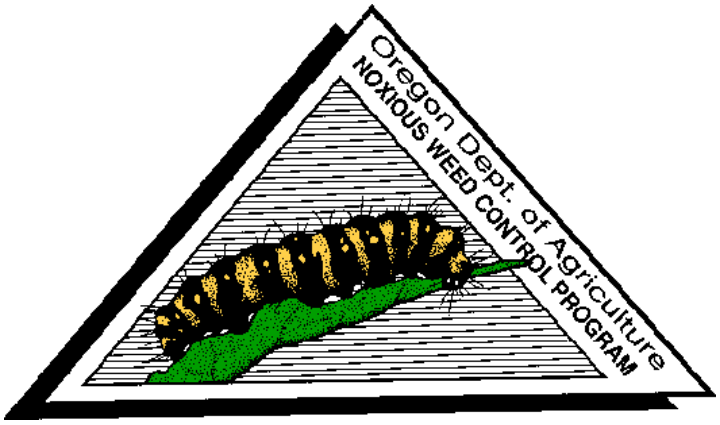
Wilson, L.M. and J.P. McCaffrey. 1999. *Biological control of noxious rangeland weeds*. Pages 97–116 *In* R.L. Sheley and J.K. Petroff, eds. Biology and Management of Noxious Rangeland Weeds. Corvallis, OR: Oregon State University Press.

APPENDIX A

OREGON DEPARTMENT OF AGRICULTURE (ODA)
OREGON NOXIOUS WEED POLICY AND CLASSIFICATION SYSTEM

Oregon Department of Agriculture

Noxious Weed Policy and Classification System 2018



Noxious Weed Control Program

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Phone: (503) 986-4621 **Fax:** (503) 986-4786
www.oregon.gov/ODA/programs/Weeds/Pages/AboutWeeds.aspx

Mission Statement

To protect Oregon's natural resources and agricultural economy from the invasion and proliferation of invasive noxious weeds.

Program Overview

The Oregon Department of Agriculture (ODA) Noxious Weed Control Program provides statewide leadership for coordination and management of state listed noxious weeds. The state program focuses on noxious weed control efforts by implementing early detection and rapid response projects for new invasive noxious weeds, implementing biological control, implementing statewide inventory and survey, assisting the public and cooperators through technology transfer and noxious weed education, maintaining noxious weed data and maps for priority listed noxious weeds, and assisting land managers and cooperators with integrated weed management projects. The Noxious Weed Control Program also supports the Oregon State Weed Board (OSWB) with administration of the OSWB Grant Program, developing statewide management objectives, developing Weed Risk Assessments, and maintaining the State Noxious Weed List.

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Noxious Weed Control Policy and Classification System

Definition

"Noxious Weed" means a terrestrial, aquatic or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.

Noxious weeds have become so thoroughly established and are spreading so rapidly on private, state, county, and federally owned lands, that they have been declared by ORS 569-350 to be a menace to public welfare. Steps leading to eradication, where possible, and intensive control are necessary. It is further recognized that the responsibility for eradication and intensive control rests not only on the private landowner and operator, but also on the county, state, and federal government.

Weed Control Policy

Therefore, it shall be the policy of ODA to:

1. Assess non-native plants through risk assessment processes and make recommendations to the State Weed Board for potential listing.
2. Rate and classify weeds at the state level.
3. Prevent the establishment and spread of listed noxious weeds.
4. Encourage and implement the control or containment of infestations of listed noxious weed species and, if possible, eradicate them.
5. Develop and manage a biological weed control program.
6. Increase awareness of potential economic losses and other undesirable effects of existing and newly invading noxious weeds, and to act as a resource center for the dissemination of information.
7. Encourage and assist in the organization and operation of noxious weed control programs with government agencies and other weed management entities.
8. Develop partnerships with county weed control districts, universities, and other cooperators in the development of control methods.
9. Conduct statewide noxious weed surveys and weed control efficacy studies.

Weed Classification System

The purpose of this Classification System is to:

1. Act as the ODA's official guideline for prioritizing and implementing noxious weed control projects.
2. Assist the ODA in the distribution of available funds through Oregon State Weed Board to assist county weed programs, cooperative weed management groups, private landowners, and other weed management entities.
3. Serve as a model for private and public sectors in developing noxious weed classification systems that aid in setting effective noxious weed control strategies.

Criteria for Determining Economic and Environmental Significance of Noxious Weeds is Based Upon:

Detrimental Effects

1. A plant species that causes or has the potential to cause severe negative impacts to Oregon's agricultural economy and natural resources.
2. A plant species that has the potential to or does endanger native flora and fauna by its encroachment into forest, range, and conservation areas.
3. A plant species that has the potential or does hamper the full utilization and enjoyment of recreational areas.
4. A plant species that is poisonous, injurious, or otherwise harmful to humans and/or animals.

Plant Reproduction

1. A plant that reproduces by seed capable of being dispersed over wide areas or that is long-lived, or produced in large numbers.
2. A plant species that reproduces and spreads by tubers, creeping roots, stolons, rhizomes, or other natural vegetative means.

Distribution

1. A weed of known economic importance which occurs in Oregon in small enough infestations to make eradication/containment possible; or not known to occur, but its presence in neighboring states makes future occurrence seem imminent.
2. A weed of economic or ecological importance and of limited distribution in Oregon.
3. A weed that has not infested the full extent of its potential habitat in Oregon.

Difficulty of Control

A plant species that is not easily controlled with current management practices such as chemical, cultural, biological, and physical methods.

Noxious Weed Control Classification Definitions

Noxious weeds, for the purpose of this system, shall be listed as either A or B, and may also be designated as T, which are priority targets for control, as directed by the Oregon State Weed Board.

- A Listed Weed:

  A weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table I).

  Recommended action: Infestations are subject to eradication or intensive control when and where found.

- B Listed Weed:

  A weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table II).

  Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.

- T Designated Weed (T):

  A designated group of weed species that are selected and will be the focus for prevention and control by the Noxious Weed Control Program. Action against these weeds will receive priority. T designated noxious weeds are determined by the Oregon State Weed Board and directs ODA to develop and implement a statewide management plan. T designated noxious weeds are species selected from either the A or B list.

Table I: A Listed Weeds

Common Name	Scientific Name
African rue (T)	*Peganum harmala*
Cape-ivy (T)	*Delairea odorata*
Camelthorn	*Alhagi pseudalhagi*
Coltsfoot	*Tussilago farfara*
Cordgrass	
Common (T)	*Spartina anglica*
Dense-flowered (T)	*Spartina densiflora*
Saltmeadow (T)	*Spartina patens*
Smooth (T)	*Spartina alterniflora*
Common frogbit	*Hydrocharis morsus-ranae*
Delta arrowhead	*Sagittaria platyphyla*
European water chestnut	*Trapa natans*
Flowering rush (T)	*Butomus umbellatus*
Garden yellow loosestrife (T)	*Lysimachia vulgaris*
Giant hogweed (T)	*Heracleum mantegazzianum*
Goatgrass	
Barbed (T)	*Aegilops triuncialis*
Ovate	*Aegilops ovata*
Goatsrue (T)	*Galega officinalis*
Hawkweed	
King-devil	*Pilosella piloselloides (Hieracium)*
Mouse-ear (T)	*Pilosella pilosella (Hieracium)*
Orange (T)	*Pilosella aurantiacum (Hieracium)*
Yellow (T)	*Pilosella floribundum (Hieracium)*
Hoary alyssum (T)	*Berteroa incana*
Hydrilla	*Hydrilla verticillata*
Japanese dodder	*Cuscuta japonica*
Kudzu (T)	*Pueraria lobata*
Matgrass (T)	*Nardus stricta*
Oblong spurge (T)	*Euphorbia oblongata*
Paterson's curse (T)	*Echium plantagineum*
Purple nutsedge	*Cyperus rotundus*
Ravennagrass (T)	*Saccharum ravennae*
Silverleaf nightshade	*Solanum elaeagnifolium*
West Indian spongeplant	*Limnobium laevigatum*

(T) T Designated Weed (See page 4)

(Continued) Table I: A Listed Weeds

Common Name	Scientific Name
Squarrose knapweed (T)	*Centaurea virgata*
Starthistle	
Iberian (T)	*Centaurea iberica*
Purple (T)	*Centaurea calcitrapa*
Syrian bean-caper	*Zygophyllum fabago*
Thistle	
Plumeless (T)	*Carduus acanthoides*
Smooth distaff	*Carthamus baeticus*
Taurian (T)	*Onopordum tauricum*
Welted (Curly plumeless) (T)	*Carduus crispus*
Woolly distaff (T)	*Carthamus lanatus*
Water soldiers	*Stratiotes aloides*
White bryonia	*Bryonia alba*
Yellow floating heart (T)	*Nymphoides peltata*
Yellowtuft (T)	*Alyssum murale, A. corsicum*

(T) T Designated Weed (See page 4)

Table II: B Listed Weeds

Common Name	Scientific Name
Armenian (Himalayan) blackberry	*Rubus armeniacus (R. procerus, R. discolor)*
Biddy-biddy	*Acaena novae-zelandiae*
Broom	
French*	*Genista monspessulana*
Portuguese (T)	*Cytisus striatus*
Scotch*	*Cytisus scoparius*
Spanish	*Spartium junceum*
Buffalobur	*Solanum rostratum*
Butterfly bush	*Buddleja davidii (B. variabilis)*
Common bugloss (T)	*Anchusa officinalis*
Common crupina	*Crupina vulgaris*
Common reed	*Phragmities australis ssp. australis*
Creeping yellow cress	*Rorippa sylvestris*
Cutleaf teasel	*Dipsacus laciniatus*
Dodder	*Cuscuta* spp.
Dyer's woad	*Isatis tinctoria*
Ivy	
Atlantic	*Hedera hibernica*
English	*Hedera helix*
Eurasian watermilfoil	*Myriophyllum spicatum*
False brome	*Brachypodium sylvaticum*
Field bindweed* (T)	*Convolvulus arvensis*
Garlic mustard (T)	*Alliaria petiolata*
Geranium	
Herb Robert	*Geranium robertianum*
Shiny leaf geranium	*Geranium lucidum*
Gorse* (T)	*Ulex europaeus*
Halogeton	*Halogeton glomeratus*
Houndstongue	*Cynoglossum officinale*
Indigo bush	*Amorpha fruticosa*
Johnsongrass	*Sorghum halepense*
Jointed goatgrass	*Aegilops cylindrica*
Jubata grass	*Cortaderia jubata*

* Targeted for biocontrol (T) T Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Knapweed	
Diffuse*	*Centaurea diffusa*
Meadow*	*Centaurea pratensis*
Russian*	*Acroptilon repens*
Spotted* (T)	*Centaurea stoebe (C. maculosa)*
Knotweed	
Giant	*Fallopia sachalinensis (Polygonum)*
Himalayan	*Polygonum polystachyum*
Japanese	*Fallopia japonica (Polygonum)*
Kochia	*Kochia scoparia*
Lesser celandine	*Ranunculus ficaria*
Meadow hawkweed (T)	*Pilosella caespitosum (Hieracium)*
Mediterranean sage	*Salvia aethiopis*
Medusahead rye	*Taeniatherum caput-medusae*
Old man's beard	*Clematis vitalba*
Parrot feather	*Myriophyllum aquaticum*
Perennial peavine	*Lathyrus latifolius*
Perennial pepperweed (T)	*Lepidium latifolium*
Pheasant's eye	*Adonis aestivalis*
Poison hemlock	*Conium maculatum*
Policeman's helmet	*Impatiens glandulifera*
Puncturevine*	*Tribulus terrestris*
Purple loosestrife*	*Lythrum salicaria*
Ragweed	*Ambrosia artemisiifolia*
Ribbongrass (T)	*Phalaris arundinacea var. Picta*
Rush skeletonweed* (T)	*Chondrilla juncea*
Saltcedar* (T)	*Tamarix ramosissima*
Small broomrape	*Orabanche minor*
South American waterweed	*Egeria densa (Elodea)*
Spanish heath	*Erica lusitanica*
Spikeweed	*Hemizonia pungens*
Spiny cocklebur	*Xanthium spinosum*
Spurge laurel	*Daphne laureola*

* Targeted for biocontrol (T) T Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Spurge	
Leafy* (T)	*Euphorbia esula*
Myrtle	*Euphorbia myrsinites*
St. Johnswort*	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Swainsonpea	*Sphaerophysa salsula*
Tansy ragwort* (T)	*Senecio jacobaea (Jacobaea vulgaris)*
Thistle	
Bull*	*Cirsium vulgare*
Canada*	*Cirsium arvense*
Italian	*Carduus pycnocephalus*
Milk*	*Silybum marianum*
Musk*	*Carduus nutans*
Scotch	*Onopordum acanthium*
Slender-flowered*	*Carduus tenuiflorus*
Toadflax	
Dalmatian* (T)	*Linaria dalmatica*
Yellow*	*Linaria vulgaris*
Tree of heaven	*Ailanthus altissima*
Velvetleaf	*Abutilon theophrasti*
Primrose Willow	
Large-flower (T)	*Ludwigia grandiflora*
Water primrose (T)	*Ludwigia hexapetala*
Floating (T)	*Ludwigia peploides*
Whitetop	
Hairy	*Lepidium pubescens*
Lens-podded	*Lepidium chalepensis*
Whitetop (hoary cress)	*Lepidium draba*
Yellow archangel	*Lamiastrum galeobdolon*
Yellow flag iris	*Iris pseudacorus*
Yellow nutsedge	*Cyperus esculentus*
Yellow starthistle*	*Centaurea solstitialis*

* Targeted for biocontrol (T) T Designated Weed (See page 4)

Oregon
Department
of Agriculture

Created 4/2018

APPENDIX B

MALHEUR COUNTY NOXIOUS WEED CONTROL
PUBLIC NOTICE

Public Notice
Malheur County Noxious Weed Control

WEED DISTRICT: The entire Malheur County is a weed control district known as the Malheur County Weed District. The weed district is governed by the Malheur County Court upon recommendations from the Malheur County Weed Advisory Board.

DESIGNATION OF NOXIOUS WEEDS: Pursuant to ORS 570.575 the following named plants are designated by the Malheur County Court to be injurious to public health, crops, livestock, land, or other property and are noxious.

It is the responsibility of private landowners the County, State and Federal governments to eradicate and control these weeds on their respective jurisdictions. Malheur County has prioritized control and/or eradication of these noxious weeds by "A" "B" & "C" classes, with Class A having the highest priority. Priorities may be adjusted by geographic areas at the recommendation of the Weed Advisory Board.

CLASS "A" WEED: A weed of known economic/environmental importance known to occur in the county in very small numbers to make eradication practicable, or not known to occur but its status in surrounding counties makes future occurrence seem imminent.

ACTION – infestations are subject to mandatory control/eradication where found with possible county assistance when funds are available.

COMMON NAME	*SCIENTIFIC NAME*
Austrian Peaweed	*Sphaerophysa salusula*
Common Crupina	*Crupina Vulgaris*
Big-Headed knapweed	*Centaurea macrocephala*
Buffalobur	*Solanum rostratum*
Camelthorn	*Alhagi pseudalhagi*
Dalmation toadflax	*Centaurea diffusa*
Dyers woad	*Isatis tinctoria*
Featherheaded knapweed	*Centaurea trichocephala*
Hydrilla	*Hydrilla venticillata*
Iberian starthistle	*Centaurea iberica*
Italian thistle	*Carduus pycnocephalus*
Jimsonweed	*Datera stramonium*
Johnsongrass	*Sorgum halepense*
Jointed goatgrass	*Aegilops cylindrical*

COMMON NAME	*SCIENTIFIC NAME*
Leafy spurge	*Euphorbia esula*
Meadow knapweed	*Centaurea pratensis*
Mediterranean sage	*Salvia aethiopis*
Milk thistle	*Silybum marianum*
Perennial pepperweed	*Lepidium latifolium*
Purple nutsedge	*Cyperus rotundus*
Purple starthistle	*Centaurea calcitrapa*
Rush skeletonweed	*Chondrilla juncea*
Short-fringe knapweed	*Centaurea nigrescens*
Silverleaf knightshade	*Solanum elaegnifolium*
Skeletonleaf bursage	*Ambrosia tomentosa*
Slender-flowered thistle	*Carduus tenuiflorus*
Smooth distaff thistle	*Carthamus baericus*
Spiny cocklebur	*Xanthium spinosum*
Spotted knapweed	*Centaurea maculosa*
Squarrose knapweed	*Centaurea virgata*
St. Johnswort (Klamath weed)	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Wild proso millet	*Panicum miliaceum*
Tansy ragwort	*Senecio jacobaea*
Wooly distaff thistle	*Carthamus lanatus*
Yellow toadflax	*Linaria vulgaris*
Yellow starthistle	*Centaurea solstitialis*

* *Class "A" Weed only in that part of Malheur County south of the road leading from the junction of Malheur County line and McBride Creek Road, west to Leslie Gulch Road, to Lake Owyhee and the area south of the road leading from the Rinehart Ranch to the Crowley Road west to Highway 78, north to the Malheur County line.*

CLASS "B" WEED – A weed of known economic/environmental importance and of moderate to wide distribution and highly invasive, subject to intensive control or eradication where feasible at the county level.

ACTION – Infestations are subject to control where found, with possible county assistance when funds are available. All CLASS"B" weeds are required to be controlled within 50 feet of all property lines, easements and rights of way, pursuant to ORS 570.525

COMMON NAME	*SCIENTIFIC NAME*
Canada thistle	*Cirsium arvense*
Houndstongue	*Cynoglossum officinale*
Musk thistle	*Carduus nutans*
Perennial pepperweed	*Lepidium latifolium*
Purple loosestrife	*Lythrum salicaria*
Scotch thistle	*Onopordum acanthium*
Hoary cress (White Top)	*Lepidium spp.*
Russian knapweed	*Acroptilon repens*

** Owners or occupants having Russian knapweed are required to control a minimum 20% of their annual infestation per discreet parcel of land per year. This includes the 50 foot buffer plus additional amounts to total 20% of the infestation.

CLASS "C" WEED – A weed of known economic/environmental importance and of general distribution, that is subject to control or eradication as local conditions warrant.

ACTION – Infestations treated at landowners discretion.

COMMON NAME	*SCIENTIFIC NAME*
Bull thistle	*Cirsium vulgare*
Cheatgrass	*Bromus tectorum*
Dodder	*Cuscutta spp.*
Field bindweed	*Convolvulus arvensis*
Halogeton	*Halogeton glomeratus*
Kochia	*Kochia scoparia*
Medusahead rye	*Taeniatherum caput-medusae*
Poison hemlock	*Conium maculatum*
Puncturevine	*Tribulus terrestris*
Quackgrass	*Agropyron repens*
Common ragweed	*Ambrosia artimisiifolia*
Salt cedar	*Tamarix parviflora*
Sweet clover	*Melilotus officinalis*
Western horsetail	*Equisetum arvense*
Yellow nutsedge	*Cyperus esculentus*

APPENDIX C

OREGON PESTICIDES OF INTEREST AND CONCERN

US-EPA and Oregon Pesticides of Interest (POI) & Concern (POC) (2012-13)

Red = a POC[2]; ***Yellow*** = Higher Priority POI Under Review[1]**; Green** = Evaluated, not a POC;
White = Under Review or Not Evaluated; (example of registered product name)

2,4-D	Acetochlor	Alachlor	Aldicarb	Atrazine (*Aatrex*)
Azinphosmethyl *(Guthion)*	Benfluralin	Bentazon	Bifenthrin	Bromacil
Carbaryl (*Sevin*)	Carbofuran	Chlorothalonil	Chlorpyrifos (*Lorsban*)	Clopyralid
Copper pesticides	Cyfluthrin	Cypermethrin	Dacthal	DBCP
Deltamethrin	Diazanon	Dicamba	Dicofol	Dimethenamid
Diuron (*Karmex*)	Endosulfan	Esfenvalerate	Ethalfluralin	Ethoprop (*Mocap*)
Fenbutatin oxide	Fipronil	Flumetsulam	Glyphosate	Hexazinone
Imazamethabenz	Imazapyr	Imidacloprid	Isoxaflutole	Lambda-cyhalothrin
Lindane	Linuron	Malathion	Mesotrione	Metalaxyl
Metolachlor (*Parallel*)	Metribuzin (*Tricor*)	Metsulfuron methyl (*Ally*)	MSMA	Myclobutanil
Napropamide	Norflurazone	Oxyfluorfen	PCP	Pendimethalin
Permethrin	Phenoxy herbicides	Phosmet	Picloram	Prometon
Prometryn	Propargite	Propiconazole (*Propimax*)	Simazine (*Princep*)	Sulfometuron Methyl (*Oust*)
Tebuthiuron	Terbacil	Thiamethoxam	Tralkoxydim	Triadimeton
Triallate	Triclopyr	Trifluralin		

Pesticide of Interest (POI): potential to occur at concentrations approaching or exceeding an established human health or environmental benchmark or standard

Pesticide of Concern (POC): approaching or exceeding an established human health or environmental benchmark or standard. Usually based on monitoring

APPENDIX D

2014 Lists of Bureau of Land Management (BLM)-Approved Herbicides and Adjuvants

Herbicides Formulations Approved for Use on Lands The BLM Administers in the 17 Western States

Update: April 4, 2019

Restrictions associated with exisitng Environmental Impact Statements and individual Environmental Assessments (EA) at the present time, may restrict the use of individual herbicide active ingredients allowed for a particular project within that state. Refer to current EAs prior to selecting the active ingredient(s) and subsequent formulation(s).

Refer to the complete label prior to considering the use of any herbicide formulation. Just because it has a Federal registration, it may not be registered in a particular State, for example California. Label changes can also impact the intended use through, such things as, creation or elimination of Special Local Need (SLN) or 24 (C) registrations, changes in application sites, rates and timing of application, county restrictions, etc.

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Aminopyralid	Milestone	Dow AgroSciences	62719-519
Aminopyralid + 2,4-D	ForeFront HL	Dow AgroSciences	62719-630
	GrazonNext HL	Dow AgroSciences	62719-628
Aminopyralid + Clopyralid	Sendero	Dow AgroSciences	62719-645
Aminopyralid + Metsulfuron methyl	Chaparral	Dow AgroSciences	62719-597
	Opensight	Dow AgroSciences	62719-597
Aminopyralid + Triclopyr	Capstone	Dow AgroSciences	62719-572
Bromacil	Alligare Bromacil 80	Alligare, LLC	81927-4
	Ceannard Bromacil 80DF	Ceannard, Inc.	58035-19
	Hyvar X	Bayer Environmental Science	432-1546
	Hyvar X	DuPont Crop Protection	352-287
	Hyvar X-L	Bayer Environmental Science	432-1548
	Hyvar X-L	DuPont Crop Protection	352-346
Bromacil + Diuron	Alligare Bromacil/Diuron 40/40	Alligare, LLC	81927-3
	Ceannard Diuron/Bromacil 80 DF	Ceannard, Inc.	58035-18
	DiBro 2+2	Nufarm Americas Inc.	228-227
	DiBro 4+2	Nufarm Americas Inc.	228-386
	DiBro 4+4	Nufarm Americas Inc.	228-235
	Krovar I DF	Bayer Environmental Science	432-1551
	Krovar I DF	DuPont Crop Protection	352-505
	Weed Blast 4G	SSI Maxim	34913-19
	Weed Blast Res. Weed Cont.	Loveland Products Inc.	34704-576

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Chlorsulfuron	Alligare Chlorsulfuron 75	Alligare, LLC	81927-43
	Chlorsulfuron E-Pro 75 WDG	Nufarm Americas Inc.	79676-72
	Nufarm Chlorsulf SPC 75 WDG Herbicide	Nufarm Americas Inc.	228-672
	Telar XP	Bayer Environmental Science	432-1561
	Telar XP	DuPont Crop Protection	352-654
Clopyralid	Alligare Clopyralid 3	Alligare, LLC	81927-14
	CleanSlate	Nufarm Americas Inc.	228-491
	Pyramid R&P	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-94
	Reclaim	Dow AgroSciences	62719-83
	Spur	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-89
	Stinger	Dow AgroSciences	62719-73
	Transline	Dow AgroSciences	62719-259
Clopyralid + 2, 4-D	Alligare Cody Herbicide	Alligare, LLC	81927-28
	Commando	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-92
	Curtail	Dow AgroSciences	62719-48
	Cutback	Nufarm Americas Inc.	71368-72
2, 4-D	2,4-D 4# Amine Weed Killer	UAP-Platte Chem. Co.	34704-120
	2,4-D Amine	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-72
	2,4-D Amine 4	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-19
	2,4-D Amine 4	Helena Agri-Enterprises, LLC (Helena Chemical Company)	42750-19-5905
	2,4-D LV 4	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-15
	2,4-D LV 6 Ester	Nufarm Americas Inc.	228-95
	2,4-D LV4	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-90
	2,4-D LV 6	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-20
	2,4-D LV6	Helena Agri-Enterprises, LLC (Helena Chemical Company)	42750-20-5905
	2,4-D LV6	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-93
	Alliagre 2,4-D Amine	Alligare, LLC	81927-38
	Alligare 2,4-D LV 6	Alligare, LLC	81927-39
	Aqua-Kleen	Nufarm Americas Inc.	71368-4
	Aqua-Kleen	Nufarm Americas Inc.	228-378
	Barrage HF	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-529
	Barrage LV Ester	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-504
	Base Camp Amine 4	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	71368-1-2935
	Base Camp LV6	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	2935-553
	Broadrange 55	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	2217-813-2935

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
2,4-D - continued	Clean Amine	Loveland Products Inc.	34704-120
	Clean Crop Amine 4	UAP-Platte Chem. Co.	34704-5 CA
	Clean Crop Low Vol 6 Ester	UAP-Platte Chem. Co.	34704-125
	Clean Crop LV-4 ES	UAP-Platte Chem. Co.	34704-124
	Cornbelt 4 lb. Amine	Van Diest Supply Co.	11773-2
	Cornbelt 4# LoVol Ester	Van Diest Supply Co.	11773-3
	Cornbelt 6# LoVol Ester	Van Diest Supply Co.	11773-4
	D-638	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-36
	Esteron 99C	Nufarm Americas Inc.	62719-9-71368
	Five Star	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-49
	Formula 40	Nufarm Americas Inc.	228-357
	Freelexx	Dow AgroSciences	62719-634
	HardBall	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-549
	Hi-Dep	PBI Gordon Corp.	2217-703
	Low Vol 4 Ester Weed Killer	Loveland Products Inc.	34704-124
	Low Vol 6 Ester Weed Killer	Loveland Products Inc.	34704-125
	Opti-Amine	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-501
	Platoon	Nufarm Americas Inc.	228-145
	Rugged	WinField-United (WinField Solutions, LLC)	1381-247
	Saber	Loveland Products Inc.	34704-803
	Salvo	Loveland Products Inc.	34704-609
	Salvo LV Ester	UAP-Platte Chem. Co.	34704-609
	Savage DS	Loveland Products Inc.	34704-606
	Savage DS	UAP-Platte Chem. Co.	34704-606
	Shredder 2,4-D LV4	WinField-United (WinField Solutions, LLC)	1381-102
	Shredder Amine 4	WinField-United (WinField Solutions, LLC)	1381-103
	Solution Water Soluble	Nufarm Americas Inc.	228-260
	Solve 2,4-D	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-22
	Unison	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-542
	Weedar 64	Nufarm Americas Inc.	71368-1
	WEEDestroy AM-40	Nufarm Americas Inc.	228-145
	Weedone LV-4	Nufarm Americas Inc.	228-139-71368
	Weedone LV-4 Solventless	Nufarm Americas Inc.	71368-14
	Weedone LV-6	Nufarm Americas Inc.	71368-11
	Whiteout 2,4-D	Loveland Products, Inc.	34704-1032
Dicamba	Alligare Cruise Control	Alligare, LLC	42750-40-81927
	Alligare Dicamba 4 Herbicide	Alligare, LLC	81927-55
	Banvel	Arysta LifeScience N.A. Corp.	66330-276
	Clarity	BASF Corporation	7969-137
	Diablo	Nufarm Americas Inc.	228-379
	Dicamba DMA	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-40

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Dicamba - continued	Kam-Ba	Drexel Chemical Company	19713-624
	Rifle	Loveland Products Inc.	34704-861
	Sterling Blue	WinField-United (WinField Solutions, LLC)	7969-137-1381
	Topeka	Rotam North America, Inc.	83100-34-83979
	Vanquish	Syngenta	100-884
	Vanquish Herbicide	Nufarm Americas Inc.	228-397
	Vision	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-576
Dicamba + 2, 4-D	Alligare Dicamba + 2,4-D DMA	Alligare, LLC	81927-42
	Brash	WinField-United (WinField Solutions, LLC)	1381-202
	Brush-Rhap	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-568
	Cimarron MAX - Part B	Bayer Environmental Science	432-1555
	Cimarron MAX - Part B	DuPont Crop Protection	352-615
	KambaMaster	Nufarm Americas Inc.	71368-34
	Latigo	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-564
	Outlaw	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-574
	Range Star	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-55
	Rifle-D	Loveland Products Inc.	34704-869
	Veteran 720	Nufarm Americas Inc.	228-295
	Weedmaster	Nufarm Americas Inc.	71368-34
Dicamba + Diflufenzopyr	Distinct	BASF Corporation	7969-150
	Overdrive	BASF Corporation	7969-150
NOTE: In accordance with the Record of Decision for the *Vegetation Treatments Using Herbicides on Bureau of Land Management* Lands in 17 Western *States Programmatic Environmental Impact Statement (PEIS), the aerial application of this herbicide* is prohibited.			
Diquat	Alligare Diquat Herbicide	Alligare, LLC	81927-43
	Diquat E-AG 2L	Nufarm Americas Inc.	79676-75
	Diquat E-Pro 2L	Nufarm Americas Inc.	79676-75
	Diquat SPC 2L Herbicide	Nufarm Americas Inc.	228-675
	Nufarm Diquat 2L Herbicide	Nufarm Americas Inc.	228-675
	Reward	Syngenta Professional Products	100-1091
Diuron	Alligare Diuron 4L	Alligare, LLC	81927-44
	Alligare Diuron 80DF	Alligare, LLC	81927-12
	Ceannard Diuron 80DF	Ceannard, Inc.	58035-16
	Direx 4L	DuPont Crop Protection	352-678
	Direx 4L	Makhteshim Agan of N. A. (ADAMA)	66222-54
	Diuron 4L	Drexel Chemical Company	19713-36

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Diuron - continued	Diuron 4L	Loveland Products Inc.	34704-854
	Diuron 4L	Makhteshim Agan of N. A. (ADAMA)	66222-54
	Diuron 80	Drexel Chemical Company	19713-274
	Diuron 80 WDG	Loveland Products Inc.	34704-648
	Diuron 80DF	WinField-United (WinField Solutions, LLC)	9779-318
	Diuron 80WDG	UAP-Platte Chem. Co.	34704-648
	Karmex DF	DuPont Crop Protection	352-692
	Karmex DF	Makhteshim Agan of N. A. (ADAMA)	66222-51
	Karmex IWC	DuPont Crop Protection	352-692
	Karmex XP	DuPont Crop Protection	352-692
	Parrot 4L	Makhteshim Agan of N. A. (ADAMA)	66222-54
	Parrot DF	Makhteshim Agan of N. A. (ADAMA)	66222-51
Fluridone	Alligare Fluridone	Alligare, LLC	81927-45
	Avast!	SePRO	67690-30
	Fluridone 4L	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-280
	Sonar AS	SePRO	67690-4
	Sonar Precision Release	SePRO	67690-12
	Sonar Q	SePRO	67690-3
	Sonar SRP	SePRO	67690-3
Fluroxypyr	Alligare Flagstaff	Alligare, LLC	81927-61
	Alligare Fluroxypyr	Alligare, LLC	66330-385-81927
	Comet Selective	Nufarm Americas Inc.	71368-87
	Vista XRT	Dow AgroSciences	62719-586
Fluroxypyr + 2,4-D + Dicamba	E-2 Herbicide	Nufarm Americas Inc.	228-442
Fluroxypyr + Clopyralid	Truslate Selective Herbicide	Nufarm Americas Inc.	71368-86
Fluroxypyr + Picloram	Alligare Triumph XTR Herbicide	Alligare , LLC	81927-64
	Surmount	Dow AgroSciences	62719-480
	Trooper Pro	Nufarm Americas Inc.	228-599
Fluroxypyr + Triclopyr	Alligare Cleargraze Pasture Herbicide	Alligare, LLC	81927-65
	PastureGard	Dow AgroSciences	62719-637
Glyphosate	Accord Concentrate	Dow AgroSciences	62719-324
	Accord SP	Dow AgroSciences	62719-322
	Accord XRT	Dow AgroSciences	62719-517
	Accord XRT II	Dow AgroSciences	62719-556
	Alligare Dryphosate 75SG	Alligare, LLC	81927-60
	Alligare Glyphosate 4 PLUS	Alligare, LLC	81927-9
	Alligare Glyphosate 5.4	Alligare, LLC	81927-8
	Aqua Neat	Nufarm Americas Inc.	228-365

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Glyphosate - continued	Aqua Star	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-59
	Aquamaster	Monsanto	524-343
	AquaPro Aquatic Herbicide	SePRO Corporation	62719-324-67690
	Buccaneer	Tenkoz	55467-10
	Buccaneer Plus	Tenkoz	55467-9
	Credit Xtreme	Nufarm Americas Inc.	71368-81
	Foresters	Nufarm Americas Inc.	228-381
	Gly Star Gold	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-61
	Gly Star Original	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-60
	Gly Star Plus	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-61
	Gly Star Pro	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-61
	Gly-4	Universal Crop Protection Alliance	42750-60-72693
	Gly-4 Plus	Universal Crop Protection Alliance	72693-1
	Gly-4 Plus	Universal Crop Protection Alliance	42750-61-72693
	GlyphoMate 41	PBI/Gordon Corporation	2217-847
	Glypro	Dow AgroSciences	62719-324
	Glypro Plus	Dow AgroSciences	62719-322
	Honcho	Monsanto	524-445
	Honcho Plus	Monsanto	524-454
	Imitator Aquatic	Drexel Chemical Company	19713-623
	Imitator DA	Drexel Chemical Company	19713-586
	Imitator Plus	Drexel Chemical Company	19713-526
	KleenUp Pro	Loveland Products, Inc.	34704-890
	Mad Dog Plus	Loveland Products, Inc.	34704-890
	Makaze	Loveland Products, Inc.	34704-890
	Mirage	Loveland Products Inc.	34704-889
	Mirage Herbicide	UAP-Platte Chem. Co.	524-445-34704
	Mirage Plus	Loveland Products Inc.	34704-890
	Rattler	Helena Agri-Enterprises, LLC (Helena Chemical Company)	524-445-5905
	Razor	Nufarm Americas Inc.	228-366
	Razor Pro	Nufarm Americas Inc.	228-366
	Rodeo	Dow AgroSciences	62719-324
	Roundup Custom	Monsanto	524-343
	Roundup Original	Monsanto	524-445
	Roundup Original II	Monsanto	524-454
	Roundup Original II CA	Monsanto	524-475
	Roundup PROMAX	Monsanto	524-579
	Roundup PRO	Monsanto	524-475
	Roundup PRO Concentrate	Monsanto	524-529
	Roundup PRO Dry	Monsanto	524-505
	Showdown	Helena Agri-Enterprises, LLC (Helena Chemical Company)	71368-25-5905

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Glyphosate + 2, 4-D	Campaign	Monsanto	524-351
	Imitator + 2,4-D	Drexel Chemical Company	19713-635
	Landmaster BW	Albaugh, LLC (Albuagh, Inc/Agri Star)	42570-62
	Landmaster BW	Monsanto	524-351
Hexazinone	Pronone 10G	Pro-Serve	33560-21
	Pronone 25G	Pro-Serve	33560-45
	Pronone MG	Pro-Serve	33560-21
	Pronone Power Pellet	Pro-Serve	33560-41
	Velosa	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-579
	Velpar DF	DuPont Crop Protection	352-581
	Velpar DF VU	Bayer Environmental Science	432-1576
	Velpar L	DuPont Crop Protection	352-392
	Velpar L VU	Bayer Environmental Science	432-1573
	Velpar ULW	DuPont Crop Protection	352-450
Hexazinone + Sulfometuron methyl	Oustar	Bayer Environmental Science	432-1553
	Oustar	DuPont Crop Protection	352-603
	Westar	Bayer Environmental Science	432-1558
	Westar	DuPont Crop Protection	352-626
NOTE: In accordance with the Record of Decision for the *Vegetation Treatments Using Herbicides on Bureau of Land Management* Lands in 17 Western *States Programmatic Environmental Impact Statement (PEIS), the aerial application of this herbicide* is prohibited.			
Imazapic	Alligare Panoramic 2SL	Alligare, LLC	66222-141-81927
	Nufarm Imazapic 2SL	Nufarm Americas Inc.	71368-99
	Open Range G	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	2935-557
	Plateau	BASF Corporation	241-365
Imazapyr	Alligare Ecomazapyr 2SL	Alligare, LLC	81927-22
	Alligare Imazapyr 4SL	Alligare, LLC	81927-24
	Alligare Rotary 2 SL	Alligare, LLC	
	Arsenal	BASF Corporation	241-346
	Arsenal Applicators Conc.	BASF Corporation	241-299
	Arsenal PowerLine	BASF Corporation	241-431
	Chopper	BASF Corporation	241-296
	EZ-JECT Copperhead Herbicide Shells	EZ-JECT, Inc.	83220-2
	Habitat	BASF Corporation	241-426
	Habitat Herbicide	SePRO	241-426-67690
	Polaris	Nufarm Americas Inc.	228-534
	Polaris AC	Nufarm Americas Inc.	241-299-228
	Polaris AC	Nufarm Americas Inc.	228-480
	Polaris AC Complete	Nufarm Americas Inc.	228-570

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Imazapyr - continued	Polaris AQ	Nufarm Americas Inc.	241-426-228
	Polaris Herbicide	Nufarm Americas Inc.	241-346-228
	Polaris RR	Nufarm Americas Inc.	241-273-228
	Polaris SP	Nufarm Americas Inc.	228-536
	Polaris SP	Nufarm Americas Inc.	241-296-228
	SSI Maxim Arsenal 0.5G	SSI Maxim Co., Inc.	34913-23
	SSI Maxim Arsenal 5.0 G	SSI Maxim Co., Inc.	34913-24
	Stalker	BASF Corporation	241-398
Imazapyr + Diuron	Alligare Mojave 70 EG	Alligare, LLC	81927-25
	Imazuron	Nufarm Americas Inc.	228-654
	Sahara DG	BASF Corporation	241-372
	SSI Maxim Topsite 2.5G	SSI Maxim Co., Inc.	34913-22
Imazapyr + Metsulfuron methyl	Lineage Clearstand	Bayer Environmental Science	432-1578
	Lineage Clearstand	DuPont Crop Protection	352-766
Imazapyr + Sulfometuron methyl +	Lineage HWC	Bayer Environmental Science	432-1577
Metsulfuron methyl	Lineage HWC	DuPont Crop Protection	352-765
	Lineage Prep	Bayer Environmental Science	432-1579
	Lineage Prep	DuPont Crop Protection	352-767
NOTE: In accordance with the Record of Decision for the *Vegetation Treatments Using Herbicides on Bureau of Land Management* Lands in 17 Western *States Programmatic Environmental Impact Statement (PEIS), the aerial application of this herbicide* is prohibited.			
Metsulfuron methyl	Alligare MSM 60	Alligare, LLC	81927-7
	AmTide MSM 60DF Herbicide	AmTide, LLC	83851-3
	Cimarron MAX - Part A	Bayer Environmental Science	432-1555
	Cimarron MAX - Part A	DuPont Crop Protection	352-615
	Escort XP	Bayer Environmental Science	432-1549
	Escort XP	DuPont Crop Protection	352-439
	Patriot	Nufarm Americas Inc.	228-391
	PureStand	Nufarm Americas Inc.	71368-38
	Rometsol	Rotam North America, Inc.	831000-2-83979
Metsulfuron methyl + Chlorsulfuron	Cimarron Plus	Bayer Environmental Science	432-1572
	Cimarron Plus	DuPont Crop Protection	352-670
	Cimarron X-tra	DuPont Crop Protection	352-669
Picloram	Alligare Picloram 22K	Alligare, LLC	81927-18
	Grazon PC	Dow AgroSciences	62719-181
	OutPost 22K	Dow AgroSciences	62719-6
	Tordon 22K	Dow AgroSciences	62719-6
	Tordon K	Dow AgroSciences	62719-17

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Picloram - continued	Triumph 22K	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-79
	Triumph K	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-81
	Trooper 22K	Nufarm Americas Inc.	228-535
Picloram + 2, 4-D	Alligare Picloram + D	Alligare, LLC	81927-16
	Graslan L	Dow AgroSciences	62719-655
	Grazon P+D	Dow AgroSciences	62719-182
	GunSlinger	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-80
	HiredHand P+D	Dow AgroSciences	62719-182
	Pathway	Dow AgroSciences	62719-31
	Tordon 101 Mixture	Dow AgroSciences	62719-5
	Tordon RTU	Dow AgroSciences	62719-31
	Trooper P + D	Nufarm Americas Inc.	228-530
Picloram + 2, 4-D + Dicamba	Trooper Extra	Nufarm Americas Inc.	228-586
Rimsulfuron	Alligare Laramie 25DF	Alligare, LLC	81927-57
	Hinge	Rotam Borth America, Inc.	83100-40-83979
	Matrix SG	Dupont Crop Protection	352-768
Sulfometuron methyl	Alligare SFM 75	Alligare, LLC	81927-26
	Oust XP	Bayer Environmenatl Science	432-1552
	Oust DF	DuPont Crop Protection	352-401
	Oust XP	DuPont Crop Protection	352-601
	Spyder	Nufarm Americas Inc.	228-408
NOTE: In accordance with the Record of Decision for the *Vegetation Treatments Using Herbicides on Bureau of Land Management* Lands in 17 Western *States Programmatic Environmental Impact Statement (PEIS), the aerial application of this herbicide* is prohibited.			
Sulfometuron methyl + Chlorsulfuron	Landmark XP	Bayer Environmental Science	432-1560
	Landmark XP	DuPont Crop Protection	352-645
NOTE: In accordance with the Record of Decision for the *Vegetation Treatments Using Herbicides on Bureau of Land Management* Lands in 17 Western *States Programmatic Environmental Impact Statement (PEIS), the aerial application of this herbicide* is prohibited.			

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Sulfometuron methyl + Metsulfuron methyl	Alligare SFM Extra	Alligare, LLC	81927-5
	Oust Extra	Bayer Environmental Science	432-1557
	Oust Extra	DuPont Crop Protection	352-622
	Spyder Extra Selective	Nufarm Americas Inc.	228-690
NOTE: In accordance with the Record of Decision for the *Vegetation Treatments Using Herbicides on Bureau of Land Management* Lands in 17 Western *States Programmatic Environmental Impact Statement (PEIS), the aerial application of this herbicide* is prohibited.			
Tebuthiuron	Alligare Tebuthiuron 20 P	Alligare, LLC	81927-41
	Alligare Tebuthiuron 80 WG	Alligare, LLC	81927-37
	Spike 20P	Dow AgroSciences	62719-121
	Spike 80DF	Dow AgroSciences	62719-107
	SpraKil S-5 Granules	SSI Maxim Co., Inc.	34913-10
Tebuthiuron + Diuron	SpraKil SK-13 Granular	SSI Maxim Co., Inc.	34913-15
	SpraKil SK-26 Granular	SSI Maxim Co., Inc.	34913-16
Triclopyr	Alligare Boulder 6.3	Alligare, LLC	81927-54
	Alligare Triclopry 4	Alligare, LLC	81927-11
	Alligare Triclopyr 3	Alligare, LLC	81927-13
	Element 3A	Dow AgroSciences	62719-37
	Element 4	Dow AgroSciences	62719-40
	Forestry Garlon XRT	Dow AgroSciences	62719-553
	Garlon 3A	Dow AgroSciences	62719-37
	Garlon 4	Dow AgroSciences	62719-40
	Garlon 4 Ultra	Dow AgroSciences	62719-527
	Pathfinder II	Dow AgroSciences	62719-176
	Relegate	Nufarm Americas Inc.	228-521
	Relegate RTU	Nufarm Americas Inc.	228-522
	Remedy	Dow AgroSciences	62719-70
	Remedy Ultra	Dow AgroSciences	62719-552
	Renovate 3	SePRO Corporation	62719-37-67690
	Renovate OTF	SePRO Corporation	67690-42
	Tahoe 3A	Nufarm Americas Inc.	228-520
	Tahoe 4E	Nufarm Americas Inc.	228-385
	Tahoe 4E Herbicide	Nufarm Americas Inc.	228-517
	Triclopyr RTU	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-173
	Trycera	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5906-580
	Vastlan	Dow AgroSciences	62719-687

ACTIVE INGREDIENT	TRADE NAME	MANUFACTURER	EPA REG. NUMBER
Triclopyr + 2, 4-D	Alligare Everett	Alligare, LLC	81927-29
	Aquasweep	Nufarm Americas Inc.	228-316
	Candor	Nufarm Americas Inc.	228-565
	Crossbow	Dow AgroSciences	62719-260
Triclopyr + Clopyralid	Alligare Prescott Herbicide	Alligare, LLC	81927-30
	Brazen	Nufarm Americas Inc.	228-564
	Redeem R&P	Dow AgroSciences	62719-337

HERBICIDE INFORMATION SUMMARY

April 4, 2019

Common Name	Manufacturer Trade Name	Manufacturer Name	EPA Reg. Number	Concentration	Units of Concentration	WSSA Herbicide Resistance Code
Aminopyralid	Milestone	Dow AgroSciences	62719-519	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Aminopyralid + 2,4-D	ForeFront HL	Dow AgroSciences	62719-630	0.41 + 3.33	Pounds Acid Equivalent Per Gallon, Respectively	Group 4
Aminopyralid + 2,4-D	GrazonNext HL	Dow AgroSciences	62719-628	0.41 + 3.33	Pounds Acid Equivalent Per Gallon, Respectively	Group 4
Aminopyralid + Clopyralid	Sendero	Dow AgroSciences	62719-645	0.5 + 2.3	Pounds Acid Equivalent Per Gallon, Respectively	Gtoup 4
Aminopyralid + Metsulfuron methyl	Chaparral	Dow AgroSciences	62719-597	52.5 + 9.45	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 4 + 2
Aminopyralid + Metsulfuron methyl	Opensight	Dow AgroSciences	62719-597	52.5 + 9.45	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 4 + 2
Aminopyralid + Triclopyr	Capstone	Dow AgroSciences	62719-572	0.1 + 1.0	Pounds Acid Equivalent Per Gallon, Respectively	Group 4
Bromacil	Alligare Bromacil 80	Alligare, LLC	81927-4	80	Percent Active Ingredient	Group 5
Bromacil	Ceannard Bromacil 80DF	Ceannard, Inc.	58035-19	80	Percent Active Ingredient	Group 5
Bromacil	Hyvar X	Bayer Environmental Science	432-1546	80	Percent Active Ingredient	Group 5
Bromacil	Hyvar X	DuPont Crop Protection	352-287	80	Percent Active Ingredient	Group 5
Bromacil	Hyvar X-L	Bayer Environmental Science	432-1548	2.0	Pounds Active Ingredient Per Gallon	Group 5
Bromacil	Hyvar X-L	DuPont Crop Protection	352-346	2.0	Pounds Active Ingredient Per Gallon	Group 5
Bromacil + Diuron	Alligare Bromacil/Diuron 40/40	Alligare, LLC	81927-3	40 + 40	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	Ceannard Diuron/Bromacil 80 DF	Ceannard, Inc.	58035-18	40 + 40	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	DiBro 2+2	Nufarm Americas Inc.	228-227	2 + 2	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	DiBro 4+2	Nufarm Americas Inc.	228-386	4 + 2	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	DiBro 4+4	Nufarm Americas Inc.	228-235	4 + 4	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	Krovar I DF	Bayer Environmental Science	432-1551	40 + 40	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	Krovar I DF	DuPont Crop Protection	352-505	40 + 40	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	Weed Blast 4G	SSI Maxim	34913-19	2 + 2	Percent Active Ingredient, Respectively	Groups 5 + 7
Bromacil + Diuron	Weed Blast Res. Weed Cont.	Loveland Products Inc.	34704-576	4 + 4	Percent Active Ingredient, Respectively	Groups 5 + 7
Chlorsulfuron	Alligare Chlorsulfuron 75	Alligare, LLC	81927-43	75	Percent Active Ingredient	Group 2
Chlorsulfuron	Chlorsulfuron E-Pro 75 WDG	Nufarm Americas Inc.	79676-72	75	Percent Active Ingredient	Group 2
Chlorsulfuron	Nufarm Chlorsulf SPC 75 WDG Herbicide	Nufarm Americas Inc.	228-672	75	Percent Active Ingredient	Group 2
Chlorsulfuron	Telar XP	Bayer Environmental Science	432-1561	75	Percent Active Ingredient	Group 2
Chlorsulfuron	Telar XP	DuPont Crop Protection	352-654	75	Percent Active Ingredient	Group 2
Clopyralid	Alligare Clopyralid 3	Alligare, LLC	81927-14	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Clopyralid	CleanSlate	Nufarm Americas Inc.	228-491	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Clopyralid	Pyramid R&P	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-94	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Clopyralid	Reclaim	Dow AgroSciences	62719-83	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Clopyralid	Spur	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-89	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Clopyralid	Stinger	Dow AgroSciences	62719-73	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Clopyralid	Transline	Dow AgroSciences	62719-259	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Clopyralid + 2, 4-D	Alligare Cody Herbicide	Alligare, LLC	81927-28	0.38 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Clopyralid + 2, 4-D	Commando	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-92	0.38 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Clopyralid + 2, 4-D	Curtail	Dow AgroSciences	62719-48	0.38 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Clopyralid + 2, 4-D	Cutback	Nufarm Americas Inc.	71368-72	0.38 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
2, 4-D	2,4-D 4# Amine Weed Killer	UAP-Platte Chem. Co.	34704-120	3.74	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D Amine	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-72	3.76	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D Amine 4	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-19	3.8	Pounds Acid Equivalent Per Gallon	Group 4

2, 4-D	2,4-D Amine 4	Helena Agri-Enterprises, LLC (Helena Chemical Company)	42750-19-5905	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D LV 4	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-15	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D LV 6	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-20	5.5	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D LV 6 Ester	Nufarm Americas Inc.	228-95	5.5	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D LV4	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-90	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D LV6	Helena Agri-Enterprises, LLC (Helena Chemical Company)	42750-20-5905	5.5	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	2,4-D LV6	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-93	5.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Alliagre 2,4-D Amine	Alligare, LLC	81927-38	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Alligare 2,4-D LV 6	Alligare, LLC	81927-39	5.5	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Aqua-Kleen	Nufarm Americas Inc.	71368-4	19.0	Percent Acid Equivalent	Group 4
2, 4-D	Aqua-Kleen	Nufarm Americas Inc.	228-378	19.0	Percent Acid Equivalent	Group 4
2, 4-D	Barrage HF	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-529	4.7	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Barrage LV Ester	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-504	4.7	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Base Camp Amine 4	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	71368-1-2935	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Base Camp LV6	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	2935-553	5.5	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Broadrange 55	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	2217-813-2935	5.03	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Clean Amine	Loveland Products Inc.	34704-120	3.74	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Clean Crop Amine 4	UAP-Platte Chem. Co.	34704-5 CA	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Clean Crop Low Vol 6 Ester	UAP-Platte Chem. Co.	34704-125	5.6	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Clean Crop LV-4 ES	UAP-Platte Chem. Co.	34704-124	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Cornbelt 4 lb. Amine	Van Diest Supply Co.	11773-2	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Cornbelt 4# LoVol Ester	Van Diest Supply Co.	11773-3	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Cornbelt 6# LoVol Ester	Van Diest Supply Co.	11773-4	5.6	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	D-638	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-36	2.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Esteron 99C	Nufarm Americas Inc.	62719-9-71368	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Five Star	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-49	5.0	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Formula 40	Nufarm Americas Inc.	228-357	3.67	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Freelexx	Dow AgroSciences	62719-634	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	HardBall	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-549	1.74	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Hi-Dep	PBI Gordon Corp.	2217-703	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Low Vol 4 Ester Weed Killer	Loveland Products Inc.	34704-124	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Low Vol 6 Ester Weed Killer	Loveland Products Inc.	34704-125	5.6	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Opti-Amine	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-501	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Platoon	Nufarm Americas Inc.	228-145	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Rugged	WinField-United (WinField Solutions, LLC)	1381-247	3.5	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Saber	Loveland Products Inc.	34704-803	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Salvo	Loveland Products Inc.	34704-609	5	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Salvo LV Ester	UAP-Platte Chem. Co.	34704-609	5.0	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Savage DS	Loveland Products Inc.	34704-606	78.9	Percent Acid Equivalent	Group 4
2, 4-D	Savage DS	UAP-Platte Chem. Co.	34704-606	78.9	Percent Acid Equivalent	Group 4
2, 4-D	Shredder 2,4-D LV4	WinField-United (WinField Solutions, LLC)	1381-102	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Shredder Amine 4	WinField-United (WinField Solutions, LLC)	1381-103	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Solution Water Soluble	Nufarm Americas Inc.	228-260	80.5	Percent Acid Equivalent	Group 4
2, 4-D	Solve 2,4-D	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-22	3.76	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Unison	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-542	1.74	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Weedar 64	Nufarm Americas Inc.	71368-1	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	WEEDestroy AM-40	Nufarm Americas Inc.	228-145	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Weedone LV-4	Nufarm Americas Inc.	228-139-71368	3.84	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Weedone LV-4 Solventless	Nufarm Americas Inc.	71368-14	3.8	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Weedone LV-6	Nufarm Americas Inc.	71368-11	5.4	Pounds Acid Equivalent Per Gallon	Group 4
2, 4-D	Whiteout 2,4-D	Loveland Products, Inc.	34704-1032	3.7	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Alligare Cruise Control	Alligare, LLC	42750-40-81927	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Alligare Dicamba 4 Herbicide	Alligare, LLC	81927-55	5.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Banvel	Arysta LifeScience N.A. Corp.	66330-276	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Clarity	BASF Corporation	7969-137	4.0	Pounds Acid Equivalent Per Gallon	Group 4

Dicamba	Diablo	Nufarm Americas Inc.	228-379	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Dicamba DMA	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-40	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Kam-Ba	Drexel Chemical Company	19713-624	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Rifle	Loveland Products Inc.	34704-861	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Sterling Blue	WinField-United (WinField Solutions, LLC)	7969-137-1381	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Topeka	Rotam North America, Inc.	83100-34-83979	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Vanquish	Syngenta	100-884	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Vanquish Herbicide	Nufarm Americas Inc.	228-397	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba	Vision	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-576	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Dicamba + 2, 4-D	Alligare Dicamba + 2,4-D DMA	Alligare, LLC	81927-42	1.0 + 2.87	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Brash	WinField-United (WinField Solutions, LLC)	1381-202	1.0 + 2.87	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Brush-Rhap	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-568	1.8 + 2.4	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Cimarron MAX - Part B	Bayer Environmental Science	432-1555	1.0 + 2.87	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Cimarron MAX - Part B	DuPont Crop Protection	352-615	1.0 + 2.87	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	KambaMaster	Nufarm Americas Inc.	71368-34	1.0 + 2.87	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Latigo	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-564	1.8 + 2.4	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Outlaw	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-574	1.09 + 1.45	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Range Star	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-55	1.0 + 2.87	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Rifle-D	Loveland Products Inc.	34704-869	1.0 + 2.88	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Veteran 720	Nufarm Americas Inc.	228-295	1.0 + 1.9	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + 2, 4-D	Weedmaster	Nufarm Americas Inc.	71368-34	1.0 + 2.87	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Dicamba + Diflufenzopyr	Distinct	BASF Corporation	7969-150	50 + 20	Percent Acid Equivalent, Respectively	Groups 4 + 19
Dicamba + Diflufenzopyr	Overdrive	BASF Corporation	7969-150	50 + 20	Percent Acid Equivalent, Respectively	Groups 4 + 19
Diquat	Alligare Diquat Herbicide	Alligare, LLC	81927-35	3.73	Pounds Active Ingredient Per Gallon	Group 22
Diquat	Diquat E-AG 2L	Nufarm Americas Inc.	79676-75	3.73	Pounds Active Ingredient Per Gallon	Group 22
Diquat	Diquat E-Pro 2L	Nufarm Americas Inc.	79676-75	3.73	Pounds Active Ingredient Per Gallon	Group 22
Diquat	Diquat SPC 2L Herbicide	Nufarm Americas Inc.	228-675	3.73	Pounds Active Ingredient Per Gallon	Group 22
Diquat	Nufarm Diquat 2L Herbicide	Nufarm Americas Inc.	228-675	3.73	Pounds Active Ingredient Per Gallon	Group 22
Diquat	Reward	Syngenta Professional Prod.	100-1091	3.73	Pounds Active Ingredient Per Gallon	Group 22
Diuron	Alligare Diuron 4L	Alligare, LLC	81927-44	4.0	Pounds Active Ingredient Per Gallon	Group 7
Diuron	Alligare Diuron 80DF	Alligare, LLC	81927-12	80	Percent Active Ingredient	Group 7
Diuron	Ceannard Diuron 80DF	Ceannard, Inc.	58035-16	80	Percent Active Ingredient	Group 7
Diuron	Direx 4L	DuPont Crop Protection	352-678	4.0	Pounds Active Ingredient Per Gallon	Group 7
Diuron	Direx 4L	Makhteshim Agan of N. A. (ADAMA)	66222-54	4.0	Pounds Active Ingredient Per Gallon	Group 7
Diuron	Diuron 4L	Drexel Chemical Company	19713-36	4.0	Pounds Active Ingredient Per Gallon	Group 7
Diuron	Diuron 4L	Loveland Products Inc.	34704-854	4.0	Pounds Active Ingredient Per Gallon	Group 7
Diuron	Diuron 4L	Makhteshim Agan of N. A. (ADAMA)	66222-54	4.0	Pounds Active Ingredient Per Gallon	Group 7
Diuron	Diuron 80	Drexel Chemical Company	19713-274	80	Percent Active Ingredient	Group 7
Diuron	Diuron 80 WDG	Loveland Products Inc.	34704-648	80	Percent Active Ingredient	Group 7
Diuron	Diuron 80DF	WinField-United (WinField Solutions, LLC)	9779-318	80	Percent Active Ingredient	Group 7
Diuron	Diuron 80WDG	UAP-Platte Chem. Co.	34704-648	80	Percent Active Ingredient	Group 7
Diuron	Karmex DF	DuPont Crop Protection	352-692	80	Percent Active Ingredient	Group 7
Diuron	Karmex DF	Makhteshim Agan of N. A. (ADAMA)	66222-51	80	Percent Active Ingredient	Group 7
Diuron	Karmex IWC	DuPont Crop Protection	352-692	80	Percent Active Ingredient	Group 7
Diuron	Karmex XP	DuPont Crop Protection	352-692	80	Percent Active Ingredient	Group 7
Diuron	Parrot 4L	Makhteshim Agan of N. A. (ADAMA)	66222-54	4.0	Pounds Active Ingredient Per Gallon	Group 7
Diuron	Parrot DF	Makhteshim Agan of N. A. (ADAMA)	66222-51	80	Percent Active Ingredient	Group 7
Fluridone	Alligare Fluridone	Alligare, LLC	81927-45	4.0	Pounds Active Ingredient Per Gallon	Group 12
Fluridone	Avast!	SePRO	67690-30	4.0	Pounds Active Ingredient Per Gallon	Group 12
Fluridone	Fluridone 4L	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-280	4.0	Pounds Active Ingredient Per Gallon	Group 12
Fluridone	Sonar AS	SePRO	67690-4	4.0	Pounds Active Ingredient Per Gallon	Group 12

Fluridone	Sonar Precision Release	SePRO	67690-12	5	Percent Active Ingredient	Group 12
Fluridone	Sonar Q	SePRO	67690-3	5	Percent Active Ingredient	Group 12
Fluridone	Sonar SRP	SePRO	67690-3	5	Percent Active Ingredient	Group 12
Fluroxypyr	Alligare Flagstaff	Alligare, LLC	81927-61	2.8	Pounds Acid Equivalent Per Gallon	Group 4
Fluroxypyr	Alligare Fluroxypyr	Alligare, LLC	66330-385-81927	2.8	Pounds Acid Equivalent Per Gallon	Group 4
Fluroxypyr	Comet Selective	Nufarm Americas Inc.	71368-87	1.5	Pounds Acid Equivalent Per Gallon	Group 4
Fluroxypyr	Vista XRT	Dow AgroSciences	62719-586	2.8	Pounds Acid Equivalent Per Gallon	Group 4
Fluroxypyr + 2,4-D + Dicamba	E-2 Herbicide	Nufarm Americas Inc.	228-442	0.4 + 3.2 + 0.4	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4 + 4
Fluroxypyr + Clopyralid	Truslate Selective Herbicide	Nufarm Americas Inc.	71368-86	0.75 + 0.75	Pounds Acid Equivalent Per Gallon, Respectively	Group 4 + 4
Fluroxypyr + Picloram	Alligare Triumph XTR Herbicide	Alligare , LLC	81927-64	0.67 + 0.67	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Fluroxypyr + Picloram	Surmount	Dow AgroSciences	62719-480	0.67 + 0.67	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Fluroxypyr + Picloram	Trooper Pro	Nufarm Americas Inc.	228-599	1.0 + 1.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Fluroxypyr + Triclopyr	Alligare Cleargraze Pasture Herbicide	Alligare, LLC	81927-65	1.0 + 3.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Fluroxypyr + Triclopyr	PastureGard	Dow AgroSciences	62719-637	1.0 + 3.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Glyphosate	Accord Concentrate	Dow AgroSciences	62719-324	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Accord SP	Dow AgroSciences	62719-322	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Accord XRT	Dow AgroSciences	62719-517	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Accord XRT II	Dow AgroSciences	62719-556	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Alligare Dryphosate 75SG	Alligare, LLC	81927-60	68.9	Percent Acid Equivalent	Group 9
Glyphosate	Alligare Glyphosate 4 PLUS	Alligare, LLC	81927-9	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Alligare Glyphosate 5.4	Alligare, LLC	81927-8	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Aqua Neat	Nufarm Americas Inc.	228-365	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Aqua Star	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-59	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Aquamaster	Monsanto	524-343	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	AquaPro Aquatic Herbicide	SePRO Corporation	62719-324-67690	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Buccaneer	Tenkoz	55467-10	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Buccaneer Plus	Tenkoz	55467-9	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Credit Xtreme	Nufarm Americas Inc.	71368-81	4.5	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Foresters	Nufarm Americas Inc.	228-381	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Gly Star Gold	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-61	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Gly Star Original	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-60	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Gly Star Plus	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-61	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Gly Star Pro	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-61	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Gly-4	Universal Crop Prot. Alliance	42750-60-72693	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Gly-4 Plus	Universal Crop Prot. Alliance	72693-1	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Gly-4 Plus	Universal Crop Prot. Alliance	42750-61-72693	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	GlyphoMate 41	PBI/Gordon Corporation	2217-847	2.8	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Glypro	Dow AgroSciences	62719-324	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Glypro Plus	Dow AgroSciences	62719-322	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Honcho	Monsanto	524-445	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Honcho Plus	Monsanto	524-454	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Imitator Aquatic	Drexel Chemical Company	19713-623	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Imitator DA	Drexel Chemical Company	19713-586	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Imitator Plus	Drexel Chemical Company	19713-526	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	KleenUp Pro	Loveland Products, Inc.	34704-890	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Mad Dog Plus	Loveland Products, Inc.	34704-890	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Makaze	Loveland Products, Inc.	34704-890	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Mirage	Loveland Products Inc.	34704-889	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Mirage Herbicide	UAP-Platte Chem. Co.	524-445-34704	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Mirage Plus	Loveland Products Inc.	34704-890	3.0	Pounds Acid Equivalent Per Gallon	Group 9

Glyphosate	Rattler	Helena Agri-Enterprises, LLC (Helena Chemical Company)	524-445-5905	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Razor	Nufarm Americas Inc.	228-366	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Razor Pro	Nufarm Americas Inc.	228-366	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Rodeo	Dow AgroSciences	62719-324	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Roundup Custom	Monsanto	524-343	4.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Roundup Original	Monsanto	524-445	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Roundup Original II	Monsanto	524-454	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Roundup Original II CA	Monsanto	524-475	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Roundup PRO	Monsanto	524-475	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Roundup PRO Concentrate	Monsanto	524-529	3.7	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Roundup PRO Dry	Monsanto	524-505	64.9	Percent Acid Equivalent	Group 9
Glyphosate	Roundup PROMAX	Monsanto	524-579	4.5	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate	Showdown	Helena Agri-Enterprises, LLC (Helena Chemical Company)	71368-25-5905	3.0	Pounds Acid Equivalent Per Gallon	Group 9
Glyphosate + 2, 4-D	Campaign	Monsanto	524-351	0.9 + 1.5	Pounds Acid Equivalent Per Gallon, Respectively	Groups 9 + 4
Glyphosate + 2, 4-D	Imitator + 2,4-D	Drexel Chemical Company	19713-635	0.9 + 1.5	Pounds Acid Equivalent Per Gallon, Respectively	Groups 9 + 4
Glyphosate + 2, 4-D	Landmaster BW	Albaugh, LLC (Albuagh, Inc/Agri Star)	42570-62	0.9 + 1.5	Pounds Acid Equivalent Per Gallon, Respectively	Groups 9 + 4
Glyphosate + 2, 4-D	Landmaster BW	Monsanto	524-351	0.9 + 1.5	Pounds Acid Equivalent Per Gallon, Respectively	Groups 9 + 4
Hexazinone	Pronone 10G	Pro-Serve	33560-21	10	Percent Active Ingredient	Group 5
Hexazinone	Pronone 25G	Pro-Serve	33560-45	25	Percent Active Ingredient	Group 5
Hexazinone	Pronone MG	Pro-Serve	33560-21	10	Percent Active Ingredient	Group 5
Hexazinone	Pronone Power Pellet	Pro-Serve	33560-41	75	Percent Active Ingredient	Group 5
Hexazinone	Velosa	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5905-579	2.4	Pounds Active Ingredient Per Gallon	Group 5
Hexazinone	Velpar DF	DuPont Crop Protection	352-581	75	Percent Active Ingredient	Group 5
Hexazinone	Velpar DF VU	Bayer Environmental Science	432-1576	75	Percent Active Ingredient	Group 5
Hexazinone	Velpar L	DuPont Crop Protection	352-392	2.0	Pounds Active Ingredient Per Gallon	Group 5
Hexazinone	Velpar L VU	Bayer Environmental Science	432-1573	75	Pounds Active Ingredient Per Gallon	Group 5
Hexazinone	Velpar ULW	DuPont Crop Protection	352-450	75	Percent Active Ingredient	Group 5
Hexazinone + Sulfometuron methyl	Oustar	Bayer Environmental Science	432-1553	63.2 + 11.8	Percent Active Ingredient, Respectively	Groups 5 + 2
Hexazinone + Sulfometuron methyl	Oustar	DuPont Crop Protection	352-603	63.2 + 11.8	Percent Active Ingredient, Respectively	Groups 5 + 2
Hexazinone + Sulfometuron methyl	Westar	Bayer Environmental Science	432-1558	68.6 + 6.5	Percent Active Ingredient, Respectively	Groups 5 + 2
Hexazinone + Sulfometuron methyl	Westar	DuPont Crop Protection	352-626	68.6 + 6.5	Percent Active Ingredient, Respectively	Groups 5 + 2
Imazapic	Alligare Panoramic 2SL	Alligare, LLC	66222-141-81927	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapic	Nufarm Imazapic 2SL	Nufarm Americas Inc.	71368-99	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapic	Open Range G	Wilbur-Ellis Co., LLC (Wilbur-Ellis Co.)	2935-557	0.8325	Percent Acid Equivalent	Group 2
Imazapic	Plateau	BASF Corporation	241-365	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Alligare Ecomazapyr 2SL	Alligare, LLC	81927-22	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Alligare Imazapyr 4SL	Alligare, LLC	81927-24	4.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Alligare Rotary 2 SL	Alligare, LLC	81927-6	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Arsenal	BASF Corporation	241-346	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Arsenal Applicators Conc.	BASF Corporation	241-299	4.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Arsenal PowerLine	BASF Corporation	241-431	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Chopper	BASF Corporation	241-296	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	EZ-JECT Copperhead Herbicide Shells	EZ-JECT, Inc.	83220-2	0.000375	Ounces Acid Equivalent Per Shell	Group 2
Imazapyr	Habitat	BASF Corporation	241-426	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Habitat Herbicide	SePRO	241-426-67690	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris	Nufarm Americas Inc.	228-534	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris AC	Nufarm Americas Inc.	241-299-228	4.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris AC	Nufarm Americas Inc.	228-480	4.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris AC Complete	Nufarm Americas Inc.	228-570	4.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris AQ	Nufarm Americas Inc.	241-426-228	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris Herbicide	Nufarm Americas Inc.	241-346-228	2.0	Pounds Acid Equivalent Per Gallon	Group 2

Imazapyr	Polaris RR	Nufarm Americas Inc.	241-273-228	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris SP	Nufarm Americas Inc.	228-536	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	Polaris SP	Nufarm Americas Inc.	241-296-228	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr	SSI Maxim Arsenal 0.5G	SSI Maxim Co., Inc.	34913-23	0.5	Percent Acid Equivalent	Group 2
Imazapyr	SSI Maxim Arsenal 5.0 G	SSI Maxim Co., Inc.	34913-24	5	Percent Acid Equivalent	Group 2
Imazapyr	Stalker	BASF Corporation	241-398	2.0	Pounds Acid Equivalent Per Gallon	Group 2
Imazapyr + Diuron	Alligare Mojave 70 EG	Alligare, LLC	81927-25	7.78 + 62.22	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 2 + 7
Imazapyr + Diuron	Imazuron	Nufarm Americas Inc.	228-654	7.78 + 62.22	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 2 + 7
Imazapyr + Diuron	Sahara DG	BASF Corporation	241-372	7.78 + 62.22	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 2 + 7
Imazapyr + Diuron	SSI Maxim Topsite 2.5G	SSI Maxim Co., Inc.	34913-22	0.5 + 2.0	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 2 + 7
Imazapyr + Metsulfuron methyl	Lineage Clearstand	Bayer Environmental Science	432-1578	63.2 + 9.5	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 2 + 2
Imazapyr + Metsulfuron methyl	Lineage Clearstand	DuPont Crop Protection	352-766	63.2 + 9.5	Percent Acid Equivalent + Percent Active Ingredient, Respectively	Groups 2 + 2
Imazapyr + Sulfometuron methyl + Metsulfuron methyl	Lineage HWC	Bayer Environmental Science	432-1577	37.5 + 28.1 + 7.5	Percent Acid Equivalent + Percent Acid Ingredient + Percent Active Ingredient, Respectively	Groups 2 + 2 + 2
Imazapyr + Sulfometuron methyl + Metsulfuron methyl	Lineage HWC	DuPont Crop Protection	352-765	37.5 + 28.1 + 7.5	Percent Acid Equivalent + Percent Acid Ingredient + Percent Active Ingredient, Respectively	Groups 2 + 2 + 2
Imazapyr + Sulfometuron methyl + Metsulfuron methyl	Lineage Prep	Bayer Environmental Science	432-1579	54.5 + 15.3 + 4.1	Percent Acid Equivalent + Percent Acid Ingredient + Percent Active Ingredient, Respectively	Groups 2 + 2 + 2
Imazapyr + Sulfometuron methyl + Metsulfuron methyl	Lineage Prep	DuPont Crop Protection	352-767	54.5 + 15.3 + 4.1	Percent Acid Equivalent + Percent Acid Ingredient + Percent Active Ingredient, Respectively	Groups 2 + 2 + 2
Metsulfuron methyl	Alligare MSM 60	Alligare, LLC	81927-7	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	AmTide MSM 60DF Herbicide	AmTide, LLC	83851-3	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	Cimarron MAX - Part A	Bayer Environmental Science	432-1555	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	Cimarron MAX - Part A	DuPont Crop Protection	352-615	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	Escort XP	Bayer Environmental Science	432-1549	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	Escort XP	DuPont Crop Protection	352-439	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	Patriot	Nufarm Americas Inc.	228-391	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	PureStand	Nufarm Americas Inc.	71368-38	60	Percent Active Ingredient	Group 2
Metsulfuron methyl	Rometsol	Rotam North America, Inc.	83100-2-83979	60	Percent Active Ingredient	Group 2
Metsulfuron methyl + Chlorsulfuron	Cimarron Plus	Bayer Environmental Science	432-1572	48 + 15	Percent Active Ingredient, Respectively	Groups 2 + 2
Metsulfuron methyl + Chlorsulfuron	Cimarron Plus	DuPont Crop Protection	352-670	48 + 15	Percent Active Ingredient, Respectively	Groups 2 + 2
Metsulfuron methyl + Chlorsulfuron	Cimarron X-tra	DuPont Crop Protection	352-669	30 + 37.5	Percent Active Ingredient, Respectively	Groups 2 + 2
Picloram	Alligare Picloram 22K	Alligare, LLC	81927-18	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram	Grazon PC	Dow AgroSciences	62719-181	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram	OutPost 22K	Dow AgroSciences	62719-6	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram	Tordon 22K	Dow AgroSciences	62719-6	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram	Tordon K	Dow AgroSciences	62719-17	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram	Triumph 22K	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-79	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram	Triumph K	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-81	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram	Trooper 22K	Nufarm Americas Inc.	228-535	2.0	Pounds Acid Equivalent Per Gallon	Group 4
Picloram + 2, 4-D	Alligare Picloram + D	Alligare, LLC	81927-16	0.54 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2,4-D	Graslan L	Dow AgroSciences	62719-655	0.81 + 3.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D	Grazon P+D	Dow AgroSciences	62719-182	0.54 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D	GunSlinger	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-80	0.54 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D	HiredHand P+D	Dow AgroSciences	62719-182	0.54 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D	Pathway	Dow AgroSciences	62719-31	0.26 + 1.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D	Tordon 101 Mixture	Dow AgroSciences	62719-5	0.54 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D	Tordon RTU	Dow AgroSciences	62719-31	0.26 + 1.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D	Trooper P + D	Nufarm Americas Inc.	228-530	0.54 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Picloram + 2, 4-D + Dicamba	Trooper Extra	Nufarm Americas Inc.	228-586	0.5 + 2.0 + 0.5	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4 + 4
Rimsulfuron	Alligare Laramie 25DF	Alligare, LLC	81927-57	25	Percent Active Ingredient	Group 2

Rimsulfuron	Hinge	Rotam North America, Inc.	83100-40-83979	25	Percent Active Ingredient	Group 2
Rimsulfuron	Matrix SG	Dupont Crop Protection	352-768	25	Percent Active Ingredient	Group 2
Sulfometuron methyl	Alligare SFM 75	Alligare, LLC	81927-26	75	Percent Active Ingredient	Group 2
Sulfometuron methyl	Oust DF	DuPont Crop Protection	352-401	75	Percent Active Ingredient	Group 2
Sulfometuron methyl	Oust XP	Bayer Environmenatl Science	432-1552	75	Percent Active Ingredient	Group 2
Sulfometuron methyl	Oust XP	DuPont Crop Protection	352-601	75	Percent Active Ingredient	Group 2
Sulfometuron methyl	Spyder	Nufarm Americas Inc.	228-408	75	Percent Active Ingredient	Group 2
Sulfometuron methyl + Chlorsulfuron	Landmark XP	Bayer Environmental Science	432-1560	50 + 25	Percent Active Ingredient, Respectively	Groups 2 + 2
Sulfometuron methyl + Chlorsulfuron	Landmark XP	DuPont Crop Protection	352-645	50 + 25	Percent Active Ingredient, Respectively	Groups 2 + 2
Sulfometuron methyl + Metsulfuron methyl	Alligare SFM Extra	Alligare, LLC	81927-5	56.25 + 15	Percent Active Ingredient, Respectively	Groups 2 + 2
Sulfometuron methyl + Metsulfuron methyl	Oust Extra	Bayer Environmental Science	432-1557	56.25 + 15	Percent Active Ingredient, Respectively	Groups 2 + 2
Sulfometuron methyl + Metsulfuron methyl	Oust Extra	DuPont Crop Protection	352-622	56.25 + 15	Percent Active Ingredient, Respectively	Groups 2 + 2
Sulfometuron methyl + Metsulfuron methyl	Spyder Extra Selective	Nufarm Americas Inc.	228-690	56.25 + 15	Percent Active Ingredient, Respectively	Groups 2 + 2
Tebuthiuron	Alligare Tebuthiuron 20 P	Alligare, LLC	81927-41	20	Percent Active Ingredient	Group 7
Tebuthiuron	Alligare Tebuthiuron 80 WG	Alligare, LLC	81927-37	80	Percent Active Ingredient	Group 7
Tebuthiuron	Spike 20P	Dow AgroSciences	62719-121	20	Percent Active Ingredient	Group 7
Tebuthiuron	Spike 80DF	Dow AgroSciences	62719-107	80	Percent Active Ingredient	Group 7
Tebuthiuron	SpraKil S-5 Granules	SSI Maxim Co., Inc.	34913-10	5	Percent Active Ingredient	Group 7
Tebuthiuron + Diuron	SpraKil SK-13 Granular	SSI Maxim Co., Inc.	34913-15	1 + 3	Percent Active Ingredient, Respectively	Groups 7 + 7
Tebuthiuron + Diuron	SpraKil SK-26 Granular	SSI Maxim Co., Inc.	34913-16	2 + 6	Percent Active Ingredient, Respectively	Groups 7 + 7
Triclopyr	Alligare Boulder 6.3	Alligare, LLC	81927-54	6.3	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Alligare Triclopry 4	Alligare, LLC	81927-11	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Alligare Triclopyr 3	Alligare, LLC	81927-13	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Element 3A	Dow AgroSciences	62719-37	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Element 4	Dow AgroSciences	62719-40	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Forestry Garlon XRT	Dow AgroSciences	62719-553	6.3	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Garlon 3A	Dow AgroSciences	62719-37	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Garlon 4	Dow AgroSciences	62719-40	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Garlon 4 Ultra	Dow AgroSciences	62719-527	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Pathfinder II	Dow AgroSciences	62719-176	0.75	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Relegate	Nufarm Americas Inc.	228-521	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Relegate RTU	Nufarm Americas Inc.	228-552	0.75	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Remedy	Dow AgroSciences	62719-70	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Remedy Ultra	Dow AgroSciences	62719-552	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Renovate 3	SePRO Corporation	62719-37-67690	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Renovate OTF	SePRO Corporation	67690-42	10	Percent Acid Equivalent	Group 4
Triclopyr	Tahoe 3A	Nufarm Americas Inc.	228-520	3.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Tahoe 4E	Nufarm Americas Inc.	228-385	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Tahoe 4E Herbicide	Nufarm Americas Inc.	228-517	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Triclopyr RTU	Albaugh, LLC (Albuagh, Inc/Agri Star)	42750-173	0.75	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Trycera	Helena Agri-Enterprises, LLC (Helena Chemical Company)	5906-580	2.87	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr	Vastlan	Dow AgroSciences	62719-687	4.0	Pounds Acid Equivalent Per Gallon	Group 4
Triclopyr + 2, 4-D	Alligare Everett	Alligare, LLC	81927-29	1.0 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Triclopyr + 2, 4-D	Aquasweep	Nufarm Americas Inc.	228-316	1.07 + 2.78	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Triclopyr + 2, 4-D	Candor	Nufarm Americas Inc.	228-565	1.0 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Triclopyr + 2, 4-D	Crossbow	Dow AgroSciences	62719-260	1.0 + 2.0	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Triclopyr + Clopyralid	Alligare Prescott Herbicide	Alligare, LLC	81927-30	2.25 + 0.75	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4
Triclopyr + Clopyralid	Brazen	Nufarm Americas Inc.	228-564	2.25 + 0.75	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4

Triclopyr + Clopyralid	Redeem R&P	Dow AgroSciences	62719-337	2.25 + 0.75	Pounds Acid Equivalent Per Gallon, Respectively	Groups 4 + 4

Adjuvants Approved for Use on BLM Administered Lands

Update: April 4, 2019

Adjuvant Class	Adjuvant Type	Trade Name	Manufacturer	Comments
Surfactant				
	Non-ionic Surfactant			
		90-10 Surfactant	Brewer International	
		A-90	Alligare, LLC	
		Alligare 90	Alligare, LLC	
		Activate Plus	WinField United (Winfield Solutions, LLC)	CA Reg. No. 9779-50004-AA
				WA Reg. No. 1381-09001
		Activator 90	Loveland Products, Inc.	CA Reg. No. 34704-50034-AA
		Ad Spray 90	Helena Agri-Enterprises, LLC (Helena Chemical Company)	WA Reg. No. 5905-70020
		Alligare Surface	Alligare, LLC	
		Alligare Surface West	Alligare, LLC	CA Reg. No. 81927-50007-AA
				WA Reg. No. 81927-15004
		Alligare Trace	Alligare, LLC	
		Aqufact	Aqumix, Inc.	
		Audible 80	Exacto, Inc.	
		Audible 90	Exacto, Inc.	
		Brewer 90-10	Brewer International	
		Chempro S-820	Chemorse Ltd.	WA Reg. No. 46059-15001
		Chempro S-910	Chemorse Ltd.	WA Reg. No. 46059-14001
		Chemsurf 80	Chemorse Ltd.	CA Reg. No. 1050984-50004-AA
				WA Reg. No. 46059-10002
		Chemsurf 90	Chemorse Ltd.	CA Reg. No. 1050984-50005-AA
				WA Reg. No. 46059-10003
		Cornbelt Premier 90	Van Diest Supply Co.	
		Cornbelt Trophy Gold	Van Diest Supply Co.	
		Denali-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50204-AA
				WA Reg. No. 2935-15006
		Elite Platinum	Red River Specialties, Inc.	
		Elite Premium	Red River Specialties, Inc.	
		EP-90	Eco-Pak, LLC	
		Haf-Pynt	Drexel Chemical Company	CA Reg. No. 19713-50007-AA
				WA Reg. No. 19713-14001
		Hum-AC 820	Drexel Chemical Company	WA Reg. No. 19713-09001
		Induce	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50091-AA
		Induce pH	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Inlet	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50099-AA
		LI-700	Loveland Products, Inc.	CA Reg. No. 34704-50035
		Magnify	Monterey AgResources	CA Reg. No. 17545-50018
		NIS 90:10	Precision Laboratories, LLC	CA Reg. No. 9349-50002-AA
				WA Reg. No. 9349-13001
		NIS-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		No Foam A	Creative Marketing & Research, Inc.	CA Reg. No. 1050775-50015
		Optima	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50075-AA
		PAS-800	Drexel Chemical Company	
		Preference	WinField United (Winfield Solutions, LLC)	WA Reg. No. 1381-50011
		R-900	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Rainer-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
Surfactant	Non-ionic Surfactant - cont.			
		Range Master	ORO Agri Inc.	WA Reg. No. 72662-19001
		Red River 90	Red River Specialties, Inc.	
		Red River NIS	Red River Specialties, Inc.	
		Scanner	Loveland Products, Inc.	CA Reg. No. 34704-50064
				WA Reg. No. 34704-09003
		Spec 90/10	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Spray Activator 85	Van Diest Supply Co.	
		Spreader 90	Loveland Products, Inc.	WA Reg. No. 34704-05002-AA
		Spret	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50098-AA
		Super Spread 90	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	WA Reg. No. AW-2935-70016
		Super Spread 7000	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50170
				WA Reg. No. AW-2935-0002
		Surf-Ac 820	Drexel Chemical Company	WA Reg. No. 19713-70002
		Surf-Ac 910	Drexel Chemical Company	WA Reg. No. 19713-70003
		UAP Surfactant 80/20	Loveland Products, Inc.	
		Wetcit	ORO Agri Inc.	CA Reg. No. 72662-50001-AA
				WA Reg. No. 72662-05001
		X-77	Loveland Products, Inc.	CA Reg. No. 34704-50044
	Spreader/Sticker			
		Agri-Trend Spreader	Agri-Trend	
		Antero-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50206
				WA Reg. No. 2935-18001
		Aqua-King Plus	WinField United (Winfield Solutions, LLC)	
		Attach	Loveland Products, Inc.	CA Reg. No. 34704-50026
		Bond	Loveland Products, Inc.	CA Reg. No. 36208-50005
		Bond Max	Loveland Products, Inc.	CA Reg. No. 34704-50060
				WA Reg. No. 34704-08003
		Chempro S-196	Chemorse Ltd.	CA Reg. No. 1050984-50006-AA
				WA Reg. No. 46059-11001
		Cohere	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50083-A
		CWC 90	CWC Chemical, Inc.	
		Gulfstream	WinField United (Winfield Solutions, LLC)	
		Insist 90	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Insist 90 Plus	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	WA Reg. No. 2935-17001
		Lastick	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Nu Film 17	Miller Chem. & Fert. Corp.	CA Reg. No. 72-50021-AA
		Nu-Film-IR	Miller Chem. & Fert. Corp.	
		Nu Film P	Miller Chem. & Fert. Corp.	CA Reg. No. 72-50022-AA
		Onside Kick	Exacto, Inc.	
		Pinene II	Drexel Chemical Company	CA Reg. No. 19713-50003-AA
				WA Reg. No. 19713-00001
		Protyx	Precision Laboratories, LLC	WA Reg. No. 9349-13002
		R-56	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50144
		Rocket DL	Monterey AgResources	CA Reg. No. 17545-50019
		Tactic	Loveland Products, Inc.	CA Reg. No. 34704-50041-AA
		TopFilm	Biosorb, Inc.	
		Widespread Max	Loveland Products, Inc.	CA Reg. No. 34704-50061
				WA Reg. No. 34704-09001

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
	Silicone-based			
		Aero Dyne-Amic	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50080-AA
		Aircover	WinField United (Winfield Solutions, LLC)	
		Alligare OSS/NIS	Alligare, LLC	
		Chempro S-172	Chemorse Ltd.	CA Reg. No. 1050984-50008-AA
				WA Reg. No. 46059-15002
		Dyne-Amic	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5095-50071-AA
		Elite Marvel	Red River Specialties, Inc.	
		Freeway	Loveland Products, Inc.	CA Reg. No. 34704-50031
				WA Reg. No. 34704-04005
		Kinetic	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50087-AA
		Phase	Loveland Products, Inc.	CA Reg. No. 34704-50037-AA
		Phase II	Loveland Products, Inc.	
		Scrimmage	Exacto, Inc.	
		SilEnergy	Brewer International	
		Sil-Fact	Drexel Chemical Company	CA Reg. No. 19713-50004-AA
		Sil-MES 100	Drexel Chemical Company	
		Silnet 200	Brewer International	
		Silwet L-77	Loveland Products, Inc.	CA Reg. No. 34704-50043
		Speed	Precision Laboratories, LLC	
		Sun Spreader	Red River Specialties, Inc.	
		Syl-coat	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50189
				WA Reg. No. 2935-12002
		Sylgard 309	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50161
		Syl-Tac	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50167
		Syl-Tac-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50203
				WA Reg. No. 2935-15004
		Thoroughbred	WinField United (Winfield Solutions, LLC)	
Oil-based				
	Crop Oil Concentrate			
		60/40 Crop Oil Concentrate	Chemorse Ltd.	WA Reg. No. 46059-15004
		Agri-Dex	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50094-AA
		Alligare Forestry Oil	Alligare, LLC	
		Brewer 83-17	Brewer International	
		Cornbelt Crop Oil Concentrate	Van Diest Supply Co.	
		Cornbelt Premium Crop Oil Concentrate	Van Diest Supply Co.	
		Crop Oil Concentrate	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50085-AA
		Crop Oil Concentrate	Loveland Products, Inc.	
		CWR Herbicide Activator	Creative Marketing & Research, Inc.	CA Reg. No. 1050775-50020-AA
		Exchange	Precision Laboratories, LLC	WA Reg. No. 9349-13008
		Herbimax	Loveland Products, Inc.	CA Reg. No. 34704-50032-AA
				WA Reg. No. 34704-04006
		Maximizer Crop Oil Conc.	Loveland Products, Inc.	CA Reg. No. 34704-50059
				WA Reg. No. 34704-08002
		Monterey Crop Oil	Monterey AgResources	CA Reg. No. 17545-50031
		Mor-Act	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50098
		Peptoil	Drexel Chemical Company	WA Reg. No. 19713-70001
		Power-Line Crop Oil	Land View Inc.	
		Primary	Drexel Chemical Company	
		Prime Oil	WinField United (Winfield Solutions, LLC)	CA Reg. No. 979-50002-AA
				WA Reg. No. 1381-13004
		R.O.C. Rigo Oil Conc.	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
Oil-based	Crop Oil Concentrate - cont.			
		Red River Forestry Oil	Red River Specialties, Inc.	
		Red River Pacer Crop Oil	Red River Specialties, Inc.	
		Superb HC	WinField United (Winfield Solutions, LLC)	WA Reg. No. 1381-06003
	Methylated Seed Oil			
		60/40 MSO	Chemorse Ltd.	WA Reg. No. 46059-15003
		Alligare MSO	Alligare, LLC	
		Alligare MSO West	Alligare, LLC	WA Reg. No. 81927-15002
		Atmos	WinField United (Winfield Solutions, LLC)	
		Conquer	Chemorse Ltd.	CA Reg. No. 1050984-50002-AA
				WA Reg. No. 46059-10001
		Cornbelt Base	Van Diest Supply Co.	
		Cornbelt Methylates Soy-Stik	Van Diest Supply Co.	
		Destiny HC	WinField United (Winfield Solutions, LLC)	WA Reg. No. 1381-09002
		Elite Supreme	Red River Specialties, Inc.	
		Glacier-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50205
				WA Re. No. 2935-16001
		Hasten	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50160
				WA Reg. No. 2935-02004
		Hasten-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50202
				WA Reg. No. 2935-15003
		Hot MES	Drexel Chemical Company	
		Inergy	WinField United (Winfield Solutions, LLC)	
		Kixyt	Precision Laboratories, LLC	WA Reg. No. 9349-12001
		MES-100	Drexel Chemical Company	CA Reg. No. 19713-50002-AA
				WA Reg. No. 19713-50002
		Methylated Spray Oil Conc.	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Monterey M.S.O.	Monterey AgResources	CA Reg. No. 17545-50025
		MSO Concentrate (Alligare)	Alligare, LLC	
		MSO Concentrate (Loveland)	Loveland Products, Inc.	CA Reg. No. 34704-50067
				WA Reg. No. 34709-04009
		Persist Ultra	Precision Laboratories, LLC	CA Reg. No. 9349-50005
				WA Reg. No. 9349-13003
		Premium MSO	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Red River Supreme	Red River Specialties, Inc.	
		Renegade 2.0	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50194
				WA Reg. No. 2935-13001
		Renegade-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50201
				WA Reg. No. 2935-15002
		Sunburn	Red River Specialties, Inc.	
		SunEnergy	Brewer International	
		Sunset	Red River Specialties, Inc.	
		Sun Wet	Brewer International	
		Super Kix	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Super Spread MSO	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
	Methylated Seed Oil + Organosilicone			
		Alligare MVO Plus	Alligare, LLC	
		Turbulence	WinField United (Winfield Solutions, LLC)	

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
Oil-based	Vegetable Oil			
		Amigo	Loveland Products, Inc.	CA Reg. No. 34704-50028-AA
				WA Reg. No. 34704-04002
		BeanOil	Drexel Chemical Company	
		Competitor	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50173
				WA Reg. No. AW-2935-04001
		Elite Natural	Red River Specialties, Inc.	
		Motion	Exacto, Inc.	
		Noble	WinField United (Winfield Solutions, LLC)	
		Vegetoil	Drexel Chemical Company	
Fertilizer-based				
	Nitrogen-based			
		Actamaster Soluble Spray Adjuvant	Loveland Products, Inc.	WA Reg. No. 34704-50001
		Actamaster Spray Adjuvant	Loveland Products, Inc.	WA Reg. No. 34704-50006
		Alliance	WinField United (Winfield Solutions, LLC)	CA Reg. No. 1381-50002-AA
				WA Reg. No.1381-05005
		AMS-All	Drexel Chemical Company	
		AMS-Supreme	Drexel Chemical Company	
		AMS-Xtra	Drexel Chemical Company	
		Bronc	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Bronc Max	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Bronc Max EDT	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Bronc Plus Dry	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Bronc Plus Dry EDT	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	WA Reg. No.2935-03002
		Bronc Total	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Cayuse Plus	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50171
		Class Act NG	WinField United (Winfield Solutions, LLC)	WA Reg. No. 1381-01004
		Cornbelt Gardian	Van Diest Supply Co.	
		Cornbelt Gardian Plus	Van Diest Supply Co.	
		Corral AMS Liquid	WinField United (Winfield Solutions, LLC)	WA Reg. No. 1381-01006
		Dispatch	Loveland Products, Inc.	
		Dispatch 111	Loveland Products, Inc.	
		Dispatch 2N	Loveland Products, Inc.	
		Dispatch AMS	Loveland Products, Inc.	
		Flame	Loveland Products, Inc.	
		Holzit	Drexel Chemical Company	
		Nitro-Surf	Drexel Chemical Company	
		Quest	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50076-AA
		TransActive HC	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
Special Function				
	Buffering Agent			
		Brimstone	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		BS-500	Drexel Chemical Company	
		Buffers P.S.	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50062-ZA
		Oblique	Red River Specialties, Inc.	
		Spray-Aide	Miller Chem. & Fert. Corp.	CA Reg. No. 72-50006-AA
		Tri-Fol	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50152
		Yardage	Exacto, Inc.	

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
Special Function				
	Colorants/Dyes			
		Alligare Super Marking Dye	Alligare, LLC	
		BullsEye	Milliken Chemical	
		Elite Ruby	Red River Specialties, Inc.	
		Elite Sapphire	Red River Specialties, Inc.	
		Elite Sapphire WSB	Red River Specialties, Inc.	
		Elite Splendor	Red River Specialties, Inc.	
		Hash Mark Blue Liquid	Exacto, Inc.	
		Hash Mark Blue Liquid HC	Exacto, Inc.	
		Hash Mark Blue Powder	Exacto, Inc.	
		Hash Mark Green Liquid	Exacto, Inc.	
		Hash Mark Green Powder	Exacto, Inc.	
		Hi-Light	Becker-Underwood	
		Hi-Light WSP	Becker-Underwood	
		Marker Dye	Loveland Products, Inc.	
		Mark-It Blue	Monterey AgResources	
		Mark-It Red	Monterey AgResources	
		Mystic HC	WinField United (Winfield Solutions, LLC)	
		Signal	Precision Laboratories, LLC	
		SPI-Max Blue Spray Marker	PROKoZ	
		Spray Indicator XL	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		TurfTrax	Loveland Products, Inc.	
		TurfTrax Blue Spray Indicator	Loveland Products, Inc.	
	Compatibility/Suspension Agent			
		Convert	Precision Laboratories, LLC	WA Reg. No. 9349-13007
		E Z MIX	Loveland Products, Inc.	CA Reg. No. 36208-50006
		Mix	Drexel Chemical Company	
		Support	Loveland Products, Inc.	WA Reg. No. 34704-04011
	Defoaming Agent			
		Alligare Anti-Foamer	Alligare, LLC	
		Alligare Defoamer	Alligare, LLC	
		Cornbelt Defoamer	Van Diest Supply Co.	
		Defoamer	Brewer International	
		Fighter-F 10	Loveland Products, Inc.	
		Fighter-F Dry	Loveland Products, Inc.	
		Foam Buster	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50072-AA
		Foambuster Max	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Foam Fighter	Miller Chem. & Fert. Corp.	CA Reg. No. 72-50005-AA
		Fome-Kil	Drexel Chemical Company	
		FTF Defoamer	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	WA Reg. No. 2935-13002
		Gundown Max	Precision Laboratories, LLC	WA Reg. No. 9349-13013
		No Foam	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50136
		Red River Defoamer	Red River Specialties, Inc.	
		Reverse	Exacto, Inc.	
		Suppression	Chemorse Ltd.	CA Reg. No. 1050984-50007
				WA Reg. No. 46059-12001
		Tripleline	Creative Marketing & Research, Inc.	CA Reg. No. 1050775-50023-AA
		Unfoamer	Loveland Products, Inc.	CA Reg. No. 34704-50062

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
Special Function				
	Deposition Aid			
		Agripharm Drift Control	Walco International	
		Alligare Downforce	Alligare, LLC	
		Alligare Pattern	Alligare, LLC	CA Reg. No. 81927-50008-AA
		Bivert	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50163
		Border AQ	Precision Laboratories, LLC	WA Reg. No. 9349-13009
		Chem-Trol	Chemorse Ltd.	CA Reg. No. 1050984-50001-AA
				WA Reg. No. 1050984-50001
		Clasp	Helena Agri-Enterprises, LLC (Helena Chemical Company)	WA Reg. No. 5905-13002
		Compadre	Loveland Products, Inc.	CA Reg. No. 34704-50050
				WA Reg. No. 34704-06004
		Coverage G-20	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Crosshair	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		CWC Sharpshooter	CWC Chemical, Inc.	
		Cygnet Plus	Brewer International	CA Reg. No. 1051114-50001
		Diligence	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Direct	Precision Laboratories, LLC	
		Droplex	WinField United (Winfield Solutions, LLC)	
		EDT Concentrate	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Elite Secure Ultra	Red River Specialties, Inc.	
		Exit	Miller Chem. & Fert. Corp.	CA Reg. No. 72-50014-AA
		Grounded	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Grounded - CA	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50096-AA
		Grounded - W	Helena Agri-Enterprises, LLC (Helena Chemical Company)	WA Reg. No. 5905-13001
		Infuse	Loveland Products, Inc.	
		Intac Plus	Loveland Products, Inc.	
		Interlock	WinField United (Winfield Solutions, LLC)	
		Liberate	Loveland Products, Inc.	CA Reg. No. 34704-50030-AA
				WA Reg. No. 34704-04008
		LOX	Drexel Chemical Company	
		LOX PLUS	Drexel Chemical Company	
		Mist-Control	Miller Chem. & Fert. Corp.	CA Reg. No. 72-50011-AA
		Offside	Exacto, Inc.	
		Pointblank	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 52467-50008-AA-5905
		Poly Control 2	Brewer International	
		Reign	Loveland Products, Inc.	CA Reg. No. 34704-50045
				WA Reg. No. 34704-05010
		Reign LC	Loveland Products, Inc.	CA Reg. No. 34704-50048
		Secure Ultra	Red River Specialties, Inc.	
		Strike Zone DF	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50084-AA
		Sustain	Miller Chem. & Fert. Corp.	CA Reg. No. 72-50015-AA
		Syndetic	Chemorse Ltd.	CA Reg. No. 1050984-50003-ZA
		Volare DC	Precision Laboratories, LLC	CA Reg. No. 9349-50004-AA
				WA Reg. No. 9349-13006
		Weather Gard	Loveland Products, Inc.	CA Reg. No. 34704-50042-AA
	Diluent/Deposition Agent			
		Bark Oil	Crop Production Services	
		Bark Oil EC	Crop Production Services	
		Elite Premier	Red River Specialties, Inc.	
		Elite Premier Blue	Red River Specialties, Inc.	
		Hy-Grade EC	CWC Chemical, Inc.	

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
Special Function				
	Diluent/Deposition Agent - cont.			
		Hy-Grade I	CWC Chemical, Inc.	
		Improved JLB Oil Plus	Brewer International	
		In-Place	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50169
		JLB Oil Plus	Brewer International	
		Red River Basal Oil	Red River Specialties, Inc.	
		Thinvert Concentrate	Waldrum Specialties, Inc.	
		Thinvert RTU	Waldrum Specialties, Inc.	
		W.E.B. Oil	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50166
				WA Reg. No. AW 2935-70023
	Foam Marker			
		Align	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		F.M.-160	Drexel Chemical Company	
		R-160	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Red River Foam Marker	Red River Specialties, Inc.	
		Trekker Trax	Loveland Products, Inc.	
		Tuff Trax Foam Concentrate	Loveland Products, Inc.	
	Invert Emulsion Agent			
		Redi-vert II	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50168
	Tank Cleaner			
		All Clear	Loveland Products, Inc.	
		Back Field	Exacto, Inc.	
		Cornbelt Tank-Aid	Van Diest Supply Co.	
		Elite Vigor	Red River Specialties, Inc.	
		Kutter	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Neutral-Clean	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Pro Tank	WinField United (Winfield Solutions, LLC)	
		Red River Tank Cleaner	Red River Specialties, Inc.	
		SSC-11	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Tank and Equipment Cleaner	Loveland Products, Inc.	
		Wipe Out	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
	Water Conditioning			
		AccuQuest WM	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Alligare Water Conditioner	Alligare, LLC	
		Blendmaster	Loveland Products, Inc.	
		Breeze	WinField United (Winfield Solutions, LLC)	WA Reg. No. 1381-13007
		Choice	Loveland Products, Inc.	CA Reg. No. 34704-50027-AA
				WA Reg. No. 34704-04004
		Choice Weather Master	Loveland Products, Inc.	CA Reg. No. 34704-50038-AA
				WA Reg. No. 34704-05005
		Choice Xtra	Loveland Products, Inc.	
		Climb	Wilbur-Ellis Co.	CA Reg. No. 2935-50181
				WA Reg. No. 2935-09001
		Completion	Exacto, Inc.	
		Cornbelt N-Tense	Van Diest Supply Co.	
		Cut-Rate	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	
		Cynder	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	CA Reg. No. 2935-50211

Adjuvant Class	Adjuvant Type	Trade Name	Munufacturer	Comments
Special Function				
	Water Conditioning - cont.			
		Elite Imperial	Red River Specialties, Inc.	
		Hel-Fire	Helena Agri-Enterprises, LLC (Helena Chemical Company)	
		Import	Precision Laboratories, LLC	WA Reg. No. 9349-14001
		Sequestra	Drexel Chemical Company	
		Smoke	Helena Agri-Enterprises, LLC (Helena Chemical Company)	CA Reg. No. 5905-50104-AA
		Transport LpH	Precision Laboratories, LLC	
		Transport Plus	Precision Laboratories, LLC	WA Reg. No. 9349-13014

Adjuvant Information Summary — MASTER LIST — April 4, 2019

Adjuvant Class	Adjuvant Type	Trade Name	Manufacturer Name	Formulation	Registration Number #1	Registration Number #2
Surfactant	Non-Ionic	90-10 Surfactant	Brewer International	Liquid		
Surfactant	Non-Ionic	A-90	Alligare, LLC	Liquid		
Surfactant	Non-Ionic	Alligare 90	Alligare, LLC	Liquid		
Surfactant	Non-Ionic	Activate Plus	WinField United (Winfield Solutions, LLC)	Liquid	CA Reg. No. 9779-50004-AA	WA Reg. No. 1381-09001
Surfactant	Non-Ionic	Activator 90	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50034-AA	
Surfactant	Non-Ionic	Ad Spray 90	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		WA Reg. No. 5905-70020
Surfactant	Non-Ionic	Alligare Surface	Alligare, LLC	Liquid		
Surfactant	Non-Ionic	Alligare Surface West	Alligare, LLC	Liquid	CA Reg. No. 81927-50007-AA	WA Reg. No. 81927-15004
Surfactant	Non-Ionic	Alligare Trace	Alligare, LLC	Liquid		
Surfactant	Non-Ionic	Aqufact	Aqumix, Inc.	Liquid		
Surfactant	Non-Ionic	Audible 80	Exacto, Inc.	Liquid		
Surfactant	Non-Ionic	Audible 90	Exacto, Inc.	Liquid		
Surfactant	Non-Ionic	Brewer 90-10	Brewer International	Liquid		
Surfactant	Non-Ionic	Chempro S-820	Chemorse Ltd.	Liquid		WA Reg. No. 46059-15001
Surfactant	Non-Ionic	Chempro S-910	Chemorse Ltd.	Liquid		WA Reg. No. 46059-14001
Surfactant	Non-Ionic	Chemsurf 80	Chemorse Ltd.	Liquid	CA Reg. No. 1050984-50004-AA	WA Reg. No. 46059-10002
Surfactant	Non-Ionic	Chemsurf 90	Chemorse Ltd.	Liquid	CA Reg. No. 1050984-50005-AA	WA Reg. No. 46059-10003
Surfactant	Non-Ionic	Cornbelt Premier 90	Van Diest Supply Co.	Liquid		
Surfactant	Non-Ionic	Cornbelt Trophy Gold	Van Diest Supply Co.	Liquid		
Surfactant	Non-Ionic	Denali-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50204-AA	WA Reg. No. 2935-15006
Surfactant	Non-Ionic	Elite Platinum	Red River Specialities, Inc.	Liquid		
Surfactant	Non-Ionic	Elite Premium	Red River Specialities, Inc.	Liquid		
Surfactant	Non-Ionic	EP-90	Eco-Pak, LLC	Liquid		
Surfactant	Non-Ionic	Haf-Pynt	Drexel Chemical Company	Liquid	CA Reg. No. 19713-50007-AA	WA Reg. No. 19713-14001
Surfactant	Non-Ionic	Hum-AC 820	Drexel Chemical Company	Liquid		WA Reg. No. 19713-09001
Surfactant	Non-Ionic	Induce	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50091-AA	
Surfactant	Non-Ionic	Induce pH	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Surfactant	Non-Ionic	Inlet	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50099-AA	
Surfactant	Non-Ionic	LI-700	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50035	WA Reg. No. AW36208-70004
Surfactant	Non-Ionic	Magnify	Monterey AgResources	Liquid	CA Reg. No. 17545-50018	
Surfactant	Non-Ionic	NIS 90:10	Precision Laboratories, LLC	Liquid	CA Reg. No. 9349-50002-AA	WA Reg. No. 9349-13001
Surfactant	Non-Ionic	NIS-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Surfactant	Non-Ionic	No Foam A	Creative Marketing & Research	Liquid	CA Reg. No. 1050775-50015	
Surfactant	Non-Ionic	Optima	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50075-AA	
Surfactant	Non-Ionic	PAS-800	Drexel Chemical Company	Liquid		
Surfactant	Non-Ionic	Preference	WinField United (Winfield Solutions, LLC)	Liquid		WA Reg. No. 1381-50011
Surfactant	Non-Ionic	R-900	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Surfactant	Non-Ionic	Rainer-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Surfactant	Non-Ionic	Range Master	ORO Agri, Inc.	Liquid		WA Reg. No. 72662-19001
Surfactant	Non-Ionic	Red River 90	Red River Specialities, Inc.	Liquid		
Surfactant	Non-Ionic	Red River NIS	Red River Specialities, Inc.	Liquid		

Surfactant	Non-Ionic	Scanner	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50064	WA Reg. No. 34704-09003
Surfactant	Non-Ionic	Spec 90/10	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Surfactant	Non-Ionic	Spray Activator 85	Van Diest Supply Co.	Liquid		
Surfactant	Non-Ionic	Spreader 90	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50055	WA Reg. No. 34704-05002
Surfactant	Non-Ionic	Spret	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50098-AA	
Surfactant	Non-Ionic	Super Spread 7000	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50170	WA Reg. No. AW-2935-0002
Surfactant	Non-Ionic	Super Spread 90	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		WA Reg. No. AW-2935-70016
Surfactant	Non-Ionic	Surf-Ac 820	Drexel Chemical Company	Liquid		WA Reg. No. 19713-70002
Surfactant	Non-Ionic	Surf-Ac 910	Drexel Chemical Company	Liquid		WA Reg. No. 19713-70003
Surfactant	Non-Ionic	UAP Surfactant 80/20	Loveland Products, Inc.	Liquid		
Surfactant	Non-Ionic	Wetcit	ORO Agri, Inc.	Liquid	CA Reg. No. 72662-50001-AA	WA Reg. No. 72662-05001
Surfactant	Non-Ionic	X-77	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50044	
Surfactant	Spreader/Sticker	Agri-Trend Spreader	Agri-Trend	Liquid		
Surfactant	Spreader/Sticker	Antero-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50206	WA Reg. No. 2935-18001
Surfactant	Spreader/Sticker	Aqua-King Plus	WinField United (Winfield Solutions, LLC)	Liquid		
Surfactant	Spreader/Sticker	Attach	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50026	
Surfactant	Spreader/Sticker	Bond	Loveland Products, Inc.	Liquid	CA Reg. No. 36208-50005	
Surfactant	Spreader/Sticker	Bond Max	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50060	WA Reg. No. 34704-08003
Surfactant	Spreader/Sticker	Chempro S-196	Chemorse Ltd.	Liquid	CA Reg. No. 1050984-50006-AA	WA Reg. No. 46059-11001
Surfactant	Spreader/Sticker	Cohere	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50083-A	
Surfactant	Spreader/Sticker	CWC 90	CWC Chemical, Inc.	Liquid		
Surfactant	Spreader/Sticker	Gulfstream	WinField United (Winfield Solutions, LLC)	Liquid		
Surfactant	Spreader/Sticker	Insist 90	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Surfactant	Spreader/Sticker	Insist 90 Plus	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		WA Reg. No. 2935-17001
Surfactant	Spreader/Sticker	Lastick	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Surfactant	Spreader/Sticker	Nu Film 17	Miller Chem. & Fert. Corp.	Liquid	CA Reg. No. 72-50021-AA	
Surfactant	Spreader/Sticker	Nu Film P	Miller Chem. & Fert. Corp.	Liquid	Ca Reg. No. 72-50022-AA	
Surfactant	Spreader/Sticker	Nu-Film-IR	Miller Chem. & Fert. Corp.	Liquid		
Surfactant	Spreader/Sticker	Onside Kick	Exacto, Inc.	Liquid		
Surfactant	Spreader/Sticker	Pinene II	Drexel Chemical Company	Liquid	CA Reg. No. 19713-50003-AA	WA Reg. No. 19713-00001
Surfactant	Spreader/Sticker	Protyx	Precision Laboratories, LLC	Liquid		WA Reg. No. 9349-13002
Surfactant	Spreader/Sticker	R-56	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50144	
Surfactant	Spreader/Sticker	Rocket DL	Monterey AgResources	Liquid	CA Reg. No. 17545-50019	
Surfactant	Spreader/Sticker	Surf-King Plus	WinField United (Winfield Solutions, LLC)	Liquid		
Surfactant	Spreader/Sticker	Tactic	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50041-AA	
Surfactant	Spreader/Sticker	TopFilm	Biosorb, Inc.	Liquid		
Surfactant	Spreader/Sticker	Widespread Max	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50061	WA Reg. No. 34704-09001
Surfactant	Silicone Based	Aero Dyne-Amic	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50080-AA	
Surfactant	Silicone Based	Aircover	WinField United (Winfield Solutions, LLC)+D66	Liquid		
Surfactant	Silicone Based	Alligare OSS/NIS	Alligare, LLC	Liquid		
Surfactant	Silicone Based	Chempro S-172	Chemorse, Ltd	Liquid	CA Reg. No. 1050984-50008-AA	WA Reg. No. 46059-15002
Surfactant	Silicone Based	Dyne-Amic	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5095-50071-AA	
Surfactant	Silicone Based	Elite Marvel	Red River Specialities, Inc.	Liquid		
Surfactant	Silicone Based	Freeway	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50031	WA Reg. No. 34704-04005
Surfactant	Silicone Based	Kinetic	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50087-AA	

Surfactant	Silicone Based	Phase	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50037-AA	
Surfactant	Silicone Based	Phase II	Loveland Products, Inc.	Liquid		
Surfactant	Silicone Based	Scrimmage	Exacto, Inc.	Liquid		
Surfactant	Silicone Based	SilEnergy	Brewer International	Liquid		
Surfactant	Silicone Based	Sil-Fact	Drexel Chemical Company	Liquid	CA Reg. No. 19713-50004-AA	
Surfactant	Silicone Based	Sil-MES 100	Drexel Chemical Company	Liquid		
Surfactant	Silicone Based	Silnet 200	Brewer International	Liquid		
Surfactant	Silicone Based	Silwet L-77	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50043	
Surfactant	Silicone Based	Speed	Precision Laboratories, LLC	Liquid		
Surfactant	Silicone Based	Sun Spreader	Red River Specialities, Inc.	Liquid		
Surfactant	Silicone Based	Syl-coat	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50189	WA Reg. No. 2935-12002
Surfactant	Silicone Based	Sylgard 309	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50161	
Surfactant	Silicone Based	Syl-Tac	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50167	
Surfactant	Silicone Based	Syl-Tac-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50203	WA Reg. No. 2935-15004
Surfactant	Silicone Based	Thoroughbred	WinField United (Winfield Solutions, LLC)	Liquid		
Oil Based	Crop Oil Concentrate	60/40 Crop Oil Concentrate	Chemorse Ltd.	Liquid		WA Reg. No. 46059-15004
Oil Based	Crop Oil Concentrate	Agri-Dex	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50094-AA	
Oil Based	Crop Oil Concentrate	Alligare Forestry Oil	Alligare, LLC	Liquid		
Oil Based	Crop Oil Concentrate	Brewer 83-17	Brewer International	Liquid		
Oil Based	Crop Oil Concentrate	Cornbelt Crop Oil Concentrate	Van Diest Supply Co.	Liquid		
Oil Based	Crop Oil Concentrate	Cornbelt Premium Crop Oil Concentrate	Van Diest Supply Co.	Liquid		
Oil Based	Crop Oil Concentrate	Crop Oil Concentrate (Loveland)	Loveland Products, Inc.	Liquid		
Oil Based	Crop Oil Concentrate	Crop Oil Concentrate (Helena)	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50085-AA	
Oil Based	Crop Oil Concentrate	CWR Herbicide Activator	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 1050775-50020-AA	
Oil Based	Crop Oil Concentrate	Exchange	Precision Laboratories, LLC	Liquid		WA Reg. No. 9349-13008
Oil Based	Crop Oil Concentrate	Herbimax	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50032-AA	WA Reg. No. 34704-04006
Oil Based	Crop Oil Concentrate	Maximizer Crop Oil Conc.	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50059	WA Reg. No. 34704-08002
Oil Based	Crop Oil Concentrate	Monterey Crop Oil	Monterey AgResources	Liquid	CA Reg. No. 17545-50031	
Oil Based	Crop Oil Concentrate	Mor-Act	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50098	
Oil Based	Crop Oil Concentrate	Peptoil	Drexel Chemical Company	Liquid		WA Reg. No. 19713-70001
Oil Based	Crop Oil Concentrate	Power-Line Crop Oil	Land View Inc.	Liquid		
Oil Based	Crop Oil Concentrate	Prime Oil	WinField United (Winfield Solutions, LLC)	Liquid	CA Reg. No. 979-50002-AA	WA Reg. No. 1381-13004
Oil Based	Crop Oil Concentrate	Primary	Drexel Chemical Company	Liquid		
Oil Based	Crop Oil Concentrate	R.O.C. Rigo Oil Conc.	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Oil Based	Crop Oil Concentrate	Red River Forestry Oil	Red River Specialities, Inc.	Liquid		
Oil Based	Crop Oil Concentrate	Red River Pacer Crop Oil	Red River Specialities, Inc.	Liquid		
Oil Based	Crop Oil Concentrate	Superb HC	WinField United (Winfield Solutions, LLC))	Liquid		WA Reg. No. 1381-06003
Oil Based	Methylated Seed Oil	60/40 MSO	Chemorse Ltd.	Liquid		WA Reg. No. 46059-15003
Oil Based	Methylated Seed Oil	Alligare MSO	Alligare, LLC	Liquid		
Oil Based	Methylated Seed Oil	Alligare MSO West	Alligare, LLC	Liquid		WA Reg. No. 81927-15002
Oil Based	Methylated Seed Oil	Atmos	WinField United (Winfield Solutions, LLC))	Liquid		
Oil Based	Methylated Seed Oil	Conquer	Chemorse Ltd.	Liquid	CA Reg. No. 1050984-50002-AA	WA Reg. No. 46059-10001
Oil Based	Methylated Seed Oil	Cornbelt Base	Van Diest Supply Co.	Liquid		
Oil Based	Methylated Seed Oil	Cornbelt Methylates Soy-Stik	Van Diest Supply Co.	Liquid		
Oil Based	Methylated Seed Oil	Destiny HC	WinField United (Winfield Solutions, LLC))	Liquid		WA Reg. No. 1381-09002

Oil Based	Methylated Seed Oil	Elite Supreme	Red River Specialities, Inc.	Liquid		
Oil Based	Methylated Seed Oil	Glacier-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50205	WA Reg. No. 2935-16001
Oil Based	Methylated Seed Oil	Hasten	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50160	WA Reg. No. 2935-02004
Oil Based	Methylated Seed Oil	Hasten-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50202	WA Reg. No. 2935-15003
Oil Based	Methylated Seed Oil	Hot MES	Drexel Chemical Company	Liquid		WA Reg. No. 19713-15001
Oil Based	Methylated Seed Oil	Inergy	WinField United (Winfield Solutions, LLC)	Liquid		
Oil Based	Methylated Seed Oil	Kixyt	Precision Laboratories, LLC	Liquid		WA Reg. No. 9349-12001
Oil Based	Methylated Seed Oil	MES-100	Drexel Chemical Company	Liquid	CA Reg. No. 19713-50002-AA	WA Reg. No. 19713-50002
Oil Based	Methylated Seed Oil	Methylated Spray Oil Conc.	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Oil Based	Methylated Seed Oil	Monterey M.S.O.	Monterey AgResources	Liquid	CA Reg. No. 17545-50025	
Oil Based	Methylated Seed Oil	MSO	Alligare, LLC	Liquid		
Oil Based	Methylated Seed Oil	MSO Concentrate (Alligare)	Alligare, LLC	Liquid		
Oil Based	Methylated Seed Oil	MSO Concentrate (Loveland)	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50067	WA Reg. No. 34709-04009
Oil Based	Methylated Seed Oil	Persist Ultra	Precision Laboratories, LLC	Liquid	CA Reg. No. 9349-50005	WA Reg. No. 9349-13003
Oil Based	Methylated Seed Oil	Premium MSO	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Oil Based	Methylated Seed Oil	Red River Supreme	Red River Specialities, Inc.	Liquid		
Oil Based	Methylated Seed Oil	Renegade 2.0	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50194	WA Reg. No. 2935-13001
Oil Based	Methylated Seed Oil	Renegade-EA	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50201	WA Reg. No. 2935-15002
Oil Based	Methylated Seed Oil	Sun Wet	Brewer International	Liquid		
Oil Based	Methylated Seed Oil	Sunburn	Red River Specialities, Inc.	Liquid		
Oil Based	Methylated Seed Oil	SunEnergy	Brewer International	Liquid		
Oil Based	Methylated Seed Oil	Sunset	Red River Specialities, Inc.	Liquid		
Oil Based	Methylated Seed Oil	Super Kix	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Oil Based	Methylated Seed Oil	Super Spread MSO	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Oil Based	Methylated Seed Oil + Organosilicate	Alligare MVO Plus	Alligare, LLC	Liquid		
Oil Based	Methylated Seed Oil + Organosilicate	Turbulence	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		WA Reg. No. 1381-13008
Oil Based	Vegetable Oil	Amigo	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50028-AA	WA Reg. No. 34704-04002
Oil Based	Vegetable Oil	BeanOil	Drexel Chemical Company	Liquid		
Oil Based	Vegetable Oil	Competitor	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50173	WA Reg. No. AW-2935-04001
Oil Based	Vegetable Oil	Elite Natural	Red River Specialities, Inc.	Liquid		
Oil Based	Vegetable Oil	Motion	Exacto, Inc.	Liquid		
Oil Based	Vegetable Oil	Noble	WinField United (Winfield Solutions, LLC))	Liquid		
Oil Based	Vegetable Oil	Vegetoil	Drexel Chemical Company	Liquid		
Fertilizer Based	Nitrogen Based	Actamaster Soluble Spray Adjuvant	Loveland Products, Inc.	Liquid		WA Reg. No. 34704-50001
Fertilizer Based	Nitrogen Based	Actamaster Spray Adjuvant	Loveland Products, Inc.	Liquid		WA Reg. No. 34704-50006
Fertilizer Based	Nitrogen Based	Alliance	WinField United (Winfield Solutions, LLC))	Liquid	CA Reg. No. 1381-50002-AA	WA Reg. No.1381-05005
Fertilizer Based	Nitrogen Based	AMS-All	Drexel Chemical Company	Liquid		
Fertilizer Based	Nitrogen Based	AMS-Supreme	Drexel Chemical Company	Liquid		
Fertilizer Based	Nitrogen Based	AMS-Xtra	Drexel Chemical Company	Liquid		
Fertilizer Based	Nitrogen Based	Bronc	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Fertilizer Based	Nitrogen Based	Bronc Max	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Fertilizer Based	Nitrogen Based	Bronc Max EDT	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Fertilizer Based	Nitrogen Based	Bronc Plus Dry	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Dry		
Fertilizer Based	Nitrogen Based	Bronc Plus Dry EDT	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Dry		WA Reg. No.2935-03002

Fertilizer Based	Nitrogen Based	Bronc Total	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Fertilizer Based	Nitrogen Based	Cayuse Plus	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50171	
Fertilizer Based	Nitrogen Based	Class Act NG	WinField United (Winfield Solutions, LLC))	Liquid		WA Reg. No. 1381-01004
Fertilizer Based	Nitrogen Based	Cornbelt Gardian	Van Diest Supply Co.	Liquid		
Fertilizer Based	Nitrogen Based	Cornbelt Gardian Plus	Van Diest Supply Co.	Liquid		
Fertilizer Based	Nitrogen Based	Corral AMS Liquid	WinField United (Winfield Solutions, LLC))	Liquid		WA Reg. No. 1381-01006
Fertilizer Based	Nitrogen Based	Dispatch	Loveland Products, Inc.	Liquid		
Fertilizer Based	Nitrogen Based	Dispatch 111	Loveland Products, Inc.	Liquid		
Fertilizer Based	Nitrogen Based	Dispatch 2N	Loveland Products, Inc.	Liquid		
Fertilizer Based	Nitrogen Based	Dispatch AMS	Loveland Products, Inc.	Liquid		
Fertilizer Based	Nitrogen Based	Flame	Loveland Products, Inc.	Liquid		
Fertilizer Based	Nitrogen Based	Holzit	Drexel Chemical Company	Liquid		
Fertilizer Based	Nitrogen Based	Nitro-Surf	Drexel Chemical Company	Liquid		
Fertilizer Based	Nitrogen Based	Quest	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50076-AA	
Fertilizer Based	Nitrogen Based	Transactive HC	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Buffering Agent	Brimstone	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Buffering Agent	BS-500	Drexel Chemical Company	Liquid		
Special Function	Buffering Agent	Buffers P.S.	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50062-ZA	
Special Function	Buffering Agent	Oblique	Red River Specialities, Inc.	Liquid		
Special Function	Buffering Agent	Spray-Aide	Miller Chem. & Fert. Corp.	Liquid	CA Reg. No. 72-50006-AA	
Special Function	Buffering Agent	Tri-Fol	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50152	
Special Function	Buffering Agent	Yardage	Exacto, Inc.	Liquid		
Special Function	Colorants/Dyes	Alligare Super Marking Dye	Alligare, LLC	Liquid		
Special Function	Colorants/Dyes	Bullseye	Milliken Chemical	Liquid		
Special Function	Colorants/Dyes	Elite Ruby	Red River Specialities, Inc.	Dry		
Special Function	Colorants/Dyes	Elite Sapphire	Red River Specialities, Inc.	Dry		
Special Function	Colorants/Dyes	Elite Sapphire WSB	Red River Specialities, Inc.	Dry		
Special Function	Colorants/Dyes	Elite Splendor	Red River Specialities, Inc.	Liquid		
Special Function	Colorants/Dyes	Hash Mark Green Powder	Exacto, Inc.	Dry		
Special Function	Colorants/Dyes	Hask Mark Blue Liquid	Exacto, Inc.	Liquid		
Special Function	Colorants/Dyes	Hask Mark Blue Liquid HC	Exacto, Inc.	Liquid		
Special Function	Colorants/Dyes	Hask Mark Blue Powder	Exacto, Inc.	Dry		
Special Function	Colorants/Dyes	Hask Mark Green Liquid	Exacto, Inc.	Liquid		
Special Function	Colorants/Dyes	Hi-Light	Becker-Underwood	Liquid		
Special Function	Colorants/Dyes	Hi-Light WSP	Becker-Underwood	Liquid		
Special Function	Colorants/Dyes	Marker Dye	Loveland Products, Inc.	Liquid		
Special Function	Colorants/Dyes	Mark-It Blue	Monterey AgResources	Liquid		
Special Function	Colorants/Dyes	Mark-It Red	Monterey AgResources	Liquid		
Special Function	Colorants/Dyes	Mystic HC	WinField United (Winfield Solutions, LLC)	Liquid		
Special Function	Colorants/Dyes	Signal	Precision Laboratories, LLC	Liquid		
Special Function	Colorants/Dyes	SPI-Max Blue Spray Marker	Prokoz	Liquid		
Special Function	Colorants/Dyes	Spray Indicator XL	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Colorants/Dyes	Turftrax	Loveland Products, Inc.	Liquid		
Special Function	Colorants/Dyes	Turftrax Blue Spray Indicator	Loveland Products, Inc.	Liquid		

Special Function	Compatibility/Suspension Agent	Convert	Precision Laboratories, LLC	Liquid		WA Reg. No. 9349-13007
Special Function	Compatibility/Suspension Agent	E Z Mix	Loveland Products, Inc.	Liquid	CA Reg. No. 36208-50006	
Special Function	Compatibility/Suspension Agent	Mix	Drexel Chemical Company	Liquid		
Special Function	Compatibility/Suspension Agent	Support	Loveland Products, Inc.	Liquid	WA Reg. No. 34704-04011	
Special Function	Defoaming Agent	Alligare Anti-Foamer	Alligare, LLC	Liquid		
Special Function	Defoaming Agent	Alligare Defoamer	Alligare, LLC	Liquid		
Special Function	Defoaming Agent	Cornbelt Defoamer	Van Diest Supply Co.	Liquid		
Special Function	Defoaming Agent	Defoamer	Brewer International	Liquid		
Special Function	Defoaming Agent	Fighter-F 10	Loveland Products, Inc.	Liquid		
Special Function	Defoaming Agent	Fighter-F Dry	Loveland Products, Inc.	Dry		
Special Function	Defoaming Agent	Foam Buster	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50072-AA	
Special Function	Defoaming Agent	Foam Fighter	Miller Chem. & Fert. Corp.	Liquid	CA Reg. No. 72-50005-AA	
Special Function	Defoaming Agent	Foambuster Max	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Defoaming Agent	Fome-Kil	Drexel Chemical Company	Liquid		
Special Function	Defoaming Agent	FTF Defoamer	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		WA Reg. No. 2935-13002
Special Function	Defoaming Agent	Gundown Max	Precision Laboratories, LLC	Liquid		WA. Reg. No. 9349-13013
Special Function	Defoaming Agent	No Foam	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50136	
Special Function	Defoaming Agent	Red River Defoamer	Red River Specialities, Inc.	Liquid		
Special Function	Defoaming Agent	Revere	Exacto, Inc.	Liquid		
Special Function	Defoaming Agent	Suppression	Chemorse Ltd.	Liquid	CA Reg. No. 1050984-50007	WA Reg. No. 46059-12001
Special Function	Defoaming Agent	Tripleline	Creative Marketing & Research	Liquid	CA Reg. No. 1050775-50023-AA	
Special Function	Defoaming Agent	Unfoamer	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50062	WA Reg. No. 34709-09002
Special Function	Deposition Aid	Agripharm Drift Control	Walco International	Liquid		
Special Function	Deposition Aid	Alligare Downforce	Alligare, LLC	Liquid		
Special Function	Deposition Aid	Alligare Pattern	Alligare, LLC	Liquid	CA Reg. No. 81927-50008-AA	WA Reg. No. 81927-15003
Special Function	Deposition Aid	Bivert	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50163	
Special Function	Deposition Aid	Border AQ	Precision Laboratories, LLC	Liquid		WA Reg. No. 9349-13009
Special Function	Deposition Aid	Chem-Trol	Chemorse Ltd.	Liquid	CA Reg. No. 1050984-50001-AA	WA Reg. No. 1050984-50001
Special Function	Deposition Aid	Clasp	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		WA Reg. No. 5905-13002
Special Function	Deposition Aid	Compadre	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50050	WA Reg. No. 34704-06004
Special Function	Deposition Aid	Coverage G-20	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Deposition Aid	Crosshair	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Deposition Aid	CWC Sharpshooter	CWC Chemical, Inc.	Liquid		
Special Function	Deposition Aid	Cygnet Plus	Brewer International	Liquid	CA Reg. No. 1051114-50001	
Special Function	Deposition Aid	Diligence	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Deposition Aid	Direct	Precision Laboratories, LLC	Liquid		
Special Function	Deposition Aid	Droplex	WinField United (Winfield Solutions, LLC)	Liquid		
Special Function	Deposition Aid	EDT Concentrate	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Deposition Aid	Elite Secure Ultra	Red River Specialities, Inc.	Liquid		
Special Function	Deposition Aid	Exit	Miller Chem. & Fert. Corp.	Liquid	CA Reg. No. 72-50014-AA	
Special Function	Deposition Aid	Grounded	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Deposition Aid	Grounded - CA	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50096-AA	
Special Function	Deposition Aid	Grounded - W	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		WA Reg. No. 5905-13001
Special Function	Deposition Aid	Infuse	Loveland Products, Inc.	Liquid		
Special Function	Deposition Aid	Intact Plus	Loveland Products, Inc.	Liquid		

Special Function	Deposition Aid	Interlock	WinField United (Winfield Solutions, LLC)	Liquid		
Special Function	Deposition Aid	Liberate	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50030-AA	WA Reg. No. 34704-04008
Special Function	Deposition Aid	LOX	Drexel Chemical Company	Liquid		
Special Function	Deposition Aid	LOX PLUS	Drexel Chemical Company	Liquid		
Special Function	Deposition Aid	Mist-Control	Miller Chem. & Fert. Corp.	Liquid	CA Reg. No. 72-50011-AA	
Special Function	Deposition Aid	Offside	Exacto, Inc.	Liquid		
Special Function	Deposition Aid	Pointblank	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg # 52467-50008-AA-5905	
Special Function	Deposition Aid	Poly Control 2	Brewer International	Liquid		
Special Function	Deposition Aid	Reign	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50045	WA Reg. No. 34704-05010
Special Function	Deposition Aid	Reign LC	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50048	
Special Function	Deposition Aid	Secure Ultra	Red River Specialities, Inc.	Liquid		
Special Function	Deposition Aid	Strike Zone DF	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Dry	CA Reg. No. 5905-50084-AA	
Special Function	Deposition Aid	Sustain	Miller Chem. & Fert. Corp.	Liquid	CA Reg. No. 72-50015-AA	
Special Function	Deposition Aid	Syndetic	Chemorse Ltd.	Liquid	CA Reg. No. 1050984-50003-ZA	
Special Function	Deposition Aid	Volare DC	Precision Laboratories, LLC	Liquid	CA Reg. No. 9349-50004-AA	WA Reg. No. 9349-13006
Special Function	Deposition Aid	Weather Gard	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50042-AA	
Special Function	Diluent/Deposition Agent	Bark Oil	Crop Production Services	Liquid		
Special Function	Diluent/Deposition Agent	Bark Oil EC	Crop Production Services	Liquid		
Special Function	Diluent/Deposition Agent	Elite Premier	Red River Specialities, Inc.	Liquid		
Special Function	Diluent/Deposition Agent	Elite Premier Blue	Red River Specialities, Inc.	Liquid		
Special Function	Diluent/Deposition Agent	Hy-Grade EC	CWC Chemical, Inc.	Liquid		
Special Function	Diluent/Deposition Agent	Hy-Grade I	CWC Chemical, Inc.	Liquid		
Special Function	Diluent/Deposition Agent	Improved JLB Oil Plus	Brewer International	Liquid		
Special Function	Diluent/Deposition Agent	In-Place	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50169	
Special Function	Diluent/Deposition Agent	JLB Oil Plus	Brewer International	Liquid		
Special Function	Diluent/Deposition Agent	Red River Basal Oil	Red River Specialities, Inc.	Liquid		
Special Function	Diluent/Deposition Agent	Thinvert Concentrate	Waldrum Specialities, Inc.	Liquid		
Special Function	Diluent/Deposition Agent	Thinvert RTU	Waldrum Specialities, Inc.	Liquid		
Special Function	Diluent/Deposition Agent	W.E.B. Oil	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50166	WA Reg. No. AW 2935-70023
Special Function	Foam Marker	Align	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Foam Marker	F.M.-160	Drexel Chemical Company	Liquid		
Special Function	Foam Marker	R-160	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Foam Marker	Red River Foam Marker	Red River Specialities, Inc.	Liquid		
Special Function	Foam Marker	Trekker Trax	Loveland Products, Inc.	Liquid		
Special Function	Foam Marker	Tuff Trax Foam Concentration	Loveland Products, Inc.	Liquid		
Special Function	Invert Emulsion Agent	Redi-Vert II	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50168	
Special Function	Tank Cleaner	All Clear	Loveland Products, Inc.	Liquid		
Special Function	Tank Cleaner	Back Field	Exacto, Inc.	Liquid		
Special Function	Tank Cleaner	Cornbelt Tank-Aid	Van Diest Supply Co.	Liquid		
Special Function	Tank Cleaner	Elite Vigor	Red River Specialities, Inc.	Liquid		
Special Function	Tank Cleaner	Kutter	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Tank Cleaner	Neutral-Clean	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Tank Cleaner	Pro Tank	WinField United (Winfield Solutions, LLC)	Liquid		

Special Function	Tank Cleaner	Red River Tank Cleaner	Red River Specialities, Inc.	Liquid		
Special Function	Tank Cleaner	SSC-11	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Tank Cleaner	Tank and Equipment Cleaner	Loveland Products, Inc.	Dry		
Special Function	Tank Cleaner	Wipe Out	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Water Conditioning	AccuQuest WM	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Water Conditioning	Alligare Water Conditioner	Alligare, LLC	Liquid		
Special Function	Water Conditioning	Blendmaster	Loveland Products, Inc.	Liquid		
Special Function	Water Conditioning	Breeze	WinField United (Winfield Solutions, LLC)	Liquid		WA Reg. No. 1381-13007
Special Function	Water Conditioning	Choice	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50027-AA	WA Reg. No. 34704-04004
Special Function	Water Conditioning	Choice Weather Master	Loveland Products, Inc.	Liquid	CA Reg. No. 34704-50038-AA	WA Reg. No. 34704-05005
Special Function	Water Conditioning	Choice Xtra	Loveland Products, Inc.	Liquid		
Special Function	Water Conditioning	Climb	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50181	WA Reg. No. 2935-09001
Special Function	Water Conditioning	Completion	Exacto, Inc.	Liquid		
Special Function	Water Conditioning	Cornbelt N-Tense	Van Diest Supply Co.	Liquid		
Special Function	Water Conditioning	Cut-Rate	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid		
Special Function	Water Conditioning	Cynder	Wilbur-Ellis Co. LLC (Wilbur-Ellis Co.)	Liquid	CA Reg. No. 2935-50211	
Special Function	Water Conditioning	Elite Imperial	Red River Specialities, Inc.	Liquid		
Special Function	Water Conditioning	Hel-Fire	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid		
Special Function	Water Conditioning	Import	Precision Laboratories, LLC	Liquid		WA Reg. No. 9349-14001
Special Function	Water Conditioning	Sequestra	Drexel Chemical Company	Liquid		
Special Function	Water Conditioning	Smoke	Helena Agri-Enterprises, LLC (Helena Chemical Company)	Liquid	CA Reg. No. 5905-50104-AA	
Special Function	Water Conditioning	Transport LpH	Precision Laboratories, LLC	Liquid		
Special Function	Water Conditioning	Transport Plus	Precision Laboratories, LLC	Liquid		WA Reg. No. 9349-13014

Appendix I: Wildlife Mitigation Plan

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT
MALHEUR COUNTY, OREGON

WILDLIFE MITIGATION PLAN

November 2019

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
WILDLIFE MITIGATION PLAN

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
WILDLIFE MITIGATION PLAN

1 INTRODUCTION

This draft Wildlife Mitigation Plan (WMP) has been prepared in support of the Grassy Mountain Mine Project (Project) located in Malheur County, Oregon, and has been included as part of the Consolidated Permit Application. The purpose of this WMP is to describe the impacts of the proposed Project on wildlife habitat and the proposed mitigation for those impacts as required by Oregon Administrative Rules (OAR) 635-415-0005 (18) and OAR 635-415-0020 (8). The habitat categorizations and mitigation strategies are preliminary and have not been reviewed by the Oregon Department of Fish and Wildlife (ODFW).

1.1 Resource Study Area

The Project is located approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 2). The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or re-routing, and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be approximately 30 feet wide, which includes a 20-foot wide road travel width (ten feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

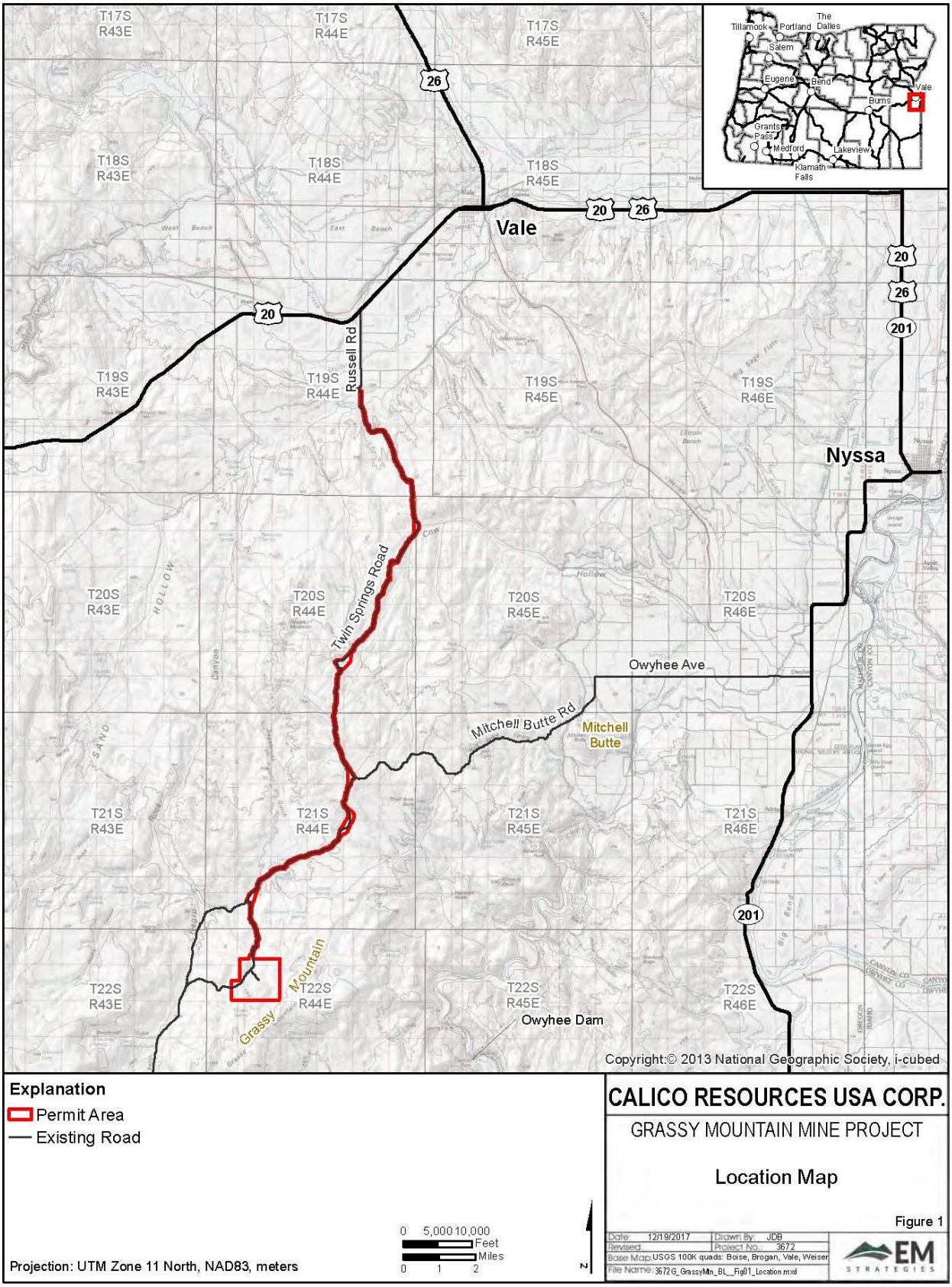

Figure 1. Location Map

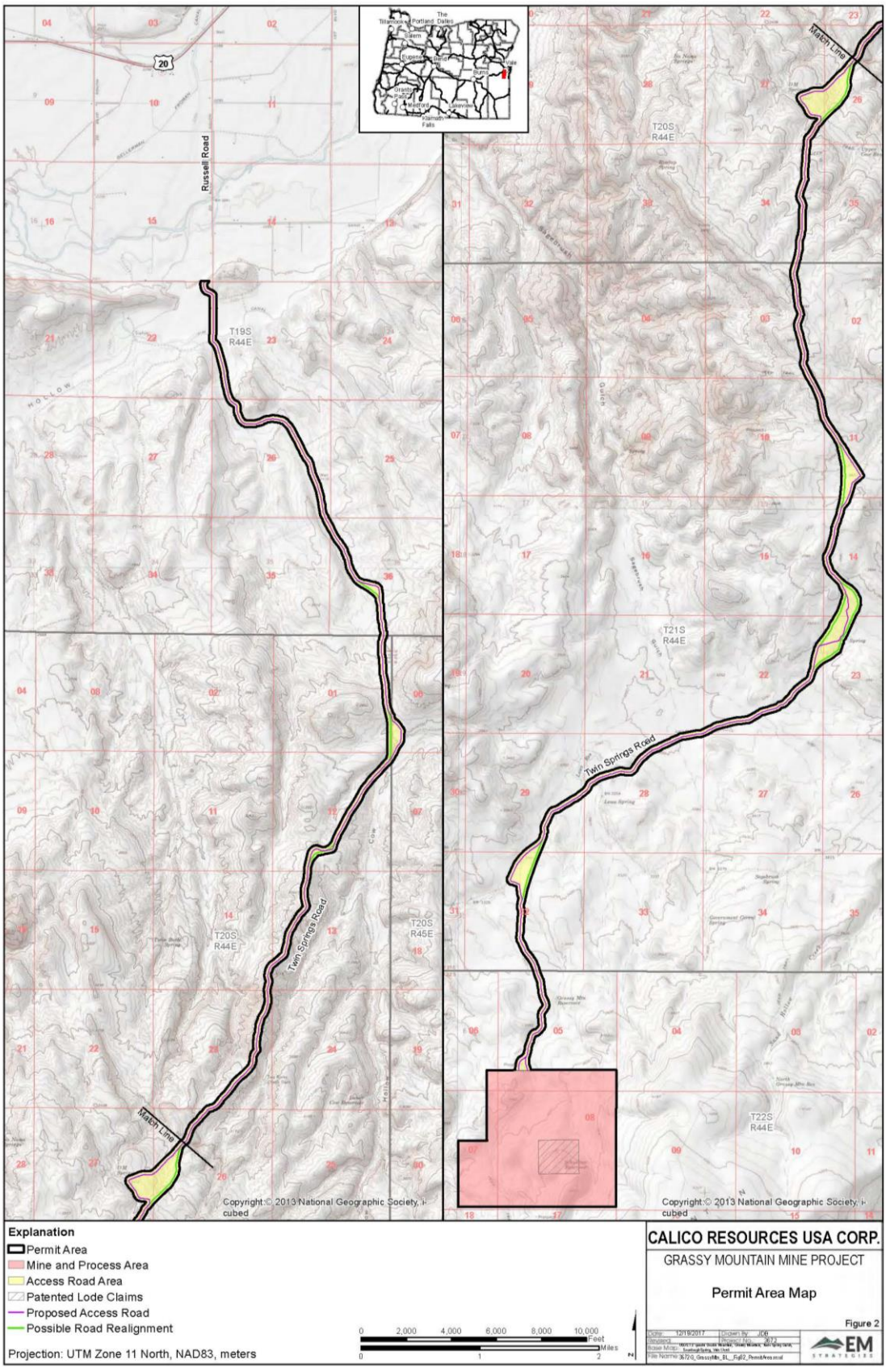

Figure 2. Permit Area Map

2 HABITAT MITIGATION GOALS AND STANDARDS

OAR 635-415-0025 defines six habitat categories and establishes mitigation goals and implementation standards for each category (Table 1).

Table 1. ODFW Mitigation Goals and Implementation Standards by Habitat Category

Habitat Category	Description	Mitigation Goal	Achieved by
1	Irreplaceable, essential habitat for a fish or wildlife species, population, or a unique assemblage of species and is limited on either a physiographic province or site-specific basis, depending on the individual species, population, or unique assemblage.	No loss of habitat quantity or quality	Avoidance of impacts through alternatives to the proposed development action.
2	Essential habitat for a fish or wildlife species, population, or unique assemblage of species and is limited either on a physiographic province or site-specific basis depending on the individual species, population or unique assemblage.	No net loss of habitat quantity or quality and to provide a net benefit of habitat quantity or quality	Avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through reliable in-kind, in-proximity habitat mitigation to achieve no net loss of either pre-development habitat quantity or quality. In addition, a net benefit of habitat quantity or quality must be provided.
3	Essential habitat for fish and wildlife, or important habitat for fish and wildlife that is limited either on a physiographic province or site-specific basis, depending on the individual species or population.	No net loss of habitat quantity or quality	Avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through reliable in-kind, in-proximity habitat mitigation to achieve no net loss in either pre-development habitat quantity or quality.
4	Important habitat for fish and wildlife species.	No net loss of habitat quantity or quality	Avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through reliable in-kind or out-of-kind, in-proximity or off-proximity habitat mitigation to achieve no net loss in either pre-development habitat quantity or quality.

Habitat Category	Description	Mitigation Goal	Achieved by
5	High potential to become either essential or important habitat.	Net benefit in habitat quantity and quality	Avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through actions that contribute to essential or important habitat.
6	Low potential to become essential or important habitat.	Minimize impacts	Actions that minimize direct habitat loss and avoid impacts to offsite habitat.

EM Strategies, Inc. (EMS) and Northwest Wildlife Consultants (NWC) completed habitat mapping and categorization of the site; avian use surveys; special status wildlife species surveys; and raptor nest surveys during the period of 2013-2014 (NWC 2014) and 2017-2018 (EMS 2018). Calico is committed to mitigate impacts to Category 3 and Category 4 grassland and shrub-steppe habitat that cannot be avoided or minimized with in-kind or out-of-kind habitat mitigation measures in proximity or off-proximity to the Permit Area with input from ODFW. Alternatively, Calico may purchase habitat credits from a mitigation bank identified by ODFW in accordance with OAR 635-415-0020 (7).

3 HABITAT TYPING AND CHARACTERIZATION

3.1 Methods

The habitat categories in the Permit Area were qualitatively categorized based on their importance to fish and wildlife, in accordance with the ODFW Fish and Wildlife Habitat Mitigation Policy. Habitat categorization was developed using a combination of the results of the terrestrial vegetation surveys of the Permit Area (EMS 2018a; HDR Engineering, Inc. [HDR] 2014; HDR 2015) and the United States Geological Survey (USGS) Northwest Regional Gap Analysis Project (NWGAP) land cover classifications (USGS 2011).

Initial habitat boundaries were delineated at a scale of one inch equals 5,000 feet in a digital geographic information system (GIS) using National Agriculture Industry Program (NAIP) one-meter resolution orthophoto quadrangle county mosaics (United States Department of Agriculture-Farm Service Agency (FSA) 2009; FSA 2010; FSA 2012), digital raster graphics of standard series USGS topographic maps, and the Natural Resources Conservation Service (NRCS) soil survey geographic database (NRCS 2017).

Biologists ground-verified and adjusted boundaries, further delineated habitat types, and developed detailed descriptions of each habitat type. These data were used to develop habitat categories based on vegetation type and wildlife species use. Habitat types were mapped according to current vegetation rather than according to the potential ecological climax for any given location.

Additional GIS layers, including ODFW Core Areas for greater sage-grouse (*Centrocercus urophasianus*) and lek location and known raptor nest shapefiles, were used to further refine the habitat category of a habitat type and area. ODFW has identified, throughout the range of the greater sage-grouse, Core Areas and Low Density use areas based on the locations of known leks (ODFW 2013). Core Area is considered by ODFW to be Category 1 habitat, irreplaceable, essential, and limited; none of this habitat exists within the Permit Area. Low Density Areas are considered by ODFW to be Category 2, essential and limited; a portion of the Permit Area is designated Low Density Area (ODFW 2013). This designation is a coarse filter based on lek locations; final habitat assessment depended on a site-specific determination of whether these areas either contain habitat upon which greater sage-grouse depend or contain signs of use by this species. Where neither applied, habitat categorization was based on vegetation characteristics or the presence of other sensitive species.

3.2 Results

Three general land cover types and five specific habitat types were found within the Permit Area; these are described below and summarized in Table 2.

Table 2. Land Cover, Habitat Types, and Habitat Categories within the Permit Area

General Land Cover Type	Habitat Type	Habitat Type Description	Category	Acres in Permit Area
Developed	Road	Compacted gravel or dirt roads devoid of vegetation and offering no value to wildlife.	6 – Low potential to become essential or important habitat	56
	Agricultural	Cultivated fields		11
Grassland	Exotic Annual Grassland	Dominated by exotic annuals, particularly cheatgrass and medusahead. Wildlife use predicated more on soil type and open landscape than on vegetation. Common breeder is horned lark. Also used by pronghorn, American badger, coyote, Merriam's and Belding's ground squirrels, and burrowing owl.	4 – Important habitat	228
	Perennial Grassland	Dominated by perennial bunchgrass. Shrubs, if present, are an inconspicuous component. Provides forage for Merriam's and Belding's ground squirrels, which in turn provide prey for ferruginous hawk, golden eagle, and other raptors, as well as American badger and coyote. Common breeding species include horned lark and western meadowlark. May support burrowing owl where soils are deep and sandy. Exotic annuals—especially cheatgrass—found between bunchgrasses. Due to	3 – Important and limited habitat	135

General Land Cover Type	Habitat Type	Habitat Type Description	Category	Acres in Permit Area
		low precipitation and cattle grazing, wildlife use limited primarily to spring.		
Shrub-steppe	Sagebrush Shrub-steppe	Dominated by >20% cover of mountain big sagebrush and/or yellow rabbitbrush. Offer high quality breeding habitat for shrub obligate species including loggerhead shrike, sage thrasher, Brewer's sparrow, sagebrush sparrow, black-throated sparrow. Also supports western meadowlark, lark sparrow, and mourning dove. In sandy or rocky soils, sagebrush lizard, desert horned lizard, Great Basin collared lizard, long-nosed leopard lizard, striped whipsnake, western rattlesnake, and other reptiles likely to be found. Exotic grasses, found beneath and between shrub layer throughout Permit Area.	3 – Important and limited habitat	1,332
Total Acres				**1,762**

3.2.1 Developed-Road and Agricultural

Approximately 56 acres of the Permit Area are developed in the form of compacted gravel or dirt roads relatively devoid of vegetation and offering little value to most wildlife. Roads are a potential source of the spread of noxious and invasive exotic grasses and weeds. They also constitute a potential source of fatality for birds, snakes, lizards, and mammals, though there is currently very little traffic on the roads within the Permit Area. Also, within this habitat type are cultivated agricultural fields at the north end of the Access Road Area (approximately ten acres). This habitat type is all characterized as Category 6 habitat, with low potential to become important or essential.

3.2.2 Grassland-Exotic Annual Grassland

Approximately 228 acres of the Permit Area is exotic annual grassland. This habitat type occurs in areas that are heavily grazed and is dominated by exotic annuals - particularly cheatgrass and medusahead. Native bunchgrasses are absent or a minor component. Heavy livestock grazing, and low and very seasonal precipitation result in low value to wildlife, as exotic annual grasslands provide little nutrition or cover. Wildlife use of this habitat is predicated more on soil type and open landscape than on vegetation. The most common breeding bird is horned lark. This habitat is also used by pronghorn, American badger, coyote, Merriam's and Belding's ground squirrels, and burrowing owl. During late winter and spring, an abundance of Merriam's ground squirrels (which is expected to vary among years, but which was quite high in spring 2014) likely provides good hunting for mammalian predators and raptors, including ferruginous hawk, golden eagle, northern harrier, and prairie falcon. Based on habitat type, condition, and use by wildlife, all the exotic annual grassland within the Permit Area is characterized as Category 4 - important habitat.

3.2.3 Grassland-Native Perennial Grassland

Approximately 135 acres of the Permit Area are perennial grassland. This habitat type is dominated by crested wheatgrass, an introduced species that was seeded in the area. Bluebunch wheatgrass and Sandberg bluegrass are the dominant native perennial grasses, which together comprise an average of 22 percent of the ground cover (EMS 2018b; HDR 2015). Shrubs (big sagebrush and yellow rabbitbrush), if present, are an inconspicuous component. This habitat provides forage and some cover for Merriam's and Belding's ground squirrels, which in turn provide prey for ferruginous hawk, golden eagle, and other raptors, as well as American badger and coyote. Common breeding species include horned lark and western meadowlark. This habitat likely provides important forage for pronghorn and may support burrowing owl denning and breeding where soils are deep and sandy. Exotic annuals—especially cheatgrass—are found between the bunchgrasses, where they tend to outcompete more nutritional forbs and limit this habitat's value to wildlife.

Based on the presence of a known greater-sage-grouse lek to the west of the area, ODFW has mapped approximately 31 acres of this habitat type as Category 2 (ODFW 2013). Ground verification yielded the conclusion, however, that this area contains neither habitat upon which greater sage-grouse depend nor evidence of greater sage-grouse use. Therefore, based on habitat type, condition, and use by wildlife, all the native perennial grassland within the Permit Area is characterized as Category 3 - essential, or important and limited habitat.

3.2.4 Shrub-steppe-Sagebrush Shrub-steppe

Approximately 1,332 acres of the Permit Area are sagebrush shrub-steppe. This habitat is dominated by less than 15 percent cover of mountain big sagebrush and yellow rabbitbrush (EMS 2018b; HDR 2015). This habitat type offers high-quality breeding habitat for shrub obligate species including loggerhead shrike, sage thrasher, Brewer's sparrow, sagebrush sparrow, and black-throated sparrow. Also breeding in this habitat are western meadowlark, lark sparrow, common nighthawk, and mourning dove. In sandy or rocky soils, sagebrush lizard, desert horned lizard, pygmy short-horned lizard, Great Basin collared lizard, long-nosed leopard lizard, western whiptail, striped whipsnake, western rattlesnake, and other reptiles are found.

Based on the presence of a known greater-sage-grouse lek to the west of the area, ODFW has mapped a portion (470 acres) of this habitat type as Category 2 (ODFW 2013). Ground verification yielded the conclusion, however, that this area contains neither habitat upon which greater sage-grouse depend nor evidence of greater sage-grouse use. Therefore, based on habitat type, condition, and use by wildlife, all the sagebrush shrub-steppe within the Permit Area is characterized as Category 3, essential, or important and limited.

4 DESCRIPTION OF POTENTIAL DISTURBANCES

Acreages of disturbance within the Permit Area are the current estimate of the maximum affected area (the permanent [mine footprint] and temporary [construction] impacts) (Table 3). The actual areas of disturbance will be determined based on the final design layout of the Project.

The final design layout of the Project will be provided to ODFW, along with the associated permanent and temporary impact acreages prior to the beginning of construction.

Table 3. Temporary and Permanent Disturbance by Habitat Category and Subtype within the Permit Area

Habitat Category	Habitat Type	Permanently Disturbed (Acres)	Temporarily Disturbed (Acres)	Total Disturbed (Acres)
6	Road	3.5	0.1	3.6
	Agricultural	0.0	0.0	0.0
4	Exotic Annual Grassland	147.0	3.8	150.8
3	Perennial Grassland	25.3	1.2	26.5
3	Sagebrush Shrub-steppe	98.5	51.0	149.5
Total		**274.3**	**56.1**	**330.4**

The mine facility footprint (area covered by permanent facility components) occupies areas of 123.8 acres of Category 3 grassland and shrub-steppe vegetation, 147 acres of Category 4 grassland, and 3.5 acres of Category 6 habitat. In addition to the areas affected by the mine facility footprint, construction may temporarily affect 56.1 acres of Category 3, 4, and 6 habitats. After disturbance, the recovery of temporarily disturbed Category 3 and 4 grassland areas to a mature stage might take two to four years; recovery of shrub-steppe vegetation might take ten to 30 years to reach maximum height and vertical branching. During the period needed to achieve full recovery of these habitat subtypes, habitat quality is temporarily degraded until recovery is successful (temporal impact).

5 HABITAT MITIGATION AREA

The exact permanent and temporary disturbance areas cannot be determined until the final design layout of the Project is known. Before beginning construction, Calico shall provide to ODFW a map showing the final design configuration of the Project and an updated Table 3 showing the estimated areas of permanent impacts and temporary impacts on habitat (by category, habitat types and habitat subtypes). Calico will calculate the size of the habitat mitigation area (HMA), based on the final design configuration of the Project. Calico will implement the habitat enhancement actions described in this plan, after ODFW has approved the size of the HMA.

For the permanent impacts to Category 3 and Category 4 habitat, and to satisfy the ODFW “no net loss” goal, the HMA must include one acre for every acre of impact (a 1:1 ratio). To address the temporal loss of habitat quality during the recovery of Category 3 and Category 4 habitat temporarily disturbed during construction of the Project, the HMA must include 0.5 acre for every one acre of habitat affected (a 0.5:1 ratio). The total HMA is shown in Table 4 and will be updated once the final design configuration is complete.

Table 4. Habitat Mitigation Area by Habitat Category and Subtype

Habitat Category	1:1 Ratio	0.5:1 Ratio	Total
4	147.0	1.9	148.9
3	123.8	26.1	149.9
Total	**270.8**	**28.0**	**298.8**

For unavoidable permanent and temporary impacts of Category 4 habitat, Calico will use in-kind or out-of-kind habitat mitigation measures in-proximity or off-proximity to the Project to effectively offset impacts in consultation with ODFW and consistent with ODFW Habitat Mitigation Policy (OAR 635-415-0005). Calico will select an HMA in the same home range or physiographic province of the Project, and either lease or purchase the area to benefit similar or different habitat than those in the Permit Area. Alternatively, Calico may purchase habitat credits from a mitigation bank identified by ODFW in accordance with OAR 635-415-0020 (7).

6 AVOIDANCE AND MINIMIZATION MEASURES

The avoidance and minimization measures listed in this section may be modified in coordination with ODFW to match the measures proposed in the National Environmental Policy Act-compliant analysis. These measures are designed to avoid or reduce adverse impacts for special status wildlife and their habitat.

6.1 Avoidance Measures

The following adjustments to the Project layout have been made:

- Wetlands—Major components and related facilities have been specifically aligned to avoid (Category 2) wetlands.
- Roads—During construction and operation, vehicles and construction equipment will use existing roads to the maximum extent possible.
- Transmission line—Any proposed transmission line(s) will be constructed consistent with the recommendations of the Avian Power Line Interaction Committee guidelines for raptor protection on power lines (including minimum conductor spacing and the use of anti-perch guards) and will also be constructed and operated in a way that avoids impacts on any occupied or potentially suitable habitat.

6.2 Minimization Measures

Calico will work to minimize the impact of construction on the environment by employing the following methods to ensure compliance with federal, state, and local regulations and industry best practices:

- Seasonal Avoidance-construction activities will not occur within proximity of occupied raptor nests as follows:
    - Ferruginous hawk: ¼ mile (between March 15–August 15)

  - Swainson's hawk: ¼ mile (between April 1–August 15)
  - Western burrowing owl: ¼ mile (between April 1–August 15)
  - Golden eagle: ½ mile (between January 1-July 15)
  - Bald eagle: ½ mile (between January 1-August 31)

- Environmental Training—A qualified biologist will develop and implement an environmental training course for site workers, which will require reporting any injured or dead wildlife on the site, adherence to site speed limits, trash control, and other subjects.

- Vegetation Clearing—Tree or native vegetation clearing, if any, will occur between September 1 and March 1 to the greatest extent feasible to avoid impacts on wildlife. Any tree or native vegetation clearing outside of this period will be conducted only following a biological survey, performed no more than seven days prior to clearing of the area to be cleared to ensure that no birds or bats are roosting in the area to be cleared. If birds are discovered, no clearing will occur until the birds have left the nest for the season. If a bat roost is discovered, ODFW will be contacted for guidance.

- Best management practices (BMPs)—The Applicant will develop an erosion and sediment control plan in accordance with the Project's 1200-Z Mining Operation Stormwater National Pollutant Discharge Elimination System (NPDES) Permit. The Applicant and its construction contractors will use BMPs to reduce potential impacts on areas immediately surrounding the construction site. Run-off detention facilities, vegetation filter strips or bioswales, and/or flow dissipation structures will be installed to control erosion and avoid contamination of discharged stormwater. Water will be sprayed in high-traffic areas to prevent fugitive dust from blowing off site. The Project Field Contact Representative and biological monitor will conduct periodic inspections of BMPs to ensure all measures are maintained and in compliance with the NPDES permit. Dust control measures will be deployed throughout the Project where construction is active.

- Hazardous material containment—Any hazardous materials generated by construction will be collected and disposed of properly. Concrete trucks will be required to wash out in designated plastic lined collection pits to prevent runoff. Equipment maintenance and fueling will be performed over drip pans and equipment is inspected for leaks regularly. Waste oil and contaminated earth from minor spills or drips will be collected for disposal. Spills will be reported in accordance with the spill prevention measures outlined in the Emergency Response Plan and Stormwater Pollution Control Plan.

- Restoration—Any disturbed ground will be prepared and sown with an appropriate native seed mix in accordance with the Noxious Weed Monitoring and Control Plan to ensure rapid growth and erosion prevention.

- Noxious weeds – Weeds will be controlled using both mechanical and chemical methods in all surface-disturbed areas in accordance with the Noxious Weed Monitoring and Control Plan. All herbicide and pesticide mixing and applications will be conducted in

accordance with all federal, state, and local laws and regulations and the specific product's label. Herbicide and pesticide application will be directly applied to a localized spot and will not be applied by broadcasting techniques.

- Lighting during Operation and Construction—Motion detectors or timers and hoods that minimize skyward light will be installed on exterior lights.

- Traffic—All personnel will be required to adhere to a reduced speed limit of 35 miles per hour while driving in the Permit Area and will be required to adhere to posted speed limits on public roads. If there are no posted speed limits, the contractor will operate vehicles in a manner consistent with typical public traffic on public roads. Travel will be restricted to designated roads where possible; no off-road travel will be allowed except in the case of an emergency. In addition, all construction personnel will be instructed to observe caution when driving through the Permit Area and to maintain reasonable driving speeds so as not to harass or accidentally strike wildlife. Speed limits will be posted throughout the Project construction area.

- Housekeeping—Trenches or other small excavations will not be left open overnight but will be filled or covered in a way that prevents animals from entering. If trenches cannot be fully covered, a wildlife escape ramp, such as a 2-by-4, will be installed to ensure no wildlife are trapped in the excavation. No burning or burying of waste materials will occur at the Project site. The contractor will be responsible for the removal of all waste materials from the construction area. All contaminated soil and construction debris will be disposed of in approved landfills in accordance with appropriate environmental regulations. Garbage will be disposed of in appropriate covered waste bins. Contractor and Calico personnel will use good-housekeeping practices to remove any waste.

7 HABITAT MITIGATION ACTIONS AND SUCCESS CRITERIA

Calico will restrict uses of the HMA during the life of the Project that are inconsistent with the goal of no net loss to Category 3 and Category 4 habitat. Specific habitat quality maintenance actions that will preserve the HMA habitat at minimum Category 3 and Category 4 quality and quantity will include the following:

- Restricting development of buildings or other structures;
- Litter removal;
- Erosion control;
- Restricting livestock grazing practices to those that benefit wildlife;
- Inspecting for and then removing or chemically treating noxious weeds in the spring prior to the growing season to benefit vegetative structure and complexity for wildlife;
- Revegetating with native vegetation (by seeding) in bare ground areas created by weed control; and
- Preparing a wildfire response plan that considers the arid nature of the region and addresses risks on a seasonal basis.

The conservation of the HMA will be completed as compensation for unavoidable temporary and permanent disturbance of Category 3 and Category 4 grassland and shrub-steppe habitat. Mitigation of the permanent and temporal habitat impacts of the Project may be considered successful if Calico protects enough habitat within the HMA to meet the ODFW goal of no net loss of habitat in Category 3 and Category 4. Calico will protect the quantity and quality of habitat within the HMA for the life of the Project. The mitigation goals are successfully achieved when the HMA contains enough quantity of habitat to meet the mitigation area requirements calculated under Section 5. Calico may count habitat of higher value toward meeting the acreage requirements for Category 3 and Category 4 habitat. Calico may demonstrate enhancement of habitat quality based on evidence of indicators such as increased avian use by a diversity of species, more abundant seed production of desirable native bunchgrass, natural recruitment of sagebrush and successful weed control.

If Calico cannot demonstrate that the HMA is trending toward meeting the success criteria within five years after the date construction of the Project begins, ODFW may require Calico to provide additional mitigation. In addition to improving maintenance actions, if possible, some enhancement actions could include the following:

- Planting native grasses and shrubs;
- Removing old barbed wire fencing;
- Installing artificial burrowing owl nest burrows; and/or
- Installing wildlife watering guzzlers.

8 MONITORING

Calico will hire a qualified investigator (a botanist, wildlife biologist or vegetation specialist) to conduct an annual site visit of the HMA to ensure that the quality of the habitat is maintained at a Category 3 or higher. Monitoring for habitat maintenance actions will include describing if any development has occurred, recording signs and extent of livestock grazing, assessing for noxious weeds, describing if any wildfires occurred and any response measures, recording incidental wildlife observations, including special status plants and animals, and documenting habitat quality category/categories. Monitoring methods for enhancement actions, including success criteria, will be established if/when they are employed. All methods and results of monitoring will be reported to ODFW. In addition, as part of the wildfire response plan, on-site owners will notify Calico of any wildfire when it occurs.

9 AMENDMENT

This WMP may be amended periodically by agreement of Calico and the ODFW.

10 REFERENCES

EM Strategies, Inc. (EMS). 2018a. Wildlife Resources Baseline Report. Calico Resources USA Corp. Grassy Mountain Mine Project, Malheur County, Oregon.

_____. 2018b. Draft Terrestrial Vegetation Baseline Report, Grassy Mountain Mine Project. Prepared for Calico Resources USA Corporation.

HDR Engineering, Inc. (HDR). 2014. Draft Vegetation Baseline Report, Grassy Mountain Exploration Project. Prepared for Calico Resources USA Corporation (Calico). May 2014.

_____. 2015. Draft Terrestrial Vegetation Baseline Study Addendum #1. Grassy Mountain Exploration Project. Prepared for Calico Resources USA Corporation (Calico). July 2015.

Northwest Wildlife Consultants, Inc. (NWC). 2014. Wildlife Resources Baseline Study. Grassy Mountain Exploration Project, Calico Resources USA Corporation. Prepared for HDR Engineering, Inc. and Calico Resources USA Corporation.

Natural Resources Conservation Service (NRCS). 2017. Web Soil Survey. Soil Survey Staff, United States Department of Agriculture. Available online at: http://websoilsurvey.nrcs.usda.gov/.

Oregon Department of Fish and Wildlife (ODFW). 2013. ODFW's data clearinghouse: ODFW sage-grouse core areas. Publish date August 24, 2011. Available online at: http://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=944.xml

United States Department of Agriculture-Farm Service Agency (FSA). 2009. National Agriculture Imagery Program (NAIP), Malheur County, Oregon compressed county mosaic, 1-meter resolution. Created and distributed by the USDA Aerial Photography Field Office. Salt Lake City, Utah.

_____. 2010. National Agriculture Imagery Program (NAIP), Malheur County, Oregon compressed county mosaic, 1-meter resolution. Created and distributed by the USDA Aerial Photography Field Office. Salt Lake City, Utah.

_____. 2012. National Agriculture Imagery Program (NAIP), Malheur County, Oregon compressed county mosaic, 1-meter resolution. Created and distributed by the USDA Aerial Photography Field Office. Salt Lake City, Utah.

United States Geological Survey, Gap Analysis Program (GAP). May 2011. National Land Cover, Version 2. Available online at: https://gapanalysis.usgs.gov/gaplandcover/data/

Appendix J: Reclamation Cost Estimate

Enter Data Below in Green and Blue Spaces

STANDARDIZED RECLAMATION COST ESTIMATOR

Version 1.4.1
Build 017b (Revised 16 May 2019)

Approved for use in Nevada, August 1, 2012

COST DATA FILE INFORMATION

File Name:	3671I.GrassyMtn Plan.RCE.V1.xlsm
Cost Data File:	SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Data Date:	August 1, 2019
Cost Data Basis:	User Data
Data Cost Units:	Imperial
Author/Source:	Nevada Division of Environmental Protection (NDEP) & NV BLM

PROJECT INFORMATION

Property/Mine Name:	Grassy Mountain
Property Code:	
Project Name:	Grassy Mountain Mine
Date of Submittal:	November 2019
Average Altitude:	3700 ft.
Select One:	○ Notice or Sm Exploration Plan ○ Lg Exploration Plan ◉ Mine Operation
Select One:	○ Private Land ◉ Public or Public/Private
Cost Estimate Type:	Surety
Cost Basis Category:	Northern Nevada
Cost Basis Description:	**Churchill, Douglas, Elko, Eureka, Humboldt, Lander, Lyon, Mineral, Pershing, Storey, Washoe, and White Pine Counties**

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Closure Cost Estimate
Cost Summary

Project Name: Grassy Mountain Mine
Project Date: November 2019
Model Version: Version 1.4.1
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm

A. Earthwork/Recontouring	Labor [1]	Equipment [2]	Materials	Total
Exploration	$335	$99	$2	$436
Exploration Roads & Drill Pads	$3,900	$5,258	$0	$9,158
Roads	$52,556	$96,065	$0	$148,621
Well Abandonment	$7,144	$19,032	$1,936	$28,112
Pits	$0	$0	N/A	$0
Quarries & Borrow Areas	$3,482	$5,155	$0	$8,637
Underground Openings	$5,266	$2,313	$2,104	$9,683
Process Ponds	$5,152	$3,382	$0	$8,534
Heaps	$0	$0	$0	$0
Waste Rock Dumps	$0	$0	$0	$0
Landfills	$0	$0	$0	$0
Tailings	$363,626	$917,146	$0	$1,280,772
Foundation & Buildings Areas	$9,513	$24,588	$0	$34,101
Yards, Etc.	$35,206	$88,520	$0	$123,726
Drainage & Sediment Control	$115,881	$69,850	$41,556	$227,287
Generic Material Hauling	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Other**				$0
Subtotal	**$602,061**	**$1,231,408**	**$45,598**	**$1,879,067**
Mob/Demob if included in Other User sheet	$0	$0	$0	$0
Mob/Demob	$2,125	$2,125		$4,250
Subtotal "A"	**$604,186**	**$1,233,533**	**$45,598**	**$1,883,317**

B. Revegetation/Stabilization	Labor [1]	Equipment [2]	Materials	Total
Exploration	$0	$0	$0	$0
Exploration Roads & Drill Pads	$1,000	$380	$3,328	$4,708
Roads	$4,244	$1,612	$10,965	$16,821
Well Abandonment				N/A
Pits	$0	$0	$0	$0
Quarries & Borrow Areas	$5,447	$2,070	$18,124	$25,641
Underground Openings				N/A
Process Ponds	$100	$38	$133	$271
Heaps	$0	$0	$0	$0
Waste Rock Dumps	$0	$0	$0	$0
Landfills	$0	$0	$0	$0
Tailings	$10,919	$4,125	$35,345	$50,389
Foundation & Buildings Areas	$2,300	$874	$827	$4,001
Yards, Etc.	$11,639	$4,423	$33,813	$49,875
Drainage & Sediment Control	$180	$68	$599	$847
Generic Material Hauling	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Other**				$0
Subtotal "B"	**$35,829**	**$13,590**	**$103,134**	**$152,553**

C. Detoxification/Water Treatment/Disposal of Wastes**	Labor [1]	Equipment [2]	Materials	Total
Process Ponds/Sludge				$0
Heaps				$0
Dumps (Waste & Landfill)				$0
Tailings				$0
Surplus Water Disposal				$0
Monitoring				$0
Miscellaneous				$0
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$1,131
Hazardous Materials				$5,317
Hydrocarbon Contaminated Soils	$0	$0	$4,498	$4,498
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Other** **Fluid Stabilization - Phase III and Evap**	**$50,048**	**$1,662,906**	**$17,407**	$1,730,361
Subtotal "C"	**$50,048**	**$1,662,906**	**$21,905**	**$1,741,307**

D. Structure, Equipment and Facility Removal, and Misc.	Labor [1]	Equipment [2]	Materials	Total
Foundation & Buildings Areas	$29,261	$20,258	$0	$49,519
Other Demolition	$0	$0	$0	$0
Equipment Removal	$2,787	$4,720	$0	$7,507
Fence Removal	$41,588	$15,286		$56,874
Fence Installation	$0	$0	$0	$0
Culvert Removal	$1,132	$398	N/A	$1,530
Pipe Removal	$0	$0	N/A	$0
Powerline Removal	$57,342			$57,342
Transformer Removal	$56,086			$56,086
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Misc. Costs	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Other**				$0
Subtotal "D"	**$188,196**	**$40,662**	**$0**	**$228,858**

E. Monitoring	Labor [1]	Equipment [2]	Materials	Total
Reclamation Monitoring and Maintenance	$19,244	$2,583	$9,929	$31,756
Ground and Surface Water Monitoring	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Subtotal "E"	**$19,244**	**$2,583**	**$9,929**	**$31,756**

F. Construction Management & Support	Labor	Equipment [2]	Materials	Total
Construction Management	$32,000	$6,109	N/A	$38,109
Construction Support	$0	$3,542	$0	$3,542
Road Maintenance	$9,000	$12,425	$0	$21,425
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Other**				$0
Subtotal "F"	**$41,000**	**$22,076**	**$0**	**$63,076**

Subtotal Operational & Maintenance Costs	Labor [1]	Equipment [2]	Materials [3]	Total
Subtotal A through F	**$938,503**	**$2,975,350**	**$180,566**	**$4,100,867**

** Other Operator supplied costs - additional documentation required.

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Closure Cost Estimate
Cost Summary

Project Name: Grassy Mountain Mine
Project Date: November 2019
Model Version: Version 1.4.1
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm

Indirect Costs				Include?	Total
1. Engineering, Design and Construction (ED&C) Plan (7)					$246,052
2. Contingency (8)					$328,069
3. Insurance (9)	$14,078				$14,078
4. Performance Bond (10)					$123,026
5. Contractor Profit (11)					$410,087
6. Contract Administration (12)					$328,069
7. Government Indirect Cost (13)					$68,894
Subtotal Add-On Costs					**$1,518,275**
Total Indirect Costs as % of Direct Cost					37%
GRAND TOTAL					**$5,619,142**

Administrative Cost Rates (%)

	Cost Ranges for Indirect Cost Percentages				
	<=	<=	<=	>	
1. Engineering, Design and Construction (ED&C) Plan (7)	$1,000,000	$25,000,000		$25,000,000	Small Plan
Variable Rate	8%	6%		4%	0%
	<=	<=	<=	>	
2. Contingency (8)	$500,000	$5,000,000	$50,000,000	$50,000,000	Small Plan
Variable Rate	10%	8%	6%	4%	0%
3. Insurance (9)	1.5%	of labor costs			
4. Bond (10)	3.0%	of the O&M costs if O&M costs are >$100,000			
5. Contractor Profit (11)	10%	of the O&M costs			
	<=	<=	<=	>	
6. Contract Administration (12)	$1,000,000	$25,000,000		$25,000,000	
Variable Rate	10%	8%		6%	
Government Indirect Cost (13)	21%	of contract administration			

RECLAMATION COST ESTIMATION SUMMARY SHEET FOOTNOTES

1. Federal construction contracts require Davis-Bacon wage rates for contracts over $2,000. Wage rate estimates may include base pay, payroll loading,
2. The reclamation cost estimate must include the estimated plugging cost of at least one drill hole for each active drill rig in the project area. Where the
3. Miscellaneous items should be itemized on accompanying worksheets.
4. Fluid management should be calculated only when mineral processing activities are involved. Fluid management represents the costs of maintaining
5. Handling of hazardous materials includes the cost of decontaminating, neutralizing, disposing, treating and/or isolating all hazardous materials used,
6. Any mitigation measures required in the Plan of Operations must be included in the reclamation cost estimate. Mitigation may include measures to avoid,
7. Engineering, design and construction (ED&C) plans are often necessary to provide details on the reclamation needed to contract for the required work. To
8. A contingency cost is included in the reclamation cost estimation to cover unforeseen cost elements. Calculate the contingency cost as a percentage of the
9. Insurance premiums are calculated at 1.5% of the total labor costs. Enter the premium amount if liability insurance is not included in the itemized unit
10. Federal construction contracts exceeding $100,000 require both a performance and a payment bond (Miller Act, 40 USC 270et seq.). Each bond premium
11. For Federal construction contracts, use 10% of estimated O&M cost for the contractor's profit.
12. To estimate the contract administration cost, use 6 to 10% of the operational and maintenance (O&M) cost. Calculate the contract administration cost as a
13. Government indirect cost rate is 21% of the contract administration costs.

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Closure Cost Estimate
Exploration

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Exploration - Cost Summary

	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$335	$99	$2	$436
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$335**	**$99**	**$2**	**$436**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$335**	**$99**	**$2**	**$436**

Exploration Drillhole Abandonment - User Input

	Facility Description		Hole Plugging							
	Description (required)	ID Code	Hole Type (select)	Diameter in	Total Number of Holes	Max Holes Open at One Time	Casing to Remove ft	Average Depth of Hole[1] ft bgs	Depth to Water ft bgs	Hole Plug Method (select)
1	**Drill Holes**		**Core**	**3.0**	**20.0**	**1.0**	**0.0**	**100.0**	**500.0**	**Grout + Backfill**

Notes:
1. If core holes are pre-drilled, use length of hole below pre-drilled length
2. If Top Plug is selected, assumes maximum 1/2hr laborer time to place plug and backfill with cuttings/soil (including move-to/set up time).

Drilling depth will range between 40 -100 feet bgs.

Exploration Trenches - User Input

	Facility Description		Trench Parameters					Backfill			Revegetation		
	Description (required)	ID Code	Trench Length ft	Trench Depth ft	Trench Bottom Width ft	Trench Sideslope Angle degrees	Additional Hrs for Walk-in[1] hr	Backfill Material (select)	Cut Material Type (select)	Backfilling Fleet (select)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

Notes:
1. Include one-way hours necessary to walk equipment in from drop-off point to work area
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Exploration Drillhole Abandonment

	Description (required)	Vol/foot of depth ft3	Hole Plugging Material[1]	Total Grout Volume[2] cy	Total Cuttings Volume cy	Total Top Seal Volume[3,4] cy	Total Drillhole Abandon. Hours[6,7] hrs	Casing Removal Labor Cost[5] $	Casing Removal Equipment Cost $	Plugging Labor Cost $	Plugging Equipment Cost $	Plugging Material Cost $	Top Seal Material Cost[2,3] $	Total Cost[6,7] $
1	**Drill Holes**	0.050	Cuttings	0.00	0.15	0.05	3	$0	$0	$335	$99	$0	$2	$436
					0.15	0.05	3	**$0**	**$0**	**$335**	**$99**	**$0**	**$2**	**$436**

Notes:

1. Assumes grout backfill from bottom of hole to 50' (15.24m) above static water level, up to 10' (3m) from top of hole
2. Assumes 25% loss to formation for grout backfill
3. If "Top Plug" hole plug method is used, assumes physical plug installed without backfill, grout or cement. Not available option for Nevada projects
4. Assumes top 20' (6 m) of hole is plugged with cement if "Grout Only", "Backfill + Grout", or "Cement Plug" hole plug method are chosen.
5. Assumes that a) casing is not cemented entire length, b) does not include temporary surface casing
6. Assumes minimum 1 hr per hole for abandonment (excluding move-to and casing removal)
7. Assumes fixed hours per hole for setup & tear-down and moving between holes (see Productivty Sheet) per drill hole (includes rig time if grouting required, labor crew only if cuttings backfill only)

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Project Name: Grassy Mountain Mine - Reclamation Plan
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File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$3,900	$5,258	N/A	$9,158
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$3,900**	**$5,258**		**$9,158**
Revegetation Cost	$1,000	$380	$3,328	$4,708
TOTALS	**$4,900**	**$5,638**	**$3,328**	**$13,866**

Exploration Roads & Pads - User Input — You must fill in ALL green cells and relevant blue cells in this section for each road

	Facility Description		Physical (1) - MANDATORY										User Overrides		Growth Media		
	Description (required)	ID Code	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Cut Slope degrees	Road + Drill Pad Length ft	Road Width ft	Number of Drill Pads	Individual Sump Volume cy	Drill Pad Width ft	Drill Pad Length ft	Slope Replacement Percent %	Regrade Volume (if calculated elsewhere) cy	Disturbed Area (if calculated elsewhere) acres	Growth Media Thickness in	Distance to Growth Media Stockpile ft	Slope from Road to Stockpile % grade
1	**Exploration Surface Disturbance**		**5.0**	**1.3**	**53.0**	**31,950**	**12.0**	**65**	**60**	**30.0**	**30**	**100%**		**10.00**			

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. Slope replacement refers to the percentage of cut volumn replaced during regrading.
3. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
4. Sump volume will be applied to all roads on slopes <20%. On slopes >20% pad width (i.e. cut volume) should be adequate to account for sump volume.

Exploration Roads & Pads - User Input (cont.) — You must fill in ALL green cells and relevant blue cells in this section for each road

		Grading				Growth Media				Revegetation				
	Description (required)	Regrade Material Condition (select)	Cut Material Type (select)	Recontouring Equipment Fleet (select)	Additional Hrs for Walk-in (1)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Additional Hrs for Walk-in (1)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarifying/ Ripping? (select)	Ripping Fleet (select)
1	**Exploration Surface Disturbance**	**1**	**Alluvium**	**Small Dozer**						**Mix 2**	**None**	**None**	**No**	**Small Dozer**

Notes:
1. Include one-way hours necessary to walk equipment in from drop-off point to work area
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$3,900	$5,258	N/A	$9,158
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$3,900**	**$5,258**		**$9,158**
Revegetation Cost	$1,000	$380	$3,328	$4,708
TOTALS	**$4,900**	**$5,638**	**$3,328**	**$13,866**

Exploration Roads & Pads - Calculations

Regrading Volume and Footprint Volume

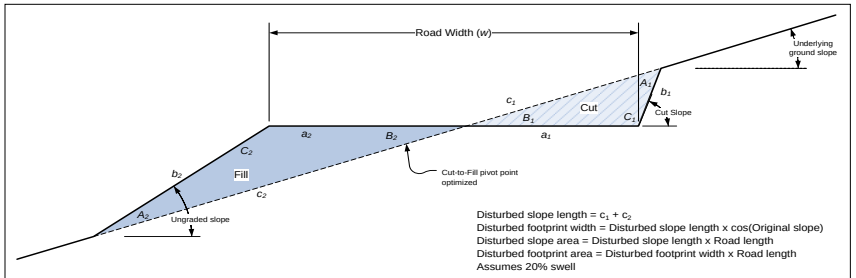

Figure 1 - Regrading Volume Calculation

Will not allow dozer for slopes greater than 30%
For dozer regrading push distance = road width
Assumes dozer push is uphill
Assumes minimum push distance of 100 ft

Swell Factor: 1.2

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per area
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Road length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
For dozer regrading assumes push distance = 3 x road width

Revegetation Calculations

Minimum of 1 acre crew time per area

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Project Name: Grassy Mountain Mine - Reclamation Plan
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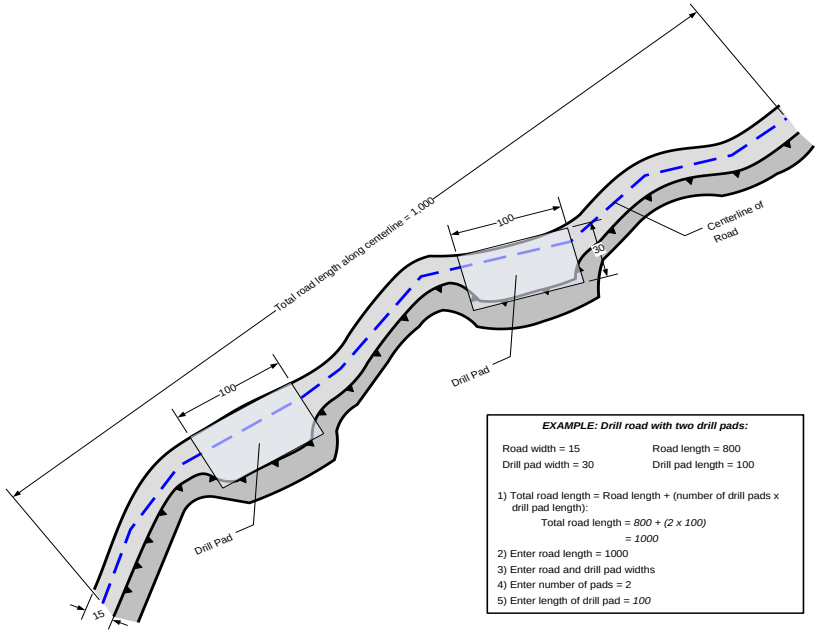
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$3,900	$5,258	N/A	$9,158
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$3,900**	**$5,258**		**$9,158**
Revegetation Cost	$1,000	$380	$3,328	$4,708
TOTALS	**$4,900**	**$5,638**	**$3,328**	**$13,866**

Inputting Exploration Roads and Drill Pads



EXAMPLE: Drill road with two drill pads:

Road width = 15 Road length = 800
Drill pad width = 30 Drill pad length = 100

1) Total road length = Road length + (number of drill pads x drill pad length):
Total road length = *800 + (2 x 100)*
= *1000*
2) Enter road length = 1000
3) Enter road and drill pad widths
4) Enter number of pads = 2
5) Enter length of drill pad = *100*

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Closure Cost Estimate
Expl. Roads & Pads

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$3,900	$5,258	N/A	$9,158
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$3,900**	**$5,258**		**$9,158**
Revegetation Cost	$1,000	$380	$3,328	$4,708
TOTALS	**$4,900**	**$5,638**	**$3,328**	**$13,866**

Exploration Roads & Pads - Regrading Costs

	Description (required)	Total Road Length ft	Total Drill Pad Length ft	Regrading Volume cy	Recontouring Fleet	Equipment Productivity cy/hr	Total Equipment Hours (1) hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**Exploration Surface Disturbance**	30,000	1,950	5,521	D6R	98	56	$3,900	$5,258	$9,158
		30,000	1,950	5,521			56	**$3,900**	**$5,258**	**$9,158**

(1) Includes walk-in time based on distance and travel speed (see Productivity sheet for speeds)

Exploration Roads & Pads - Growth Media Costs

	Description (required)	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Exploration Surface Disturbance**						$0	$0	$0
							$0	**$0**	**$0**

Exploration Roads & Pads - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Ripping/ Scarifying Fleet	Ripping Hours hrs	Ripping Labor Costs $	Ripping Equipment Cost $	Total Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Exploration Surface Disturbance**	10.00						$1,000	$380	$3,328	$4,708
		10.00			**$0**	**$0**	**$0**	**$1,000**	**$380**	**$3,328**	**$4,708**

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Bond Calculation
Tailings

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$2,995	$9,660	N/A	$12,655
Tailings Surface Grading Cost	$100,142	$323,032	N/A	$423,174
Cover Placement Cost	$78,668	$177,701	N/A	$256,369
Topsoil Placement Cost	$176,737	$399,226	N/A	$575,963
Ripping/Scarifying Cost	$5,084	$7,527	N/A	$12,611
Subtotal Earthworks	**$363,626**	**$917,146**	**$0**	**$1,280,772**
Revegetation Cost	$10,919	$4,125	$35,345	$50,389
TOTALS	**$374,545**	**$921,271**	**$35,345**	**$1,331,161**

Tailings - User Input

You must fill in ALL green cells and relevant blue cells in this section for each tailings impoundment

	Facility Description		Physical - MANDATORY								Cover				Growth Media			
	Description (required)	ID Code	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final (Regraded) Embankment Slope _H:1V	Final Embankment Height ft	Final Tailings Surface Area acres	Mid-Embankment or Ripping Length ft	Embankment Regrade Volume (if calculated elsewhere) cy	Surface Regrade Volume (calculated elsewhere) cy	Embankment Cover Thickness in	Tailings Surface Cover Thickness in	Distance from Cover Borrow ft	Slope from Tailings to Borrow % grade	Embankment Growth Media Thickness in	Tailings Surface Growth Media Thickness in	Distance from Growth Material Stockpile ft	Slope from Tailings to Stockpile % grade
1	**Tailing Storage Facility**	**T01**	**3.0**	**1.3**	**2.5**	**70**	**98.80**	**1,683**		**326,314**		**12.0**	**1,359**	**3.7**	**24.0**	**24.0**	**1,740**	**-0.9**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

All waste rock will be used for backfill and cover for the tailing facility.

Tailings - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each tailings impoundment

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Regrading Material Condition (select)	Embankment Material Type (select)	Regrading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Embankment Slope (select)	Seed Mix Tailings Surface (select)	Mulch Embankment Slopes (select)	Mulch Tailings Surface (select)	Fertilizer Embankment Slopes (select)	Fertilizer Tailing Surface (select)	Embankment Slope Scarify/ Rip? (select)	Tailings Surface Scarify/ Rip? (select)	Scarifying/ Ripping Fleet (select)
1	**Tailing Storage Facility**	**1.2**	**Gravel**	**Med**	**No**	**LS - crushed**	**Small Truck**	**Alluvium**	**Small Truck**	**Mix 2**	**Mix 2**	**None**	**None**	**None**	**None**	**Yes**	**Yes**	**Small Dozer**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$2,995	$9,660	N/A	$12,655
Tailings Surface Grading Cost	$100,142	$323,032	N/A	$423,174
Cover Placement Cost	$78,668	$177,701	N/A	$256,369
Topsoil Placement Cost	$176,737	$399,226	N/A	$575,963
Ripping/Scarifying Cost	$5,084	$7,527	N/A	$12,611
Subtotal Earthworks	**$363,626**	**$917,146**	**$0**	**$1,280,772**
Revegetation Cost	$10,919	$4,125	$35,345	$50,389
TOTALS	**$374,545**	**$921,271**	**$35,345**	**$1,331,161**

Tailings - Calculations

Surface Area Calculations

Top Surface Area provided by user

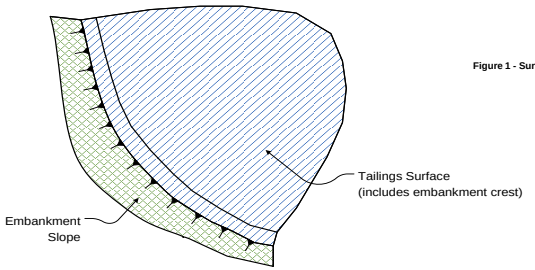

Figure 1 - Surface Areas

Final Slope Area and Footprint Area Calculations

$$\text{Overall slope length (c)} = \frac{\text{Embankment height}}{\cos(\text{Overal l slope angle})}$$

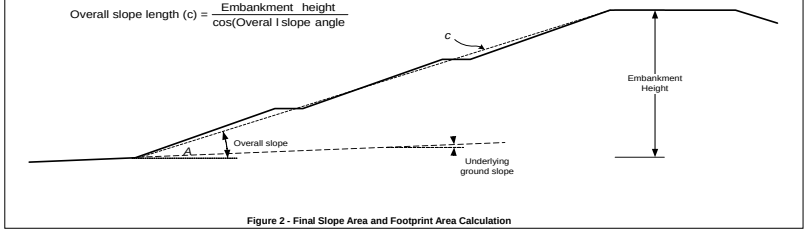

Figure 2 - Final Slope Area and Footprint Area Calculation

Grading Calculations

Grading assumed on impoundment surface only, not embankment
Average push distance assumed to be 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Material assumed to be loose stockile (1.2 productivity factor)
Dozing density correction based on dry sand = 2300/2400 = 0.96
Slope assumed to be 0 to 5% (1.0 productivity factor)

Ripping/Scarifying/Revegetation Calculation

Minimum 1 hr ripping/scarifying per area
Minimum 1 acre revegetation crew time per area

Regrading Volume Calculation

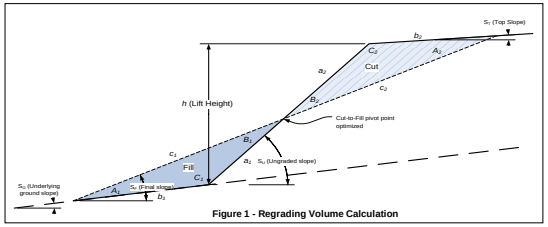

Figure 1 - Regrading Volume Calculation

Regrading Push Distance Calculation

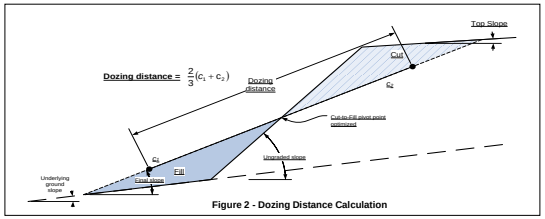

Figure 2 - Dozing Distance Calculation

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Tailings - Cost Summary

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Subtotal Earthworks	**$363,626**	**$917,146**	**$0**	**$1,280,772**
Revegetation Cost	$10,919	$4,125	$35,345	$50,389
TOTALS	**$374,545**	**$921,271**	**$35,345**	**$1,331,161**

Tailings - Embankment Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material Condition	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**Tailing Storage Facility**	46,674	101	D9R	1,160	1.40	1.20	0.90	1.00	1,092	43	$2,995	$9,660	$12,655
		46,674									43	**$2,995**	**$9,660**	**$12,655**

Tailings - Surface Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Density Correction	Dozing Material	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**Tailing Storage Facility**	326,314	400	D9R	317	1.00	0.96	1.20	1.00	227	1,438	$100,142	$323,032	$423,174
		326,314									1,438	**$100,142**	**$323,032**	**$423,174**

Tailings - Cover and Growth Media Costs

		Cover Placement								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Placement Fleet	Cover Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $	Growth Media Volume cy	Growth Media Placement Fleet	Growth Media Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Tailing Storage Facility**	159,397	725/966G/D7R	538	3	296	$78,668	$177,701	$256,369	342,737	725/966G/D7R	515	3	665	$176,737	$399,226	$575,963
		159,397				296	**$78,668**	**$177,701**	**$256,369**	342,737				665	**$176,737**	**$399,226**	**$575,963**

Tailings - Scarifying/Revegetation Costs

	Description (required)	Embankment Slope Area acres	Tailings Surface Area acres	Total Surface Area acres	Final Slope Length ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Cost $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Cost $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Tailing Storage Facility**	7.42	98.80	106.22	192	D7R	5	68	$5,084	$7,527	$12,611	$10,919	$4,125	$35,345	$50,389
		7.42	98.80	106.22			5	68	**$5,084**	**$7,527**	**$12,611**	**$10,919**	**$4,125**	**$35,345**	**$50,389**

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Closure Cost Estimate
Roads

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
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Model Version: Version 1.4.1
Cost Data: User Data
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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$23,712	$30,922	N/A	$54,634
Cover Placement Cost	$25,983	$60,918	N/A	$86,901
Ripping/Scarifying Cost	$2,861	$4,225	N/A	$7,086
Subtotal Earthworks	**$52,556**	**$96,065**		**$148,621**
Revegetation Cost	$4,244	$1,612	$10,965	$16,821
TOTALS	**$56,800**	**$97,677**	**$10,965**	**$165,442**

Roads - User Input

You must fill in ALL green cells and relevant blue cells in this section for each road

	Facility Description			Physical (1) - MANDATORY						User Overrides		Growth Media		
	Description (required)	ID Code	Type	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Cut Slope degrees	Road Width ft	Road Length ft	Slope Replacement Percent %	Regrade Volume (if calculated elsewhere) cy	Disturbed Area (if calculated elsewhere) acres	Growth Media Thickness in	Haul Distance from Growth Media Stockpile ft	Slope from Road to Stockpile % grade
1	Access Road	R01	Access Road	6.0	1.5	0.0	30.0	3,578	100%		2.50	12.0	1,752	-1%
2	Plant Road	R02a	Project Road	6.0	1.5	0.0	24.0	513	100%		0.28	12.0	4,918	-2%
3	Plant Road	R02b	Project Road	6.0	1.5	0.0	12.0	930	100%		0.26	12.0	4,918	-2%
4	Mine Road	R03	Project Road	7.0	1.5	0.0	25.0	480	100%		0.28	12.0	4,918	-2%
5	Mine Road	R04a	Project Road	5.0	1.5	0.0	50.0	3,049	100%		3.48	12.0	1,740	-1%
6	Mine Road	R04b	Project Road	5.0	1.5	0.0	30.0	6,078	100%		4.20	12.0	1,740	-1%
7	Mine Road	R05	Project Road	5.0	1.5	0.0	15.0	197	100%		0.07	12.0	2,007	-2%
8	Mine Road	R06	Project Road	10.0	1.5	34.0	15.0	210	100%		0.07	12.0	2,417	-4%
9	Mine Road	R07	Project Road	10.0	1.5	34.0	20.0	313	100%		0.14	12.0	3,129	-2%
10	Mine Road	R08	Project Road	11.0	1.5	34.0	18.0	190	100%		0.09	12.0	4,968	-1%
11	Mine Road	R09	Project Road	6.0	1.5	0.0	50.0	237	100%		0.28	12.0	5,478	-1%
12	Mine Road	R10	Project Road	25.0	1.5	34.0	16.0	6,644	100%		2.47	12.0	7,076	-3%
13	Mine Road	R11	Project Road	15.0	1.5	34.0	20.0	1,306	100%		0.60	12.0	1,821	0%
14	Mine Road	R12	Project Road	0.0	1.5	0.0	15.0	480	100%		0.17	12.0	4,918	-2%
15	Mine Road	R13	Project Road	15.0	1.5	34.0	50.0	339	100%		0.39	12.0	6,079	-2%
16	Haul Road	HR01	Haul Road	6.0	1.5	0.0	51.0	205	100%		0.24	12.0	3,278	-3%
17	Haul Road	HR02	Haul Road	21.0	1.5	34.0	68.0	911	100%		1.43	12.0	6,978	-2%
18	Haul Road	HR03	Haul Road	15.0	1.5	34.0	68.0	4,228	100%		6.51	12.0	5,609	-2%
19	Haul Road	HR04	Haul Road	12.0	1.5	34.0	51.0	945	100%		1.11	12.0	2,605	-1%
20	Haul Road	HR05	Haul Road	22.0	1.5	34.0	68.0	389	100%		0.63	12.0	7,753	-2%
21	Perimeter Fence Road	F01	Project Road	15.0	1.5	34.0	15.0	22,480	100%		7.74			

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Because the work required for building roads with a dozer is similar to that required to regrade a road with a dozer, this sheet could be used to provide a rough estimate of road construction costs if a dozer is selected as the grading fleet.

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Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$23,712	$30,922	N/A	$54,634
Cover Placement Cost	$25,983	$60,918	N/A	$86,901
Ripping/Scarifying Cost	$2,861	$4,225	N/A	$7,086
Subtotal Earthworks	**$52,556**	**$96,065**		**$148,621**
Revegetation Cost	$4,244	$1,612	$10,965	$16,821
TOTALS	**$56,800**	**$97,677**	**$10,965**	**$165,442**

Roads - User Input (cont.)

		Haul Road Safety Berms				
	Description (required)	Berm Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Number of Berms (2) (1 or 2 sides)
1	Access Road	3,578.0	2.0	6.0	1.5	2
2	Plant Road					
3	Plant Road					
4	Mine Road	480.0	4.0	12.0	1.5	2
5	Mine Road	3,049.0	2.0	6.0	1.5	2
6	Mine Road	6,078.0	2.0	6.0	1.5	2
7	Mine Road	197.0	2.0	6.0	1.5	2
8	Mine Road	210.0	2.0	6.0	1.5	2
9	Mine Road	313.0	2.0	6.0	1.5	2
10	Mine Road	190.0	2.0	6.0	1.5	2
11	Mine Road	237.0	2.0	6.0	1.5	1
12	Mine Road	6,644.0	2.0	6.0	1.5	1
13	Mine Road	1,306.0	2.0	6.0	1.5	1
14	Mine Road					
15	Mine Road	6,079.0	4.0	12.0	1.5	1
16	Haul Road	205.0	4.0	12.0	1.5	2
17	Haul Road	911.0	4.0	12.0	1.5	2
18	Haul Road	4,228.0	4.0	12.0	1.5	2
19	Haul Road	945.0	4.0	12.0	1.5	2
20	Haul Road	389.0	4.0	12.0	1.5	2
21	Perimeter Fence Road					

(2) Enter 1 if berm on only one side of road, 2 if both sides of road are bermed.

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Closure Cost Estimate
Roads

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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$23,712	$30,922	N/A	$54,634
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TOTALS	**$56,800**	**$97,677**	**$10,965**	**$165,442**

Roads - User Input (cont.) — You must fill in ALL green cells and relevant blue cells in this section for each road

		Grading				Growth Media			Revegetation				
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	No. of Excavators if grade >30% (select)	Growth Media Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarifying/ Ripping? (select)	Ripping Fleet (select)
1	Access Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
2	Plant Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
3	Plant Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
4	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
5	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
6	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
7	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
8	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
9	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
10	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
11	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
12	Mine Road	1	Alluvium	Sm Excavator	1	Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
13	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
14	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
15	Mine Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
16	Haul Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
17	Haul Road	1	Alluvium	Sm Excavator	1	Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
18	Haul Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
19	Haul Road	1	Alluvium	Sm Excavator		Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
20	Haul Road	1	Alluvium	Sm Excavator	1	Alluvium	Small Truck		Mix 2	None	None	Yes	Small Dozer
21	Perimeter Fence Road	1	Alluvium	Sm Excavator					Mix 2	None	None	Yes	Small Dozer

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table
2. If original slope >30% only excavators are allowed.

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Roads - Calculations

Regrading Volume and Footprint Volume

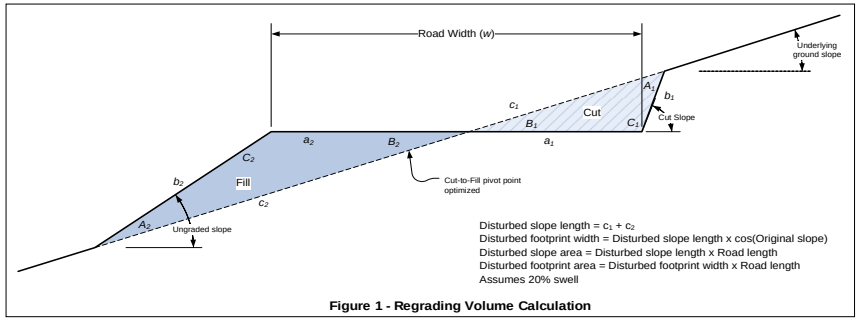


Figure 1 - Regrading Volume Calculation

Will not allow dozer for slopes greater than 30%
For dozer regrading push distance = road width
Assumes dozer push is uphill
Assumes minimum push distance of 100 ft

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per area
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Road length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
For dozer regrading assumes push distance = 3 x road width

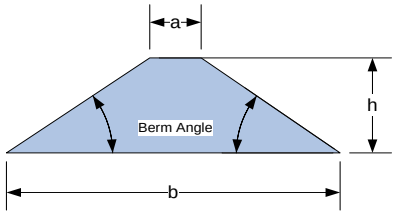
Revegetation Calculations

Minimum of 1 acre crew time per area

Safety Berm Volume Calculation

Cross Sectional Area = $\frac{(a+b)}{2} \times h$

Berm Volume = Berm Length x Cross Sectional Area x No. Sides



Total berm volume doubled if both sides of road are bermed.
If length of berm on each side of road is different, input total length of both berms and input 1 for number of sides

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File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$23,712	$30,922	N/A	$54,634
Cover Placement Cost	$25,983	$60,918	N/A	$86,901
Ripping/Scarifying Cost	$2,861	$4,225	N/A	$7,086
Subtotal Earthworks	**$52,556**	**$96,065**		**$148,621**
Revegetation Cost	$4,244	$1,612	$10,965	$16,821
TOTALS	**$56,800**	**$97,677**	**$10,965**	**$165,442**

Roads - Regrading Costs

	Description (required)	Regrading Volume cy	Recontouring Fleet	Fleet Productivity cy/hr	Total Fleet Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**Access Road**	1,590	325C	398	4	$561	$732	$1,293
2	**Plant Road**	0				$0	$0	$0
3	**Plant Road**	0				$0	$0	$0
4	**Mine Road**	853	325C	398	2	$281	$366	$647
5	**Mine Road**	1,355	325C	398	3	$421	$549	$970
6	**Mine Road**	2,701	325C	398	7	$982	$1,281	$2,263
7	**Mine Road**	88	325C	398	1	$140	$183	$323
8	**Mine Road**	121	325C	398	1	$140	$183	$323
9	**Mine Road**	213	325C	398	1	$140	$183	$323
10	**Mine Road**	125	325C	398	1	$140	$183	$323
11	**Mine Road**	53	325C	398	1	$140	$183	$323
12	**Mine Road**	4,908	325C	398	12	$1,684	$2,196	$3,880
13	**Mine Road**	801	325C	398	2	$281	$366	$647
14	**Mine Road**	0				$0	$0	$0
15	**Mine Road**	6,233	325C	398	16	$2,245	$2,927	$5,172
16	**Haul Road**	364	325C	398	1	$140	$183	$323
17	**Haul Road**	8,139	325C	398	20	$2,806	$3,659	$6,465
18	**Haul Road**	26,636	325C	398	67	$9,401	$12,258	$21,659
19	**Haul Road**	3,498	325C	398	9	$1,263	$1,647	$2,910
20	**Haul Road**	3,673	325C	398	9	$1,263	$1,647	$2,910
21	**Perimeter Fence Road**	4,943	325C	398	12	$1,684	$2,196	$3,880
		66,294			169	**$23,712**	**$30,922**	**$54,634**

Roads - Growth Media Costs

	Description (required)	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Access Road**	4,037	725/966G/D7R	515	3	8	$2,126	$4,803	$6,929
2	**Plant Road**	453	725/966G/D7R	471	4	1	$308	$731	$1,039
3	**Plant Road**	426	725/966G/D7R	471	4	1	$308	$731	$1,039
4	**Mine Road**	458	725/966G/D7R	471	4	1	$308	$731	$1,039
5	**Mine Road**	5,619	725/966G/D7R	515	3	11	$2,923	$6,604	$9,527
6	**Mine Road**	6,771	725/966G/D7R	515	3	13	$3,455	$7,804	$11,259
7	**Mine Road**	111	725/966G/D7R	496	3	1	$266	$600	$866
8	**Mine Road**	111	725/966G/D7R	466	3	1	$266	$600	$866
9	**Mine Road**	232	725/966G/D7R	426	3	1	$266	$600	$866
10	**Mine Road**	145	725/966G/D7R	468	4	1	$308	$731	$1,039
11	**Mine Road**	445	725/966G/D7R	448	4	1	$308	$731	$1,039
12	**Mine Road**	3,984	725/966G/D7R	490	5	8	$2,795	$6,890	$9,685
13	**Mine Road**	968	725/966G/D7R	515	3	2	$532	$1,201	$1,733
14	**Mine Road**	268	725/966G/D7R	471	4	1	$308	$731	$1,039
15	**Mine Road**	629	725/966G/D7R	531	5	1	$349	$861	$1,210
16	**Haul Road**	387	725/966G/D7R	418	3	1	$266	$600	$866
17	**Haul Road**	2,311	725/966G/D7R	494	5	5	$1,747	$4,306	$6,053
18	**Haul Road**	10,509	725/966G/D7R	442	4	24	$7,382	$17,539	$24,921
19	**Haul Road**	1,791	725/966G/D7R	456	3	4	$1,063	$2,401	$3,464
20	**Haul Road**	1,015	725/966G/D7R	469	5	2	$699	$1,723	$2,422
21	**Perimeter Fence Road**						$0	$0	$0
		40,670				88	**$25,983**	**$60,918**	**$86,901**

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Subtotal Earthworks	**$52,556**	**$96,065**		**$148,621**
Revegetation Cost	$4,244	$1,612	$10,965	$16,821
TOTALS	**$56,800**	**$97,677**	**$10,965**	**$165,442**

Roads - Scarifying/Revegetation Costs

	Description (required)	Total Surface Area acres	Final Slope Length ft	Ripping/ Scarifying Fleet	Ripping Hours hrs	Ripping Labor Costs $	Ripping Equipment Cost $	Total Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Access Road**	2.50	30.0	D7R	2	$139	$206	$345	$250	$95	$833	$1,178
2	**Plant Road**	0.28	24.0	D7R	1	$70	$103	$173	$100	$38	$93	$231
3	**Plant Road**	0.26	12.0	D7R	1	$70	$103	$173	$100	$38	$88	$226
4	**Mine Road**	0.28	26.0	D7R	1	$70	$103	$173	$100	$38	$94	$232
5	**Mine Road**	3.48	50.0	D7R	3	$209	$309	$518	$348	$132	$1,159	$1,639
6	**Mine Road**	4.20	30.0	D7R	3	$209	$309	$518	$420	$159	$1,397	$1,976
7	**Mine Road**	0.07	15.0	D7R	1	$70	$103	$173	$100	$38	$23	$161
8	**Mine Road**	0.07	14.0	D7R	1	$70	$103	$173	$100	$38	$23	$161
9	**Mine Road**	0.14	20.0	D7R	1	$70	$103	$173	$100	$38	$48	$186
10	**Mine Road**	0.09	21.0	D7R	1	$70	$103	$173	$100	$38	$30	$168
11	**Mine Road**	0.28	51.0	D7R	1	$70	$103	$173	$100	$38	$92	$230
12	**Mine Road**	2.47	16.0	D7R	3	$209	$309	$518	$247	$94	$822	$1,163
13	**Mine Road**	0.60	20.0	D7R	1	$70	$103	$173	$100	$38	$200	$338
14	**Mine Road**	0.17	15.0	D7R	1	$70	$103	$173	$100	$38	$55	$193
15	**Mine Road**	0.39	50.0	D7R	1	$70	$103	$173	$100	$38	$130	$268
16	**Haul Road**	0.24	51.0	D7R	1	$70	$103	$173	$100	$38	$80	$218
17	**Haul Road**	1.43	68.0	D7R	1	$70	$103	$173	$143	$54	$477	$674
18	**Haul Road**	6.51	67.0	D7R	6	$418	$619	$1,037	$651	$248	$2,167	$3,066
19	**Haul Road**	1.11	51.0	D7R	1	$70	$103	$173	$111	$42	$369	$522
20	**Haul Road**	0.63	70.0	D7R	1	$70	$103	$173	$100	$38	$209	$347
21	**Perimeter Fence Road**	7.74	15.0	D7R	9	$627	$928	$1,555	$774	$294	$2,576	$3,644
		32.95			41	**$2,861**	**$4,225**	**$7,086**	**$4,244**	**$1,612**	**$10,965**	**$16,821**

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Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$2,577	$3,815	N/A	$6,392
Safety Berm Construction Cost	$905	$1,340	N/A	$2,245
Subtotal Earthwork	**$3,482**	**$5,155**	**$0**	**$8,637**
Revegetation Cost	$4,289	$1,630	$14,271	$20,190
Safety Berm Revegetation Cost	$1,158	$440	$3,853	$5,451
	$5,447	**$2,070**	**$18,124**	**$25,641**
TOTALS	**$8,929**	**$7,225**	**$18,124**	**$34,278**

Quarries & Borrow Pits - User Input

You must fill in ALL green cells in this section for each dump, lift or dump category

	Facility Description			Physical - MANDATORY									Cover				Growth Media			
	Description (required)	ID Code	Type	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final Slope _H:1V	Final Top Slope % Grade	Bench or Highwall Height ft	Mid-Bench Length ft	Average Flat Area Long Dimension (ripping distance) ft	Final (Regraded) Footprint acres	Regrade Volume (1) (if calculated elsewhere) cy	Cover Thickness Slopes in	Cover Thickness Flat Areas in	Distance from Cover Borrow ft	Slope from Dump to Cover Borrow % grade	Slope Growth Media Thickness in	Flat Area Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Dump to Stockpile % grade
1	**Borrow Pit**	**BP01**	**Borrow Pit**	**22.0**				**80**		**3,115**	**42.89**									

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Quarries & Borrow Pits - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each dump, lift or dump category

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Slopes (select)	Seed Mix Flat Areas (select)	Mulch Slopes (select)	Mulch Flat Areas (select)	Fertilizer Slopes (select)	Fertilizer Flat Areas (select)	Slope Scarify/ Rip? (select)	Flat Area Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)
1	**Borrow Pit**									**Mix 2**	**Mix 2**	**None**	**None**	**None**	**None**	**No**	**Yes**	**Small Dozer**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Quarries & Borrow Pits - User Input (cont.)

	Facility Description	Highwall Berms					Berm Construction		Excavate or Doze	Hauling (if selected method)				Revegetation		
	Description (required)	Berm (or Highwall) Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Volume (if calculated elsewhere) cy	Construction Method (select)	Berm Material Type (select)	Berm Construction Equipment Fleet (select)	Berm Hauling Fleet (select)	Distance to Borrow Source ft	Slope to Borrow Source % grade	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)
1	**Borrow Pit**	**4,273.0**	**3.0**	**18.0**	**2.5**		**Dozer**	**Alluvium**	**Small**					**Mix 2**	**None**	**None**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$2,577	$3,815	N/A	$6,392
Safety Berm Construction Cost	$905	$1,340	N/A	$2,245
Subtotal Earthwork	**$3,482**	**$5,155**	**$0**	**$8,637**
Revegetation Cost	$4,289	$1,630	$14,271	$20,190
Safety Berm Revegetation Cost	$1,158	$440	$3,853	$5,451
	$5,447	**$2,070**	**$18,124**	**$25,641**
TOTALS	**$8,929**	**$7,225**	**$18,124**	**$34,278**

Quarries & Borrow Pits - Calculations

Regrading Volume Calculation

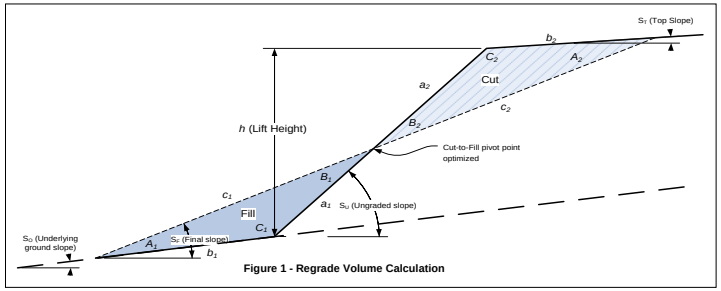


Figure 1 - Regrade Volume Calculation

Regrading Push Distance Calculation

dozing distance: based on 2/3 final cut slope + 2/3 final fill slope (minimum = 50 ft)

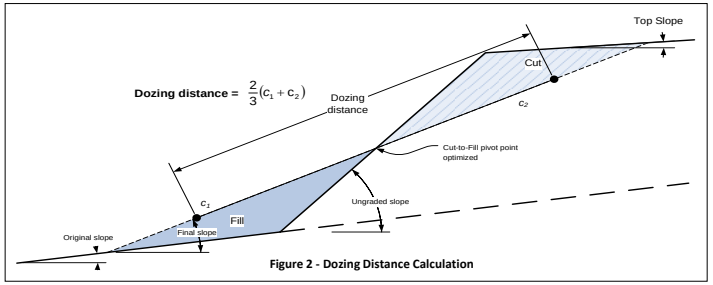
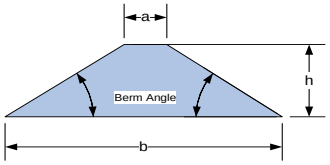


Figure 2 - Dozing Distance Calculation

Safety Berm Volume Calculation

$$\text{Cross Sectional Area} = \frac{(a+b)}{2} \times h$$

Berm Volume = Berm Length x Cross Sectional Area



Dozer productivity assumes push distance of:
100 feet

Dozer:
Length x (Berm Base Width + Dozer Push Distance) - accounts for disturbance created in borrow area

Excavator:
Length x (Berm Base Width + (2 x Excavator Track Width) - accounts for disturbance created in borrow area

Haul & Place:
Length x Berm Base Width - if necessary use Yards sheet to account for disturbance created in borrow area

Final Slope Area and Footprint Area Calculations

Final slope length = $c_1 + c_2$
Final slope area = Final slope length *x* Mid-bench Length
Final lift height (h_{final}) = $(c_1 + c_2)$ *x* sin(Final slope)
Final slope width (d) = $(c_1 + c_2)$ *x* cos(Final slope)
Final slope footprint = Final slope width *x* Mid-bench Length
Final flat area = Final footprint – Final slope footprint

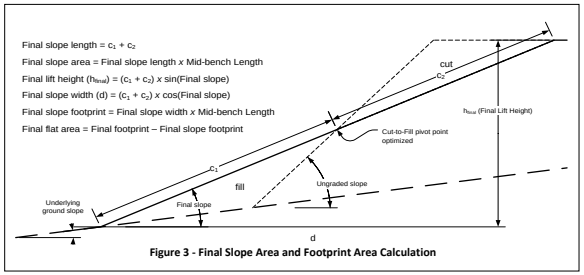


Figure 3 - Final Slope Area and Footprint Area Calculation

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per dump

Slopes:
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Mid-bench length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr

Flat Areas:
Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation: Minimum 1 acre revegetation crew time per area

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Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$2,577	$3,815	N/A	$6,392
Safety Berm Construction Cost	$905	$1,340	N/A	$2,245
Subtotal Earthwork	**$3,482**	**$5,155**	**$0**	**$8,637**
Revegetation Cost	$4,289	$1,630	$14,271	$20,190
Safety Berm Revegetation Cost	$1,158	$440	$3,853	$5,451
	$5,447	**$2,070**	**$18,124**	**$25,641**
TOTALS	**$8,929**	**$7,225**	**$18,124**	**$34,278**

Quarries & Borrow Pits - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**Borrow Pit**			**Select Fleet**								$0	$0	$0
												$0	**$0**	**$0**

Quarries & Borrow Pits - Cover and Growth Media Costs

		Cover (lower layer)								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity BCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Borrow Pit**						$0	$0	$0						$0	$0	$0
							$0	**$0**	**$0**						**$0**	**$0**	**$0**

Quarries & Borrow Pits - Scarifying/Revegetation Costs

	Description (required)	Slope Area acres	Flat Area acres	Total Surface Area acres	Final Slope Length ft	Flat Area Long Dimension ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Borrow Pit**	0.00	42.89	42.89		3,115	D7R		37	$2,577	$3,815	$6,392	$4,289	$1,630	$14,271	$20,190
			42.89	42.89					37	**$2,577**	**$3,815**	**$6,392**	**$4,289**	**$1,630**	**$14,271**	**$20,190**

Notes: 1) Minimum total ripping hours = 1 (i.e. If total ripping hrs (slope + flat) < 1, then one hour of fleet time is assumed, regardless of acres shown in in scarifying table.)
2) Assumes 50min/hr equipment availability

Quarries & Borrow Pits - Safety Berm Construction Costs

		Safety Berm							
	Description (required)	Safety Berm Volume cy	Selected Fleet	Number of Trucks/ Scrapers	Corrected Fleet Productivity cy/hr	Total Hours	Safety Berm Labor Cost $	Safety Berm Equipment Cost $	Total Safety Berm Cost $
1	**Borrow Pit**	4,985	Small (D7R)		390	13	$905	$1,340	$2,245
		4,985				13	**$905**	**$1,340**	**$2,245**

Quarries & Borrow Pits - Safety Berms - Revegetation Costs

	Description (required)	Flat Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Borrow Pit**	11.58	$1,158	$440	$3,853	$5,451
		11.58	**$1,158**	**$440**	**$3,853**	**$5,451**

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Underground Openings Cost Summary

	Labor	Equipment	Materials	Totals
Adits, Portals & Declines Plugging	$279	$864	$0	$1,143
Shaft Backfill/Cover	$448	$940	N/A	$1,388
Shaft Capping	$4,539	$509	$2,104	$7,152
TOTALS	**$5,266**	**$2,313**	**$2,104**	**$9,683**

Adits, Portals & Declines - User Input

	Facility Description		Physical Characteristics				Backfill Material			
	Description (required)	ID Code	Height ft	Width ft	Backfill/ Plug Type	Distance to Bulkhead ft	Backfill Material Condition (select)	Backfill Material Type (select)	Distance to Backfill Borrow ft	Slope from Adit to Borrow Area % grade
1	**Portal**	**U01**	**15.0**	**15.0**	**Rock Backfill**	**10**	**1.2**	**Stone - crush**	**1,612**	**-7.4**

Notes: 1) Foam (adit) option is for smaller openings that can be plugged with simple forms and a 5 ft thick plug.
2) Foam (production) option is for larger production openings (declines, etc.) and requires larger form construction and minimum 10 ft thick plug.
3) All foam plugs include minimum 15ft of backfill from opening to plug.
4) Bat gate option is for small openings and the material cost is the same for any size opening.
5) Backfilling assumes that small dozer will push material from nearby stockpile or dump
6) Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Shaft Openings - User Input — **You must fill in ALL green cells and relevant blue cells in this section for each shaft**

	Facility Description		Physical Characteristics			Backfill or Foundation Cover					
	Description (required)	ID Code	Diameter ft	Shaft Depth (for backfill method) ft	Backfill/ Plug Type (select)	Backfill Material Type (select)	Cover/ Backfill Fleet (select)	Thickness (if not complete backfill) ft	Distance to Backfill Borrow ft	Slope from Shaft to Borrow Area % grade	Maximum Fleet Size (user override)
1	**Vent Shaft #1**	**U02**	**9.0**	**10**	**Concrete Cap**	**Stone - crushed**	**Small Truck**		**2,719**	**-4.0**	**2**
2	**Vent Shaft #2**	**U03**	**9.0**	**10**	**Concrete Cap**	**Stone - crushed**	**Small Truck**		**4,289**	**-5.0**	**2**

Notes:
1. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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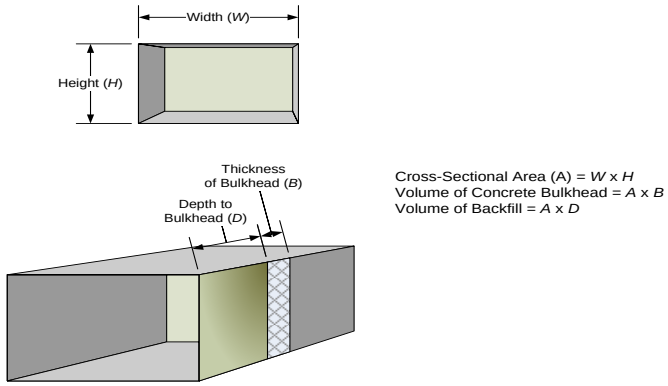
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Underground Openings Cost Summary

	Labor	Equipment	Materials	Totals
Adits, Portals & Declines Plugging	$279	$864	$0	$1,143
Shaft Backfill/Cover	$448	$940	N/A	$1,388
Shaft Capping	$4,539	$509	$2,104	$7,152
TOTALS	**$5,266**	**$2,313**	**$2,104**	**$9,683**

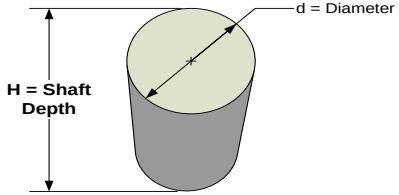
Underground Openings - Calculations

Adits, Declines and Portals - Volume Calculations



Cross-Sectional Area (A) = W x H
Volume of Concrete Bulkhead = A x B
Volume of Backfill = A x D

Shaft Volume Calculations



Radius (r) = ½d
Cross-Sectional Area (A) = πr^2
Volume = A x H

Concrete Cover/Bulkhead Volume Calculation

Using Means Heavy Construction Cost Data (2004)
Estimage cover/bulkhead thickness
Assumes that all concrete works are reinforced
Productivity for crew from Means Heavy Construction Cost Data (2004) adjusted for supervision (addressed in Misc. Costs) and Davis-Bacon Wage Rates
Assumes 18 in thick slab

Backfill Calculations

Uses 1 large and 1 small dozer for adit backfill
Assumes max 400 foot push
Assumes average operator and 50 min/hr availability

Uses truck & loader load, haul place fleets for shafts
Concrete cap will be 1.5 feet thick, reinforced, structually supported.
If concrete cap is used, assume 10 feet of rock backfill on top of cap.
Assumes that all concrete works are reinforced
If backfill is used, assume overfill by 5 feet
Carpenter rate incl Fringe: 0 per hour

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Closure Cost Estimate
Underground Openings

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Shaft Backfill/Cover	$448	$940	N/A	$1,388
Shaft Capping	$4,539	$509	$2,104	$7,152
TOTALS	**$5,266**	**$2,313**	**$2,104**	**$9,683**

Adits, Portals & Declines Plugging — Uses RS Means Heavy Construction Cost Data for bulkhead production rate, material costs and crews

							Bulkhead Construction				Backfill or Foam (1)				Bat Gate or Culvert (2,3,4)				Total Costs			
	Description (required)	Bulkhead Volume cy	Backfill (rock) Volume cy	Backfill Equipment Fleet	Backfill Productivity LCY/hr	Backfill Hours	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Bulkhead Cost $	Total Labor Cost $	Total Equipment Cost $	Material (Foam) Cost $	Total Backfill Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Bat Gate Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Plugging Costs $
1	**Portal**		83	D7R/D10R	-34	2	$0	$0	$0	$0	$279	$864	$0	$1,143	$0	$0	$0	$0	$279	$864	$0	**$1,143**
			83			2	**$0**	**$0**	**$0**	**$0**	**$279**	**$864**	**$0**	**$1,143**	**$0**	**$0**	**$0**	**$0**	**$279**	**$864**	**$0**	**$1,143**

Notes:
1) Foam costs include 1 hour move to and setup + 1 hr. minimum crew time
2) Assumes 1 hr walk-in/walk-out time for equipment
3) Batgate assumes 8 hr install time each
4) Bat culvert backfill costs based on one 8-hr day (i.e. backfilling hours = 8 hrs).

Shaft Plugging

								Cover/Cap					Backfill/Cover		
	Description (required)	Cover Area ft2	Backfill or Cover Volume cy	Backfill Equipment Fleet	Number of Trucks	Backfill Productivity LCY/hr	Backfill Hours	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Shaft Cap Cost $	Total Labor Cost $	Total Equipment Cost $	Total Backfill Cost $
1	**Vent Shaft #1**	64	0					$2,269	$255	$1,052	$3,576	$224	$470	**$694**
2	**Vent Shaft #2**	64	0					$2,269	$255	$1,052	$3,576	$224	$470	**$694**
		128						**$4,539**	**$509**	**$2,104**	**$7,152**	**$448**	**$940**	**$1,388**

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Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
Building Demolition Cost	$0	$0	N/A	$0
Wall Demolition Cost	$21,042	$0	N/A	$21,042
Slab Demolition	$8,219	$20,258	N/A	$28,477
Subtotal Demolition	**$29,261**	**$20,258**	**$0**	**$49,519**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$7,903	$19,413	N/A	$27,316
Ripping/Scarifying Cost	$1,610	$5,175	N/A	$6,785
Subtotal Earthworks	**$9,513**	**$24,588**	**$0**	**$34,101**
Revegetation Cost	$2,300	$874	$827	$4,001
TOTALS	**$41,074**	**$45,720**	**$827**	**$87,621**

Buildings & Foundation - User Input

You must fill in ALL green cells and relevant blue cells in this section for each building or facility

	Facility Description			Physical - MANDATORY								Foundation Cover (1)			Growth Media (1) (entire footprint)		
	Description (required)	ID Code	Type	Length ft	Width ft	Eve Height ft	Slab Thickness in	Foundation Wall Thickness in	Foundation Wall Height ft	Average Flat Area Long Dimension (ripping distance) ft	Building Area Footprint (including surrounding facilities) acres	Foundation Cover Thickness in	Distance from Foundation Cover Borrow Area ft	Slope from Facility to Borrow Area % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade
1	Administration Building	FB01	Site Facilities - Buildings	69	61		6	6	1	69	0.10				12	4,918	-1.6
2	Plant Offices	FB02	Site Facilities - Buildings	69	49		6	6	1	69	0.08				12	4,918	-1.6
3	Laboratory	FB03	Site Facilities - Buildings	73	28		6	6	1	73	0.05				12	4,918	-1.6
4	Plant Workshop and Warehouse	FB04	Site Facilities - Buildings	63	41		6	6	1	63	0.06				12	4,918	-1.6
5	Gold Room	FB05	Site Facilities - Buildings	56	62		6	6	1	56	0.07				12	4,918	-1.6
6	Elution Area	FB06	Process - Plant & Buildings	96	54		6	6	1	96	0.09				12	4,918	-1.6
7	Reagent Area	FB07	Site Facilities - Buildings	49	37		6	6	1	49	0.03				12	4,918	-1.6
8	Reagent Area	FB08	Site Facilities - Buildings	40	40		6	6	1	40	0.03				12	4,918	-1.6
9	Grinding Area	FB09	Process - Crushing & Screeni	49	32		6	6	1	49	0.04				12	4,918	-1.6
10	CIL Area	FB10	Process - Plant & Buildings	160	81		6	6	1	160	0.23				12	4,918	-1.6
11	Water Service Area	FB11	Site Facilities - Buildings	70	57		6	6	1	70	0.04				12	4,918	-1.6
12	Truck Workhshop and Warehouse	FB12	Site Facilities - Buildings	139	55		6	6	1	139	0.16				12	4,918	-1.6
13	Mine Office	FB13	Site Facilities - Buildings	73	61		6	6	1	73	0.10				12	4,918	-1.6
14	Truck Scale	FB14	Site Facilities - Mobile/Fixed E	80	30	0	6	6	1	80	0.06				12	4,918	-1.6
15	Guard House	FB15	Site Facilities - Structures	50	30		6	6	1	50	0.03				12	4,918	-1.6
16	Pad	PD01	Other Facilities	60	44	0	6	6	1	60	0.04				12	4,918	-1.6
17	Pad	PD02	Other Facilities	56	38	0	6	6	1	56	0.04				12	4,918	-1.6
18	Crusher Wall	PD03	Other Facilities	124	8	0	6	8	20	124	0.00				12	4,918	-1.6
19	Truck Wash	PD04	Other Facilities	40	33	0	6	6	1	40	0.03				12	4,918	-1.6
20	Fuel Storage Pad	PD05	Other Facilities	42	17	0	6	6	1	42	0.02				12	4,918	-1.6
21	UG Backfill Plant	PD06	Site Facilities - Structures	75	70	0	6	6	1	75	0.12				12	3,278	-3.7
22	Guard House	PD07	Site Facilities - Structures	50	30	0	6	6	1	50	0.03				12	667	5.2
23	Water Tank	WT01	Other Facilities	40	40	0	6	6	1	40	0.03				12	4,823	-5.1

Notes:
1. Foundation cover only calculated to cover slab. Growth media estimated over entire footprint area
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

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	Labor	Equipment	Materials	Totals
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Growth Media Placement Cost	$7,903	$19,413	N/A	$27,316
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Subtotal Earthworks	**$9,513**	**$24,588**	**$0**	**$34,101**
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TOTALS	**$41,074**	**$45,720**	**$827**	**$87,621**

Buildings & Foundation - User Input (cont.) — You must fill in ALL green cells and relevant blue cells in this section for each building or facility

		Construction Materials		Slab Demolition		Foundation Cover			Growth Media			Revegetation				
	Description (required)	Building Type (select)	Foundation Wall Type (select)	Slab Demo Method (select)	Slab Breaking Equipment Fleet (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Ripping Fleet (select)
1	Administration Building	Lg. steel	Block 6 in (150 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
2	Plant Offices	Lg. steel	Block 6 in (150 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
3	Laboratory	Lg. steel	Block 6 in (150 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
4	Plant Workshop and Warehouse	Lg. steel	Block 6 in (150 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
5	Gold Room	Sm. concrete	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
6	Elution Area	Sm. concrete	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
7	Reagent Area	Sm. wood	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
8	Reagent Area	Sm. wood	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
9	Grinding Area	Sm. wood	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
10	CIL Area	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
11	Water Service Area	Sm. steel	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
12	Truck Workhshop and Warehouse	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
13	Mine Office	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
14	Truck Scale	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
15	Guard House	Sm. wood	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
16	Pad			Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
17	Pad			Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
18	Crusher Wall	Sm. steel	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
19	Truck Wash	Lg. steel	Block 6 in (150 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
20	Fuel Storage Pad			Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
21	UG Backfill Plant	Sm. steel	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
22	Guard House	Sm. wood	Block 4 in (100 mm) thick	Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
23	Water Tank			Break & bury	Sm Excavator				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Subtotal Earthworks	**$9,513**	**$24,588**	**$0**	**$34,101**
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TOTALS	**$41,074**	**$45,720**	**$827**	**$87,621**

Buildings & Foundation - Calculations

Building Volume Calculations

Using Means Heavy Construction Cost Data (2004) calculates cubic feet from building dimensions
- Estimage slab thickness and wall thickness if not known
- Assumes that all concrete slabs are reinforced
- Productivity for crew from Means Heavy Construction Cost Data (2004) adjusted for supervision (addressed in Misc. Costs) and Davis-Bacon Wage Rates
- Demolition costs do not include hauling or disposing if debris - Use Waste Disposal module

Slab Demolition Calculations

Minimum 1 hr excavator time for slab demolition

Cover Volume Calculation

Foundation area x cover thickness
- If "Bury in Place" is selected as slab demolition method, cover thickness is adjusted such that total cover (cover + growth media) equals value entered in "Minimum thickness of cover over unbroken slab" cell above

Ripping/Scarifying Calculations

Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation

Minimum 1 acre revegetation crew time per area

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TOTALS	**$41,074**	**$45,720**	**$827**	**$87,621**

Building & Foundation Demolition Costs

Uses RS Means Heavy Construction Cost Data for building and wall demolition cost calculations. Uses CAT Handbook for slab breaking production.

								Building Demolition			Wall Demolition			Slab Demolition			Total Costs		
	Description (required)	Building Footprint (slab area) sqft	Building Volume cu ft	Wall Length ft	Wall Area sq ft	Slab Demolition Fleet	Slab Volume cy	Total Labor Cost $	Total Equipment Cost $	Total Building Demolition Cost $	Total Labor Cost $	Total Equipment Cost $	Total Wall Demolition Cost $	Total Labor Cost $	Total Equipment Cost $	Total Slab Breaking Cost $	Total Labor Cost $	Total Equipment Cost $	Total Demolition Costs $
1	**Administration Building**	4,209	0	260	260	325C	78	$0	$0	$0	$603	$0	$603	$463	$1,141	$1,604	$1,066	$1,141	$2,207
2	**Plant Offices**	3,381	0	236	236	325C	63	$0	$0	$0	$548	$0	$548	$365	$899	$1,264	$913	$899	$1,812
3	**Laboratory**	2,044	0	202	202	325C	38	$0	$0	$0	$469	$0	$469	$224	$553	$777	$693	$553	$1,246
4	**Plant Workshop and Warehouse**	2,583	0	208	208	325C	48	$0	$0	$0	$483	$0	$483	$281	$691	$972	$764	$691	$1,455
5	**Gold Room**	3,472	0	236	236	325C	64	$0	$0	$0	$514	$0	$514	$379	$933	$1,312	$893	$933	$1,826
6	**Elution Area**	5,184	0	300	300	325C	96	$0	$0	$0	$654	$0	$654	$561	$1,383	$1,944	$1,215	$1,383	$2,598
7	**Reagent Area**	1,813	0	172	172	325C	34	$0	$0	$0	$375	$0	$375	$196	$484	$680	$571	$484	$1,055
8	**Reagent Area**	1,600	0	160	160	325C	30	$0	$0	$0	$349	$0	$349	$182	$449	$631	$531	$449	$980
9	**Grinding Area**	1,568	0	162	162	325C	29	$0	$0	$0	$353	$0	$353	$168	$415	$583	$521	$415	$936
10	**CIL Area**	12,960	0	482	482	325C	240	$0	$0	$0	$1,051	$0	$1,051	$1,403	$3,457	$4,860	$2,454	$3,457	$5,911
11	**Water Service Area**	3,990	0	254	254	325C	74	$0	$0	$0	$554	$0	$554	$435	$1,072	$1,507	$989	$1,072	$2,061
12	**Truck Workhshop and Warehouse**	7,645	0	388	388	325C	142	$0	$0	$0	$846	$0	$846	$828	$2,040	$2,868	$1,674	$2,040	$3,714
13	**Mine Office**	4,453	0	268	268	325C	82	$0	$0	$0	$584	$0	$584	$477	$1,175	$1,652	$1,061	$1,175	$2,236
14	**Truck Scale**	2,400	0	220	220	325C	44	$0	$0	$0	$480	$0	$480	$253	$622	$875	$733	$622	$1,355
15	**Guard House**	1,500	0	160	160	325C	28	$0	$0	$0	$349	$0	$349	$168	$415	$583	$517	$415	$932
16	**Pad**	2,640	0	208	208	325C	49	$0	$0	$0	$0	$0	$0	$281	$691	$972	$281	$691	$972
17	**Pad**	2,128	0	188	188	325C	39	$0	$0	$0	$0	$0	$0	$224	$553	$777	$224	$553	$777
18	**Crusher Wall**	992	0	264	5,280	325C	18	$0	$0	$0	$11,510	$0	$11,510	$140	$346	$486	$11,650	$346	$11,996
19	**Truck Wash**	1,320	0	146	146	325C	24	$0	$0	$0	$339	$0	$339	$140	$346	$486	$479	$346	$825
20	**Fuel Storage Pad**	714	0	118	118	325C	13	$0	$0	$0	$0	$0	$0	$140	$346	$486	$140	$346	$486
21	**UG Backfill Plant**	5,250	0	290	290	325C	97	$0	$0	$0	$632	$0	$632	$561	$1,383	$1,944	$1,193	$1,383	$2,576
22	**Guard House**	1,500	0	160	160	325C	28	$0	$0	$0	$349	$0	$349	$168	$415	$583	$517	$415	$932
23	**Water Tank**	1,600	0	160	160	325C	30	$0	$0	$0	$0	$0	$0	$182	$449	$631	$182	$449	$631
							1,388	**$0**	**$0**	**$0**	**$21,042**	**$0**	**$21,042**	**$8,219**	**$20,258**	**$28,477**	**$29,261**	**$20,258**	**$49,519**

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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
Building Demolition Cost	$0	$0	N/A	$0
Wall Demolition Cost	$21,042	$0	N/A	$21,042
Slab Demolition	$8,219	$20,258	N/A	$28,477
Subtotal Demolition	**$29,261**	**$20,258**	**$0**	**$49,519**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$7,903	$19,413	N/A	$27,316
Ripping/Scarifying Cost	$1,610	$5,175	N/A	$6,785
Subtotal Earthworks	**$9,513**	**$24,588**	**$0**	**$34,101**
Revegetation Cost	$2,300	$874	$827	$4,001
TOTALS	**$41,074**	**$45,720**	**$827**	**$87,621**

Building & Foundation - Foundation Cover and Growth Media Costs

		Foundation Cover								Growth Media								Total Cover & Growth Media Costs			
	Description (required)	Cover Volume cy	Cover Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $	Total Labor Cost $	Total Equipment Cost $	Total Costs $
1	**Administration Building**						$0	$0	$0	154	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
2	**Plant Offices**						$0	$0	$0	124	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
3	**Laboratory**						$0	$0	$0	74	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
4	**Plant Workshop and Warehouse**						$0	$0	$0	97	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
5	**Gold Room**						$0	$0	$0	106	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
6	**Elution Area**						$0	$0	$0	151	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
7	**Reagent Area**						$0	$0	$0	56	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
8	**Reagent Area**						$0	$0	$0	47	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
9	**Grinding Area**						$0	$0	$0	58	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
10	**CIL Area**						$0	$0	$0	375	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
11	**Water Service Area**						$0	$0	$0	68	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
12	**Truck Workhshop and Warehouse**						$0	$0	$0	256	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
13	**Mine Office**						$0	$0	$0	163	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
14	**Truck Scale**						$0	$0	$0	89	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
15	**Guard House**						$0	$0	$0	55	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
16	**Pad**						$0	$0	$0	68	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
17	**Pad**						$0	$0	$0	67	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
18	**Crusher Wall**						$0	$0	$0	3	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
19	**Truck Wash**						$0	$0	$0	50	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
20	**Fuel Storage Pad**						$0	$0	$0	26	725/966G/D7R	510	5	1	$349	$861	$1,210	$349	$861	$1,210
21	**UG Backfill Plant**						$0	$0	$0	194	725/966G/D7R	455	4	1	$308	$731	$1,039	$308	$731	$1,039
22	**Guard House**						$0	$0	$0	55	725/966G/D7R	415	2	1	$224	$470	$694	$224	$470	$694
23	**Water Tank**						$0	$0	$0	47	725/966G/D7R	553	6	1	$391	$992	$1,383	$391	$992	$1,383
							$0	**$0**	**$0**	2,383				23	**$7,903**	**$19,413**	**$27,316**	**$7,903**	**$19,413**	**$27,316**

Building & Foundation - Scarifying/Revegetation Costs

					Scarifying/Ripping			Revegetation				Total Scarify & Revegation Costs			
	Description (required)	Flat Area acres	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Costs $
1	**Administration Building**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
2	**Plant Offices**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
3	**Laboratory**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
4	**Plant Workshop and Warehouse**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
5	**Gold Room**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
6	**Elution Area**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
7	**Reagent Area**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
8	**Reagent Area**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
9	**Grinding Area**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
10	**CIL Area**	0.20	D9R	1	$70	$225	$295	$100	$38	$67	$205	$170	$263	$67	$500
11	**Water Service Area**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
12	**Truck Workhshop and Warehouse**	0.20	D9R	1	$70	$225	$295	$100	$38	$67	$205	$170	$263	$67	$500
13	**Mine Office**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
14	**Truck Scale**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
15	**Guard House**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
16	**Pad**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
17	**Pad**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
18	**Crusher Wall**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
19	**Truck Wash**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
20	**Fuel Storage Pad**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
21	**UG Backfill Plant**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
22	**Guard House**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
23	**Water Tank**	0.10	D9R	1	$70	$225	$295	$100	$38	$33	$171	$170	$263	$33	$466
		2.50		23	**$1,610**	**$5,175**	**$6,785**	**$2,300**	**$874**	**$827**	**$4,001**	**$3,910**	**$6,049**	**$827**	**$10,786**

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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Other Demoltion and Equipment Removal - Cost Summary

	Labor	Equipment	Materials	Totals
Other Demolition	$0	$0	$0	$0
Equipment Removal	$2,787	$4,720	$0	$7,507
TOTALS	**$2,787**	**$4,720**	**$0**	**$7,507**

Other Demolition

Facility Description

	Description (required)	ID Code	Type	Quantity	Units	Labor Unit Cost $	Equipment Unit Cost $	Material Unit Cost $	Total Cost $
						$0	**$0**	**$0**	

Notes:

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Other Demoltion and Equipment Removal - Cost Summary

	Labor	Equipment	Materials	Totals
Other Demolition	$0	$0	$0	$0
Equipment Removal	$2,787	$4,720	$0	$7,507
TOTALS	**$2,787**	**$4,720**	**$0**	**$7,507**

Equipment & Material Removal

	Facility Description								
	Description (required)	ID Code	Type	Quantity	Units	Labor Unit Cost ($)	Equipment Unit Cost ($)	Material Unit Cost ($)	Total Cost ($)
1	**Water Tank removal**	**WT01**	**Site Facilities - Mobile/Fixed Equi**	**6**	**Hours**	**$40.99**	**$39.79**		$485
2	**Waste Rock Storage Area - HDPE Liner Removal**	**WD01**	**Site Facilities**	**40**	**Hours**	**$40.99**	**$90.15**		$5,246
3	**Oil-Water Separator**		**Site Facilities - Mobile/Fixed Equi**	**8**	**Hours**	**$40.99**	**$39.79**		$646
4	**Generator removal (2)**		**Site Facilities - Mobile/Fixed Equi**	**8**	**Hours**	**$40.99**	**$39.79**		$646
5	**Fuel Tank removal**		**Site Facilities - Mobile/Fixed Equi**	**6**	**Hours**	**$40.99**	**$39.79**		$485
						$2,787	**$4,720**	**$0**	**$7,508**

Notes:

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Cost Estimate Type: Surety **Cost Basis: Northern Nevada**

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$6,546	$9,692	N/A	$16,238
Liner Installation	$107,419	$55,670	$41,556	$204,645
Sed Pond Cover	$1,846	$4,385	N/A	$6,231
Ripping/Scarifying Cost	$70	$103	N/A	$173
Subtotal Earthworks	**$115,881**	**$69,850**	**$41,556**	**$227,287**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$180	$68	$599	$847
Subtotal Revegetation	**$180**	**$68**	**$599**	**$847**
TOTALS	**$116,061**	**$69,918**	**$42,155**	**$228,134**

Diversion Ditches - User Input

			Diversions Ditches							Revegetation			Liner and Rip-Rap Installation			
	Description (required)	ID Code	Diversion Length ft	Diversion Depth ft	Ditch Bottom Width ft	Ditch Sideslope Angle _H:1V	Excavate Volume (if calculated elsewhere) cy	Excavating Material Condition (select)	Excavating Equipment Fleet (select)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Liner Area S.Y.	Liner Type (select)	Rip-Rap Area S.Y.	Rip-Rap Type (select type)

Notes:
the diversion channels, outlet structure, and sediment basins will remain post reclamation for stormwater control.
Diversion ditches at the Process Plant will be reclaimed during the ripping and recontouring of the main yard (Y01).

Sediment/Evaporation Pond Construction/Removal - User Input

			Sediment Ponds								Growth Media		
	Description (required)	ID Code	Pond Width ft	Pond/Berm Length ft	Berm Height ft	Crest Width ft	Sideslope Angle _H:1V	Final Area (if calculated elsewhere) acres	Regrade Volume (if calculated elsewhere) cy	Cover Volume (if calculated elsewhere) cy	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Pond to Borrow % grade
1	**Collection Pond**	**CP01**	**112**	**273**	**25.0**	**12.0**	**3.0**				**12**	**4,968**	**-1.2**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

the diversion channels, outlet structure, and sediment basins will remain post reclamation for stormwater control.

Sediment/Evaporation Pond Construction/Removal - User Input (cont.)

		Sediment Ponds				Growth Media			Revegetation			Ripping/Scarifying	
	Description (required)	Excavating Material Condition (select)	Material Type (select)	Excavating Equipment Fleet (select)	Liner Type (select)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)
1	**Collection Pond**	**1**	**Alluvium**	**Small**	**60 mil HDPE**	**Alluvium**	**Small Truck**		**Mix 2**	**None**	**None**	**Yes**	**Small Dozer**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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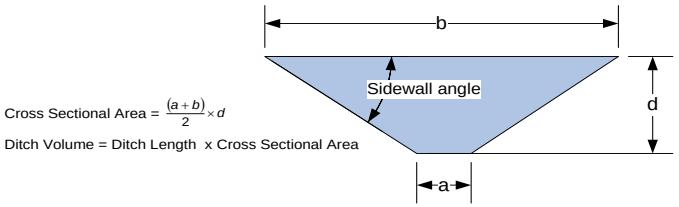
Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$6,546	$9,692	N/A	$16,238
Liner Installation	$107,419	$55,670	$41,556	$204,645
Sed Pond Cover	$1,846	$4,385	N/A	$6,231
Ripping/Scarifying Cost	$70	$103	N/A	$173
Subtotal Earthworks	**$115,881**	**$69,850**	**$41,556**	**$227,287**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$180	$68	$599	$847
Subtotal Revegetation	**$180**	**$68**	**$599**	**$847**
TOTALS	**$116,061**	**$69,918**	**$42,155**	**$228,134**

Drainage Control - Calculations

Diversion Ditch Volume Calculation



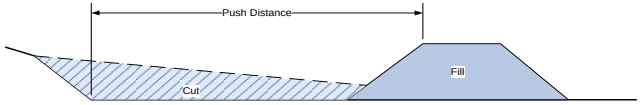
Cross Sectional Area = $\frac{(a+b)}{2} \times d$

Ditch Volume = Ditch Length x Cross Sectional Area

Figure 1 - Ditch Volume Calculation

1) Assume 20% swell for excavations
2) Assumes heavy duty trenching bucket is used

Sediment/Evaporation Pond Construction Calculation



Cut = Fill
Push distance = pond width up to 2/3 max push distance (400 ft)

Figure 2 - Sediment Ponds

1) Assume balanced cut-to-fill for berm construction
2) Include cost for liner, if required.
3) Include line items for removal, if necessary.
4) Assume 20% swell for excavations
5) Minimum 1 hr ripping/scarifying per area
6) Minimum 1 acre revegetation crew time per area

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Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$6,546	$9,692	N/A	$16,238
Liner Installation	$107,419	$55,670	$41,556	$204,645
Sed Pond Cover	$1,846	$4,385	N/A	$6,231
Ripping/Scarifying Cost	$70	$103	N/A	$173
Subtotal Earthworks	**$115,881**	**$69,850**	**$41,556**	**$227,287**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$180	$68	$599	$847
Subtotal Revegetation	**$180**	**$68**	**$599**	**$847**
TOTALS	**$116,061**	**$69,918**	**$42,155**	**$228,134**

Sediment/Evaporation Ponds - Construction/Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83)

	Description (required)	Regrading Volume cy	Sed/Evap Pond Equipment	Dozing Distance (see above) ft	Uncorrected Dozer Productivity LCY/hr	Grade Correction	Density Correction	Excavating Material	Corrected Productivity LCY/hr	Total Dozer Hours hr	Earthwork: Total Labor Cost $	Earthwork: Total Equipment Cost $	Earthwork: Total Constr/ Regrading Cost $	Liner: Total Labor Cost $	Liner: Total Equipment Cost $	Liner: Total Material Cost $	Liner: Total Liner Cost $
1	**Collection Pond**	26,390	D7R	112	574	1.00	0.79	1.00	282	94	$6,546	$9,692	$16,238	$107,419	$55,670	$41,556	$204,645
		26,390								94	**$6,546**	**$9,692**	**$16,238**	**$107,419**	**$55,670**	**$41,556**	**$204,645**

Sediment/Evaporation Ponds - Growth Media Costs

		Growth Media							
	Description (required)	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $
1	**Collection Pond**	2,904	725/966G/D7R	468	4	6	$1,846	$4,385	$6,231
		2,904				6	**$1,846**	**$4,385**	**$6,231**

Sediment/Evaporation Ponds - Revegetation Costs

	Description (required)	Surface Area acres	Long Ripping Distance ft	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Collection Pond**	1.80	273	D7R	1	$70	$103	$173	$180	$68	$599	$847
		1.80			1	**$70**	**$103**	**$173**	**$180**	**$68**	**$599**	**$847**

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Closure Cost Estimate
Process Ponds

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Process Ponds - Cost Summary

	Labor	Equipment	Materials	Totals
Backfilling Costs	$348	$516	N/A	$864
Growth Media Placement Costs	$224	$470	N/A	$694
Liner Cutting & Folding Costs	$4,580	$2,396	N/A	$6,976
Subtotal Earthworks	**$5,152**	**$3,382**	**$0**	**$8,534**
Revegetation Costs	$100	$38	$133	$271
TOTALS	**$5,252**	**$3,420**	**$133**	**$8,805**

Process Ponds - User Input

You must fill in ALL green cells and relevant blue cells in this section for each pond

	Facility Description		Pond Dimensions (1)					Backfill - (If trucks are used) (1)				Growth Media		
	Description (required)	ID Code	Pond Length ft	Pond Width ft	Pond Depth ft	Pond Sideslope Angle _H:1V	Disturbed Area (if calculated elsewhere) acres	Percent Backfill (100% if blank)	Distance from Backfill Borrow ft	Slope from Facility to Borrow Area % grade	Pond Volume (if calculated elsewhere) cy	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade
1	**Reclaim Pond**	**PP01**	**100**	**80**	**9.0**	**2.5**	**0.37**					**6**	**602**	**4%**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Reclaim pond will be converted to an E cell when no longer needed for solution management and will remain post mine.

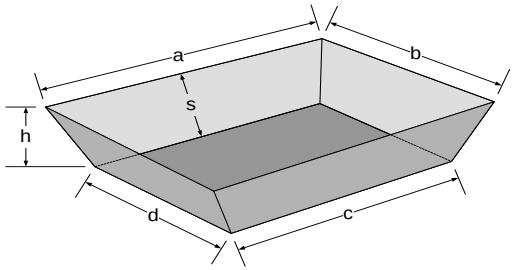
Process Ponds - User Input (cont.)

		Liner	Backfill			Growth Media			Revegetation		
	Description (required)	Crew Cut & Fold Time (2) hrs	Backfill Material Type (select)	Backfill Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)
1	**Reclaim Pond**	**30.0**	**Alluvium**	**Small Dozer**		**Alluvium**	**Small Truck**		**Mix 2**	**None**	**None**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table
(2) Pond liner removal crew (2Clab + excavator) = 2 General Laborers + 325C Excavator

Process Ponds - Calculations

Pond Volume Calculation



Area and Volume of the Frustrum of a Pyramid

$$\text{Surface Area} = ab + cd + (a+b+c+d) \times \frac{s}{2}$$

$$\text{Volume} = \frac{h\,(ab + cd + \sqrt{abcd}\,)}{3}$$

Revegetation Calculations

Minimum 1 acre revegetation crew time per area

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Revegetation Costs	$100	$38	$133	$271
TOTALS	**$5,252**	**$3,420**	**$133**	**$8,805**

Process Ponds - Liner Cutting and Folding

	Description (required)	Crew Hours hrs	Total Labor Cost $	Total Equipment Cost $	Total Liner Removal Cost $
1	**Reclaim Pond**	30	$4,580	$2,396	$6,976
		30	**$4,580**	**$2,396**	**$6,976**

Process Ponds - Backfill and Growth Media Costs

		Pond Backfill								Growth Media							
	Description (required)	Backfill Volume cy	Backfill Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours hrs	Total Labor Cost $	Total Equipment Cost $	Total Backfill Cost $	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Reclaim Pond**	1,539	D7R	308		5	$348	$516	$864	297	725/966G/D7R	427	2	1	$224	$470	$694
		1,539				5	**$348**	**$516**	**$864**	297				1	**$224**	**$470**	**$694**

Process Ponds - Revegetation Costs

	Description (required)	Surface Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Reclaim Pond**	0.40	$100	$38	$133	$271
		0.40	**$100**	**$38**	**$133**	**$271**

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Yards, Etc. - Cost Summary

	Labor	Equipment	Materials	Totals
Regrading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,860	$68,069	N/A	$96,929
Ripping/Scarifying Cost	$6,346	$20,451	N/A	$26,797
Subtotal Earthworks	**$35,206**	**$88,520**		**$123,726**
Revegetation Cost	$11,639	$4,423	$33,813	$49,875
TOTALS	**$46,845**	**$92,943**	**$33,813**	**$173,601**

Yards, Etc. - User Input

You must fill in ALL green cells and relevant blue cells in this section for each building or facility

	Facility Description			Physical			Cover			Growth Media		
	Description (required)	ID Code	Type	Area acres	Average Flat Area Long Dimension (ripping distance) ft	Regrade Volume (calculated elsewhere) cy	Cover Thickness in	Distance from Cover Borrow Area ft	Slope from Facility to Borrow Area % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade
1	Yard	Y01	Yard	5.02	1,128					12	4,918	-1.6
2	Substation	Y02	Yard	0.11	80					12	4,918	-1.6
3	Sanitation Field	Y03	Other Facilities	2.40	432					12	3,222	-1.9
4	Sanitation Field	Y04	Other Facilities	2.84	490					12	2,881	-1.7
5	UG Utilities	Y05	Yard	1.92	371					12	3,278	-3.7
6	Parking Lot	Y06	Yard	0.55	196					12	861	4.1
7	Parking Lot	Y07	Yard	0.11	81					12	667	5.2
8	Contractor Laydown Yard	Y08	Yard	4.93	755					12	1,525	-0.3
9	Contractor Office Laydown	Y09	Yard	0.65	262					12	7,753	-2.7
10	Helipad	Y10	Yard	0.17	120					12	2,417	-3.9
11	Weather Station	Y11	Yard	0.26	116					12	3,129	-2.4
12	Well Pad	Y12	Yard	0.19	119							
13	Vent Shaft #1 Pad	Y13	Yard	0.05	50					12	4,636	-4.1
14	Vent Shaft #2 Pad	Y14	Yard	0.06	50					12	6,206	-5.3
15	Water Tank Pad	Y15	Yard	0.09	40					12	4,823	-5.1
16	Explosive Magazine	Y16	Yard	0.03	40					12	5,200	-4.2
17	Well Pad	Y17	Yard	0.07	60							
18	Well Pad	Y18	Yard	0.08	60							
19	Well Pad	Y19	Yard	0.07	60							
20	Well Pad	Y20	Yard	0.08	60							
21	Well Pad	Y21	Yard	0.07	60							
22	Disturbed Area	DA01	Other Facilities	50.91	4,300							
23	Disturbed Area	DA02	Other Facilities	3.77	2,075							
24	Growth Media Stockpile	GM01	Other Facilities	11.62	1,108							
25	Growth Media Stockpile	GM02	Other Facilities	5.38	823							
26	Growth Media Stockpile	GM03	Other Facilities	1.21	271							
27	UG Backfill Aggregate Stockpile	SP01	Other Facilities	0.11	95					12	2,881	-3.7
28	ROM Stockpile	SP02	Other Facilities	0.18	152					12	4,918	-1.6
29	Waste Rock Dump Area	WD01	Other Facilities	8.39	861					12	1,917	0.0

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
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Yards, Etc. - Cost Summary

	Labor	Equipment	Materials	Totals
Regrading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,860	$68,069	N/A	$96,929
Ripping/Scarifying Cost	$6,346	$20,451	N/A	$26,797
Subtotal Earthworks	**$35,206**	**$88,520**		**$123,726**
Revegetation Cost	$11,639	$4,423	$33,813	$49,875
TOTALS	**$46,845**	**$92,943**	**$33,813**	**$173,601**

Yards, Etc. - User Input (cont.) You must fill in ALL green cells and relevant blue cells in this section for each building or facility

		Grading			Cover			Growth Media			Revegetation				
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Ripping Fleet (select)
1	Yard	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
2	Substation	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
3	Sanitation Field	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
4	Sanitation Field	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
5	UG Utilities	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
6	Parking Lot	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
7	Parking Lot	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
8	Contractor Laydown Yard	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
9	Contractor Office Laydown	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
10	Helipad	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
11	Weather Station	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
12	Well Pad	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
13	Vent Shaft #1 Pad	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
14	Vent Shaft #2 Pad	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
15	Water Tank Pad	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
16	Explosive Magazine	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
17	Well Pad	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
18	Well Pad	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
19	Well Pad	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
20	Well Pad	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
21	Well Pad	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
22	Disturbed Area	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
23	Disturbed Area	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
24	Growth Media Stockpile	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
25	Growth Media Stockpile	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
26	Growth Media Stockpile	1	Alluvium	Small							Mix 2	None	None	Yes	Med Dozer
27	UG Backfill Aggregate Stockpile	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
28	ROM Stockpile	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer
29	Waste Rock Dump Area	1	Alluvium	Small				Alluvium	Small Truck		Mix 2	None	None	Yes	Med Dozer

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Yards, Etc. - Cost Summary

	Labor	Equipment	Materials	Totals
Regrading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,860	$68,069	N/A	$96,929
Ripping/Scarifying Cost	$6,346	$20,451	N/A	$26,797
Subtotal Earthworks	**$35,206**	**$88,520**		**$123,726**
Revegetation Cost	$11,639	$4,423	$33,813	$49,875
TOTALS	**$46,845**	**$92,943**	**$33,813**	**$173,601**

Yards, Etc. - Calculations

Grading Calculations

Average push distance assumed to be 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Material assumed to be loose stockile (1.2 productivity factor)
Slope assumed to be 0 to 5% (1.0 productivity factor)

Cover Volume Calculation

Yard area x cover thickness

Ripping/Scarifying Calculations

Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr ripping/scarifying per area

Revegetation

Minimum 1 acre revegetation crew time per area

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TOTALS	**$46,845**	**$92,943**	**$33,813**	**$173,601**

Yards, Etc. - Cover and Growth Media Costs

		Cover								Growth Media							
	Description (required)	Cover Volume cy	Topsoil Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Yard**						$0	$0	$0	8,067	725/966G/D7R	510	5	16	$5,591	$13,780	$19,371
2	**Substation**						$0	$0	$0	161	725/966G/D7R	510	5	1	$349	$861	$1,210
3	**Sanitation Field**						$0	$0	$0	3,872	725/966G/D7R	501	4	8	$2,461	$5,846	$8,307
4	**Sanitation Field**						$0	$0	$0	4,517	725/966G/D7R	528	4	9	$2,768	$6,577	$9,345
5	**UG Utilities**						$0	$0	$0	3,065	725/966G/D7R	455	4	7	$2,153	$5,116	$7,269
6	**Parking Lot**						$0	$0	$0	807	725/966G/D7R	397	2	2	$448	$940	$1,388
7	**Parking Lot**						$0	$0	$0	161	725/966G/D7R	415	2	1	$224	$470	$694
8	**Contractor Laydown Yard**						$0	$0	$0	7,905	725/966G/D7R	533	3	15	$3,987	$9,005	$12,992
9	**Contractor Office Laydown**						$0	$0	$0	1,129	725/966G/D7R	552	7	2	$866	$2,244	$3,110
10	**Helipad**						$0	$0	$0	323	725/966G/D7R	528	4	1	$308	$731	$1,039
11	**Weather Station**						$0	$0	$0	484	725/966G/D7R	508	4	1	$308	$731	$1,039
12	**Well Pad**						$0	$0	$0						$0	$0	$0
13	**Vent Shaft #1 Pad**						$0	$0	$0	1	725/966G/D7R	469	5	1	$349	$861	$1,210
14	**Vent Shaft #2 Pad**						$0	$0	$0	161	725/966G/D7R	552	7	1	$433	$1,122	$1,555
15	**Water Tank Pad**						$0	$0	$0	161	725/966G/D7R	553	6	1	$391	$992	$1,383
16	**Explosive Magazine**						$0	$0	$0	1	725/966G/D7R	528	6	1	$391	$992	$1,383
17	**Well Pad**						$0	$0	$0						$0	$0	$0
18	**Well Pad**						$0	$0	$0						$0	$0	$0
19	**Well Pad**						$0	$0	$0						$0	$0	$0
20	**Well Pad**						$0	$0	$0						$0	$0	$0
21	**Well Pad**						$0	$0	$0						$0	$0	$0
22	**Disturbed Area**						$0	$0	$0						$0	$0	$0
23	**Disturbed Area**						$0	$0	$0						$0	$0	$0
24	**Growth Media Stockpile**						$0	$0	$0						$0	$0	$0
25	**Growth Media Stockpile**						$0	$0	$0						$0	$0	$0
26	**Growth Media Stockpile**						$0	$0	$0						$0	$0	$0
27	**UG Backfill Aggregate Stockpile**						$0	$0	$0	161	725/966G/D7R	485	4	1	$308	$731	$1,039
28	**ROM Stockpile**						$0	$0	$0	323	725/966G/D7R	510	5	1	$349	$861	$1,210
29	**Waste Rock Dump Area**						$0	$0	$0	13,552	725/966G/D7R	508	3	27	$7,176	$16,209	$23,385
							$0	**$0**	**$0**	44,851				96	**$28,860**	**$68,069**	**$96,929**

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Yards, Etc. - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Area Long Dimension ft	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Yard**	5.02	1,128	D9R	4	$279	$899	$1,178	$502	$191	$1,670	$2,363
2	**Substation**	0.11	80	D9R	1	$70	$225	$295	$100	$38	$37	$175
3	**Sanitation Field**	2.40	432	D9R	2	$139	$449	$588	$240	$91	$799	$1,130
4	**Sanitation Field**	2.84	490	D9R	2	$139	$449	$588	$284	$108	$945	$1,337
5	**UG Utilities**	1.92	371	D9R	1	$70	$225	$295	$192	$73	$639	$904
6	**Parking Lot**	0.55	196	D9R	1	$70	$225	$295	$100	$38	$183	$321
7	**Parking Lot**	0.11	81	D9R	1	$70	$225	$295	$100	$38	$37	$175
8	**Contractor Laydown Yard**	4.93	755	D9R	4	$279	$899	$1,178	$493	$187	$1,640	$2,320
9	**Contractor Office Laydown**	0.65	262	D9R	1	$70	$225	$295	$100	$38	$216	$354
10	**Helipad**	0.17	120	D9R	1	$70	$225	$295	$100	$38	$57	$195
11	**Weather Station**	0.26	116	D9R	1	$70	$225	$295	$100	$38	$87	$225
12	**Well Pad**	0.19	119	D9R	1	$70	$225	$295	$100	$38	$63	$201
13	**Vent Shaft #1 Pad**	0.10	50	D9R	1	$70	$225	$295	$100	$38	$33	$171
14	**Vent Shaft #2 Pad**	0.10	50	D9R	1	$70	$225	$295	$100	$38	$33	$171
15	**Water Tank Pad**	0.10	40	D9R	1	$70	$225	$295	$100	$38	$33	$171
16	**Explosive Magazine**	0.10	40	D9R	1	$70	$225	$295	$100	$38	$33	$171
17	**Well Pad**	0.10	60	D9R	1	$70	$225	$295	$100	$38	$33	$171
18	**Well Pad**	0.10	60	D9R	1	$70	$225	$295	$100	$38	$33	$171
19	**Well Pad**	0.10	60	D9R	1	$70	$225	$295	$100	$38	$33	$171
20	**Well Pad**	0.10	60	D9R	1	$70	$225	$295	$100	$38	$33	$171
21	**Well Pad**	0.10	60	D9R	1	$70	$225	$295	$100	$38	$33	$171
22	**Disturbed Area**	50.91	4,300	D9R	37	$2,577	$8,312	$10,889	$5,091	$1,935	$16,940	$23,966
23	**Disturbed Area**	3.77	2,075	D9R	3	$209	$674	$883	$377	$143	$1,254	$1,774
24	**Growth Media Stockpile**	11.62	1,108	D9R	9	$627	$2,022	$2,649	$1,162	$442	$3,867	$5,471
25	**Growth Media Stockpile**	5.38	823	D9R	4	$279	$899	$1,178	$538	$204	$1,790	$2,532
26	**Growth Media Stockpile**	1.21	271	D9R	1	$70	$225	$295	$121	$46	$403	$570
27	**UG Backfill Aggregate Stockpile**	0.11	95	D9R	1	$70	$225	$295	$100	$38	$37	$175
28	**ROM Stockpile**	0.18	152	D9R	1	$70	$225	$295	$100	$38	$60	$198
29	**Waste Rock Dump Area**	8.39	861	D9R	6	$418	$1,348	$1,766	$839	$319	$2,792	$3,950
		101.62			91	**$6,346**	**$20,451**	**$26,797**	**$11,639**	**$4,423**	**$33,813**	**$49,875**

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Closure Cost Estimate
Waste Disposal

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$1,131
Hazardous Materials				$5,317
Hydrocarbon Contaminated Soils	$0	$0	$4,498	$4,498
TOTALS	**$0**	**$0**	**$4,498**	**$10,946**

Waste Disposal - User Input - Solid Waste

	Description (required)	ID Code	Waste Type (select)	Disposal Method (select)	Quantity cy	Landfill (Bulk) Disposal: Distance to Landfill ft	Landfill (Bulk) Disposal: Slope to Landfill % grade	Landfill (Bulk) Disposal: Number of Trucks (user override)	Dumpster: Months Dumpster Rental months
1	**Misc. Site Clean-Up**		**Waste Mgmt & Disposal**	**Dumpster**	**5**				**5**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Waste Disposal - User Input - Hazardous Materials

	Description (required)	ID Code	Waste Type (select)	Container Type (select)	Vacuum Truck Size (select)	Liquid Quantity gallons	Soild Quantity cy	One Way Travel Distance to Disposal Site mi	One Way Travel Time to Disposal Site hr
1	**Misc. Solid Hazardous Waste**		**Waste Mgmt & Disposal**	**Solid Bulk**			**5**	**250**	**5.0**
2	**Misc. Liquid Hazardous Waste**		**Waste Mgmt & Disposal**	**Liquid Bulk**	**Small (2,200 gal)**			**250**	**5.0**

Notes:
1. Use Other Demo & Equip Removal Sheet for tank removal

Waste Disposal - User Input - Hydrocarbon Contaminated Soils

	Description (required)	ID Code	Waste Type (select)	Disposal Method (select)	Quantity cy	Travel Distance to Offsite Disposal mi
1	**Misc. Hydrocarbon Contaminated Soils**		**Waste Mgmt & Disposal**	**Off site**	**5**	**250**

Notes:
1. Use Yards or Landfills Sheets for bioremediation facility reclamation

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Closure Cost Estimate
Waste Disposal

Project Name: Grassy Mountain Mine - Reclamation Plan
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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$1,131
Hazardous Materials				$5,317
Hydrocarbon Contaminated Soils	$0	$0	$4,498	$4,498
TOTALS	**$0**	**$0**	**$4,498**	**$10,946**

Waste Disposal - Assumptions & Calculations

Solid Waste Disposal

Off site disposal assumes use of average rolloff dumpster [30 cy (m3), 10 ton (tonne)]
On site disposal assumes use of small loader/truck fleet for haulage
Average density for on site disposal = 2,600 lb/cy (1,540 kg/m3)
For on site disposal only 1 truck is required unless total truck hours > 8, only 2 trucks unless total truck hours are > 16

Hazardous Materials Disposal

Assumes all hazardous materials are known
Enter EITHER solid or liquid quantity each line.
If container type = 55 gallon (200 liter) drum then solid waste hauling costs apply
Average density for solids assumed to be 2,600 lb/cy (1,540 kg/m3)
Vacuum truck sizes: small = 2,200 gal (~8,300 litres), large = 5,000 gal (~19,000 litres)
Vacuum truck on site for 4 hours for each load

Hydrocarbon Contaminated Soils Disposal

Assumes all hazardous materials are known
On site disposal assumes biopad treatment
Exavation productivity =45 cy./hr (35 m3/hr) (Means Heavy Construction, 2006: 02315-424-0360)

Waste Disposal - Solid Waste Disposal

	Description (required)	Waste Volume cy	Number of Off Site Dumpster Loads	Landfill Fleet Equipment	Landfill Fleet Productivity LCY/hr	Number of Trucks	Total Fleet Hours	Total Dumpster Cost $	Total Labor Cost $	Total Equipment Cost $	Total Waste Disposal Cost $
1	**Misc. Site Clean-Up**	5	1					$1,131	$0	$0	$0
		5						**$1,131**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Waste Disposal

Project Name: Grassy Mountain Mine - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$1,131
Hazardous Materials				$5,317
Hydrocarbon Contaminated Soils	$0	$0	$4,498	$4,498
TOTALS	**$0**	**$0**	**$4,498**	**$10,946**

Waste Disposal - Hazardous Materials Disposal

	Description (required)	Liquid Waste Volume gallons	Solid Waste Volume cy	Number of Truck Loads	Tons of Waste Tons	Pick-up Fees $	Transport Fees $	Disposal Fees $	Total Hazardous Material Cost $
1	**Misc. Solid Hazardous Waste**		5	1	7	$2,766	$611	$1,940	$5,317
2	**Misc. Liquid Hazardous Waste**	Enter Quantity!		**Enter Quantity!**	0	$0	$0	$0	$0
			5		7	**$2,766**	**$611**	**$1,940**	**$5,317**

Waste Disposal - Hydrocarbon Contaminated Soils

	Description (required)	Quantity cy	Disposal Equipment Fleet	Total Fleet Hours	Treatment Cost $	Transport Fees $	Disposal Fees $	Total Labor Cost $	Total Equipment Cost $	Total Waste Disposal Cost $
1	**Misc. Hydrocarbon Contaminated Soils**	5	Road Trucks	0	$0	$3,055	$1,443	$0	$0	$4,498
		5			**$0**	**$3,055**	**$1,443**	**$0**	**$0**	**$4,498**

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Closure Cost Estimate
Well Abandonment

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Well Abandonment

	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$7,144	$19,032	$1,936	$28,112
Monitoring Wells	$0	$0	$0	$0
TOTALS	**$7,144**	**$19,032**	**$1,936**	**$28,112**

Production, Dewatering and Infiltration Well Closure

	Description (required)	ID Code	Number of Holes	Casing Diam in	Average Depth[1] ft bgs	Depth to First Water ft bgs	Original Static Water Level ft bgs	Top of Slotted Casing[2] ft bgs	Blank Casing Below Top of Screen[2] ft	Type of Pump (if any) (select)	Depth to Pump ft bgs	Hole Plug Method (select)	Casing Volume per ft cf	Perforation Length[3,4] ft	Grout Volume per Hole[4,5] cy	Cement Volume per Hole[6] cy	Inert Media Volume per Hole[7] cy	Pump Removal Labor Cost $	Pump Removal Equip Cost $	Perf Labor Cost $	Perf Equip Cost[8] $	Grout + Cement Labor Cost[9] $	Grout + Cement Equip Cost[9] $	Grout + Cement Material Cost $	Inert Media Labor Cost[10] $	Inert Media Equip Cost[9] $	Total Cost $
1	**Production Well 4**	**W-W4**	**1**	**10.0**	**500**	**270**		**270**	**140**			**Grout + Ba**	0.550	190	11.40	0.40	3.50	$0	$0	$883	$2,716	$791	$2,009	$484	$112	$33	$7,028
2	**Production Well 5**	**W-W5**	**1**	**10.0**	**500**	**270**		**270**	**140**			**Grout + Ba**	0.550	190	11.40	0.40	3.50	$0	$0	$883	$2,716	$791	$2,009	$484	$112	$33	$7,028
3	**Production Well 6 (Alt)**	**W-W6**	**1**	**10.0**	**500**	**270**		**270**	**140**			**Grout + Ba**	0.550	190	11.40	0.40	3.50	$0	$0	$883	$2,716	$791	$2,009	$484	$112	$33	$7,028
4	**Production Well 7 (Alt)**	**W-W7**	**1**	**10.0**	**500**	**270**		**270**	**140**			**Grout + Ba**	0.550	190	11.40	0.40	3.50	$0	$0	$883	$2,716	$791	$2,009	$484	$112	$33	$7,028
																		$0	**$0**	**$3,532**	**$10,864**	**$3,164**	**$8,036**	**$1,936**	**$448**	**$132**	**$28,112**

(1) For previously abandoned holes enter "0" for depth
(2) Wells abandoned per Nevada Administrative Code (NAC 534.420). Hole grouted and perforated from bottom to 50 feet (15.24m) above the top of the screen, or first water encountered or original static water level, depending on vertical hydraulic gradient and well construction parameters. Inert media (cuttings or alluvium) used from top of grout to top seal.
(3) Perforation length = amount of blank casing below first water (for confined aquifers) or predicted recovered water table (unconfined aquifers) + 50 feet (15.24m) of blank casing above water table
(4) Assumes 50' (15.24m) sanitary seal at top of hole. Therefore, perforation and grouting only required to bottom of sanitary seal.
(5) Assumes 100% loss to formation for grout (abandonite) for screened and perforated sections.
(6) Assumes 20' (6m) top seal of cement in casing only. See note 4.
(7) Inert material is cuttings or alluvium sourced locally.
(8) Includes perforation tool wear cost/ft of perforation (see Productivty Sheet).
(9) See Productivity Sheet for hourly production. Minimum 1 hr per hole + fixed hours per hole for move and setup. If no perforation required, use standard drill rig.
(10) See Productivity Sheet for hourly production. Minimum 1 hr per hole.

Notes:
Wells 2 and 3 are pre-existing wells and will remain post-mine.
Wells 4-7 have not been drill yet. Numbers are from the conceptual designs.

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Closure Cost Estimate
Well Abandonment

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Well Abandonment

	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$7,144	$19,032	$1,936	$28,112
Monitoring Wells	$0	$0	$0	$0
TOTALS	**$7,144**	**$19,032**	**$1,936**	**$28,112**

Monitoring Well Closure

	Description (required)	ID Code	Number of Holes	Casing Diam in	Average Depth ft bgs	Top of Screen[1] ft bgs	Hole Plug Method (select)	Casing Volume per ft ft3	Grout Volume/ Well[2,3] cy	Cement Volume per Hole[4] cy	Inert Backfill Volume per Hole[5] cy	Total Grouting Hours/ Hole hr	Total Inert Media Hours/ Hole hr	Grout + Cement Labor Cost[6] $	Grout + Cement Equip Cost[6] $	Grout + Cement Material Cost $	Inert Material Labor Cost[7] $	Inert Material Equip Cost[7] $	Total Cost $
														$0	**$0**	**$0**	**$0**	**$0**	**$0**

Wells abandoned per NAC 534.420 with bentonite grout placed to 50 feet above the top of the screen (see note 1).
(1) Assumes top of screen is at or above the static water level (in unconfined aquifers) or the depth of first water encountered (in confined aquifers).
(2) Assumes 25% loss to formation for grouting
(3) Grouting only required to 50' (15.24m) above the top of screen because monitor wells are constructed with a seal in the annular space.
(4) Assumes top 20' (6m) plugged with cement.
(5) Assumes hole plugged with inert material (cuttings or alluvium) above grout up to cement surface plug.
(6) See Productivity Sheet for hourly production. Minimum 1 hr per hole + fixed hours per hole for move and setup (see Productivty Sheet).
(7) See Productivity Sheet for hourly production. Minimum 1 hr per hole.

Notes:

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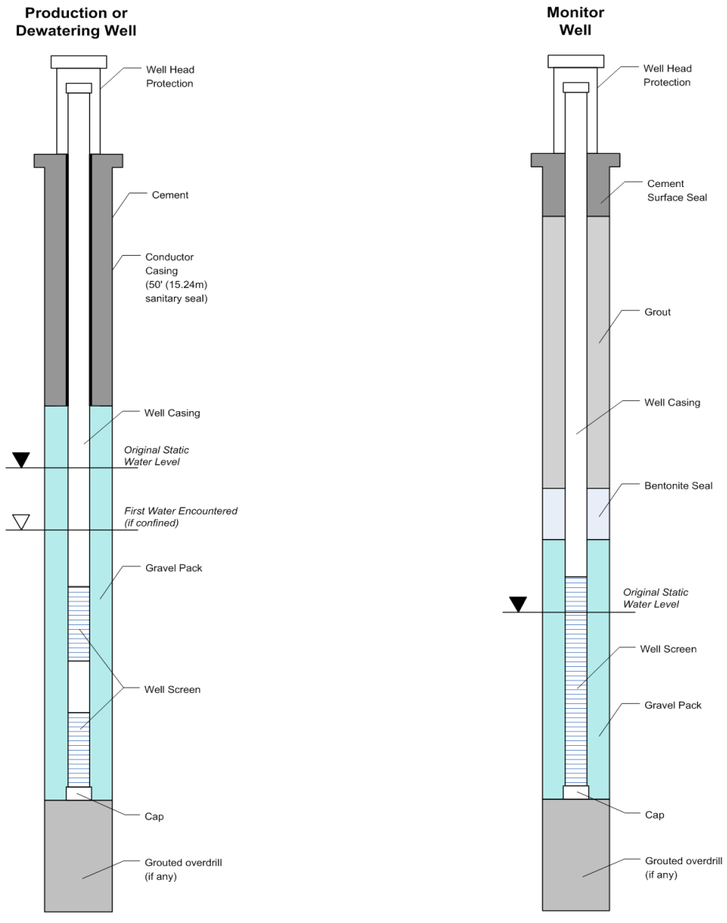
Well Abandonment

	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$7,144	$19,032	$1,936	$28,112
Monitoring Wells	$0	$0	$0	$0
TOTALS	**$7,144**	**$19,032**	**$1,936**	**$28,112**

Well Construction



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Closure Cost Estimate
Misc. Costs

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$41,588	$15,286	N/A	$56,874
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$1,132	$398	N/A	$1,530
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$57,342	N/A	N/A	$57,342
Substations/Transformers	$56,086	N/A	N/A	$56,086
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$156,148**	**$15,684**	**$0**	**$171,832**

Fence Removal — You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Length ft	Input: Type (select type)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Total Cost $
1	**Project Perimeter Fence**	**F01**	**22,480**	**Barbed 4-strand**	$41,588	$15,286	$56,874
					$41,588	**$15,286**	**$56,874**

Notes:

Fence Installation — You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Length ft	Input: Type (select type)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Material Cost ($)	Costs: Total Cost $
					$0	**$0**	**$0**	**$0**

Notes:

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Project Name: Grassy Mountain Mine - Reclamation Plan
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Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$41,588	$15,286	N/A	$56,874
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$1,132	$398	N/A	$1,530
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$57,342	N/A	N/A	$57,342
Substations/Transformers	$56,086	N/A	N/A	$56,086
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$156,148**	**$15,684**	**$0**	**$171,832**

Culvert & Buried Pipe Removal

You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Length ft	Input: Type (select type)	Input: Location (select)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Total Cost $
1	**Culvert 5**	**C05**	**24**	**24 in (600 mm) Di**	**On site**	$243	$85	$328
2	**Culvert 6**	**C06**	**58**	**24 in (600 mm) Di**	**On site**	$586	$206	$792
3	**Culvert 7**	**C07**	**30**	**24 in (600 mm) Di**	**On site**	$303	$107	$410
						$1,132	**$398**	**$1,530**

Notes: **All water supply and infrastructure pad pipelines are 18-inches deep and will be capped and abandoned in place.**
Culverts 1-4 will be left in place for stormwater control.

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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$41,588	$15,286	N/A	$56,874
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$1,132	$398	N/A	$1,530
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$57,342	N/A	N/A	$57,342
Substations/Transformers	$56,086	N/A	N/A	$56,086
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$156,148**	**$15,684**	**$0**	**$171,832**

Surface Pipe Removal

You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Length ft	Input: Type (select type)	Input: Location (select)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Total Cost $
						$0	**$0**	**$0**

Notes:

Power Line and Substation Removal

You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Power Line Length miles	Input: Power Line Type (select)	Input: Number of Substations #	Input: Location (select)	Costs: Power Line Removal $	Costs: Substation Removal $	Costs: Total Cost $	Cost Breakdown: Labor Cost $	Cost Breakdown: Equipment Cost $
1	**Power Line 1**	**PL01**	**0.20642**	**Single Pole**	**1**	**On-site**	$9,184	$56,086	$65,270	$13,054	$52,216
2	**Power Line 2**	**PL02**	**0.424266**	**Single Pole**		**On-site**	$18,877	$0	$18,877	$3,775	$15,102
3	**Power Line 3**	**PL03**	**0.082453**	**Single Pole**		**On-site**	$3,669	$0	$3,669	$734	$2,935
4	**Power Line 4**	**PL04**	**0.575619**	**Single Pole**		**On-site**	$25,612	$0	$25,612	$5,122	$20,490
							$57,342	**$56,086**	**$113,428**	**$22,685**	**$90,743**

Notes: If substation owned by operator, use Other Demo & Equipment Removal sheet
User may need to add line items in Foundations & Buildings for substation slab demolition and fence removal
Labor/Equipment costs assume approximately 80% of cost are equipment and 20% are labor related costs
On-site Powerlines from one Substartion

Rip-Rap & Rock Lining

You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Area S.Y.	Input: Type (select type)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Material Cost $	Costs: Total Cost $
					$0	**$0**	**$0**	**$0**

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Cost Data: User Data
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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Reclamation Monitoring & Maintenance - Cost Summary

	Labor	Equipment	Lab & Materials	Totals
Revegetation Maintenance	$2,984	$1,134	$9,929	$14,047
Erosion Maintenance	$0	$0	N/A	$0
Reclamation Monitoring	$16,260	$1,449	N/A	$17,709
Subtotal Reclamation Monitoring	**$19,244**	**$2,583**	**$9,929**	**$31,756**
Water Quality Monitoring	$0	$0	$0	$0
TOTAL MONITORING	**$19,244**	**$2,583**	**$9,929**	**$31,756**

Reclamation Maintenance

Description	Total Revegetation Surface Area (1,2) acres	% Area Requiring Reseeding	Seed Mix (select)	Area Requiring Reseeding acres	Seed $/acres	Labor $/acres	Equipment $/acres	Totals $
Revegetation Maintenance	298	**10%**	**Mix 2**	29.8	$332.75	$100.00	$38.00	
Labor								$2,984
Equipment								$1,134
Materials								$9,929
Cost/Acre								$471
							Subtotal	**$14,047**

Notes: 1) Surface area is NOT the same as footprint disturbance area typically used for permitting purposes.

	Total Volume Growth Media cy	% Volume Requiring Maintenance	Average Growth Media Placement Cost $/CY	Volume Requiring Replacement cy		Labor (assume: 25%) $/acres	Equipment (assume: 75%) $/acres	Total $
Erosion Maintenance	430,937		$1.84	0		$0.00	$0.00	$0

Notes:

Reclamation Monitoring

Description	Hrs/Day	Days/Year	Number of Years	Rate $/hr		
Field Work						
Field Geologist/Engineer	**8**	**2**	**3**	$169.38		$8,130
Range Scientist				$155.34		$0
Reporting						
Field Geologist/Engineer	**8**	**2**	**3**	$169.38		$8,130
Range Scientist				$155.34		$0
					Subtotal	**$16,260**
Travel						
	Hrs/Trip hr	**Trips/Year**	**Years**	**Truck Cost** $/hr		
Travel	**8**	**2**	**3**	$30.19		$1,449
					Subtotal	**$1,449**
					Total Reclamation Monitoring	**$17,709**

Notes:

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Closure Cost Estimate
Constr. Mgmt

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671I.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
Cost Estimate Type: Surety Cost Basis: Northern Nevada

Construction Management & Road Maintenance - Cost Summary				
	Labor	Equipment	Materials	Totals
Construction Management	$32,000	$6,109	N/A	$38,109
Construction Support		$3,542		$3,542
Road Maintenance	$9,000	$12,425	$0	$21,425
TOTAL CONSTRUCTION MANAGEMENT	**$41,000**	**$22,076**	**$0**	**$63,076**

Construction Management

Construction Management Staff

Description	Duration mo.	Hours/ Month hr.	Number of Supervisors	Supervisor Rate $/hr	Labor Cost $	Equipment Cost[1] $	Totals $
Active Reclamation	**2**	**160**	**1**	$100.00	$32,000	$6,109	$38,109
Monitoring & Maintenance					$0	$0	$0
				Total Staff	**$32,000**	**$6,109**	**$38,109**

Construction Management Support

Description	Duration mo.	Number of Units		Rental Rate $/mo	Generator Cost $/mo	Equipment Cost[1] $	Totals $
Temporary Office Rental	**2**	**1**		$213	$1,342	$3,111	$3,111
Temporary Toilets	**2**	**1**		$216		$432	$432
					Total Support	**$3,542**	**$3,542**

Notes: Office rental assumes only 1 generator required for every 4 trailers

Total Construction Management **$41,651**

Road Maintenance

Description	Fleet Size (select)	Number	Duration mo.	Hours/ Month hr.	Labor Cost $	Equipment Cost $	Totals $
Active Reclamation							
Water Truck	**Small**	**1**	**2**	**40**	$3,346	$5,159	$8,505
Grader	**Small**	**1**	**2**	**40**	$5,654	$7,266	$12,920
Monitoring & Maintenance							
Water Truck					$0	$0	$0
Grader					$0	$0	$0

Description	Gallons/ Day	Days/ Month	Duration mo.	Cost/ Gallon $			Totals $
Water Fees							
Water Fees							$0
				Total Project Maintenance	**$9,000**	**$12,425**	**$21,425**

Notes: 1) Supervisor equipment = pickup truck
Water truck and grader are assumed to be active 25% of time during reclamation

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Closure Cost Estimate
Labor Rates

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
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Model Version: Version 1.4.1
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Cost Estimate Type: Surety Cost Basis: Northern Nevada

Color Code Key	
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User Input - Pull Down List	Pull Down Selection
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ZONE ADJUSTMENTS		
Cost Basis/Project Region	Northern Nevada	Churchill, Douglas, Elko, Eureka, Humboldt, Lander, Lyon, Mineral, Pershing, Storey, Washoe, and White Pine Counties
Power Equipment Operators	50-150 miles	$0.00
Truck Drivers	50-150 miles	$0.00
Laborers	50-150 miles	$0.00

INDIRECT COSTS	
Unemployment (%)	3.00%
Retirement/SS/Medicare (%)	7.65%
Workman's Compensation (%)	8.90%
Other Indirects	
State Payroll Tax (13),(15),(17),(	
Total Other Indirects	**0.00%**

HOURLY LABOR RATE TABLE

EQUIPMENT TYPE (1) OR JOB DESCRIPTION	Labor Group	Base Rate ($/hr)	Zone Adjustment ($/hr)	Hourly Wage ($/hr)	Fringe ($/hr)	Retirement/ Medicare ($/hr)	Unemployment Insurance ($/hr)	Workman's Compensation ($/hr)	Other Indirect Costs ($/hr)	Total ($/hr)
Equipment Operators ($/hr) (2)										
Bulldozers										
D6R		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
D6R w/ Winch					$24.80					
D7R		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
D8R		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
D9R		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
D10R		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
D11R		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
Wheeled Dozers										
824G					$24.80					
834G					$24.80					
844					$24.80					
854G					$24.80					
Motor Graders										
120H		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
14G/H		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
16G/H		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
24M					$24.80					
Track Excavators										
312C		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
320C		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
325C		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
330C		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
345B		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
365BL					$24.80					
385BL		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
Scrapers										
631G		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
637G		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
Wheeled Loaders										
924G		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
928G		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
950G		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
966G		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
972G		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
980G		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
988G		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
990					$24.80					
992G		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
994D					$24.80					
L2350					$24.80					
Shovels										
PC2000					$24.80					
PC3000					$24.80					
PC4000					$24.80					
PC5500					$24.80					
PC8000					$24.80					
Hydraulic Hammers										
H-120 (fits 325)										
H-160 (fits 345)										
H-180 (fits 365/385)										
Demolition Shears										
S340 (fits 322/325/330)										
S365 (fits 330/345)										
S390 (fits 365/385)										
Demolition Grapples										
G315 (fits 322/325)										
G320 (fits 325/330)										
G330 (fits 345/365)										

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Closure Cost Estimate
Labor Rates

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
File Name: 3671l.GrassyMtn Plan.RCE.V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_Data_File_1_12_Std_2019.xlsm
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ZONE ADJUSTMENTS			
Cost Basis/Project Region	Northern Nevada	Churchill, Douglas, Elko, Eureka, Humboldt, Lander, Lyon, Mineral, Pershing, Storey, Washoe, and White Pine Counties	
Power Equipment Operators	50-150 miles	$0.00	
Truck Drivers	50-150 miles	$0.00	
Laborers	50-150 miles	$0.00	

INDIRECT COSTS	
Unemployment (%)	3.00%
Retirement/SS/Medicare (%)	7.65%
Workman's Compensation (%)	8.90%
Other Indirects	
State Payroll Tax (13),(15),(17),(	
Total Other Indirects	**0.00%**

HOURLY LABOR RATE TABLE

Other Equipment										
420D 4WD Backhoe		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
428D 4WD Backhoe		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
CS533E Vibratory Roller		$36.92	$0.00	$36.92	$24.80	$1.11	$2.82	$3.29	$0.00	$68.94
CS633E Vibratory Roller					$24.80					
CP533E Sheepsfoot Compactor					$24.80					
CP633E Sheepsfoot Compactor					$24.80					
Light Truck - 1.5 Ton					$24.80					
Supervisor's Truck					$24.80					
Flatbed Truck					$24.80					
Air Compressor + tools		$35.46	$0.00	$35.46	$24.80	$1.06	$2.71	$3.16	$0.00	$67.19
Welding Equipment		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
Heavy Duty Drill Rig		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
Pump (plugging) Drill Rig		$37.51	$0.00	$37.51	$24.80	$1.13	$2.87	$3.34	$0.00	$69.64
Concrete Pump					$24.80					
Gas Engine Vibrator		$36.92	$0.00	$36.92	$24.80	$1.11	$2.82	$3.29	$0.00	$68.94
Generator 5KW					$24.80					
HDEP Welder (pipe or liner)					$24.80					
5 Ton Crane		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
20 Ton Crane		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
50 Ton Crane		$38.37	$0.00	$38.37	$24.80	$1.15	$2.94	$3.41	$0.00	$70.67
120 Ton Crane					$24.80					

NOTES:

(1) Equipment Type:	Catepillar model or equivalent, LeTourneau
(2) Equipment Operator Source:	D-B NV20190002 7/5/2019
(3) Zone Basis:	From Washoe Co. Courthouse

Truck Drivers ($/hr) (4)										
725	ruck Driver > 25 yds	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
730	ruck Driver > 25 yds	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
735	ruck Driver > 25 yds	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
740	ruck Driver > 25 yds	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
769D	ruck Driver > 25 yds	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
773E					$4.16					
777D	ruck Driver > 60 yds	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
785C					$4.16					
793C					$4.16					
797B					$4.16					
613E (5,000 gal) Water Wagon	ter Truck > 2,500 gal	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
621E (8,000 gal) Water Wagon	ter Truck > 2,500 gal	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82
777D Water Truck					$4.16					
785C Water Truck					$4.16					
Dump Truck (10-12 yd3)	Truck Driver > 8 yds <	$31.50	$0.00	$31.50	$4.16	$0.95	$2.41	$2.80	$0.00	$41.82

NOTES:

(4) Truck Driver Source:	D-B SUNV2014-014 9/8/2016
(5) Zone Basis:	From Washoe Co. Courthouse

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Closure Cost Estimate
Labor Rates

Project Name: Grassy Mountain Mine - Reclamation Plan
Date of Submittal: November 2019
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ZONE ADJUSTMENTS			
Cost Basis/Project Region	**Northern Nevada**	Churchill, Douglas, Elko, Eureka, Humboldt, Lander, Lyon, Mineral, Pershing, Storey, Washoe, and White Pine Counties	
Power Equipment Operators	**50-150 miles**	$0.00	
Truck Drivers	**50-150 miles**	$0.00	
Laborers	**50-150 miles**	$0.00	
INDIRECT COSTS			
Unemployment (%)	3.00%		
Retirement/SS/Medicare (%)	7.65%		
Workman's Compensation (%)	8.90%		
Other Indirects			
State Payroll Tax (13),(15),(17),(			
Total Other Indirects	**0.00%**		

HOURLY LABOR RATE TABLE

Laborers ($/hr) (6,7)

General Laborer	Group 1	$25.45	$0.00	$25.45	$10.56	$0.76	$1.95	$2.27	$0.00	$40.99
Skilled Laborer	Group 4	$25.95	$0.00	$25.95	$10.56	$0.78	$1.99	$2.31	$0.00	$41.58
Driller's Helper	Group 3	$25.70	$0.00	$25.70	$10.56	$0.77	$1.97	$2.29	$0.00	$41.28
Rodmen (reinforcing concrete)	Group 1	$25.45	$0.00	$25.45	$10.56	$0.76	$1.95	$2.27	$0.00	$40.99
Cement finisher	Group 3	$25.70	$0.00	$25.70	$10.56	$0.77	$1.97	$2.29	$0.00	$41.28
Carpenter		$38.73	$0.00	$38.73	$14.29	$1.16	$2.96	$3.45	$0.00	$60.59

NOTES:

(6) Laborer Source:	D-B SUNV2011-005 10/1/2010
(7) Carpenter Source:	D-B Projected from Southern Nevada
(8) Zone Basis:	From Washoe Co. Courthouse

Project Management and Technical Labor ($/hr) (9)

Project Manager		$74.81		$74.81	$10.56	$2.24	$5.72	$6.66	$0.00	$100.00
Foreman		$69.19		$69.19	$10.56	$2.08	$5.29	$6.16	$0.00	$93.27
Field Geologist/Engineer		$132.85		$132.85	$10.56	$3.99	$10.16	$11.82	$0.00	$169.38
Field Tech/Sampler		$108.45		$108.45	$10.56	$3.25	$8.30	$9.65	$0.00	$140.21
Range Scientist		$121.10		$121.10	$10.56	$3.63	$9.26	$10.78	$0.00	$155.34
Senior Planning Engineer					$10.56					
Project Engineer					$10.56					
Mechanic/Fitter					$10.56					
					$10.56					
					$10.56					
					$10.56					
					$10.56					

NOTES:

(9) Project Manager:	R.S.Means 2019 Q2 (01 31 1320 0200 Total Incl.O&P-10%) Adjusted for Elko, NV
(9) Foreman Source:	R.S.Means 2019 Q2 (01 31 1320 0200 Total Incl.O&P-10%) Adjusted for Elko, NV
(9) Techical Labor Source:	SRK Consulting 2019 (Total Incl. O&P-10%) Adjusted for Zone,Tax and Ins.
Other Labor Source:	
Other Labor Source:	
†Additional User Markups	
(These are added by the user to the	
base rate to account for site-specific	
conditions or corporate requirements)	

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Closure Cost Estimate
User 1

PROCESS FLUID STABILIZATION - Phase III

LABOR REQUIREMENTS

SITE Phase III Duration (months) | 0

Site Workers	# per shift	hrs. per shift	shifts per day	days per wk.	hrs. per wk.	hrs. per mo.	total hrs.	rate per hr.*	**Totals**
General Laborers	2	12	1	5	120	520.00	1,040	$43.35	$45,084
Security Personnel	0	12	0	7	0	0.00	0	$43.05	$0
Electrician/Welder	1	8	1	2	16	69.33	69	$71.60	$4,964
On-Site Supervisor	0	8	0	2	0	0.00	0	$82.72	$0

* Frpm PFCE IFM tab, Labor Req.

TOTAL LABOR $50,048

EQUIPMENT REQUIREMENTS

Support Equipment Rentals	# of each	# of mo.	rental rate per mo.	operating hrs per mo*	operating cost per hr.	total cost per mo.	
Backhoe (CAT 420D)	1	60	$2,650	35.2	$20.51	$3,372	$202,316
Generator (5 KW)	0	0	$712	35.2	$2.63	$804	$0
Pickup Truck	2	100	$2,592	35.2	$6.18	$2,809	$561,857
Motor Grader (CAT 14G) - if required for snow removal	1	60	$13,500	35.2	$42.01	$14,979	$898,732
Welding Equipment	1	0	$2,039	n/a	n/a	$2,039	$0
HDPE Welder (pipe or liner)	1	0	$8,628	n/a	n/a	$8,628	$0
Office Trailer	1	0	$213	n/a	n/a	$213	$0
Portable Toilet	1	0	$216	n/a	n/a	$216	0

* Percent of time support equipment assumed operating during a 176 hour month | 20%

TOTAL EQUIPMENT **$1,662,906**

MATERIAL REQUIREMENTS

Sampling and Lab Costs

Type	# samples	cost $/ea	total cost
NDEP Profile I Water	20	$411.00	$8,220.00
NDEP Profile II Water	0	$461.00	$0.00

Subtotal Sampling and Lab Costs $8,220

Misc. Costs (phones, shipping, supplies, etc. @ $1,000 per month) $0

TOTAL MATERIALS **$8,220**

	Labor	Equipment	Materials	Total
Total Shared Costs Phase III	**$50,048**	**$1,662,906**	**$8,220**	**$1,721,174**
ET Cell Conversion Costs				
Calculated from BMRR EZ E-Cell Calc Sheet	$48,281	$122,671	$9,187	**$180,139**
	$0	$0	$0	**$0**
	$0	$0	$0	**$0**
	$0	$0	$0	**$0**
Total Non-Shared Costs Phase III	**$0**	**$0**	**$9,187**	**$9,187**
TOTAL COSTS	**$50,048**	**$1,662,906**	**$17,407**	**$1,730,361**

Closure Cost Estimate
User 2

Interim Fluid Management (IFM)
Process Fluid Stabilization (PFS)

LABOR COSTS (2019 Cost Data)

	Northern Nevada	Southern Nevada
Site Workers (SRCE & Davis-Bacon Wage Rates)	per hour	per hour
Laborer (Common or General, landscape,)	$0.00	$0.00
Security Personnel (Electrician,)	$0.00	$0.00
Electrician/Welder (,)	$0.00	$0.00
On-Site Supervisor (SRCE-from R.S. Means)	$0.00	$0.00

CEM Contractor (Consulting Rates)	per hour
Program Director	$180.50
Senior Engineer/Geologist	$139.03
Field Technician	$76.34
Administrative	$79.56

	($) per day
Full per diem rate	$149.00
Partial per diem rate	$41.25

	($) per mile
Mileage rate	$0.580

EQUIPMENT RENTAL COSTS

	rental cost	operating cost
SRCE Rates (2019 Cost Data)	per month	per hour
Backhoe (CAT 420D)	$2,650	$20.51
Generator (5 KW)	$712	$2.63
Pickup Truck	$2,592	$6.18
Motor Grader (CAT 14G)	$13,500	$42.01
Welding Equipment	$2,039	n/a
HDPE Welder (pipe or liner)	$8,628	n/a
Office Trailer	$213	n/a
Portable Toilet	$216	n/a

MISC. COSTS

Pumps	High Head			
Model Number	HH-225c	HH-150	HH-125c	HH-80c
B.E.P. Flow Rate (gpm)	4,000	2,090	620	410
B.E.P. Head (feet)	260	260	340	320
RPM	1,900	2,000	2,200	2,200
Monthly Rental Rate - 24/7 operation (1)	$ 4,484	$ 3,364	$ 2,906	$ 1,566
Monthly Maintenance Rate - 24/7 operation (2)				
Environmental Fee (3)				
Total Monthly Rental Rate	$ 4,484	$ 3,364	$ 2,906	$ 1,566

	per gallon
Diesel Fuel	$2.36

	per KW-hr
Electrical Power Cost	$0.07918

Evaporation Equipment	each
EcoMister Standard Dual Pack Evaporator (2)	$169,500
Pumps for Elevation Head (HH-80c) (3)	$47,099

	each
NDEP Profile I Water analysis	$411.00
NDEP Profile II Water analysis	$461.00

(1) Rain for Rent June 2019 for 24/7 operation
(2) Slimline Manufacturing July 2019 Quote.
(3) Rain for Rent June 2019

Closure Cost Estimate
User 2

	FICA	UE	WC
	7.65%	3.00%	8.90%

Northern Nevada	Base	Fringes	Base +	Add Add'l	FICA	UE	WC	Total
Laborer	$25.70	$10.56	$36.26	$36.26	$0.00	$0.00	$0.00	$36.26
Security Personnel	$25.45	$10.56	$36.01	$36.01	$0.00	$0.00	$0.00	$36.01
Electrician/Welder	$40.50	$19.39	$59.89	$59.89	$0.00	$0.00	$0.00	$59.89
On-Site Supervisor (SRCE-from R.S. Means)	$69.19	$0.00	$69.19	$69.19	$0.00	$0.00	$0.00	$69.19

Southern Nevada	Base	Fringes	Base +	Add Add'l	FICA	UE	WC	Total
Laborer	$26.31	$26.79	$53.10	$53.10	$0.00	$0.00	$0.00	$53.10
Security Personnel	$27.65	$26.79	$54.44	$54.44	$0.00	$0.00	$0.00	$54.44
Electrician/Welder	$52.00	$20.13	$72.13	$74.63	$0.00	$0.00	$0.00	$74.63
On-Site Supervisor (SRCE-from R.S. Means)	$85.50	$0.00	$85.50	$85.50	$0.00	$0.00	$0.00	$85.50

Notes:
Union wages assumed.

Northern Nevada

Category	Code		Group	Description	Zone Adjustment
Labor	DB LABO0169-034	10/1/2017 - Elko Building	Group 3	Mason Tender Cement/Concrete	
Security Personal	DB LABO0169-034	10/1/2017 - Elko Building	Group 1	Common or General	
Electrician/Welder	DB ELEC0401-010	7/1/2019 - Elko Building		Electrician	
On-site Supervisor	RS Means 2019 Q2 (01 31 1320 0260 Total Incl. O&P-10%) adjusted for Elko, NV (898)				

Southern Nevada

Category	Code		Group	Description	Zone Adjustment
Labor	DB LABO0872-015	7/1/2018 - Clark Building	Group 3	Mason Tender Cement/Concrete	
Security Personal	DB LABO0872-015	7/1/2018 - Clark Building	Group 1	Common or General, landscape	
Electrician/Welder	DB ELEC0357-002	10/1/2017 - Clark Heavy		Electrician	$ 2.5 Zones 2 & 3
On-site Supervisor	RS Means 2019 Q2 (01 31 1320 0260 Total Incl. O&P-10%) adjusted for Las Vegas, NV (898, 890,891)				

Closure Cost Estimate
User 2

SHARED COSTS FOR ALL FACILITIES

LABOR REQUIREMENTS

yellow cells are from Unit Costs sheet

Site Workers	# per shift	hrs. per shift	shifts per day	days per wk.	hrs. per wk.	hrs. per mo.	total hrs.	rate per hr.	Six Month Totals
General Laborers	1	12	2	7	168	728.00	4,368	$0.00	$0
Security Personnel	0	12	0	7	0	0.00	0	$0.00	$0
Electrician/Welder	1	8	1	5	40	173.33	1,040	$0.00	$0
On-Site Supervisor	0	8	0	5	0	0.00	0	$0.00	$0

Subtotal Site-Workers **$0**

CEM Contractor Site Worker Oversight	on-site hrs./wk.	round trip (3) to hotel hrs./wk.	round trips (4) to site hrs./wk.	total hrs./wk.	on-site # of wks.	start-up hrs.	billing rate per hr.	
Program Director	0.00	0.00	0	0.00	0	32.00	$0.00	$0
Senior Engineer(1)	16.00	0.00	0.00	16.00	12	80.00	$0.00	$0
Field Technician(2)	16.00	0.00	0.00	16.00	24	80.00	$0.00	$0
Administrative	0.00	0.00	0	0.00	0	8.00	$0.00	$0

	# of trips (weeks)		total trips	total days of per diem	per diem rate per day	
	senior engr.	field tech.				
Full per diem (lodging + meals) - 2 days/trip	12	24	0	0	$0.00	$0
Partial per diem (meals only) - 1 day/trip	12	24	0	0	$0.00	$0

	one-way miles	# of weeks		round trips per week	total round trips	total miles	mileage rate per mile	
		senior engr.	field tech.					
One-Way Mileage to hotel accommodations (3	0	12	24	1	0	0	$0.000	$0
One-Way Mileage from hotel to site (4)	0	12	24	3	0	0	$0.000	$0

Subtotal CEM Contractor Site Worker Oversight **$0**

Notes:
(1) Senior Engineer - 2 week start-up time and 16 hrs/week (2, 4 hr. days & 1, 8 hr. day) every other week on-site.
(2) Field Technician - 2 week start-up time and 16 hrs./week (2, 4 hr. days & 1, 8 hr. day) every week on-site.
(3) From Carson City, Nevada to nearest town to site having hotel accommodations. One round trip per week.
(4) From town to site. Three round trips per week.

CEM Contractor Reporting

Weekly Status Reports, Quarterly Reports	hrs. per wk.	# of wks.	total hrs.	rate per hr.	
Senior Engineer	4	26	104	$0.00	$0
Field Technician	4	26	104	$0.00	$0
Administrative	4	26	104	$0.00	$0

Subtotal CEM Contractor Reporting **$0**

TOTAL LABOR **$0**

Simplified Evaporation Cell Reclamation Cost Estimate

DRAFT VERSION FOR INTERNAL BMRR EVALUATION ONLY V1.0.0 Beta 08.01.13

Facility:	**Reclaim Pond**					
Location:	**Malheur County, Oregon**					
Operator:	**Calico Resources USA Corp.**					
Prepared By:	**EM Strategies, Inc**					
SubmittalDate:	**November 1, 2019**					
Fleet:	Small Fleet	Small Fleet	Large Fleet			
Ex Pond Config:	Double Liner	Double Liner	Double Liner			
Pond Area (ac)	**0.37 ac**					
Pond Depth (ft)	**9.0 ft**					
Source (%)	**4.0%**					
Source (ft)	**602 ft**					

Labor	$48,281					
Equip	$122,671					
Material	$9,187					
Total	$180,138.66					
	$486,861/ac					

Summary			
Labor	**Equipment**	**Material**	**Total**
$48,281	**$122,671**	**$9,187**	**$180,139**
	Average Cost =	**$486,861/ac**	

User Notes:

Assumptions:

1) Labor, Equipment and Material Prices are based on 2011 SRCE Cost Data. Cost Basis is Northern Nevada, Mine Plan of Operations, Public/Public Private, Standardized Data.
2) Small Fleet: 769D Truck,325C Loader, 966C Excavator, D9R Dozer, D7R Dozer
3) Large Fleet: 777D Truck,385BL Loader, 988C Excavator, D10R Dozer, D7R Dozer
4) Excavation, Backfill, Cover, Ripping, Growth Medium and Grading materials are based on Alluvium properties and are from the same source location.
5) Includes revegitation cost over stated pond area.
6) Growth Medium/Cover is 24 inches over the stated pond area.
7) Mix 2, "Low Hills" is used for revegitation seed mix.
8) Includes installation costs for 10 foot high chain link perimiter fencing setback 20 feet. Perimiter is 4x square root of the area.
9) Includes installation cost for new heap to pond double wall pipe.
10) Includes installation cost for one 1500 gallon dosing tank.
11) Includes installation costs for distributing piping.
12) Includes costs for inspection, repair and removal of 1/2 foot of sludge on existing lined ponds.
13) Includes excavation costs for new ponds.
14) Includes installation costs for double liners with geonetting on new and unlined ponds, a single liner, geonetting on single lined ponds, and no liner cost on existing double lined ponds.
15) New liner installation includes cost for a key trench

DRAFT VERSION FOR INTERNAL BMRR EVALUATION ONLY

2019 MOB/DEMOB using R.S. MEANS and SRCE equipment and DAVIS-BACON wages

blue font is for project specific user input

Miles from Washoe County Courthouse to project, one way: 27

Miles from equipment rental yard to project, one way (9): 27

Grassy Mountain Mine Project - November 2019 - Mob from Vale, OR

Hours travel time @ 55 MPH: 0.49

Equipment	Mobilization $/hour (1)	$ Flat Rate load & unload (2)	$/hour Deadhead (empty return cost (3)	Disassembly and assembly (4)	Permit cost $ (5)	Pilot car costs	# of units	One Way Mob Cost	Total Mob and Demob Cost
Bulldozers									
D6R	$ 97	$ 97	$ -	$ -	$ -	$ -		$ -	$ -
D7R	$ 126	$ 126	$ -	$ -	$ 25	$ -	2	$ 427	$ 854
D8R	$ 148	$ 148	$ -	$ -	$ 25	$ -		$ -	$ -
D9R	$ 148	$ 148	$ -	$ -	$ 25	$ -	1	$ 246	$ 492
D10R	$ 148	$ 148	$ -	$ 63,720	$ 25	$ -		$ -	$ -
D11R (two transports) (7)	$ 148	$ 148	$ -	$ 135,720	$ 25	$ -		$ -	$ -
Motor Graders									
14G/H	$ 97	$ 97	$ -	$ -	$ -	$ -	1	$ 145	$ 290
16G/H	$ 126	$ 126	$ -	$ -	$ 25	$ -		$ -	$ -
Track Excavators									
320C	$ 126	$ 126	$ -	$ -	$ -	$ -		$ -	$ -
325C	$ 126	$ 126	$ -	$ -	$ -	$ -	3	$ 565	$ 1,131
345B	$ 148	$ 148	$ -	$ -	$ 25	$ -		$ -	$ -
385BL	$ 148	$ 148	$ -	$ 44,880	$ 25	$ -		$ -	$ -
Scrapers									
631G	$ 148	$ 148	$ -	$ -	$ 25	$ -		$ -	$ -
637G PP	$ 148	$ 148	$ -	$ -	$ 25	$ -		$ -	$ -
Wheeled Loaders									
928G	$ 97	$ 97	$ -	$ -	$ -	$ -		$ -	$ -
966G	$ 97	$ 97	$ -	$ -	$ -	$ -	1	$ 145	$ 290
972G	$ 126	$ 126	$ -	$ -	$ -	$ -		$ -	$ -
988G	$ 126	$ 126	$ -	$ -	$ 25	$ -		$ -	$ -
992G (two transports) (7)	$ 148	$ 148	$ -	$ 74,160	$ 25	$ -		$ -	$ -
Hydraulic Hammers									
H-120 (fits 325) no charge, mobilize with macl	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -
H-160 (fits 345) no charge, mobilize with macl	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -
H-180 (fits 365/385) no charge, mobilize with t	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -
Other Equipment									
420D 4WD Backhoe	$ 97	$ 97	$ -	$ -	$ -	$ -	1	$ 145	$ 290
CS563E Vibratory Roller	$ 97	$ 97	$ -	$ -	$ -	$ -		$ -	$ -
Light Truck - 1.5 Ton	$ 67	$ 67	$ -	$ -	$ -	$ -		$ -	$ -
Supervisor's Truck	$ 58	$ 58	$ -	$ -	$ -	$ -	1	$ 86	$ 172
Air Compressor + tools	$ 74	$ 74	$ -	$ -	$ -	$ -		$ -	$ -
Welding Equipment	$ 74	$ 74	$ -	$ -	$ -	$ -		$ -	$ -
Heavy Duty Drill Rig	$ 397	$ 397	$ -	$ -	$ -	$ -		$ -	$ -
Pump (plugging) Drill Rig	$ 397	$ 397	$ -	$ -	$ -	$ -		$ -	$ -
Concrete Pump	$ 74	$ 74	$ -	$ -	$ -	$ -		$ -	$ -
Gas Engine Vibrator	$ 74	$ 74	$ -	$ -	$ -	$ -		$ -	$ -
Generator 5KW	$ 74	$ 74	$ -	$ -	$ -	$ -		$ -	$ -
HDEP Welder (pipe or liner)	$ 74	$ 74	$ -	$ -	$ -	$ -		$ -	$ -
5 Ton Crane Truck	$ 107	$ 107	$ -	$ -	$ -	$ -		$ -	$ -
25 Ton Crane	$ 146	$ 146	$ -	$ -	$ -	$ -		$ -	$ -
Trucks									
725	$ 97	$ 97	$ -	$ -	$ -	$ -	1	$ 145	$ 290
740	$ 126	$ 126	$ -	$ -	$ 25	$ -		$ -	$ -
769D	$ 126	$ 126	$ -	$ -	$ 25	$ -		$ -	$ -
777D (two transports) (8)	$ 148	$ 148	$ -	$ 71,280	$ 25	$ -		$ -	$ -
613E (5,000 gal) Water Wagon	$ 148	$ 148	$ -	$ -	$ -	$ -	1	$ 221	$ 442
621E (8,000 gal) Water Wagon	$ 148	$ 148	$ -	$ -	$ 25	$ -		$ -	$ -
Dump Truck (10-12 yd^3)	$ 111	$ 111	$ -	$ -	$ -	$ -		$ -	$ -
Miscellaneous									
Equipment for dry hole abandonment (420D 4WD	$ 97	$ 97	$ -	$ -	$ -	$ -		$ -	$ -
Pilot car (Light Truck)	$ 58	$ 58	$ -	$ -	$ -	$ -		$ -	$ -
Truck Tractor + Lowbed Trailer 75 ton	$ 148	$ 148	$ -	$ -	$ -	$ -		$ -	$ -
Truck Tractor + Flatbed Trailer 40 ton	$ 126	$ 126	$ -	$ -	$ -	$ -		$ -	$ -
Light Truck + Flatbed Trailer 25 ton	$ 74	$ 74	$ -	$ -	$ -	$ -		$ -	$ -
							12		**$ 4,250**

Footnotes and explanations of assumptions

(1) The sum of the cost of equipment from either the SRCE or RSM equipment tab plus Davis-Bacon labor tab

(2) Assumes minimum of 30 minutes load and secure and 30 minutes unsecure and unload machine.

(3) No "Deadhead" (empty) charge for Mob up to 50 miles. More than 50 miles the cost of deadhead same rate as loaded miles.

(4) Only large equipment requires disassembly for transport. Includes cost of mechanic + mechanic's truck + crane operator + crane.

(5) Nevada Dept. of Transportation overdimensional permits are $25 per trip or $60 per year.

(6) Sum of mobilization plus all ancillary costs for one way loaded and return empty.

(7) Two transports are required but the second transport does not need pilot cars or permits or a heavy duty trailer.

(8) Two transports required with both requiring full complement of pilot cars and permits.

(9) For large mining operations, mobilization may be required from more than one location. For example, the Elko yard may not have four 631 scrapers. Additional equipment may need to mobilize from Reno, Las Vegas, or Salt Lake City. Input the further distance here.

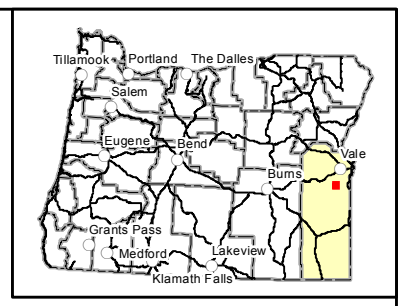
(10) Pilot Car costs based on SRCE light truck costs and Davis-Bacon wages

(11) SRCE costs based on July 2019 vendor quotes.

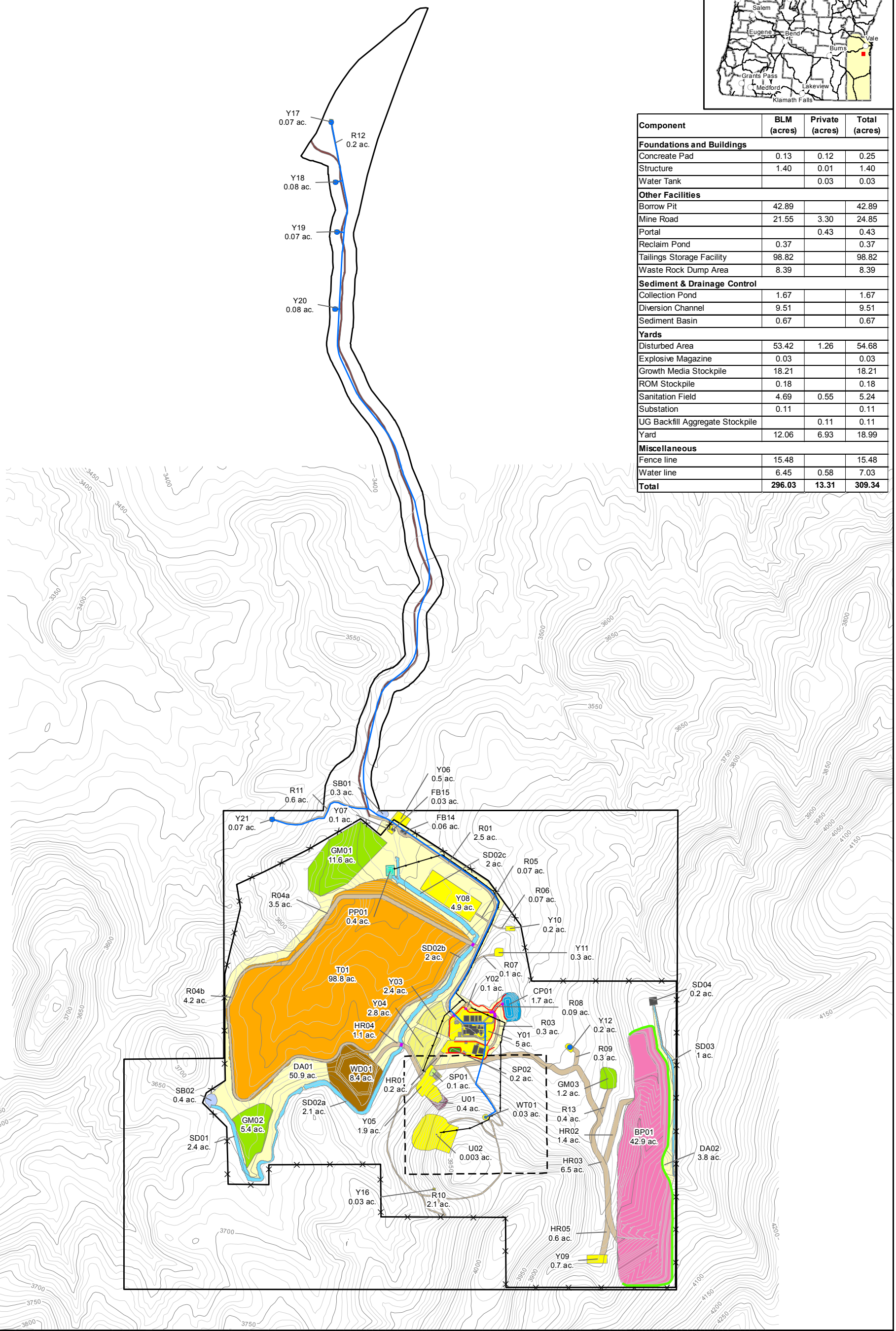
(12) RS Means costs based on R.S. Means Heavy Construction Cost Data, 2019, Q2

(13) Davis Bacon wages based on 2019 determination.

SRCE FIGURES



Component	BLM (acres)	Private (acres)	Total (acres)
Foundations and Buildings			
Concreate Pad	0.13	0.12	0.25
Structure	1.40	0.01	1.40
Water Tank		0.03	0.03
Other Facilities			
Borrow Pit	42.89		42.89
Mine Road	21.55	3.30	24.85
Portal		0.43	0.43
Reclaim Pond	0.37		0.37
Tailings Storage Facility	98.82		98.82
Waste Rock Dump Area	8.39		8.39
Sediment & Drainage Control			
Collection Pond	1.67		1.67
Diversion Channel	9.51		9.51
Sediment Basin	0.67		0.67
Yards			
Disturbed Area	53.42	1.26	54.68
Explosive Magazine	0.03		0.03
Growth Media Stockpile	18.21		18.21
ROM Stockpile	0.18		0.18
Sanitation Field	4.69	0.55	5.24
Substation	0.11		0.11
UG Backfill Aggregate Stockpile		0.11	0.11
Yard	12.06	6.93	18.99
Miscellaneous			
Fence line	15.48		15.48
Water line	6.45	0.58	7.03
Total	**296.03**	**13.31**	**309.34**



Explanation

- Project Area
- Patented Outline
- Existing Access Road
- Production Well
- Berm
- Culvert
- Ditch
- Fence
- Power Line
- Water Line

Other Facilities

- Borrow Pit
- Mine Road
- Portal
- Reclaim Pond
- Tailings Storage Facility
- Waste Rock Dump Area

Foundations and Buildings

- Concreate Pad
- Water Tank
- Structure

Sediment & Drainage Control

- Collection Pond
- Diversion Channel
- Sediment Basin

Yards

- Disturbed Area
- Explosive Magazine
- Growth Media Stockpile
- ROM Stockpile
- Sanitation Field
- Substation
- UG Backfill Aggregate Stockpile
- Yard

Contours Lines

- Minor (10-foot Interval)
- Major (50-foot Interval)

1 inch = 1,200 feet
When printed at 11" x 17"

0 600 1,200 Feet

N

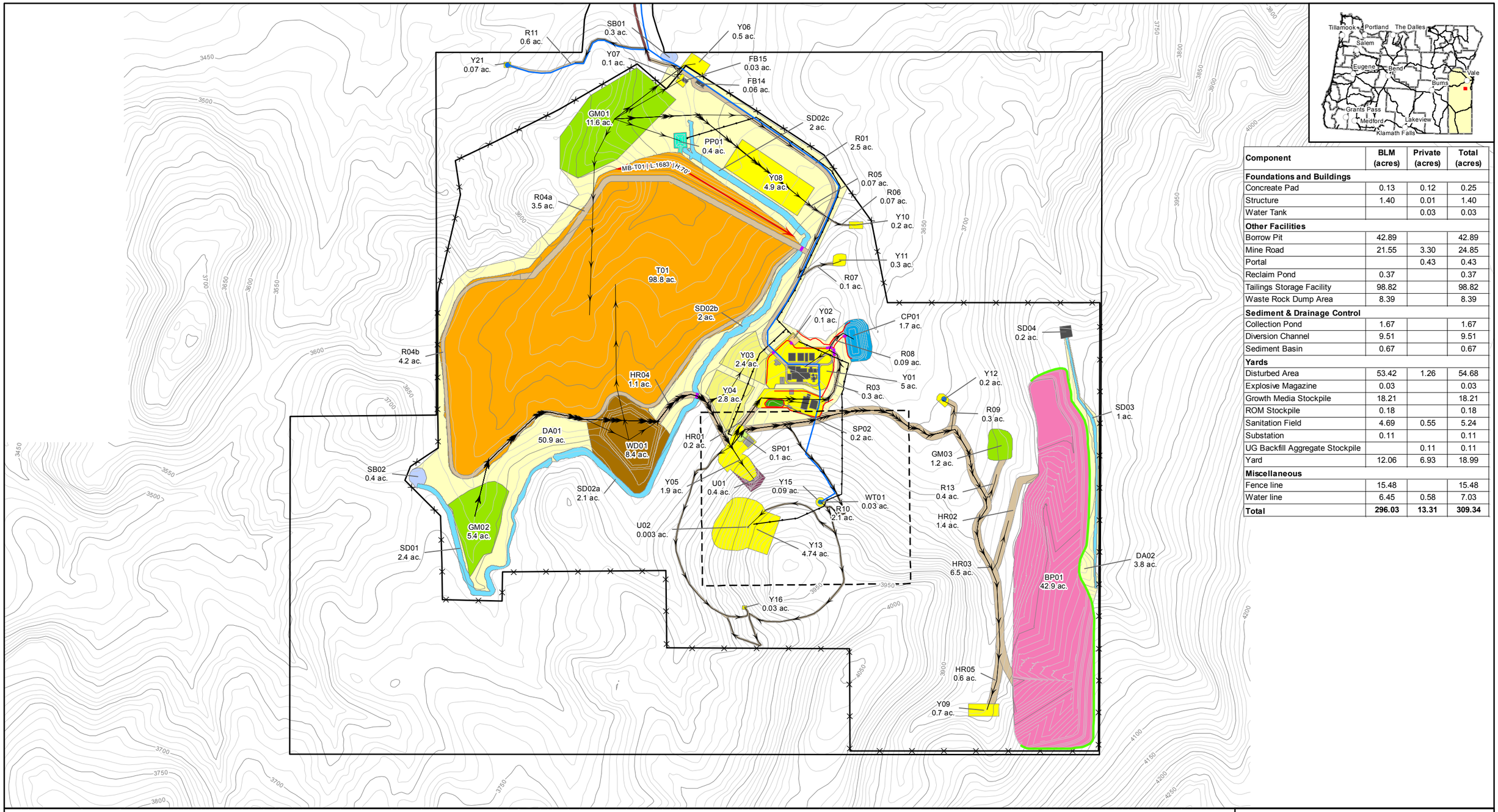
CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT

RCE
Planned Reclamation Disturbance Overview

Label: Figure 1	Drawn By: JDB
Date: 11/11/2019	Project No.: 3671
Base Map:	
File Name: 3671G_GrassyMtn_SCRE_Fig1_OV.mxd	

EM STRATEGIES



Component	BLM (acres)	Private (acres)	Total (acres)
Foundations and Buildings			
Concreate Pad	0.13	0.12	0.25
Structure	1.40	0.01	1.40
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Other Facilities			
Borrow Pit	42.89		42.89
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Portal		0.43	0.43
Reclaim Pond	0.37		0.37
Tailings Storage Facility	98.82		98.82
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Sediment & Drainage Control			
Collection Pond	1.67		1.67
Diversion Channel	9.51		9.51
Sediment Basin	0.67		0.67
Yards			
Disturbed Area	53.42	1.26	54.68
Explosive Magazine	0.03		0.03
Growth Media Stockpile	18.21		18.21
ROM Stockpile	0.18		0.18
Sanitation Field	4.69	0.55	5.24
Substation	0.11		0.11
UG Backfill Aggregate Stockpile		0.11	0.11
Yard	12.06	6.93	18.99
Miscellaneous			
Fence line	15.48		15.48
Water line	6.45	0.58	7.03
Total	**296.03**	**13.31**	**309.34**

Explanation

- Project Area
- Patented Outline
- Existing Access Road
- Production Well
- Berm
- Culvert
- Ditch
- Fence
- Power Line
- Water Line
- Haul Route
- Mid-Bench

Other Facilities
- Borrow Pit
- Mine Road
- Portal
- Reclaim Pond
- Tailings Storage Facility
- Waste Rock Dump Area

Foundations and Buildings
- Concreate Pad
- Water Tank
- Structure

Sediment & Drainage Control
- Collection Pond
- Diversion Channel
- Sediment Basin

Yards
- Disturbed Area
- Explosive Magazine
- Growth Media Stockpile
- ROM Stockpile
- Sanitation Field
- Substation
- UG Backfill Aggregate Stockpile
- Yard

Contours Lines
- Minor (10-foot Interval)
- Major (50-foot Interval)

1 inch = 800 feet
When printed at 11" x 17"

0 400 800 Feet

N

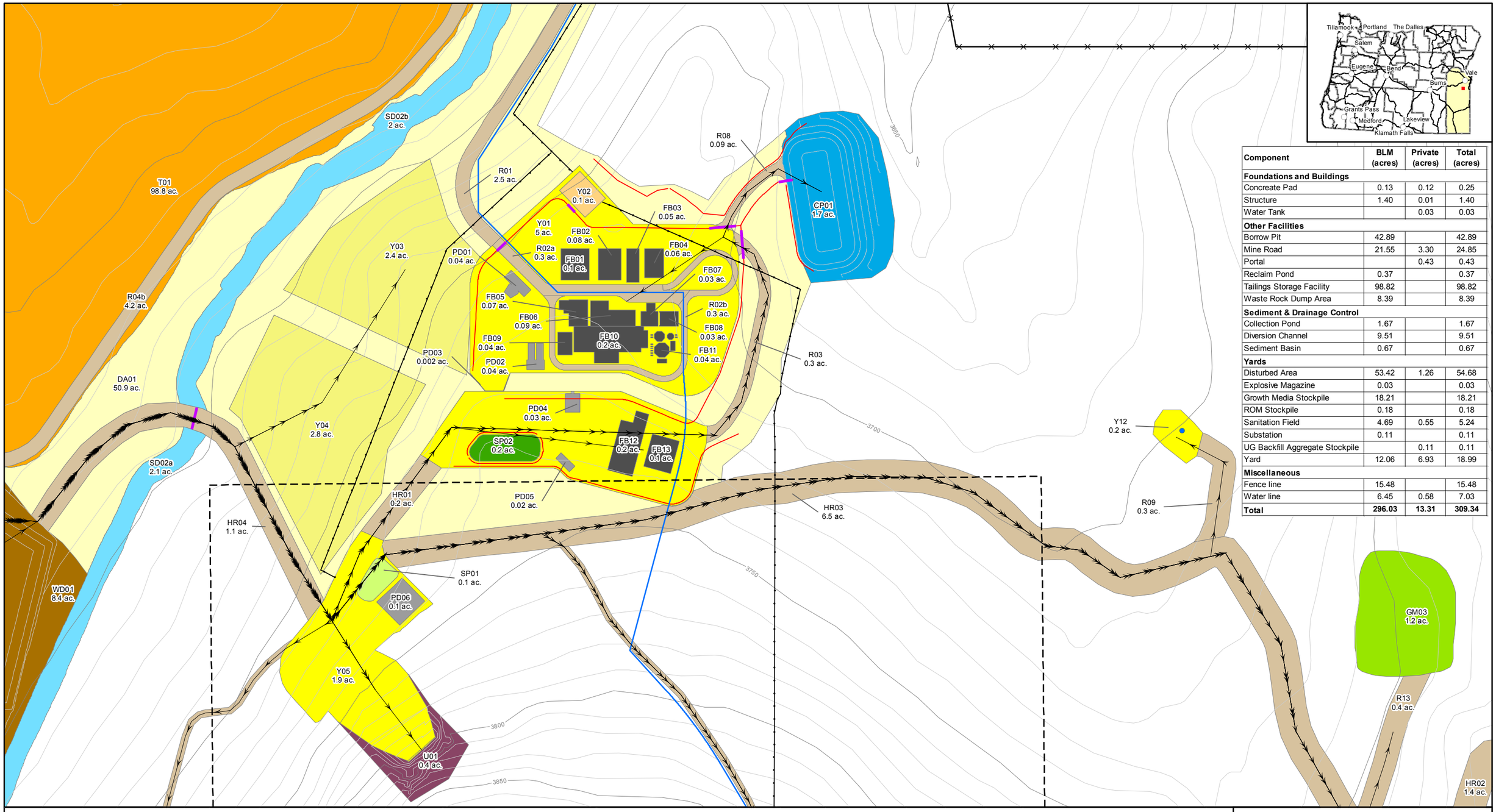
CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT

RCE
Planned Reclamation Disturbance
Mine Site

Label: Figure 2	Drawn By: JDB
Date: 11/11/2019	Project No.: 3671
Base Map:	
File Name: 3671G_GrassyMtn_SCRE_Fig2_MS.mxd	

EM STRATEGIES



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Sediment & Drainage Control			
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Diversion Channel	9.51		9.51
Sediment Basin	0.67		0.67
Yards			
Disturbed Area	53.42	1.26	54.68
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Growth Media Stockpile	18.21		18.21
ROM Stockpile	0.18		0.18
Sanitation Field	4.69	0.55	5.24
Substation	0.11		0.11
UG Backfill Aggregate Stockpile		0.11	0.11
Yard	12.06	6.93	18.99
Miscellaneous			
Fence line	15.48		15.48
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Total	**296.03**	**13.31**	**309.34**

Explanation

- Project Area
- Patented Outline
- Production Well
- Culvert
- Ditch
- Fence
- Power Line
- Water Line
- Haul Route

Other Facilities
- Mine Road
- Portal
- Tailings Storage Facility
- Waste Rock Dump Area

Foundations and Buildings
- Concreate Pad
- Structure

Sediment & Drainage Control
- Collection Pond
- Diversion Channel

Yards
- Disturbed Area
- Growth Media Stockpile
- ROM Stockpile
- Sanitation Field
- Substation
- UG Backfill Aggregate Stockpile
- Yard

Contours Lines
- Minor (10-foot Interval)
- Major (50-foot Interval)

1 inch = 200 feet
When printed at 11" x 17"

0 100 200 Feet

N

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT

RCE
Planned Reclamation Disturbance Process Area

Label: Figure 3	Drawn By: JDB
Date: 11/11/2019	Project No.: 3671
Base Map:	
File Name: 3671G_GrassyMtn_SCRE_Fig3_PA.mxd	

EM STRATEGIES

Appendix K: Interim Management Plan

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT
MALHEUR COUNTY, OREGON

INTERIM MANAGEMENT PLAN

June 2019

Submitted to

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation & Reclamation
229 Broadalbin Street SW
Albany, Oregon 97321-2246

Prepared for

Calico Resources USA Corp.
665 Anderson Street
Winnemucca, Nevada 89445

Prepared by:

Reno:
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Elko:
835 Railroad Street
Elko, Nevada 89801
Phone: (775) 753-9496 | Fax: (775) 826-8857

CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
INTERIM MANAGEMENT PLAN

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
INTERIM MANAGEMENT PLAN

1 INTRODUCTION

This Interim Management Plan (IMP) has been prepared in support of the Grassy Mountain Mine Project (Project) located in Malheur County, Oregon, and has been included as part of the Consolidated Permit Application. Calico Resources USA Corp. (Calico) proposes to construct, operate, reclaim, and close the Project, which is an underground mining and precious metal milling operation.

The Project is located approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 2). The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The Access Road Area totals approximately 876 acres.

1.1 Regulatory Requirements

Temporary and interim closure activities are managed by the BLM, the Oregon Department of Geology and Mineral Industries (DOGAMI), and the Oregon Department of Environmental Quality (ODEQ). Both federal and state requirements necessitate that the Project develop an IMP to address specific conditions and activities.

1.1.1 Federal Regulations

IMP requirements require the following items be addressed:

- Measures to stabilize excavations and workings;
- Measures to isolate or control toxic or deleterious materials;
- Provisions for the storage or removal of equipment, supplies, and structures;
- Measures to maintain the Permit Area in a safe and clean condition;

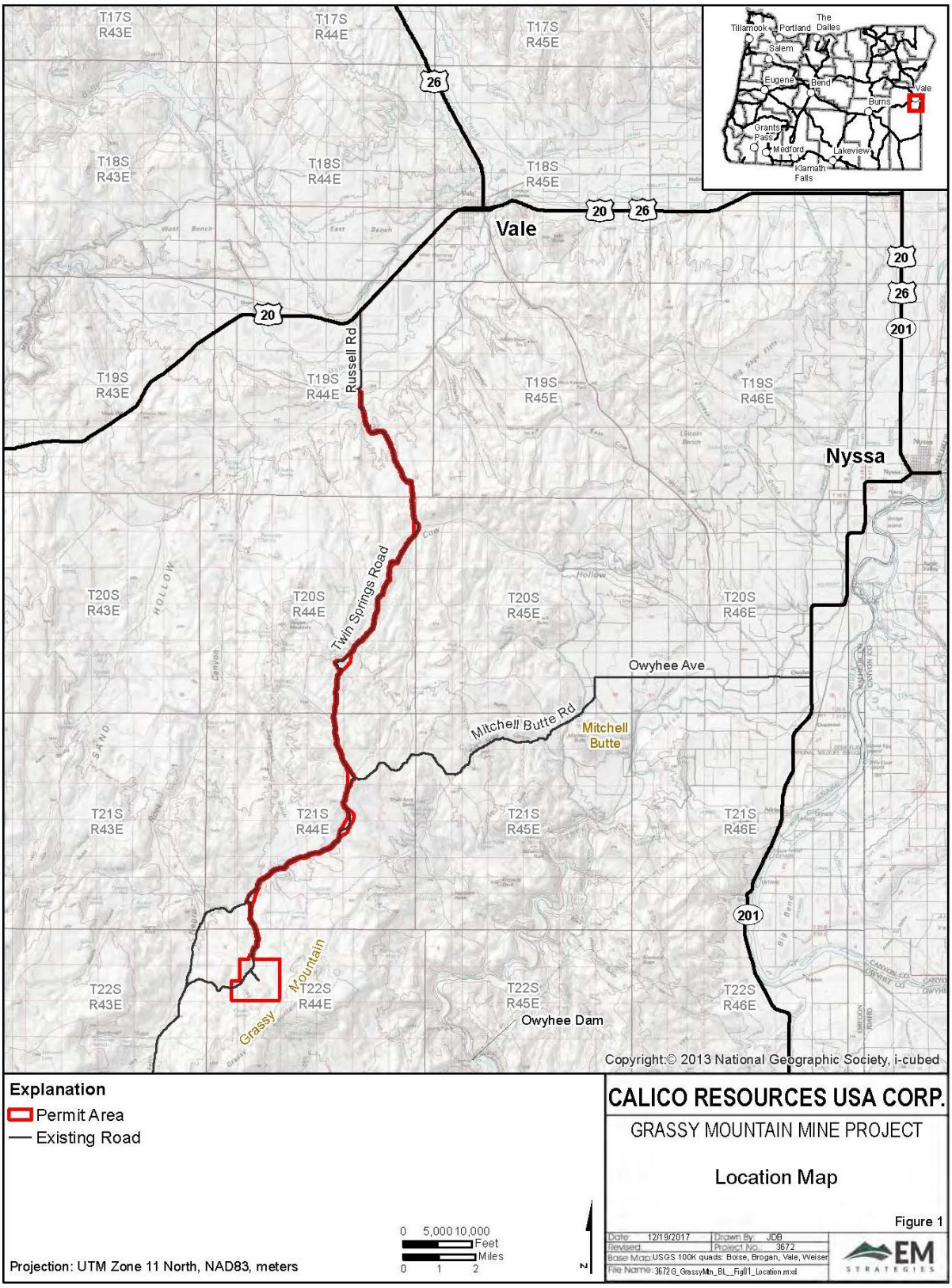


Figure 1: Location Map

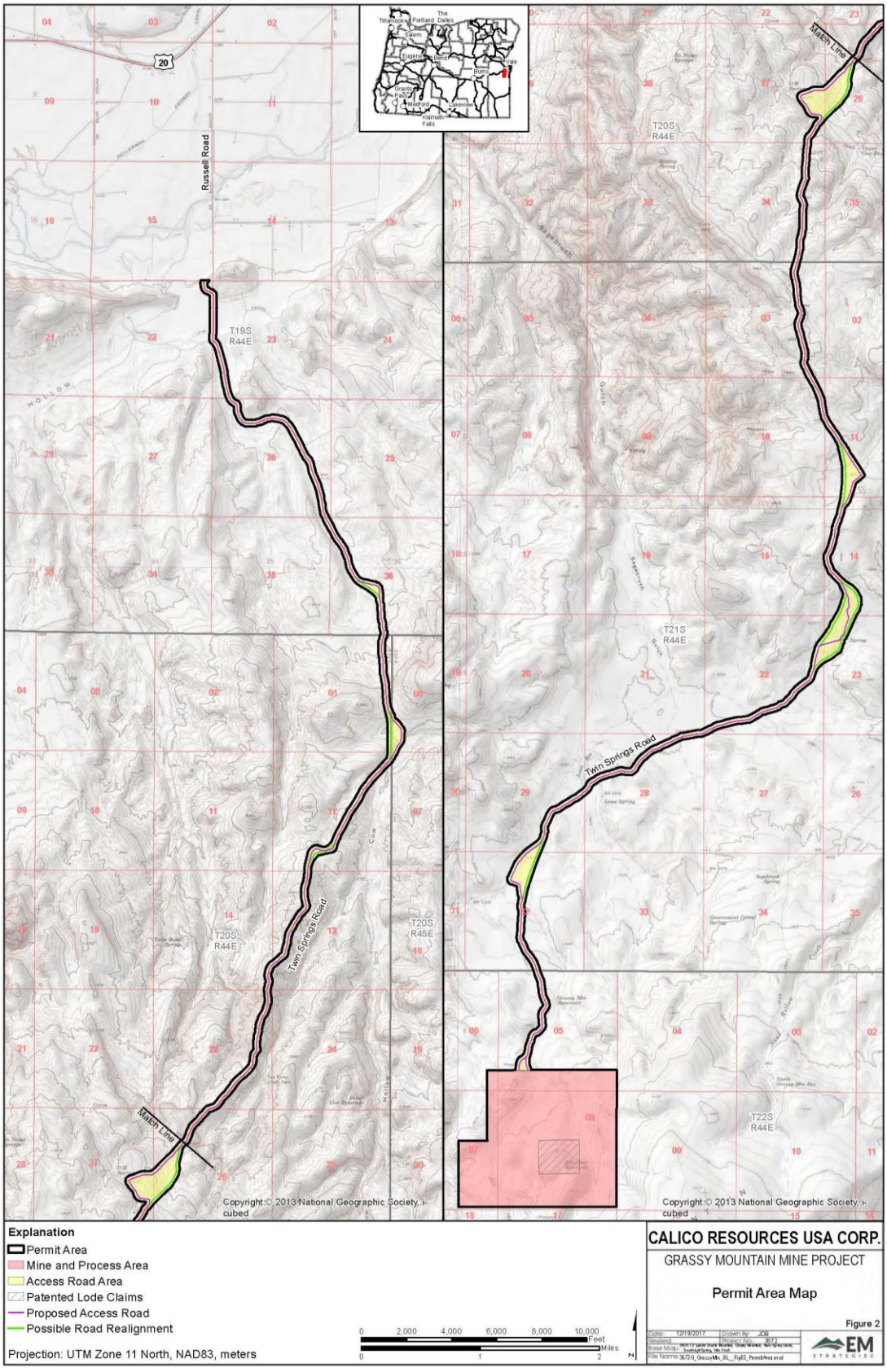


Figure 2: Permit Area Map

- Plans for monitoring site conditions during periods of non-operations; and
- A schedule of anticipated periods of temporary closure during which the Project personnel would implement the IMP, including provisions for notifying agencies of unplanned or extended temporary closures.

1.1.2 State Regulations

The Oregon Revised Statute 517.971 applies directly to the operating plan for chemical mining operations in Oregon and specifically the Consolidated Permit Process (CP). The CP is further defined under Oregon Administrative Rule (OAR) 632-037 (Division 37), where the seasonal or temporary closure procedures are specified under OAR 632-037-0060(6). Additional requirements for chemical mining operations are defined under OAR 340-043 (Division 43). The following are listed under OAR 632-037-0060(6) as including but not limited to:

- Target seasonal or temporary storage volumes;
- Total system storage capacity;
- Procedures to handle volumes of water in excess of seasonal or temporary storage capacities;
- Estimated schedule for closure; and
- Monitoring and reporting programs, including but not limited to:
    - Surface and groundwater monitoring systems within and outside of the permit area and reporting frequency;
    - Water balance of the process system and leak detection systems and reporting frequency;
    - Biological monitoring and reporting procedures and frequency; and
    - Fish and wildlife injury and mortality monitoring and reporting frequency developed according to standards adopted by the Department of Fish and Wildlife.

For purposes of this proposed IMP the following are considered examples of both planned and unplanned closure:

- Seasonal closures because of normal weather cycles;
- Interruptions in the active beneficiation processes to provide planned periods of quiescence for metallurgical or operating reasons;
- Any other planned process condition which will interrupt the active beneficiation process;
- A closure because of unforeseen weather events;
- A failure in a major system component or a process failure which causes the fluid management system or a portion thereof to shut down; and
- The discontinuation of a facility's operations because of litigation.

2 Closure Plan

2.1 Schedule of Anticipated Periods of Temporary Closure

The standard operating schedules for the Project will be 24 hours a day, seven days a week for the processing circuits and 24 hours a day, 4 days a week for the mining activities. No temporary or seasonal closures of the facility are planned in the mine operation schedule. However, it is possible that due to mechanical or technical difficulties, unfavorable economic conditions, litigation or other unforeseen events, mining and processing facilities may have to be temporarily closed. In the event of an unplanned temporary closure, the following actions will be initiated by Calico:

- Calico will notify DOGAMI, ODEQ, and BLM, within 30 days of the temporary closure of the precious metal recovery processing activities. This notification will include a description of the procedures and controls that have been, or will be, initiated in order to maintain and control process components and process fluids during the temporary closure period.
- If the interim closure period exceeds 180 days, Calico will petition DOGAMI, ODEQ, and BLM for an extension to delay permanent closure or initiate procedures to permanently close process components. Any delay to permanent closure will be coordinated with Calico, DOGAMI, ODEQ, and BLM.
- Calico will provide DOGAMI, ODEQ, and BLM with a list of supervisory personnel whose responsibility it will be to oversee the Project during a temporary closure period. This list also will include the number of support staff which will be required in each department to maintain the Project during the closure period. Standard security procedures will remain in place for the duration of any temporary closure period.

2.2 Measures to Stabilize Excavations and Workings

The underground workings will be monitored according to the plan submitted to the BLM, DOGAMI, and ODEQ with the notification of temporary closure. The portal will be blocked from access except by authorized personnel. Underground workings will be inspected on a regular basis to evaluate the overall condition and safety of the mine. Interim reclamation procedures will be implemented, as necessary, to stabilize any disturbed areas during the temporary closure period. These procedures will be coordinated with Calico, BLM, DOGAMI, and ODEQ.

Pursuant to OAR-037-0060(6), adequate storage capacity will be maintained for all process components to accommodate any storm water runoff resulting from any 100-year, 24-hour storm event.

2.3 Measures to Isolate or Control Toxic or Deleterious Materials

Calico will continue to follow the waste rock management procedures and all other management plans as they are described in the BLM Plan of Operations, DOGAMI CP (Division 37) and the ODEQ Water Pollution Control Facility (WPCF) permit (Division 43), during unplanned temporary

closure. Explosives and other hazardous substances will continue to be stored, secured, and handled according to federal and state regulations. Any hazardous materials will continue to be stored, secured, handled, and disposed of according to federal and state regulations.

Any drums and containers of regulated wastes will be scheduled for removal and disposal at an appropriately permitted off-site facility. Any drums of material remaining on site, which are not identified with proper labeling, will be placed within the hazardous waste storage for sampling. As soon as these materials are identified, they will be either returned to a secured location as products or shipped off site for disposal.

2.4 Storage or Removal of Equipment, Supplies, and Structures

In the event of a temporary closure, Calico will not remove supplies, and structures will not be removed or placed into storage. Some mobile equipment or bulk commodities may be relocated into buildings or covered with tarps to remove them from the weather, depending on the anticipated duration of the temporary closure. In addition, Calico will initiate the following actions:

- Additional reagents will not be introduced into any process component during the temporary unplanned closure period. Process piping and pumps will be drained when the process circuits are shut down. Stored equipment will be clearly identified as having contained process solutions.
- Any mine equipment remaining in operation during the temporary closure, including haul trucks, loaders, drills, and personal vehicles will continue to be maintained according to standard company procedure.
- Following any temporary closure period, the fluid management system will be evaluated prior to start-up. Solution tanks, pumps, piping, and ponds will be inspected and repaired as necessary. The mineral processing circuit will be charged with process solution and visually inspected for any evidence of leaks, which includes, but is not limited to the following: piping; secondary containment conditions for cracks; deterioration; torn liners; leak detection ports; tank integrity; meters and gauges; and pumps. All mine equipment will be inspected for compliance with appropriate federal and state mining regulations before mining activities re-commence.

2.5 Monitoring During Periods of Non-Operation

Calico will adhere to all provisions included in the WPCF permit, this IMP, and other regulatory requirements, which may be required during the temporary closure period. Provisions will be made to ensure that reporting continues including operational controls, monitoring, reporting, and notifications including all monitoring, notifications, and report submittals. The site monitoring and monitoring of leak detection systems for the pond, tanks, and piping containing process solution or draindown effluent will continue throughout the temporary closure period. The monitoring may also include inspections of fencing around the facility, building conditions, gates, and signs, as well as for wildlife mortalities.

Appendix L: ODEQ Water Pollution Control Facility Application and Division 43 Permit Application

DEQ USE ONLY

Application #: _____
File #: _____
Mail ID #2 / #9: _____
LLID / RM: _____
ACD Fee Paid: _____
Doc Conf: _____
Notes:

DEQ
State of Oregon Department of Environmental Quality

APPLICATION FOR NEW WATER POLLUTION CONTROL FACILITIES INDIVIDUAL PERMIT

(WPCF-N)

(See pages 4 – 7 for detailed instructions)

State of Oregon
Department of Environmental Quality

DEQ USE ONLY

Date Received: _____
Amount Received: _____
Amt. Due (if any): _____
Check #: _____
Deposit #: _____
Receipt #: _____
☐ IND ☐ DOM
☐ OSS Surcharge: _____

A. Reference Information

1. Legal Name of Applicant: Calico Resources USA Corp
2. Is the applicant the owner of the operation or facility? ◉ Yes ○ No
3. Legal Status of Applicant: ○ Federal ○ State ◉ Public ○ Private ○ Other: _____
4. Name of Facility (if different than legal name): _____
5. Facility SIC Code: 1041 or NAICS Code: _____

B. Facility Location

1. Physical Street Address: 17 miles south of Vale, Oregon, off of Russell Road
   City: Vale State: OR Zip Code: 97918 County: Malheur
2.

Latitude:	Deg.	43	Min.	40	Sec.	27
Longitude:	Deg.	117	Min.	21	Sec.	38

3. Township: 22 South Section: 5, 6, 7, 8 Range: 44 East Tax Lot#: 100 and 101

C. Facility Contacts

1. **Responsible Official**
   Full Name: Carlo Buffone Telephone #: 775-625-3600
   Mailing Address: 665 Anderson Street City: Winnemucca State: NV Zip Code: 89445
   Email Address: carlo@paramountnevada.com
2. **Facility Contact**
   Full Name: Carlo Buffone Telephone #: 775-625-3600
   Mailing Address: 665 Anderson Street City: Winnemucca State: NV Zip Code: 89445
   Email Address: carlo@paramountnevada.com
3. **Invoice Contact**
   Full Name: Carlo Buffone Telephone #: 775-625-3600
   Billing Address: 665 Anderson Street City: Winnemucca State: NV Zip Code: 89445
   Email Address: carlo@paramountnevada.com

D. General Information

1. Briefly describe the proposed facility, type of wastewater, and primary method of wastewater treatment and disposal:

   The Project is an underground precious metal mining operation, with a mill to extract the metal and a tailings facility to strore the processed ore. The mill and tailings facilities are a zero-discharge desing. In addition there will be a septic system with a leach field. Please see text attached to this form for further details.

2. Does the proposed facility include a graywater reuse and disposal system?

   ◉ Yes ○ No

3. Is the proposed facility located within the service boundary of a municipal sanitary sewerage system?

   ○ *Yes ◉ No

   *If "Yes", explain why this discharge is not being connected to a sanitary sewer.

4. Does the proposed facility described in D.1, discharge wastewater to an Underground Injection Control (UIC) System?

   ◉ Yes ○ No

5. Is there any other wash water or wastewater that will be or is being discharged to a UIC system not described in D.1?

   ○ *Yes ◉ No

   *If "Yes", also provide the information required in Section C, Preliminary Engineering Report / Facility Plan for each UIC.

6. Does or will stormwater at the facility be drained to a UIC system other than described by this application?

   ○ *Yes ◉ No

   *If "Yes", also complete UIC Registration Form: Stormwater Drainage Systems (enclosed with this application.

E. Other DEQ or Public Agency Permits

List all other DEQ or public agency permits issued to or applied for this project:

1. DEQ NPDES Stormwater Permit 2. DEQ Air Quality Permit 3. OWRD Dam Permit. Please see attached text for complete list..

F. Preliminary Engineering Report / Facility Plan

Attach two copies of a Preliminary Engineering Report or Facility Plan Report that fully describes the proposed project using written discussion, maps, diagrams, and any other necessary materials. The report must contain the following information (see instructions for more detail):

1. Complete description of the proposal.
2. Location of the project, adjacent facilities, and waterways on a USGS topographic map. Including the location and latitude / longitude for all UIS wastewater systems on this map. Also, provide a tax lot map for this project.
3. Schedule for development, including future expansion plan if applicable.
4. Schematic diagrams of waste streams and treatment / disposal facilities. Include the source and quantity of drainging water and water used for processing or manufacturing.
5. Wastewater characterization.
6. Plans for disposal of solid waste and sledges.
7. Site evaluation report prepared as outlined by OAR 340-071-0150 (on-site sewage disposal systems only).
8. Groundwater information for all areas where wastewater or sludge will be stored or disposed.

9. Evaluation of groundwater and surface water impacts and the steps that will be taken to prevent impacts from occurring
10. Operation and maintenance plan that specifies the normal operation parameters of the system.

G. Land Use Compatibility Statement

Attach a complete Land Use Compatibility Statement (LUCS) signed by the local land use authority. The application will not be processed without evidence that the proposal is approved by the local land use authority and meets statewide planning goals.

H. Underground Injection Control (UIC) Registration

Federal and state regulations require that all UIC systems be registered with DEQ. By completing this application, your wastewater UIC systems (UIC) will be registered with the DEQ and you will be sent a UIC registration conformation letter to be maintained at the facility. You will be informed by DEQ of any additional UIC regulations that are applicable to your UIC system once this application has been reviewed.

I. Signature Of Legally Authorized Representative

I hereby certify that the information contained in the application is true and correct to the best of my knowledge and belief. In addition, I agree to pay all permit fees required by Oregon Administrative rules 340-045 and/or 340-071. This includes a new application fee to obtain the permit and a compliance determination fee invoiced annually by DEQ to maintain the permit.

Carlo Buffone	CEO and Treasurer
Name of Legally Authorized Representative (Type or Print)	Title
C.B.L	11/06/2019
Signature of Legally Authorized Representative	Date

DEQ Use Only

Regional WQ Permit Coordinator Route copy of application and Preliminary Engineering Report / Facility Plan to HQ UIC Coordinator.

Date Sent to HQ and Initials: _____ Date Received by HQ and Initials: _____

EPA Well Type

5A5 Electric Power Generator	**5R21** Aquifer Recharge	**5W20** Industrial Process Water	**5X15** In Situ Fossil (fuel recover)
5A6 Geothermal Heat (open loop)	**5W9** Untreated Sewage	**5W31** Septic System (well disposal)	**5X16** Spent Brine Return Flow
5A7 Closed Loop Heat Pump Return	**5W10** Cesspool	**5W32** Septic System (drain field)	**5X25** Experimental Technology
5A19 Cooling Water Return	**5W11** Septic System (general)	**5X13** Mine Tailing Backfill	**5X26** Aquifer Remediation
5G30 Special Drainage Water	**5W12** Water Treatment Plant Effluent	**5X14** Solution Mining	**5X27** Other Wells

Application Instructions For New WPCF Individual Permit
Oregon Department of Environmental Quality

- **Please answer all questions and submit with the required application fees.**
- **An incomplete application or application with incorrect fees will not be processed.**
- **If the information requested is not applicable, please indicate as such.**

A. Reference Information

1. Enter the legal name of the applicant. The permit will be issued to this entity. This is the person, business, public organization, or other entity that controls the facility described in this application and will be responsible for complying with the conditions of the permit. This must be the legal Oregon name (i.e., Acme Products, Inc.) or the legal representative of the company if it operates under an assumed business name (i.e. John Smith, dba Acme Products). The name must be a legal active name registered with the Oregon Department of Commerce, Corporation Division (503-378-4752), unless otherwise exempted by their regulations
2. Indicate if the applicant is the owner of the facility.
3. Provide the legal status of the applicant. Indicate "public" for a facility solely owned by local government.
4. Enter the common name of the facility or operation if different than the legal name of the applicant.
5. Enter the Standard Industrial Classification (SIC) four-digit code or North American Industry Classification System five or six-digit code (NAICS) for the facility. These codes are used to describe the primary activity at the facility and may be found on fire marshal reports, insurance papers, or tax forms. The NAICS codes replaced the SIC system in 1997, however, it is usually easy to convert between the two systems so either code is acceptable. SIC or NAICS information is also available from the U.S. Census Bureau at 1-888-756-2427 or at http://www.naics.com/search.htm.

B. Facility Location

1. Enter the physical location of the facility (street address, not mailing address), including city, state, zip code, and county.
2. Enter the latitude and longitude of the approximate center of the facility or site in degrees/minutes/seconds. Latitude and longitude can be obtained from DEQ's location finder web site at https://www.oregon.gov/deq/wq/wqpermits/Pages/Tools-and-Data.aspx or from United States Geological Survey (USGS) quadrangle topographic maps by calling toll-free at 1-888-ASK-USGS (1-888-275-8747). For obtaining latitude and longitude from USGS maps, instructions may be obtained from DEQ's web site at http://www.oregon.gov/deq/FilterDocs/latlonginstr.pdf.
3. Enter the Township, Range, Section, and Tax Lot numbers for the regulated site.

C. Facility Contacts

1. Enter the name, telephone number, and mailing address of the Responsible Official. The Responsible Official is the person that receives official correspondence from DEQ, such as renewal notices or notices of noncompliance, and may be contacted if there are questions about this application.
2. Enter the name, telephone number and mailing address of the Facility Contact if different from the Responsible Official. The Facility Contact is the person located at the facility that has specific knowledge of the facility or operation under permit (e.g., the treatment plant operator), and may be contacted if there are specific questions about this application.
3. Enter invoicing information for billing purposes if different from the Responsible Official (e.g., "Invoice To: Business Office - Accounts Payable").

D. General Information

1. Briefly describe the proposed facility, type of wastewater (industrial, sewage or both), and primary method of wastewater treatment and disposal. For example, "2 MGD domestic sewage treatment plant consisting of non-discharging, evaporative lagoons" or "Seasonal jelly processing facility with land irrigation of process wastewater."
2. Indicate if a sanitary sewer system is available to receive this wastewater. If "yes," explain why this discharge is not being connected to sanitary sewer.
3. Indicate if the facility includes a graywater reuse disposal system.
4. Indicate if an Underground Injection Control (UIC) system will be used or is currently used to dispose of wastewater for the proposed facility described in D.1. Wastewater includes wash waster, process wastewater, and/or sewage. The following wastewater disposal systems are considered UICs:
   - Non-residential onsite sewage system with a design flow of 2,5000 gallons per day or designed to serve 20 or more people a day (excluding single-family residential systems)
   - Multi-family residential onsite sewage systems regardless of size.
   - Any onsite sewage system, regardless of size, that receives industrial wastewater
   - Dry wells or sumps
   - Infiltration trenches
   - French drains
   - Industrial wasterwater drain hose
   - Cesspools / sewage drain holes
5. Indicate if there is any other wash water or wastewater at the regulated site that will be or is being discharged to a UIC system not included in the proposed facility description found in D.1. If "yes," also provide the information required in Section F, Preliminary Engineering Report/Facility Plan for each UIC.
6. Indicate if a UIC system other than the one described in this application will be used or is currently used to drain storm water. If "yes," complete the UIC Registration Form: Storm Water Drainage Systems enclosed with this application. The following storm drainage systems are considered UICs:
   - Any UIC wastewater system also used form storm drain
   - Dry wells or sumps
   - Infiltration trenches
   - French drains
   - Storm drain holes

E. Other DEQ or Public Agency Permits

In order for DEQ to coordinate with other DEQ divisions and public agencies, list all permits issued to or applied for this project.

F. Preliminary Engineering Report / Facility Plan

Two copies of a Preliminary Engineering Report or Facility Plan Report must accompany this application and contain the following minimum information:

[***Note:*** When constructing community sewage treatment facilities, also refer to DEQ's Guidelines for Planning Community Wastewater Projects (January 1998) for assistance on developing a facility plan.]

1. A description that includes all aspects of the facility, including services to be provided and activities to be conducted.
2. A USGS topography map that shows the location and scope of the project, locations of adjacent facilities, waterways, wetlands, drainage ways, residential areas, industrial facilities, and commercial areas, including the location and latitude/longitude for all UIC wastewater systems. Also provide a tax lot map for the project.
3. The proposed development and construction schedule. Also include future expansion plans or potential plans.
4. Schematic diagrams that include each waste stream, collection facilities, treatment and control facilities, and ultimate disposal methods for each waste product or wastewater effluent. Include a water balance for each waste stream. If alternatives for treatment are also being considered, they should be included as well. Also include the source and quantity of drinking water and water used for processing or manufacturing if different from drinking water supply.
5. A characterization of the quantity and quality of each waste stream.
6. Plans for collection, storage, and disposal of any sludges generated by the treatment process, including a characterization of volume and quality.

7. For on-site sewage systems only, a site evaluation report prepared as outlined in OAR 340-071-0150 by an Agent of the Department or qualified consultant. The report shall contain, at a minimum, a site diagram and observations of the site characteristics.
8. Groundwater information for all areas where wastewater or sludge will be stored or disposed. The following minimum information is required:
   - Climatic information
   - Topography and soil profile description
   - Flood and erosion potential
   - Ground water aquifer characteristics, including quality and gradient
   - Location of all wells and springs within a ½ mile radius
9. A description of the groundwater and surface water impacts that may occur during construction and operation of the facility. Also details the steps that will be taken to prevent such impacts from occurring.
10. An operation and maintenance plan that specifies the normal operating parameters of the system(s). Include, for example, the length and spacing of dose cycles, gallonage of a dose cycle, and calibration of flow meters or elapsed time meters. The maintenance schedule should address ALL components to be inspected and maintained, together with procedures for doing so. For each item, include the frequency for inspecting it and the maintenance procedure. If available, include the manufacturer's operation and maintenance literature for system components.

G. Land Use Compatibility Statement

A completed Land Use Compatibility Statement (LUCS) signed by the local land use authority must be submitted with this application. The application will not be processed without evidence that the proposal is approved by the local land use authority and meets statewide planning goals. A LUCS form is enclosed with this application.

H. Signature of Legally Authorized Representative

The signature of a legally authorized representative must be provided in order to process this application. See the table below for more information.

Definition of Legally Authorized Representative
Please also provide the information requested in brackets [ ]

- ***Corporation:*** President, Secretary, Treasure, Vice-President, or any person who performs principal business functions; or a manager of one or more facilities that is authorized in accordance to corporate procedure to sign such documents
- ***Partnership:*** General partner [list of general partners, their addresses, telephone numbers, and email address.
- ***City, County, State, Federal, or other Public Facility:*** Principal executive office or ranking elected official.
- ***Limited Liability Company:*** Member [articles of organization]
- ***Trusts:*** Acting trustee [list of trustees, their addresses, telephones numbers, and email address.

Fee and Application Submittal

Please see the cover letter enclosed with this application form or call the appropriate regional office below for fee information and to determine where to send this application. Send this form and fee to the following regional office. Make your check payable to the Department of Environmental Quality.

For Onsite Sewage Systems in Northwest and Western Region

	DEQ Western Region Attn: WPCF-OS 165 East 7th Avenue, Suite 100 Eugene, OR 97401-3049 541-686-7838 or 1-800-844-8467	

For All Other Systems or Facilities

DEQ Northwest Region 700 NE Multnomah St., Suite 600 Portland, OR 97232 503-229-5263 or 1-800-452-4011	**DEQ Western Region** 4026 Fairview Industrial Dr. SE Salem, OR 97302 503-378-8240 or 1-800-349-7677	**DEQ Eastern Region** 800 SE Emigrant Avenue, Suite 330 Pendleton, OR 97801 541-276-4063 or 1-800-452-4011

DEQ Regional and Branch Offices

Submit your Application to the Appropriate Regional Office

Northwest Region Counties

Clackamas	Clatsop	Columbia	Multnomah	Tillamook	Washington

Western Region Counties

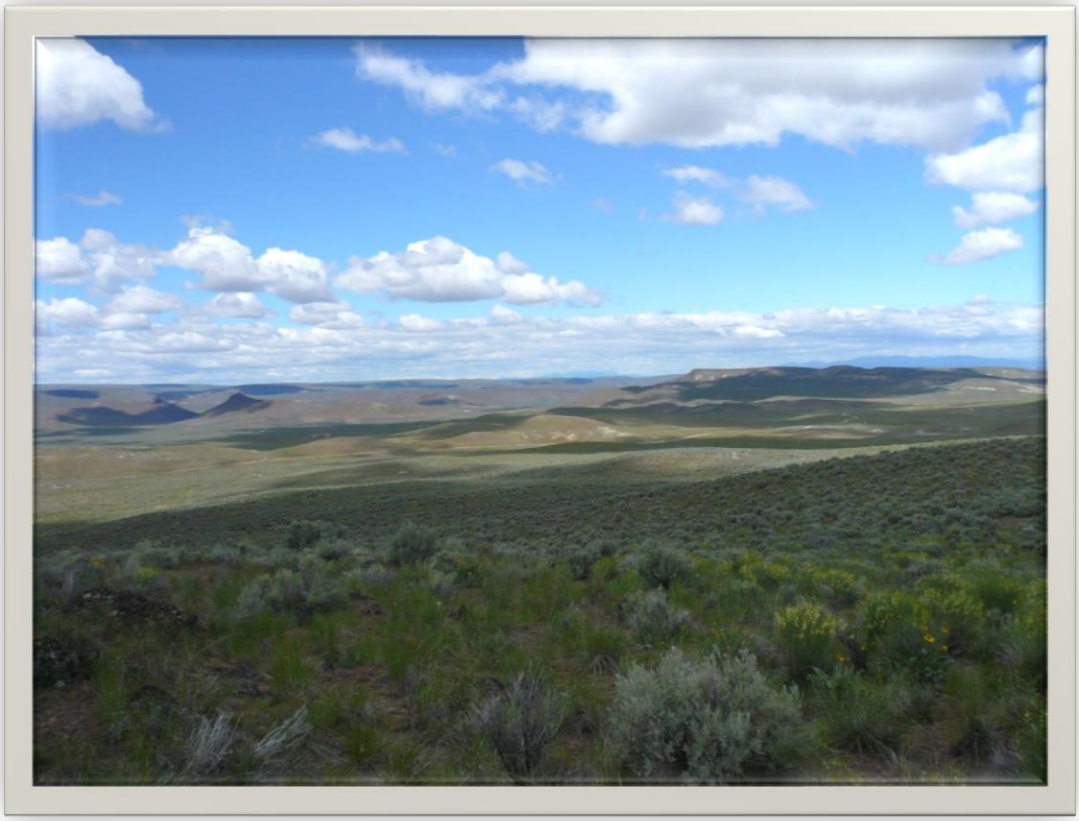
Benton	Coos	Curry	Douglas	Jackson	Josephine
Lane	Lincoln	Linn	Marion	Polk	Yamhill

Eastern Region Counties

Baker	Rook	Deschutes	Gilliam	Grant	Harney
Hood River	Jefferson	Klamath	Lake	Malheur	Morrow
Sherman	Umatilla	Union	Wallowa	Wasco	Wheeler

CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
STATE OF OREGON
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION 43 PERMIT APPLICATION

NOVEMBER 2019



EM STRATEGIES

Reno:
1650 Meadow Wood Lane
Reno, Nevada 89502
Phone: (775) 826-8822 | Fax: (775) 826-8857

Elko:
835 Railroad Street
Elko, Nevada 89801
Phone: (775) 753-9496 | Fax: (775) 826-8857

CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
STATE OF OREGON
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION 43 PERMIT APPLICATION

This Division 43 Permit Application (Application) is submitted as part of the Department of Geology and Mineral Industries (DOGAMI) Division 37 Consolidated Permit Application (CPA) and summarizes the information required by the Department of Environmental Quality (DEQ). Oregon Administrative Rules (OAR)-632-037 make DOGAMI the umbrella agency for the permitting of metal mines, except placer mines and operations using only gravity separation to process ore.

The CPA will be delivered to DOGAMI in paper and digital formats. For ease of addressing the specific topics required by the DEQ, this Application includes references to the sections of the CPA text and appendices that address those topics. Table 1 is a summary of the CPA report organization that will be uploaded to the DOGAMI sharesite for review by all coordinating, commenting, cooperating and permitting agencies.

Table 1. Organization of Grassy CPA on the DOGAMI sharesite

CPA Text	Grassy Mountain Mine Project, State of Oregon, DOGAMI Division 37 Consolidated Permit Application
Appendix A	Oversize Figures
Appendix B	Baseline Studies and Work Plans (to be uploaded to DOGAMI sharesite)
Appendix C	Tailings Design Report
Appendix D	Mill Design Report
Appendix E	Emergency Response Plan
Appendix F	Cyanide Management Plan
Appendix G	Monitoring Plan
Appendix H	Noxious Weed Monitoring and Control Plan
Appendix I	Wildlife Mitigation Plan
Appendix J	Reclamation Cost Estimate
Appendix K	Interim Management Plan
Appendix L	ODEQ Water Pollution Control Facility Application and Division 43 Report
Appendix M	ODEQ Class I Air Quality Operating Permit Application
Appendix N	OWRD Dam Permit Application
Appendix O	ODEQ Storm Water Permit Application
Appendix P	OWRD Water Rights Amendment
Appendix Q	Monitor Well Plan
Appendix R	Malheur County Land Use Compatibility Statement (LUCS)
Appendix S	Portal Design Report
Appendix T	Ecological Risk Assessment
Appendix U	Inadvertent Discovery Plan
Appendix V	Aggregate Application
Appendix W	Alternatives Support Documents
Appendix X	Mining Claim Information
Appendix Y	Stormwater Management Plan
Appendix Z	Petroleum Contaminated Soil Management Plan
Appendix AA	Quality Assurance Plan
Appendix AB	Hazardous Material Reporting
Appendix AC	Road Design Report
Appendix AD	Well Field Design Report
Appendix AE	Water and Wastewater Design

1 INTRODUCTION AND GENERAL INFORMATION

Calico Resources USA Corp. (Calico) proposes to construct, operate, reclaim, and close an underground mining and precious metal milling operation known as the Grassy Mountain Mine Project (Project). The Project is proposed in Township 21 South, Range 44 East (T21S, R44E), and T22S, R44E, Malheur County, Oregon. Additional Project description and location information is below and in the **CPA Text Section 1 and Appendix L of the CPA**.

This Application addresses the specific requirements in DEQ Division 43 (OAR-340-043). The information required is included in the CPA; therefore, this Application serves as a reference guide to the sections of the CPA text and appendices that address each topic (Table 1). The information below and in the CPA, along with the WPCF-N Permit Application (**Appendix L of the CPA**) constitute the Division 43 permit required for chemical mining operations.

Applicant

Operator Name:	Calico Resources USA Corp.
Mailing Address:	665 Anderson Street Winnemucca, Nevada 89445
Phone Number:	(775) 625-3600
Taxpayer Identification Number:	45-2188867
Oregon Registry Number:	78127694

Contact Information

Point of Contact for this Permit Application:

Nancy J. Wolverson
665 Anderson Street
Winnemucca, Nevada 89445
Phone (775) 770-4615

Corporate Point of Contact:

Carlo Buffone
665 Anderson Street
Winnemucca, Nevada 89445
Phone (775) 625-3600

Additional information about the applicant can be found in **CPA Text Section 1 and Appendix L of the CPA.**

Facility Location

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 1 and Figure 2 below). The Permit Area shown in all figures and text shows and

describes the boundary of the proposed Project. The Access Road extends north from the Mine and Process Area to the Malheur County Road named Twin Springs Road.

Additional information about the facility location, contact information, land status and surface ownership can be found in **CPA Text Section 1 and Appendix L of the CPA.**

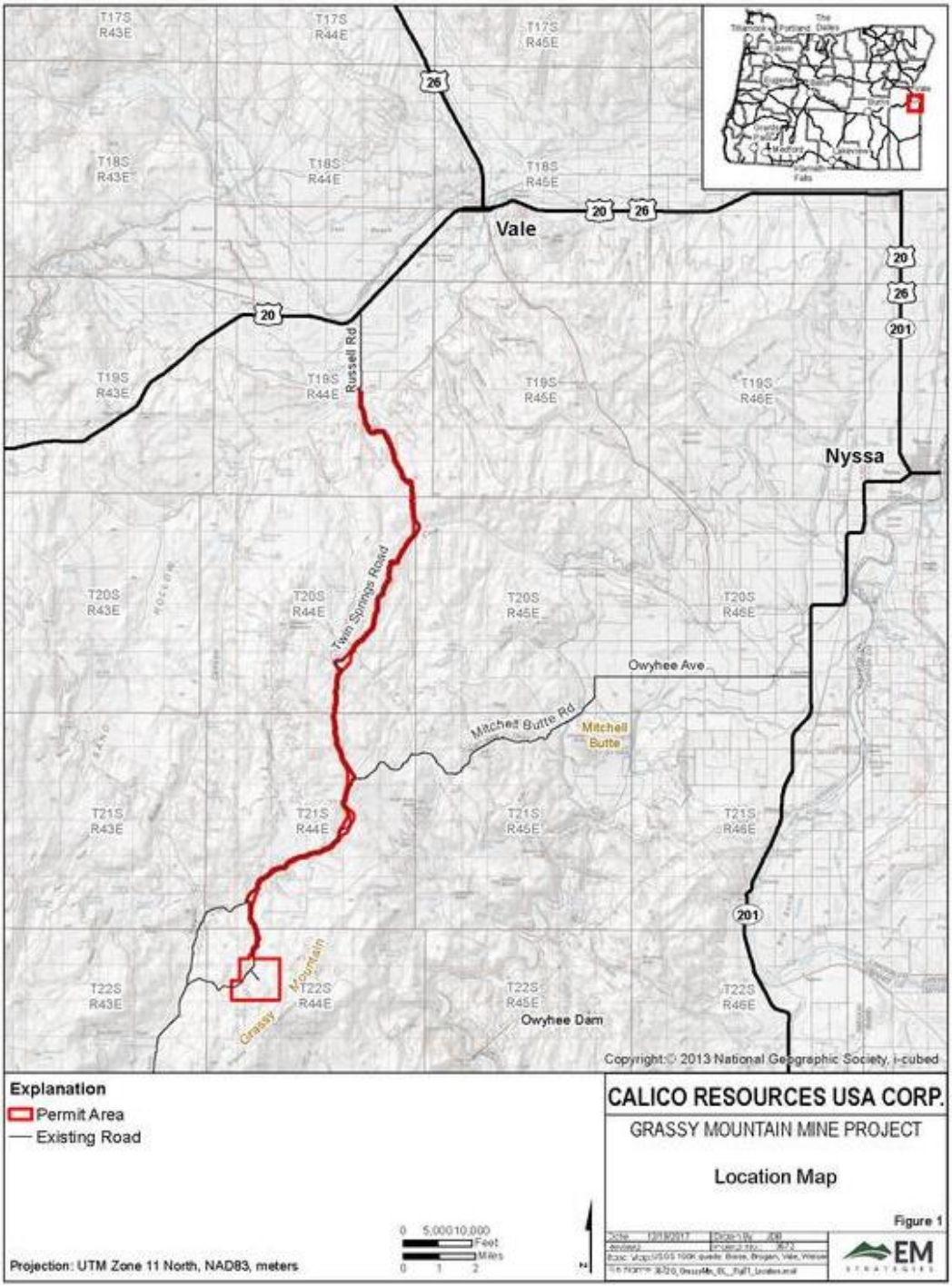


Figure 1. Location Map

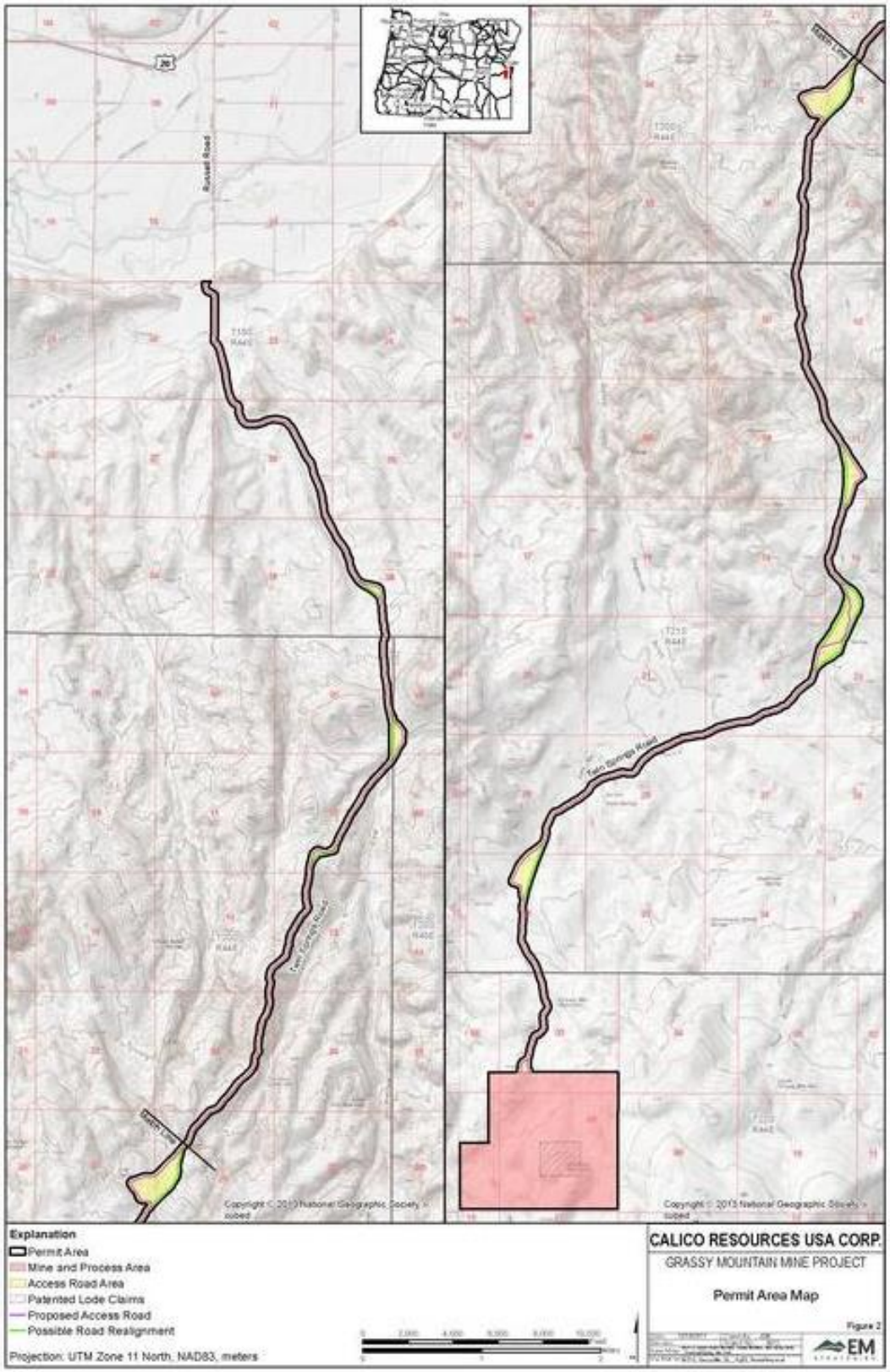


Figure 2. Permit Area Map

2 GENERAL INFORMATION

The Project is an underground precious metal mining operation, with a mill to extract the metal and a tailings facility to store the processed ore. The mill and tailings facilities are a zero-discharge design. In addition, there will be a septic system with a leach field.

The mining operation, including processing and mine tailings management are described in **CPA Text Section 3 and Appendices C, D, L, N, O, S, V, AC, AD, and AE of the CPA**. A complete description and a set of drawings for the planned Water and Wastewater facilities are in **Appendix AE of the CPA.**

3 LIST OF PERMITS ASSOCIATED WITH THE PROJECT

Table 2 Permits Associated with the Project

Permit	Regulatory Agency
Air Quality Operating Permits	Oregon Department of Environmental Quality, Bureau of Air Pollution Control
Chemical Mining Permit	Oregon Department of Environmental Quality
Chemical Process Mines Permit	Oregon Department of Geology and Mineral Industries
Permit to Appropriate Water	Oregon Water Resources Department
General Discharge Permit (Storm Water)	Oregon Department of Environmental Quality
Dam Safety Permit	Oregon Water Resources Department
Air Quality Operating Permit	Oregon Department of Environmental Quality
Hazardous Waste Identification Number	United States Environmental Protection Agency
Plan of Operations/Record of Decision	United States Department of the Interior, Bureau of Land Management
Explosives Permit	United States Department of the Treasury, Bureau of Alcohol, Tobacco, Firearms, and Explosives

4 DESCRIPTION OF THE SITE

In general, the proposed mining and precious metal processing operations will consist of an underground mine and ore processing facilities, including a conventional mill and tailings storage facility (TSF), and waste rock storage areas, as well as other support facilities. The Project will include the following major components (**Error! Reference source not found.**3):

- One underground mine;
- One waste rock storage area;
- One carbon-in-leach (CIL) processing plant;
- One borrow pit area;
- One Tailings Storage Facility (TSF);
- Run-of-mine (ROM) ore stockpile;

- One reclaim pond;
- A water supply well field and pipeline, associated water delivery pipelines, and power;
- A power substation and distribution system;
- One ventilation shaft;
- Access and haul roads;
- Ancillary facilities that include the following: haul, secondary, and exploration roads; truck workshop; warehouse; stormwater diversions; sediment control basins; reagent and fuel storage; storage and laydown yards; explosive magazines; fresh water storage; monitoring wells; meteorological station, an administration/security building; borrow areas; growth media stockpiles; and solid and hazardous waste management facilities to manage wastes; and
- Reclamation and closure, including the potential development of an Evaporation Cell (E-Cell) for the TSF.

Calico proposes to mine approximately three million tons (mtons) of mill-grade ore and 0.2 mtons of waste rock (total of 3.2 mtons). The material (both ore and waste) will be extracted from the underground mine using conventional underground mining techniques of drilling, blasting, mucking, loading, and hauling.

A complete description of the site is included in the **CPA Text, along with detail on the specific topics in the Appendices**.

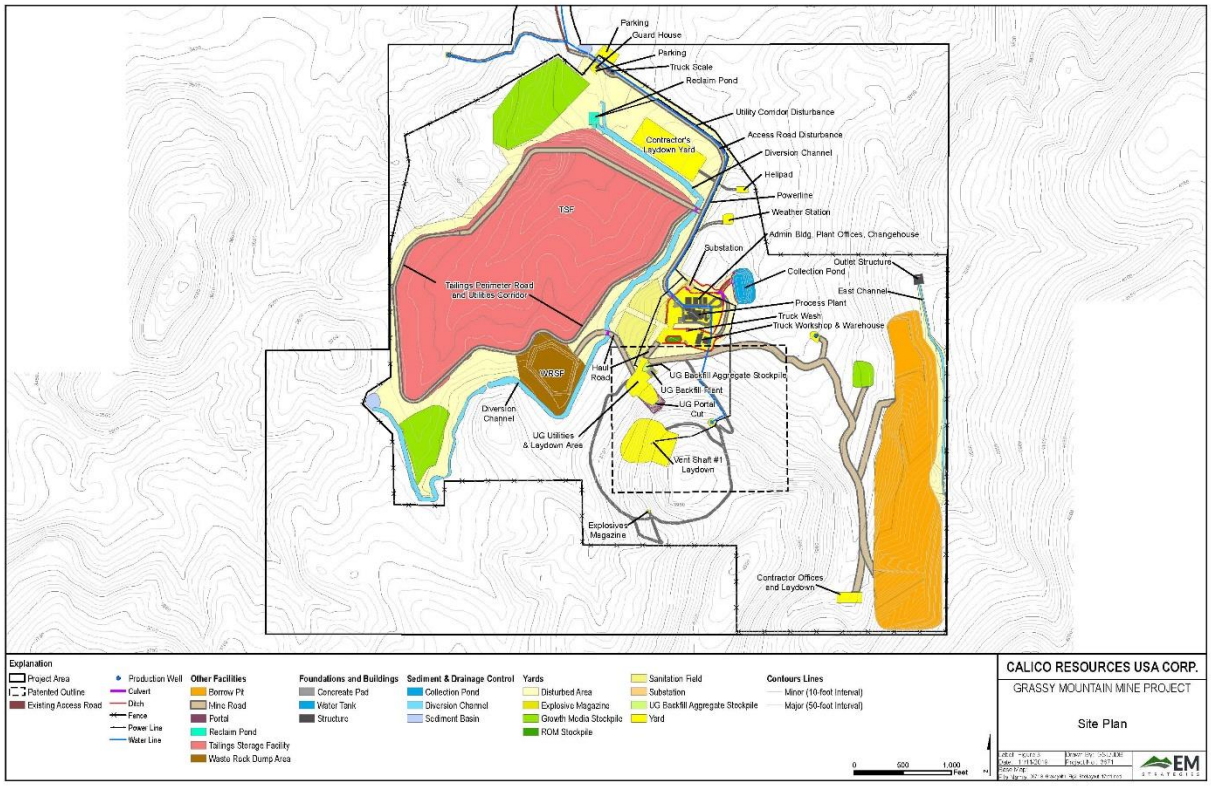


Figure 3 Project general arrangement map

5 SITE CONDITIONS (BASELINE DATA REPORTS)

The Baseline Data Reports (BDRs) and the Environmental Baseline Study Work Plans (September 22, 2017) (Work Plans) are in **Appendix B of the CPA**.

The following BDRs are included in **Appendix B of the CPA**:

- Air Quality Resources
- Aquatic Resources
- Areas of Critical Environmental Concern/Research Natural Areas
- Cultural Resources
- Environmental Justice
- Geochemistry
- Geology and Soils
- Grazing Management
- Groundwater
- Land Use
- Noise
- Oregon Natural Heritage Plan Areas
- Outstanding Natural Areas
- Recreation
- Socioeconomics
- Surface Water
- Terrestrial Vegetation
- Transportation
- Visual Resources
- Wetlands
- Wild, Scenic or Recreational Rivers
- Wildlife Resources

Individual BDRs are referenced in this application, as needed for clarity.

Specific site condition topics listed below from OAR 340-043, are shown with reference to the corresponding section (s) and appendices of the CPA which address the topic in detail.

- Climate/meteorology characterization, with supporting data (**Appendix C of the CPA**)
- Soils characterization, with supporting data (**Appendix B; Geology and Soils BDR**)
- Surface Water hydrology study, with supporting data (**Appendix B; Surface Water BDR**)
- Characterization of surface and groundwater quality (**Appendix B; Surface Water BDR and Groundwater BDR**)
- Inventory of surface water and groundwater beneficial uses (**Appendix B; Surface Water BDR and Groundwater BDR**)

- Hydrogeologic characterization of groundwater with supporting data (**Appendix B; Groundwater BDR**)
- Geologic engineering, hazards and geotechnical study with supporting data (**CPA Text Section 3 and Appendix C of the CPA**)
- Characterization of mine materials and wastes (**Appendix B; Geochemistry BDR and Appendix T of the CPA**). Includes discussion on the following in relation to overburden, waste rock, stockpiled ore and mine tailings:
    - chemical and mineral analysis related to toxicity,
    - determination of the potential for acid water formation,
    - determination of the potential for long-term leaching of toxic materials from the wastes;
- Characterization of wastewater produced by the operation, including quantity, chemical quality and physical quality (**Appendix AE of the CPA**)
    - Quantity
    - Chemical quality
    - Physical quality
- Assessment of potential for acid-water formation from waste disposal facilities, low grade stockpiles and waste rock piles (**Appendix B; Geochemistry BDR and Appendix T of the CPA**)

6 ANALYSIS OF HOW THE PROPOSED OPERATION WILL AFFECT THE SITE AND THE ENVIRONMENT

The Project is designed as a zero-discharge facility.

The TSF is designed as a zero-discharge facility capable of storing the 500-year, 24-hour storm event and an allowance for wave action and to meet the minimum requirements for a Low Hazard Dam. Permanent and temporary stormwater diversions will collect and divert a majority of the stormwater runoff around the facility to a natural drainage on the north side of the TSF. The TSF will be a continuous geomembrane-lined facility with continuous primary and secondary containment. A network of perforated pipes will capture and convey underflow via gravity to the reclaim pond located downstream of the main embankment. Water from the reclaim pond will be pumped back to the mill for reuse in the process circuit. For details on the design of the TSF and Storm Water Management see **Appendices C and Y of the CPA**.

The design of the Mill and Processing is also zero-discharge. The containment strategy associated with the process plant can be divided between the containment of process flows and reagents, and the collection and containment of surface contact water. Each containment area is located on a cast in-situ concrete slab, which will have curbs providing the required containment volume. Diversion ditches will be constructed above plant infrastructure where required to prevent runoff from entering the process plant areas. Precipitation that falls directly on the pad will be collected in a system of ditches and culverts and directed by gravity towards the collection pond. Details of the design of the Mill and Processing area, including the containment details and stormwater management, see **Appendices D and Y of the CPA**.

The Mining Operation is also designed for zero-discharge. When groundwater is encountered during mining, it will be collected, taken to the surface and used in the processing circuit, as needed. The mine will be backfilled as each level is mined out with material that is not acid-generating, either basalt from the borrow pit on the east side of the Permit Area, or cemented waste rock from the mining operation. For details of the mining operation and the testwork that has been completed to evaluate the groundwater, waste rock and basalt, see **CPA Text Section 3 and Appendix B (Geochemistry and Groundwater BDRs) of the CPA**.

Reclamation and Closure plans are described in **CPA Text Section 4 of the CPA**. Additionally, Operational Environmental Protection Measures are described in **CPA Text Section 3.6**. Also refer to **Appendices E, F, G, H, I, K, T, Y, Z, AA, and AB.** Additionally, a Post-Reclamation Topography Map is included in **Appendix A of the CPA.**

As part of the CPA process, DOGAMI will be completing an Environmental Evaluation (EE) (OAR-632-037-0085), which will address the impacts to the environment based on the information submitted in the CPA.

7 PLANS AND SPECIFICATIONS

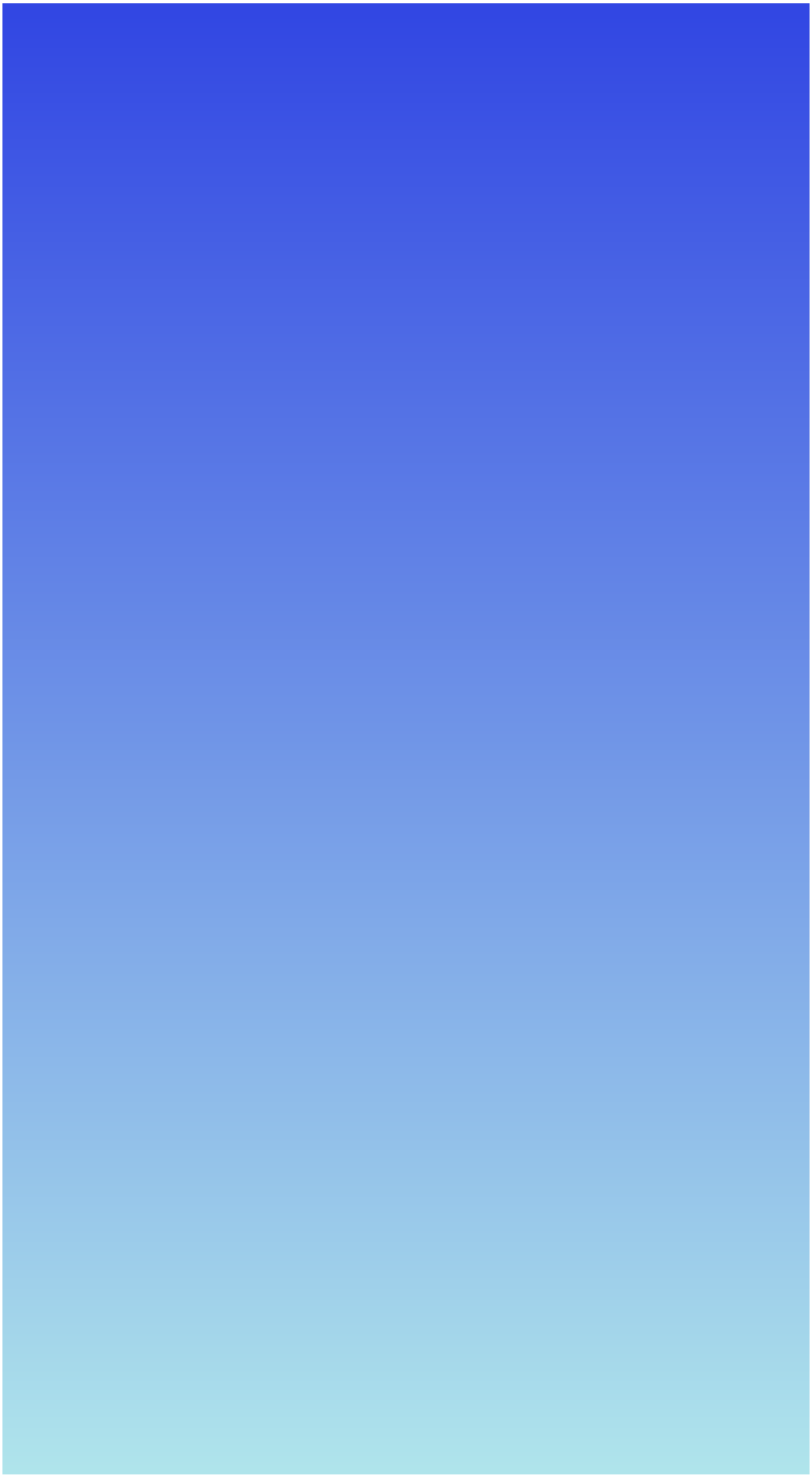
Description of the facilities to be constructed, including the following specific topics shown with reference to the section (s) and appendices of the CPA that describe the topic in detail (**CPA Text Section 3, Appendices C, D, L, Q, S, V, AD and AE of the CPA**).

- Tanks (**Appendix D**)
- Pipes and other storage and conveyance means for processing chemicals and solution wastewaters (**Appendices C and D of the CPA**)
    - All chemical conveyances (ditches, troughs, pipes, etc.) shall be equipped with secondary containment and leak detection means for preventing and detecting release of chemicals to surface water, groundwater or soils.
- Management plan for control of surface water (**Appendix O and Y of the CPA**)
- Management for treatment of excess wastewater (**Appendix AE of the CPA**)
    - Include provision for reuse and wastewater minimization
- Facility construction plan including, as applicable (**Appendix C of the CPA**):
    - Low-permeability soils barriers,
    - Types of geosynthetics to be use and a description of their installation methods
    - Design of wastewater treatment facilities and processes,
- Quality assurance plan for applicable phases of construction (**Appendix AA of the CPA**)
- Preliminary closure plan (**CPA Text Section 4, Appendices C, D, and V of the CPA**)
- Preliminary post-closure monitoring plan (**CPA Text Section 4.9, Appendices C, G, V, Y of the CPA**)
- Preliminary post-closure maintenance plan (**CPA Text Section 4.9**)
- Spill containment and control plan (**CPA Text Section 4, Appendices E, Z, AB of the CPA**)

8 DESIGN, CONSTRUCTION, OPERATION AND CLOSURE REQUIREMENTS

- Design, construction, operation and closure requirements for: (**CPA Text Section 3, Appendices C, D, S, V, AD and AE**)
    - Chemical process facilities
    - Waste disposal facilities
    - Mixing, distribution and application of chemicals associated with mining operations d. Ore preparation and beneficiation facilities
    - Process ore facilities
- Alternative facilities may be approved by the DEQ (**CPA Text Section 5 of the CPA**)
    - Applicant must demonstrate that alternatives will provide equivalent or better environmental protection; burden of proof is with the applicant
    - Written approval required
- Groundwater monitoring plan (**Appendix Q**)
    - Monitoring wells shall be installed for detection of groundwater contamination as required by OAR Ch340, Div40

Appendix M: ODEQ Class I Air Quality Operating Permit Application



AIR SCIENCES INC.

DENVER • PORTLAND • LOS ANGELES

Grassy Mountain Mine Standard Air Contaminant Discharge Permit Application

PREPARED FOR:
CALICO RESOURCES, INC.

PROJECT NO. 343-1
AUGUST 2, 2019

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1.0 Application Forms 1
1.1 AQ100 Series Forms 1
1.2 AQ200 and AQ300 Series Forms 1
1.3 AQ400 Series Forms 35
2.0 References 53

Attachments

Attachment A – Emissions Inventory Worksheets
Attachment B – Modeling Report and CAO Risk Assessment Work Plan

1.0 APPLICATION FORMS

The Oregon Department of Environmental Quality application forms are provided here for the Standard Air Contaminant Discharge Permit (ACDP) application for the Calico Resources, Inc. Grassy Mountain Mine project.

1.1 AQ100 Series Forms

The following forms provide administrative information for the project, including location, process flows, emission points, and fee calculations.

State of Oregon Department of Environmental Quality

Cleaner Air Oregon Pre-Application Fee Form

Form AQ100CAO

For DEQ Use Only			
Permit Number:	Type of Application:		
Application Number:			
Date Received:			
Regional Office HQ-14 AQ I CAO	Check No.:	Amount:	

1. Company Information	**2. Facility Location Information**
Legal Name: Calico Resources USA Corp	Name: Grassy Mountain Mine
Mailing Address: 665 Anderson Street	Street Address: (T21S, R44E)
City, State, ZIP Code Winnemuca, NV 89445	City, County, ZIP Code: Malheur County
3. Site Contact Person	**4. Industrial Classification Code(s)**
Name: Nancy Wolverson	Primary SIC and NAICS: 1041 10410103
Title: Authorized Field Representative	Secondary SIC and NAICS: 10410202
Telephone number: (775) 625-3600	**5. Other DEQ Permits**
Fax number: N/A	N/A
Email address: nancy@paramountnevada.com	

6. Permit Action:

		√	Title V or Standard ACDP	√	Simple ACDP	√	General or Basic ACDP
1	Existing Source Call-In Fee		$10,000		$1,000		$500
2	New Source Consulting Fee *In conjunction, a new source must also submit an Emissions Inventory (AQ405CAO) form to the appropriate regional office.	✓	$12,000		$1,900		$1,000

Please attach a check payable to Oregon Dept. of Environmental Quality, and mail to:

Oregon Dept. of Environmental Quality
Financial Services - Revenue Section
700 NE Multnomah St., Suite 600
Portland, Oregon 97232-4100

If you don't know which permit type applies to your facility, please contact DEQ. Contact information can be found here: www.oregon.gov/deq/aq/aqPermits/Pages/Contacts.aspx

DEQ
State of Oregon Department of Environmental Quality

Administrative Information

FORM AQ101
ANSWER SHEET

FOR DEQ USE ONLY	
Permit Number:	Type of Application:
Application No:	RNW☐ MOD☐ NEW☐ EXT☐
Date Received :	
Regional Office:	Check No. Amount $

1. Company	2. Facility Location
Legal Name: Calico Resources USA Corp	Name: Grassy Mountain Mine
Mailing Address: 665 Anderson Street	Street Address: (T21S, R44E)
City, State, Zip Code: Winnemuca, NV 89445	City, County, Zip Code: Malheur County
Number of employees (corporate):	Number of employees (facility):
3. Facilty Contact Person	**4. Industrial Classification Code(s)**
Name: Nancy Wolverson	Primary SIC and NAICS: 1041 10410103
Title: Authorized Field Representative	Secondary SIC and NAICS: 10410202
Telephone number: (775) 625-3600	**5. Other DEQ Permits** N/A
Fax. number: N/A	
e-mail address: nancy@paramountnevada.com	

6. Permit Action:

- ☐ Short Term Activity ACDP
- ☐ New Simple ACDP
- ☐ New Construction ACDP
- ☒ New Standard ACDP
- ☐ New Standard ACDP (PSD/NSR)
- ☐ Renewal of an existing permit without changes (include form AQ403 for Standard ACDPs)
- ☐ Renewal of an existing permit with changes (include form AQ403 for Standard ACDPs)
- ☐ Revision (or Modification) to an existing permit application

7. Signature

I hereby apply for permission to discharge air contaminants in the State of Oregon, as stated or described in this application, and certify that the information contained in this application and the schedules and exhibits appended hereto, are true and correct to the best of my knowledge and belief.

CARLO BUFFONE	TREASURER 775-625-3600
Name of official (Printed or Typed)	Title of official and phone number
C. Buffone	AUGUST 30, 2019
Signature of official	Date

FEE INFORMATION
(Make the check payable to DEQ)

Note: The initial application fees and annual fees specified below (OAR 340-216-8020, Table 2, Parts 1 and 2) are only required for initial permit applications. These fees are not required for an application to renew or modify an existing permit. The appropriate specific activity fee(s) specified below (OAR 340-216-8020, Table 2, Part 3) applies to permit modifications or may be in addition to initial permit application fees.

OAR 340-216-8020, Table 2, Part 1 – INITIAL PERMITTING APPLICATION FEES:		
Short Term Activity ACDP	☐	$3,600.00
Basic ACDP	☐	$144.00
Assignment to General ACDP	☐	$1,440.00
Simple ACDP	☐	$7,200.00
Construction ACDP	☐	$11,520.00
Standard ACDP	☒	$14,400.00
Standard ACDP (Major NSR or Type A State NSR)	☐	$50,400.00
OAR 340-216-8020, TABLE 2, PART 2 - ANNUAL FEES:		
Simple ACDP – Low Fee Class	☐	$2,304.00
Simple ACDP – High Fee Class	☐	$4,608.00
Standard ACDP	☐	$9,216.00
OAR 340-216-8020, TABLE 2, PART 3 - SPECIFIC ACTIVITY FEES:		
Non-Technical Permit Modification	☐	$432.00
Basic Technical Permit Modification	☐	$432.00
Simple Technical Permit Modification	☐	$1,440.00
Moderate Technical Permit Modification	☐	$7,200.00
Complex Technical Permit Modification	☐	$14,400.00
Major NSR or type A State NSR Permit Modification	☐	$50,400.00
Modeling review (outside Major NSR or Type A State NSR)	☐	$7,200.00
Public Hearing at Source's Request	☐	$2,880.00
State MACT Determination	☐	$7,200.00
TOTAL FEES		**0**

Submit two copies of the completed application to:

New or Modified Permits (include fees):	**Permit Renewals (no fees):**
Oregon Department of Environmental Quality Financial Services - Revenue Section 700 NE Multnomah St., Suite 600 Portland, OR 97232-4100	Oregon Department of Environmental Quality Air Quality Program, Eastern Region Office 475 NE Bellevue Drive, Suite 110 Bend, OR 97701-7415

Administrative Information

CONTACT LIST

1. Company Information:

Legal Name:	Other company name (if different than legal name):
Calico Resources USA Corp	N/A

2. Site Contact Person: *(A person who deals with DEQ staff about equipment problems.)*

Name:	Telephone number:
Nancy Wolverson	(775) 625-3600
Title:	Email address:
Authorized Field Representative	nancy@paramountnevada.com

3. Facility Contact Person: *(If other than the site contact person, a person involved with all environmental issues at the facility although they may be housed at a different site.)*

Name:	Telephone number:
See Site Contact Person	
Title:	Email address:

4. Mailing Contact Person: *(If other than the site contact person, a person to whom the company would like all agency communications directed.)*

Name:	Telephone number:
See Site Contact Person	
Title:	Email address:

5. Invoice Contact Person: *(If other than the site contact person, a valid contact information to which invoices and communications related to resolving invoice questions can be directed.)*

Name:	Telephone number:
See Site Contact Person	
Title:	Email address:

State of Oregon
Department of
Environmental
Quality

FACILITY DESCRIPTION

FORM AQ102
ANSWER SHEET

Facility Name: Grassy Mountain Mine Permit Number: N/A

1. Description of facility and processes:

See attached description.

2. Attach plot plan.

3. Attach process flow diagram.

4. Attach a city map or drawing showing the facility location.

Description of Facility and Processes:

The Project consists of an underground gold and silver ore mine using the Drift and Fill method, and a process facility to mill, refine, and melt gold and silver ore into doré bars for further processing off-site.

The underground mine will be developed by blasting, using emulsion, a level access tunnel and then mining drifts off of the main tunnel. As ore is removed, backfill from a nearby borrow pit will be hauled in to fill the drifts. Cemented rock fill (CRF) will be used for a portion of the backfill, requiring a batch cement plant at the surface. A mobile crushing unit will crush borrow material in the borrow pit, and material will be loaded and hauled to the waste rock storage facility, the CRF plant, or directly underground.

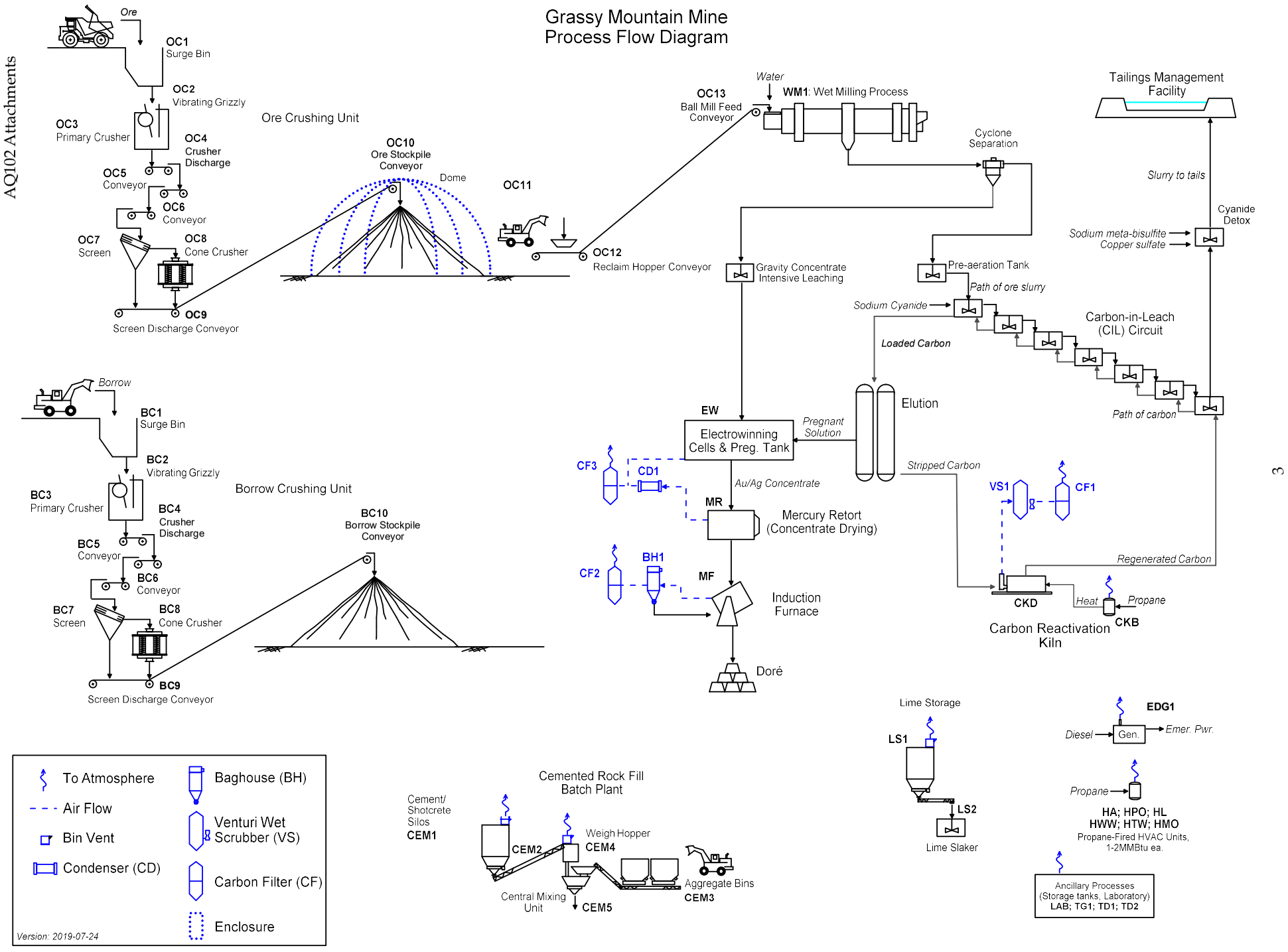
Ore removed from the mine is dumped by haul trucks directly into a mobile crushing unit that consists of a primary jaw crusher and a secondary screening/cone crusher unit. Crushed ore is then conveyed to a covered ore stockpile. A front-end loader transfers stockpiled ore to the mill via a feed conveyor; from here, the process is a closed, wet process. Milled ore is cycloned to separate free gold in coarse ore that will be extracted in a gravity concentrate intensive leaching process; the remaining ore slurry is sent directly to the carbon-in-leach (CIL) process.

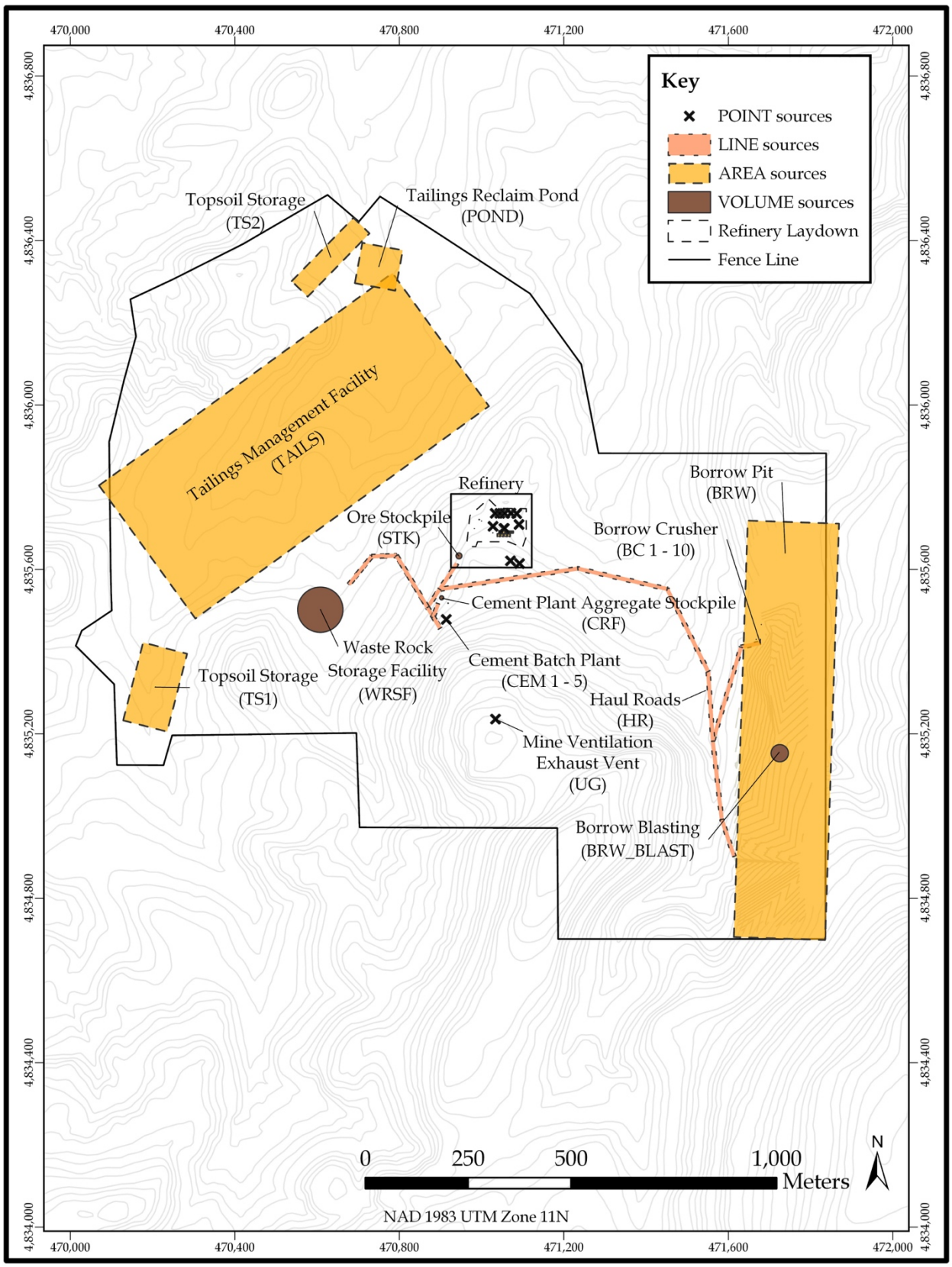
The CIL circuit consists of a pre-aeration tank and a series of 7 CIL tanks. Lime is added during pre-aeration to control pH, and cyanide is added to the first CIL tank. Leached gold and silver will be adsorbed onto granular carbon, which is present in all tanks. Slurry advances through each of the 7 tanks, once per day. Barren carbon is added to the last tank and flows through the circuit in the opposite direction: loaded carbon extracted for the elution process is removed from tank 1. The elution process strips gold and silver from the carbon into solution. Pregnant solution (solution loaded with gold and silver) is transferred to the gold room, and stripped carbon is regenerated in the propane-fired carbon regeneration kiln before being recycled for the leach process. Some carbon loss occurs during heating in the kiln, and new carbon is added along with regenerated carbon to CIL tank 7.

The gold room will house the electrowinning cells, retort, induction furnace, and associated support equipment. In the electrowinning cells, gold and silver are plated onto cathodes using electrolysis. Periodically, the electrowinning cells will be opened and the sludge cleaned out manually with a high-pressure spray gun. Sludge from the cells will flow by gravity to the electrowinning-sludge-filter feed tank and into manually operated pressure canister filters to be dewatered. Dewatered sludge is to be collected in trays and placed in the mercury retort to dry the sludge and remove mercury. Dried sludge will be removed from the retort and combined with fluxes in a flux mixer before being charged into the melting furnace, where the sludge is melted and poured into doré bars.

The CIL tailings will be pumped to the 2-stage agitated cyanide-detoxification tanks, where lime will be added to buffer pH, copper sulfate will be added as a reaction catalyst, and sodium meta-bisulfite will be added. Detoxified slurry will overflow the second detoxification tank to the final tailings pump box where it will be pumped to the tailings management facility by the final tailings pumps.

Grassy Mountain Mine
Process Flow Diagram




Key
POINT sources
LINE sources
AREA sources
VOLUME sources
Refinery Laydown
Fence Line
Topsoil Storage (TS2)
Tailings Reclaim Pond (POND)
Tailings Management Facility (TAILS)
Refinery
Ore Stockpile (STK)
Borrow Pit (BRW)
Borrow Crusher (BC 1 - 10)
Cement Plant Aggregate Stockpile (CRF)
Waste Rock Storage Facility (WRSF)
Cement Batch Plant (CEM 1 - 5)
Topsoil Storage (TS1)
Haul Roads (HR)
Mine Ventilation Exhaust Vent (UG)
Borrow Blasting (BRW_BLAST)
0 250 500 1,000 Meters
N
NAD 1983 UTM Zone 11N
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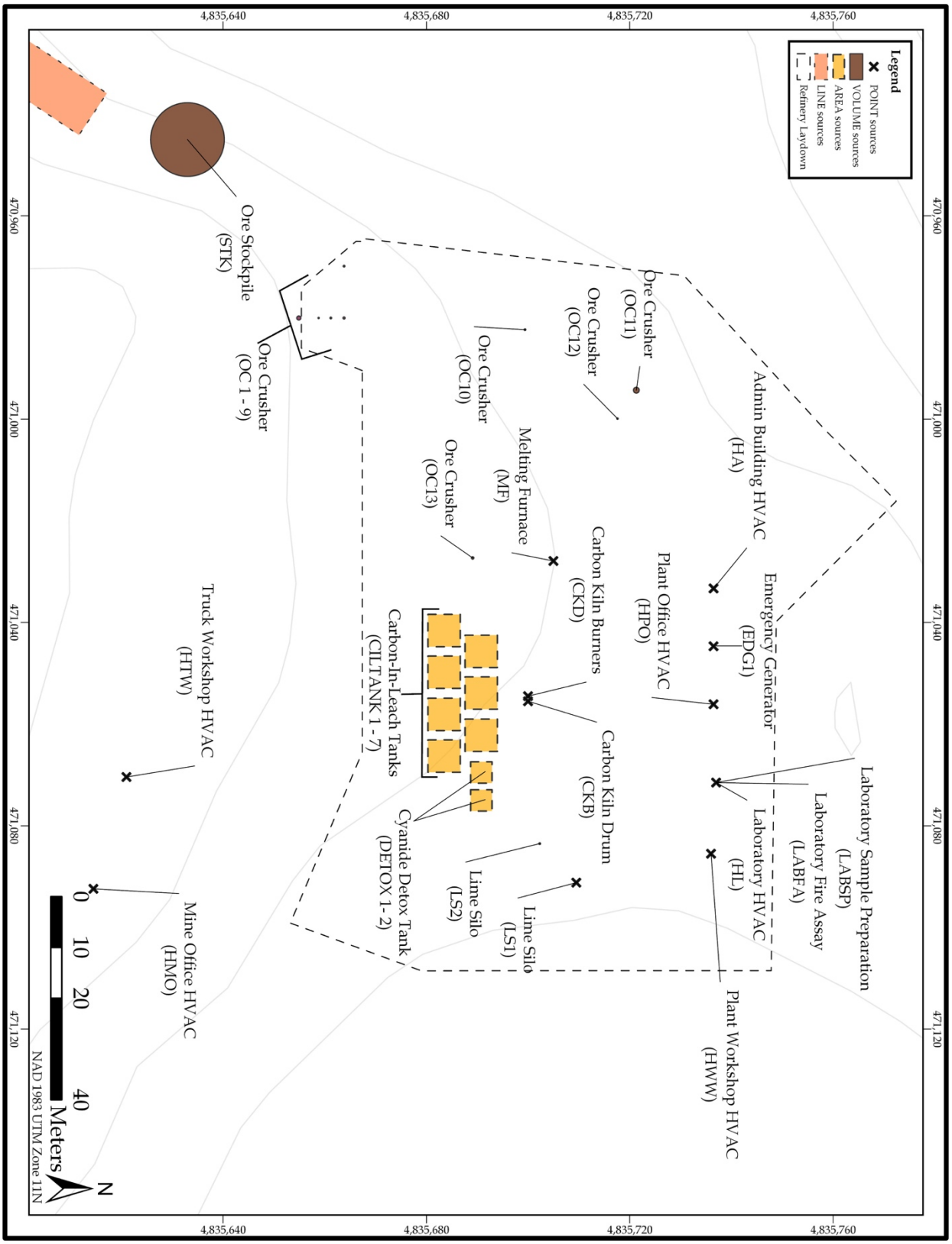
Legend
POINT sources
VOLUME sources
AREA sources
LINE sources
Refinery Laydown
4,835,640
4,835,680
4,835,720
4,835,760
470,960
471,000
471,040
471,080
471,120
Ore Stockpile (STK)
Ore Crusher (OC 1 - 9)
Ore Crusher (OC11)
Ore Crusher (OC12)
Ore Crusher (OC10)
Ore Crusher (OC13)
Melting Furnace (MF)
Admin Building HVAC (HA)
Plant Office HVAC (HPO)
Emergency Generator (EDG1)
Carbon Kiln Burners (CKD)
Carbon Kiln Drum (CKB)
Carbon-In-Leach Tanks (CILTANK 1 - 7)
Cyanide Detox Tank (DETOX 1- 2)
Lime Silo (LS1)
Lime Silo (LS2)
Laboratory Sample Preparation (LABSP)
Laboratory Fire Assay (LABFA)
Laboratory HVAC (HL)
Plant Workshop HVAC (HWW)
Truck Workshop HVAC (HTW)
Mine Office HVAC (HMO)
0 10 20 40 Meters
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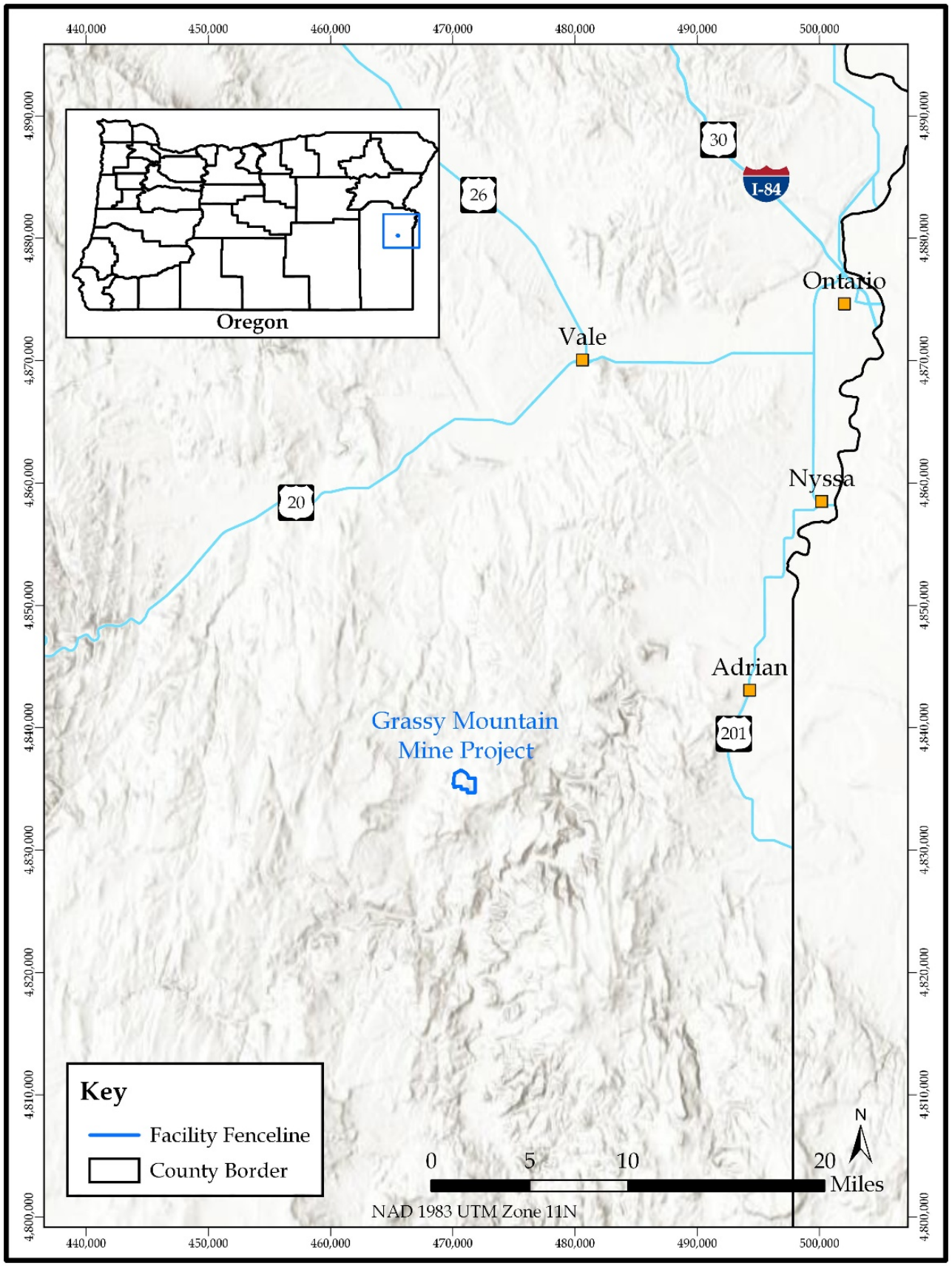
NAD 1983 UTM Zone 11N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4,830,000
4,820,000
4,810,000
4,800,000
Oregon
26
30
I-84
Ontario
Vale
Nyssa
20
Adrian
201
Grassy Mountain
Mine Project
Key
Facility Fenceline
County Border
0
5
10
20
Miles
N
NAD 1983 UTM Zone 11N

1.2 AQ200 and AQ300 Series Forms

The following forms provide process and control device information for the project.

Facility Name: Grassy Mountain Mine Permit Number: N/A

Plant Information

Device ID: BC

1.	Portable plant? (yes/no)			YES
2.	Date installed at current location			TBD
3.	Manufacturer and date manufactured			TBD
4.	Crusher heads: (number of each)			
	Jaws	1	Roll	0
	Cones	1	Other (specify)	N/A
5.	Plant electrical power supply (e.g., on-site generator or electric service company). If generators are used, complete form AQ213.			Electric Service Company

Projected Operating Schedule

6. Hours of operation:	Hours/day	Days/week	Weeks/year	**Total** hours/year
Primary schedule	12	7	37	3120
Secondary schedule	N/A	N/A	N/A	

Production Information

7.	Design Capacity (tons/hour)	93
8.	Projected maximum (tons/hour)	93
9.	Projected maximum (tons/year)	289800

Dust Control Information

10. You will be required to control dust at the plant site, including dust from product manufacture, receipt, movement, and loading of materials, and dust from interior and access roads. Describe how you will accomplish this.

Emissions calculations assume no dust control, however, dust will be controlled by best management practices, including periodic wetting of borrow stockpile.

Waste Process Water

11.	A permit to discharge and/or store process wastewater may be required. Do you have, or have you applied for such a permit from DEQ? (yes/no)	NO
	If "no", have you contacted your Region's water quality section? (yes/no)	NO

State of Oregon Department of Environmental Quality

FORM AQ203
ROCK CRUSHER **ANSWER SHEET**

Facility Name: Grassy Mountain Mine Device ID: OC Permit Number: N/A

Plant Information

Device ID: OC

1.	Portable plant? (yes/no)			NO
2.	Date installed at current location			TBD
3.	Manufacturer and date manufactured			TBD
4.	Crusher heads: (number of each)			
	Jaws	1	Roll	0
	Cones	1	Other (specify)	N/A
5.	Plant electrical power supply (e.g., on-site generator or electric service company). If generators are used, complete form AQ213.			Electric Service Company

Projected Operating Schedule

6. Hours of operation:	Hours/day	Days/week	Weeks/year	**Total** hours/year
Primary schedule	24	7	52	8760
Secondary schedule	N/A	N/A	N/A	

Production Information

7.	Design Capacity (tons/hour)	33
8.	Projected maximum (tons/hour)	33
9.	Projected maximum (tons/year)	289700

Dust Control Information

10. You will be required to control dust at the plant site, including dust from product manufacture, receipt, movement, and loading of materials, and dust from interior and access roads. Describe how you will accomplish this.

Wet ore from underground mine will be fed to crusher. Moisture inherent in ore will control dust.

Waste Process Water

11.	A permit to discharge and/or store process wastewater may be required. Do you have, or have you applied for such a permit from DEQ? (yes/no)	NO
	If "no", have you contacted your Region's water quality section? (yes/no)	NO

Facility Name: Grassy Mountain Mine Permit Number: N/A

Plant Information

Device ID: CEM

1. Portable plant? (yes/no)	No
2. Date installed at current location	TBD
3. Manufacturer and date manufactured	Simem Eagle 7000
4. Truck mixed, central mixed, or dry batch?	Central Mix
5. Plant electrical power supply (e.g., on-site generator or electric service company). If generators are used, complete form AQ213.	Electric Service Company

Projected Operating Schedule

6. Hours of operation:	Hours/day	Days/week	Weeks/year	**Total** hours/year
Primary schedule	24	7	52	8760
Secondary schedule	N/A	N/A	N/A	

Production Information

7. Design Capacity (cubic yards/hour)	236
8. Projected maximum (cubic yards/hour)	236
9. Projected maximum (cubic yards/year)	70,106

Dust Control Information

10. You will be required to control dust at the plant site, including dust from product manufacture, receipt, movement, and loading of materials, and dust from interior and access roads. Describe how you will accomplish this.

Types of controls used may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and the like.

Waste Process Water

11. A permit to discharge and/or store process wastewater may be required. Do you have, or have you applied for such a permit from DEQ? (yes/no)	NO
If "no", have you contacted your Region's water quality section? (yes/no)	NO

Facility Name: Grassy Mountain Mine Permit Number: N/A

Tank Information:

	Tank Identification Number			
	TG1			
1. Existing or future?	Future			
2. Manufacturer	TBD			
3. Date construction commenced (month/year)	TBD			
4. Date installed (month/year)	TBD			
5. Rated capacity (gallons)	1,000			
6. Height (feet)	9			
7. Diameter (feet)	4.4			
8. Submerged fill pipe? (yes or no)	No			
9. Type of tank	Horizontal			
10. Underground? (yes or no)	NO			
Underground tank fill type	N/A			
11. Above ground? (yes or no)	Yes			
a. Pipe material	TBD			
b. Pipe size	TBD			
c. Piping continuously drains downward? (yes or no)	Yes			
d. Description of condensate collection tank.	TBD			
e. Isolation valves? (yes or no)	No			
12. Pressure/vacuum relief valves				
a. vent pressure settings (psia)	-0.03			
b. months	N/A			
13. Pressure conservation vent? (yes or no)	Yes			
If yes, enter psia.	0.03			
14. Fixed roof tank? (yes or no)	Yes			
a. roof color	White			

	Tank Identification Number			
	TG1			
b. shell color	White			
c. vapor space height (feet)	2.2			
d. shell condition	Good			
15. Floating roof tank? (yes or no)	No			
a. type of construction	N/A			
b. condition	N/A			
c. tank color	N/A			
d. deck type	N/A			
16. External floating roof tank seal type	N/A			
17. Internal floating roof tanks				
a. seal type	N/A			
b. number of columns	N/A			
c. effective column diameter (feet)	N/A			
d. total deck seam length (feet)	N/A			
e.i deck fitting types – access hatch				
(1) bolted cover, gasketed	N/A			
(2) unbolted cover, gasketed	N/A			
(3) unbolted cover, ungasketed	N/A			
e.ii deck fitting types – automatic gauge float well				
(1) bolted cover, gasketed	N/A			
(2) unbolted cover, gasketed	N/A			
(3) unbolted cover, ungasketed	N/A			
e.iii deck fitting types – column well				
(1) built-up column, sliding cover, gasketed	N/A			

	Tank Identification Number			
	TG1			
(2) built up column, sliding cover, ungasketed	N/A			
(3) pipe column, flexible fabric sleeve seal	N/A			
(4) pipe column, sliding cover, gasketed	N/A			
(5) pipe column, sliding cover, ungasketed	N/A			
e.iv deck fitting types – ladder well				
(1) sliding cover, gasketed	N/A			
(2) sliding cover, ungasketed	N/A			
e.v deck fitting types – sample well or pipe				
(1) slotted pipe, sliding cover, gasket	N/A			
(2) slotted pipe, sliding cover, ungasketed	N/A			
(3) sample well, slit fabric seal, 10% open area	N/A			
(4) stub drain, 1-inch diameter	N/A			
e.vi deck fitting types – roof leg or hanger well				
(1) adjustable	N/A			
(2) fix	N/A			
e.vii deck fitting types – vacuum breaker				
(1) weighted mechanical actuation, gasketed	N/A			
(2) weighted mechanical actuation, ungasketed	N/A			
18. Maximum liquid loading rate (gallons/hour)	TBD			
19. Description of submerged fill out-loading	TBD			
20. Vapor recovery system? (yes or no)	No			

Material Stored:

21. Name/type of material stored in the tank	Gasoline			
22. Maximum projected throughput (gallons/year)	52,000			
23. Maximum projected turnovers per year	52			

	Tank Identification Number			
	TG1			
24. Density (pounds/gallon)	6.17			
25. Molecular weight	92			
26. Average storage temperature (°F)	50.94			
27. Vapor pressure (psia)	3.995			

Facility Name: Grassy Mountain Mine Permit Number: N/A

1. Boiler Information:				
Boiler identification	HA	HPO	HL	HWW
Manufacturer	TBD	TBD	TBD	TBD
Date manufactured (month/year)	TBD	TBD	TBD	TBD
Date construction commenced (month/year)	TBD	TBD	TBD	TBD
Date installed (month/year)	TBD	TBD	TBD	TBD
Rated design heat input capacity (million Btu per hour)	1.0	1.0	1.0	1.0
Rated steam production capacity (pounds per hour)	N/A	N/A	N/A	N/A
Primary fuel type	Propane	Propane	Propane	Propane
Max. fuel quantity used per hour (include units)	11.0 gal	11.0 gal	11.0 gal	11.0 gal
Max. fuel quantity used per year (include units)	96,800 gal	96,800 gal	96,800 gal	96,800 gal
If oil is used, sulfur content (% by wt.)	N/A	N/A	N/A	N/A
Secondary fuel type	N/A	N/A	N/A	N/A
Max. fuel quantity used per hour (include units)	N/A	N/A	N/A	N/A
Max. fuel quantity used per year (include units)	N/A	N/A	N/A	N/A
If oil is used, sulfur content (% by wt.)	N/A	N/A	N/A	N/A
Stack identification	HVAC1	HVAC2	HVAC3	HVAC4
Stack height (feet)	27.3	27.3	27.0	27.3
Stack gas flow rate at maximum load (dscf/minute)	169	169	169	169
Control device(s) identification from AQ300	N/A	N/A	N/A	N/A
Continuous monitoring systems	N/A	N/A	N/A	N/A

2. Describe how the boilers(s) is operated. (Refer to instructions for guidance)

Propane-fired HVAC units for conditioning buildings at the facility. Units will be used primarily during summer and winter, but maximum usage assumes year-round operation.

Facility Name: Grassy Mountain Mine Permit Number: N/A

1. Boiler Information:				
Boiler identification	HTW	HMO		
Manufacturer	TBD	TBD		
Date manufactured (month/year)	TBD	TBD		
Date construction commenced (month/year)	TBD	TBD		
Date installed (month/year)	TBD	TBD		
Rated design heat input capacity (million Btu per hour)	2.0	1.0		
Rated steam production capacity (pounds per hour)	N/A	N/A		
Primary fuel type	Propane	Propane		
Max. fuel quantity used per hour (include units)	22.1 gal	11.0 gal		
Max. fuel quantity used per year (include units)	193,600 gal	96,800 gal		
If oil is used, sulfur content (% by wt.)	N/A	N/A		
Secondary fuel type	N/A	N/A		
Max. fuel quantity used per hour (include units)	N/A	N/A		
Max. fuel quantity used per year (include units)	N/A	N/A		
If oil is used, sulfur content (% by wt.)	N/A	N/A		
Stack identification	HVAC5	HVAC6		
Stack height (feet)	53.3	27.6		
Stack gas flow rate at maximum load (dscf/minute)	339	169		
Control device(s) identification from AQ300	N/A	N/A		
Continuous monitoring systems	N/A	N/A		

2. Describe how the boilers(s) is operated. (Refer to instructions for guidance)

Propane-fired HVAC units for conditioning buildings at the facility. Units will be used primarily during summer and winter, but maximum usage assumes year-round operation.

Facility Name: Grassy Mountain | Permit Number: N/A

Engine Information

1.	Device ID Number	CKB
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	TBD
6.	Date manufactured	TBD
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	1.7 MMbtu/hr
8.	Control device(s) (yes/no)	No
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Propane burners for carbon regeneration kiln ducted through a dedicated burner stack.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	8760

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	Propane	1.7 MMbtu	14,892 MMbtu
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	18
14.	Exit diameter (ft)	0.48
15.	Design flowrate (dscf/min)	80

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	No	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Facility Name: Grassy Mountain | Permit Number: N/A

Engine Information

1.	Device ID Number	EDG1
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	TBD
6.	Date manufactured	2007 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	536 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	
Emergency Diesel Generator		

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	100 (for maintenance and testing)

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	3.75 MMBtu	375.5 MMBtu
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	10
14.	Exit diameter (ft)	0.67
15.	Design flowrate (dscf/min)	1,500

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	Hour meter	recorder? (y/n)	Yes

Internal Combustion Engines and Turbines

Facility Name: Grassy Mountain Mine Permit Number: N/A

Engine Information

1.	Device ID Number	EQP1
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Sandvik DD21-40
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	83 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Drilling Development Jumbo. Unit has a small engine for tramming. Operates on line power when drilling. Exhaust will be released to atmosphere via mine vent. Annual schedule and fuel usage is for 2 units combined.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	731

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	4 gal	2,905 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment			
fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Internal Combustion Engines and Turbines

Facility Name: Grassy Mountain Mine | Permit Number: N/A

Engine Information

1.	Device ID Number	EQP2
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Sandvik DS311
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	83
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Bolter unit. Small engine for tramming, otherwise operates on line power. Exhaust will be released to atmosphere via mine vent.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	466

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	4 gal	1,853 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Internal Combustion Engines and Turbines

Facility Name: Grassy Mountain Mine | Permit Number: N/A

Engine Information

1.	Device ID Number	EQP3
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Sandvik LH410
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	315 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Load-Haul-Dump mobile equipment for underground mining. Exhaust will be released to atmosphere via mine vent. Annual schedule and fuel usage is for 4 trucks combined.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	4,428

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	8.45 gal	37,432 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Facility Name: Grassy Mountain Mine Permit Number: N/A

Engine Information

1.	Device ID Number	EQP4
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Cat 926M
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	153 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Front-end wheel loader for underground mining activities. Exhaust will be released to atmosphere via mine vent.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	2,220

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	2.7 gal	5,994 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Internal Combustion Engines and Turbines

Facility Name: Grassy Mountain Mine | Permit Number: N/A

Engine Information

1.	Device ID Number	EQP5
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Cat AD30
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	409 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Articulated low-profile haul truck for underground mining. Annual schedule and fuel usage is for 3 trucks combined. Exhaust will be released to atmosphere via mine vent.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	13,980

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	11 gal	153,081 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Internal Combustion Engines and Turbines

Facility Name: Grassy Mountain Mine | Permit Number: N/A

Engine Information

1.	Device ID Number	EQP6
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Paus Universa 50
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	101 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Emulsion loader. Unit will run on line power unless tramming. Exhaust will be released to atmosphere via mine vent.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	731

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	4.9 gal	3,565 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Facility Name: Grassy Mountain Mine | Permit Number: N/A

Engine Information

1.	Device ID Number	EQP7
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Cat TL943D
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	111 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Telehandler to support underground mining activities. Annual schedule and fuel usage is for 2 units combined. Exhaust will be released to atmosphere via mine vent.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	8,232

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	3 gal	24,696 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment			
fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Facility Name: Grassy Mountain Mine Permit Number: N/A

Engine Information

1.	Device ID Number	EQP8
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Cat D6T
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	200 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Bulldozer to support underground mining activities. Exhaust will be released to atmosphere via mine vent.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	2,760

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	6.5	17,802
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Facility Name: Grassy Mountain Mine Permit Number: N/A

Engine Information

1.	Device ID Number	EQP9
2.	Existing or future?	Future
3.	Date construction/installation commenced	TBD
4.	Date construction/installation completed	TBD
5.	Manufacturer	Paus PG5HA
6.	Date manufactured	2018 or newer
7.	Maximum rating (MMbtu/hr for turbines, Hp for others)	101 HP
8.	Control device(s) (yes/no)	NO
	If yes, enter the identification number(s)	N/A
9.	Description of device:	

Low-profile motor grader to support underground mining activities. Exhaust will be released to atmosphere via mine vent.

Operating Schedule

10.	Projected maximum hours/day	24
11.	Projected maximum hours/year	2,796

Fuel Information

12. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	4.9 gal	13,640 gal
Back-up	N/A	N/A	N/A
Other	N/A	N/A	N/A

Stack Information

13.	Exit height (ft)	N/A
14.	Exit diameter (ft)	N/A
15.	Design flowrate (dscf/min)	N/A

Monitoring Information

16. Monitoring equipment

fuel flow (y/n)	NO	recorder? (y/n)	NO
engine load (y/n)	NO	recorder? (y/n)	NO
other (specify)	NO	recorder? (y/n)	NO

Facility Name: Grassy Mountain Mine Permit Number: N/A

Process Information

1. ID Number	LAB
2. Descriptive name	Analytical Laboratory
3. Existing or future?	Future
4. Date commenced	TBD
5. Date installed/completed	TBD
6. Description of process:	
An analytical laboratory will be maintained on site. Ore samples will first be prepared by crushing, grinding, and screening, and then a sub-sample will undergo a fire assay to measure precious metal concentrations in the sample. Exhaust from the sample preparation and fire assay sources is ducted through a fume hood with a potential to emit particulates.	

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	BATCH
9. Projected maximum hours/day	24
10. Projected maximum hours/year	2,920

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
ore sample	6	tons/day	2,190	tons
Fire assay sample	.025	tons/day	9	tons
Products				
Precious metal from assay	N/A	N/A	N/A	N/A

12. Control devices(s) (yes/no)	NO
If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).	
N/A	

Form AQ230 Process Flow Attachment

See form AQ102, page 8, for process flow diagrams for all AQ230 Answer Sheets.

MISCELLANEOUS PROCESS OR DEVICE

Facility Name: Grassy Mountain Mine Permit Number: N/A

Process Information

1. ID Number	LS
2. Descriptive name	Lime Silo
3. Existing or future?	Future
4. Date commenced	TBD
5. Date installed/completed	TBD
6. Description of process:	
55-ton silo holding dry lime for input to the lime slaker	

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	Continuous
9. Projected maximum hours/day	24
10. Projected maximum hours/year	8760

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Lime loading to silo	55	ton/hr	292	tons
Lime unloading to slaker	0.8	ton/hr	292	tons
Products				
N/A	N/A	N/A	N/A	N/A

12. Control devices(s) (yes/no)	NO
If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).	
Passive silo vent filter to control product losses during silo loading.	

Facility Name: Grassy Mountain Mine Permit Number: N/A

Process Information

1. ID Number	CKD
2. Descriptive name	Carbon Regeneration Kiln Drum
3. Existing or future?	Future
4. Date commenced	TBD
5. Date installed/completed	TBD
6. Description of process:	

Device regenerates carbon used in carbon-in-leach (CIL) process. Stripped carbon is loaded into a drum and indirectly heated with propane burners (See AQ210_CKB) to burn off contaminants and re-activate the carbon for re-use in the CIL process. Emissions from the carbon kiln drum are controlled by a wet scrubber (control device VS1) and carbon filter (control device CF1). It is expected that the kiln drum has the potential to emit particulates, CO, and mercury emissions.

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	CONTINUOUS
9. Projected maximum hours/day	24
10. Projected maximum hours/year	8,760

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Stripped carbon	0.2	tons/hr	1,752	tons
Products				
Activated carbon	0.2	tons/hr	1,752	tons

12. Control devices(s) (yes/no)

If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).

VS1, CF1

Facility Name: Grassy Mountain Mine Permit Number: N/A

1.	Control Device ID	CF1
2.	Process/Device(s) Controlled	Carbon Kiln Drum (ID CKD)
3.	Year installed	TBD
4.	Manufacturer/Model No.	TBD
5.	Control Efficiency (%)	Not specified
6.	Design inlet gas flow rate (acfm)	TBD by vendor
7.	Design parameter(s)	Carbon bed inlet temperature (F) and carbon bed loading (percent mercury loading by weight). Maximum values TBD by vendor.
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	VS1
9.	Describe the control device	
	Sulfur impregnated (or halogenated) activated carbon adsorption bed designed for the removal of mercury	

Facility Name: Grassy Mountain Mine Permit Number: N/A

1.	Control Device ID	VS1		
2.	Process/Device(s) Controlled	Carbon Kiln Drum (ID CKD)		
3.	Year installed	TBD		
4.	Manufacturer/Model No.	TBD		
5.	Control Efficiency (%)	Vendor guarantee requirement of 0.06 lbs PM/hr		
6.	Type of scrubber	Venturi		
7.	Is water re-circulated?	yes		
8.	Design water flow rate (gpm)	TBD by vendor		
9.	Design water pressure (psig)	TBD by vendor		
10.	Design inlet gas flow rate (acfm)	TBD by vendor		
11.	Design pressure drop (inches of water)	TBD by vendor		
12.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No		
13.	Describe any water treatment systems*	TBD by vendor		

* Attach additional pages, if necessary.

Facility Name: Grassy Mountain Mine Permit Number: N/A

Process Information

1. ID Number	EW
2. Descriptive name	Electrowinning Cells/Pregnant Solution Tank
3. Existing or future?	Future
4. Date commenced	TBD
5. Date installed/completed	TBD
6. Description of process:	

Solution is fed to the electrowinning (EW) cells from a Pregnant Solution Tank (PST). Current is supplied to an inert anode through the solution and metal is plated onto a cathode. Periodically, the "cells" are opened and the plated metal is cleaned from the cathodes. Emissions from the EW Cells and PST are combined with the retort exhaust downstream of the retort condenser and are controlled by a carbon filter (control device CF3). It is expected that the EW cells and PST have the potential to emit Hg and HCN.

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	batch
9. Projected maximum hours/day	24
10. Projected maximum hours/year	8760

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Pregnant eluate solution	N/A	N/A	N/A	N/A
No data are available on the amount of solution entering the cells, only the end product.				
Products				
Wet Au Concentrate	N/A	N/A	8	ton

12. Control devices(s) (yes/no)	
If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).	
CF3 (shared with mercury retort)	

Facility Name: Grassy Mountain Mine Permit Number: N/A

Process Information

1. ID Number	MR
2. Descriptive name	Mercury Retort
3. Existing or future?	Future
4. Date commenced	TBD
5. Date installed/completed	TBD
6. Description of process:	

Au/Ag concentrate is heated in an oven to evacuate mercury as a gas from the concentrate. The mercury vapor is then cooled, condensed, and collected as a liquid in the retort condenser (control device CD1). The exhaust exiting the retort condenser is combined with Electrowinning Cells and Pregnant Solution Tank (ID EW) exhaust and ducted through a carbon bed (control device CF3) to remove any residual mercury. It is expected that the retort has the potential to emit mercury emissions.

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	Continuous
9. Projected maximum hours/day	24
10. Projected maximum hours/year	8760

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Au/Ag Concentrate	TBD		8	tons
Products				
Au/Ag Concentrate	N/A		8	tons

12. Control devices(s) (yes/no)	Yes

If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).

CF3 (shared with Electrowinning Cells and Pregnant Solution Tank); CD1

Facility Name: Grassy Mountain Mine Permit Number: N/A

1.	Control Device ID	CD1
2.	Process/Device(s) Controlled	Mercury Retort (ID MR)
3.	Year installed	TBD
4.	Manufacturer/Model No.	TBD
5.	Control Efficiency (%)	Not specified
6.	Design inlet gas flow rate (acfm)	TBD by vendor
7.	Design parameter(s)	Outlet exhaust temperature (F). Minimum value TBD by vendor.
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No
9.	Describe the control device	
	Condenser designed to cool, condense, and collect mercury from the retort exhaust.	

Facility Name: Grassy Mountain Mine Permit Number: N/A

1.	Control Device ID	CF3
2.	Process/Device(s) Controlled	Mercury Retort (ID MR) and Electrowinning Cells / Pregnant Solution Tank (EW)
3.	Year installed	TBD
4.	Manufacturer/Model No.	TBD
5.	Control Efficiency (%)	Not specified
6.	Design inlet gas flow rate (acfm)	TBD by vendor
7.	Design parameter(s)	Carbon bed inlet temperature (F) and carbon bed loading (percent mercury loading by weight). Maximum values TBD by vendor.
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	CD1 (Mercury retort exhaust only)
9.	Describe the control device	
	Sulfur impregnated (or halogenated) activated carbon adsorption bed designed for the removal of mercury	

Facility Name: Grassy Mountain Mine Permit Number: N/A

Process Information

1. ID Number	MF
2. Descriptive name	Induction Melting Furnace
3. Existing or future?	Future
4. Date commenced	TBD
5. Date installed/completed	TBD
6. Description of process:	
Induction (electric) furnace for melting Au/Ag concentrate to produce dore bars. It is expected that the melting furnace has the potential to emit particulates and mercury emissions. Emissions from the melting furnace are controlled by a baghouse (control device BH1) and carbon bed (control device CF2).	

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	Batch
9. Projected maximum hours/day	12
10. Projected maximum hours/year	960

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Dried metal concentrate	0.1	ton/batch	8	tons
Flux	N/A	N/A	N/A	N/A
Products				
gold and silver doré bars	0.1	ton/batch	8	ton

12. Control devices(s) (yes/no)	Yes
If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).	
BH1, CF2	

Facility Name: Grassy Mountain Mine Permit Number: N/A

1.	Control Device ID	BH1		
2.	Process/Device(s) Controlled	Induction Melting Furnace (ID MF)		
3.	Year installed	TBD		
4.	Manufacturer/Model No.	TBD		
5.	Control Efficiency (%)	Vendor guarantee requirement of 0.004 grains per dscf		
6.	Type of cleaning mechanism and frequency	TBD by vendor		
7.	Design inlet gas flow rate (acfm)	TBD by vendor		
8.	Number of bags	TBD by vendor		
9.	Design air-to-cloth ratio	TBD by vendor		
10.	Design pressure drop (inches of water)	TBD by vendor		
11.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No		

Facility Name: Grassy Mountain Mine Permit Number: N/A

1.	Control Device ID	CF2
2.	Process/Device(s) Controlled	Induction Melting Furnace (ID MF)
3.	Year installed	TBD
4.	Manufacturer/Model No.	TBD
5.	Control Efficiency (%)	Not specified
6.	Design inlet gas flow rate (acfm)	TBD by vendor
7.	Design parameter(s)	Carbon bed inlet temperature (F) and carbon bed loading (percent mercury loading by weight). Maximum values TBD by vendor.
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	BH1
9.	Describe the control device	
	Sulfur impregnated (or halogenated) activated carbon adsorption bed designed for the removal of mercury	

1.3 AQ400 Series Forms

The following forms provide summary emissions information for all emissions points, including criteria pollutants and hazardous air pollutants. Form AQ403 emissions are included instead in form AQ405.

References for emission factors refer to the emissions inventory worksheets in Attachment A, which in turn refer to the reference list in Section 2.0.

Electronic versions of all AQ400 Series forms, as well as the worksheets presented in Attachment A, are available upon request.

Facility Name: Grassy Mountain Mine Permit Number: N/A

Table 1

1. Emissions Point	Production Rates		4. Pollutant	Emissions Factors			Emissions	
	2. Short-term (Specify units)	3. Annual (Specify units)		5. Short-term	6. Long-term	7. Reference(s)	8. Short-term (Specify units)	9. Annual (tons/year)
See attached Table								
Example	200 tons of rock/hr	400,000 tons	PM	0.04 lb/ton	0.04 lb/ton	DEQ	8.0 lb/hr	8.0

1. Emissions Point	Production Rates		4. Pollutant	Emissions Factors			Emissions	
	2. Short-term (Specify units)	3. Annual (Specify Units)		5. Short-term	6. Long-term	7. Reference(s)	8. Short-term (Specify units)	9. Annual (tons/year)
OC1	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC2	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC3	794 ton Ore/day	289,700 ton Ore/yr	PM	0.0012	0.0012	See Process Sheet	0.952 lbs/day	0.174
OC4	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC5	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC6	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC7	794 ton Ore/day	289,700 ton Ore/yr	PM	0.0022	0.0022	See Process Sheet	1.75 lbs/day	0.319
OC8	794 ton Ore/day	289,700 ton Ore/yr	PM	0.0012	0.0012	See Process Sheet	0.952 lbs/day	0.174
OC9	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC10	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC11	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC12	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
OC13	794 ton Ore/day	289,700 ton Ore/yr	PM	0.00014	0.00014	See Process Sheet	0.111 lbs/day	0.020
BC1	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.003	0.003	See Process Sheet	3.344 lbs/day	0.435
BC2	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.003	0.003	See Process Sheet	3.344 lbs/day	0.435
BC3	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.0054	0.0054	See Process Sheet	6.02 lbs/day	0.782
BC4	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.003	0.003	See Process Sheet	3.344 lbs/day	0.435
BC5	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.003	0.003	See Process Sheet	3.344 lbs/day	0.435
BC6	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.003	0.003	See Process Sheet	3.344 lbs/day	0.435
BC7	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.025	0.025	See Process Sheet	27.87 lbs/day	3.623
BC8	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.0054	0.0054	See Process Sheet	6.02 lbs/day	0.782
BC9	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.003	0.003	See Process Sheet	3.344 lbs/day	0.435
BC10	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.003	0.003	See Process Sheet	3.344 lbs/day	0.435
LS1	55 ton Lime/day	292 ton Lime/yr	PM	0.00099	0.00099	See Process Sheet	0.054 lbs/day	0.0001
LS2	1 ton Lime/day	292 ton Lime/yr	PM	0.0048	0.0048	See Process Sheet	0.004 lbs/day	0.001
CKD	5 ton Carbon/day	1,752 ton Carbon/yr	PM	0.3	0.3	See Process Sheet	1.44 lbs/day	0.263
CKB	41 MMBtu Propane/day	14,892 MMBtu Propane/yr	PM	0.00765	0.00765	See Process Sheet	0.312 lbs/day	0.057
MF	24 hours per day	960 hours per year	PM	0.12	0.12	See Process Sheet	2.88 lbs/day	0.058
LABSP	6 ton Samples/day	2,190 ton Samples/yr	PM	0.02	0.02	See Process Sheet	0.120 lbs/day	0.022
LABFA	0 ton Samples/day	9 ton Samples/yr	PM	20	20	See Process Sheet	0.500 lbs/day	0.091
EDG1	110 kW Diesel/day	40,000 kW Diesel/yr	PM	0.00044	0.00044	See Process Sheet	0.049 lbs/day	0.009
HA	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HPO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HL	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HWW	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HTW	48 MMBtu Propane/day	17,520 MMBtu Propane/yr	PM	0.00765	0.00765	See Process Sheet	0.367 lbs/day	0.067
HMO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
CEM1	80 ton Cement/day	7,053 ton Cement/yr	PM	0.00099	0.00099	See Process Sheet	0.079 lbs/day	0.003
CEM2	80 ton Cement/day	7,053 ton Cement/yr	PM	0.00099	0.00099	See Process Sheet	0.079 lbs/day	0.003
CEM3	1,125 ton Aggregate/day	134,000 ton Aggregate/yr	PM	0.0069	0.0069	See Process Sheet	7.76 lbs/day	0.462
CEM4	1,125 ton Aggregate/day	134,000 ton Aggregate/yr	PM	0.0048	0.0048	See Process Sheet	5.40 lbs/day	0.322
CEM5	59 ton Cemented Rock Fill/day	7,053 ton Cemented Rock Fill/yr	PM	0.0184	0.0184	See Process Sheet	1.09 lbs/day	0.065
Underground Drilling	1,400 ton ore/day	291,200 ton Ore/yr	PM	0.00017	0.00017	See Mine Sheet, p. 3	0.237 lbs/day	0.025
Borrow Drilling	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.0058	0.0058	See Mine Sheet, p. 3	6.50 lbs/day	0.845
Underground Blasting	1,400 ton ore/day	291,200 ton Ore/yr	PM	0.00034	0.00034	See Mine Sheet, p. 4	0.470 lbs/day	0.049
Borrow Blasting	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM	0.00444	0.00044	See Mine Sheet, p. 4	4.950 lbs/day	0.064
Underground Hauling	385 VMT/day	80,073 VMT/yr	PM	0.565	0.565	See Mine Sheet, pp. 5–7	217 lbs/day	22.6
Borrow Pit Hauling	63 VMT/day	13,072 VMT/yr	PM	0.851	0.851	See Mine Sheet, pp. 5–7	53.5 lbs/day	5.56
Process Area Hauling	34 VMT/day	7,143 VMT/yr	PM	0.851	0.851	See Mine Sheet, pp. 5–7	29.2 lbs/day	3.04
Underground Load/Unload	2,800 Ton material transferred/day	582,400 Ton material transferred/yr	PM	0.00012	0.00012	See Mine Sheet, p. 8	0.343 lbs/day	0.036
Material Load / Unload	6,875 Ton material transferred/day	1,430,096 Ton material transferred/yr	PM	0.00016	0.00016	See Mine Sheet, p. 8	1.09 lbs/day	0.113
Underground Mobile Tailpipes	308 VMT/day	80,073 VMT/yr	PM	0.010	0.010	See Mine Sheet, pp. 10–14	3.00 lbs/day	0.390
Dozing	24 hr/day	2,760 hr/yr	PM	2.18	3.94	See Mine Sheet, p. 16	52.3 lbs/day	5.44
Grading	87 VMT/day	18,174 VMT/yr	PM	0.60	0.60	See Mine Sheet, p. 16	52.4 lbs/day	5.45
Water Truck Travel	33 VMT/day	8,701 VMT/yr	PM	1.21	1.21	See Mine Sheet, p. 17	41 lbs/day	5.3
Wind Erosion	2 Erodible Area (acre/day)	194 Erodible Area (acre/yr)	PM	1.97	4.84	See Mine Sheet, pp. 18–26	3.62 lbs/day	0.470
TOTAL			**PM**				**555 lbs/day**	**60.04**

1. Emissions Point	Production Rates		4. Pollutant	Emissions Factors			Emissions	
	2. Short-term (Specify units)	3. Annual (Specify Units)		5. Short-term	6. Long-term	7. Reference(s)	8. Short-term (Specify units)	9. Annual (tons/year)
OC1	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC2	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC3	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.00054	0.00054	See Process Sheet	0.429 lbs/day	0.078
OC4	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC5	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC6	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC7	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.00074	0.00074	See Process Sheet	0.59 lbs/day	0.107
OC8	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.00054	0.00054	See Process Sheet	0.429 lbs/day	0.078
OC9	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC10	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC11	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC12	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
OC13	794 ton Ore/day	289,700 ton Ore/yr	PM10	0.000046	0.000046	See Process Sheet	0.037 lbs/day	0.007
BC1	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0011	0.0011	See Process Sheet	1.226 lbs/day	0.159
BC2	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0011	0.0011	See Process Sheet	1.226 lbs/day	0.159
BC3	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0024	0.0024	See Process Sheet	2.68 lbs/day	0.348
BC4	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0011	0.0011	See Process Sheet	1.226 lbs/day	0.159
BC5	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0011	0.0011	See Process Sheet	1.226 lbs/day	0.159
BC6	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0011	0.0011	See Process Sheet	1.226 lbs/day	0.159
BC7	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0087	0.0087	See Process Sheet	9.70 lbs/day	1.261
BC8	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0024	0.0024	See Process Sheet	2.68 lbs/day	0.348
BC9	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0011	0.0011	See Process Sheet	1.226 lbs/day	0.159
BC10	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0011	0.0011	See Process Sheet	1.226 lbs/day	0.159
LS1	55.0 ton Lime/day	292 ton Lime/yr	PM10	0.00034	0.00034	See Process Sheet	0.019 lbs/day	0.0000
LS2	0.8 ton Lime/day	292 ton Lime/yr	PM10	0.0028	0.0028	See Process Sheet	0.002 lbs/day	0.000
CKD	4.8 ton Carbon/day	1,752 ton Carbon/yr	PM10	0.3	0.3	See Process Sheet	1.44 lbs/day	0.263
CKB	40.8 MMBtu Propane/day	14,892 MMBtu Propane/yr	PM10	0.00765	0.00765	See Process Sheet	0.312 lbs/day	0.057
MF	24 hours per day	960 hours per year	PM10	0.12	0.12	See Process Sheet	2.88 lbs/day	0.058
LABSP	6.0 ton Samples/day	2,190 ton Samples/yr	PM10	0.01	0.01	See Process Sheet	0.046 lbs/day	0.008
LABFA	0.025 ton Samples/day	9 ton Samples/yr	PM10	20	20	See Process Sheet	0.500 lbs/day	0.091
EDG1	110 kW Diesel/day	40,000 kW Diesel/yr	PM10	0.00044	0.00044	See Process Sheet	0.049 lbs/day	0.009
HA	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM10	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HPO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM10	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HL	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM10	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HWW	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM10	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HTW	48 MMBtu Propane/day	17,520 MMBtu Propane/yr	PM10	0.00765	0.00765	See Process Sheet	0.367 lbs/day	0.067
HMO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM10	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
CEM1	80 ton Cement/day	7,053 ton Cement/yr	PM10	0.00034	0.00034	See Process Sheet	0.027 lbs/day	0.001
CEM2	80 ton Cement/day	7,053 ton Cement/yr	PM10	0.00034	0.00034	See Process Sheet	0.027 lbs/day	0.001
CEM3	1,125 ton Aggregate/day	134,000 ton Aggregate/yr	PM10	0.0033	0.0033	See Process Sheet	3.71 lbs/day	0.221
CEM4	1,125 ton Aggregate/day	134,000 ton Aggregate/yr	PM10	0.0028	0.0028	See Process Sheet	3.15 lbs/day	0.188
CEM5	59 ton Cemented Rock Fill/day	7,053 ton Cemented Rock Fill/yr	PM10	0.0055	0.0055	See Process Sheet	0.33 lbs/day	0.019
Underground Drilling	1,400 ton ore/day	291,200 ton Ore/yr	PM10	0.00008	0.00008	See Mine Sheet, p. 3	0.112 lbs/day	0.012
Borrow Drilling	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.0030	0.0030	See Mine Sheet, p. 3	3.38 lbs/day	0.439
Underground Blasting	1,400 ton ore/day	291,200 ton Ore/yr	PM10	0.00017	0.00017	See Mine Sheet, p. 4	0.244 lbs/day	0.025
Borrow Blasting	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM10	0.00231	0.00023	See Mine Sheet, p. 4	2.574 lbs/day	0.033
Underground Hauling	385 VMT/day	80,073 VMT/yr	PM10	0.149	0.149	See Mine Sheet, pp. 5–7	58 lbs/day	6.0
Borrow Pit Hauling	63 VMT/day	13,072 VMT/yr	PM10	0.225	0.225	See Mine Sheet, pp. 5–7	14.2 lbs/day	1.47
Process Area Hauling	34 VMT/day	7,143 VMT/yr	PM10	0.225	0.225	See Mine Sheet, pp. 5–7	7.7 lbs/day	0.80
Underground Load/Unload	2,800 Ton material transferred/day	582,400 Ton material transferred/yr	PM10	0.00006	0.00006	See Mine Sheet, p. 8	0.162 lbs/day	0.017
Material Load / Unload	6,875 Ton material transferred/day	1,430,096 Ton material transferred/yr	PM10	0.00008	0.00008	See Mine Sheet, p. 8	0.52 lbs/day	0.054
Underground Mobile Tailpipes	385 VMT/day	80,073 VMT/yr	PM10	0.010	0.010	See Mine Sheet, pp. 10–14	3.75 lbs/day	0.390
Dozing	24 hr/day	2,760 hr/yr	PM10	0.42	0.75	See Mine Sheet, p. 16	10.0 lbs/day	1.04
Grading	87 VMT/day	18,174 VMT/yr	PM10	0.18	0.18	See Mine Sheet, p. 16	15.7 lbs/day	1.64
Water Truck Travel	33 VMT/day	8,701 VMT/yr	PM10	0.32	0.32	See Mine Sheet, p. 17	11 lbs/day	1.4
Wind Erosion	2 Erodible Area (acre/day)	194 Erodible Area (acre/yr)	PM10	0.99	2.42	See Mine Sheet, pp. 18–26	1.81 lbs/day	0.235
TOTAL			**PM10**				**168 lbs/day**	**18.1**

1. Emissions Point	Production Rates		4. Pollutant	Emissions Factors			Emissions	
	2. Short-term (Specify units)	3. Annual (Specify Units)		5. Short-term	6. Long-term	7. Reference(s)	8. Short-term (Specify units)	9. Annual (tons/year)
OC1	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC2	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC3	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.0001	0.0001	See Process Sheet	0.079 lbs/day	0.014
OC4	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC5	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC6	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC7	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.00005	0.00005	See Process Sheet	0.04 lbs/day	0.007
OC8	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.0001	0.0001	See Process Sheet	0.079 lbs/day	0.014
OC9	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC10	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC11	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC12	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
OC13	794 ton Ore/day	289,700 ton Ore/yr	PM2.5	0.000013	0.000013	See Process Sheet	0.010 lbs/day	0.002
BC1	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00017	0.00017	See Process Sheet	0.189 lbs/day	0.025
BC2	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00017	0.00017	See Process Sheet	0.189 lbs/day	0.025
BC3	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00036	0.00036	See Process Sheet	0.40 lbs/day	0.052
BC4	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00017	0.00017	See Process Sheet	0.189 lbs/day	0.025
BC5	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00017	0.00017	See Process Sheet	0.189 lbs/day	0.025
BC6	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00017	0.00017	See Process Sheet	0.189 lbs/day	0.025
BC7	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00132	0.00132	See Process Sheet	1.47 lbs/day	0.191
BC8	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00036	0.00036	See Process Sheet	0.40 lbs/day	0.052
BC9	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00017	0.00017	See Process Sheet	0.189 lbs/day	0.025
BC10	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00017	0.00017	See Process Sheet	0.189 lbs/day	0.025
LS1	55 ton Lime/day	292 ton Lime/yr	PM2.5	0.00005	0.00005	See Process Sheet	0.003 lbs/day	7.3E-06
LS2	0.8 ton Lime/day	292 ton Lime/yr	PM2.5	0.0004	0.0004	See Process Sheet	0.000 lbs/day	5.8E-05
CKD	4.8 ton Carbon/day	1,752 ton Carbon/yr	PM2.5	0.3	0.3	See Process Sheet	1.44 lbs/day	0.263
CKB	40.8 MMBtu Propane/day	14,892 MMBtu Propane/yr	PM2.5	0.00765	0.00765	See Process Sheet	0.312 lbs/day	0.057
MF	24 hours per day	960 hours per year	PM2.5	0.12	0.12	See Process Sheet	2.88 lbs/day	0.058
LABSP	6 ton Samples/day	2,190 ton Samples/yr	PM2.5	0.00	0.00	See Process Sheet	0.004 lbs/day	0.001
LABFA	0.025 ton Samples/day	9 ton Samples/yr	PM2.5	20	20	See Process Sheet	0.500 lbs/day	0.091
EDG1	110 kW Diesel/day	40,000 kW Diesel/yr	PM2.5	0.00044	0.00044	See Process Sheet	0.049 lbs/day	0.009
HA	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM2.5	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HPO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM2.5	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HL	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM2.5	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HWW	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM2.5	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
HTW	48 MMBtu Propane/day	17,520 MMBtu Propane/yr	PM2.5	0.00765	0.00765	See Process Sheet	0.367 lbs/day	0.067
HMO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	PM2.5	0.00765	0.00765	See Process Sheet	0.184 lbs/day	0.034
CEM1	80 ton Cement/day	7,053 ton Cement/yr	PM2.5	0.00005	0.00005	See Process Sheet	0.004 lbs/day	0.000
CEM2	80 ton Cement/day	7,053 ton Cement/yr	PM2.5	0.00005	0.00005	See Process Sheet	0.004 lbs/day	0.000
CEM3	1,125 ton Aggregate/day	134,000 ton Aggregate/yr	PM2.5	0.0005	0.0005	See Process Sheet	0.56 lbs/day	0.034
CEM4	1,125 ton Aggregate/day	134,000 ton Aggregate/yr	PM2.5	0.0004	0.0004	See Process Sheet	0.45 lbs/day	0.027
CEM5	59.4 ton Cemented Rock Fill/day	7,053 ton Cemented Rock Fill/yr	PM2.5	0.0008	0.0008	See Process Sheet	0.05 lbs/day	0.003
Underground Drilling	1,400 ton ore/day	291,200 ton Ore/yr	PM2.5	0.00001	0.00001	See Mine Sheet, p. 3	0.017 lbs/day	0.002
Borrow Drilling	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.0002	0.0002	See Mine Sheet, p. 3	0.195 lbs/day	0.025
Underground Blasting	1,400 ton ore/day	291,200 ton Ore/yr	PM2.5	0.00001	0.00001	See Mine Sheet, p. 4	0.014 lbs/day	0.001
Borrow Blasting	1,115 ton Borrow/day	289,800 ton Borrow/yr	PM2.5	0.00013	0.00001	See Mine Sheet, p. 4	0.148 lbs/day	0.002
Underground Hauling	385 VMT/day	80,073 VMT/yr	PM2.5	0.015	0.015	See Mine Sheet, pp. 5–7	6 lbs/day	0.6
Borrow Pit Hauling	63 VMT/day	13,072 VMT/yr	PM2.5	0.023	0.023	See Mine Sheet, pp. 5–7	1.4 lbs/day	0.15
Process Area Hauling	34 VMT/day	7,143 VMT/yr	PM2.5	0.023	0.023	See Mine Sheet, pp. 5–7	0.8 lbs/day	0.08
Underground Load/Unload	2,800 Ton material transferred/day	582,400 Ton material transferred/yr	PM2.5	0.00001	0.00001	See Mine Sheet, p. 8	0.025 lbs/day	0.003
Material Load / Unload	6,875 Ton material transferred/day	1,430,096 Ton material transferred/yr	PM2.5	0.00001	0.00001	See Mine Sheet, p. 8	0.08 lbs/day	0.008
Underground Mobile Tailpipes	385 VMT/day	80,073 VMT/yr	PM2.5	0.006	0.006	See Mine Sheet, pp. 10–14	2.40 lbs/day	0.249
Dozing	24 hr/day	2,760 hr/yr	PM2.5	0.23	0.41	See Mine Sheet, p. 16	5.5 lbs/day	0.57
Grading	87 VMT/day	18,174 VMT/yr	PM2.5	0.02	0.02	See Mine Sheet, p. 16	1.6 lbs/day	0.17
Water Truck Travel	33 VMT/day	8,701 VMT/yr	PM2.5	0.03	0.03	See Mine Sheet, p. 17	1.07 lbs/day	0.139
Wind Erosion	2 Erodible Area (acre/day)	194 Erodible Area (acre/yr)	PM2.5	0.15	0.36	See Mine Sheet, pp. 18–26	0.271 lbs/day	0.035
TOTAL			**PM2.5**				**31 lbs/day**	**3.3**

1. Emissions Point	Production Rates		4. Pollutant	Emissions Factors			Emissions	
	2. Short-term (Specify units)	3. Annual (Specify Units)		5. Short-term	6. Long-term	7. Reference(s)	8. Short-term (Specify units)	9. Annual (tons/year)
CKD	0.2 ton Carbon/hr	1,752 ton Carbon/yr	CO	5.25	5.25	See Process Sheet	1.05 lbs/hr	4.599
CKB	1.7 MMBtu Propane/hr	14,892 MMBtu Propane/yr	CO	0.08197	0.08197	See Process Sheet	0.14 lbs/hr	0.610
EDG1	400.0 kW Diesel/hr	40,000 kW Diesel/yr	CO	0.00772	0.00772	See Process Sheet	3.09 lbs/hr	0.154
HA	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	CO	0.08197	0.08197	See Process Sheet	0.08 lbs/hr	0.359
HPO	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	CO	0.08197	0.08197	See Process Sheet	0.08 lbs/hr	0.359
HL	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	CO	0.08197	0.08197	See Process Sheet	0.08 lbs/hr	0.359
HWW	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	CO	0.08197	0.08197	See Process Sheet	0.08 lbs/hr	0.359
HTW	2.0 MMBtu Propane/hr	17,520 MMBtu Propane/yr	CO	0.08197	0.08197	See Process Sheet	0.16 lbs/hr	0.718
HMO	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	CO	0.08197	0.08197	See Process Sheet	0.08 lbs/hr	0.359
Underground Blasting	58 ton ore/hr	291,200 ton Ore/yr	CO	1.41831	0.05910	See Mine Sheet, p. 4	82.7 lbs/hr	8.604
Borrow Blasting	93 ton Borrow/hr	289,800 ton Borrow/yr	CO	1.89348	0.01578	See Mine Sheet, p. 4	176 lbs/hr	2.286
Underground Mobile Tailpipe	13 VMT/hr	80,073 VMT/yr	CO	0.499	0.399	See Mine Sheet, pp. 10–14	6.41 lbs/hr	15.987
TOTAL			**CO**				**270 lbs/hr**	**34.8**
CKB	1.7 MMBtu Propane/hr	14,892 MMBtu Propane/yr	NOX	0.142	0.142	See Process Sheet	0.242 lbs/hr	1.058
EDG1	400 kW Diesel/hr	40,000 kW Diesel/yr	NOX	0.0141	0.0141	See Process Sheet	5.644 lbs/hr	0.282
HA	1 MMBtu Propane/hr	8,760 MMBtu Propane/yr	NOX	0.142	0.142	See Process Sheet	0.142 lbs/hr	0.622
HPO	1 MMBtu Propane/hr	8,760 MMBtu Propane/yr	NOX	0.142	0.142	See Process Sheet	0.142 lbs/hr	0.622
HL	1 MMBtu Propane/hr	8,760 MMBtu Propane/yr	NOX	0.142	0.142	See Process Sheet	0.142 lbs/hr	0.622
HWW	1 MMBtu Propane/hr	8,760 MMBtu Propane/yr	NOX	0.142	0.142	See Process Sheet	0.142 lbs/hr	0.622
HTW	2 MMBtu Propane/hr	17,520 MMBtu Propane/yr	NOX	0.142	0.142	See Process Sheet	0.284 lbs/hr	1.245
HMO	1 MMBtu Propane/hr	8,760 MMBtu Propane/yr	NOX	0.142	0.142	See Process Sheet	0.142 lbs/hr	0.622
Underground Blasting	58 ton ore/hr	291,200 ton Ore/yr	NOX	0.26858	0.01119	See Mine Sheet, p. 4	15.7 lbs/hr	1.629
Borrow Blasting	93 ton Borrow/hr	289,800 ton Borrow/yr	NOX	0.05087	0.00042	See Mine Sheet, p. 4	4.73 lbs/hr	0.061
Underground Mobile Tailpipe	16 VMT/hr	80,073 VMT/yr	NOX	0.106	0.106	See Mine Sheet, pp. 10–14	1.70 lbs/hr	4.231
TOTAL			**NOX**				**29 lbs/hr**	**11.6**
CKB	1.7 MMBtu Propane/hr	14,892 MMBtu Propane/yr	SO2	0.01738	0.01738	See Process Sheet	0.030 lbs/hr	0.129
EDG1	400.0 kW Diesel/hr	40,000 kW Diesel/yr	SO2	0.00001	0.00001	See Process Sheet	0.006 lbs/hr	0.000
HA	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	SO2	0.01738	0.01738	See Process Sheet	0.017 lbs/hr	0.076
HPO	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	SO2	0.01738	0.01738	See Process Sheet	0.017 lbs/hr	0.076
HL	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	SO2	0.01738	0.01738	See Process Sheet	0.017 lbs/hr	0.076
HWW	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	SO2	0.01738	0.01738	See Process Sheet	0.017 lbs/hr	0.076
HTW	2.0 MMBtu Propane/hr	17,520 MMBtu Propane/yr	SO2	0.01738	0.01738	See Process Sheet	0.035 lbs/hr	0.152
HMO	1.0 MMBtu Propane/hr	8,760 MMBtu Propane/yr	SO2	0.01738	0.01738	See Process Sheet	0.017 lbs/hr	0.076
Underground Blasting	58 ton ore/hr	291,200 ton Ore/yr	SO2	0.00E+00	0.00E+00	See Mine Sheet, p. 4	0.00E+00 lbs/hr	0.00E+00
Borrow Blasting	93 ton Borrow/hr	289,800 ton Borrow/yr	SO2	1.02E-04	8.48E-07	See Mine Sheet, p. 4	9.45E-03 lbs/hr	1.23E-04
Underground Mobile Tailpipe	16 VMT/hr	80,073 VMT/yr	SO2	0.001	0.001	See Mine Sheet, pp. 10–14	0.01 lbs/hr	0.030
TOTAL			**SO2**				**0.18 lbs/hr**	**0.7**
CKB	40.8 MMBtu Propane/day	14,892 MMBtu Propane/yr	VOC	0.0087	0.0087	See Process Sheet	0.357 lbs/day	0.065
EDG1	110 kW Diesel/day	40,000 kW Diesel/yr	VOC	0.0029	0.0029	See Process Sheet	0.315 lbs/day	0.057
HA	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	VOC	0.0087	0.0087	See Process Sheet	0.210 lbs/day	0.038
HPO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	VOC	0.0087	0.0087	See Process Sheet	0.210 lbs/day	0.038
HL	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	VOC	0.0087	0.0087	See Process Sheet	0.210 lbs/day	0.038
HWW	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	VOC	0.0087	0.0087	See Process Sheet	0.210 lbs/day	0.038
HTW	48 MMBtu Propane/day	17,520 MMBtu Propane/yr	VOC	0.0087	0.0087	See Process Sheet	0.420 lbs/day	0.077
HMO	24 MMBtu Propane/day	8,760 MMBtu Propane/yr	VOC	0.0087	0.0087	See Process Sheet	0.210 lbs/day	0.038
TG1	24 hours/day	8,760 hours/year	VOC	0.0454	0.0454	See Process Sheet	1.09 lbs/day	0.199
TD1	24 hours/day	8,760 hours/year	VOC	4.30E-04	4.30E-04	See Process Sheet	0.01 lbs/day	0.002
TD2	24 hours/day	8,760 hours/year	VOC	5.05E-05	5.05E-05	See Process Sheet	1.2E-03 lbs/day	2.2E-04
Underground Mobile Tailpipe	385 VMT/day	80,073 VMT/yr	VOC	0.028	0.028	See Mine Sheet, pp. 10–14	10.95 lbs/day	1.139
TOTAL			**VOC**				**14 lbs/day**	**1.7**

Facility Name: Grassy Mountain Mine Permit Number: N/A

Table 2

1. Device/process ID	2. PM_{10} PSEL (tons/year)	3. $PM_{2.5}$ fraction (f)	4. Reference	5. $PM_{2.5}$ PSEL (tons/yr)
See attached Table				
TOTAL	0			0

1. Device/process ID	2. PM_{10} PSEL (tons/year)	3. $PM_{2.5}$ fraction (f)	4. Reference	5. $PM_{2.5}$ PSEL (tons/yr)
BC - Borrow Crusher	3.07	0.152	*See Process Sheet*	0.468
All Other Process Sources	1.48	0.561	*See Process Sheet*	0.831
UG - Underground Activity	8.05	0.184	*See Mining Activity Emissions Sheet*	1.48
HR - Aboveground Haul Road	4.23	0.159	*See Mining Activity Emissions Sheet*	0.674
All Other Mine Activities	1.81	0.220	*See Mining Activity Emissions Sheet*	0.400
TOTAL	**19**			**4**

Facility Name: Grassy Mountain Mine Permit Number: N/A

Emissions Data

1. Emissions Point	2. Annual Production Rate (specify units)	3. Pollutant	4. Emission Factor	5. EF reference	6. Annual Emissions (tons/yr)
See Form AQ405 for complete HAPs inventory.					

Applications for Standard ACDPs must also include the most recent Toxics Release Inventory report, if applicable (see instructions).

State of Oregon Department of Environmental Quality

Facility name: Grassy Mountain Mine Permit Number: N/A

Indicate which of the following categorically insignificant activities are present at the facility by placing an "X" in the "Yes" or "No" column.

Yes	No	Type of activity — Categorically Insignificant Activities
		Constituents of a chemical mixture present at less than 1 percent by weight of any chemical or compound regulated under divisions 200 through 268 excluding divisions 248 and 262 of this chapter, or less than 0.1 percent by weight of any carcinogen listed in the U.S. Department of Health and Human Service's Annual Report on Carcinogens when usage of the chemical mixture is less than 100,000 pounds/year
✓		Evaporative and tail pipe emissions from on-site motor vehicle operation
✓		Distillate oil, kerosene, gasoline, natural gas or propane burning equipment, provided the aggregate expected actual emissions of the equipment identified as categorically insignificant do not exceed the de minimis level for any regulated pollutant, based on the expected maximum annual operation of the equipment. If a source's expected emissions from all such equipment exceed the de minimis levels, then the source may identify a subgroup of such equipment as categorically insignificant with the remainder not categorically insignificant. The following equipment may never be included as categorically insignificant: A. Any individual distillate oil, kerosene or gasoline burning equipment with a rating greater than 0.4 million Btu/hour; B. Any individual natural gas or propane burning equipment with a rating greater than 2.0 million Btu/hour
		Distillate oil, kerosene, gasoline, natural gas or propane burning equipment brought on site for six months or less for maintenance, construction or similar purposes, such as but not limited to generators, pumps, hot water pressure washers and space heaters, provided that any such equipment that performs the same function as the permanent equipment, must be operated within the source's existing PSEL
		Office activities
		Food service activities
		Janitorial activities
		Personal care activities
		Grounds keeping activities, including, but not limited to building painting and road and parking lot maintenance
		On-site laundry activities
		On-site recreation facilities
		Instrument calibration
✓		Maintenance and repair shop
		Automotive repair shops or storage garages;
✓		Air cooling or ventilating equipment not designed to remove air contaminants generated by or released from associated equipment
		Refrigeration systems with less than 50 pounds of charge of ozone depleting substances regulated under Title VI, including pressure tanks used in refrigeration systems but excluding any combustion equipment associated with such systems
✓		Bench scale laboratory equipment and laboratory equipment used exclusively for chemical and physical analysis, including associated vacuum producing devices but excluding research and development facilities

Yes	No	Type of activity
		Temporary construction activities
✓		Warehouse activities
		Accidental fires
		Air vents from air compressors
		Air purification systems
		Continuous emissions monitoring vent lines
		Demineralized water tanks
		Pre-treatment of municipal water, including use of deionized water purification systems
		Electrical charging stations
		Fire brigade training
		Instrument air dryers and distribution
		Process raw water filtration systems
		Pharmaceutical packaging
		Fire suppression
		Blueprint making
✓		Routine maintenance, repair, and replacement such as anticipated activities most often associated with and performed during regularly scheduled equipment outages to maintain a plant and its equipment in good operating condition, including but not limited to steam cleaning, abrasive use, and woodworking
		Electric motors
		Storage tanks, reservoirs, transfer and lubricating equipment used for ASTM grade distillate or residual fuels, lubricants, and hydraulic fluids
✓		On-site storage tanks not subject to any New Source Performance Standard (NSPS), including underground storage tanks (UST), storing gasoline or diesel used exclusively for fueling of the facility's fleet of vehicles
✓		Natural gas, propane, and liquefied petroleum gas (LPG) storage tanks and transfer equipment
		Pressurized tanks containing gaseous compounds
		Vacuum sheet stacker vents
		Emissions from wastewater discharges to publicly owned treatment works (POTW) provided the source is authorized to discharge to the POTW, not including on-site wastewater treatment and/or holding facilities
		Log ponds
		Storm water settling basins
		Fire suppression and training
		Paved roads and paved parking lots within an urban growth boundary
✓		Hazardous air pollutant emissions in fugitive dust from paved and unpaved roads except for those sources that have processes or activities that contribute to the deposition and entrainment of hazardous air pollutants from surface soils
✓		Health, safety, and emergency response activities

Yes	No	Type of activity
✓		Emergency generators and pumps used only during loss of primary equipment or utility service due to circumstances beyond the reasonable control of the owner or operator, or to address a power emergency, provided that the aggregate horsepower rating of all stationary emergency generator and pump engines is not more than 3,000 horsepower. If the aggregate horsepower rating of all stationary emergency generator and pump engines is more than 3,000 horsepower, then no emergency generators and pumps at the source may be considered categorically insignificant
		Non-contact steam vents and leaks and safety and relief valves for boiler steam distribution systems
		Non-contact steam condensate flash tanks
		Non-contact steam vents on condensate receivers, deaerators and similar equipment
		Boiler blow down tanks
		Industrial cooling towers that do not use chromium-based water treatment chemicals
		Ash piles maintained in a wetted condition and associated handling systems and activities
		Uncontrolled oil/water separators in effluent treatment systems, excluding systems with a throughput of more than 400,000 gallons per year of effluent located at the following sources: A. Petroleum refineries; B. Sources that perform petroleum refining and re-refining of lubricating oils and greases including asphalt production by distillation and the reprocessing of oils and/or solvents for fuels; or C. Bulk gasoline plants, bulk gasoline terminals, and pipeline facilities
		Combustion source flame safety purging on startup
		Broke beaters, pulp and repulping tanks, stock chests and pulp handling equipment, excluding thickening equipment and repulpers
		Stock cleaning and pressurized pulp washing, excluding open stock washing systems
		White water storage tanks

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4/5/2019

Facility Information	
Facility Name	Grassy Mountain Mine
Facility Address	(T21S, R44E)
City	Malheur County
Zip Code	
Source Number (for existing sources)	
Facility Contact	Nancy Wolverson
Phone Number	(775) 625-3600

Emissions Unit Information			Stack/Fugitive Information		Activity Information							
Toxics Emissions Unit ID	Unit Description	Control Device[s]	Emission Type (e.g. Point or Fugitive)	Stack or Fugitive ID	Units (e.g. hours operation, tons material, gallons)	Description/Type	Annual - Chronic [units/year]			Max Daily - Acute [units/day]		
							Actual	Requested PTE	Capacity	Actual	Requested PTE	Capacity
OC	Ore crusher		Fugitive	OCF	tons PM from ore crushing		0.869		0.869	0.00238		0.00238
BC	Borrow crusher		Fugitive	BCF	tons PM from borrow crushing		8.23		8.23	0.0317		0.0317
CKB	Carbon Regeneration Kiln (Burners)		Point	RFS1	MMBtu		14,892		14,892	40.8		40.8
HA	Administration HVAC		Point	HVAC1	MMBtu		8,760		8,760	24		24
HPO	Plant Office and Dry HVAC		Point	HVAC2	MMBtu		8,760		8,760	24		24
HL	Laboratory HVAC		Point	HVAC3	MMBtu		8,760		8,760	24		24
HWW	Plant Workshop and Warehouse HVAC		Point	HVAC4	MMBtu		8,760		8,760	24		24
HTW	Truck Workshop and Warehouse HVAC		Point	HVAC5	MMBtu		17,520		17,520	48		48
HMO	Mine Office and Changehouse HVAC		Point	HVAC6	MMBtu		8,760		8,760	24		24
EDG1	Emergency Generator (Mfr. Yr. >2007; diesel)		Point	EDGS1	MMBtu		375		375	90.1		90.1
MR	Mercury Retort	CF2, CF3, BH1	Point	RFS2	tons material	Au concentrate	8		8	0.022		0.022
UFD	Underground Fugitive Dust - Ore handling		Point	MINE	tons PM from ore		0.109		0	0.00052		0.001
AFD	Fugitive Dust - Ore and backfill handling		Fugitive	FD	tons PM from ore		1.49		1	0.00574		0.006
TAILS	Tailings Storage Facility		Fugitive	TAIL1	Hours of operation		8,760		8,760	24		24
POND	Tailings Pipeline Reclaim Pond		Fugitive	TAIL2	Hours of operation		8,760		8,760	24		24
DETOX1	CN Detoxification Tank 1		Fugitive	DET1	Hours of operation		8,760		8,760	24		24
DETOX2	CN Detoxification Tank 2		Fugitive	DET2	Hours of operation		8,760		8,760	24		24
CILTANK1	CIL Tank 1		Fugitive	CIL1	Hours of operation		8,760		8,760	24		24
CILTANK2	CIL Tank 2		Fugitive	CIL2	Hours of operation		8,760		8,760	24		24
CILTANK3	CIL Tank 3		Fugitive	CIL3	Hours of operation		8,760		8,760	24		24
CILTANK4	CIL Tank 4		Fugitive	CIL4	Hours of operation		8,760		8,760	24		24
CILTANK5	CIL Tank 5		Fugitive	CIL5	Hours of operation		8,760		8,760	24		24
CILTANK6	CIL Tank 6		Fugitive	CIL6	Hours of operation		8,760		8,760	24		24
CILTANK7	CIL Tank 7		Fugitive	CIL7	Hours of operation		8,760		8,760	24		24

Toxic Emissions Unit ID	Pollutant Information		Control Efficiency	Emission Factor Information				Calculated Emissions					
				EF Values		Units	Reference/Notes	Annual - Chronic [lb/yr]			Max Daily - Acute [lb/day]		
	CAS	Chemical Name		Annual Chronic	Max Daily - Acute			Actual	Requested PTE	Capacity	Actual	Requested PTE	Capacity
OC	106-99-0	1,3-Butadiene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	75-07-0	Acetaldehyde				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	107-02-8	Acrolein				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	7440-36-0	Antimony and compounds		7.40E-02	7.40E-02	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	6.43E-02		6.43E-02	1.76E-04		1.76E-04
OC	7440-38-2	Arsenic and compounds		3.04E-01	3.04E-01	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	2.64E-01		2.64E-01	7.24E-04		7.24E-04
OC	7440-39-3	Barium and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	71-43-2	Benzene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	7440-41-7	Beryllium and compounds		2.20E-03	2.20E-03	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	1.91E-03		1.91E-03	5.24E-06		5.24E-06
OC	7440-43-9	Cadmium and compounds		4.00E-04	4.00E-04	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	3.48E-04		3.48E-04	9.52E-07		9.52E-07
OC	18540-29-9	Chromium VI, chromate, and dichromate particulate		5.40E-02	5.40E-02	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	4.69E-02		4.69E-02	1.29E-04		1.29E-04
OC	7440-48-4	Cobalt and compounds		3.00E-03	3.00E-03	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	2.61E-03		2.61E-03	7.14E-06		7.14E-06
OC	7440-50-8	Copper and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	74-90-8	Cyanide, Hydrogen				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	106-46-7	p-Dichlorobenzene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC		Diesel Particulate Matter				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	100-41-4	Ethyl benzene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	50-00-0	Formaldehyde				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	110-54-3	Hexane				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	7439-92-1	Lead and compounds		1.40E-02	1.40E-02	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	1.22E-02		1.22E-02	3.33E-05		3.33E-05
OC	7439-96-5	Manganese and compounds		1.62E-01	1.62E-01	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	1.41E-01		1.41E-01	3.86E-04		3.86E-04
OC	7439-97-6	Mercury and compounds		4.40E-03	4.40E-03	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	3.82E-03		3.82E-03	1.05E-05		1.05E-05
OC	91-20-3	Naphthalene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	7440-02-0	Nickel and compounds		9.60E-03	9.60E-03	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	8.34E-03		8.34E-03	2.29E-05		2.29E-05
OC		PAHs				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	115-07-1	Propylene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	7782-49-2	Selenium and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	108-88-3	Toluene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	7440-62-2	Vanadium (fume or dust)				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	1330-20-7	Xylene (mixture)				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
OC	7440-66-6	Zinc and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	106-99-0	1,3-Butadiene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	75-07-0	Acetaldehyde				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	107-02-8	Acrolein				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	7440-36-0	Antimony and compounds		3.20E-02	3.20E-02	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	2.63E-01		2.63E-01	1.01E-03		1.01E-03
BC	7440-38-2	Arsenic and compounds		3.08E-01	3.08E-01	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	2.53E+00		2.53E+00	9.75E-03		9.75E-03
BC	7440-39-3	Barium and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	71-43-2	Benzene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	7440-41-7	Beryllium and compounds		6.20E-04	6.20E-04	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	5.10E-03		5.10E-03	1.96E-05		1.96E-05
BC	7440-43-9	Cadmium and compounds		4.80E-04	4.80E-04	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	3.95E-03		3.95E-03	1.52E-05		1.52E-05
BC	18540-29-9	Chromium VI, chromate, and dichromate particulate		2.40E-02	2.40E-02	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	1.98E-01		1.98E-01	7.60E-04		7.60E-04
BC	7440-48-4	Cobalt and compounds		4.00E-03	4.00E-03	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	3.29E-02		3.29E-02	1.27E-04		1.27E-04
BC	7440-50-8	Copper and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	74-90-8	Cyanide, Hydrogen				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	106-46-7	p-Dichlorobenzene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC		Diesel Particulate Matter				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	100-41-4	Ethyl benzene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	50-00-0	Formaldehyde				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	110-54-3	Hexane				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	7439-92-1	Lead and compounds		1.00E-02	1.00E-02	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	8.23E-02		8.23E-02	3.17E-04		3.17E-04
BC	7439-96-5	Manganese and compounds		1.08E-01	1.08E-01	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	8.89E-01		8.89E-01	3.42E-03		3.42E-03
BC	7439-97-6	Mercury and compounds		5.00E-03	5.00E-03	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	4.12E-02		4.12E-02	1.58E-04		1.58E-04
BC	91-20-3	Naphthalene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	7440-02-0	Nickel and compounds		6.00E-03	6.00E-03	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*	4.94E-02		4.94E-02	1.90E-04		1.90E-04
BC		Polycyclic aromatic hydrocarbons (PAHs)				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	115-07-1	Propylene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	7782-49-2	Selenium and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	108-88-3	Toluene				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	7440-62-2	Vanadium (fume or dust)				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	1330-20-7	Xylene (mixture)				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
BC	7440-66-6	Zinc and compounds				lb/ton	*See Process HAP and GHG Emissions Sheet, p. 5*						
CKB	106-99-0	1,3-Butadiene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
CKB	75-07-0	Acetaldehyde		7.26E-06	7.26E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.08E-01		1.08E-01	2.96E-04		2.96E-04
CKB	107-02-8	Acrolein		4.35E-06	4.35E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.48E-02		6.48E-02	1.78E-04		1.78E-04
CKB	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
CKB	7440-38-2	Arsenic and compounds		1.96E-07	1.96E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.92E-03		2.92E-03	8.00E-06		8.00E-06
CKB	7440-39-3	Barium and compounds		4.31E-06	4.31E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.42E-02		6.42E-02	1.76E-04		1.76E-04
CKB	71-43-2	Benzene		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.07E-02		3.07E-02	8.40E-05		8.40E-05
CKB	7440-41-7	Beryllium and compounds		1.18E-08	1.18E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.75E-04		1.75E-04	4.80E-07		4.80E-07
CKB	7440-43-9	Cadmium and compounds		1.08E-06	1.08E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.61E-02		1.61E-02	4.40E-05		4.40E-05
CKB	18540-29-9	Chromium VI, chromate, and dichromate particulate		1.37E-06	1.37E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.04E-02		2.04E-02	5.60E-05		5.60E-05
CKB	7440-48-4	Cobalt and compounds		8.24E-08	8.24E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.23E-03		1.23E-03	3.36E-06		3.36E-06
CKB	7440-50-8	Copper and compounds		8.33E-07	8.33E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.24E-02		1.24E-02	3.40E-05		3.40E-05
CKB	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
CKB	106-46-7	p-Dichlorobenzene		1.18E-06	1.18E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.75E-02		1.75E-02	4.80E-05		4.80E-05
CKB		Diesel Particulate Matter				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
CKB	100-41-4	Ethyl benzene		2.21E-06	2.21E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.29E-02		3.29E-02	9.00E-05		9.00E-05
CKB	50-00-0	Formaldehyde		7.35E-05	7.35E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.10E+00		1.10E+00	3.00E-03		3.00E-03
CKB	110-54-3	Hexane		1.76E-03	1.76E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.63E+01		2.63E+01	7.20E-02		7.20E-02
CKB	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
CKB	7439-96-5	Manganese and compounds		3.73E-07	3.73E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	5.55E-03		5.55E-03	1.52E-05		1.52E-05
CKB	7439-97-6	Mercury and compounds		2.55E-07	2.55E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.80E-03		3.80E-03	1.04E-05		1.04E-05
CKB	91-20-3	Naphthalene		5.98E-07	5.98E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	8.91E-03		8.91E-03	2.44E-05		2.44E-05
CKB	7440-02-0	Nickel and compounds		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.07E-02		3.07E-02	8.40E-05		8.40E-05
CKB		Polycyclic aromatic hydrocarbons (PAHs)		8.65E-08	8.65E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.29E-03		1.29E-03	3.53E-06		3.53E-06
CKB	115-07-1	Propylene		1.60E-04	1.60E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.38E+00		2.38E+00	6.52E-03		6.52E-03
CKB	7782-49-2	Selenium and compounds		2.35E-08	2.35E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.50E-04		3.50E-04	9.60E-07		9.60E-07
CKB	108-88-3	Toluene		3.33E-06	3.33E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	4.96E-02		4.96E-02	1.36E-04		1.36E-04
CKB	7440-62-2	Vanadium (fume or dust)		2.25E-06	2.25E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.36E-02		3.36E-02	9.20E-05		9.20E-05
CKB	1330-20-7	Xylene (mixture)		9.80E-06	9.80E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.46E-01		1.46E-01	4.00E-04		4.00E-04
CKB	7440-66-6	Zinc and compounds		2.84E-05	2.84E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	4.23E-01		4.23E-01	1.16E-03		1.16E-03

Toxic Emissions Unit ID	Pollutant Information		Control Efficiency	Emission Factor Information				Calculated Emissions					
				EF Values		Units	Reference/Notes	Annual - Chronic [lb/yr]			Max Daily - Acute [lb/day]		
	CAS	Chemical Name		Annual Chronic	Max Daily - Acute			Actual	Requested PTE	Capacity	Actual	Requested PTE	Capacity
HA	106-99-0	1,3-Butadiene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HA	75-07-0	Acetaldehyde		7.26E-06	7.26E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.36E-02	6.36E-02	6.36E-02	1.74E-04	1.74E-04	1.74E-04
HA	107-02-8	Acrolein		4.35E-06	4.35E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.81E-02	3.81E-02	3.81E-02	1.04E-04	1.04E-04	1.04E-04
HA	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HA	7440-38-2	Arsenic and compounds		1.96E-07	1.96E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.72E-03	1.72E-03	1.72E-03	4.71E-06	4.71E-06	4.71E-06
HA	7440-39-3	Barium and compounds		4.31E-06	4.31E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.78E-02	3.78E-02	3.78E-02	1.04E-04	1.04E-04	1.04E-04
HA	71-43-2	Benzene		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HA	7440-41-7	Beryllium and compounds		1.18E-08	1.18E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-04	1.03E-04	1.03E-04	2.82E-07	2.82E-07	2.82E-07
HA	7440-43-9	Cadmium and compounds		1.08E-06	1.08E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	9.45E-03	9.45E-03	9.45E-03	2.59E-05	2.59E-05	2.59E-05
HA	18540-29-9	Chromium VI, chromate, and dichromate particulate		1.37E-06	1.37E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.20E-02	1.20E-02	1.20E-02	3.29E-05	3.29E-05	3.29E-05
HA	7440-48-4	Cobalt and compounds		8.24E-08	8.24E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.21E-04	7.21E-04	7.21E-04	1.98E-06	1.98E-06	1.98E-06
HA	7440-50-8	Copper and compounds		8.33E-07	8.33E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.30E-03	7.30E-03	7.30E-03	2.00E-05	2.00E-05	2.00E-05
HA	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HA	106-46-7	p-Dichlorobenzene		1.18E-06	1.18E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-02	1.03E-02	1.03E-02	2.82E-05	2.82E-05	2.82E-05
HA		Diesel Particulate Matter				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HA	100-41-4	Ethyl benzene		2.21E-06	2.21E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.93E-02	1.93E-02	1.93E-02	5.29E-05	5.29E-05	5.29E-05
HA	50-00-0	Formaldehyde		7.35E-05	7.35E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.44E-01	6.44E-01	6.44E-01	1.76E-03	1.76E-03	1.76E-03
HA	110-54-3	Hexane		1.76E-03	1.76E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.55E+01	1.55E+01	1.55E+01	4.24E-02	4.24E-02	4.24E-02
HA	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HA	7439-96-5	Manganese and compounds		3.73E-07	3.73E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.26E-03	3.26E-03	3.26E-03	8.94E-06	8.94E-06	8.94E-06
HA	7439-97-6	Mercury and compounds		2.55E-07	2.55E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.23E-03	2.23E-03	2.23E-03	6.12E-06	6.12E-06	6.12E-06
HA	91-20-3	Naphthalene		5.98E-07	5.98E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	5.24E-03	5.24E-03	5.24E-03	1.44E-05	1.44E-05	1.44E-05
HA	7440-02-0	Nickel and compounds		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HA		Polycyclic aromatic hydrocarbons (PAHs)		8.65E-08	8.65E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.57E-04	7.57E-04	7.57E-04	2.08E-06	2.08E-06	2.08E-06
HA	115-07-1	Propylene		1.60E-04	1.60E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.40E+00	1.40E+00	1.40E+00	3.84E-03	3.84E-03	3.84E-03
HA	7782-49-2	Selenium and compounds		2.35E-08	2.35E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.06E-04	2.06E-04	2.06E-04	5.65E-07	5.65E-07	5.65E-07
HA	108-88-3	Toluene		3.33E-06	3.33E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.92E-02	2.92E-02	2.92E-02	8.00E-05	8.00E-05	8.00E-05
HA	7440-62-2	Vanadium (fume or dust)		2.25E-06	2.25E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.98E-02	1.98E-02	1.98E-02	5.41E-05	5.41E-05	5.41E-05
HA	1330-20-7	Xylene (mixture)		9.80E-06	9.80E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	8.59E-02	8.59E-02	8.59E-02	2.35E-04	2.35E-04	2.35E-04
HA	7440-66-6	Zinc and compounds		2.84E-05	2.84E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.49E-01	2.49E-01	2.49E-01	6.82E-04	6.82E-04	6.82E-04
HPO	106-99-0	1,3-Butadiene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HPO	75-07-0	Acetaldehyde		7.26E-06	7.26E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.36E-02	6.36E-02	6.36E-02	1.74E-04	1.74E-04	1.74E-04
HPO	107-02-8	Acrolein		4.35E-06	4.35E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.81E-02	3.81E-02	3.81E-02	1.04E-04	1.04E-04	1.04E-04
HPO	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HPO	7440-38-2	Arsenic and compounds		1.96E-07	1.96E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.72E-03	1.72E-03	1.72E-03	4.71E-06	4.71E-06	4.71E-06
HPO	7440-39-3	Barium and compounds		4.31E-06	4.31E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.78E-02	3.78E-02	3.78E-02	1.04E-04	1.04E-04	1.04E-04
HPO	71-43-2	Benzene		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HPO	7440-41-7	Beryllium and compounds		1.18E-08	1.18E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-04	1.03E-04	1.03E-04	2.82E-07	2.82E-07	2.82E-07
HPO	7440-43-9	Cadmium and compounds		1.08E-06	1.08E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	9.45E-03	9.45E-03	9.45E-03	2.59E-05	2.59E-05	2.59E-05
HPO	18540-29-9	Chromium VI, chromate, and dichromate particulate		1.37E-06	1.37E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.20E-02	1.20E-02	1.20E-02	3.29E-05	3.29E-05	3.29E-05
HPO	7440-48-4	Cobalt and compounds		8.24E-08	8.24E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.21E-04	7.21E-04	7.21E-04	1.98E-06	1.98E-06	1.98E-06
HPO	7440-50-8	Copper and compounds		8.33E-07	8.33E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.30E-03	7.30E-03	7.30E-03	2.00E-05	2.00E-05	2.00E-05
HPO	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HPO	106-46-7	p-Dichlorobenzene		1.18E-06	1.18E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-02	1.03E-02	1.03E-02	2.82E-05	2.82E-05	2.82E-05
HPO		Diesel Particulate Matter				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HPO	100-41-4	Ethyl benzene		2.21E-06	2.21E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.93E-02	1.93E-02	1.93E-02	5.29E-05	5.29E-05	5.29E-05
HPO	50-00-0	Formaldehyde		7.35E-05	7.35E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.44E-01	6.44E-01	6.44E-01	1.76E-03	1.76E-03	1.76E-03
HPO	110-54-3	Hexane		1.76E-03	1.76E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.55E+01	1.55E+01	1.55E+01	4.24E-02	4.24E-02	4.24E-02
HPO	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HPO	7439-96-5	Manganese and compounds		3.73E-07	3.73E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.26E-03	3.26E-03	3.26E-03	8.94E-06	8.94E-06	8.94E-06
HPO	7439-97-6	Mercury and compounds		2.55E-07	2.55E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.23E-03	2.23E-03	2.23E-03	6.12E-06	6.12E-06	6.12E-06
HPO	91-20-3	Naphthalene		5.98E-07	5.98E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	5.24E-03	5.24E-03	5.24E-03	1.44E-05	1.44E-05	1.44E-05
HPO	7440-02-0	Nickel and compounds		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HPO		Polycyclic aromatic hydrocarbons (PAHs)		8.65E-08	8.65E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.57E-04	7.57E-04	7.57E-04	2.08E-06	2.08E-06	2.08E-06
HPO	115-07-1	Propylene		1.60E-04	1.60E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.40E+00	1.40E+00	1.40E+00	3.84E-03	3.84E-03	3.84E-03
HPO	7782-49-2	Selenium and compounds		2.35E-08	2.35E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.06E-04	2.06E-04	2.06E-04	5.65E-07	5.65E-07	5.65E-07
HPO	108-88-3	Toluene		3.33E-06	3.33E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.92E-02	2.92E-02	2.92E-02	8.00E-05	8.00E-05	8.00E-05
HPO	7440-62-2	Vanadium (fume or dust)		2.25E-06	2.25E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.98E-02	1.98E-02	1.98E-02	5.41E-05	5.41E-05	5.41E-05
HPO	1330-20-7	Xylene (mixture)		9.80E-06	9.80E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	8.59E-02	8.59E-02	8.59E-02	2.35E-04	2.35E-04	2.35E-04
HPO	7440-66-6	Zinc and compounds		2.84E-05	2.84E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.49E-01	2.49E-01	2.49E-01	6.82E-04	6.82E-04	6.82E-04
HL	106-99-0	1,3-Butadiene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HL	75-07-0	Acetaldehyde		7.26E-06	7.26E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.36E-02	6.36E-02	6.36E-02	1.74E-04	1.74E-04	1.74E-04
HL	107-02-8	Acrolein		4.35E-06	4.35E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.81E-02	3.81E-02	3.81E-02	1.04E-04	1.04E-04	1.04E-04
HL	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HL	7440-38-2	Arsenic and compounds		1.96E-07	1.96E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.72E-03	1.72E-03	1.72E-03	4.71E-06	4.71E-06	4.71E-06
HL	7440-39-3	Barium and compounds		4.31E-06	4.31E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.78E-02	3.78E-02	3.78E-02	1.04E-04	1.04E-04	1.04E-04
HL	71-43-2	Benzene		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HL	7440-41-7	Beryllium and compounds		1.18E-08	1.18E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-04	1.03E-04	1.03E-04	2.82E-07	2.82E-07	2.82E-07
HL	7440-43-9	Cadmium and compounds		1.08E-06	1.08E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	9.45E-03	9.45E-03	9.45E-03	2.59E-05	2.59E-05	2.59E-05
HL	18540-29-9	Chromium VI, chromate, and dichromate particulate		1.37E-06	1.37E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.20E-02	1.20E-02	1.20E-02	3.29E-05	3.29E-05	3.29E-05
HL	7440-48-4	Cobalt and compounds		8.24E-08	8.24E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.21E-04	7.21E-04	7.21E-04	1.98E-06	1.98E-06	1.98E-06
HL	7440-50-8	Copper and compounds		8.33E-07	8.33E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.30E-03	7.30E-03	7.30E-03	2.00E-05	2.00E-05	2.00E-05
HL	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HL	106-46-7	p-Dichlorobenzene		1.18E-06	1.18E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-02	1.03E-02	1.03E-02	2.82E-05	2.82E-05	2.82E-05
HL		Diesel Particulate Matter				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HL	100-41-4	Ethyl benzene		2.21E-06	2.21E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.93E-02	1.93E-02	1.93E-02	5.29E-05	5.29E-05	5.29E-05
HL	50-00-0	Formaldehyde		7.35E-05	7.35E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.44E-01	6.44E-01	6.44E-01	1.76E-03	1.76E-03	1.76E-03
HL	110-54-3	Hexane		1.76E-03	1.76E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.55E+01	1.55E+01	1.55E+01	4.24E-02	4.24E-02	4.24E-02
HL	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HL	7439-96-5	Manganese and compounds		3.73E-07	3.73E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.26E-03	3.26E-03	3.26E-03	8.94E-06	8.94E-06	8.94E-06
HL	7439-97-6	Mercury and compounds		2.55E-07	2.55E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.23E-03	2.23E-03	2.23E-03	6.12E-06	6.12E-06	6.12E-06
HL	91-20-3	Naphthalene		5.98E-07	5.98E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	5.24E-03	5.24E-03	5.24E-03	1.44E-05	1.44E-05	1.44E-05
HL	7440-02-0	Nickel and compounds		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HL		Polycyclic aromatic hydrocarbons (PAHs)		8.65E-08	8.65E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.57E-04	7.57E-04	7.57E-04	2.08E-06	2.08E-06	2.08E-06
HL	115-07-1	Propylene		1.60E-04	1.60E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.40E+00	1.40E+00	1.40E+00	3.84E-03	3.84E-03	3.84E-03
HL	7782-49-2	Selenium and compounds		2.35E-08	2.35E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.06E-04	2.06E-04	2.06E-04	5.65E-07	5.65E-07	5.65E-07
HL	108-88-3	Toluene		3.33E-06	3.33E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.92E-02	2.92E-02	2.92E-02	8.00E-05	8.00E-05	8.00E-05
HL	7440-62-2	Vanadium (fume or dust)		2.25E-06	2.25E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.98E-02	1.98E-02	1.98E-02	5.41E-05	5.41E-05	5.41E-05
HL	1330-20-7	Xylene (mixture)		9.80E-06	9.80E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	8.59E-02	8.59E-02	8.59E-02	2.35E-04	2.35E-04	2.35E-04
HL	7440-66-6	Zinc and compounds		2.84E-05	2.84E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.49E-01	2.49E-01	2.49E-01	6.82E-04	6.82E-04	6.82E-04

Toxic Emissions Unit ID	Pollutant Information		Control Efficiency	Emission Factor Information				Calculated Emissions					
				EF Values		Units	Reference/Notes	Annual - Chronic [lb/yr]			Max Daily - Acute [lb/day]		
	CAS	Chemical Name		Annual Chronic	Max Daily - Acute			Actual	Requested PTE	Capacity	Actual	Requested PTE	Capacity
HWW	106-99-0	1,3-Butadiene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HWW	75-07-0	Acetaldehyde		7.26E-06	7.26E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.36E-02	6.36E-02	6.36E-02	1.74E-04	1.74E-04	1.74E-04
HWW	107-02-8	Acrolein		4.35E-06	4.35E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.81E-02	3.81E-02	3.81E-02	1.04E-04	1.04E-04	1.04E-04
HWW	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HWW	7440-38-2	Arsenic and compounds		1.96E-07	1.96E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.72E-03	1.72E-03	1.72E-03	4.71E-06	4.71E-06	4.71E-06
HWW	7440-39-3	Barium and compounds		4.31E-06	4.31E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.78E-02	3.78E-02	3.78E-02	1.04E-04	1.04E-04	1.04E-04
HWW	71-43-2	Benzene		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HWW	7440-41-7	Beryllium and compounds		1.18E-08	1.18E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-04	1.03E-04	1.03E-04	2.82E-07	2.82E-07	2.82E-07
HWW	7440-43-9	Cadmium and compounds		1.08E-06	1.08E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	9.45E-03	9.45E-03	9.45E-03	2.59E-05	2.59E-05	2.59E-05
HWW	18540-29-9	Chromium VI, chromate, and dichromate particulate		1.37E-06	1.37E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.20E-02	1.20E-02	1.20E-02	3.29E-05	3.29E-05	3.29E-05
HWW	7440-48-4	Cobalt and compounds		8.24E-08	8.24E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.21E-04	7.21E-04	7.21E-04	1.98E-06	1.98E-06	1.98E-06
HWW	7440-50-8	Copper and compounds		8.33E-07	8.33E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.30E-03	7.30E-03	7.30E-03	2.00E-05	2.00E-05	2.00E-05
HWW	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HWW	106-46-7	p-Dichlorobenzene		1.18E-06	1.18E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-02	1.03E-02	1.03E-02	2.82E-05	2.82E-05	2.82E-05
HWW		Diesel Particulate Matter				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HWW	100-41-4	Ethyl benzene		2.21E-06	2.21E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.93E-02	1.93E-02	1.93E-02	5.29E-05	5.29E-05	5.29E-05
HWW	50-00-0	Formaldehyde		7.35E-05	7.35E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.44E-01	6.44E-01	6.44E-01	1.76E-03	1.76E-03	1.76E-03
HWW	110-54-3	Hexane		1.76E-03	1.76E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.55E+01	1.55E+01	1.55E+01	4.24E-02	4.24E-02	4.24E-02
HWW	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HWW	7439-96-5	Manganese and compounds		3.73E-07	3.73E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.26E-03	3.26E-03	3.26E-03	8.94E-06	8.94E-06	8.94E-06
HWW	7439-97-6	Mercury and compounds		2.55E-07	2.55E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.23E-03	2.23E-03	2.23E-03	6.12E-06	6.12E-06	6.12E-06
HWW	91-20-3	Naphthalene		5.98E-07	5.98E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	5.24E-03	5.24E-03	5.24E-03	1.44E-05	1.44E-05	1.44E-05
HWW	7440-02-0	Nickel and compounds		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HWW		Polycyclic aromatic hydrocarbons (PAHs)		8.65E-08	8.65E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.57E-04	7.57E-04	7.57E-04	2.08E-06	2.08E-06	2.08E-06
HWW	115-07-1	Propylene		1.60E-04	1.60E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.40E+00	1.40E+00	1.40E+00	3.84E-03	3.84E-03	3.84E-03
HWW	7782-49-2	Selenium and compounds		2.35E-08	2.35E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.06E-04	2.06E-04	2.06E-04	5.65E-07	5.65E-07	5.65E-07
HWW	108-88-3	Toluene		3.33E-06	3.33E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.92E-02	2.92E-02	2.92E-02	8.00E-05	8.00E-05	8.00E-05
HWW	7440-62-2	Vanadium (fume or dust)		2.25E-06	2.25E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.98E-02	1.98E-02	1.98E-02	5.41E-05	5.41E-05	5.41E-05
HWW	1330-20-7	Xylene (mixture)		9.80E-06	9.80E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	8.59E-02	8.59E-02	8.59E-02	2.35E-04	2.35E-04	2.35E-04
HWW	7440-66-6	Zinc and compounds		2.84E-05	2.84E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.49E-01	2.49E-01	2.49E-01	6.82E-04	6.82E-04	6.82E-04
HTW	106-99-0	1,3-Butadiene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HTW	75-07-0	Acetaldehyde		7.26E-06	7.26E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.27E-01	1.27E-01	1.27E-01	3.49E-04	3.49E-04	3.49E-04
HTW	107-02-8	Acrolein		4.35E-06	4.35E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.63E-02	7.63E-02	7.63E-02	2.09E-04	2.09E-04	2.09E-04
HTW	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HTW	7440-38-2	Arsenic and compounds		1.96E-07	1.96E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.44E-03	3.44E-03	3.44E-03	9.41E-06	9.41E-06	9.41E-06
HTW	7440-39-3	Barium and compounds		4.31E-06	4.31E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.56E-02	7.56E-02	7.56E-02	2.07E-04	2.07E-04	2.07E-04
HTW	71-43-2	Benzene		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.61E-02	3.61E-02	3.61E-02	9.88E-05	9.88E-05	9.88E-05
HTW	7440-41-7	Beryllium and compounds		1.18E-08	1.18E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.06E-04	2.06E-04	2.06E-04	5.65E-07	5.65E-07	5.65E-07
HTW	7440-43-9	Cadmium and compounds		1.08E-06	1.08E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.89E-02	1.89E-02	1.89E-02	5.18E-05	5.18E-05	5.18E-05
HTW	18540-29-9	Chromium VI, chromate, and dichromate particulate		1.37E-06	1.37E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.40E-02	2.40E-02	2.40E-02	6.59E-05	6.59E-05	6.59E-05
HTW	7440-48-4	Cobalt and compounds		8.24E-08	8.24E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.44E-03	1.44E-03	1.44E-03	3.95E-06	3.95E-06	3.95E-06
HTW	7440-50-8	Copper and compounds		8.33E-07	8.33E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.46E-02	1.46E-02	1.46E-02	4.00E-05	4.00E-05	4.00E-05
HTW	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HTW	106-46-7	p-Dichlorobenzene		1.18E-06	1.18E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.06E-02	2.06E-02	2.06E-02	5.65E-05	5.65E-05	5.65E-05
HTW		Diesel Particulate Matter				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HTW	100-41-4	Ethyl benzene		2.21E-06	2.21E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.86E-02	3.86E-02	3.86E-02	1.06E-04	1.06E-04	1.06E-04
HTW	50-00-0	Formaldehyde		7.35E-05	7.35E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.29E+00	1.29E+00	1.29E+00	3.53E-03	3.53E-03	3.53E-03
HTW	110-54-3	Hexane		1.76E-03	1.76E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.09E+01	3.09E+01	3.09E+01	8.47E-02	8.47E-02	8.47E-02
HTW	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HTW	7439-96-5	Manganese and compounds		3.73E-07	3.73E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.53E-03	6.53E-03	6.53E-03	1.79E-05	1.79E-05	1.79E-05
HTW	7439-97-6	Mercury and compounds		2.55E-07	2.55E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	4.47E-03	4.47E-03	4.47E-03	1.22E-05	1.22E-05	1.22E-05
HTW	91-20-3	Naphthalene		5.98E-07	5.98E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.05E-02	1.05E-02	1.05E-02	2.87E-05	2.87E-05	2.87E-05
HTW	7440-02-0	Nickel and compounds		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.61E-02	3.61E-02	3.61E-02	9.88E-05	9.88E-05	9.88E-05
HTW		Polycyclic aromatic hydrocarbons (PAHs)		8.65E-08	8.65E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.51E-03	1.51E-03	1.51E-03	4.15E-06	4.15E-06	4.15E-06
HTW	115-07-1	Propylene		1.60E-04	1.60E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.80E+00	2.80E+00	2.80E+00	7.67E-03	7.67E-03	7.67E-03
HTW	7782-49-2	Selenium and compounds		2.35E-08	2.35E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	4.12E-04	4.12E-04	4.12E-04	1.13E-06	1.13E-06	1.13E-06
HTW	108-88-3	Toluene		3.33E-06	3.33E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	5.84E-02	5.84E-02	5.84E-02	1.60E-04	1.60E-04	1.60E-04
HTW	7440-62-2	Vanadium (fume or dust)		2.25E-06	2.25E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.95E-02	3.95E-02	3.95E-02	1.08E-04	1.08E-04	1.08E-04
HTW	1330-20-7	Xylene (mixture)		9.80E-06	9.80E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.72E-01	1.72E-01	1.72E-01	4.71E-04	4.71E-04	4.71E-04
HTW	7440-66-6	Zinc and compounds		2.84E-05	2.84E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	4.98E-01	4.98E-01	4.98E-01	1.36E-03	1.36E-03	1.36E-03
HMO	106-99-0	1,3-Butadiene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HMO	75-07-0	Acetaldehyde		7.26E-06	7.26E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.36E-02	6.36E-02	6.36E-02	1.74E-04	1.74E-04	1.74E-04
HMO	107-02-8	Acrolein		4.35E-06	4.35E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.81E-02	3.81E-02	3.81E-02	1.04E-04	1.04E-04	1.04E-04
HMO	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HMO	7440-38-2	Arsenic and compounds		1.96E-07	1.96E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.72E-03	1.72E-03	1.72E-03	4.71E-06	4.71E-06	4.71E-06
HMO	7440-39-3	Barium and compounds		4.31E-06	4.31E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.78E-02	3.78E-02	3.78E-02	1.04E-04	1.04E-04	1.04E-04
HMO	71-43-2	Benzene		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HMO	7440-41-7	Beryllium and compounds		1.18E-08	1.18E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-04	1.03E-04	1.03E-04	2.82E-07	2.82E-07	2.82E-07
HMO	7440-43-9	Cadmium and compounds		1.08E-06	1.08E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	9.45E-03	9.45E-03	9.45E-03	2.59E-05	2.59E-05	2.59E-05
HMO	18540-29-9	Chromium VI, chromate, and dichromate particulate		1.37E-06	1.37E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.20E-02	1.20E-02	1.20E-02	3.29E-05	3.29E-05	3.29E-05
HMO	7440-48-4	Cobalt and compounds		8.24E-08	8.24E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.21E-04	7.21E-04	7.21E-04	1.98E-06	1.98E-06	1.98E-06
HMO	7440-50-8	Copper and compounds		8.33E-07	8.33E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.30E-03	7.30E-03	7.30E-03	2.00E-05	2.00E-05	2.00E-05
HMO	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HMO	106-46-7	p-Dichlorobenzene		1.18E-06	1.18E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.03E-02	1.03E-02	1.03E-02	2.82E-05	2.82E-05	2.82E-05
HMO		Diesel Particulate Matter				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HMO	100-41-4	Ethyl benzene		2.21E-06	2.21E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.93E-02	1.93E-02	1.93E-02	5.29E-05	5.29E-05	5.29E-05
HMO	50-00-0	Formaldehyde		7.35E-05	7.35E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	6.44E-01	6.44E-01	6.44E-01	1.76E-03	1.76E-03	1.76E-03
HMO	110-54-3	Hexane		1.76E-03	1.76E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.55E+01	1.55E+01	1.55E+01	4.24E-02	4.24E-02	4.24E-02
HMO	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*						
HMO	7439-96-5	Manganese and compounds		3.73E-07	3.73E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	3.26E-03	3.26E-03	3.26E-03	8.94E-06	8.94E-06	8.94E-06
HMO	7439-97-6	Mercury and compounds		2.55E-07	2.55E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.23E-03	2.23E-03	2.23E-03	6.12E-06	6.12E-06	6.12E-06
HMO	91-20-3	Naphthalene		5.98E-07	5.98E-07	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	5.24E-03	5.24E-03	5.24E-03	1.44E-05	1.44E-05	1.44E-05
HMO	7440-02-0	Nickel and compounds		2.06E-06	2.06E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.80E-02	1.80E-02	1.80E-02	4.94E-05	4.94E-05	4.94E-05
HMO		Polycyclic aromatic hydrocarbons (PAHs)		8.65E-08	8.65E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	7.57E-04	7.57E-04	7.57E-04	2.08E-06	2.08E-06	2.08E-06
HMO	115-07-1	Propylene		1.60E-04	1.60E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.40E+00	1.40E+00	1.40E+00	3.84E-03	3.84E-03	3.84E-03
HMO	7782-49-2	Selenium and compounds		2.35E-08	2.35E-08	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.06E-04	2.06E-04	2.06E-04	5.65E-07	5.65E-07	5.65E-07
HMO	108-88-3	Toluene		3.33E-06	3.33E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.92E-02	2.92E-02	2.92E-02	8.00E-05	8.00E-05	8.00E-05
HMO	7440-62-2	Vanadium (fume or dust)		2.25E-06	2.25E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	1.98E-02	1.98E-02	1.98E-02	5.41E-05	5.41E-05	5.41E-05
HMO	1330-20-7	Xylene (mixture)		9.80E-06	9.80E-06	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	8.59E-02	8.59E-02	8.59E-02	2.35E-04	2.35E-04	2.35E-04
HMO	7440-66-6	Zinc and compounds		2.84E-05	2.84E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 2*	2.49E-01	2.49E-01	2.49E-01	6.82E-04	6.82E-04	6.82E-04

Toxic Emissions Unit ID	Pollutant Information		Control Efficiency	Emission Factor Information				Calculated Emissions					
				EF Values		Units	Reference/Notes	Annual - Chronic [lb/yr]			Max Daily - Acute [lb/day]		
	CAS	Chemical Name		Annual Chronic	Max Daily - Acute			Actual	Requested PTE	Capacity	Actual	Requested PTE	Capacity
EDG1	106-99-0	1,3-Butadiene		3.91E-05	3.91E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	1.47E-02		1.47E-02	3.52E-03		3.52E-03
EDG1	75-07-0	Acetaldehyde		7.67E-04	7.67E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	2.88E-01		2.88E-01	6.91E-02		6.91E-02
EDG1	107-02-8	Acrolein		9.25E-05	9.25E-05	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	3.47E-02		3.47E-02	8.34E-03		8.34E-03
EDG1	7440-36-0	Antimony and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7440-38-2	Arsenic and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7440-39-3	Barium and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	71-43-2	Benzene		9.33E-04	9.33E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	3.50E-01		3.50E-01	8.41E-02		8.41E-02
EDG1	7440-41-7	Beryllium and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7440-43-9	Cadmium and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	18540-29-9	Chromium VI, chromate, and dichromate particulate				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7440-48-4	Cobalt and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7440-50-8	Copper and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	74-90-8	Cyanide, Hydrogen				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	106-46-7	p-Dichlorobenzene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1		Diesel Particulate Matter		4.70E-02	4.70E-02	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	1.76E+01		1.76E+01	4.23E+00		4.23E+00
EDG1	100-41-4	Ethyl benzene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	50-00-0	Formaldehyde		1.18E-03	1.18E-03	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	4.43E-01		4.43E-01	1.06E-01		1.06E-01
EDG1	110-54-3	Hexane				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7439-92-1	Lead and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7439-96-5	Manganese and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7439-97-6	Mercury and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	91-20-3	Naphthalene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7440-02-0	Nickel and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1		Polycyclic aromatic hydrocarbons (PAHs)		1.68E-04	1.68E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	6.31E-02		6.31E-02	1.51E-02		1.51E-02
EDG1	115-07-1	Propylene				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	7782-49-2	Selenium and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	108-88-3	Toluene		4.09E-04	4.09E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	1.54E-01		1.54E-01	3.69E-02		3.69E-02
EDG1	7440-62-2	Vanadium (fume or dust)				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
EDG1	1330-20-7	Xylene (mixture)		2.85E-04	2.85E-04	lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*	1.07E-01		1.07E-01	2.57E-02		2.57E-02
EDG1	7440-66-6	Zinc and compounds				lb/MMBtu	*See Process HAP and GHG Emissions Sheet, p. 4*						
MR	7439-97-6	Mercury and compounds	50%	8.00E-01	8.00E-01	lb/ton	*See Process HAP and GHG Emissions Sheet, p. 6*	3.20E+00		3.20E+00	8.77E-03		8.77E-03
MR	74-90-8	Cyanide, Hydrogen		5.00E+00	5.00E+00	lb/ton	*See Grassy Mountain HCN Emissions Sheet*	4.00E+01		4.00E+01	1.10E-01		1.10E-01
UFD	106-99-0	1,3-Butadiene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	75-07-0	Acetaldehyde				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	107-02-8	Acrolein				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	7440-36-0	Antimony and compounds		6.71E-02	6.71E-02	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	7.33E-03		7.33E-03	3.52E-05		3.52E-05
UFD	7440-38-2	Arsenic and compounds		3.05E-01	3.05E-01	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	3.33E-02		3.33E-02	1.60E-04		1.60E-04
UFD	7440-39-3	Barium and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	71-43-2	Benzene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	7440-41-7	Beryllium and compounds		1.94E-03	1.94E-03	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	2.12E-04		2.12E-04	1.02E-06		1.02E-06
UFD	7440-43-9	Cadmium and compounds		4.13E-04	4.13E-04	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	4.51E-05		4.51E-05	2.17E-07		2.17E-07
UFD	18540-29-9	Chromium VI, chromate, and dichromate particulate		4.91E-02	4.91E-02	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	5.36E-03		5.36E-03	2.58E-05		2.58E-05
UFD	7440-48-4	Cobalt and compounds		3.16E-03	3.16E-03	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	3.45E-04		3.45E-04	1.66E-06		1.66E-06
UFD	7440-50-8	Copper and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	74-90-8	Cyanide, Hydrogen				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	106-46-7	p-Dichlorobenzene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD		Diesel Particulate Matter				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	100-41-4	Ethyl benzene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	50-00-0	Formaldehyde				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	110-54-3	Hexane				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	7439-92-1	Lead and compounds		1.33E-02	1.33E-02	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	1.46E-03		1.46E-03	7.00E-06		7.00E-06
UFD	7439-96-5	Manganese and compounds		1.53E-01	1.53E-01	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	1.67E-02		1.67E-02	8.04E-05		8.04E-05
UFD	7439-97-6	Mercury and compounds		4.50E-03	4.50E-03	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	4.91E-04		4.91E-04	2.36E-06		2.36E-06
UFD	91-20-3	Naphthalene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	7440-02-0	Nickel and compounds		9.01E-03	9.01E-03	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	9.84E-04		9.84E-04	4.73E-06		4.73E-06
UFD		Polycyclic aromatic hydrocarbons (PAHs)				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	115-07-1	Propylene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	7782-49-2	Selenium and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	108-88-3	Toluene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	7440-62-2	Vanadium (fume or dust)				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	1330-20-7	Xylene (mixture)				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
UFD	7440-66-6	Zinc and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	106-99-0	1,3-Butadiene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	75-07-0	Acetaldehyde				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	107-02-8	Acrolein				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	7440-36-0	Antimony and compounds		4.02E-02	4.02E-02	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	6.00E-02		6.00E-02	2.31E-04		2.31E-04
AFD	7440-38-2	Arsenic and compounds		3.07E-01	3.07E-01	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	4.59E-01		4.59E-01	1.76E-03		1.76E-03
AFD	7440-39-3	Barium and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	71-43-2	Benzene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	7440-41-7	Beryllium and compounds		9.29E-04	9.29E-04	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	1.39E-03		1.39E-03	5.33E-06		5.33E-06
AFD	7440-43-9	Cadmium and compounds		4.64E-04	4.64E-04	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	6.93E-04		6.93E-04	2.67E-06		2.67E-06
AFD	18540-29-9	Chromium VI, chromate, and dichromate particulate		2.99E-02	2.99E-02	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	4.46E-02		4.46E-02	1.71E-04		1.71E-04
AFD	7440-48-4	Cobalt and compounds		3.80E-03	3.80E-03	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	5.68E-03		5.68E-03	2.18E-05		2.18E-05
AFD	7440-50-8	Copper and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	74-90-8	Cyanide, Hydrogen				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	106-46-7	p-Dichlorobenzene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD		Diesel Particulate Matter				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	100-41-4	Ethyl benzene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	50-00-0	Formaldehyde				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	110-54-3	Hexane				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	7439-92-1	Lead and compounds		1.08E-02	1.08E-02	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	1.61E-02		1.61E-02	6.19E-05		6.19E-05
AFD	7439-96-5	Manganese and compounds		1.19E-01	1.19E-01	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	1.77E-01		1.77E-01	6.81E-04		6.81E-04
AFD	7439-97-6	Mercury and compounds		4.88E-03	4.88E-03	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	7.29E-03		7.29E-03	2.80E-05		2.80E-05
AFD	91-20-3	Naphthalene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	7440-02-0	Nickel and compounds		6.70E-03	6.70E-03	lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*	1.00E-02		1.00E-02	3.85E-05		3.85E-05
AFD		Polycyclic aromatic hydrocarbons (PAHs)				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	115-07-1	Propylene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	7782-49-2	Selenium and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	108-88-3	Toluene				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	7440-62-2	Vanadium (fume or dust)				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	1330-20-7	Xylene (mixture)				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
AFD	7440-66-6	Zinc and compounds				lb/ton	*See Mine HAP and GHG Emissions Sheet, p. 3*						
TAILS	74-90-8	Cyanide, Hydrogen		7.02E-02	7.02E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.15E+02		6.15E+02	1.68E+00		1.68E+00
POND	74-90-8	Cyanide, Hydrogen		2.93E-03	2.93E-03	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	2.56E+01		2.56E+01	7.03E-02		7.03E-02
DETOX1	74-90-8	Cyanide, Hydrogen		1.16E-02	1.16E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	1.02E+02		1.02E+02	2.78E-01		2.78E-01
DETOX2	74-90-8	Cyanide, Hydrogen		1.16E-02	1.16E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	1.02E+02		1.02E+02	2.78E-01		2.78E-01
CILTANK1	74-90-8	Cyanide, Hydrogen		7.85E-02	7.85E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.88E+02		6.88E+02	1.89E+00		1.89E+00
CILTANK2	74-90-8	Cyanide, Hydrogen		7.85E-02	7.85E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.88E+02		6.88E+02	1.89E+00		1.89E+00
CILTANK3	74-90-8	Cyanide, Hydrogen		7.85E-02	7.85E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.88E+02		6.88E+02	1.89E+00		1.89E+00
CILTANK4	74-90-8	Cyanide, Hydrogen		7.85E-02	7.85E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.88E+02		6.88E+02	1.89E+00		1.89E+00
CILTANK5	74-90-8	Cyanide, Hydrogen		7.85E-02	7.85E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.88E+02		6.88E+02	1.89E+00		1.89E+00
CILTANK6	74-90-8	Cyanide, Hydrogen		7.85E-02	7.85E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.88E+02		6.88E+02	1.89E+00		1.89E+00
CILTANK7	74-90-8	Cyanide, Hydrogen		7.85E-02	7.85E-02	lb/hr	*See Grassy Mountain HCN Emissions Sheet*	6.88E+02		6.88E+02	1.89E+00		1.89E+00

2.0 REFERENCES

Air Sciences. 2018. "Unpaved Road Dust Control Efficiency from Chemical Suppressants." Memorandum from K. Lewis (Air Sciences), January 12.

ATRI. 2016. "A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck." American Transportation Research Institute. Report No. SWT-2016-12, October.

Barton. 2019.03.31. "RE: Tails Data for Air Quality Analysis." Email from M. Barton (Golder) to K. Lewis (Air Sciences), March 31.

CAPCOA. 2011. "Modeling Compliance of The Federal 1-Hour NO2 NAAQS." California Air Pollution Control Officers Association, October 27.

Card. 2009. "Quality Assurance Project Plan Comprehensive Air Emissions Testing for Hydrogen Cyanide at Three Nevada Gold Mine Sites Using the USEPA Surface Isolation Flux Chamber Technology." *Docket ID: EPA-HQ-OAR-2010-0239-0102.* October 7. Accessed June 6, 2018. https://www.regulations.gov/docketBroswer?rpp=25&so=DESC&sb=commentDueDate&po=0.

Cat Lift Trucks. 2008. "Engine Powered Lift Trucks." August.

Caterpillar. 2018. "Caterpillar Performance Handbook 48." June.

CSIRO. 2008. "NOx Emissions from Blasting Operations in Open-Cut Coal Mining." *Atmospheric Environment.* Vol. 42. Elsevier. 7874-7883.

Diesel Service and Supply. 2019b. "Approximate Fuel Consumption Chart." *Diesel Service and Supply Generator Source.* Accessed March 28, 2019. https://www.dieselserviceandsupply.com/temp/Fuel_Consumption_Chart.pdf.

—. 2019a. "kVa & kW Amperage Chart." *Diesel Service and Supply Generator Source.* Accessed March 28, 2019. https://www.dieselserviceandsupply.com/temp/Amperage_Chart.pdf.

Duetz. n.d. a. "BF4M2011 engine specification sheet."

—. n.d. b. "BF4M2012 engine specification sheet for Paus motor grader."

Dyer. 2019.03.29a. "Air Permits." Email from T. Dyer (MDA) to M. Mavko (Air Sciences) regarding the power source of mining equipment, March 29.

—. 2019.03.29b. "Re: Air Permits." Email from T. Dyer (MDA) to M. Mavko (Air Sciences) regarding borrow pit mining fleet, March 29.

—. 2019.04.26. "RE: Borrow Pit." Email from T. Dyer (MDA) to M. Mavko (Air Sciences) regarding borrow pit activities, April 26.

—. 2019.04.19. "RE: Grassy Mtn Mine Fleet Equipment." Email from T. Dyer (MDA) to M. Mavko (Air Sciences), April 19.

—. 2019.03.21. "RE: Miscellaneous Air Permit Items." Email from T. Dyer (MDA) to T. Mills (Ausenco) regarding the fuel throughput and tank size for underground fleet, March 21.

—. 2019.06.24. "Telephone Communication." Telephone call between T. Dyer (MDA) and M. Mavko (Air Sciences), June 24.

EPA. 1995 w/ Updates. "Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources." *AP-42 Fifth Edition Including all the Latest Updates.* Office of Air Quality Planning and Standards. Office Of Air and Radiation. U.S. Environmental Protection Agency. Research Triangle Park, NC 2711, January. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors.

—. 2012. "Haul Road Workgroup Final Report Submission to EPA-OAQPS." Memorandum from Tyler Fox (EPA Air Quality Modeling Group Leader) to Regional Office Modeling Contacts, March 2. Accessed July 2, 2015.

—. 1994. "Modeling Fugitive Dust Impacts from Surface Coal Mining Operations - Phase II."

—. 2018. "MOVES2014b Technical Guidance." *EPA-420-B-18-039.* Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency. EPA-420-B-15-095, August. Accessed July 11, 2019. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100V7EY.pdf.

Ford. 2017. "2018 Fleet Preview Guide."

Li et al. 2008. "Water truck routing and location of refilling stations in open pit mines." *Australian Mining Technology Conference.* September.

McDonald et al. 2003. "Source Apportionment of Airborne Fine Particulate Matter in an Underground Mine." *Journal of the Air And Waste Management Association.* Vol. 53. Taylor and Francis, April. 386-395.

MDA. 2018. "Preliminary Feasibility Study and Technical Report for the Grasy Mountain Gold and Silver Project." *Malheur County, Oregon, USA.* 2018: Mine Development Associates (MDA), July 9.

Mills. 2019.03.27. "RE: Air Permit requirements." Email from T. Mills (Ausenco) to K. Lewis (Air Sciences) March 27.

—. 2019.03.29. "RE: Air Permits." Email from T. Mills (Ausenco) to M. Mavko (Air Sciences) regarding laboratory and stockpile fleet, March 29.

—. 2019.03.21. "RE: Miscellaneous Air Permit Items." Email from T. Mills (Ausenco) to T. Dyer (MDA) regarding sizing of emergency generator, March 21.

—. 2019.04.29. "Re: Section Views of Grassy Mtn Site." Email from T. Mills (Ausenco) to M. Mavko (Air Sciences), April 29.

—. 2019.04.18. "Re: Section Views of Grassy Mtn Site." Email from T. Mills (Ausenco) to M. Mavko (Air Sciences), April 18.

—. 2019.06.21. "RE: Section Views of Grassy Mtn Site." Email from T. Mills (Ausenco) to M. Mavko (Air Sciences), June 21.

—. 2019.03.20. "RE: Tails Data for Air Quality Analysis." *Files: GM_AirPermitReqs_EI_20190121 Ausenco TM.xlsm; Head Assay - Grassy Mt - 15944-001.xlsx.* Email from T. Mills (Ausenco) to K. Lewis (Air Sciences), March 20.

NDEP. 2017.06. "Calendar Year 2017 Actual Production/Emission Reporting Spreadsheet for Mercury Emissions from the Precious Metals Mining Industry." Nevada Devision of Environmental Protection (NDEP) Bureau of Air Pollution Control. Accessed June 20, 2019. https://ndep.nv.gov/uploads/air-nmcp-docs/cy2017-nmcp-mercury-emissions.pdf.

—. 2018. "Class I Air Quality Operating Permit No. AP1041-2967." *Issued to: Marigold Mining Company.* Nevada Devision of Environmental Protection (NDEP) Bureau of Air Pollution Control, July 23. Accessed June 20, 2019. https://documentviewerpublic.ndep.nv.gov/AppExtender/ViewDocument.aspx.

—. 2017.07. "Mercury Operating Permit to Construct: Phase 2." *Issued to: Smoky Valley Common Operation - Round Mountain Gold Corporation.* Nevada Department of Conservation and Natural Resources. Division of Environmental Protection (NDEP). Bureau of Air Pollution Control, July 5.

NIOSH. n.d. "Factors Affecting Fumes Production of an Emulsion and ANFO/Emulsion Blends."

Paus. 2013. "PG5HA Grader Specification Sheet."

Prestia. 2019.04.18. "RE: Air Permit input from SRK." Email from A. Prestia (SRK) to K. Lewis (Air Sciences), April 19.

Sandvik Mining and Rock Technology. 2018. "DS311 Rock Support Bolter Technical Specification." Accessed March 28, 2019. https://www.rocktechnology.sandvik/globalassets/products/underground-drill-rigs-and-bolters/pdf/ds311-specification-sheet-english.pdf.

—. 2017. "Sandvik LH410 Underground Loader Technical Specification." Accessed March 28, 2019. https://www.rocktechnology.sandvik/globalassets/products/underground-loaders-and-trucks/pdf/lh410-specification-sheet-english.pdf.

Schmidt. 2010. "Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Isolation Flux Chamber Technology." *Docket ID: EPA-HQ-OAR-2010-0239-0163.* Accessed June 6, 2018. https://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&dct=SR&D=EPA-HQ-OAR-2010-0239.

Simem. 2018. "Super Transportable Plant Concrete Technologies." February.

Wolverson. 2019.03.04. "FW: Air Permit requirements." Email regarding ICP analysis from drill-hole database, March 04.

—. 2019.03.25. "FW: Met Data for Calico - Vale site." Email from N. Wolverson (Calico Resources) to M. Mavko (Air Sciences), March 25.

—. 2019.03.17. "RE: [SPAM?] Re: Grassy Site Plan Map." *Files: Updated_SiteLayout.pdf; Updated_Grassy_SitePlan.zip.* Email from N. Wolverson (Calico Resources) to K. Lewis (Air Sciences), March 17.

Attachment A – Emissions Inventory Worksheets

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS								
Model ID	Source Description	Design Throughput unit/hr	unit/day	unit/yr	units	Material	hr/yr	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference
OC1	Dump of Ore to Ore Surge Bin	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC2	Surge Bin to Vibrating Grizzly Transfer	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC3	Primary Crusher (including transfers in and out)	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.
OC4	Crusher Discharge Conveyor Transfer Point	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC5	Screen Feed Conveyor 1 Transfer Point	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC6	Screen Feed Conveyor 2 Transfer Point	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC7	Screen (including transfers in and out)	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.0022	0.00074	0.00005					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - ctrl.
OC8	Cone Crusher (including transfers in and out)	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.
OC9	Screen Discharge Conveyor Transfer to Stockpile Conveyor	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC10	Ore Stockpile Conveyor Transfer to Ore Stockpile	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC11	Load Reclaim Hopper	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC12	Reclaim Hopper to Ball Mill Feed Conveyor Tansfer	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC13	Ball Mill Feed Conveyor to Ball Mill Transfer	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
BC1	Dump of Borrow to Surge Bin	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
BC2	Surge Bin to Vibrating Grizzly Transfer	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
BC3	Primary Crusher (including transfers in and out)	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - unctrl.; PM2.5 Ch. 13.2.4
BC4	Crusher Discharge Conveyor Transfer Point	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
BC5	Screen Feed Conveyor 1 Transfer Point	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
BC6	Screen Feed Conveyor 2 Transfer Point	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
BC7	Screen (including transfers in and out)	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.025	0.0087	0.00132					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
BC8	Cone Crusher (including transfers in and out)	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - unctrl.; PM2.5 Ch. 13.2.4
BC9	Screen Discharge Conveyor Transfer to Stockpile Conveyor	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
BC10	Ore Stockpile Conveyor Transfer to Borrow Stockpile	93	1,115	289,800	ton	Borrow	3,120	(MDA 2018) pp. 178-180	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
WM1	Wet Milling	33	794	289,700	ton	Ore	8,760	(MDA 2018) pp. 178-180									
LS1	Lime Silo Loading	55	55	292	ton	Lime	8,760	(Mills 2019.06.21)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.
LS2	Lime Silo Unloading to Lime Slaker	0.033	0.8	292	ton	Lime	8,760	(Mills 2019.03.20)	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.
CKD	Carbon Regeneration Kiln (Drum)	0.2	4.8	1,752	ton	Carbon	8,760	(Mills 2019.03.20)	0.06	0.06	0.06	1.05				lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Marigold (NDEP 2018)]
CKB	Carbon Regeneration Kiln (Burners)	1.7	40.8	14,892	MMBtu	Propane	8,760	(Mills 2019.03.20)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft3 & 91,500 Btu/gal

SOURCE DESCRIPTION		EMISSION CONTROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	control system	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
OC1	Dump of Ore to Ore Surge Bin	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC2	Surge Bin to Vibrating Grizzly Transfer	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC3	Primary Crusher (including transfers in and out)	Underground wet ore	0.040	0.018	0.0033					0.95	0.43	0.079					0.17	0.078	0.014				
OC4	Crusher Discharge Conveyor Transfer Point	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC5	Screen Feed Conveyor 1 Transfer Point	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC6	Screen Feed Conveyor 2 Transfer Point	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC7	Screen (including transfers in and out)	Underground wet ore	0.073	0.024	0.0017					1.7	0.59	0.040					0.32	0.11	0.0072				
OC8	Cone Crusher (including transfers in and out)	Underground wet ore	0.040	0.018	0.0033					0.95	0.43	0.079					0.17	0.078	0.014				
OC9	Screen Discharge Conveyor Transfer to Stockpile Conveyor	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC10	Ore Stockpile Conveyor Transfer to Ore Stockpile	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC11	Load Reclaim Hopper	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC12	Reclaim Hopper to Ball Mill Feed Conveyor Tansfer	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
OC13	Ball Mill Feed Conveyor to Ball Mill Transfer	Underground wet ore	0.0046	0.0015	4.3E-4					0.11	0.037	0.010					0.020	0.0067	0.0019				
BC1	Dump of Borrow to Surge Bin		0.28	0.10	0.016					3.3	1.2	0.19					0.43	0.16	0.025				
BC2	Surge Bin to Vibrating Grizzly Transfer		0.28	0.10	0.016					3.3	1.2	0.19					0.43	0.16	0.025				
BC3	Primary Crusher (including transfers in and out)		0.50	0.22	0.033					6.0	2.7	0.40					0.78	0.35	0.052				
BC4	Crusher Discharge Conveyor Transfer Point		0.28	0.10	0.016					3.3	1.2	0.19					0.43	0.16	0.025				
BC5	Screen Feed Conveyor 1 Transfer Point		0.28	0.10	0.016					3.3	1.2	0.19					0.43	0.16	0.025				
BC6	Screen Feed Conveyor 2 Transfer Point		0.28	0.10	0.016					3.3	1.2	0.19					0.43	0.16	0.025				
BC7	Screen (including transfers in and out)		2.3	0.81	0.12					27.9	9.7	1.5					3.6	1.3	0.19				
BC8	Cone Crusher (including transfers in and out)		0.50	0.22	0.033					6.0	2.7	0.40					0.78	0.35	0.052				
BC9	Screen Discharge Conveyor Transfer to Stockpile Conveyor		0.28	0.10	0.016					3.3	1.2	0.19					0.43	0.16	0.025				
BC10	Ore Stockpile Conveyor Transfer to Borrow Stockpile		0.28	0.10	0.016					3.3	1.2	0.19					0.43	0.16	0.025				
WM1	Wet Milling	Wet process																					
LS1	Lime Silo Loading	Bin Vent	0.054	0.019	0.0028					0.054	0.019	0.0028					1.4E-4	5.0E-5	7.3E-6				
LS2	Lime Silo Unloading to Lime Slaker		1.6E-4	9.3E-5	1.3E-5					0.0038	0.0022	3.2E-4					7.0E-4	4.1E-4	5.8E-5				
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber / Carbon Filter	0.060	0.060	0.060	1.1				1.4	1.4	1.4	25.2				0.26	0.26	0.26	4.6			
CKB	Carbon Regeneration Kiln (Burners)		0.013	0.013	0.013	0.14	0.24	0.030	0.015	0.31	0.31	0.31	3.3	5.8	0.71	0.36	0.057	0.057	0.057	0.61	1.1	0.13	0.065

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS								
Model ID	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference
		unit/hr	unit/day	unit/yr	units	Material	hr/yr										
EW	Electrowinning Cells & Pregnant Solution Tank																Hg and HCN emissions only
MR	Mercury Retort			8	ton	Wet Au Conc	8,760	(MDA 2018) p. 174 (1.5x Au+Ag)									Hg emissions only
MF	Induction Melting Furnace	#######	12 hr	8	ton	Wet Au Conc	960	(MDA 2018) p. 174 (1.5x Au+Ag)	0.12	0.12	0.12					lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Marigold (NDEP 2018)]
LABSP	Sample Preparation	0.75	6	2,190	ton	Samples	8,760	(Mills 2019.03.29) 100x of est.	0.0200	0.00772	0.00074					lb/ton	AP-42, Table 11.19.2-2 (08/04), 6 splitters, 3 crushers, 3, screens, 3 pulverizers - ctrl
LABFA	Fire Assay	0.003125	0.025	9	ton	Samples	8,760	(Mills 2019.03.29)	20	20	20					lb/ton	AP-42 Tab. 12.7-2, Zinc smelting, Electric retort furnace
EDG1	Emergency Generator (Mfr. Yr. >2007; diesel)	400	110	40,000	kW	Diesel	100	(Mills 2019.03.21); (DSS 2019a)	0.00044	0.00044	0.00044	0.00772	0.01411	1.45E-05	0.00287	lb/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15 ppm ULSD) (CFR 2018b)
HA	Administration HVAC	1.00	24.00	8,760	MMBtu	Propane	8,760	Standard industry size	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HPO	Plant Office and Dry HVAC	1.00	24.00	8,760	MMBtu	Propane	8,760	Standard industry size	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HL	Laboratory HVAC	1.00	24.00	8,760	MMBtu	Propane	8,760	Standard industry size	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HWW	Plant Workshop and Warehouse HVAC	1.00	24.00	8,760	MMBtu	Propane	8,760	Standard industry size	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HTW	Truck Workshop and Warehouse HVAC	2.00	48.00	17,520	MMBtu	Propane	8,760	Standard industry size	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HMO	Mine Office and Changehouse HVAC	1.00	24.00	8,760	MMBtu	Propane	8,760	Standard industry size	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
CEM1	Cement/Shotcrete loading to silo	80	80	7,053	ton	Cement	8,760	(Dyer 2019.06.24)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.
CEM2	Cement/Shotcrete unloading to batch plant	80	80	7,053	ton	Cement	8,760	(Dyer 2019.06.24)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.
CEM3	Aggregate transfer	141	1,125	134,000	ton	Aggregate	8,760	(MDA 2018) p. 139 & (Dyer 2019.06.24)	0.0069	0.0033	0.0005					lb/ton	AP-42, Table 11.12-2 (6/06), aggregate transfer-unctrl.
CEM4	Weigh hopper loading	141	1,125	134,000	ton	Aggregate	8,760	(MDA 2018) p. 139 & (Dyer 2019.06.24)	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.
CEM5	Mixer loading (central mix)	7.42 (475)	59.36	7,053 (131k)	ton	Cemented Rock Fill	8,760		0.0184	0.0055	0.0008					lb/ton	AP-42, Table 11.12-2 (6/06), central mixer-ctrl.
TG1	Mine Site Gasoline Tank #1			52,000	gal	Gasoline	8,760	Based on 1 turaround per week							0.045	lb/hr	EPA Tanks 4.0.9d (EPA 1999)
TD1	Mine Site Diesel Tank #1			240,000	gal	Diesel	8,760	(Mills 2019.03.29)							4.3E-4	lb/hr	EPA Tanks 4.0.9d (EPA 1999)
TD2	Mine Site Diesel Tank #2			3,000	gal	Diesel	8,760	Based on 100 hr/yr of emer. gen. oper.							5.1E-5	lb/hr	EPA Tanks 4.0.9d (EPA 1999)
Total																	

SOURCE DESCRIPTION		EMISSION CONTROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	control system	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
EW	Electrowinning Cells & Pregnant Solution Tank	Shared Carbon Filter																					
MR	Mercury Retort	Condenser / Carbon Filter																					
MF	Induction Melting Furnace	Baghouse / Carbon Filter	0.12	0.12	0.12					2.9	2.9	2.9					0.058	0.058	0.058				
LABSP	Sample Preparation	Fume Hood	0.015	0.0058	5.5E-4					0.12	0.046	0.0044					0.022	0.0084	8.1E-4				
LABFA	Fire Assay	Fume Hood	0.063	0.063	0.063					0.50	0.50	0.50					0.091	0.091	0.091				
EDG1	Emergency Generator (Mfr. Yr. >2007; diesel)		0.18	0.18	0.18	3.1	5.6	0.0058	1.1	0.049	0.049	0.049	0.85	1.6	0.0016	0.32	0.0088	0.0088	0.0088	0.15	0.28	2.9E-4	0.057
HA	Administration HVAC		0.0077	0.0077	0.0077	0.082	0.142	0.0174	0.0087	0.184	0.184	0.184	1.97	3.41	0.42	0.210	0.0335	0.0335	0.0335	0.359	0.62	0.076	0.0383
HPO	Plant Office and Dry HVAC		0.0077	0.0077	0.0077	0.082	0.142	0.0174	0.0087	0.184	0.184	0.184	1.97	3.41	0.42	0.210	0.0335	0.0335	0.0335	0.359	0.62	0.076	0.0383
HL	Laboratory HVAC		0.0077	0.0077	0.0077	0.082	0.142	0.0174	0.0087	0.184	0.184	0.184	1.97	3.41	0.42	0.210	0.0335	0.0335	0.0335	0.359	0.62	0.076	0.0383
HWW	Plant Workshop and Warehouse HVAC		0.0077	0.0077	0.0077	0.082	0.142	0.0174	0.0087	0.184	0.184	0.184	1.97	3.41	0.42	0.210	0.0335	0.0335	0.0335	0.359	0.62	0.076	0.0383
HTW	Truck Workshop and Warehouse HVAC		0.0153	0.0153	0.0153	0.164	0.28	0.035	0.0175	0.37	0.37	0.37	3.9	6.8	0.83	0.42	0.067	0.067	0.067	0.72	1.24	0.152	0.077
HMO	Mine Office and Changehouse HVAC		0.0077	0.0077	0.0077	0.082	0.142	0.0174	0.0087	0.184	0.184	0.184	1.97	3.41	0.42	0.210	0.0335	0.0335	0.0335	0.359	0.62	0.076	0.0383
CEM1	Cement/Shotcrete loading to silo	Bin Vent	0.079	0.027	0.0040					0.079	0.027	0.0040					0.0035	0.0012	1.8E-4				
CEM2	Cement/Shotcrete unloading to batch plant	Bin Vent	0.079	0.027	0.0040					0.079	0.027	0.0040					0.0035	0.0012	1.8E-4				
CEM3	Aggregate transfer		0.97	0.47	0.071					7.8	3.7	0.56					0.46	0.22	0.034				
CEM4	Weigh hopper loading		0.68	0.39	0.056					5.4	3.2	0.45					0.32	0.19	0.027				
CEM5	Mixer loading (central mix)	Types of controls used may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, and the like.	0.14	0.041	0.0059					1.1	0.33	0.047					0.065	0.019	0.0028				
TG1	Mine Site Gasoline Tank #1								0.045							1.1							0.20
TD1	Mine Site Diesel Tank #1								4.3E-4							0.010							0.0019
TD2	Mine Site Diesel Tank #2								5.1E-5							0.0012							2.2E-4
Total			**8.0**	**3.5**	**0.9**	**4.8**	**6.9**	**0.2**	**1.3**	**89.1**	**39.2**	**11.4**	**43.2**	**31.2**	**3.6**	**3.24**	**10.7**	**4.6**	**1.3**	**7.9**	**5.7**	**0.7**	**0.6**

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
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Hazardous Air Pollutants and Greenhouse Gas Emissions

HAP Emissions Summary

	Emissions	
Pollutant	lb/yr	ton/yr
1,3-Butadiene	0.015	7.3E-6
Acetaldehyde	0.84	4.2E-4
Acrolein	0.37	1.8E-4
Antimony and compounds	-	1.6E-4
Arsenic and compounds	2.8141	1.4E-3
Barium and compounds	0.33	1.6E-4
Benzene	0.51	2.5E-4
Copper and compounds	0.064	3.2E-5
Beryllium and compounds	7.9E-3	4.0E-6
Cadmium and compounds	0.086	4.3E-5
Chromium VI, chromate, and dichrom	0.349	1.7E-4
Cobalt and compounds	0.0418	2.1E-5
Cyanide, Hydrogen	40.0	2.0E-2
p-Dichlorobenzene	0.090	4.5E-5
Diesel Particulate Matter	17.6	8.8E-3
Ethyl benzene	0.168	8.4E-5
Formaldehyde	6.0	3.0E-3
Hexane	134.5	6.7E-2
Lead and compounds	-	4.7E-5
Manganese and compounds	1.058	5.3E-4
Mercury and compounds	3.3	1.6E-3
Naphthalene	0.046	2.3E-5
Nickel and compounds	0.215	1.1E-4
Propylene	12.2	6.1E-3
Polycyclic aromatic hydrocarbons (PA	0.070	3.5E-5
Selenium and compounds	1.8E-3	9.0E-7
Toluene	0.41	2.0E-4
Vanadium (fume or dust)	0.172	8.6E-5
Xylene (mixture)	0.85	4.3E-4
Zinc and compounds	2.17	1.1E-3
Total HAP	**222.53**	**0.112**
		chk
		cao-chk

See HCN Sheet

GHG Emissions Summary

Source Category	**CO2e** *(ton/yr)*
Propane Combustion	5,303
Diesel Combustion	31
Total GHGs	**5,334**

Conversions

2,000	lb/ton
907.186	kg/ton
1.341	hp/kW
1E+6	Btu/MMBtu

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PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/yr
CKB	Carbon Regeneration Kiln (Burners)	14,892
HA	Administration HVAC	8,760
HPO	Plant Office and Dry HVAC	8,760
HL	Laboratory HVAC	8,760
HWW	Plant Workshop and Warehouse HVAC	8,760
HTW	Truck Workshop and Warehouse HVAC	17,520
HMO	Mine Office and Changehouse HVAC	8,760
Total		76,212

**Propane heating value* 91,500 *Btu/gal*

HAP Emissions - Propane Combustion

		Emission Factor*		Emissions
Pollutant		lb/MMScf	lb/MMBtu**	ton/yr
Acetaldehyde	***	7.41E-03	7.26E-6	2.77E-04
Acrolein	***	4.44E-03	4.35E-6	1.66E-04
Barium and compounds		4.40E-03	4.31E-6	1.64E-04
Benzene		2.10E-03	2.06E-6	7.85E-05
Copper and compounds		8.50E-04	8.33E-7	3.18E-05
p-Dichlorobenzene		1.20E-03	1.18E-6	4.48E-05
Ethyl benzene	***	2.25E-03	2.21E-6	8.41E-05
Formaldehyde		7.50E-02	7.35E-5	2.80E-03
Hexane		1.80E+00	1.76E-3	6.72E-02
Naphthalene		6.10E-04	5.98E-7	2.28E-05
Propylene	***	1.63E-01	1.60E-4	6.09E-03
Toluene		3.40E-03	3.33E-6	1.27E-04
Xylene (mixture)	***	1.00E-02	9.80E-6	3.74E-04
Polycyclic aromatic hydrocarbons (PAHs)		< 8.82E-05	8.65E-8	3.30E-06
Arsenic and compounds		2.00E-04	1.96E-7	7.47E-06
Beryllium and compounds		< 1.20E-05	1.18E-8	4.48E-07
Cadmium and compounds		1.10E-03	1.08E-6	4.11E-05
Chromium VI, chromate, and dichromate particulate		1.40E-03	1.37E-6	5.23E-05
Cobalt and compounds		8.40E-05	8.24E-8	3.14E-06
Manganese and compounds		3.80E-04	3.73E-7	1.42E-05
Mercury and compounds		2.60E-04	2.55E-7	9.71E-06
Nickel and compounds		2.10E-03	2.06E-6	7.85E-05
Selenium and compounds		< 2.40E-05	2.35E-8	8.97E-07
Vanadium (fume or dust)		2.30E-03	2.25E-6	8.59E-05
Zinc and compounds		2.90E-02	2.84E-5	1.08E-03
Total HAP				7.89E-02

**AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion*

***Natural Gas Higher Heating Value* 1,020 *MMBtu/MMScf*

****California Air Toxics Emission Factors Database, Natural Gas Heaters (SCC 31000404)*

PROPANE COMBUSTION - CONTINUED

Propane CO_2e Emission Factors:	62.87	*kg CO2/MMBtu*	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) Propane (CFR 2018d)*
	3.0E-03	*kg CH4/MMBtu*	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018d)*
	6.0E-04	*kg N2O/MMBtu*	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018d)*

Total Propane Combustion 76,212 *MMBtu/yr*

Propane CO2e Emissions - Process Sources:

Greenhouse Gas	Emissions ton/yr	Global Warming Potential*	CO2e ton/yr
CO2	5,282	1	5,282
CH4	0.25	25	6
N2O	0.05	298	15
Total GHG			5,303

** 40 CFR 98, Table A-1 (12/2014) (CFR 2018d)*

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DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/yr	Fuel Consumption MMBtu/hr*	Fuel Consumption MMBtu/yr
EDG1	Emergency Generator (Mfr. Yr. >2007; diesel)	400	536	100	3.75	375.5
Total						375.5

** Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr AP-42 Tbl 3.3-1*

*** Heat Content of* 0.137 *MMBtu/gal*

HAP Emissions - Diesel Combustion, Small Engines

Pollutant	Emission Factor* lb/MMBtu	Emissions ton/yr
1,3-Butadiene	3.91E-05	7.34E-06
Acetaldehyde	7.67E-04	1.44E-04
Acrolein	9.25E-05	1.74E-05
Benzene	9.33E-04	1.75E-04
Formaldehyde	1.18E-03	2.22E-04
Polycyclic aromatic hydrocarbons (PAHs)	1.68E-04	3.16E-05
Toluene	4.09E-04	7.68E-05
Xylene (mixture)	2.85E-04	5.35E-05
Total HAPs		7.27E-04

**AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

Combustion Diesel Particulate Matter Emissions

Pollutant/Group		Total lbs/yr	Total ton/yr
Diesel Particulate Matter	(as PM2.5)	18	0.01
DPM Total		18	0.01

Diesel CO2e Emission Factors:

73.96 *kg* CO_2*/MMBtu*	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) No.2*
3.0E-03 *kg* CH_4*/MMBtu*	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*
6.0E-04 *kg* N_2O*/MMBtu*	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*

Total Diesel Combustion 375.5 *MMBtu/yr*

Diesel CO2e Emissions - Process Sources:

Greenhouse Gas	Emissions ton/yr	Global Warming Potential*	CO2e ton/yr
CO2	30.61	1	30.61
CH4	1.24E-03	25	0.03
N2O	2.48E-04	298	0.07
Total GHG			30.72

** 40 CFR 98, Table A-1 (CFR 2018d)*

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FUGITIVE DUST EMISSIONS

HAP Emissions Summary - Fugitive Dust Sources

Activity Information

0	PM ton/yr	
Process Area Crushing	0.87	*See Process Sheet*
Borrow Crushing	8.23	*See Process Sheet*
Ore/Waste Subtotal	9.10	

Ore and Waste Dust HAP Concentrations [1] ***and Emissions***

CAS No	Pollutant	Ore ppm	Waste ppm	Ore lb/ton	Waste lb/ton	Total [2] lb/yr	Total ton/yr	AG lb/ton
7440-38-	Arsenic and compounds	152	154	0.3040	0.31	2.80	1.4E-3	0.0093617
7440-41-	Beryllium and compounds	1.1	0.31	0.0022	0.00	0.01	3.5E-6	2.346E-05
7440-43-	Cadmium and compounds	0.2	0.24	0.0004	0.00	0.00	2.1E-6	1.438E-05
7440-48-	Cobalt and compounds	1.5	2	0.0030	0.00	0.04	1.8E-5	0.0001188
18540-2	Chromium VI, chromate, and dichromate particul	27	12	0.0540	0.02	0.24	1.2E-4	0.0008176
7439-97-	Mercury and compounds	2.2	2.5	0.0044	0.01	0.04	2.2E-5	0.0001504
7439-96-	Manganese and compounds	81	54	0.1620	0.11	1.03	5.1E-4	0.0034437
7440-02-	Nickel and compounds	4.8	3	0.0096	0.01	0.06	2.9E-5	0.0001931
7439-92-	Lead and compounds	7	5	0.0140	0.01	0.09	4.7E-5	0.000316
7440-36-	Antimony and compounds	37	16	0.0740	0.03	0.33	1.6E-4	0.0010959
Dust HAP Total						4.64	2.3E-3	

[#] *(Wolverson 2019.03.04)*

[#] *Process Area activities using ore EF; Borrow activities using waste EF*

Conversions

2,000 lb/ton

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40 CFR 63 Subpart 7E MERCURY SOURCES

Mercury Emissions

Description	Subpart 7E Hg Emissions ton/yr	% of Subpart 7E for Controlled Systems* %	Controlled Hg Emissions* lb/yr	ton/yr
Refinery Sources (Kiln, EW, Retort, Furnace)	0.003	50%	3.20	1.6E-03
Total	0.003		3.20	1.6E-03

**Based on Similar Source Hg Reporting Levels provided below*

Subpart 7E Limit - Carbon Processes with Mercury Retorts

$$\frac{0.8 \text{ lb}}{\text{~~ton~~}} \times \frac{8 \text{ ~~ton~~}}{\text{yr}} = \frac{6.4 \text{ lb}}{\text{yr}}$$

Similar Source Hg Reporting Levels

Cortez Hills (2017 Hg Report) *(NDEP 2017.06)*

$$\frac{1.92 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{47.40 \text{ ton}} = \frac{0.04 \text{ lb}}{\text{ton}} \times \frac{\text{ton}}{0.8 \text{ lb}} = 5.1\%$$

Rawhide Mine (2017 Hg Report) *(NDEP 2017.06)*

$$\frac{0.32 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{35.40 \text{ ton}} = \frac{0.01 \text{ lb}}{\text{ton}} \times \frac{\text{ton}}{0.8 \text{ lb}} = 1.1\%$$

Gold Hill Mine (2017 Hg Report) *(NDEP 2017.06)*

$$\frac{0.16 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{16.90 \text{ ton}} = \frac{0.01 \text{ lb}}{\text{ton}} \times \frac{\text{ton}}{0.8 \text{ lb}} = 1.2\%$$

Gold Hill Mine (2017 Hg Report) *(NDEP 2017.06)*

$$\frac{0.002 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{0.94 \text{ ton}} = \frac{0.00 \text{ lb}}{\text{ton}} \times \frac{\text{ton}}{0.8 \text{ lb}} = 0.3\%$$

Conversions

2,000 lb/ton

Grassy Mountain HCN Emissions

Wind: m/s = 3.20, Fw = 1.05

Snow Cover: 0 days w/ 0.5+ in. 0% snow

Fugitive Emissions

Area	Source	Cat.	Category Description	Acres	Snow Cover Adjustment Acres	pH	Free CN- g/m3	T C	pKa	a0	H	Overall kG or Flux m/s or g/m2-s[1]	Fa*Fw	g/s	lb/yr
Tails	Tailings Storage Facility	TA	Tails, Aqueous Surface	8.03	8.03	8.00	1.00	12.82	9.567	0.9736	0.00350	1.89E-05	0.49	0.0010	71.3
		TW	Tails, Wet Sediment	26.37	26.37 snow							5.31E-08	0.49	0.0028	192.9
		TD	Tails, Dry Sediment	53.53	53.53 snow							2.33E-08	1.00	0.0050	350.3
			Active Surface Subtotal	**34.40**											
Mill															
	Tailings Pipeline Reclaim Pond	TA	Tails, Aqueous Surface	2.502	2.502	8.00	1.00	12.82	9.567	0.9736	0.00350	1.89E-05	0.57	0.0004	25.6
	CN Detoxification Tank 1	TK	Tanks	0.0076	0.008	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.78	0.0015	101.5
	CN Detoxification Tank 2	TK	Tanks	0.0076	0.008	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.78	0.0015	101.5
	CIL Tank 1	TK	Tanks	0.0574	0.057	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.70	0.0099	688.1
	CIL Tank 2	TK	Tanks	0.0574	0.057	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.70	0.0099	688.1
	CIL Tank 3	TK	Tanks	0.0574	0.057	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.70	0.0099	688.1
	CIL Tank 4	TK	Tanks	0.0574	0.057	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.70	0.0099	688.1
	CIL Tank 5	TK	Tanks	0.0574	0.057	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.70	0.0099	688.1
	CIL Tank 6	TK	Tanks	0.0574	0.057	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.70	0.0099	688.1
	CIL Tank 7	TK	Tanks	0.0574	0.057	10.00	238.87	25.00	9.250	0.1510	0.00545	3.11E-04	0.70	0.0099	688.1
												Overall			
	Snow Adjustments	Tsn	Tails, Snow Covered		0.00 snow							1.17E-08	1.00	0.0000	0.0
			Snow Covered Surface Subtotal		***0.0***										
			TOTAL AREA	**90.85**	**90.85**										

Fugitive Total (lb/yr) **5,659.7**

Fugitive Total (ton/yr) **2.83**

Stack Emissions

	lb/hr[2]	hr/yr	lb/yr
EW Cells	0.000567	8,760	**5.0**
Preg/Barren Tanks	0.004	8,760	**35.0**

Stack Total (lb/yr) **40.0**

Stack Total (ton/yr) **0.02**

Total (ton/yr) **2.85**

[1] *Per EPA's request, three gold mines in Nevada conducted fugitive HCN emission measurements in the fourth quarter of 2009 in order to quantify emissions from the various fugitive HCN sources at gold mines. The Quality Assurance Project Plan (QAPP) for this testing, the EPA's approval letter of this QAPP, and the final fugitive HCN test report are provided on the federal docket website athttps://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&s=EPA-HQ-OAR-2010-0239-0163&dct=SR&D=EPA-HQ-OAR-2010-0239. The IDs for these documents are EPA-HQ-OAR-2010-0239-0102, EPA-HQ-OAR-2010-0239-0103, and EPA-HQ-OAR-2010-0239-0163 (0163.0 through 0163.6), respectively. The above emission factors were taken from the final fugitive HCN test report, "Card and Schmidt. Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Isolation Flux Chamber Technology. April 2010." (Card 2009) (EPA 2009) (Schmidt 2010)*

[2] The emission factor is baes on the average HCN test data from similar facilities (EW cells with carbon control):

See: http://www.regulations.gov/#!docketDetail;rpp=250;po=0;s=HCN;D=EPA-HQ-OAR-2010-0239
Hydrogen Cyanide (HCN) Stack Test for Cortez November 2009
Hydrogen Cyanide (HCN) Stack Test for Goldstrike September & November 2009
HCN (Hydrogen Cyanide) Stack Test for Round Mountain November 2009
HCN (Hydrogen Cyanide) Stack Test for Gold Quarry July 2009
HCN (Hydrogen Cyanide) Stack Test for Twin Creeks November 2009

Conversion Factors:

453.59	g/lb
4046.86	m2/acre
8760	hr/yr
60	min/hr
3600	s/hr
43560	ft2/acre
2000	lb/ton
1	lb/ton NaCN =
265.408	g/m^3 CN

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
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Fuel Storage Tanks

	Dimensions					VOC Emissions[1]		
	Capacity	Diameter	Length	Throughput				Reference
Storage Tank	gal	ft	ft	gal/yr	**Configuration**	lb/yr	ton/yr	
Mine Site Gasoline Tank #1	1,000	4.4	9	52,000	Horizontal	397.6	0.20	*Based on 1 turaround per week*
Mine Site Diesel Tank #1	5,000	10	10	240,000	Vertical	3.8	0.0019	*(Dyer 2019.03.21)*
Mine Site Diesel Tank #2	2,200	6	12	3,000	Horizontal	0.44	2.2E-4	*(Dyer 2019.03.21)*

[#] *Emissions calculated using EPA Tanks 4.0.9d (EPA 1999)*

Mine Site Gasoline Tank #1

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	TG1
City:	Malheur County
State:	Oregon
Company:	Paramount Gold Nevada Corp.
Type of Tank:	Horizontal Tank
Description:	Mine Site Gasoline Tank #1

Tank Dimensions

Shell Length (ft):	9.00
Diameter (ft):	4.40
Volume (gallons):	1,000.00
Turnovers:	52.00
Net Throughput(gal/yr):	52,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TG1 - Horizontal Tank
Malheur County, Oregon

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	52.81	46.88	58.74	50.94	3.9950	3.5384	4.4980	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

Mine Site Gasoline Tank #1 - continued

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TG1 - Horizontal Tank
Malheur County, Oregon

Annual Emission Calcaulations	
Standing Losses (lb):	151.2133
Vapor Space Volume (cu ft):	87.1642
Vapor Density (lb/cu ft):	0.0487
Vapor Space Expansion Factor:	0.1431
Vented Vapor Saturation Factor:	0.6822
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	87.1642
Tank Diameter (ft):	4.4000
Effective Diameter (ft):	7.1025
Vapor Space Outage (ft):	2.2000
Tank Shell Length (ft):	9.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0487
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.1431
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.9596
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	3.5384
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	4.4980
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.6822
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Space Outage (ft):	2.2000
Working Losses (lb):	246.4222
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Annual Net Throughput (gal/yr.):	52,000.0000
Annual Turnovers:	52.0000
Turnover Factor:	0.7436
Tank Diameter (ft):	4.4000
Working Loss Product Factor:	1.0000
Total Losses (lb):	397.6356

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TG1 - Horizontal Tank
Malheur County, Oregon

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	246.42	151.21	397.64

Mine Site Diesel Tank #1

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	TD3
City:	Malheur County
State:	Oregon
Company:	Paramount Gold Nevada Corp.
Type of Tank:	Vertical Fixed Roof Tank
Description:	Mine Site Diesel Tank #2

Tank Dimensions

Shell Height (ft):	10.00
Diameter (ft):	10.00
Liquid Height (ft) :	8.51
Avg. Liquid Height (ft):	5.00
Volume (gallons):	5,000.00
Turnovers:	48.00
Net Throughput(gal/yr):	240,000.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	10.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TD3 - Vertical Fixed Roof Tank
Malheur County, Oregon

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	52.81	46.88	58.74	50.94	0.0051	0.0041	0.0062	130.0000			188.00	Option 1: VP50 = .0045 VP60 = .0065

Mine Site Diesel Tank #1 - continued

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TD3 - Vertical Fixed Roof Tank
Malheur County, Oregon

Annual Emission Calcaulations	
Standing Losses (lb):	0.7907
Vapor Space Volume (cu ft):	432.4926
Vapor Density (lb/cu ft):	0.0001
Vapor Space Expansion Factor:	0.0419
Vented Vapor Saturation Factor:	0.9985
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	432.4926
Tank Diameter (ft):	10.0000
Vapor Space Outage (ft):	5.5067
Tank Shell Height (ft):	10.0000
Average Liquid Height (ft):	5.0000
Roof Outage (ft):	0.5067
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5067
Dome Radius (ft):	10.0000
Shell Radius (ft):	5.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0001
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0419
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.0022
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0041
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0062
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9985
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Space Outage (ft):	5.5067
Working Losses (lb):	2.9773
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Annual Net Throughput (gal/yr.):	240,000.0000
Annual Turnovers:	48.0000
Turnover Factor:	0.7917
Maximum Liquid Volume (gal):	5,000.0000
Maximum Liquid Height (ft):	8.5103
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	3.7680

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TD3 - Vertical Fixed Roof Tank
Malheur County, Oregon

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	2.98	0.79	3.77

Mine Site Diesel Tank #2

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	TD4
City:	Malheur County
State:	Oregon
Company:	Paramount Gold Nevada Corp.
Type of Tank:	Horizontal Tank
Description:	Mine Site Diesel Tank #3

Tank Dimensions

Shell Length (ft):	12.00
Diameter (ft):	6.00
Volume (gallons):	2,200.00
Turnovers:	1.36
Net Throughput(gal/yr):	3,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TD4 - Horizontal Tank
Malheur County, Oregon

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	52.81	46.88	58.74	50.94	0.0051	0.0041	0.0062	130.0000			188.00	Option 1: VP50 = .0045 VP60 = .0065

Mine Site Diesel Tank #2 - continued

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TD4 - Horizontal Tank
Malheur County, Oregon

Annual Emission Calcaulations	
Standing Losses (lb):	0.3954
Vapor Space Volume (cu ft):	216.1096
Vapor Density (lb/cu ft):	0.0001
Vapor Space Expansion Factor:	0.0419
Vented Vapor Saturation Factor:	0.9992
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	216.1096
Tank Diameter (ft):	6.0000
Effective Diameter (ft):	9.5770
Vapor Space Outage (ft):	3.0000
Tank Shell Length (ft):	12.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0001
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0419
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.0022
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0041
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0062
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9992
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0051
Vapor Space Outage (ft):	3.0000
Working Losses (lb):	0.0470
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Annual Net Throughput (gal/yr.):	3,000.0000
Annual Turnovers:	1.3636
Turnover Factor:	1.0000
Tank Diameter (ft):	6.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	0.4424

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TD4 - Horizontal Tank
Malheur County, Oregon

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.05	0.40	0.44

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
	PROJECT NO: 343-1	PAGE: 1 OF: 26 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity Emissions	DATE: July 26, 2019

Mining Scenario Ore

Mining Activity Emissions Emissions Summary

By Area/Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
Area/	Location of	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
UG	Underground Activity	30.50	77.43	8.05	14.28	1.48	89.14	24.59	17.36	5.86	0.01	0.03	1.14
BRW	Borrow Activities	1.24	5.86	0.76	2.14	0.28	2.69	4.20	4.12	6.42	0.01	0.01	6.42
BRW_BLAST	Borrow Blasting	0.06	2.57	0.03	0.15	0.00	175.88	2.29	4.73	0.06	0.01	0.00	--
STK	Ore Stockpile	0.17	0.72	0.09	0.18	0.02	0.68	1.70	0.07	0.18	0.00	0.00	0.08
HR-BRW	Borrow Pit Hauling	5.56	14.15	1.47	1.42	0.15	--	--	--	--	--	--	--
HR-PC	Process Area Hauling	3.04	7.73	0.80	0.77	0.08	--	--	--	--	--	--	--
WRSF	WRSF	0.16	0.66	0.08	0.10	0.01	--	--	--	--	--	--	--
CRF	CRF Stockpile	0.08	0.30	0.04	0.05	0.01	--	--	--	--	--	--	--
TS1	Topsoil Storage 1	0.02	0.07	0.01	0.01	0.00	--	--	--	--	--	--	--
TS2	Topsoil Storage 2	0.01	0.03	0.00	0.00	0.00	--	--	--	--	--	--	--
HR	Aboveground Haul Roads	9.08	23.87	2.76	4.80	0.53	2.50	6.24	2.32	5.79	0.00	0.01	4.54
Total		49.92	133.40	14.10	23.89	2.56	270.89	39.02	28.60	18.32	0.03	0.05	12.18

See worksheet ROADS for haul road (HR) emissions by Model ID.

By Activity

	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk-17	chk
	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Underground Drilling	0.02	0.11	0.01	0.017	0.0018							
Borrow Drilling	0.85	3.38	0.44	0.195	0.025							
Underground Blasting	0.05	0.24	0.03	0.014	0.0015	82.73	8.60	15.67	1.63	--	--	
Borrow Blasting	0.06	2.57	0.03	0.15	0.0019	175.88	2.29	4.73	0.06	9.5E-03	1.2E-04	
Onsite Hauling	31.20	79.41	8.26	7.94	0.826							
Material Load / Unload	0.11	0.52	0.05	0.078	0.0081							
Material Load / Unload UG	0.04	0.16	0.02	0.025	0.0026							
Mobile Tailpipes	0.57	4.99	0.57	4.61	0.528	5.87	12.14	6.51	12.40	0.01	0.02	11.05
Mobile Tailpipes UG	0.39	3.75	0.39	2.40	0.249	6.41	15.99	1.70	4.23	0.01	0.03	1.14
Dozing	5.44	9.99	1.04	5.49	0.571							
Grading	5.45	15.73	1.64	1.63	0.17							
Water Truck Travel	5.27	10.72	1.39	1.07	0.139							
Wind Erosion	0.47	1.81	0.24	0.271	0.035							
Total	49.92	133.40	14.10	23.89	2.56	270.89	39.02	28.60	18.32	0.03	0.05	12.18

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
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Mining Scenario Ore

Mining Activity Emissions Source Parameters Summary

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG
Model ID	Location of Activity	Source Type	UTM NAD 83 E m	N m	Elev. m	Rel. Ht. m	S-y m	S-z m	X-init. m	Y-init. m	Angle deg
UG	Underground	POINT	471,034	4,835,236	1,209.0	3.0	*point*	*point*	*point*	*point*	*point*
BRW	Borrow	AREA	471,613	4,834,706	1,185.3	2.3	*area*	2.1	222.1	1,013.6	1.9
BRW_BLAST	Borrow Blasting	VOLUMI	471,725	4,835,153	1,185.3	75.0	20.9	34.9	*volume*	*volume*	*volume*
WRSF	WRSF	VOLUME	470,608	4,835,502	1,113.7	2.3	55.1	2.1	*volume*	*volume*	*volume*
STK	Ore Stockpile	VOLUME	470,945	4,835,633	1,137.0	2.3	7.2	2.1	*volume*	*volume*	*volume*
CRF	CRF Stockpile	VOLUME	470,903	4,835,531	1,140.3	2.3	4.9	2.1	*volume*	*volume*	*volume*
TS1	Topsoil Storage 1	AREA	470,129	4,835,233	1,108	-	*area*	-	110.4	195.7	14.4
TS2	Topsoil Storage 2	AREA	470,538	4,836,301	1,084	-	*area*	-	54.4	215.2	44.3
HR	Aboveground Hauling	LINE	See worksheet: ROADS			2.3	9.9	2.1	*volume*	*volume*	*volume*
TAILS	Tailings Storage Facility	AREA	470,070	4,835,804	1,103	-	*area*	-	*399.8*	*881.1*	*54.1*
POND	Tailings Pipeline Reclaim Pond	AREA	470,692	4,836,296	1,076	-	*area*	-	*100.0*	*100.0*	*10.5*
DETOX1	CN Detoxification Tank 1	AREA	471,067	4,835,689	1,131	5.8	*area*	-	*4.2*	*4.2*	-
DETOX2	CN Detoxification Tank 2	AREA	471,073	4,835,689	1,131	5.8	*area*	-	*4.2*	*4.2*	-
CILTANK1	CIL Tank 1	AREA	471,038	4,835,680	1,131	7.8	*area*	-	*6.4*	*6.4*	-
CILTANK2	CIL Tank 2	AREA	471,043	4,835,688	1,131	7.8	*area*	-	*6.4*	*6.4*	-
CILTANK3	CIL Tank 3	AREA	471,047	4,835,680	1,131	7.8	*area*	-	*6.4*	*6.4*	-
CILTANK4	CIL Tank 4	AREA	471,051	4,835,688	1,131	7.8	*area*	-	*6.4*	*6.4*	-
CILTANK5	CIL Tank 5	AREA	471,055	4,835,680	1,131	7.8	*area*	-	*6.4*	*6.4*	-
CILTANK6	CIL Tank 6	AREA	471,059	4,835,688	1,131	7.8	*area*	-	*6.4*	*6.4*	-
CILTANK7	CIL Tank 7	AREA	471,063	4,835,680	1,131	7.8	*area*	-	*6.4*	*6.4*	-

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
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Mining Scenario Ore

Pit and Tunnel Drilling

Activity Information

Underground schedule	208	day/yr	24	hrs/day	*(MDA 2018) p. 168*
Underground Blast sched.	54	holes/blast	3	hrs/cycle	*(MDA 2018) p. 158*
Borrow schedule	260	day/yr	12	hrs/day	*(Dyer 2019.04.26)*
Borrow Pit Blast sched.	50	holes/blast	1,300	holes/yr	*(Dyer 2019.04.26)*

Annual LOM-Ore rates			Material blasted			Drilling	
Underground	1,400	ton/day	291,200	ton/yr	*(MDA 2018) p. 6*	89,856	hole/yr
Borrow	1,115	ton/day	289,800	ton/yr	*(Dyer 2019.04.26)*	1,300	hole/yr
Total			581,000	ton/yr		91,156	hole/yr

Emission Factors	Underground			Borrow		
TSP (PM)				1.3	lb/hole	*(EPA 1995), Tab. 11.9-4, 7/98 (overburden)*
PM10	0.00008	lb/ton	*(EPA 1995), Table 11.19.2-2, 8/04*			
PM Scaling Factors						
PM	0.74		*(EPA 1995), Sec. 13.2.4-4, 11/06*	1		
PM10	0.35		*(EPA 1995), Sec. 13.2.4-4, 11/06*	0.52		*(EPA 1995), Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.053		*(EPA 1995), Sec. 13.2.4-4, 11/06*	0.03		*(EPA 1995), Tab. 11.9-1, 7/98 (blasting, overburden)*

Underground drilling will be a wet process: (MDA 2018) p. 154

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
UG	Underground Drilling	0.025	0.11	0.012	0.017	0.0018
BRW	Borrow Drilling	0.85	3.4	0.44	0.20	0.025
Total	Pit and Tunnel Drilling	0.87	3.5	0.45	0.21	0.027

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	FLOW_MPS	DIA_M	TEMP_K	RELHT_M
		Source	UTM NAD 83		Elev.	Vel.	Dia.	Temp	Ht
Model ID	Activity	Type	E m	N m	m	mps	m	K	m
UG	Underground	POINT	471,034	4,835,236	1,209	7.07	6.78	298.15	3

[1] *UTM, Elev. - (Wolverson 2019.03.17); Stack Params: (MDA 2018) page 153*

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG		Area
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-z	Pit X	Pit Y	Angle	WCB	
[1] *Model ID*	Activity	Type	E m	N m	m	m	m^3	m	m	deg	deg	
BRW	Borrow	AREA	471,613	4,834,706	1,185	2.27	2.11	222.1	1013.6	1.9	88.09	225067.6595

UTM, Elev., Pit Vol. - (Wolverson 2019.03.17); Rel. Ht. - (EPA 2012); Pit X, Pit Y, Angle - best-fit equal area rectangle

Conversions

2,000	lb/ton
3.28084	ft/m
60	sec/min

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
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Mining Scenario Ore

Open Pit and Underground Blasting

Activity Information

Underground schedule	208	day/yr	24	hr/day	*(MDA 2018) p. 168*
Underground Blasting	260	ft²/blast	8	blast/da	*(MDA 2018) pp. 158, 168*
Borrow Schedule	260	day/yr	12	hr/day	*(Dyer 2019.04.26)*
Borrow Blasting	100	ft²/hole	50	holes/bl	*(Dyer 2019.04.26)*

Annual LOM-Ore rates	Material blasted		Blasting		ANFO/emulsion use		
Underground	291,200	ton/yr	1,664	blast/yr	529	ton emulsion/yr	*(MDA 2018) p. 159*
Borrow	289,800	ton/yr	26	blast/yr	68	ton ANFO/yr	*(Dyer 2019.04.26)*
Total	581,000	ton/yr	1,690	blast/yr			

Emission Factors

	Underground			Borrow		
A = Area per blast	260	ft²		5,000	ft²	TSP (lb/blast) = 0.000014 x A^1.5
TSP (PM)	0.06	lb/blast		4.95	lb/blast	*(EPA 1995), Tab. 11.9-1, 7/98 (blasting, overburden)*
CO	32.53	lb/ton-emulsion	*(NIOSH n.d.)*	67	lb/ton-ANFO	*(EPA 1995), Tab. 13.3-1, 2/80 (ANFO)*
NOX	6.16	lb/ton-emulsion	*(NIOSH n.d.)*	0.9	kg/t-ANFO	*(CSIRO 2008)*
				1.8	lb/ton-ANFO	
SO2	0.0	lb/ton-emulsion		3.6E-03	lb/ton-ANFO	
				Based on:	6%	*diesel content in ANFO (NIOSH n.d.)*

$$\frac{1.5\text{E-}05\ \text{lb S}}{\text{lb FO}} \times \frac{2\ \text{lb SO2}}{\text{lb S}} \times \frac{6\%\ \text{lb FO}}{\text{lb ANFO}} \times \frac{2{,}000\ \text{lb ANFO}}{\text{ton ANFO}} = \frac{3.6\text{E-}03\ \text{lb SO2}}{\text{ton ANFO}}$$

PM Scaling Factors

PM10	0.52	*(EPA 1995), Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*(EPA 1995), Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY
		PM	PM10		PM2.5		CO		NOX[1]		SO2	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
UG	Underground Blasting	0.049	0.24	0.025	0.014	0.0015	82.7	8.6	15.67	1.6	0.0E+0	0.0E+0
BRW_BLAST	Borrow Blasting	0.064	2.6	0.033	0.15	0.0019	176	2.3	4.7	0.061	0.0095	1.2E-4
Total	Blasting	0.11	2.8	0.059	0.16	0.0034	259	10.9	20.4	1.7	0.0095	0.0001

[1] *NO2/NOX:* 0.0357 *(CSIRO 2008)*

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
BRW_BLAST	Borrow Blasting	VOLUME	471,725	4,835,153	1,185	75	20.93	34.88

[1] *UTM, Elev. - (Wolverson 2019.03.17); Rel. Ht. - (CSIRO 2008); S-y, S-z factors - (EPA 2016)*

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	FLOW_MPS	DIA_M	TEMP_K	RELHT_M
		Source	UTM NAD 83		Elev.	Flow	Dia.	Temp	Ht
Model ID	Activity	Type	E m	N m	m	mps	m	K	m
UG	Underground Blasting	POINT	471,034	4,835,236	1,209	7.07	6.78	298.15	3

[1] *UTM, Elev. - (Wolverson 2019.03.17); Stack Params: (MDA 2018) page 153*

Conversions		Blast height (BH)	150	m	*(CSIRO 2008)*	Sigma divider			
2,000	lb/ton	Blast width	90	m	*(CSIRO 2008)*	Rel. Ht.	2	of BH	*(EPA 2016)*
2.205	lb/kg	Blast depth	90	m	*(CSIRO 2008)*	S-y	4.3	of SL	*(EPA 2016)*
1.102	ton/t	Equal area side length (SL)	90	m		S-z	4.3	of BH	*(EPA 2016)*

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Mining Scenario Ore
Onsite Hauling

Activity Information

Operating schedule	208	day/yr	*(MDA 2018) p. 168*
Percent backfill as CRF	46%		*(MDA 2018) p. 139*

Hauling Routes, Production Rates and Distances

	Route Origin		Destination		Material Hauled [1] Material Type	Rate ton/yr	One-Way Hauling [2] mi	Truck Loads [3] load/yr	Total Travel [4] VMT/yr
	Unpaved Roads								
PC-WRSF	Portal Cut	PC	WRSF	WRSF	Rock	1,500	0.23	46	21
PC-STK	Portal Cut	PC	Ore Stockpile	STK	Ore	289,700	0.15	8,761	2,711
UG-PC	Underground	UG	Portal Cut	PC	Ore	289,700	2.27	8,761	39,823
UG-PC	Underground	UG	Portal Cut	PC	Rock	1,500	2.27	46	209
BRW-WRSF	Borrow	BRW	WRSF	WRSF	Rock	289,800	1.02	6,412	13,072
WRSF-PC	WRSF	WRSF	Portal Cut	PC	Rock	157,302	0.23	4,757	2,215
WRSF-CRF	WRSF	WRSF	CRF Stockpile	CRF	Rock	133,998	0.21	4,053	1,696
CRF-PC	CRF Stockpile	CRF	Portal Cut	PC	Rock	133,998	0.06	4,053	499
UGP-UG	UG Portal	UGP	Underground	UG	Rock	291,300	2.27	8,809	40,041
	Total					######	8.73		100,287
					Aboveground Subtotal		4.18		
					Underground Subtotal		4.55		

[1] *(MDA 2018) p. 164*
[2] *(Wolverson 2019.03.17); Underground: (MDA 2018) p. 166*
[3] *See truck fleet information below.*
[4] *Truck loads × One-way hauli* 2 *(round-trip)*

Truck Fleet

Truck		Payload Capacity [1] ton	Empty Weight [1] ton	Operation [2] hr/yr	Average Weight ton
Cat AD30	Mine	33.07	31.8	13,980	48.4
Cat 745C	Borrow	45.2	36.8	9,360	59.4
Weighted Average		37.9			52.8

[1] *(Caterpillar 2018)*
[2] *Cat AD30: (MDA 2018) p. 167; Cat 745: Borrow Schedule 3 units.*

Conversions
2,000 lb/ton
5,280 ft/mi

Mining Scenario Ore

Onsite Hauling - continued

Hauling Emissions by Route

	Route Origin		Destination		Material Hauled Material Type	PM_TPY PM ton/yr	PM10_PPD PM10 lb/day	PM10_TPY PM10 ton/yr	PM2.5_PPD PM2.5 lb/day	PM2.5_TPY PM2.5 ton/yr
	Unpaved Roads									
PC-WRSF	Portal Cut	PC	WRSF	WRSF	Rock	0.0091	0.023	0.0024	0.0023	2.4E-4
PC-STK	Portal Cut	PC	Ore Stockpile	STK	Ore	1.2	2.9	0.31	0.29	0.031
UG-PC	Underground	UG	Portal Cut	PC	Ore	11.2	28.6	3.0	2.9	0.30
UG-PC	Underground	UG	Portal Cut	PC	Rock	0.059	0.15	0.016	0.015	0.0016
BRW-WRSF	Borrow	BRW	WRSF	WRSF	Rock	5.6	14.2	1.5	1.4	0.15
WRSF-PC	WRSF	WRSF	Portal Cut	PC	Rock	0.94	2.4	0.25	0.24	0.025
WRSF-CRF	WRSF	WRSF	CRF Stockpile	CRF	Rock	0.72	1.8	0.19	0.18	0.019
CRF-PC	CRF Stockpile	CRF	Portal Cut	PC	Rock	0.21	0.54	0.056	0.054	0.0056
UGP-UG	UG Portal	UGP	Underground	UG	Rock	11.3	28.8	3.0	2.9	0.30
	Pit Subtotal					31.2	79.4	8.3	7.9	0.83

Aboveground Emission Factors

Emission factor equation $E = k(s/12)^a (W/3)^b [(365-P)/365]$ *(EPA 1995), Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*

s = Surface material silt content 5.8 % *(EPA 1995), Tab. 13.2.2-1 Taconite Mining*

W = Mean vehicle weight 59.4 ton

P = Days/year with ≥0.01 in precip. 90 day/yr *(EPA 1995), Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*(EPA 1995), Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*(EPA 1995), Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*(EPA 1995), Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	8.51	2.25	0.225	lb/VMT	

Aboveground Emission Controls

Aboveground unpaved roads - periodic application of water and chemical dust suppressant

Control efficiency: 90% *(Air Sciences 2018)*

Underground Emission Factors

Emission factor equation $E = k(s/12)^a (W/3)^b$ *(EPA 1995), Tab. 13.2.2-2, Eq. 1a, 11/06*

	PM	PM10	PM2.5	
k = Size-specific empirical constant	4.9	1.5	0.15	
a = Size-specific empirical constant	0.7	0.9	0.9	
b = Size-specific empirical constant	0.45	0.45	0.45	
E = Size-specific emission factor	11.29	2.99	0.299	lb/VMT

Underground Emission Controls

Control efficiency: 95% *AP-42, Fig. 13.2.2-2, 11/06*

Since dewatering is needed assume maximum control (wet conditions) (MDA 2018) p. 155

Conversions

2,000 lb/ton

Mining Scenario Ore
Onsite Hauling - continued

Underground Emissions Comparison

Umax = PM2.5 conc. from Rock Dust in an underground gold mine	72.2	ug/m3	*(McDonald et al. 2003), Tab. 4*
V= Through-flow ventilation	142	m3/sec	*(McDonald et al. 2003), p. 387*
Production rate	1,300	tons/day	*(McDonald et al. 2003), p. 387*
Underground Rock Dust Emissions Rate (URDER)	V * (U_{max}) * (sec/day) / (tons/day) / (g/lb) / (ug/g)		

Summary of Underground Fugitive Emissions

Activity	PM2.5 lb/day
Underground Hauling (95% CE)	5.8
Underground load/unload (page 8)	0.025
Underground Blasting	0.014
Underground Drilling	0.017
Total	5.8

URDER	0.0015	lb/ton
Grassy Mtn	0.0041	lb/ton

Grassy Mtn. Production rate 1,400 tons/day

Emissions by Area

		chk	PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		Travel	PM	PM10		PM2.5	
Area ID	Activity	VMT/yr	ton/yr	lb/day	ton/yr	lb/day	ton/yr
HR-BRW	Borrow Pit Hauling	13,072	5.56	14.15	1.47	1.42	0.15
UG	Underground Hauling	80,073	22.60	57.53	5.98	5.75	0.60
HR-PC	Process Area Hauling	7,143	3.04	7.73	0.80	0.77	0.08
Total		100,287	31.20	79.41	8.26	7.94	0.83

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
HR	Aboveground Hauling	LINE	*See worksheet: ROADS*			2.27	9.88	2.11

UTM, Elev. - (Wolverson 2019.03.17); Rel. Ht., Sy, Sz - (EPA 2012)

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	FLOW_MPS	DIA_M	TEMP_K	RELHT_M
		Source	UTM NAD 83		Elev.	Flow	Dia.	Temp	Ht
Model ID	Activity	Type	E m	N m	m	mps	m	K	m
UG	Underground	POINT	471,034	4,835,236	1,209	7.07	6.78	298.15	3

[#] *UTM, Elev. - (Wolverson 2019.03.17); Stack Params: (MDA 2018) page 153*

Truck	Height	Reference
Cat AD30	2.4 m	*(Caterpillar 2018)*
Cat 745C	3 m	*(Caterpillar 2018)*
Weighted	2.67 m	
Road width (RW)	15.2 m	*(Wolverson 2019.03.17)*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	4.54	1.7
Release height - unpaved	0.5 x PT	2.27	0.5
Plume width (PW)	RW + 6 m	21.24	6
Sigma-z - unpaved	PT / 2.15	2.11	2.15
Sigma-y	PW / 2.15	9.88	2.15

(EPA 2012)

Conversions

2,000	lb/ton	453.59	g/lb
3.28	ft/m	86,400	sec/day
12	in/ft	1.E+06	ug/g

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Mining Scenario Ore

Material Load / Unload

Activity Information

Mine Operating schedule 208 day/yr

Throughput Rates

Model ID	Location of Activity	No. of Xfers	Rate ton/yr	Total Rate ton/yr	Xfer Description
UG	Underground	2	291,200	582,400	Load Ore/Rock & Unload Backfill
BRW	Borrow	1	289,800	289,800	Load
WRSF	WRSF	2	291,300	582,600	Unload from Borrow & Load to CRF
STK	Ore Stockpile	1	289,700	289,700	Unload
CRF	CRF Stockpile	2	133,998	267,996	Unload from WRSF & Load to Portal

Emission Factors

	PM	PM10	PM2.5		
k = Particle size multiplier	0.74	0.35	0.053		*(EPA 1995), Sec. 13.2.4, Pg. 4, 11/06*
E = Emission factor Load	0.00021	0.0001	0.00002	lb/ton	*(EPA 1995), Tab. 11.19.2-2, 8/04 (truck loading - crshed stone)*
Unload	0.00003	1.6E-05	0.000002	lb/ton	*(EPA 1995), Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone)*

Emissions by Model ID

		chk	PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
Model ID	Location of Activity	Total Rate ton/yr	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr
UG	Underground	582,400	0.036	0.16	0.017	0.025	0.0026
BRW	Borrow	289,800	0.031	0.14	0.014	0.021	0.0022
WRSF	WRSF	582,600	0.036	0.16	0.017	0.025	0.0026
STK	Ore Stockpile	289,700	0.031	0.14	0.014	0.021	0.0022
CRF	CRF Stockpile	267,996	0.016	0.07	0.008	0.011	0.0012
Total	Material Load / Unload	######	0.15	0.68	0.071	0.10	0.011

Conversions

2.237 mi/hr per m/s

2,000 lb/ton

Mining Scenario Ore

Material Load / Unload - continued

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG	
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	S-z	Pit X	Pit Y	Angle	WCB
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	deg	deg
BRW	Borrow	AREA	471,613	4,834,706	1,185	2.27	2.11	222.1	1,013.6	1.9	88.09

[1] *UTM, Elev., Pit Vol. - (Wolverson 2019.03.17); Rel. Ht. - (EPA 2012); Pit X, Pit Y, Angle - best-fit equal area rectangle*

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	Surface	
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Area	Length
Model ID	Activity	Type	E m	N m	m	m	m	m	m^2	m
WRSF	WRSF	VOLUME	470,608	4,835,502	1,114	2.27	55.08	2.11	56,089	236.8
STK	Ore Stockpile	VOLUME	470,945	4,835,633	1,137	2.27	7.25	2.11	971	31.2
CRF	CRF Stockpile	VOLUME	470,903	4,835,531	1,140	2.27	4.91	2.11	445	21.1

[1] *UTM, Elev., Area - (Wolverson 2019.03.17); Rel. Ht. - (Caterpillar 2018); S-y, S-z factors - (Wolverson 2019.03.17)*

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	FLOW_MPS	DIA_M	TEMP_K	RELHT_M
		Source	UTM NAD 83		Elev.	Flow	Dia.	Temp	Ht
Model ID	Activity	Type	E m	N m	m	mps	m	K	m
UG	Underground	POINT	471,034	4,835,236	1,209	7.07	6.78	298.15	3

[1] *UTM, Elev. - (Wolverson 2019.03.17); Stack Params: (MDA 2018) page 153*

Vehicle height (VH):
Weighted Average 2.67 m

Plume Parameter	Calculatio	Value (m)	Const.
Plume top (PT)	1.7 x VH	4.54	1.7
Release height	0.5 x PT	2.27	0.5
Sigma-z	PT / 2.15	2.11	2.15

(EPA 2012)

Sample calculation for WRSF

Plume Parameter	Calculatio	Value (m)	Const.
Surface area (SA)	Map	56,089	
Side length (SL)	SA^0.5	236.8	0.5
Sigma-y	SL / 4.3	55.08	4.3

(EPA 2016)

Conversions
4,047 m2/acre

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Mining Scenario Ore

Mobile Equipment (Tailpipes)

Operating schedule
- Underground schedule: 208 day/yr, 24 hrs/day
- Borrow schedule: 260 day/yr, 12 hrs/day

Mobile Equipment Specifications and Activity

Equipment[5,6+]	Equipment[1,5+] Model	ID	Rating hp	Rating kW	Oper. hr/yr	Equip. Count	Diesel gal/yr	Output[2] kW-hr/yr	Travel[3] VMT/yr	Equip. Cat.	MOVES[4] Class ID
Drilling Development Jumb	Sandvik DD21-40	EQP1	83	62 [11]	731 [5 6]	2 [5]	2,905 [12]	42,392		Non-road	
Bolter	Sandvik DS311	EQP2	83	62 [11]	466 [5]	1 [5]	1,853 [12]	27,043		Non-road	
LHD 5.2 yd3	Sandvik LH410	EQP3	315	235 [10]	4,428 [5]	4 [5]	37,432 [10]	546,305		Non-road	
Front-end Loader	Cat 926M	EQP4	153	114 [1]	2,220 [5]	1 [5]	5,994 [1]	87,480		Non-road	
Low Profile Truck	Cat AD30	EQP5	409	305 [1]	#####	3 [5]	######	2,234,164		Non-road	
Emulsion Loader	Paus Universa 50	EQP6	101	75 [13]	731	1+	3,565 [13]	52,031		Non-road	
Telehandler	Cat TL943D	EQP7	111	83 [1]	8,232 [5]	2 [5]	24,696 [1]+	360,430		Non-road	
Bulldozer	Cat D6T	EQP8	200	149 [1]	2,760 [5]	1 [5]	17,802 [1]	259,814		Non-road	
Motor Grader	Paus PG5HA	EQP9	101	75 [14]	2,796 [5]	1 [5]	13,640 [13]	199,067		Non-road	
Fuel Truck	F-650	EQP10	330 [15]	246	2,724 [5]	1 [5]	12,258+	178,901	68,100	On-road	MHD
Service Truck	F-650	EQP11	330 [15]	246	1,944 [5]	1 [5]	8,748+	127,674	48,600	On-road	MHD
Front-end Loader	Cat 988K	EQP12	579	432 [1]	3,120 [16]	1 [7]	32,448 [1]	473,567		Non-road	
Blast hole drill	Cat MD6420C	EQP13	912	680 [1]	3,120 [16]	1 [7]	42,120+	614,727		Non-road	
Articulated haul trucks	Cat 745C	EQP14	511	381 [1]	9,360 [16]	3 [7]	66,924 [1]	976,733		Non-road	
Man Van	F-350 (MV)	EQP15	440 [15]	328	4,992	2 [5]	7,488+	109,285	124,800	On-road	LHD45
Pickup Truck	F-350	EQP16	440 [15]	328	9,984	4 [5]	9,984+	145,713	249,600	On-road	LHD45
Front-end Loader	Cat 926M	EQP17	153	114 [1]	8,059 [8]	1 [5]	21,760 [1]	317,577		Non-road	
Water Truck	Cat 777G	EQP18	1,026	765 [1]	725+	1+	9,825 [1]	143,390		Non-road	
Forklift	Cat DP160N	EQP19	148	110 [9]	2,496	1 [5]	5,934 [9]	86,609		Non-road	
Motor Grader	Cat 160M	EQP20	213	159 [1]	2,496	1 [5]	11,232 [1]	163,927		Non-road	

[1] *(Caterpillar 2018)*

[2] *Based on:* 137,000 *BTU/gal* *(EPA 1995), App. A (Diesel)* 7,000 *BTU/hp-hr* *(EPA 1995), Sec. 3.3, (Diesel)*

[3] *Based on the following average speeds (mph), typical for mine sites:*

Fuel Truck	*F-650*	*25*
Service Truck	*F-650*	*25*
Man Van	*F-350 (MV)*	*25*
Pickup Truck	*F-350*	*25*

[4] *On-road vehicle codes and descriptions provided in MOVES2014b emission factors table (EPA 2018)*

[5] *(MDA 2018) pp. 166, 167, 217*

[6] *(Dyer 2019.03.29a)*

[7] *(Dyer 2019.03.29b)*

[8] *(Mills 2019.04.29)*

[9] *(Cat Lift Trucks 2008)*

[##] *(Sandvik 2017)*

[##] *(Sandvik 2018)*

[##] *(Deutz n.d. a)*

[##] *(Deutz n.d. b)*

[##] *(Paus 2013)*

[##] *(Ford 2017)*

[##] *(Dyer 2019.04.26)*

Underground drilling equipment tramming time:	*15%*	*(MDA 2018)*
Water Truck Utilization:	*12*	mph *(Li et al. 2008)*
Pickup/Van Utilization:	*50%*	*Air Sciences recommendation*
Forklift utilization:	*50%*	*Air Sciences recommendation*
Grader utilization (road maintenance):	*50%*	*Air Sciences recommendation*

[+] *Air Sciences recommended value/estimated from similar mine operations*

VMT = Vehicle Miles Travelled

Conversions

7.05	lb/gal distillate oil
1.341	hp/kW
453.59	g/lb
0.2642	gal/L

Mining Scenario Ore

Mobile Equipment (Tailpipes)

Operating schedule

EPA Non-Road Standards

ID	Equipment Type	Model Year[1]	Power Category	EPA Tier	Lookup ID	MOVES Class ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
EQP1	Drill	>2018	56≤kW<75, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP2	Support Truck	≥2018	56≤kW<75, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP3	Loader	≥2018	130≤kW<560, Ph-ir	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP4	Loader	>2018	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP5	Haul Truck	>2018	130≤kW<560, Ph-ir	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP6	Support Truck	>2018	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP7	Forklift	>2018	56≤kW<75, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP8	Dozer	>2018	130≤kW<560, Ph-ir	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP9	Grader	>2018	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP10	Support Truck	>2018			No Standard	MHD				
EQP11	Support Truck	>2018			No Standard	MHD				
EQP12	Loader	>2010	225≤kW<450, ≤201	3	§89-225≤kW<450 200		0.2	3.5	4	4
EQP13	Drill	>2010	kW>560	2	§89-kW>560 2006		0.2	3.5	6.4	6.4
EQP14	Haul Truck	>2010	225≤kW<450, ≤201	3	§89-225≤kW<450 200		0.2	3.5	4	4
EQP15	Support Truck	>2018			No Standard	LHD45				
EQP16	Support Truck	>2018			No Standard	LHD45				
EQP17	Loader	>2018	130≤kW<560, Ph-ir	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP18	Water Truck	>2018	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP19	Forklift	>2018	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP20	Grader	>2018	130≤kW<560, Ph-ir	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19

[1] *(Dyer 2019.04.19)*

[2] *(CFR 2017)*

Mining Scenario Ore

Mobile Equipment (Tailpipes) - continued
Fuel Sulfur-Content Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*Non-road diesel specification per 40 CFR 80.510*
Diesel Density	7.05	lb/gal	*(EPA 1995), App. A*
Molecular Wt. of SO2	64.064	lb/lb-mol	
Molecular Wt. of S	32.065	lb/lb-mol	
Diesel Heat Content	137,000	BTU/gal	*(EPA 1995), App. A (Diesel)*
Brake-Specific Fuel Use	7,000	BTU/hp-hr	*(EPA 1995), Sec. 3.3, (Diesel)*

SO2 emission factor:

$$0.000011 \frac{\text{lb/hp-hr}}{} = \frac{0.0015\% \frac{\text{lb S}}{\text{lb Fuel}} \times 7.05 \frac{\text{lb Fuel}}{\text{gal Fuel}} \times 64.064 \frac{\text{lb SO2}}{\text{lb S}}}{137{,}000 \frac{\text{gal Fuel}}{\text{BTU}} \times 7{,}000 \frac{\text{BTU}}{\text{hp-hr}}}$$

$$0.006567 \frac{\text{g/kW-hr}}{} = \frac{0.000011 \frac{\text{lb}}{\text{hp-hr}} \times 1.341 \frac{\text{hp}}{\text{kW}} \times 453.593 \frac{\text{g}}{\text{lb}}}{}$$

EPA MOVES 2014b Emission Factors[1]

Vehicle Class	Description	Emission Factor (g/VMT)[2] PM	PM10	PM2.5	CO	NOX	VOC	SO2
LHD45	Single Unit Truck 14k-19.5k lb, Diesel	0.680	0.680	0.375	2.311	6.019	0.884	0.011
MHD	Single Unit Truck 19.5k-33k lb, Diesel	0.924	0.924	0.498	2.725	7.218	1.097	0.011

(1) *MOVES 2014b run dated 2019-07-10*
(2) *PM = PM10*

EPA Engine Certification Data

ID	Lookup I Engine Description		Emission Factor (g/kW-hr) PM	PM10	PM2.5	CO	NOX	VOC
	EPA_Cert	hp	(1)					
	EPA_Cert	hp	(1)					

(1)

Conversions
1.341 hp/kW
453.593 g/lb

Mining Scenario Ore

Mobile Equipment (Tailpipes) - continued

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
EQP1	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	42,392	kW-hr/yr
EQP2	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	27,043	kW-hr/yr
EQP3	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	546,305	kW-hr/yr
EQP4	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	87,480	kW-hr/yr
EQP5	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	######	kW-hr/yr
EQP6	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	52,031	kW-hr/yr
EQP7	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	360,430	kW-hr/yr
EQP8	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	259,814	kW-hr/yr
EQP9	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	199,067	kW-hr/yr
EQP10	MHD	0.92	0.92	0.50	2.72	7.22	1.10	0.011	g/VMT	*EPA_MOVES2014b*	68,100	VMT/yr
EQP11	MHD	0.92	0.92	0.50	2.72	7.22	1.10	0.011	g/VMT	*EPA_MOVES2014b*	48,600	VMT/yr
EQP12	§89-225≤kW<450 200(	0.20	0.20	0.20	3.50	4.00	4.00	0.007	g/kW-hr	*EPA_NRS*	473,567	kW-hr/yr
EQP13	§89-kW>560 2006	0.20	0.20	0.20	3.50	6.40	6.40	0.007	g/kW-hr	*EPA_NRS*	614,727	kW-hr/yr
EQP14	§89-225≤kW<450 200(	0.20	0.20	0.20	3.50	4.00	4.00	0.007	g/kW-hr	*EPA_NRS*	976,733	kW-hr/yr
EQP15	LHD45	0.68	0.68	0.37	2.31	6.02	0.88	0.011	g/VMT	*EPA_MOVES2014b*	124,800	VMT/yr
EQP16	LHD45	0.68	0.68	0.37	2.31	6.02	0.88	0.011	g/VMT	*EPA_MOVES2014b*	249,600	VMT/yr
EQP17	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	317,577	kW-hr/yr
EQP18	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	143,390	kW-hr/yr
EQP19	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	86,609	kW-hr/yr
EQP20	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	163,927	kW-hr/yr

Final emission factor options:

Category	EF Unit	Activity Unit	Emission Unit	Multiplier
EPA_CERT	g/kW-hr	kW-hr/yr	ton/yr	1.10E-6
EPA_NRS	g/kW-hr	kW-hr/yr	ton/yr	1.10E-6
EPA_MOVES2014b	g/VMT	VMT/yr	ton/yr	1.10E-6

Conversions

453.6	g/lb
1.341	hp/kW
2,000	lb/ton

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Mining Scenari Ore

Mobile Equipment (Tailpipes) - continued

Emissions by Area

			chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk-17	chk
		Equipment	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Area ID	Equipn	Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
UG	EQP1	Drill	9.3E-4	0.0090	9.3E-4	0.0090	9.3E-4	0.094	0.23	0.0075	0.019	1.2E-4	3.1E-4	0.0089
UG	EQP2	Support Truck	6.0E-4	0.0057	6.0E-4	0.0057	6.0E-4	0.060	0.15	0.0048	0.012	7.8E-5	2.0E-4	0.0057
UG	EQP3	Loader	0.012	0.12	0.012	0.12	0.012	0.84	2.1	0.097	0.24	0.0016	0.0040	0.11
UG	EQP4	Loader	0.0019	0.019	0.0019	0.019	0.0019	0.193	0.48	0.015	0.039	2.5E-4	6.3E-4	0.018
HR-MINE	EQP5	Haul Truck	0.049	0.47	0.049	0.47	0.049	3.5	8.6	0.39	0.99	0.0065	0.016	0.47
UG	EQP6	Support Truck	0.0011	0.011	0.0011	0.011	0.0011	0.11	0.29	0.009	0.023	1.5E-4	3.8E-4	0.011
UG	EQP7	Forklift	0.0079	0.076	0.0079	0.076	0.0079	0.80	2.0	0.064	0.16	0.0010	0.0026	0.075
UG	EQP8	Dozer	0.0057	0.055	0.0057	0.055	0.0057	0.40	1.00	0.046	0.11	7.5E-4	0.0019	0.054
UG	EQP9	Grader	0.0044	0.042	0.0044	0.042	0.0044	0.44	1.1	0.035	0.088	5.8E-4	0.0014	0.042
HR-All	EQP10	Support Truck	0.069	0.67	0.069	0.36	0.037	0.082	0.20	0.22	0.54	3.2E-4	8.1E-4	0.082
HR-All	EQP11	Support Truck	0.049	0.48	0.049	0.26	0.027	0.058	0.15	0.15	0.39	2.3E-4	5.8E-4	0.059
BRW	EQP12	Loader	0.10	0.80	0.10	0.80	0.10	1.2	1.8	1.3	2.1	0.0022	0.0034	2.1
BRW	EQP13	Drill	0.14	1.0	0.14	1.0	0.14	1.5	2.4	2.8	4.3	0.0029	0.0044	4.3
HR-BRW	EQP14	Haul Truck	0.22	2.1	0.22	2.1	0.22	1.5	3.8	1.7	4.3	0.0028	0.0071	4.3
HR-All	EQP15	Support Truck	0.09	0.9	0.09	0.5	0.05	0.13	0.32	0.33	0.8	0.0006	0.0015	0.12
HR-All	EQP16	Support Truck	0.19	1.8	0.19	1.0	0.10	0.25	0.6	0.7	1.7	0.0012	0.0029	0.24
STK	EQP17	Loader	0.0070	0.067	0.0070	0.067	0.0070	0.49	1.23	0.056	0.140	9.2E-4	0.0023	0.067
HR	EQP18	Water Truck	0.006	0.06	0.006	0.06	0.006	0.2	0.6	0.2	0.6	0.0004	0.0010	0.03
STK	EQP19	Forklift	0.0019	0.018	0.0019	0.018	0.0019	0.19	0.5	0.015	0.038	2.5E-4	0.0006	0.018
HR	EQP20	Grader	0.0036	0.035	0.0036	0.035	0.0036	0.25	0.6	0.029	0.07	4.8E-4	0.0012	0.034
Total			1.0	8.7	1.0	7.0	0.78	12.3	28.1	8.2	16.6	0.023	0.053	12.2

(1) *"HR-All" includes aboveground and underground haul routes; "HR-MINE" includes aboveground and underground haul routes used to move ore*

		Travel	Distance	Proportional Dist.
Area ID	Activity	VMT/yr	mi	pct
HR-BRW	Borrow Pit Hauling	13,072	1.02	12%
UG	Underground Hauling	80,073	6.82	78%
HR-PC	Process Area Hauling	7,143	0.89	10%
Total		100,287	8.73	100%

See worksheet ROADS for haul road (HR) emissions by Model ID.

Emissions by Model ID (1)

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
		PM	PM10		PM2.5		CO		NOX(2)		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
UG	Underground (Incl. Haulir	0.39	3.8	0.39	2.4	0.25	6.4	16.0	1.7	4.2	0.012	0.030	1.1
HR	Aboveground Haul Roads	0.32	3.1	0.32	2.7	0.28	2.5	6.2	2.3	5.8	0.0050	0.012	4.5
BRW	Borrow Pit	0.24	1.8	0.24	1.8	0.24	2.7	4.2	4.1	6.4	0.0050	0.0079	6.4
STK	Ore Stockpile	0.0089	0.086	0.0089	0.086	0.0089	0.68	1.7	0.071	0.18	1.2E-3	0.0029	0.085
Total	Mobile Tailpipes	1.0	8.7	1.0	7.0	0.78	12.3	28.1	8.2	16.6	0.023	0.053	12.2

(1) *See worksheet ROADS for haul road (HR) emissions by Model ID.*

(2) *NO2 / NOX:* *11%* *(CAPCOA 2011)*

Short-term emissions are based on annual emissions divided by Underground schedule or the Borrow schedule

Conversions

2,000 lb/ton

453.59 g/lb

		Multipliers	
LT Unit	ST Unit	*BRW*	*UG*
ton/yr	lb/day	7.692	9.615
ton/yr	lb/hr	0.641	0.401

Mining Scenario Ore

Mobile Equipment (Tailpipes) - continued

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	FLOW_MPS	DIA_M	TEMP_K	RELHT_M
Model ID	Activity	Source Type	UTM NAD 83 E m	N m	Elev. m	Flow mps	Dia. m	Temp K	Ht m
UG	Underground	POINT	471,034	4,835,236	1,209	7.07	6.78	298.15	3

[1] *UTM, Elev. - (Wolverson 2019.03.17); Stack Params: (MDA 2018) page 153*

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG	
Model ID	Location of Activity	Source Type	UTM NAD 83 E m	N m	Elev. m	Rel. Ht. m	S-z m^3	Pit X m	Pit Y m	Angle deg	WCB deg
BRW	Borrow	AREA	471,613	4,834,706	1,185	2.27	2.11	222.1	1,013.6	1.9	88.09

[1] *UTM, Elev., Pit Vol. - (Wolverson 2019.03.17); Rel. Ht. - (EPA 2012); Pit X, Pit Y, Angle - best-fit equal area rectangle*

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	Surface	
Model ID	Location of Activity	Source Type	UTM NAD 83 E m	N m	Elev. m	Rel. Ht. m	S-y m	S-z m	Area m^2	Length m
STK	Ore Stockpile	VOLUME	470,945	4,835,633	1,137	2.27	7.25	2.11	971	31.2

[1] *UTM, Elev., Area - (Wolverson 2019.03.17); Rel. Ht. - (Caterpillar 2018); S-y, S-z factors - (Wolverson 2019.03.17)*

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Mining Scenario Ore

Dozing and Grading

Activity Information

Operating schedule 208 day/yr

Dozer and Grader Fleet

Equip. Cat.	Activity			
Dozer	2,760	hr/yr		
Grader Underground	2,796	hr/yr	18,174	VMT/yr
Grader Aboveground	2,496	hr/yr	16,224	VMT/yr

Dozing Emission Factors

Emission Factor Equation	TSP (lb/hr) = 5.7 $(s)^{1.2}/(M)^{1.3}$		*(EPA 1995), Tab. 11.9-1, 07/98, (bulldozing, overburden)*
	PM15 (lb/hr) = 1.0 $(s)^{1.5}/(M)^{1.4}$		*(EPA 1995), Tab. 11.9-1, 07/98, (bulldozing, overburden)*
s = Surface material silt content	6.9	%	*(EPA 1995), Table 11.9-3, 07/98, (bulldozers, overburden)*
M = Material moisture content	7.9	%	*(EPA 1995), Table 11.9-3, 07/98, (bulldozers, overburden)*
TSP(PM)	3.941	lb/hr	
PM15	1.004	lb/hr	

Dozing PM Scaling Factors

PM10	0.75	*(EPA 1995), Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.105	*(EPA 1995), Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Grading Emission Factors

Emission Factor Equation	TSP (lb/VMT) = 0.04 $(S)^{2.5}$		*(EPA 1995), Tab. 11.9-1, 07/98, (grading)*
	PM15 (lb/VMT) = 0.051 $(S)^{2}$		*(EPA 1995), Tab. 11.9-1, 07/98, (grading)*
S - Grader average speed	6.5	mph	*(Caterpillar 2018), Road Maintenance, page 11-6, average*
TSP(PM)	4.309	lb/VMT	
PM15	2.155	lb/VMT	

Grading PM Scaling Factors

PM10	0.6	*(EPA 1995), Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.031	*(EPA 1995), Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls

Grading

Aboveground Control efficiency:	90%	*See Onsite Hauling (Aboveground)*
Underground Control efficiency:	95%	*See Onsite Hauling (Underground)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
UG	Dozing	5.44	9.99	1.04	5.49	0.57
UG	Grading	1.96	5.65	0.59	0.58	0.06
HR	Grading	3.50	10.08	1.05	1.04	0.11

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters [1]

		TYPE	UTM_E	UTM_N	ELEV_M	FLOW_MPS	DIA_M	TEMP_K	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Flow	Dia.	Temp	Ht	S-y	S-z
Model ID	Activity	Type	E m	N m	m	mps	m	K	m	m	m
HR	Haul Roads	LINE	*See worksheet: ROADS*						2.27	9.88	2.11
UG	Underground	POINT	471,034	4,835,236	1,209	7.07	6.78	298.15	3		

[#] *UTM, Elev. - (Wolverson 2019.03.17); Stack Params: (MDA 2018) page 153*

Conversions

2,000 lb/ton

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Mining Scenario Ore

Water Truck Travel

Activity Information

Operating schedule 260 day/yr

Truck Fleet

Water Truck	Payload Capacity ton	Empty Weight ton	Gross Weight ton	Units	Reference	Average Weight ton
Cat 777G	100	80	180	1	*(Caterpillar 2018)*	130

Total vehicle miles traveled (VMT) 8,701 VMT/yr 4 passes/day (max) 4.18 mi, aboveground haul roads
8.37 mi (round trip), aboveground haul roads

Emission Factors

Emission factor equation $E = k(s/12)^a (W/3)^b [(365-P)/365]$ *(EPA 1995), Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*

s = Surface material silt content 5.8 % *(EPA 1995), Tab. 13.2.2-1 Taconite Mining*

W = Mean vehicle weight 130 ton

P = Days/year with ≥0.01 in precip. 90 day/yr *(EPA 1995), Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	12.11	3.20	0.32	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling (Aboveground)*

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
HR	Water Truck Travel	5.27	10.72	1.39	1.07	0.14

Source Parameters

Source Parameters [(1)]

		TYPE	UTM_E	UTM_N	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
HR	Aboveground Hauling	LINE	*See worksheet: ROADS*			2.27	9.88	2.11

UTM, Elev. - (Wolverson 2019.03.17); Rel. Ht., Sy, Sz - (EPA 2012)

Conversions

2,000 lb/ton

Mining Scenario Ore

Wind Erosion

Activity Information

Operating schedule 260 day/yr

Erodible Area

Model ID	Location of Activity		Surface Type	Unload ton/yr	Erodible Area (acre/yr)[2] Flat	Pile	Surface Footprint
WRSF	WRSF		Pile	291,300		53.4	13.9
STK	Ore Stockpile		Pile	289,700		53.1	0.2
BRW	Borrow Stockpile		Pile	289,800		53.1	0.2
CRF	CRF Stockpile		Pile	133,998		24.6	0.1
TS1	Topsoil Storage 1		Pile	0		7.1	7.1
TS2	Topsoil Storage 2		Pile	0		3.0	3.0
HR	Haul Roads	[1]	Flat		158.7		8

[1] *Based on total haul road length of* 2,152 *m (Wolverson 2019.03.17) and width of* 15.2 *m (Wolverson 2019.03.17)*

[2] *Pile surface area calculations:*

Truck dump (TD) size	37.9	ton	
Material density	140.0	lb/ft^3	
	0.070	ton/ft^3	*(Dyer 2019.04.26)*
Material specific volume	14.3	ft^3/ton	
TD volume (V)	542	ft^3	
Conical surface calculations			
Side slope	38	deg	
	0.7	rad	
Conical surface area (SA)	Π × r × (h^2 + r^2)^0.5		
Conical volume (V)	(Π × h × r^2) ÷ 3		
Conical base radius	r =	s × cos(slope)	
Conical height	h =	s × sin(slope)	
Sloped side length	s =	(h^2 + r^2)^0.5	
Solution of conical volume equation			
Replacing h and r with s × sin(slope) and s × cos(slope), respectively:			
s = [3 × V/(pi × sin(slope) × cos^2(slope)]^(1/3)	11.1	ft	
r	8.7	ft	
h	6.8	ft	
SA	303	ft^2	
	0.007	acre	
	1.8E-4	acre/ton-TD	

Scaling Factors

PM10	0.5	*(EPA 1995), Pg. 13.2.5-3, 11/06*
PM2.5	0.075	*(EPA 1995), Pg. 13.2.5-3, 11/06*

Conversions

4,046.86	m^2/acre
43,560	ft^2/acre
1609.34	m/mi
3.28084	ft/m
2,000	lb/ton

Mining Scenario Ore

Wind Erosion - continued ***Wind erosion potential calculations based on Sep-2014 through Sep-2015 Grassy Mtn on site meteorological data***

Stockpile Surface Wind Erosion Event Emission Calculations

Based on 1 acre/yr 8,760 hr/yr 0.00011 acre/hr

Threshold Wind Event	Date / Hour	u10 (m/s) (1)	u10+ (m/s) (2)	u* (m/s) ID-A (3)	u* (m/s) ID-B (3)	u* (m/s) ID-C (3)	Hours Elapsed ID-A (4)	Hours Elapsed ID-B (4)	Hours Elapsed ID-C (4)	Erodible Surface Area (acre) ID-A (5)	Erodible Surface Area (acre) ID-B (5)	Erodible Surface Area (acre) ID-C (5)
0	9/25/2014 21:00											
1	10/15/2014 09:00	11.300	13.560	1.220	0.814	0.271	468	468	468	0.00641	0.0256	0.0214
2	10/15/2014 10:00	11.700	14.040	1.264	0.842	0.281	1	469	469	0.00001	0.0257	0.0214
3	10/15/2014 13:00	10.200	12.240	1.102	0.734	0.245	3	472	472	0.00004	0.0259	0.0216
4	10/15/2014 14:00	11.000	13.200	1.188	0.792	0.264	1	473	473	0.00001	0.0259	0.0216
5	10/20/2014 21:00	12.700	15.240	1.372	0.914	0.305	127	600	600	0.00174	0.0329	0.0274
6	10/20/2014 22:00	11.400	13.680	1.231	0.821	0.274	1	601	601	0.00001	0.0329	0.0274
7	10/20/2014 23:00	10.900	13.080	1.177	0.785	0.262	1	602	602	0.00001	0.0330	0.0275
8	10/21/2014 00:00	10.300	12.360	1.112	0.742	0.247	1	603	603	0.00001	0.0330	0.0275
9	10/25/2014 16:00	12.200	14.640	1.318	0.878	0.293	112	715	715	0.00153	0.0392	0.0326
10	10/25/2014 17:00	13.100	15.720	1.415	0.943	0.314	1	716	716	0.00001	0.0392	0.0327
11	10/25/2014 18:00	10.200	12.240	1.102	0.734	0.245	1	717	717	0.00001	0.0393	0.0327
12	10/25/2014 22:00	11.400	13.680	1.231	0.821	0.274	4	721	721	0.00005	0.0395	0.0329
13	10/25/2014 23:00	12.200	14.640	1.318	0.878	0.293	1	722	722	0.00001	0.0396	0.0330
14	10/26/2014 00:00	11.200	13.440	1.210	0.806	0.269	1	723	723	0.00001	0.0396	0.0330
15	10/26/2014 01:00	11.300	13.560	1.220	0.814	0.271	1	724	724	0.00001	0.0397	0.0331
16	11/1/2014 14:00	9.600	11.520	1.037	0.691	0.230	157	881	881	0.00215	0.0483	0.0402
17	11/1/2014 15:00	10.700	12.840	1.156	0.770	0.257	1	882	882	0.00001	0.0483	0.0403
18	11/22/2014 18:00	10.200	12.240	1.102	0.734	0.245	507	1,389	1,389	0.00695	0.0761	0.0634
19	11/22/2014 19:00	10.200	12.240	1.102	0.734	0.245	1	1,390	1,390	0.00001	0.0762	0.0635
20	11/23/2014 13:00	9.500	11.400	1.026	0.684	0.228	18	1,408	1,408	0.00025	0.0772	0.0643
21	11/23/2014 15:00	9.900	11.880	1.069	0.713	0.238	2	1,410	1,410	0.00003	0.0773	0.0644
22	11/28/2014 14:00	10.400	12.480	1.123	0.749	0.250	119	1,529	1,529	0.00163	0.0838	0.0698
23	11/28/2014 15:00	12.400	14.880	1.339	0.893	0.298	1	1,530	1,530	0.00001	0.0838	0.0699
24	11/28/2014 16:00	9.600	11.520	1.037	0.691	0.230	1	1,531	1,531	0.00001	0.0839	0.0699
25	11/28/2014 17:00	9.900	11.880	1.069	0.713	0.238	1	1,532	1,532	0.00001	0.0839	0.0700
26	11/29/2014 09:00	9.800	11.760	1.058	0.706	0.235	16	1,548	1,548	0.00022	0.0848	0.0707
27	12/21/2014 01:00	10.600	12.720	1.145	0.763	0.254	520	2,068	2,068	0.00712	0.1133	0.0944
28	12/21/2014 02:00	14.800	17.760	1.598	1.066	0.355	1	1	2,069	0.00001	0.0001	0.0945
29	12/21/2014 03:00	15.000	18.000	1.620	1.080	0.360	1	1	2,070	0.00001	0.0001	0.0945
30	12/21/2014 04:00	15.200	18.240	1.642	1.094	0.365	1	1	2,071	0.00001	0.0001	0.0946
31	12/21/2014 05:00	15.100	18.120	1.631	1.087	0.362	1	1	2,072	0.00001	0.0001	0.0946
32	12/21/2014 06:00	12.400	14.880	1.339	0.893	0.298	1	2	2,073	0.00001	0.0001	0.0947
33	12/21/2014 07:00	10.000	12.000	1.080	0.720	0.240	1	3	2,074	0.00001	0.0002	0.0947
34	12/21/2014 08:00	9.800	11.760	1.058	0.706	0.235	1	4	2,075	0.00001	0.0002	0.0947
35	12/24/2014 19:00	9.800	11.760	1.058	0.706	0.235	83	87	2,158	0.00114	0.0048	0.0985
36	12/24/2014 20:00	9.700	11.640	1.048	0.698	0.233	1	88	2,159	0.00001	0.0048	0.0986
37	12/25/2014 07:00	11.500	13.800	1.242	0.828	0.276	11	99	2,170	0.00015	0.0054	0.0991
38	12/25/2014 08:00	9.700	11.640	1.048	0.698	0.233	1	100	2,171	0.00001	0.0055	0.0991
39	2/6/2015 17:00	11.800	14.160	1.274	0.850	0.283	1,041	1,141	3,212	0.01426	0.0625	0.1467
40	2/6/2015 20:00	10.600	12.720	1.145	0.763	0.254	3	1,144	3,215	0.00004	0.0627	0.1468
41	2/7/2015 00:00	10.000	12.000	1.080	0.720	0.240	4	1,148	3,219	0.00005	0.0629	0.1470

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
	PROJECT NO: 343-1	PAGE: 20 OF: 26 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity Emissions	DATE: July 26, 2019

Mining Scenario Ore

Wind Erosion - continued ***Wind erosion potential calculations based on Sep-2014 through Sep-2015 Grassy Mtn on site meteorological data***

Stockpile Surface Wind Erosion Event Emission Calculations - continued
Based on 1 acre/yr 8,760 hr/yr 0.00011 acre/hr

Threshold Wind Event	Date / Hour	u10 (m/s) (1)	u10+ (m/s) (2)	u* (m/s) ID-A (3)	u* (m/s) ID-B (3)	u* (m/s) ID-C (3)	Hours Elapsed ID-A (4)	Hours Elapsed ID-B (4)	Hours Elapsed ID-C (4)	Erodible Surface Area (acre) ID-A (5)	Erodible Surface Area (acre) ID-B (5)	Erodible Surface Area (acre) ID-C (5)
42	2/7/2015 06:00	10.100	12.120	1.091	0.727	0.242	6	1,154	3,225	0.00008	0.06323	0.14726
43	2/7/2015 11:00	15.100	18.120	1.631	1.087	0.362	5	5	3,230	0.00007	0.00027	0.14749
44	2/7/2015 12:00	15.400	18.480	1.663	1.109	0.370	1	1	3,231	0.00001	0.00005	0.14753
45	2/7/2015 13:00	12.700	15.240	1.372	0.914	0.305	1	2	3,232	0.00001	0.00011	0.14758
46	2/7/2015 14:00	11.800	14.160	1.274	0.850	0.283	1	3	3,233	0.00001	0.00016	0.14763
47	2/7/2015 15:00	11.700	14.040	1.264	0.842	0.281	1	4	3,234	0.00001	0.00022	0.14767
48	2/7/2015 16:00	10.600	12.720	1.145	0.763	0.254	1	5	3,235	0.00001	0.00027	0.14772
49	2/7/2015 17:00	10.000	12.000	1.080	0.720	0.240	1	6	3,236	0.00001	0.00033	0.14776
50	2/9/2015 16:00	10.000	12.000	1.080	0.720	0.240	47	53	3,283	0.00064	0.00290	0.14991
51	2/9/2015 17:00	10.100	12.120	1.091	0.727	0.242	1	54	3,284	0.00001	0.00296	0.14995
52	2/21/2015 17:00	9.800	11.760	1.058	0.706	0.235	288	342	3,572	0.00395	0.01874	0.16311
53	3/11/2015 13:00	11.000	13.200	1.188	0.792	0.264	428	770	4,000	0.00586	0.04219	0.18265
54	3/15/2015 21:00	12.500	15.000	1.350	0.900	0.300	104	874	4,104	0.00142	0.04789	0.18740
55	3/15/2015 22:00	14.500	17.400	1.566	1.044	0.348	1	1	4,105	0.00001	0.00005	0.18744
56	3/15/2015 23:00	11.900	14.280	1.285	0.857	0.286	1	2	4,106	0.00001	0.00011	0.18749
57	3/16/2015 00:00	12.500	15.000	1.350	0.900	0.300	1	3	4,107	0.00001	0.00016	0.18753
58	3/21/2015 10:00	10.400	12.480	1.123	0.749	0.250	130	133	4,237	0.00178	0.00729	0.19347
59	3/21/2015 12:00	11.100	13.320	1.199	0.799	0.266	2	135	4,239	0.00003	0.00740	0.19356
60	3/21/2015 13:00	11.400	13.680	1.231	0.821	0.274	1	136	4,240	0.00001	0.00745	0.19361
61	3/23/2015 02:00	11.400	13.680	1.231	0.821	0.274	37	173	4,277	0.00051	0.00948	0.19530
62	3/23/2015 03:00	11.200	13.440	1.210	0.806	0.269	1	174	4,278	0.00001	0.00953	0.19534
63	3/23/2015 04:00	10.900	13.080	1.177	0.785	0.262	1	175	4,279	0.00001	0.00959	0.19539
64	3/23/2015 11:00	9.500	11.400	1.026	0.684	0.228	7	182	4,286	0.00010	0.00997	0.19571
65	3/23/2015 12:00	9.600	11.520	1.037	0.691	0.230	1	183	4,287	0.00001	0.01003	0.19575
66	3/28/2015 02:00	10.200	12.240	1.102	0.734	0.245	110	293	4,397	0.00151	0.01605	0.20078
67	3/28/2015 03:00	10.900	13.080	1.177	0.785	0.262	1	294	4,398	0.00001	0.01611	0.20082
68	3/28/2015 06:00	11.800	14.160	1.274	0.850	0.283	3	297	4,401	0.00004	0.01627	0.20096
69	3/31/2015 15:00	10.100	12.120	1.091	0.727	0.242	81	378	4,482	0.00111	0.02071	0.20466
70	3/31/2015 16:00	9.700	11.640	1.048	0.698	0.233	1	379	4,483	0.00001	0.02077	0.20470
71	4/14/2015 03:00	11.300	13.560	1.220	0.814	0.271	323	702	4,806	0.00442	0.03847	0.21945
72	4/14/2015 04:00	10.800	12.960	1.166	0.778	0.259	1	703	4,807	0.00001	0.03852	0.21950
73	4/14/2015 10:00	10.100	12.120	1.091	0.727	0.242	6	709	4,813	0.00008	0.03885	0.21977
74	4/14/2015 12:00	9.600	11.520	1.037	0.691	0.230	2	711	4,815	0.00003	0.03896	0.21986
75	4/14/2015 17:00	10.400	12.480	1.123	0.749	0.250	5	716	4,820	0.00007	0.03923	0.22009
76	4/15/2015 16:00	9.700	11.640	1.048	0.698	0.233	23	739	4,843	0.00032	0.04049	0.22114
77	5/12/2015 19:00	10.400	12.480	1.123	0.749	0.250	651	1,390	5,494	0.00892	0.07616	0.25087
78	5/12/2015 20:00	14.700	17.640	1.588	1.058	0.353	1	1	5,495	0.00001	0.00005	0.25091
79	5/12/2015 21:00	12.900	15.480	1.393	0.929	0.310	1	2	5,496	0.00001	0.00011	0.25096
80	6/21/2015 18:00	10.500	12.600	1.134	0.756	0.252	957	959	6,453	0.01311	0.05255	0.29466
81	6/21/2015 19:00	9.500	11.400	1.026	0.684	0.228	1	960	6,454	0.00001	0.05260	0.29470
82	6/29/2015 01:00	9.700	11.640	1.048	0.698	0.233	174	1,134	6,628	0.00238	0.06214	0.30265
83	6/29/2015 02:00	11.200	13.440	1.210	0.806	0.269	1	1,135	6,629	0.00001	0.06219	0.30269

Mining Scenario Ore

Wind Erosion - continued ***Wind erosion potential calculations based on Sep-2014 through Sep-2015 Grassy Mtn on site meteorological data***

Stockpile Surface Wind Erosion Event Emission Calculations - continued

Based on 1 acre/yr 8,760 hr/yr 0.00011 acre/hr

Threshold Wind Event	Date / Hour	u10 (m/s) (1)	u10+ (m/s) (2)	u* (m/s) ID-A (3)	u* (m/s) ID-B (3)	u* (m/s) ID-C (3)	Hours Elapsed ID-A (4)	Hours Elapsed ID-B (4)	Hours Elapsed ID-C (4)	Erodible Surface Area (acre) ID-A (5)	Erodible Surface Area (acre) ID-B (5)	Erodible Surface Area (acre) ID-C (5)
84	7/5/2015 07:00	9.600	11.520	1.037	0.691	0.230	149	1,284	6,778	0.00204	0.07036	0.30950
85	7/5/2015 08:00	10.600	12.720	1.145	0.763	0.254	1	1,285	6,779	0.00001	0.07041	0.30954
86	7/5/2015 09:00	10.600	12.720	1.145	0.763	0.254	1	1,286	6,780	0.00001	0.07047	0.30959
87	7/5/2015 10:00	9.500	11.400	1.026	0.684	0.228	1	1,287	6,781	0.00001	0.07052	0.30963
88	7/5/2015 16:00	10.200	12.240	1.102	0.734	0.245	6	1,293	6,787	0.00008	0.07085	0.30991
89	7/8/2015 14:00	10.200	12.240	1.102	0.734	0.245	70	1,363	6,857	0.00096	0.07468	0.31311
90	7/8/2015 15:00	10.600	12.720	1.145	0.763	0.254	1	1,364	6,858	0.00001	0.07474	0.31315
91	7/8/2015 19:00	10.600	12.720	1.145	0.763	0.254	4	1,368	6,862	0.00005	0.07496	0.31333
92	7/9/2015 23:00	10.700	12.840	1.156	0.770	0.257	28	1,396	6,890	0.00038	0.07649	0.31461
93	7/10/2015 00:00	10.000	12.000	1.080	0.720	0.240	1	1,397	6,891	0.00001	0.07655	0.31466
94	7/21/2015 21:00	9.900	11.880	1.069	0.713	0.238	285	1,682	7,176	0.00390	0.09216	0.32767
95	8/3/2015 02:00	9.900	11.880	1.069	0.713	0.238	293	1,975	7,469	0.00401	0.10822	0.34105
96	8/3/2015 03:00	15.400	18.480	1.663	1.109	0.370	1	1	7,470	0.00001	0.00005	0.34110
97	8/3/2015 04:00	13.600	16.320	1.469	0.979	0.326	1	2	7,471	0.00001	0.00011	0.34114
98	8/3/2015 05:00	11.500	13.800	1.242	0.828	0.276	1	3	7,472	0.00001	0.00016	0.34119
99	8/4/2015 00:00	10.500	12.600	1.134	0.756	0.252	19	22	7,491	0.00026	0.00121	0.34205
100	8/14/2015 18:00	9.600	11.520	1.037	0.691	0.230	258	280	7,749	0.00353	0.01534	0.35384
101	8/14/2015 19:00	9.800	11.760	1.058	0.706	0.235	1	281	7,750	0.00001	0.01540	0.35388
102	8/29/2015 12:00	10.200	12.240	1.102	0.734	0.245	353	634	8,103	0.00484	0.03474	0.37000
103	8/29/2015 14:00	11.000	13.200	1.188	0.792	0.264	2	636	8,105	0.00003	0.03485	0.37009
104	8/29/2015 15:00	10.100	12.120	1.091	0.727	0.242	1	637	8,106	0.00001	0.03490	0.37014
105	9/4/2015 17:00	11.700	14.040	1.264	0.842	0.281	146	783	8,252	0.00200	0.04290	0.37680
106	9/4/2015 18:00	12.700	15.240	1.372	0.914	0.305	1	784	8,253	0.00001	0.04296	0.37685

Flat Surface Wind Erosion Event Emission Calculations

Threshold Wind Event	Date / Hour	u10 (m/s) (1)	u10+ (m/s) (2)	u* (m/s) Flat (3)	Hours Elapsed Flat (4)	Erodible Surface Area (acre) Flat (5)
N/A	No wind events above 16.04 m/s					

Mining Scenario Ore

Wind Erosion - continued

Stockpile Surface Wind Erosion Event Emission Calculations - continued

Threshold	Erosion Potential (lb/acre)[1]			PM Emissions (lb)				PM10 (lb)	PM2.5 (lb)
Wind Event	ID-A (6)	ID-B (6)	ID-C (6)	ID-A (7)	ID-B (7)	ID-C (7)	Total (8)	Total (9)	Total (10)
1	65.48	--	--	0.420	--	--	0.420	0.210	0.031
2	85.04	--	--	0.001	--	--	0.001	0.001	0.000
3	21.65	--	--	0.001	--	--	0.001	0.000	0.000
4	52.08	--	--	0.001	--	--	0.001	0.000	0.000
5	142.4	--	--	0.248	--	--	0.248	0.124	0.019
6	70.19	--	--	0.001	--	--	0.001	0.000	0.000
7	47.85	--	--	0.001	--	--	0.001	0.000	0.000
8	25.03	--	--	0.000	--	--	0.000	0.000	0.000
9	112.21	--	--	0.172	--	--	0.172	0.086	0.013
10	168.71	--	--	0.002	--	--	0.002	0.001	0.000
11	21.65	--	--	0.000	--	--	0.000	0.000	0.000
12	70.19	--	--	0.004	--	--	0.004	0.002	0.000
13	112.21	--	--	0.002	--	--	0.002	0.001	0.000
14	60.89	--	--	0.001	--	--	0.001	0.000	0.000
15	65.48	--	--	0.001	--	--	0.001	0.000	0.000
16	3.89	--	--	0.008	--	--	0.008	0.004	0.001
17	39.76	--	--	0.001	--	--	0.001	0.000	0.000
18	21.65	--	--	0.150	--	--	0.150	0.075	0.011
19	21.65	--	--	0.000	--	--	0.000	0.000	0.000
20	1.36	--	--	0.000	--	--	0.000	0.000	0.000
21	12.23	--	--	0.000	--	--	0.000	0.000	0.000
22	28.53	--	--	0.047	--	--	0.047	0.023	0.003
23	123.92	--	--	0.002	--	--	0.002	0.001	0.000
24	3.89	--	--	0.000	--	--	0.000	0.000	0.000
25	12.23	--	--	0.000	--	--	0.000	0.000	0.000
26	9.33	--	--	0.002	--	--	0.002	0.001	0.000
27	35.90	--	--	0.256	--	--	0.256	0.128	0.019
28	302.12	11	--	0.004	0.001	--	0.005	0.002	0.000
29	320.11	15	--	0.004	0.001	--	0.005	0.003	0.000
30	338.59	19	--	0.005	0.001	--	0.006	0.003	0.000
31	329.29	17	--	0.005	0.001	--	0.005	0.003	0.000
32	123.92	--	--	0.002	--	--	0.002	0.001	0.000
33	15.25	--	--	0.000	--	--	0.000	0.000	0.000
34	9.33	--	--	0.000	--	--	0.000	0.000	0.000
35	9.33	--	--	0.011	--	--	0.011	0.005	0.001
36	6.55	--	--	0.000	--	--	0.000	0.000	0.000
37	75.02	--	--	0.011	--	--	0.011	0.006	0.001
38	6.55	--	--	0.000	--	--	0.000	0.000	0.000
39	90.23	--	--	1.287	--	--	1.287	0.643	0.097
40	35.90	--	--	0.001	--	--	0.001	0.001	0.000
41	15.25	--	--	0.001	--	--	0.001	0.000	0.000
Stockpile Subtotal							2.655	1.327	0.199

Mining Scenario Ore

Wind Erosion - continued

Stockpile Surface Wind Erosion Event Emission Calculations - continued

Threshold	Erosion Potential (lb/acre)[1]			PM Emissions (lb)				PM10 (lb)	PM2.5 (lb)
Wind Event	ID-A (6)	ID-B (6)	ID-C (6)	ID-A (7)	ID-B (7)	ID-C (7)	Total (8)	Total (9)	Total (10)
42	18.39	--	--	0.002	--	--	0.002	0.001	0.000
43	329.29	17	--	0.023	0.005	--	0.027	0.014	0.002
44	357.54	24	--	0.005	0.001	--	0.006	0.003	0.000
45	142.39	--	--	0.002	--	--	0.002	0.001	0.000
46	90.23	--	--	0.001	--	--	0.001	0.001	0.000
47	85.0	--	--	0.001	--	--	0.001	0.001	0.000
48	35.90	--	--	0.000	--	--	0.000	0.000	0.000
49	15.25	--	--	0.000	--	--	0.000	0.000	0.000
50	15.25	--	--	0.010	--	--	0.010	0.005	0.001
51	18.39	--	--	0.000	--	--	0.000	0.000	0.000
52	9.33	--	--	0.037	--	--	0.037	0.018	0.003
53	52.08	--	--	0.305	--	--	0.305	0.153	0.023
54	129.96	--	--	0.185	--	--	0.185	0.093	0.014
55	276.05	6	--	0.004	0.000	--	0.004	0.002	0.000
56	95.55	--	--	0.001	--	--	0.001	0.001	0.000
57	129.96	--	--	0.002	--	--	0.002	0.001	0.000
58	28.53	--	--	0.051	--	--	0.051	0.025	0.004
59	56.42	--	--	0.002	--	--	0.002	0.001	0.000
60	70.19	--	--	0.001	--	--	0.001	0.000	0.000
61	70.19	--	--	0.036	--	--	0.036	0.018	0.003
62	60.89	--	--	0.001	--	--	0.001	0.000	0.000
63	47.85	--	--	0.001	--	--	0.001	0.000	0.000
64	1.36	--	--	0.000	--	--	0.000	0.000	0.000
65	3.89	--	--	0.000	--	--	0.000	0.000	0.000
66	21.65	--	--	0.033	--	--	0.033	0.016	0.002
67	47.85	--	--	0.001	--	--	0.001	0.000	0.000
68	90.23	--	--	0.004	--	--	0.004	0.002	0.000
69	18.39	--	--	0.020	--	--	0.020	0.010	0.002
70	6.55	--	--	0.000	--	--	0.000	0.000	0.000
71	65.48	--	--	0.290	--	--	0.290	0.145	0.022
72	43.74	--	--	0.001	--	--	0.001	0.000	0.000
73	18.39	--	--	0.002	--	--	0.002	0.001	0.000
74	3.89	--	--	0.000	--	--	0.000	0.000	0.000
75	28.53	--	--	0.002	--	--	0.002	0.001	0.000
76	6.55	--	--	0.002	--	--	0.002	0.001	0.000
77	28.53	--	--	0.254	--	--	0.254	0.127	0.019
78	293.31	9	--	0.004	0.001	--	0.005	0.002	0.000
79	155.31	--	--	0.002	--	--	0.002	0.001	0.000
80	32.15	--	--	0.421	--	--	0.421	0.211	0.032
81	1.36	--	--	0.000	--	--	0.000	0.000	0.000
82	6.55	--	--	0.016	--	--	0.016	0.008	0.001
83	60.89	--	--	0.001	--	--	0.001	0.000	0.000
Stockpile Subtotal							1.728	0.864	0.130

Mining Scenario Ore

Wind Erosion - continued

Stockpile Surface Wind Erosion Event Emission Calculations - continued

Threshold Wind Event	Erosion Potential (lb/acre)[1] ID-A (6)	ID-B (6)	ID-C (6)	PM Emissions (lb) ID-A (7)	ID-B (7)	ID-C (7)	Total (8)	PM10 (lb) Total (9)	PM2.5 (lb) Total (10)
84	3.89	--	--	0.008	--	--	0.008	0.004	0.001
85	35.90	--	--	0.000	--	--	0.000	0.000	0.000
86	35.90	--	--	0.000	--	--	0.000	0.000	0.000
87	1.36	--	--	0.000	--	--	0.000	0.000	0.000
88	21.65	--	--	0.002	--	--	0.002	0.001	0.000
89	21.65	--	--	0.021	--	--	0.021	0.010	0.002
90	35.90	--	--	0.000	--	--	0.000	0.000	0.000
91	35.90	--	--	0.002	--	--	0.002	0.001	0.000
92	39.76	--	--	0.015	--	--	0.015	0.008	0.001
93	15.25	--	--	0.000	--	--	0.000	0.000	0.000
94	12.23	--	--	0.048	--	--	0.048	0.024	0.004
95	12.23	--	--	0.049	--	--	0.049	0.025	0.004
96	357.54	24	--	0.005	0.001	--	0.006	0.003	0.000
97	204.33	--	--	0.003	--	--	0.003	0.001	0.000
98	75.02	--	--	0.001	--	--	0.001	0.001	0.000
99	32.15	--	--	0.008	--	--	0.008	0.004	0.001
100	3.89	--	--	0.014	--	--	0.014	0.007	0.001
101	9.33	--	--	0.000	--	--	0.000	0.000	0.000
102	21.65	--	--	0.105	--	--	0.105	0.052	0.008
103	52.08	--	--	0.001	--	--	0.001	0.001	0.000
104	18.39	--	--	0.000	--	--	0.000	0.000	0.000
105	85.04	--	--	0.170	--	--	0.170	0.085	0.013
106	142.39	--	--	0.002	--	--	0.002	0.001	0.000
Stockpile Subtotal							0.457	0.228	0.034

Final Emission Factors (lb/acre-yr)

Surface Type	PM	PM10	PM2.5
Pile	4.84	2.42	0.36
Flat	--	--	--

Mining Scenario Ore

Wind Erosion - continued

Stockpile Surface Wind Erosion Event Emission Calculations - Notes

(1) u10 = wind speed at 10 meters reference height, m/s

(2) u10+ = fastest-mile wind speed, m/s
Based on hourly to fastest-mile wind speed conversion factor of 1.2 *(EPA 1994)*

(3) Pile: u* = friction velocity, m/s = (us/ur) × 0.1 × u10+ *(EPA 1995), Sec. 13.2.5, Eqs. 6 & 7, 11/06*

Area ID	A	B	C	
(us/ur)	0.9	0.6	0.2	*(EPA 1995), Page 13.2.5-10, 11/06*

Flat surface:
u* = friction velocity, m/s = 0.053 × u10+ *(EPA 1995), Sec. 13.2.5, Eq. 4, 11/06*

(4) Hours elapsed since previous wind erosion event

(5) Erodible surface area = hours elapsed since previous erosion event × hourly erodible surface area (acre) × surface regime area fraction Surface regime area fractions:

Area ID	A	B	C	
% Surfac	0.12	0.48	0.4	*(EPA 1995), Page 13.2.5-10, 11/06*

(6) Erosion potential, g/m², = P = 58(u* - ut*)^2 + 25(u* - ut*); P = 0 for u* ≤ ut* *(EPA 1995), Page 13.2.5, Eq. 3, 11/06*
where, ut* = threshold friction velocity 1.02 m/s *(EPA 1995), Page 13.2.5-5 (overburden), 11/06*
P converted to lb/acre by multiplying with: 0.0022 lb/g and 4,046.86 m^2/acre
Solving u* = (us/ur) × 0.1 × u10+ for u10, when u* = ut* = 1.02 m/s and u10+ = u* × 1.2
yields the following minimum wind speeds to disturb each stockpile surface regime:

ID-A	9.44 m/s
ID-B	14.17 m/s
ID-C	42.50 m/s

The threshold wind speed to disturb flat surfaces is 1.02/0.053/1.2
Flat surface 16.04 m/s
The maximum hourly wind speed in the onsite data is 12.7 m/s, which is less than the threshold wind speeds to cause a disturbance of stockpile regimes ID-B and ID-C, and flat surfaces.

(7) PM emissions, lb = P (lb/acre) × erodible surface area (acre)

(8) Total PM emissions, lb = PM (ID-A), lb + PM (ID-B), lb + PM(ID-C), lb

(9) Total PM10 emissions, lb = total PM emissions, lb × PM10 scaling factors of 0.5 *(EPA 1995), Page 13.2.5-3, 11/06*

(10) Total PM2.5 emissions, lb = total PM emissions, lb × PM2.5 scaling factors of 0.075 *(EPA 1995), Page 13.2.5-3, 11/06*

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Mining Scenario Ore

Wind Erosion - continued

chk

Emissions by Model ID

				PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
	Location of	Control[1]		PM	PM10		PM2.5	
Model ID	Activity		Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr
WRSF	WRSF	--	Pile	0.129	0.497	0.065	0.075	0.010
STK	Ore Stockpile	--	Pile	0.129	0.494	0.064	0.074	0.010
BRW	Borrow Stockpile	--	Pile	0.129	0.494	0.064	0.074	0.010
CRF	CRF Stockpile	--	Pile	0.059	0.229	0.030	0.034	0.004
TS1	Topsoil Storage 1		Pile	0.017	0.067	0.009	0.010	0.001
TS2	Topsoil Storage 2		Pile	0.007	0.027	0.004	0.004	0.001
HR	Haul Roads	90%	Flat	--	--	--	--	--
Total	Wind Erosion			0.470	1.808	0.235	0.271	0.035

No wind events above 16.04 m/s - Threshold wind speed for flat surfaces

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
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Mining Scenario Ore

Hazardous Air Pollutants and Greenhouse Gas Emissions

HAP Emissions Summary

CAS No.	Pollutant/Group	UG lb/yr	AG lb/yr	Total ton/yr
106-99-0	1,3-Butadiene	-	-	-
75-07-0	Acetaldehyde	-	-	-
107-02-8	Acrolein	-	-	-
7440-36-0	Antimony and compounds	7.33E-03	6.00E-02	3.37E-05
7440-38-2	Arsenic and compounds	3.33E-02	4.59E-01	2.46E-04
No RBC	Barium and compounds	-	-	-
71-43-2	Benzene	-	-	-
7440-41-7	Beryllium and compounds	2.12E-04	1.39E-03	7.99E-07
7440-43-9	Cadmium and compounds	4.51E-05	6.93E-04	3.69E-07
18540-29-9	Chromium VI, chromate, and dichr	5.36E-03	4.46E-02	2.50E-05
7440-48-4	Cobalt and compounds	3.45E-04	5.68E-03	3.01E-06
74-90-8	Cyanide, Hydrogen	-	5.7E+03	2.8E+00
106-46-7	p-Dichlorobenzene	-	-	-
	Diesel Particulate Matter			-
100-41-4	Ethyl benzene	-	-	-
50-00-0	Formaldehyde	-	-	-
110-54-3	Hexane	-	-	-
7439-92-1	Lead and compounds	1.46E-03	1.61E-02	8.78E-06
7439-96-5	Manganese and compounds	1.67E-02	1.77E-01	9.69E-05
7439-97-6	Mercury and compounds	4.91E-04	7.29E-03	3.89E-06
91-20-3	Naphthalene	-	-	-
7440-02-0	Nickel and compounds	9.84E-04	1.00E-02	5.50E-06
115-07-1	Propylene	-	-	-
	Polycyclic aromatic hydrocarbons (	-	-	-
7782-49-2	Selenium and compounds	-	-	-
108-88-3	Toluene	-	-	-
7440-62-2	Vanadium (fume or dust)	-	-	-
1330-20-7	Xylene (mixture)	-	-	-
No RBC	Zinc and compounds	-	-	-
Total HAP			5,660	2.8
		chk-17	chk	chk

GHG Emissions Summary

Pollutant	Emissions ton/yr
Total GHGs	5,488

Conversions

2,000	lb/ton
1.10231	ton/t

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Mining Scenario Ore

Greenhouse Gas Emissions - Combustion Sources

Activity Information

chk

Mining Mobile Equipment	Underground			Aboveground			
Large diesel machinery (> 600 h	-- gal/yr	-- MMBtu/yr[1]		51,945 gal/yr	7,116 MMBtu/yr[1]		*See Mine Sheet*
Small diesel machinery (≤ 600 h	273,329 gal/yr	37,446 MMBtu/yr[1]		164,414 gal/yr	22,525 MMBtu/yr[1]		*See Mine Sheet*

[1] Based on diesel heating value of 137,000 Btu/gal *AP-42, Appendix A, p. A-5, 9/85*

Greenhouse Gas Emission Factors [1] ***and Emissions***

Fuel	CO2	CH4	N2O	CO2	CH4	N2O	CO2e
	kg/MMBtu			mt/yr	mt/yr	mt/yr	mt/yr
Diesel	73.96	3.0E-3	6.0E-4	4,962	0.20	0.040	4,979
Combustion Total GHG				4,962	0.20	0.040	4,979

[1] *40 CFR 98 Tab. C-1 and C-2 (CFR 2018d)*

Global Warming Potential [1]

CO2	1
CH4	25
N2O	298

[1] *40 CFR 98 Tab. A-1 (CFR 2018d)*

Conversions
2,000 lb/ton
1,000 kg/mt

Air Sciences Inc.	PROJECT TITLE: Grassy Mountain Mine	BY: M. Mavko
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Mining Scenario Ore

Hazardous Air Pollutants and Greenhouse Gas Emissions - Fugitive Dust Sources

Activity Information

By Activity	UG/AG	PM ton/yr	
Underground Drilling	UG	0.02	*See Mine Sheet*
Borrow Drilling	AG	0.85	*See Mine Sheet*
Underground Blasting	UG	0.05	*See Mine Sheet*
Borrow Blasting	AG	0.06	*See Mine Sheet*
Material Load / Unload	AG	0.11	*See Mine Sheet*
Material Load / Unload UG	UG	0.04	*See Mine Sheet*
Wind Erosion	AG	0.47	*See Mine Sheet*
Ore/Waste Subtotal		0.98	

Ore and Waste Dust HAP Concentrations [1] and Emissions

CAS No.	Pollutant	Ore ppm	Waste ppm	Ore lb/ton	Waste lb/ton	UG[2] lb/yr	AG[3] lb/yr	Total ton/yr	UG lb/ton	AG lb/ton
7440-38-2	Arsenic and compounds	152	154	0.3040	0.31	0.033	0.46	2.5E-4	0.304654	0.307218
7440-41-7	Beryllium and compounds	1.1	0.31	0.0022	6.2E-4	2.1E-4	0.0014	8.0E-7	0.001942	0.000929
7440-43-9	Cadmium and compounds	0.2	0.24	0.0004	4.8E-4	4.5E-5	6.9E-4	3.7E-7	0.000413	0.000464
7440-48-4	Cobalt and compounds	1.5	2	0.003	0.0040	3.5E-4	0.0057	3.0E-6	0.003164	0.003805
18540-29-9	Chromium VI, chromate, and dichromate parti	27	12	0.054	0.024	0.0054	0.045	2.5E-5	0.049093	0.029863
7439-97-6	Mercury and compounds	2.2	2.5	0.0044	0.0050	4.9E-4	0.0073	3.9E-6	0.004498	0.004883
7439-96-5	Manganese and compounds	81	54	0.162	0.11	0.017	0.18	9.7E-5	0.153168	0.118554
7440-02-0	Nickel and compounds	4.8	3	0.0096	0.0060	9.8E-4	0.010	5.5E-6	0.009011	0.006704
7439-92-1	Lead and compounds	7	5	0.014	0.0100	0.0015	0.016	8.8E-6	0.013346	0.010782
7440-36-0	Antimony and compounds	37	16	0.074	0.032	0.0073	0.060	3.4E-5	0.067131	0.040209
Dust HAP Total						0.066	0.78	4.2E-4		

[1] *(Wolverson 2019.03.04)*

[2] *Underground activities using ore EF, material load/unload split between ore and waste*

[3] *Borrow activities using waste EF, material load/unload and wind erosion split between ore and waste*

Conversions

2,000 lb/ton

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Conversions

60	sec/min
60	min/hr
24	hr/day
365	day/yr
8,760	hr/yr
3,600	s/hr
2,000	lb/ton
453.593	g/lb
3.28084	ft/m
35.3147	ft^3/m^3
7,000	gr/lb
1.341	hp/kW
907.1858	kg/ton
459.67	°R at 0°F
68	°F, standard
7,000	BTU/hp-hr
7.05	lb/gal distillate oil
137,000	BTU/gal
2.2369	mi/hr per m/s
7.48052	gal/ft^3
1.10231	ton/t
2.20462	lb/kg
1609.34	m/mi
4046.9	m^2/acre
43,560	ft^2/acre
12	in/ft
1.10231	ton/mt
1.0E+6	g/mt
3	ft/yd
1.0E+6	scf/MMscf
10,000	m^2/ha
1,000	kg/mt
273.15	°K at 0°C
32	°F at 0°C
1.8	°F/°C
1,000	ng/µg
0.293297	MW-hr/MMBtu
12	mo/yr
5280	ft/mi
29.9213	inHg/atm

Fuel Specifications

15	ppm S content	*40 CFR 80.510 (Non-road diesel)*
7.05	lb/gal-fuel	*(EPA 1995), App. A*
32.065	lb/lb-mol S, and	
64.06	lb/lb-mol SO2	
7,000	Btu/hp-hr	*(EPA 1995), Sec. 3.3, (Diesel engine)*
0.00939	MMBtu/kW-hr	Diesel
0.137	MMBtu/gal	*(EPA 1995), App. A (Diesel)*
0.0915	MMBtu/gal Propane	

Bulk Material

2,750	kg/m^3, Limestone	*https://www.engineeringtoolbox.com/soil-rock-bulking-factor-d_1557.html*		
4,635	lb/yd^3			
4,024	lb/yd^3, concrete	*(EPA 1995)AP-42 p. 11-12.9, 6/06*	0.00025	0.49702

14.5833	troy oz/lb
1	(g/s)/(g/s)
0.126	(g/s)/(lb/hr)
0.00525	(g/s)/(lb/day)
0.02877	(g/s)/(ton/yr)

Constants

M.W. SO2	64.0638
M.W. S	32.065
M.W. O	15.9994

Diesel SO2

15	parts S	7.05	lb	64.06	SO2		gal	0.00939	MMBtu	453.593	g	=	6.57E-03 g SO2
1.0E+06			gal diese	32.065	S	0.137	MMBtu		kW-hr		lb		kW-hr

Calculation

185	lb S	44.08	lb C3H8		lb mol	7,000	gr	100	SCF	=	15.90	gr S
1.00E+06	lb C3H8		lb mol	359.05	SCF (0C)		lb		100SCF			100 SCF

Propane heating value 91,500 *Btu/gal* *(EPA 1995), Table 1.5-1 (07/08) Footnote a*

AP-42, Chapter 13.2.4 Particle Size Fractions

0.35	PM10
0.053	PM2.5

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Fuel Combustion Exhaust Flow (EPA Method 19, F-factor)

Propane Heater

F-factor	8,710	dscf/MMBtu	Propane, dry
O2%dry	3	%	
Heat input	1	MMBtu/hr	
Standard exhaust flow	10,170	dscf/hr	
	169	dscfm	
Vol % moisture	15.0%	standard for propane boilers	
Temperature	360	°F, Engineering Toolbox* (LPG heating appliances)	
Pressure, site	0.87	atm	
Actual exhaust flow	356	acfm (wet)/MMBtu	

Diesel Engine

F-factor	9,190	dscf/MMBtu	Oil, dry
O2%dry	9	%	
Heat input	0.007	MMBtu/hp-hr	*(EPA 1995), Sec. 3.3, (Diesel engine)*
Standard exhaust flow	113	dscf/hp-hr	
	1.9	dscfm/hp	2.5 dscfm/kW
Vol % moisture	8.0%	standard for diesel engines	
Temperature	1,100	°F, Engineering Toolbox* (diesel exhaust)	
Pressure, site	0.87	atm	
Actual exhaust flow	7.0	acfm (wet)/hp	9.3 acfm (wet)/kW

* *http://www.engineeringtoolbox.com/fuels-exhaust-temperatures-d_168.html*

Refinery Exhaust Flow

			dscfm	acfm	temp_F		dia_ft	
	Hourly		Exhaust Parameters					BH
			Flow		Temp	Velocity	Dia	PM
Source	Design Rate	Water	dscfm	acfm	F	ft/s	ft	gr/dscf
Carbon Regeneration Kiln (Drum)	0.2 ton	1%	80	110	150	10	0.48	
Electrowinning Cells & Pregnant Solution Tank		4%	2,660	3,380	100	161	0.67	
Mercury Retort		1%	16	20	150	5	0.29	
Induction Melting Furnace	0.1/batch ton	1%	3,500	4,700	150	100	1	0.004

(NDEP 2017.07)

Site Pressure Calculation

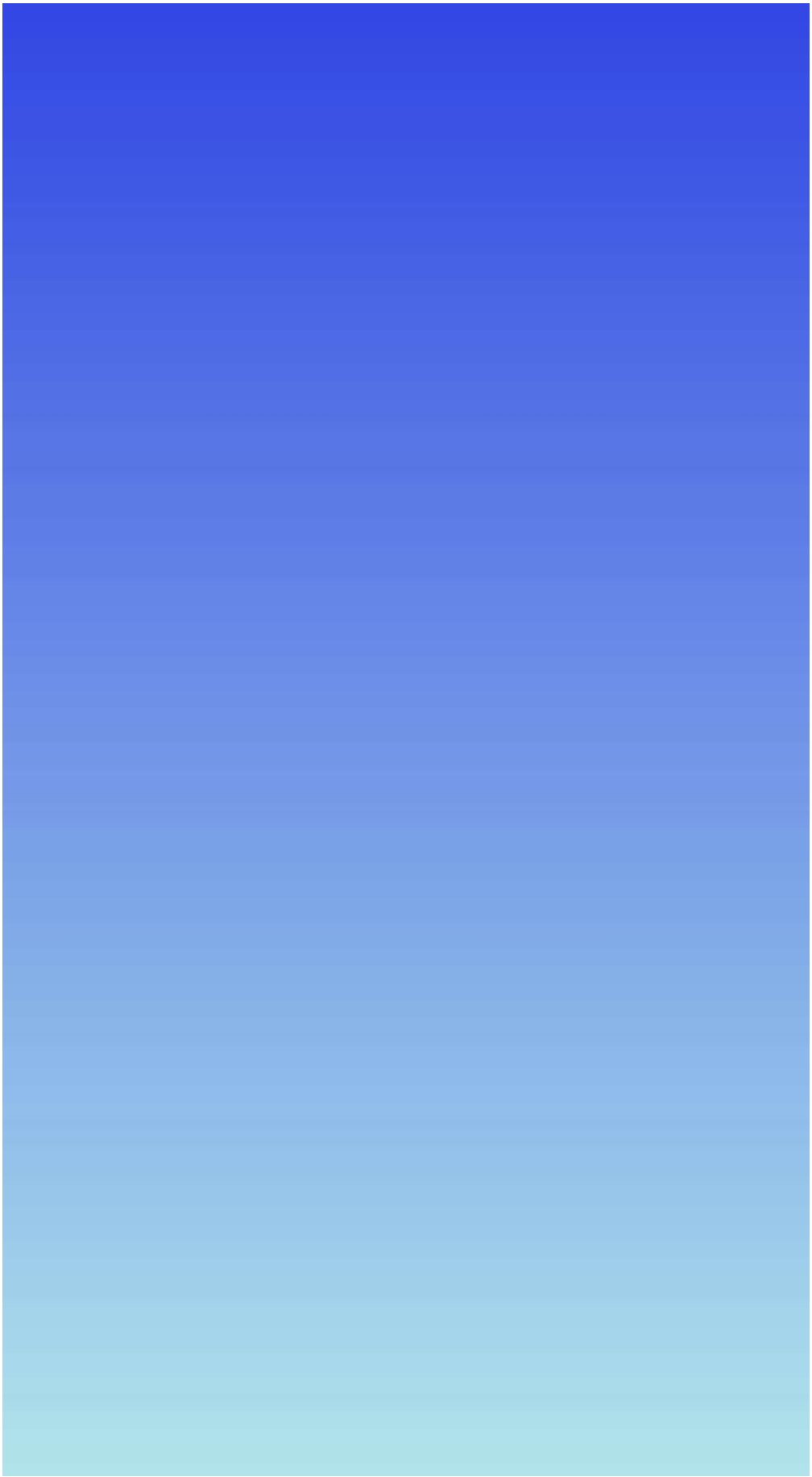
http://www.sensorsone.com/altitude-pressure-units-conversion/

~ Site Elev. (m)	~ Site Elev. (ft)
1160	3805.77

Elev(ft)	Pres(inHg)
3000	26.817
4000	25.842

Site (ft)	Site (inH	Site(atm)
3805.77	26.0314	0.86999

Attachment B – Modeling Report and CAO Risk Assessment Work Plan



AIR SCIENCES INC.

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Grassy Mountain Mine Air Quality Modeling Report and Risk Assessment Work Plan

PREPARED FOR:
CALICO RESOURCES, INC.

PROJECT NO. 343-1
AUGUST 2, 2019

1.0 INTRODUCTION

Calico Resources is providing this Modeling Report and Risk Assessment Work Plan to support its request for a Standard Air Contaminant Discharge Permit (ACDP) for the proposed Grassy Mountain Mine facility (facility). The facility will be located approximately 24 kilometers south southwest of Adrian, Oregon, in Malheur County. A location map for the facility is presented in Figure 1. The facility is expected to emit particulate matter of 10 microns or less in diameter (PM_{10}) at a rate above the Significant Emission Rate (SER) for PM_{10}.

The Modeling Report presents the methods used for an air quality evaluation of the potential air emissions from Facility sources. The dispersion model (AERMOD), modeling techniques, source characterizations and emissions, the receptors, the meteorological dataset, the background concentrations, and the ambient air quality standards are described in the Report.

As part of the Standard ACDP application, it is expected that the facility will be required to demonstrate compliance under the Cleaner Air Oregon Rules (CAO). For that demonstration, the facility has conducted a Level 3 Risk Assessment. For a Level 3 Risk Assessment, a Risk Assessment Work Plan (work plan) is required as described in the Oregon Administrative Rules (OAR)[1]. The work plan includes a conceptual site model, the proposed exposure assessment using AERMOD and risk characterization, and an uncertainty evaluation.

1.1 Facility Process Description

The Project will consist of an underground gold and silver ore mine using the Drift and Fill method, and a process facility to mill, refine, and melt gold and silver ore into doré bars for further processing off-site.

The underground mine will be developed by blasting, using emulsion, a level access tunnel and then mining drifts off of the main tunnel. As ore is removed, backfill from a nearby borrow pit will be hauled in to fill the drifts. Cemented rock fill (CRF) will be used for a portion of the backfill, requiring a batch cement plant at the surface. A mobile crushing unit will crush borrow material in the borrow pit, and material will be loaded and hauled to the waste rock storage facility, the CRF plant, or directly underground.

Ore removed from the mine is dumped by haul trucks directly into a mobile crushing unit that consists of a primary jaw crusher and a secondary screening/cone crusher unit. Crushed ore is then conveyed to a covered ore stockpile. A front-end loader transfers stockpiled ore to the mill via a feed conveyor; from here, the process is a closed, wet process. Milled ore is cycloned to

[1] OAR 340-245-0210. https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=252165. Accessed July 25th, 2019.

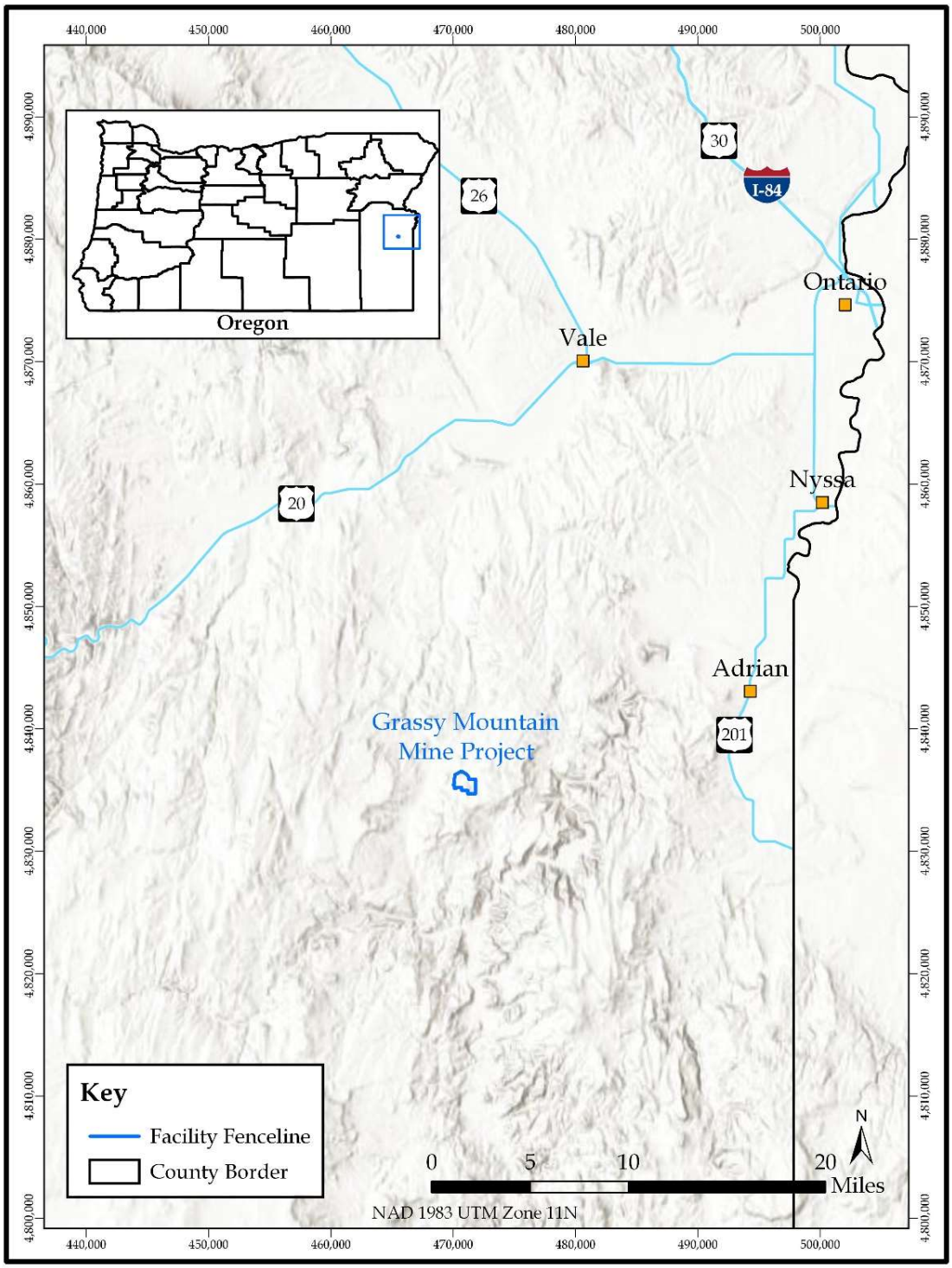
separate free gold in coarse ore that will be extracted in a gravity concentrate intensive leaching process; the remaining ore slurry is sent directly to the carbon-in-leach (CIL) process.

The CIL circuit consists of a pre-aeration tank and a series of 7 CIL tanks. Lime is added during pre-aeration to control pH, and cyanide is added to the first CIL tank. Leached gold and silver will be adsorbed onto granular carbon, which is present in all tanks. Slurry advances through each of the 7 tanks, once per day. Barren carbon is added to the last tank and flows through the circuit in the opposite direction: loaded carbon extracted for the elution process is removed from tank 1. The elution process strips gold and silver from the carbon into solution. Pregnant solution (solution loaded with gold and silver) is transferred to the gold room, and stripped carbon is regenerated in the propane-fired carbon regeneration kiln before being recycled for the leach process. Some carbon loss occurs during heating in the kiln, and new carbon is added along with regenerated carbon to CIL tank 7.

The gold room will house the electrowinning cells, retort, induction furnace, and associated support equipment. In the electrowinning cells, gold and silver are plated onto cathodes using electrolysis. Periodically, the electrowinning cells will be opened and the sludge cleaned out manually with a high-pressure spray gun. Sludge from the cells will flow by gravity to the electrowinning-sludge-filter feed tank and into manually operated pressure canister filters to be dewatered. Dewatered sludge is to be collected in trays and placed in the mercury retort to dry the sludge and remove mercury. Dried sludge will be removed from the retort and combined with fluxes in a flux mixer before being charged into the melting furnace, where the sludge is melted and poured into doré bars.

The CIL tailings will be pumped to the 2-stage agitated cyanide-detoxification tanks, where lime will be added to buffer pH, copper sulfate will be added as a reaction catalyst, and sodium meta-bisulfite will be added. Detoxified slurry will overflow the second detoxification tank to the final tailings pump box where it will be pumped to the tailings management facility by the final tailings pumps.

Figure 1. Facility Location Map



2.0 MODELING PROTOCOL

2.1 Model Selection

The analysis was conducted using version 18081 of the AERMOD modeling system. The AERMOD modeling system is the recommended model for short-range analyses (up to 50 kilometers) in the Guideline on Air Quality Models, which is maintained by the United States Environmental Protection Agency (EPA) and published as Appendix W to the Code of Federal Regulations, Title 40, Part 51.

2.2 Modeled Sources

This analysis included evaluation of potential emissions from all sources identified in the ACDP application at the facility. Emission sources include exhaust stacks (generators, silo vents, heaters, and process sources) as well as fugitive emission sources (blasting, hauling, material handling, crushing, and conveying). Fugitive emissions of Hazardous Air Pollutants (HAPs) from several additional sources were modeled, including the tailings management facility, tailings pond, and CIL process tanks.

A complete list of modeled sources and descriptions is provided in 3.4Appendix A.

2.3 Air Pollutants and Emissions

A summary of facility-wide potential annual emissions of pollutants subject to National Ambient Air Quality Standards (NAAQS) in tons per year (ton/yr) is provided in Table 1, along with the Significant Emission Rates (SERs) as defined in OAR 340-200-0020.

Table 1. Facility-Wide Potential Emissions, NAAQS (ton/yr)

Source Category	PM_{10}	$PM_{2.5}$	CO	NO_X	SO_2	VOC	NO_X + SO_2	NO_X + VOC	Lead (Pb)
Process	4.55	1.30	7.88	5.70	0.66	0.59	6.36	6.29	4.72E-05
Mining & Fugitive	14.10	2.56	39.02	18.32	0.05	12.18	18.37	30.50	8.78E-06
Facility-Wide Total	**18.65**	**3.86**	**46.89**	**24.01**	**0.72**	**12.78**	**24.73**	**36.79**	**5.60E-05**
SER	***15***	***10***	***100***	***40***	***40***	***40***	***40***	***40***	***0.6***

As shown in Table 1, with the exception of PM_{10}, expected emissions of all NAAQS pollutants are below their respective SERs. The quality analysis presents modeling results for comparison with the PM_{10} 24-hour NAAQS.

Emissions of HAPs for the Risk Assessment are discussed in the Risk Assessment Work Plan.

2.4 Source Characterization and Model Input Parameters

All the sources with stacks included in this analysis were characterized as POINT sources in the model. An exhaust temperature of 0˚K was entered for sources not associated with heated processes (e.g., silo vents). AERMOD substitutes a 0˚K exhaust temperature with the hourly ambient temperature provided in the meteorological data for dispersion calculations.

All process fugitive sources without a stack (e.g., crushing) were characterized as VOLUME sources. The initial lateral and vertical dispersion parameters were calculated based on approximate source dimensions and coefficients provided in EPA guidance.[2]

Emissions from underground mining activities were characterized as a single POINT source located at and assuming the stack parameters of the mine ventilation exhaust vent.

Aboveground road-way emissions from on-site hauling and water truck activity were characterized as LINE sources. The sources' release heights were based on the mobile equipment heights, and the sources' width based on planned road widths.

Several fugitive emissions sources were characterized as AREA sources, including: wind erosion emissions at the topsoil storage locations; general mining activity across the borrow site; and Hazardous Air Pollutants (HAPs) emissions from the tailings management facility, a tailings pond, and the carbon-in-leach and cyanide detoxification tanks. For these sources whose emission location extents are not rectangular, the AREA sources were characterized as rectangular approximations of the locations.

The model input parameters for each source are presented in 3.4Appendix A, and the modeled emission are summarized in 3.4Appendix B. A facility plot plan showing the project boundary and layout of sources is provided in Figure 2.

For references and additional details regarding source characterization, the reader is referred to Attachment A of the Grassy Mountain Mine Standard Air Contaminant Discharge Permit Application (August 2019).

2.5 Coordinate System

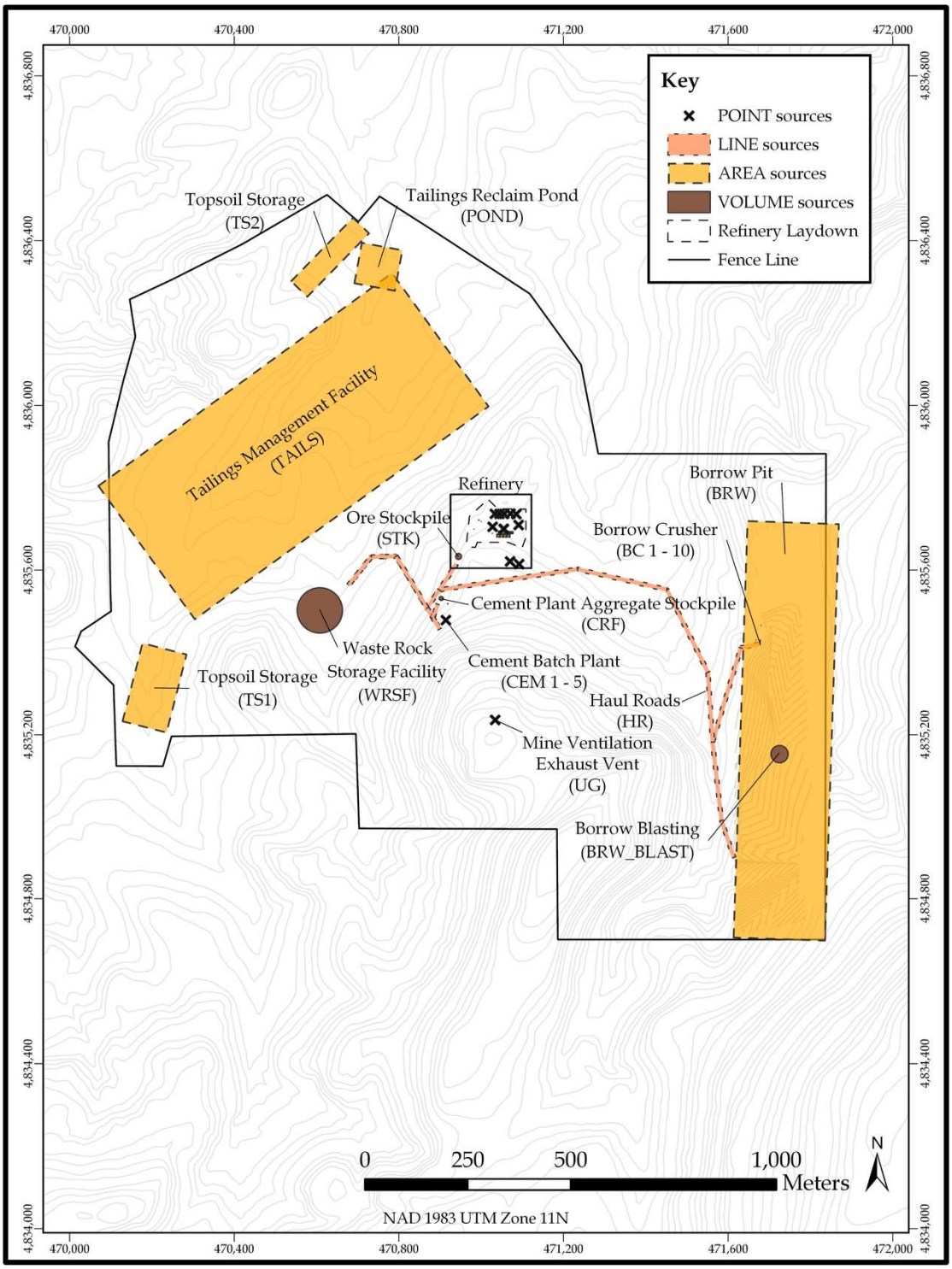
The Universal Transverse Mercator (UTM) coordinate system projected in North American Datum of 1983 (NAD83), Zone 11, was used in this modeling analysis to define all locations in the modeling domain (sources, buildings, and receptors).

[2] EPA. 2016. User's Guide for the AMS/EPA Regulatory Model (AERMOD). EPA-454/B-16-011. December 2016.

2.6 Building Downwash

The effects of the building-induced downwash were incorporated into this modeling analysis. The building downwash parameters were calculated using the Building Profile Input Program (BPIP) with the Plume Rise Model Enhancement (PRIME) algorithm (BPIP-PRIME version 04274). The building parameters used in the modeling are provided in a BPIP-ready format in Appendix C.

Figure 2. Model Source Locations for Grassy Mountain Mine Facility



2.7 Receptors

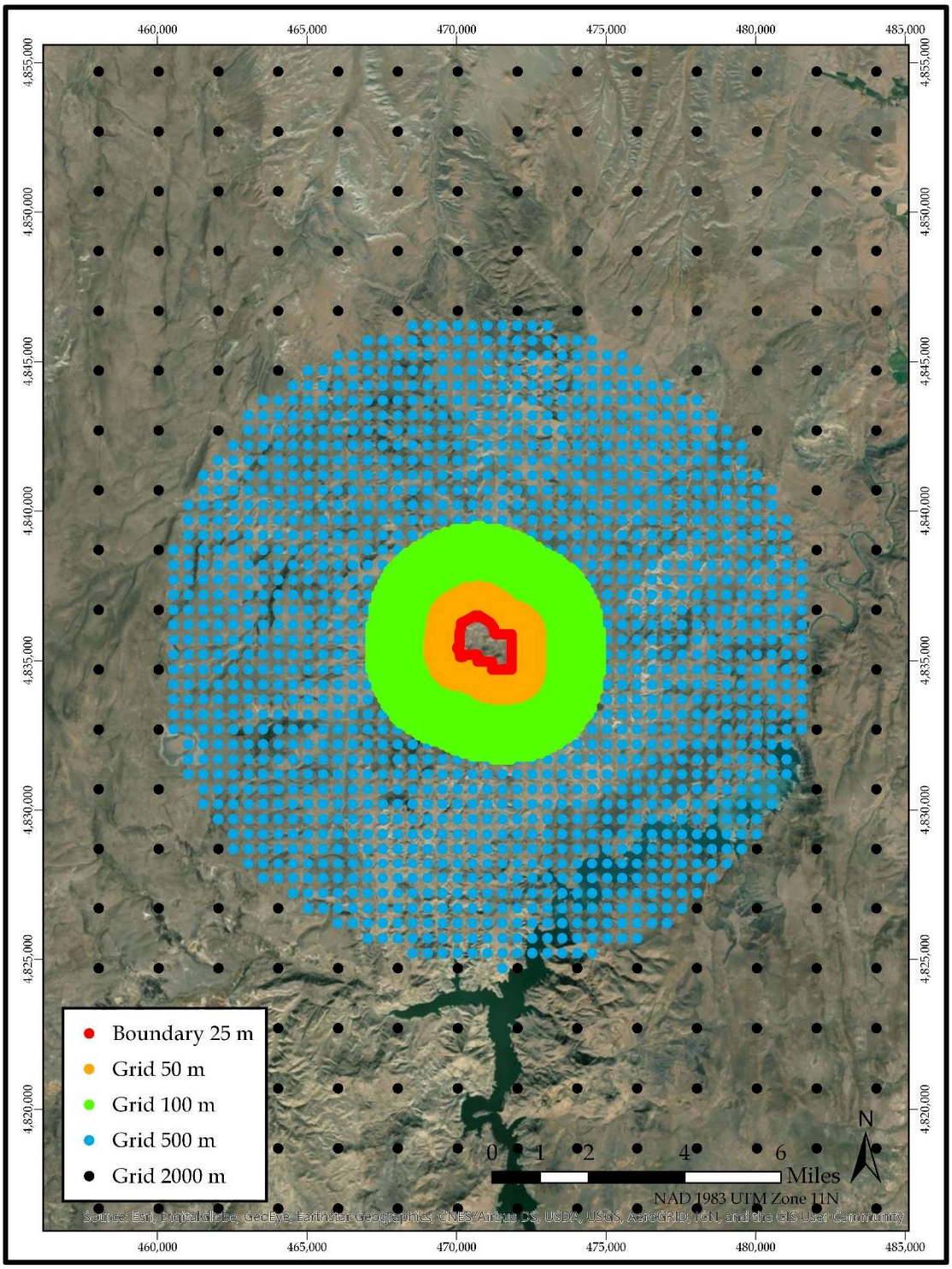
A series of nested Cartesian receptor grids were used to assess ground-level impacts from the facility air emissions:

- Boundary line receptors at 25-meter spacing
- Gridded receptors at 50-meter spacing out to 2 kilometers from the modeling boundary
- Gridded receptors at 100-meter spacing out to 5 kilometers from the modeling boundary
- Gridded receptors at 500-meter spacing to 10 kilometers from the modeling boundary
- Gridded receptors at 2-kilometer spacing to 50 kilometers from the modeling boundary

All of the above grids were centered on the facility. Receptors within the project boundary were not modeled. The receptor locations are shown in Figure 3. Additional receptors were modeled for the risk assessment, and are discussed in the Risk Assessment Work Plan.

All receptors were processed with the AERMOD terrain preprocessor (AERMAP, version 11103) to generate receptor terrain elevations and hill height values using the one-third-arc-second (10-meter) resolution United States Geographical Survey National Elevation Dataset (NED) files.

Figure 3. Receptor Locations



2.8 Meteorological Data

This air quality analysis was conducted using one year (2014/10/1–2015/9/30) of site-specific hourly meteorological data. The meteorological data were collected at the Calico-Vale meteorological station as part of the Air Quality Baseline study for the facility project area (Baseline Study)[3]. The site is located approximately four kilometers west of the facility project area, as shown in Figure 4. A wind frequency distribution diagram (wind rose) for the meteorological data is presented in Figure 5. The data quality meets or exceeds all specifications described in the Environmental Protection Agency's (EPA's) Meteorological Monitoring Guidance for Regulatory Modeling Applications[4].

The data set was processed with AERMET version 18081, supplemented with upper-air data from Boise, ID, and National Weather Service (NWS) surface station data, including cloud cover, from Ontario, OR. The processing included the AERMET stage 3 adjusted surface friction velocity option (ADJ_U*).

[3] EM Strategies. 2018. Grassy Mountain Mine Project Air Quality Resources Baseline Report. January, 2018.

[4] EPA. 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA-454/R-9905. February, 2000.

Figure 4. Calico-Vale Meteorological Tower Location

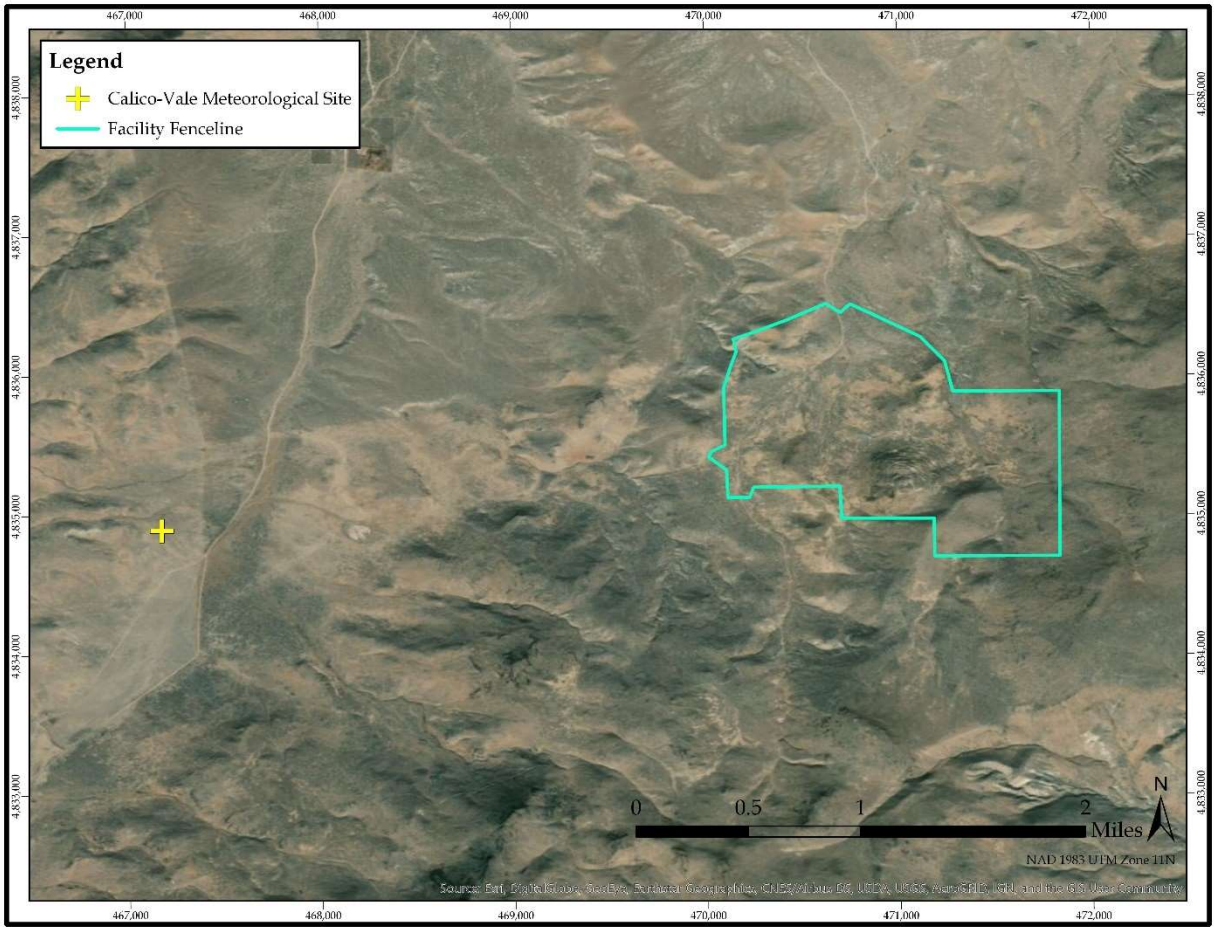
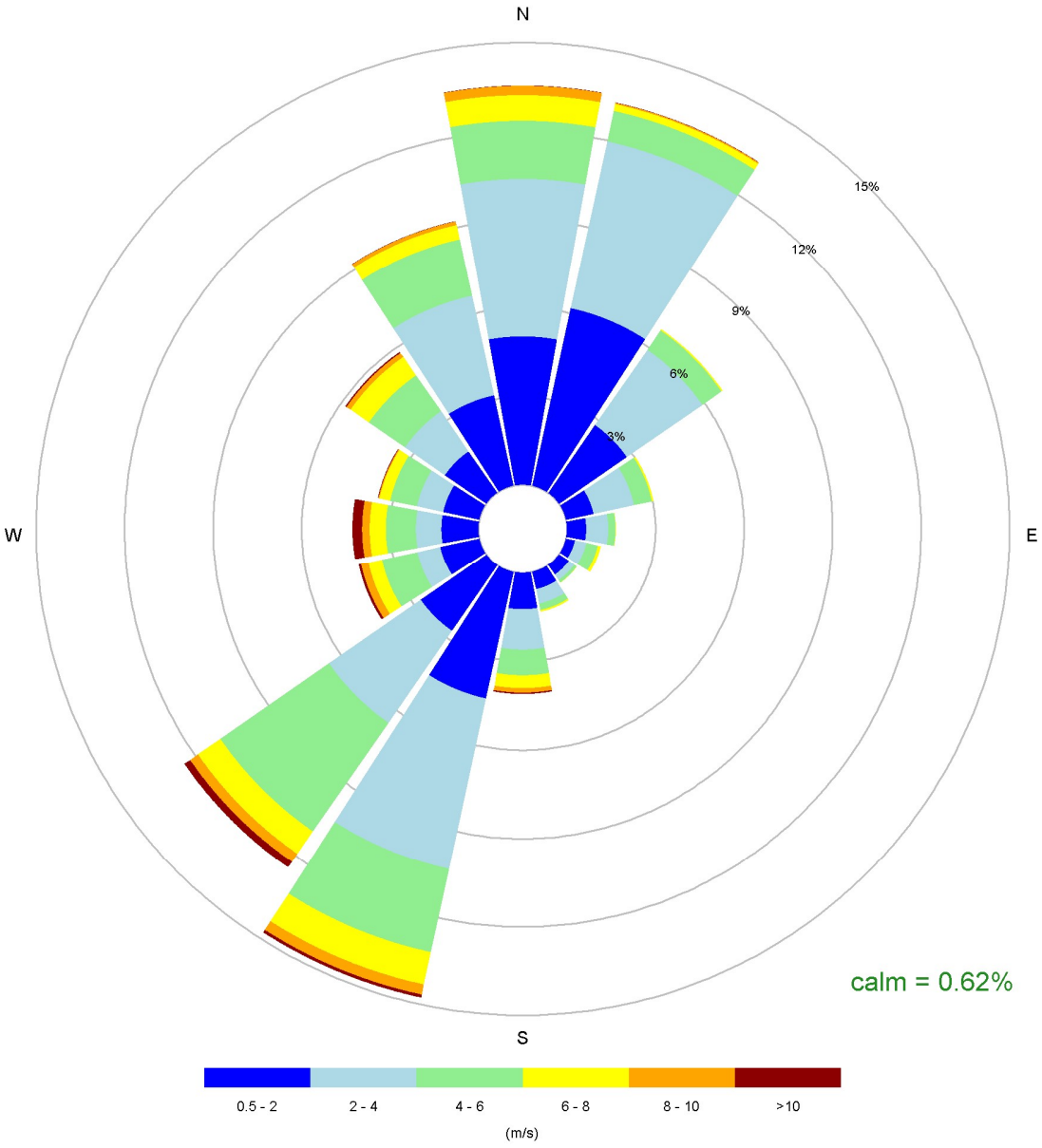


Figure 5. Wind rose for the Calico-Vale Meteorological Station



2.9 Background Concentrations

A background concentration was added to the modeled PM_{10} concentrations to account for the prevailing air pollution in the modeling domain before comparison with standard for the NAAQS compliance demonstration. The Baseline Study included monitoring PM_{10} and determining a background concentration as the second highest concentration Oct. 2014 – Sept. 2015 period, excluding periods affected by wildfires[5]. The background concentration used is presented in Table 2.

Table 2. Background Concentration

Pollutant	Averaging Period	Form	Background Concentration (µg/m³)
PM_{10}	24-Hour	2nd High	23.0

2.10 NAAQS Modeling Methodology

Regulatory default options in AERMOD were used to estimate the ground-level concentrations for the PM_{10} standard.

2.11 NAAQS Modeling Results

A summary the results of NAAQS modeling demonstration is provided in Table 3. The total PM_{10} concentrations (modeled plus background) are below the PM_{10} 24-hour NAAQS.

Table 3. NAAQS Modeling Results Summary

Pollutant	Averaging Period	Form	Background Concentration (µg/m³)	Modeled Concentration (µg/m³)	Total Concentration (µg/m³)	Standard (µg/m³)
PM_{10}	24-Hour	Highest 2nd High	23	20.6	43.6	150

[5] EM Strategies. 2018. Grassy Mountain Mine Project Air Quality Resources Baseline Report. January, 2018.

3.0 RISK ASSESSMENT WORK PLAN

3.1 Level 3 Risk Assessment

As part of the application for the Standard ACDP, a Level 3 Risk Assessment was performed for the facility. The Risk Assessment used many of the same modeling procedures described in the Modeling Protocol, including source characterization, meteorology, and receptor grids. For the Level 3 Risk Assessment, this Risk Assessment Work Plan provides additional information regarding a conceptual site model for exposure, the exposure assessment and risk characterization, and an uncertainty evaluation.

3.2 Conceptual Site Model

3.2.1 Toxic Emissions

For the risk assessment, toxic emissions impacting the inhalation pathway are expected to occur from the following facility activities described in Section 1.1:

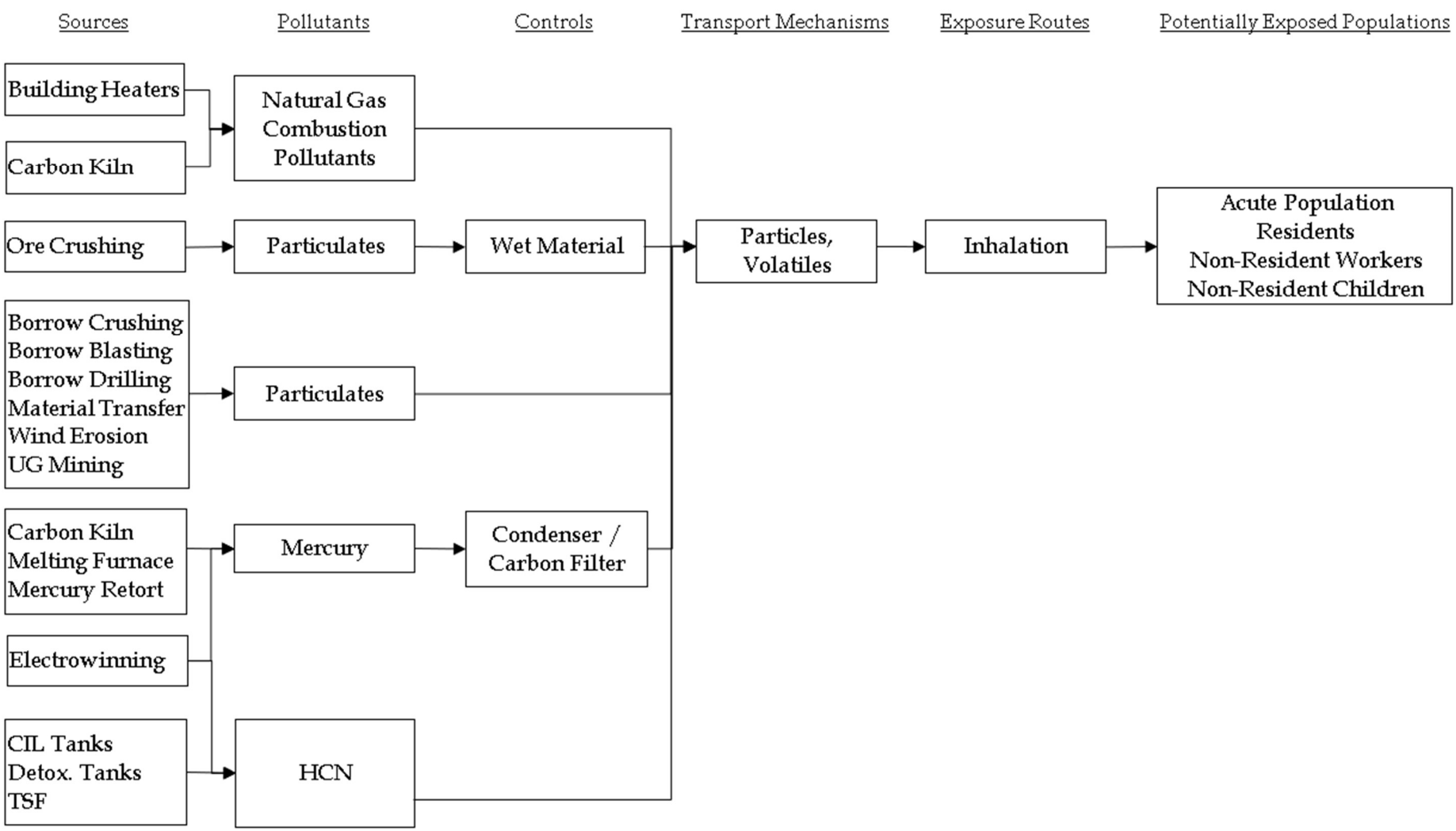
- Propane combustion, including combustion at the carbon regeneration kiln and assuming all building heaters are propane fired
- Toxic pollutants found in the dust emitted from site activities, including ore and waste rock crushing, rock drilling, rock blasting, material transfers, and wind erosion
- Mercury emissions from the following process sources: kiln, electrowinning circuit, mercury retort, and melting furnace
- Hydrogen cyanide emissions from CIL tanks, cyanide detoxification tanks, and the tailings management facility

A summary of facility-wide potential emissions of HAPs is provided in Table 4. Potential emissions of HAPs by individual TEU are provided in 3.4Appendix D. Detailed emissions calculations for are provided as Form AQ405CAO and in the emissions inventory. The conceptual site model for the CAO is summarized in Figure 6.

Table 4. Facility-Wide Potential Emissions of HAPs

HAP	Facility Total	
	(ton/year)	(pound/day)
1,3-Butadiene	7.34E-06	3.52E-03
Acetaldehyde	4.21E-04	7.06E-02
Acrolein	1.83E-04	9.24E-03
Antimony and compounds	1.98E-04	1.46E-03
Arsenic and compounds	1.65E-03	1.24E-02
Barium and compounds	1.64E-04	9.01E-04
Benzene	2.54E-04	8.45E-02
Beryllium and compounds	4.76E-06	3.37E-05
Cadmium and compounds	4.36E-05	2.44E-04
Chromium VI, chromate, and dichromate particulate	2.00E-04	1.37E-03
Cobalt and compounds	2.39E-05	1.74E-04
Copper and compounds	3.18E-05	1.74E-04
Cyanide, Hydrogen	2.85E+00	1.56E+01
Diesel Particulate Matter	8.82E-03	4.23E+00
Ethyl benzene	8.41E-05	4.61E-04
Formaldehyde	3.02E-03	1.22E-01
Hexane	6.72E-02	3.68E-01
Lead and compounds	5.60E-05	4.19E-04
Manganese and compounds	6.26E-04	4.64E-03
Mercury and compounds	1.64E-03	9.02E-03
Naphthalene	2.28E-05	1.25E-04
Nickel and compounds	1.13E-04	6.86E-04
p-Dichlorobenzene	4.48E-05	2.46E-04
Polycyclic aromatic hydrocarbons (PAHs)	3.48E-05	1.52E-02
Propylene	6.09E-03	3.34E-02
Selenium and compounds	8.97E-07	4.91E-06
Toluene	2.04E-04	3.76E-02
Vanadium (fume or dust)	8.59E-05	4.71E-04
Xylene (mixture)	4.27E-04	2.77E-02
Zinc and compounds	1.08E-03	5.94E-03

Figure 6. CAO Conceptual Site Model Diagram



3.2.2 Exposure Locations

For the risk assessment, the gridded receptors presented in Section 2.7 were compared with land use data to determine which receptor s represent the following types of locations (and potentially exposed population types):

- Acute open space (acute population)
- Residential (residents)
- Commercial (non-resident workers)
- Schools (non-resident children)

The classification of the receptors within the gridded receptor networks in shown in Figure 7.

In addition, receptors were modeled to represent specific population locations, including the closest campgrounds, residences, businesses, and schools. These specific receptors are listed and in Table 5 and the locations are shown in Figure 8.

Table 5. Specific Population Receptors for the CAO Risk Assessment

Receptor	Northing	Easting	Classification
Campground	480,119	4,833,116	Acute open space
Campground 2	479,233	4,834,611	Acute open space
Residential 1	481,167	4,835,722	Residential
Residential 2	484,473	4,838,898	Residential
Residential 3	486,593	4,842,860	Residential
Residential 4	485,667	4,843,772	Residential
Occupational 1	467,702	4,839,557	Commercial
Occupational 2	474,243	4,839,495	Commercial
Occupational 3	466,287	4,829,471	Commercial
School 1	451,130	4,857,129	School
School 2	480,485	4,869,487	School
School 3	494,402	4,843,162	School

For those receptors classified as representing any potential exposure population, the acute exposure hazard was calculated. Additionally, chronic cancer and chronic non-cancer risks were calculated for those receptors representing residents, non-resident workers, and non-resident children. A description of the risk calculation is provided in Section 3.3.

Figure 7. Gridded Receptor Classifications

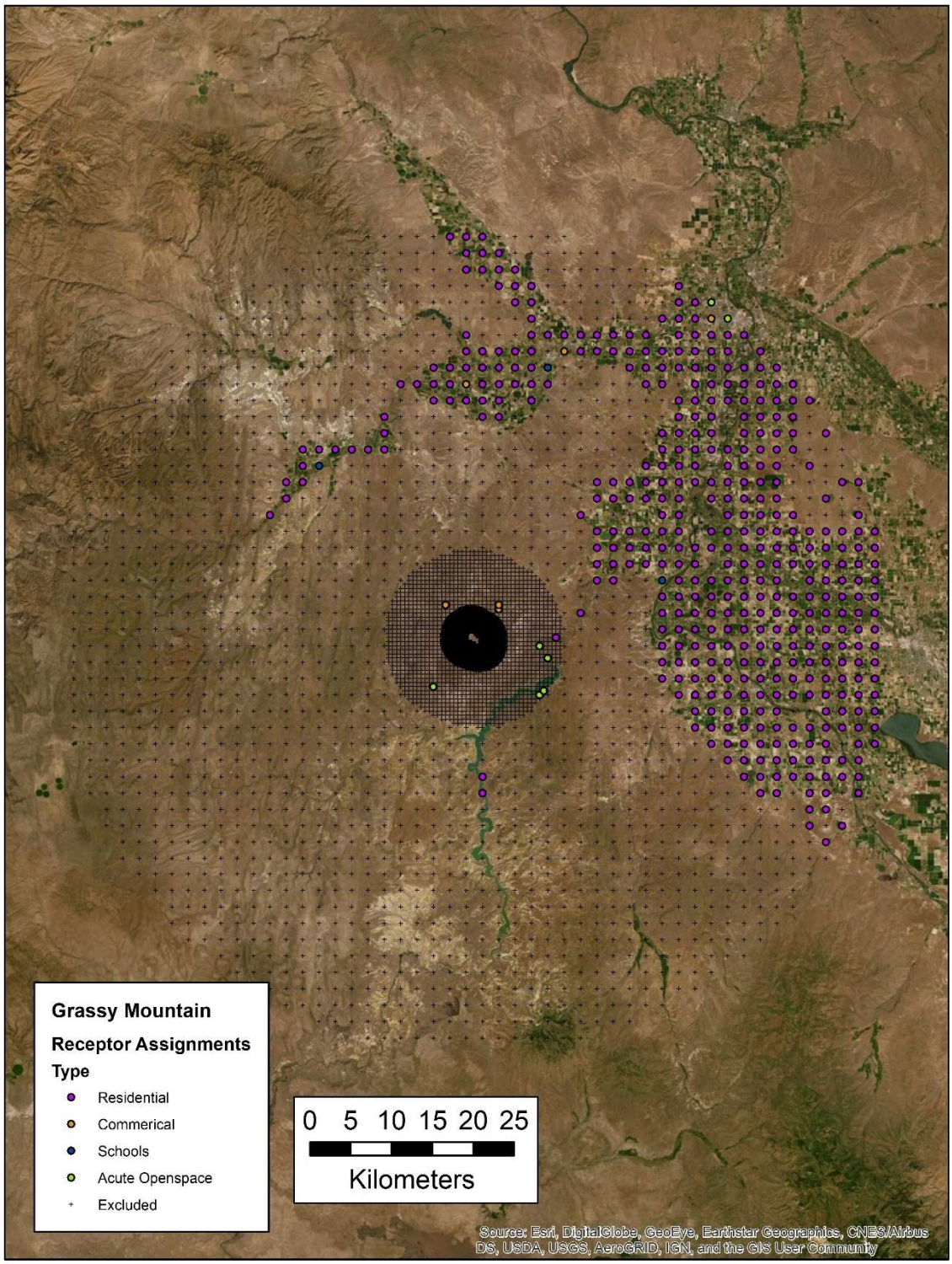
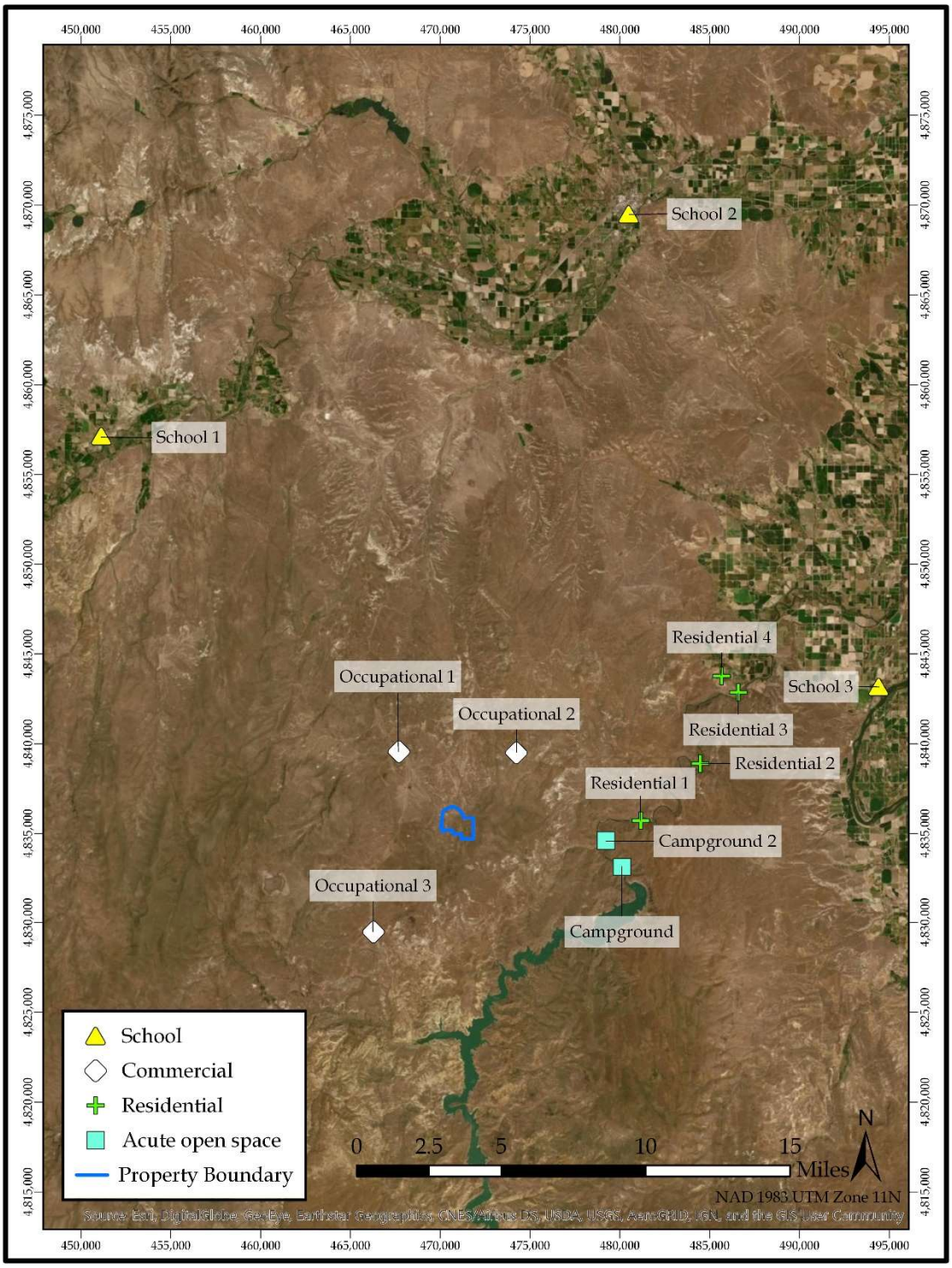


Figure 8. Specific Population Receptors



3.3 Exposure Assessment and Risk Characterization

Concentrations of each of the emitted HAPs listed in Table 4 were estimated using AERMOD modeling, as described in Section 3.3.1. Once concentrations were produced for each pollutant at the receptors, they were used along with the Risk-Based Concentrations (RBCs) provided in the OAR[6] to estimate the potential risks at the exposure locations as described in Section 3.3.2.

3.3.1 Exposure Assessment

AERMOD modeling for the Level 3 risk assessment used the same source characterizations, building downwash parameters, and meteorological data as described in the Modeling Report.

For the CAO risk assessment modeling, each Toxic Emissions Unit (TEU), as presented in the CAO form AQ405.2, was modeled at a unit emission rate (i.e., one gram per sec, or 1 g/s). Some TEU's in AQ405.2 represent multiple AERMOD sources. Those sources were aggregated into source groups, using the SRCGROUP cards in AERMOD, with each group representing a single TEU. Each group was modeled with a 1 g/s emission rate, allocated among the associated sources based on relative activity. A list of the proposed TEU's, associated model sources, and allocation percentages is provided in Table 6 and again in 3.4Appendix D for convenience.

For example, CAO HAPs emissions are calculated for Ore Crushing circuit source group (OC), based on the estimated total particulate matter (PM) emitted. Modeled sources for the OC group include sources OC1 through OC13, which represent individual material transfers and crusher emissions, and the PM emissions from each source are calculated for the emissions inventory. In the CAO model, the emission rates for OC1 through OC13 sum to the unit emission rate of 1 g/s, allocated to the thirteen specific sources based on the portion of PM emitted by each source. In Table 6, OC8 is shown to have an allocation of 20.0%, the percentage of the OC group PM emissions. In the CAO AERMOD modeling, then, OC8 will be modeled with a 0.200 g/s emission rate.

The maximum, time-independent concentrations for each TEU's source group were output into AERMOD plot files for both daily and annual averaging periods. The daily plot files are used for the acute exposure analysis, and the annual plot files are used for the chronic cancer and chronic non-cancer exposure analyses. The groups' concentrations were multiplied by the appropriate CAO emissions for each TEU and pollutant, as presented in CAO form AQ405.3.

[6] OAR 340-245-8040, Table 4.

Table 6. TEU Modeling Sources and Allocation

TEU / SRCGROUP	SOURCE	Allocation
OC	OC1	2.3%
	OC2	2.3%
	OC3	20.0%
	OC4	2.3%
	OC5	2.3%
	OC6	2.3%
	OC7	36.7%
	OC8	20.0%
	OC9	2.3%
	OC10	2.3%
	OC11	2.3%
	OC12	2.3%
	OC13	2.3%
BC	BC1	5.3%
	BC2	5.3%
	BC3	9.5%
	BC4	5.3%
	BC5	5.3%
	BC6	5.3%
	BC7	44.0%
	BC8	9.5%
	BC9	5.3%
	BC10	5.3%
CKB	CKB	100%
MR	MF	100%
EDG1	EDG1	100%
HA	HA	100%
HPO	HPO	100%
HL	HL	100%
HWW	HWW	100%
HTW	HTW	100%
HMO	HMO	100%
UFD	UG	100%
AFD	BRW	67.3%
	BRW_BLAST	4.3%
	STK	10.7%
	WRSF	11.0%
	CRF	5.1%
	TS1	1.2%
	TS2	0.5%
TAILS	TAILS	100%
POND	POND	100%
DETOX1	DETOX1	100%
DETOX2	DETOX2	100%
CILTANK1	CILTANK1	100%
CILTANK2	CILTANK2	100%
CILTANK3	CILTANK3	100%
CILTANK4	CILTANK4	100%
CILTANK5	CILTANK5	100%
CILTANK6	CILTANK6	100%
CILTANK7	CILTANK7	100%

The concentrations from all TEU's were summed, without pairing the concentrations in time, to produce total concentrations for each pollutant at each receptor for the CAO Level 3 analysis and risk assessment. This approach to the Level 3 analysis is conservative since it overestimates total acute exposure: the maximum exposure from each TEU is considered, even if those maximums did not occur in the same modeled day. This approach also reduces the number of models to be performed and reviewed.

3.3.2 Risk Characterization

Each TEU's risk at each receptor was calculated by dividing a TEU's pollutants' concentrations by the appropriate RBCs, then summing across all pollutants' risk. The total risk at each receptor will be calculated by summing all TEUs' risks.

The risk at each receptor from a single TEU ($R_{r,t}$) is given by:

$$R_{r,t} = X_{r,t} \sum_{p} \frac{Q_{p,t}}{RBC_{p,L(r)}}$$

where $X_{r,t}$ is the unit concentration for TEU t at receptor r, $Q_{p,t}$ is the emission rate (lb/day or lb/year) of pollutant p from TEU t, and $RBC_{p,L(r)}$ is the RBC for pollutant p and exposure location type L at the receptor r.

The total risk at the receptor, R_r, is the sum of each TEU's risk at the receptor:

$$R_r = \sum_{t} R_{r,t}$$

Each receptor has three risk values: chronic cancer risk, chronic non-cancer risk, and acute risk. For informational purposes, the chronic risk values are grouped by exposure location type (residents, non-resident workers, and non-resident children). This results in seven risk levels being determined.

The risk values are compared to the appropriate new facility Risk Action Levels (RALs), shown in Table 7.

Table 7. Risk Action Levels

Risk Action Level	Cancer	Non-Cancer
Source Permit Level	0.5	0.5
Community Engagement Level	5	1
TBACT Level	10	1
Permit Denial Level	25	1

3.3.1 Risk Assessment Results

The summary of the results of the Level-3 Risk Assessment for the facility are provided in Table 8. The risks shown represent the highest of each category type calculated at any modeled receptor, the RAL associated with that calculated risk, and the threshold for the associated RAL. The assessment demonstrates that the Source Permit Level is the appropriate RAL for the facility.

Table 8. Risk Assessment Results Summary

Risk Category	Maximum Calculated Risk	RAL	RAL Threshold
Residential Chronic Cancer	0.066	Source Permit Level	0.5
Non-Residential Chronic Child Cancer	0.000	Source Permit Level	0.5
Non-Residential Chronic Worker Cancer	0.031	Source Permit Level	0.5
Residential Chronic Non-Cancer	0.011	Source Permit Level	0.5
Non-Residential Chronic Child Non-Cancer	0.000	Source Permit Level	0.5
Non-Residential Chronic Worker Non-Cancer	0.015	Source Permit Level	0.5
Acute Non-Cancer	0.003	Source Permit Level	0.5

3.4 Uncertainty Evaluation

Several sources of uncertainty exist within the risk assessment, including,

- Uncertainty in emission factors
- Uncertainty in the existing RBC
- Uncertainty in AERMOD model performance

The Level-3 assessment includes several layers of expected overestimation of risk, including,

- Conservatively high emission factors for the PM emissions (a primary source of HAPs)
- Conservatively high activity estimates for facility emissions
- The time-independent summation of TEU impacts
- AERMOD's well-documented bias toward overprediction[7]

Given the source of known overestimation in the Level-3 assessment and the relatively low risks compared to the RALs, it is reasonable to conclude that the outcome of the risk assessment (Source Permit Level) is appropriate for the facility.

[7] See, e.g., EPA. 2018. Environmental Protection Agency, "AERMOD Model Formulation and Evaluation." EPA-454/R-18-2003. April, 2018.

Appendix A – Model Source Parameters

Table A-1. AERMOD POINT Source Parameters

Model ID	Description	UTM E. (m)	UTM N. (m)	Elev. (m)	Rel. Ht. (m)	T (K)	Vel. (m/s)	Dia. (m)
LS1	Lime Silo Loading	471,091.16	4,835,709.46	1130.81	13.41	0	30.48	0.15
CKD	Carbon Regeneration Kiln (Drum)	471,054.46	4,835,699.94	1130.81	5.52	338.71	3.09	0.15
CKB	Carbon Regeneration Kiln (Burners)	471,055.46	4,835,699.94	1130.81	12.19	699.82	22.46	0.15
MF	Induction Melting Furnace	471,027.90	4,835,705.04	1130.81	5.43	338.71	30.40	0.30
LABSP	Sample Preparation	471,071.49	4,835,736.88	1134.10	7.24	0	4.15	0.76
LABFA	Fire Assay	471,071.49	4,835,736.88	1134.10	7.24	0	4.15	0.76
EDG1	Emergency Generator (Mfr. Yr. >2007; diesel)	471,044.72	4,835,736.46	1134.19	3.05	727.59	28.82	0.20
HA	Administration HVAC	471,033.34	4,835,736.46	1133.84	8.32	455.37	0.17	1.13
HPO	Plant Office and Dry HVAC	471,056.10	4,835,736.46	1134.33	8.32	455.37	0.17	1.13
HL	Laboratory HVAC	471,071.49	4,835,736.88	1134.10	8.24	455.37	0.17	1.13
HWW	Plant Workshop and Warehouse HVAC	471,085.50	4,835,736.03	1133.68	8.32	455.37	0.17	1.13
HTW	Truck Workshop and Warehouse HVAC	471,070.38	4,835,621.18	1140.58	16.24	455.37	0.34	1.13
HMO	Mine Office and Changehouse HVAC	471,092.36	4,835,614.52	1140.69	8.41	455.37	0.17	1.13
CEM1	Cement/Shotcrete loading to silo	470,914.33	4,835,478.67	1141.73	13.41	255.37	30.48	0.15
UG	Underground	471,034.00	4,835,236.00	1209.00	3.00	298.15	7.07	6.78

Table A-2. AERMOD VOLUME Source Parameters

Model ID	Description	UTM E. (m)	UTM N. (m)	Elev. (m)	Rel. Ht. (m)	$\sigma_{y,0}$ (m)	$\sigma_{z,0}$ (m)
OC1	Dump of Ore to Ore Surge Bin	470,980.13	4,835,654.85	1,137.93	6.11	0.40	2.51
OC2	Surge Bin to Vibrating Grizzly Transfer	470,980.13	4,835,658.85	1,137.77	3.75	0.13	0.28
OC3	Primary Crusher (including transfers in and out)	470,980.13	4,835,661.24	1,137.77	2.67	0.17	0.50
OC4	Crusher Discharge Conveyor Transfer Point	470,980.13	4,835,663.76	1,137.77	2.62	0.17	0.23
OC5	Screen Feed Conveyor 1 Transfer Point	470,980.13	4,835,663.76	1,137.77	0.91	0.11	0.28
OC6	Screen Feed Conveyor 2 Transfer Point	470,980.13	4,835,663.76	1,137.77	3.78	0.11	0.23
OC7	Screen (including transfers in and out)	470,980.13	4,835,663.76	1,137.77	3.15	0.21	0.92
OC8	Cone Crusher (including transfers in and out)	470,980.13	4,835,661.24	1,137.77	3.67	0.14	0.44
OC9	Screen Discharge Conveyor Transfer to Stockpile Conveyor	470,969.93	4,835,663.76	1,137.77	2.07	0.17	0.37
OC10	Ore Stockpile Conveyor Transfer to Ore Stockpile	470,982.41	4,835,699.42	1,137.77	7.50	0.17	1.25
OC11	Load Reclaim Hopper	470,994.26	4,835,721.29	1,137.77	5.12	0.57	1.62
OC12	Reclaim Hopper to Ball Mill Feed Conveyor Transfer	470,999.86	4,835,717.64	1,137.77	2.76	0.14	1.03
OC13	Ball Mill Feed Conveyor to Ball Mill Transfer	471,027.30	4,835,689.08	1,130.81	6.87	0.24	1.09
BC1	Dump of Borrow to Surge Bin	471,677.83	4,835,421.21	1,162.61	6.11	0.40	2.51
BC2	Surge Bin to Vibrating Grizzly Transfer	471,677.83	4,835,425.21	1,161.78	3.75	0.13	0.28
BC3	Primary Crusher (including transfers in and out)	471,677.83	4,835,427.60	1,161.28	2.67	0.17	0.50
BC4	Crusher Discharge Conveyor Transfer Point	471,677.83	4,835,430.12	1,160.76	2.62	0.17	0.23
BC5	Screen Feed Conveyor 1 Transfer Point	471,677.83	4,835,430.12	1,160.76	0.91	0.11	0.28
BC6	Screen Feed Conveyor 2 Transfer Point	471,677.83	4,835,430.12	1,160.76	3.78	0.11	0.23
BC7	Screen (including transfers in and out)	471,677.83	4,835,430.12	1,160.76	3.15	0.21	0.92
BC8	Cone Crusher (including transfers in and out)	471,677.83	4,835,427.60	1,161.28	3.67	0.14	0.44
BC9	Screen Discharge Conveyor Transfer to Stockpile Conveyor	471,667.63	4,835,430.12	1,160.04	2.07	0.17	0.37
BC10	Ore Stockpile Conveyor Transfer to Borrow Stockpile	471,680.12	4,835,465.77	1,160.95	7.50	0.17	1.25
LS2	Lime Silo Unloading to Lime Slaker	471,083.54	4,835,702.30	1,130.81	1.14	0.17	1.06
CEM2	Cement/Shotcrete unloading to batch plant	470,918.73	4,835,517.90	1,141.73	1.14	0.17	1.06
CEM3	Aggregate transfer	470,918.73	4,835,517.90	1,141.73	1.86	0.59	1.73
CEM4	Weigh hopper loading	470,918.73	4,835,517.90	1,141.73	1.86	0.59	1.73
CEM5	Mixer loading (central mix)	470,918.73	4,835,517.90	1,141.73	1.86	0.59	1.73
BRW_BLAST	Borrow Blasting	471,725.00	4,835,153.00	1,185.27	75.00	20.93	34.88
WRSF	WRSF	470,608.00	4,835,502.00	1,113.73	2.27	55.08	2.11
STK	Ore Stockpile	470,945.00	4,835,633.00	1,137.03	2.27	7.25	2.11
CRF	CRF Stockpile	470,903.00	4,835,531.00	1,140.34	2.27	4.91	2.11

Table A-3. AERMOD AREA Source Parameters

Model ID	Description	UTM E. (m)	UTM N. (m)	Elev. (m)	Rel. Ht. (m)	X_0 (m)	Y_0 (m)	$\sigma_{z,0}$ (m)
BRW	Borrow	471,613.41	4,834,705.82	1,185.27	2.27	222.05	1,013.59	1.91
TS1	Topsoil Storage 1	470,128.59	4,835,232.66	1,108.38	0.00	110.43	195.65	14.35
TS2	Topsoil Storage 2	470,538.36	4,836,301.43	1,083.58	0.00	54.43	215.22	44.30
TAILS	Tailings Storage Facility	470,069.82	4,835,804.30	1,103.38	0.00	399.81	881.07	54.10
POND	Tailings Pipeline Reclaim Pond	470,691.92	4,836,296.31	1,076.06	0.00	100.00	100.00	10.50
DETOX1	CN Detoxification Tank 1	471,067.37	4,835,688.68	1,130.81	5.84	4.21	4.21	0.00
DETOX2	CN Detoxification Tank 2	471,072.85	4,835,688.68	1,130.81	5.84	4.21	4.21	0.00
CILTANK1	CIL Tank 1	471,038.40	4,835,680.29	1,130.81	7.80	6.37	6.37	0.00
CILTANK2	CIL Tank 2	471,042.51	4,835,687.60	1,130.81	7.80	6.37	6.37	0.00
CILTANK3	CIL Tank 3	471,046.63	4,835,680.29	1,130.81	7.80	6.37	6.37	0.00
CILTANK4	CIL Tank 4	471,050.74	4,835,687.60	1,130.81	7.80	6.37	6.37	0.00
CILTANK5	CIL Tank 5	471,054.86	4,835,680.29	1,130.81	7.80	6.37	6.37	0.00
CILTANK6	CIL Tank 6	471,058.97	4,835,687.60	1,130.81	7.80	6.37	6.37	0.00
CILTANK7	CIL Tank 7	471,063.09	4,835,680.29	1,130.81	7.80	6.37	6.37	0.00

Table A-4. AERMOD LINE Source Locations

Route	Model ID	X1	Y1	X2	Y2	Elev. (m)
Portal Cut to WRSF	HR_POR_WRF1	470,899.15	4,835,456.84	470,882.68	4,835,484.36	1,145.72
	HR_POR_WRF2	470,882.68	4,835,484.36	470,868.72	4,835,507.67	1,139.93
	HR_POR_WRF3	470,868.72	4,835,507.67	470,793.34	4,835,633.62	1,127.30
	HR_POR_WRF4	470,793.34	4,835,633.62	470,732.85	4,835,631.70	1,114.15
	HR_POR_WRF5	470,732.85	4,835,631.70	470,677.88	4,835,563.65	1,110.32
Portal Cut to Ore Stockpile	HR_POR_ORE1	470,899.15	4,835,456.84	470,882.68	4,835,484.36	1,145.72
	HR_POR_ORE2	470,882.68	4,835,484.36	470,868.72	4,835,507.67	1,139.93
	HR_POR_ORE3	470,868.72	4,835,507.67	470,939.99	4,835,614.43	1,137.82
South Entrance Borrow to WRSF	HR_BWS_WRF1	471,613.97	4,834,902.04	471,584.03	4,834,992.14	1,172.41
	HR_BWS_WRF2	471,584.03	4,834,992.14	471,562.21	4,835,182.20	1,158.90
	HR_BWS_WRF3	471,562.21	4,835,182.20	471,550.93	4,835,351.66	1,149.58
	HR_BWS_WRF4	471,550.93	4,835,351.66	471,451.28	4,835,552.61	1,140.36
	HR_BWS_WRF5	471,451.28	4,835,552.61	471,233.88	4,835,601.96	1,133.31
	HR_BWS_WRF6	471,233.88	4,835,601.96	470,898.18	4,835,551.79	1,135.69
	HR_BWS_WRF7	470,898.18	4,835,551.79	470,868.72	4,835,507.67	1,137.56
	HR_BWS_WRF8	470,868.72	4,835,507.67	470,793.34	4,835,633.62	1,127.30
	HR_BWS_WRF9	470,793.34	4,835,633.62	470,732.85	4,835,631.70	1,114.15
	HR_BWS_WRF10	470,732.85	4,835,631.70	470,677.88	4,835,563.65	1,110.32
North Entrance Borrow to WRSF	HR_BWN_WRF1	471,677.83	4,835,421.21	471,630.99	4,835,410.94	1,160.96
	HR_BWN_WRF2	471,630.99	4,835,410.94	471,562.21	4,835,182.20	1,155.40
	HR_BWN_WRF3	471,562.21	4,835,182.20	471,550.93	4,835,351.66	1,149.58
	HR_BWN_WRF4	471,550.93	4,835,351.66	471,451.28	4,835,552.61	1,140.36
	HR_BWN_WRF5	471,451.28	4,835,552.61	471,233.88	4,835,601.96	1,133.31
	HR_BWN_WRF6	471,233.88	4,835,601.96	470,898.18	4,835,551.79	1,135.69
	HR_BWN_WRF7	470,898.18	4,835,551.79	470,868.72	4,835,507.67	1,137.56
	HR_BWN_WRF8	470,868.72	4,835,507.67	470,793.34	4,835,633.62	1,127.30
	HR_BWN_WRF9	470,793.34	4,835,633.62	470,732.85	4,835,631.70	1,114.15
	HR_BWN_WRF10	470,732.85	4,835,631.70	470,677.88	4,835,563.65	1,110.32
WRSF to Portal Cut	HR_WRF_POR1	470,677.88	4,835,563.65	470,732.85	4,835,631.70	1,110.32
	HR_WRF_POR2	470,732.85	4,835,631.70	470,793.34	4,835,633.62	1,114.15
	HR_WRF_POR3	470,793.34	4,835,633.62	470,868.72	4,835,507.67	1,127.30
	HR_WRF_POR4	470,868.72	4,835,507.67	470,882.68	4,835,484.36	1,139.93
	HR_WRF_POR5	470,882.68	4,835,484.36	470,899.15	4,835,456.84	1,145.72
WRSF to CRF Stockpile	HR_WRF_CRF1	470,677.88	4,835,563.65	470,732.85	4,835,631.70	1,110.32
	HR_WRF_CRF2	470,732.85	4,835,631.70	470,793.34	4,835,633.62	1,114.15
	HR_WRF_CRF3	470,793.34	4,835,633.62	470,868.72	4,835,507.67	1,127.30
	HR_WRF_CRF4	470,868.72	4,835,507.67	470,882.68	4,835,484.36	1,139.93
	HR_WRF_CRF5	470,882.68	4,835,484.36	470,894.69	4,835,516.89	1,141.56
CRF Stockpile to Portal Cut	HR_CRF_POR1	470,894.69	4,835,516.89	470,882.68	4,835,484.36	1,141.56
	HR_CRF_POR2	470,882.68	4,835,484.36	470,899.15	4,835,456.84	1,145.72

Table A-5. AERMOD LINE Source Parameters[a]

Model ID	Rel. Ht. (m)	Width (m)	$\sigma_{z,0}$ (m)
HR_*	2.27	9.88	2.11

[a] All haul road LINE sources are characterized with identical release heights, widths, and initial vertical dispersion based on the mobile machinery parameters.

Appendix B – Emission Rates

Table B-1. POINT Source Emission Rates, PM_{10}

Model ID	PM_{10} (g/s)
LS1	9.817E-05
CKD	7.560E-03
CKB	1.639E-03
MF	1.512E-02
LABSP	2.431E-04
LABFA	2.625E-03
EDG1	2.546E-04
HA	9.639E-04
HPO	9.639E-04
HL	9.639E-04
HWW	9.639E-04
HTW	1.928E-03
HMO	9.639E-04
CEM1	1.428E-04
UG	4.065E-01

Table B-2. VOLUME Source Emission Rates, PM_{10}

Model ID	PM_{10} (g/s)
OC1	1.917E-04
OC2	1.917E-04
OC3	2.250E-03
OC4	1.917E-04
OC5	1.917E-04
OC6	1.917E-04
OC7	3.083E-03
OC8	2.250E-03
OC9	1.917E-04
OC10	1.917E-04
OC11	1.917E-04
OC12	1.917E-04
OC13	1.917E-04
BC1	6.437E-03
BC2	6.437E-03
BC3	1.404E-02
BC4	6.437E-03
BC5	6.437E-03
BC6	6.437E-03
BC7	5.091E-02
BC8	1.404E-02
BC9	6.437E-03
BC10	6.437E-03
LS2	1.176E-05
CEM2	1.428E-04
CEM3	1.949E-02
CEM4	1.654E-02
CEM5	1.714E-03
BRW_BLAST	1.351E-02
WRSF	3.462E-03
STK	3.776E-03
CRF	1.593E-03

Table B-3. AREA Source Emission Rates

Model ID	PM_{10} (g/s)	Area (m^2)	PM_{10} ($g/s/m^2$)
BRW	3.076E-02	225,067.66	1.367E-07
TS1	3.493E-04	21,605.49	1.617E-08
TS2	1.443E-04	11,714.48	1.232E-08
TAILS	0	352,263.95	0
POND	0	10,000.00	0
DETOX1	0	17.76	0
DETOX2	0	17.76	0
CILTANK1	0	40.64	0
CILTANK2	0	40.64	0
CILTANK3	0	40.64	0
CILTANK4	0	40.64	0
CILTANK5	0	40.64	0
CILTANK6	0	40.64	0
CILTANK7	0	40.64	0

Table B-4. LINE Source Emission Rates

Model ID	PM_{10} (g/s)	Area (m^2)	PM_{10} ($g/s/m^2$)
HR_POR_WRF1	2.305E-05	316.84	7.276E-08
HR_POR_WRF2	1.953E-05	268.42	7.276E-08
HR_POR_WRF3	1.055E-04	1,450.09	7.276E-08
HR_POR_WRF4	4.350E-05	597.89	7.276E-08
HR_POR_WRF5	6.288E-05	864.21	7.276E-08
HR_POR_ORE1	5.508E-03	316.84	1.738E-05
HR_POR_ORE2	4.666E-03	268.42	1.738E-05
HR_POR_ORE3	2.204E-02	1,268.11	1.738E-05
HR_BWS_WRF1	4.636E-03	937.96	4.942E-06
HR_BWS_WRF2	9.341E-03	1,889.95	4.942E-06
HR_BWS_WRF3	8.293E-03	1,677.81	4.942E-06
HR_BWS_WRF4	1.095E-02	2,215.89	4.942E-06
HR_BWS_WRF5	1.089E-02	2,202.35	4.942E-06
HR_BWS_WRF6	1.657E-02	3,353.24	4.942E-06
HR_BWS_WRF7	2.590E-03	524.10	4.942E-06
HR_BWS_WRF8	7.167E-03	1,450.09	4.942E-06
HR_BWS_WRF9	2.955E-03	597.89	4.942E-06
HR_BWS_WRF10	4.271E-03	864.21	4.942E-06
HR_BWN_WRF1	2.341E-03	473.73	4.941E-06
HR_BWN_WRF2	1.166E-02	2,359.69	4.941E-06
HR_BWN_WRF3	8.290E-03	1,677.81	4.941E-06
HR_BWN_WRF4	1.095E-02	2,215.89	4.941E-06
HR_BWN_WRF5	1.088E-02	2,202.35	4.941E-06
HR_BWN_WRF6	1.657E-02	3,353.24	4.941E-06
HR_BWN_WRF7	2.589E-03	524.10	4.941E-06
HR_BWN_WRF8	7.165E-03	1,450.09	4.941E-06
HR_BWN_WRF9	2.954E-03	597.89	4.941E-06
HR_BWN_WRF10	4.270E-03	864.21	4.941E-06
HR_WRF_POR1	6.502E-03	864.21	7.524E-06
HR_WRF_POR2	4.498E-03	597.89	7.524E-06
HR_WRF_POR3	1.091E-02	1,450.09	7.524E-06
HR_WRF_POR4	2.020E-03	268.42	7.524E-06
HR_WRF_POR5	2.384E-03	316.84	7.524E-06
HR_WRF_CRF1	4.945E-03	864.21	5.722E-06
HR_WRF_CRF2	3.421E-03	597.89	5.722E-06
HR_WRF_CRF3	8.297E-03	1,450.09	5.722E-06
HR_WRF_CRF4	1.536E-03	268.42	5.722E-06
HR_WRF_CRF5	1.960E-03	342.57	5.722E-06
HR_CRF_POR1	3.080E-03	342.57	8.991E-06
HR_CRF_POR2	2.849E-03	316.84	8.991E-06

Appendix C - BPIPPRM Building Parameters

Buildings dimensions were based on the planned facility layout. The formatted BPIP-Prime text file that includes building information is available upon request.

Appendix D – HAP Emission Rates

Table D-1. HAP Emissions by TEU for Chronic Exposure

	TEU Emissions (lb/yr)							
HAP	OC	BC	CKB	HA	HPO	HL	HWW	HTW
1,3-Butadiene	-	-	-	-	-	-	-	-
Acetaldehyde	-	-	1.082E-01	6.364E-02	6.364E-02	6.364E-02	6.364E-02	1.273E-01
Acrolein	-	-	6.482E-02	3.813E-02	3.813E-02	3.813E-02	3.813E-02	7.626E-02
Antimony and compounds	6.431E-02	2.634E-01	-	-	-	-	-	-
Arsenic and compounds	2.642E-01	2.535E+00	2.920E-03	1.718E-03	1.718E-03	1.718E-03	1.718E-03	3.435E-03
Barium and compounds	-	-	6.424E-02	3.779E-02	3.779E-02	3.779E-02	3.779E-02	7.558E-02
Benzene	-	-	3.066E-02	1.804E-02	1.804E-02	1.804E-02	1.804E-02	3.607E-02
Beryllium and compounds	1.912E-03	5.103E-03	1.752E-04	1.031E-04	1.031E-04	1.031E-04	1.031E-04	2.061E-04
Cadmium and compounds	3.476E-04	3.951E-03	1.606E-02	9.447E-03	9.447E-03	9.447E-03	9.447E-03	1.889E-02
Chromium VI, chromate, and dichromate particulate	4.693E-02	1.975E-01	2.044E-02	1.202E-02	1.202E-02	1.202E-02	1.202E-02	2.405E-02
Cobalt and compounds	2.607E-03	3.292E-02	1.226E-03	7.214E-04	7.214E-04	7.214E-04	7.214E-04	1.443E-03
Copper and compounds	-	-	1.241E-02	7.300E-03	7.300E-03	7.300E-03	7.300E-03	1.460E-02
Cyanide, Hydrogen	-	-	-	-	-	-	-	-
p-Dichlorobenzene	-	-	1.752E-02	1.031E-02	1.031E-02	1.031E-02	1.031E-02	2.061E-02
Diesel Particulate Matter	-	-	-	-	-	-	-	-
Ethyl benzene	-	-	3.285E-02	1.932E-02	1.932E-02	1.932E-02	1.932E-02	3.865E-02
Formaldehyde	-	-	1.095E+00	6.441E-01	6.441E-01	6.441E-01	6.441E-01	1.288E+00
Hexane	-	-	2.628E+01	1.546E+01	1.546E+01	1.546E+01	1.546E+01	3.092E+01
Lead and compounds	1.217E-02	8.230E-02	-	-	-	-	-	-
Manganese and compounds	1.408E-01	8.889E-01	5.548E-03	3.264E-03	3.264E-03	3.264E-03	3.264E-03	6.527E-03
Mercury and compounds	3.824E-03	4.115E-02	3.796E-03	2.233E-03	2.233E-03	2.233E-03	2.233E-03	4.466E-03
Naphthalene	-	-	8.906E-03	5.239E-03	5.239E-03	5.239E-03	5.239E-03	1.048E-02
Nickel and compounds	8.343E-03	4.938E-02	3.066E-02	1.804E-02	1.804E-02	1.804E-02	1.804E-02	3.607E-02
PAHs	-	-	-	-	-	-	-	-
Propylene	-	-	2.380E+00	1.400E+00	1.400E+00	1.400E+00	1.400E+00	2.800E+00
Selenium and compounds	-	-	3.504E-04	2.061E-04	2.061E-04	2.061E-04	2.061E-04	4.122E-04
Toluene	-	-	4.964E-02	2.920E-02	2.920E-02	2.920E-02	2.920E-02	5.840E-02
Vanadium (fume or dust)	-	-	3.358E-02	1.975E-02	1.975E-02	1.975E-02	1.975E-02	3.951E-02
Xylene (mixture)	-	-	1.460E-01	8.588E-02	8.588E-02	8.588E-02	8.588E-02	1.718E-01
Zinc and compounds	-	-	4.234E-01	2.491E-01	2.491E-01	2.491E-01	2.491E-01	4.981E-01
Polycyclic aromatic hydrocarbons (PAHs)	-	-	1.288E-03	7.575E-04	7.575E-04	7.575E-04	7.575E-04	1.515E-03

Table D-1. HAP Emissions by TEU for Chronic Exposure (cont.)

	TEU Emissions (lb/yr)							
HAP	HMO	EDG1	MR	UFD	AFD	TAILS	POND	DETOX1
1,3-Butadiene	-	1.468E-02	-	-	-	-	-	-
Acetaldehyde	6.364E-02	2.880E-01	-	-	-	-	-	-
Acrolein	3.813E-02	3.473E-02	-	-	-	-	-	-
Antimony and compounds	-	-	-	7.329E-03	6.003E-02	-	-	-
Arsenic and compounds	1.718E-03	-	-	3.326E-02	4.587E-01	-	-	-
Barium and compounds	3.779E-02	-	-	-	-	-	-	-
Benzene	1.804E-02	3.503E-01	-	-	-	-	-	-
Beryllium and compounds	1.031E-04	-	-	2.120E-04	1.387E-03	-	-	-
Cadmium and compounds	9.447E-03	-	-	4.510E-05	6.933E-04	-	-	-
Chromium VI, chromate, and dichromate particulate	1.202E-02	-	-	5.360E-03	4.458E-02	-	-	-
Cobalt and compounds	7.214E-04	-	-	3.454E-04	5.680E-03	-	-	-
Copper and compounds	7.300E-03	-	-	-	-	-	-	-
Cyanide, Hydrogen	-	-	4.000E+01	-	-	6.146E+02	2.564E+01	1.015E+02
p-Dichlorobenzene	1.031E-02	-	-	-	-	-	-	-
Diesel Particulate Matter	-	1.764E+01	-	-	-	-	-	-
Ethyl benzene	1.932E-02	-	-	-	-	-	-	-
Formaldehyde	6.441E-01	4.431E-01	-	-	-	-	-	-
Hexane	1.546E+01	-	-	-	-	-	-	-
Lead and compounds	-	-	-	1.457E-03	1.610E-02	-	-	-
Manganese and compounds	3.264E-03	-	-	1.672E-02	1.770E-01	-	-	-
Mercury and compounds	2.233E-03	-	3.200E+00	4.911E-04	7.290E-03	-	-	-
Naphthalene	5.239E-03	-	-	-	-	-	-	-
Nickel and compounds	1.804E-02	-	-	9.837E-04	1.001E-02	-	-	-
PAHs	-	-	-	-	-	-	-	-
Propylene	1.400E+00	-	-	-	-	-	-	-
Selenium and compounds	2.061E-04	-	-	-	-	-	-	-
Toluene	2.920E-02	1.536E-01	-	-	-	-	-	-
Vanadium (fume or dust)	1.975E-02	-	-	-	-	-	-	-
Xylene (mixture)	8.588E-02	1.070E-01	-	-	-	-	-	-
Zinc and compounds	2.491E-01	-	-	-	-	-	-	-
Polycyclic aromatic hydrocarbons (PAHs)	7.575E-04	6.310E-02	-	-	-	-	-	-

Table D-1. HAP Emissions by TEU for Chronic Exposure (cont.)

	TEU Emissions (lb/yr)							
HAP	DETOX2	CILTANK1	CILTANK2	CILTANK3	CILTANK4	CILTANK5	CILTANK6	CILTANK7
1,3-Butadiene	-	-	-	-	-	-	-	-
Acetaldehyde	-	-	-	-	-	-	-	-
Acrolein	-	-	-	-	-	-	-	-
Antimony and compounds	-	-	-	-	-	-	-	-
Arsenic and compounds	-	-	-	-	-	-	-	-
Barium and compounds	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	-	-	-	-
Beryllium and compounds	-	-	-	-	-	-	-	-
Cadmium and compounds	-	-	-	-	-	-	-	-
Chromium VI, chromate, and dichromate particulate	-	-	-	-	-	-	-	-
Cobalt and compounds	-	-	-	-	-	-	-	-
Copper and compounds	-	-	-	-	-	-	-	-
Cyanide, Hydrogen	1.015E+02	6.881E+02	6.881E+02	6.881E+02	6.881E+02	6.881E+02	6.881E+02	6.881E+02
p-Dichlorobenzene	-	-	-	-	-	-	-	-
Diesel Particulate Matter	-	-	-	-	-	-	-	-
Ethyl benzene	-	-	-	-	-	-	-	-
Formaldehyde	-	-	-	-	-	-	-	-
Hexane	-	-	-	-	-	-	-	-
Lead and compounds	-	-	-	-	-	-	-	-
Manganese and compounds	-	-	-	-	-	-	-	-
Mercury and compounds	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-
Nickel and compounds	-	-	-	-	-	-	-	-
PAHs	-	-	-	-	-	-	-	-
Propylene	-	-	-	-	-	-	-	-
Selenium and compounds	-	-	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-
Vanadium (fume or dust)	-	-	-	-	-	-	-	-
Xylene (mixture)	-	-	-	-	-	-	-	-
Zinc and compounds	-	-	-	-	-	-	-	-
Polycyclic aromatic hydrocarbons (PAHs)	-	-	-	-	-	-	-	-

Table D-2. HAP Emissions by TEU for Acute Exposure

	TEU Emissions (lb/day)							
HAP	OC	BC	CKB	HA	HPO	HL	HWW	HTW
1,3-Butadiene	-	-	-	-	-	-	-	-
Acetaldehyde	-	-	2.964E-04	1.744E-04	1.744E-04	1.744E-04	1.744E-04	3.487E-04
Acrolein	-	-	1.776E-04	1.045E-04	1.045E-04	1.045E-04	1.045E-04	2.089E-04
Antimony and compounds	1.762E-04	1.013E-03	-	-	-	-	-	-
Arsenic and compounds	7.239E-04	9.750E-03	8.000E-06	4.706E-06	4.706E-06	4.706E-06	4.706E-06	9.412E-06
Barium and compounds	-	-	1.760E-04	1.035E-04	1.035E-04	1.035E-04	1.035E-04	2.071E-04
Benzene	-	-	8.400E-05	4.941E-05	4.941E-05	4.941E-05	4.941E-05	9.882E-05
Beryllium and compounds	5.238E-06	1.963E-05	4.800E-07	2.824E-07	2.824E-07	2.824E-07	2.824E-07	5.647E-07
Cadmium and compounds	9.524E-07	1.519E-05	4.400E-05	2.588E-05	2.588E-05	2.588E-05	2.588E-05	5.176E-05
Chromium VI, chromate, and dichromate particulate	1.286E-04	7.597E-04	5.600E-05	3.294E-05	3.294E-05	3.294E-05	3.294E-05	6.588E-05
Cobalt and compounds	7.143E-06	1.266E-04	3.360E-06	1.976E-06	1.976E-06	1.976E-06	1.976E-06	3.953E-06
Copper and compounds	-	-	3.400E-05	2.000E-05	2.000E-05	2.000E-05	2.000E-05	4.000E-05
Cyanide, Hydrogen	-	-	-	-	-	-	-	-
p-Dichlorobenzene	-	-	4.800E-05	2.824E-05	2.824E-05	2.824E-05	2.824E-05	5.647E-05
Diesel Particulate Matter	-	-	-	-	-	-	-	-
Ethyl benzene	-	-	9.000E-05	5.294E-05	5.294E-05	5.294E-05	5.294E-05	1.059E-04
Formaldehyde	-	-	3.000E-03	1.765E-03	1.765E-03	1.765E-03	1.765E-03	3.529E-03
Hexane	-	-	7.200E-02	4.235E-02	4.235E-02	4.235E-02	4.235E-02	8.471E-02
Lead and compounds	3.334E-05	3.166E-04	-	-	-	-	-	-
Manganese and compounds	3.857E-04	3.419E-03	1.520E-05	8.941E-06	8.941E-06	8.941E-06	8.941E-06	1.788E-05
Mercury and compounds	1.048E-05	1.583E-04	1.040E-05	6.118E-06	6.118E-06	6.118E-06	6.118E-06	1.224E-05
Naphthalene	-	-	2.440E-05	1.435E-05	1.435E-05	1.435E-05	1.435E-05	2.871E-05
Nickel and compounds	2.286E-05	1.899E-04	8.400E-05	4.941E-05	4.941E-05	4.941E-05	4.941E-05	9.882E-05
PAHs	-	-	-	-	-	-	-	-
Propylene	-	-	6.520E-03	3.835E-03	3.835E-03	3.835E-03	3.835E-03	7.671E-03
Selenium and compounds	-	-	9.600E-07	5.647E-07	5.647E-07	5.647E-07	5.647E-07	1.129E-06
Toluene	-	-	1.360E-04	8.000E-05	8.000E-05	8.000E-05	8.000E-05	1.600E-04
Vanadium (fume or dust)	-	-	9.200E-05	5.412E-05	5.412E-05	5.412E-05	5.412E-05	1.082E-04
Xylene (mixture)	-	-	4.000E-04	2.353E-04	2.353E-04	2.353E-04	2.353E-04	4.706E-04
Zinc and compounds	-	-	1.160E-03	6.824E-04	6.824E-04	6.824E-04	6.824E-04	1.365E-03
Polycyclic aromatic hydrocarbons (PAHs)	-	-	3.528E-06	2.075E-06	2.075E-06	2.075E-06	2.075E-06	4.151E-06

Table D-2. HAP Emissions by TEU for Acute Exposure (cont.)

	TEU Emissions (lb/ day)							
HAP	HMO	EDG1	MR	UFD	AFD	TAILS	POND	DETOX1
1,3-Butadiene	-	3.524E-03	-	-	-	-	-	-
Acetaldehyde	1.744E-04	6.912E-02	-	-	-	-	-	-
Acrolein	1.045E-04	8.336E-03	-	-	-	-	-	-
Antimony and compounds	-	-	-	3.523E-05	2.309E-04	-	-	-
Arsenic and compounds	4.706E-06	-	-	1.599E-04	1.764E-03	-	-	-
Barium and compounds	1.035E-04	-	-	-	-	-	-	-
Benzene	4.941E-05	8.408E-02	-	-	-	-	-	-
Beryllium and compounds	2.824E-07	-	-	1.019E-06	5.333E-06	-	-	-
Cadmium and compounds	2.588E-05	-	-	2.168E-07	2.666E-06	-	-	-
Chromium VI, chromate, and dichromate particulate	3.294E-05	-	-	2.577E-05	1.715E-04	-	-	-
Cobalt and compounds	1.976E-06	-	-	1.660E-06	2.185E-05	-	-	-
Copper and compounds	2.000E-05	-	-	-	-	-	-	-
Cyanide, Hydrogen	-	-	1.096E-01	-	-	1.684E+00	7.026E-02	2.782E-01
p-Dichlorobenzene	2.824E-05	-	-	-	-	-	-	-
Diesel Particulate Matter	-	4.233E+00	-	-	-	-	-	-
Ethyl benzene	5.294E-05	-	-	-	-	-	-	-
Formaldehyde	1.765E-03	1.063E-01	-	-	-	-	-	-
Hexane	4.235E-02	-	-	-	-	-	-	-
Lead and compounds	-	-	-	7.005E-06	6.191E-05	-	-	-
Manganese and compounds	8.941E-06	-	-	8.039E-05	6.807E-04	-	-	-
Mercury and compounds	6.118E-06	-	8.767E-03	2.361E-06	2.804E-05	-	-	-
Naphthalene	1.435E-05	-	-	-	-	-	-	-
Nickel and compounds	4.941E-05	-	-	4.730E-06	3.849E-05	-	-	-
PAHs	-	-	-	-	-	-	-	-
Propylene	3.835E-03	-	-	-	-	-	-	-
Selenium and compounds	5.647E-07	-	-	-	-	-	-	-
Toluene	8.000E-05	3.686E-02	-	-	-	-	-	-
Vanadium (fume or dust)	5.412E-05	-	-	-	-	-	-	-
Xylene (mixture)	2.353E-04	2.568E-02	-	-	-	-	-	-
Zinc and compounds	6.824E-04	-	-	-	-	-	-	-
Polycyclic aromatic hydrocarbons (PAHs)	2.075E-06	1.514E-02	-	-	-	-	-	-

Table D-2. HAP Emissions by TEU for Acute Exposure (cont.)

	TEU Emissions (lb/ day)							
HAP	DETOX2	CILTANK1	CILTANK2	CILTANK3	CILTANK4	CILTANK5	CILTANK6	CILTANK7
1,3-Butadiene	-	-	-	-	-	-	-	-
Acetaldehyde	-	-	-	-	-	-	-	-
Acrolein	-	-	-	-	-	-	-	-
Antimony and compounds	-	-	-	-	-	-	-	-
Arsenic and compounds	-	-	-	-	-	-	-	-
Barium and compounds	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	-	-	-	-
Beryllium and compounds	-	-	-	-	-	-	-	-
Cadmium and compounds	-	-	-	-	-	-	-	-
Chromium VI, chromate, and dichromate particulate	-	-	-	-	-	-	-	-
Cobalt and compounds	-	-	-	-	-	-	-	-
Copper and compounds	-	-	-	-	-	-	-	-
Cyanide, Hydrogen	2.782E-01	1.885E+00	1.885E+00	1.885E+00	1.885E+00	1.885E+00	1.885E+00	1.885E+00
p-Dichlorobenzene	-	-	-	-	-	-	-	-
Diesel Particulate Matter	-	-	-	-	-	-	-	-
Ethyl benzene	-	-	-	-	-	-	-	-
Formaldehyde	-	-	-	-	-	-	-	-
Hexane	-	-	-	-	-	-	-	-
Lead and compounds	-	-	-	-	-	-	-	-
Manganese and compounds	-	-	-	-	-	-	-	-
Mercury and compounds	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-
Nickel and compounds	-	-	-	-	-	-	-	-
PAHs	-	-	-	-	-	-	-	-
Propylene	-	-	-	-	-	-	-	-
Selenium and compounds	-	-	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-
Vanadium (fume or dust)	-	-	-	-	-	-	-	-
Xylene (mixture)	-	-	-	-	-	-	-	-
Zinc and compounds	-	-	-	-	-	-	-	-
Polycyclic aromatic hydrocarbons (PAHs)	-	-	-	-	-	-	-	-

Table D-3. TEU Modeling Sources and Allocation

TEU / SRCGROUP	SOURCE	Allocation
OC	OC1	2.3%
	OC2	2.3%
	OC3	20.0%
	OC4	2.3%
	OC5	2.3%
	OC6	2.3%
	OC7	36.7%
	OC8	20.0%
	OC9	2.3%
	OC10	2.3%
	OC11	2.3%
	OC12	2.3%
	OC13	2.3%
BC	BC1	5.3%
	BC2	5.3%
	BC3	9.5%
	BC4	5.3%
	BC5	5.3%
	BC6	5.3%
	BC7	44.0%
	BC8	9.5%
	BC9	5.3%
	BC10	5.3%
CKB	CKB	100%
MR	MF	100%
EDG1	EDG1	100%
HA	HA	100%
HPO	HPO	100%
HL	HL	100%
HWW	HWW	100%
HTW	HTW	100%
HMO	HMO	100%
UFD	UG	100%
AFD	BRW	67.3%
	BRW_BLAST	4.3%
	STK	10.7%
	WRSF	11.0%
	CRF	5.1%
	TS1	1.2%
	TS2	0.5%
TAILS	TAILS	100%
POND	POND	100%
DETOX1	DETOX1	100%
DETOX2	DETOX2	100%
CILTANK1	CILTANK1	100%
CILTANK2	CILTANK2	100%
CILTANK3	CILTANK3	100%
CILTANK4	CILTANK4	100%
CILTANK5	CILTANK5	100%
CILTANK6	CILTANK6	100%
CILTANK7	CILTANK7	100%

Appendix N: OWRD Dam Permit Application

Application for a Permit to

Store Water in a Reservoir

(Standard Review)

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
503-986-0900
www.oregon.gov/OWRD

You must use this form for any reservoir storing more than 9.2 acre-feet and with a dam more than 10 feet high.

SECTION 1: APPLICANT INFORMATION AND SIGNATURE

Applicant

NAME				PHONE (HM)
Calico Resources USA Corp.				TBD
PHONE (WK)	CELL			FAX
775-625-3600				775-625-3603
ADDRESS				
665 Anderson St				
CITY	STATE	ZIP	E-MAIL *	
Winnemucca	NV	89445	carlo@paramountnevada.com	

Organization

NAME			PHONE	FAX
same as above				
ADDRESS				CELL
CITY	STATE	ZIP	E-MAIL *	

Agent – The agent is authorized to represent the applicant in all matters relating to this application.

AGENT / BUSINESS NAME			PHONE	FAX
Nancy J. Wolverson			775-770-4615	775-625-3603
ADDRESS				CELL
665 Anderson St				
CITY	STATE	ZIP	E-MAIL *	
Winnemucca	NV	89445	nancy@paramountnevada.com	

Note: Attach multiple copies as needed

* By providing an e-mail address, consent is given to receive all correspondence from the Department electronically. (Paper copies of the final order documents will also be mailed.)

By my signature below I confirm that I understand:

- I am asking to use water specifically as described in this application.
- Evaluation of this application will be based on information provided in the application packet.
- I cannot legally store water until the Water Resources Department issues a permit to me.
- The Department encourages all applicants to wait for a permit to be issued before beginning construction of any proposed diversion. Acceptance of this application does not guarantee a permit will be issued.
- If I begin construction prior to the issuance of a permit, I assume all risks associated with my actions.
- If I get a permit, I must not waste water.
- If development of the water use is not according to the terms of the permit, the permit can be cancelled.
- The water use must be compatible with local comprehensive land use plans.
- Even if the Department issues a permit, I may have to stop using water to allow senior water right holders to get water to which they are entitled.

I (we) affirm that the information contained in this application is true and accurate.

Applicant Signature	Print Name and Title if applicable	Date
C.B.	Carlo Buffone CEO/Treasurer	11/06/2019
Applicant Signature	Print Name and Title if applicable	Date

For Department Use: App. Number: _____

SECTION 2: PROPERTY OWNERSHIP

Indicate if you own all the lands associated with the project from which the water is to be diverted, conveyed, and used.

☐ YES, there are no encumbrances.
☐ YES, the land is encumbered by easements, rights of way, roads or other encumbrances.

☐ NO, I have a recorded easement or written authorization permitting access.
☐ NO, I do not currently have written authorization or easement permitting access.
☐ NO, written authorization or an easement is not necessary, because the only affected lands I do not own are state-owned submersible lands, and this application is for irrigation and/or domestic use only (ORS 274.040).
☒ NO, because water is to be diverted, conveyed, and/or used only on federal lands.

Affected Landowners: List the names and mailing addresses of all the owners of any lands that are not owned by the applicant and that are crossed by the proposed ditch, canal or other work, even if the applicant has obtained written authorization or an easement from the owner. (*Attach additional sheets if necessary)*.

See Sections 1.3 and 1.7 of the Consolidated Permit Application text.

Legal Description: You must provide the legal description of: (1) the property from which the water is to be diverted, (2) any property crossed by the proposed ditch, canal or other work, and (3) any property on which the water is to be used as depicted on the map.

See section 1.7.1.1 of the Consolidated Permit Application text.

SECTION 3: SOURCE OF WATER

A. Reservoir Name: _____

B. Source: Provide the name of the water body or other source from which water will be diverted, and the name of the stream or lake it flows into. Indicate if source is run-off, seepage, or an unnamed stream or spring.

Source 1: Groundwater	Tributary to: N/A
TRSQQ of POD:	
Source 2:	Tributary to:
TRSQQ of POD:	

- Is the proposed reservoir in a wetland (as determined by DSL)? ☐Yes ☒No ☐Don't know
- Is the proposed reservoir an enlargement of an existing dam/reservoir? ☐ Yes ☒ No
- Is the proposed reservoir in-channel of a stream or off-channel: ☒ In-channel ☐ Off-Channel
- If the reservoir is proposed to be in-channel, is the stream: ☐ Perennial ☐ Intermittent ☒ Ephemeral
- If the reservoir is proposed to be in-channel, has ODFW determined that native migratory fish are present? ☒ Yes ☐ No ☐ Don't know
- Is the reservoir in the 100-year floodplain? ☐ Yes ☒ No ☐ Don't know
- If the reservoir is not in the channel of a stream, state how it is to be filled:

SECTION 4: SENSITIVE, THREATENED OR ENDANGERED FISH SPECIES PUBLIC INTEREST INFORMATION

This information must be provided for your application to be accepted as complete. The Water Resources Department will determine whether the proposed use will impair or be detrimental to the public interest with regard to sensitive, threatened or endangered fish species.

To answer the following questions, refer to the map shown on Attachment 3 or the link below to determine whether the proposed point of diversion (POD) is located in an area where the Upper Columbia, the Lower Columbia, and/or the Statewide public interest rules apply.

For more detailed information, click on the following link and enter the TRSQQ or the Lat/Long of a POD and click on "Submit" to retrieve a report that will show which section, if any, of the rules apply:
https://apps.wrd.state.or.us/apps/misc/lkp_trsqq_features/

If you need help to determine in which area the proposed POD is located, please call the customer service desk at (503) 986-0801.

Upper Columbia - OAR 690-033-0115 thru -0130

Is the POD located in an area where the Upper Columbia Rules apply?

☒ Yes ☐ No

If yes, you are notified that the Water Resources Department will consult with numerous federal, state, local and tribal governmental entities so it may determine whether the proposed use is consistent with the "Columbia River Basin Fish and Wildlife Program" adopted by the Northwest Power Planning Council in 1994 for the protection and recovery of listed fish species. The application may be denied, heavily conditioned, or if appropriate, mitigation for impacts may be needed to obtain approval for the proposed use.

If yes,

- I understand that the proposed use does not involve appropriation of direct streamflow during the time period April 15 to September 30, except as provided in OAR 690-033-0140.
- I understand that I will install, operate and maintain a fish screen and fish passage as listed in ORS 498.301 through 498.346, and 509.580 through 509.910, to the specifications and extent required by Oregon Department of Fish and Wildlife, prior to diversion of water under any permit issued pursuant to this application.
- I understand that the Oregon Department of Environmental Quality will review my application to determine if the proposed use complies with existing state and federal water quality standards.
- I understand that I will install and maintain water use measurement and recording devices as required by the Water Resources Department, and comply with recording and reporting permit condition requirements prior to diversion or use of water under any permit issued pursuant to this application.

Lower Columbia - OAR 690-033-0220 thru -0230

Is the POD located in an area where the Lower Columbia rules apply?

☐ Yes ☒ No

If yes, you are notified that that the Water Resources Department will determine, by reviewing recovery plans, the Columbia River Basin Fish and Wildlife Program, and regional restoration programs applicable to threatened or endangered fish species, in coordination with state and federal agencies, as appropriate, whether the proposed use is detrimental to the protection or recovery of a threatened or endangered fish species and whether the use can be conditioned or mitigated to avoid the detriment.

If a permit is issued, it will likely contain conditions to ensure the water use complies with existing state and federal water quality standards; and water use measurement, recording and reporting required by the Water Resources Department. The application may be denied, or if appropriate, mitigation for impacts may be needed to obtain approval of the proposed use.

If yes, provide the following information (the information must be provided with the application to be considered complete).

☐ Yes ☐ No The proposed use is for more than **one** cubic foot per second (448.8 gpm) and is not subject to the requirements of OAR 690, Division 86 (Water Management and Conservation Plans).

If yes, provide a description of the measures to be taken to assure reasonably efficient water use:

Statewide - OAR 690-033-0330 thru -0340

Is the POD located in an area where the Statewide rules apply?

☐ Yes ☒ No

If yes, the Water Resources Department will determine whether the proposed use will occur in an area where endangered, threatened or sensitive fish species are located. If so, the Water Resources Department, Department of Fish and Wildlife, Department of Environmental Quality, and the Department of Agriculture will recommend conditions required to achieve "no loss of essential habitat of threatened and endangered (T&E) fish species," or "no net loss of essential habitat of sensitive (S) fish species." If conditions cannot be identified that meet the standards of no loss of essential T&E fish habitat or no net loss of essential S fish habitat, the agencies will recommend denial of the application unless they conclude that the proposed use would not harm the species.

SECTION 5: WATER USE

a) The use of the impounded water will be: Process water for mining

b) The amount of water to be stored is: 35 acre-feet.

c) The area submerged by the reservoir, when filled, will be 20 acres.

SECTION 6: DAM HEIGHT AND COMPOSITION

The maximum height of the structure will be 120 feet above streambed or ground surface at the centerline of the crest of the dam.

Attach preliminary plans, specifications and supporting information for the dam and impoundment area including 1) dam height, 2) width, 3) crest width, 4) surface area and 5) preliminary fish passage design.
*Note: If your dam height is greater than or equal to 10.0' above land surface **AND** your reservoir will store equal to or greater than 9.2 acre-feet, engineered plans and specifications must be approved by the Department' Dam Safety Section prior to storage of water.*

The dam will be (check one): [X] Earthfill [ ] Concrete [ ] Flash board [ ] Other

If "other," provide the description: _____

SECTION 7: PRIMARY OUTLET WORKS

a) Describe the location and the dimensions of the outlet conduit through the dam:
NOTE: Most dams across a natural stream channel will need an outlet conduit having a minimum diameter of 8 inches or greater.
See the design work in Appendix C of the Consolidated Permit Application.

b) How and when will the outlet be operated?
See the design work in Appendix C of the Consolidated Permit Application.

c) If ODFW has determined fish are present in the stream, how do you propose to protect fish through the outlet conduit (the conduit does not constitute fish passage)?
N/A

SECTION 8: EMERGENCY SPILLWAY

a) Describe the location and the dimensions of the spillway channel.
See the design work in Appendix C of the Consolidated Permit Application.

b) How will the emergency spillway be designed to prevent erosion?
See the design work in Appendix C of the Consolidated Permit Application.

c) What is the maximum design flow for the spillway? (Should be able to handle high flow events. 10-year flood events? 50-year flood events?)
See the design work in Appendix C of the Consolidated Permit Application.

SECTION 9: WATER QUALITY

a) Describe how the reservoir will be managed to maintain water quality in the reservoir and downstream.
See the design work in Appendices C and D of the Consolidated Permit Application.

b) Describe how the perimeter of the reservoir will be buffered to limit nutrient and bacteria contamination.
See the design work in Appendices C and D of the Consolidated Permit Application.

c) Describe how annual maintenance of the reservoir will be accomplished without discharging contaminated water instream.
See the design work in Appendices C and D of the Consolidated Permit Application.

SECTION 10: PROJECT SCHEDULE (List Month and Year)

a) Proposed date construction work will begin: _____
(Fish passage approval is necessary prior to construction.)

b) Proposed date construction work will be completed: _____

c) Proposed date water use will be completed: _____

SECTION 11: WITHIN A DISTRICT

☐ Check here if the point of diversion or place of use are located within or are served by an irrigation or other water district.

Irrigation District Name	Address	
City	State	Zip

SECTION 12: REMARKS

Use this space to clarify any information you have provided in the application.

Minimum Requirements Checklist

Minimum Requirements (OAR 690-310-0040, OAR 690-310-0050 & ORS 537.140)

Include this checklist with the application

Check that each of the following sections are completed. The application will be returned if all required items are not included. If you have questions, please call the Water Rights Customer Service Group at (503) 986-0900.

Please submit the original application and signatures to the Water Resources Department. Applicants are encouraged to keep a copy of the completed application.

- ☐ SECTION 1: Applicant Information and Signature
- ☐ SECTION 2: Property Ownership
- ☐ SECTION 3: Source of Water
- ☐ SECTION 4: Sensitive, Threatened or Endangered Fish Species Public Interest Information
- ☐ SECTION 5: Water Use
- ☐ SECTION 6: Dam Height and Composition
- ☐ SECTION 7: Primary Outlet Works
- ☐ SECTION 8: Emergency Spillway
- ☐ SECTION 9: Water Quality
- ☐ SECTION 10: Project Schedule
- ☐ SECTION 11: Within a District
- ☐ SECTION 12: Remarks

Include the following additional items:

- ☐ Land Use Information Form with approval and signature of local planning department (*must be an original*) or signed receipt.
- ☐ Provide the legal description of: (1) the property from which the water is to be diverted, (2) any property crossed by the proposed ditch, canal or other work, and (3) any property on which the water is to be used as depicted on the map.
- ☐ Fees - Amount enclosed: $ _____
  See the Department's Fee Schedule at www.oregon.gov/owrd or call (503) 986-0900.
- ☐ Map that includes the following items:
  - ☐ Map must be prepared by a Certified Water Rights Examiner
  - ☐ Permanent quality and drawn in ink
  - ☐ Even map scale not less than 4" = 1 mile (example: 1" = 400 ft, 1" = 1320 ft, etc.)
  - ☐ North directional symbol
  - ☐ Township, Range, Section, Quarter/Quarter, Tax Lots
  - ☐ Reference public-land survey corner on map
  - ☐ Location of each dam by reference to a recognized public land survey corner (distances north/south and east/west)
  - ☐ Indicate the area of use by Quarter/Quarter and tax lot identified clearly
  - ☐ Number of acres per Quarter/Quarter and hatching to indicate area of use if for primary irrigation, supplemental irrigation, or nursery
  - ☐ Location of main canals, ditches, pipelines or flumes (if well is outside of the area of use)

Please note that a secondary application is required if there are out-of-reservoir uses associated with this application.

Water-Use Permit Application Processing

1. **Completeness Determination**

The Department evaluates whether the application and accompanying map contain all of the information required under OAR 690-310-0040 and OAR 690-310-0050. The Department also determines whether the proposed use is prohibited by statute. If the Department determines that the application is incomplete, all fees have not been paid, or the use is prohibited by statute, the application and all fees submitted are returned to the applicant.

2. Initial Review

The Department reviews the application to determine whether water is available during the period requested, whether the proposed use is restricted or limited by rule or statute, and whether other issues may preclude approval of or restrict the proposed use. An Initial Review (IR) containing preliminary determinations is mailed to the applicant. The applicant has 14 days from the mailing date to withdraw the application from further processing and receive a refund of all fees paid minus $260. The applicant may put the application on hold for up to 180 days and may request additional time if necessary.

3. Public Notice

Within 7 days of the mailing of the initial review, the Department gives public notice of the application in the weekly notice published by the Department at www.oregon.gov/owrd. The public comment period is 30 days from publication in the weekly notice.

4. Proposed Final Order Issued

The Department reviews any comments received, including comments from other state agencies related to the protection of sensitive, threatened or endangered fish species. Within 60 days of completion of the IR, the Department issues a Proposed Final Order (PFO) explaining the proposed decision to deny or approve the application. A PFO proposing approval of an application will include a draft permit, and may request additional information or outstanding fees required prior to permit issuance.

5. Public Notice

Within 7 days of issuing the PFO, the Department gives public notice in the weekly notice. Notice includes information about the application and the PFO. Protest must be received by the Department within 45 days after publication of the PFO in the weekly notice. Anyone may file a protest. The protest filing fee is $410.00 for the applicant and $810.00 for non-applicants. Protests are filed on approximately 10 percent of Proposed Final Orders. If a protest is filed the Department will attempt to settle the protest but will schedule a contested case hearing if necessary.

6. Final Order Issued

If no protests are filed, the Department can issue a Final Order within 60 days of the close of the period for receiving protest. If the application is approved, a permit is issued. The permit specifies the details of the authorized use and any terms, limitations or conditions that the Department deems appropriate

Land Use Information Form

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
503-986-0900
www.oregon.gov/OWRD

NOTE TO APPLICANTS

In order for your application to be processed by the Water Resources Department (WRD), this Land Use Information Form must be completed by a local government planning official in the jurisdiction(s) where your water right will be used and developed. The planning official may choose to complete the form while you wait, or return the receipt stub to you. Applications received by WRD without the Land Use Form or the receipt stub will be returned to you. Please be aware that your application will not be approved without land use approval.

This form is NOT required if:

1) Water is to be diverted, conveyed, **and/or** used only on federal lands; **OR**
2) The application is for a water right transfer, allocation of conserved water, exchange, permit amendment, or groundwater registration modification, **and all** of the following apply:
   a) The existing and proposed water use is located entirely within lands zoned for exclusive farm-use or within an irrigation district;
   b) The application involves a change in place of use only;
   c) The change does not involve the placement or modification of structures, including but not limited to water diversion, impoundment, distribution facilities, water wells and well houses; and
   d) The application involves irrigation water uses only.

NOTE TO LOCAL GOVERNMENTS

The person presenting the attached Land Use Information Form is applying for or modifying a water right. The Water Resources Department (WRD) requires its applicants to obtain land use information to be sure the water rights do not result in land uses that are incompatible with your comprehensive plan. Please complete the form or detach the receipt stub and return it to the applicant for inclusion in their water right application. You will receive notice once the applicant formally submits his or her request to the WRD. The notice will give more information about WRD's water rights process and provide additional comment opportunities. You will have 30 days from the date of the notice to complete the land use form and return it to the WRD. If no land use information is received from you within that 30-day period, the WRD may presume the land use associated with the proposed water right is compatible with your comprehensive plan. Your attention to this request for information is greatly appreciated by the Water Resources Department. If you have any questions concerning this form, please contact the WRD's Customer Service Group at 503-986-0801.

Land Use Information Form

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
503-986-0900
www.oregon.gov/OWRD

Applicant

NAME			PHONE (HM)
PHONE (WK)	CELL		FAX
ADDRESS			
CITY	STATE	ZIP	E-MAIL*

A. Land and Location

Please include the following information for all tax lots where water will be diverted (taken from its source), conveyed (transported), and/or used or developed. Applicants for municipal use, or irrigation uses within irrigation districts may substitute existing and proposed service-area boundaries for the tax-lot information requested below.

Township	Range	Section	¼ ¼	Tax Lot #	Plan Designation (e.g., Rural Residential/RR-5)	Water to be:	Proposed Land Use:
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	

List all counties and cities where water is proposed to be diverted, conveyed, and/or used or developed:

B. Description of Proposed Use

Type of application to be filed with the Water Resources Department:

☐ Permit to Use or Store Water ☐ Water Right Transfer ☐ Permit Amendment or Groundwater Registration Modification
☐ Limited Water Use License ☐ Allocation of Conserved Water ☐ Exchange of Water

Source of water: ☐ Reservoir/Pond ☐ Groundwater ☐ Surface Water (name) ____

Estimated quantity of water needed: ____ ☐ cubic feet per second ☐ gallons per minute ☐ acre-feet

Intended use of water: ☐ Irrigation ☐ Commercial ☐ Industrial ☐ Domestic for ____ household(s)
☐ Municipal ☐ Quasi-Municipal ☐ Instream ☐ Other ____

Briefly describe:

Note to applicant: If the Land Use Information Form cannot be completed while you wait, please have a local government representative sign the receipt at the bottom of the next page and include it with the application filed with the Water Resources Department.

For Local Government Use Only

The following section must be completed by a planning official from each county and city listed unless the project will be located entirely within the city limits. In that case, only the city planning agency must complete this form. This deals only with the local land use plan. Do not include approval for activities such as building or grading permits.

Please check the appropriate box below and provide the requested information

☐ Land uses to be served by the proposed water uses (including proposed construction) are allowed outright or are not regulated by your comprehensive plan. Cite applicable ordinance section(s): _____.

☐ Land uses to be served by the proposed water uses (including proposed construction) involve discretionary land use approvals as listed in the table below. (Please attach documentation of applicable land use approvals which have already been obtained. Record of Action/land use decision and accompanying findings are sufficient.) **If approvals have been obtained but all appeal periods have not ended, check "Being pursued."**

Type of Land Use Approval Needed (e.g., plan amendments, rezones, conditional-use permits, etc.)	Cite Most Significant, Applicable Plan Policies & Ordinance Section References	Land Use Approval:	
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued

Local governments are invited to express special land use concerns or make recommendations to the Water Resources Department regarding this proposed use of water below, or on a separate sheet.

NAME		TITLE:
SIGNATURE	PHONE:	DATE:
GOVERNMENT ENTITY		

Note to local government representative: Please complete this form or sign the receipt below and return it to the applicant. If you sign the receipt, you will have 30 days from the Water Resources Department's notice date to return the completed Land Use Information Form or WRD may presume the land use associated with the proposed use of water is compatible with local comprehensive plans.

Receipt for Request for Land Use Information

Applicant name: _____

City or County: _____ Staff contact: _____

Signature: _____ Phone: _____ Date: _____

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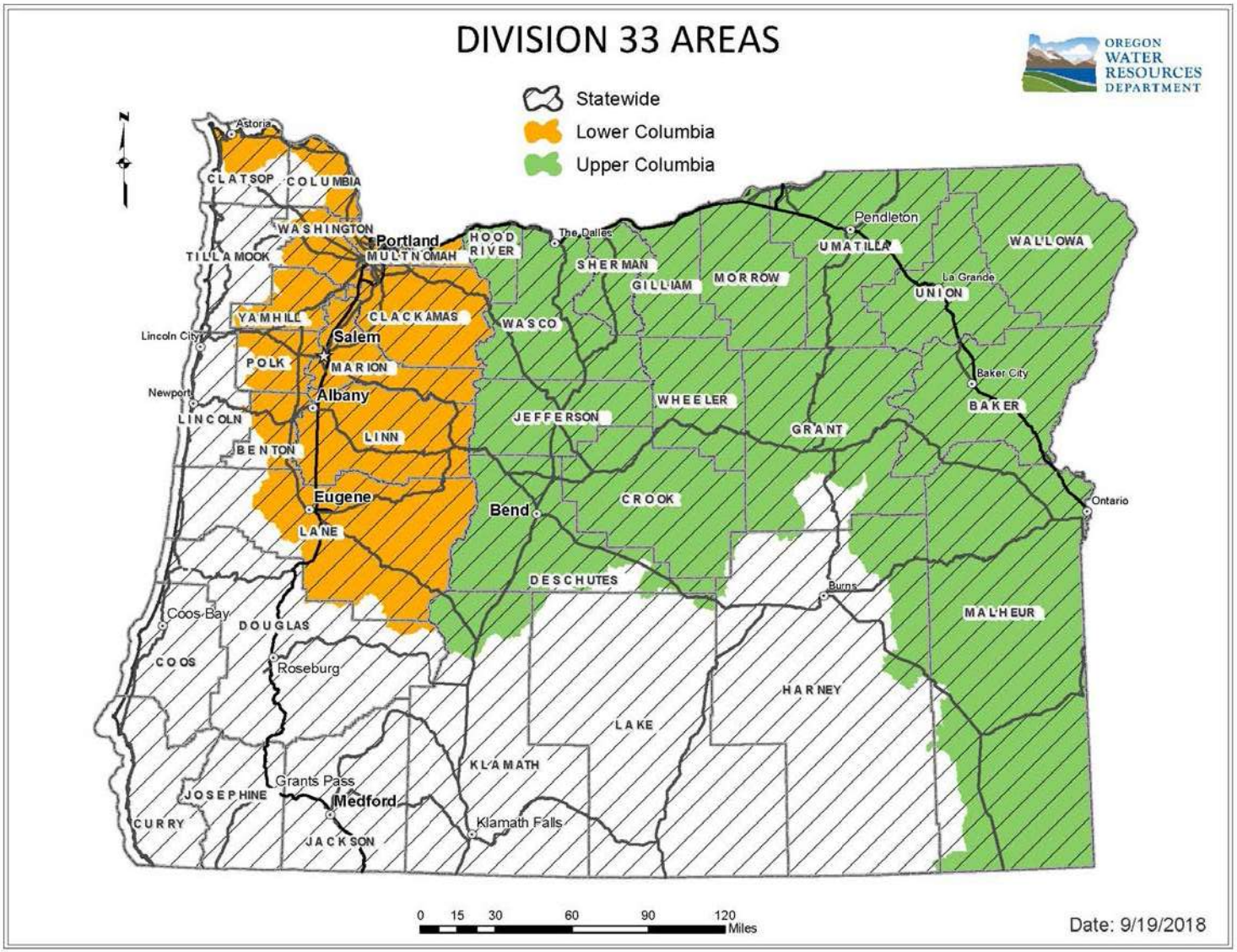
Figure 1: Map of Division 33 Areas



For more detailed information, click on the following link and enter the TRSQQ or the Lat/Long of a POD and click on "Submit" to retrieve a report that will show which section, if any, of the rules apply: https://apps.wrd.state.or.us/apps/misc/lkp_trsqq_features/

Appendix O: ODEQ Storm Water Permit Application

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

APPLICATION FOR NEW NPDES GENERAL PERMIT 1200-Z

Instructions for Completion of 1200-Z Industrial Stormwater Application: Please answer all questions. An incomplete application will not be processed. If the information requested is not applicable, please indicate as such.

A. REFERENCE INFORMATION

1. Enter the legal name of the applicant. This must be the legal Oregon name (i.e., Acme Products, Inc.) or the legal representative of the company if it operates under an assumed business name (i.e., John Smith, dba Acme Products). The name must be a legal, active name registered with the Oregon Department of Commerce, Corporation Division (503) 378-4752, (http://egov.sos.state.or.us/br/pkg_web_name_srch_inq.login), unless otherwise exempted by their regulations. The permit will be issued to the legal name of the applicant.
2. Enter the common name of the facility or operation if different than the legal name.
3. Enter the physical location of the facility (not mailing address), including city, state, zip code, and county.
4. Enter the latitude and longitude of the approximate center of the facility or site in degrees/minutes/seconds to the nearest 15 seconds. Latitude and longitude can be obtained from DEQ's location finder web site at http://deqapp1/website/lit/data.asp. To get the longitude and latitude to appear you can also zoom in and re-center until you find the area. You may want to turn off DEQ interests to eliminate the yellow dots and you may want to turn on the Aerial Photos to help you locate the site (note that the aerial photos are over ten years old). The latitude and longitude will be indicated on the left side of the page once you have checked the locate place at the top of the page and clicked on a location.
5. Provide the primary Standard Industrial Classification (SIC) Code and Title for the facility and any additional SIC Codes that apply to the site. The SIC Code is a four digit number assigned to different businesses. The SIC Title corresponds to the Code and is a short description of activities that occur at a business. Typically, SIC Codes are used by the fire marshal or insurance companies. They are also used when filing taxes or registering as a corporation with the state. This may or may not be the SIC Codes(s) that you will use. The SIC Code must be the one(s) that pertain to the site industrial activities and may differ from that used for other purposes. If you do not know your SIC Code and Title, try the OSHA Web Site at http://www.osha.gov/pls/imis/sic_manual.html or contact DEQ or Agent office for assistance.
6. Indicate if the applicant is the owner of the facility.
7. Enter the name, telephone number, and mailing address of the Legal Contact. The Legal Contact is the person that receives official correspondence from DEQ, such as renewal notices or notices of noncompliance, and may be contacted if there are questions about this application.
8. Enter the name, telephone number and mailing address of the Facility Contact if different from the Legal Contact. The Facility Contact is the person located at the facility that has specific knowledge of the facility or operation under permit (e.g., the treatment plant operator), and may be contacted if there are specific questions about this application.
9. Enter invoicing information for billing purposes if different from the Legal Contact (e.g., "Invoice To: Business Office - Accounts Payable"). This must be the same company as the applicant.

B. STORMWATER DISCHARGE INFORMATION

1. Briefly describe the activities at the site that have the potential to contaminate stormwater. Such activities include the storage of materials or equipment outside, unloading and loading activities, maintenance activities, etc.
2. Indicate the name(s) of the receiving water(s) (i.e., indicate where stormwater runoff during construction will flow). Request information from local authority or other resource to determine the name of the receiving waterbody. Your receiving water may be a lake, stream, river, wetland or other waterbody, and may or may not be located adjacent to the site. Your stormwater may discharge directly to the receiving water or indirectly via a storm sewer system, an open drain or ditch, or other conveyance structure. Do NOT list a man-made conveyance, such as a storm sewer system, as your receiving water. If you discharge to an irrigation channel or ditch you must also indicate the owner or operator of the irrigation channel or ditch. Indicate the first natural receiving water your stormwater discharge enters.

   For example, if your discharge enters a storm sewer system, that empties into Trout Creek, which flows into Pine River, your receiving water is Trout Creek, because it is the first natural waterbody your discharge will reach. Similarly, a discharge into a ditch that feeds Spring Creek should be identified as "Spring Creek" since the ditch is a manmade conveyance. If you discharge into a municipal separate storm sewer system (MS4), you must identify the waterbody into which that portion of the storm sewer discharges. That information should be readily available from the operator of the MS4.

3. Determine if stormwater from your site will discharge to an impaired waterbody and identify the impairment pollutant(s) if the answer is yes. You can find this information by searching the database at: http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp.

When searching the database, be sure the waterbody selected is in the correct watershed (basin) and choose Water Quality Limited TMDL needed – 303(d) (Category 5).

If you answered 'Yes' to the previous question, your site must meet one of the following conditions to obtain coverage under this permit:

i. Prevent all pollutants for which the waterbody is impaired from exposure to stormwater and document in the Stormwater Pollution Control Plan (SWPCP) procedures taken to prevent exposure on-site; or
ii. Document in SWPCP that the pollutant(s) for which the waterbody is impaired are not present at the site; or
iii. Provide data and other technical information that demonstrates that the discharge is not expected to cause or contribute to an exceedance of the water quality standard for which the waterbody is impaired at the point of discharge to the waterbody if the pollutant(s) for which the waterbody is impaired are likely to be present at the site and DEQ has not issued a TMDL for the pollutant(s).Indicate if any tests have been done on the facility's stormwater runoff associated with industrial activities on the site. Attach any sampling results that may be available.

If a new discharger is unable to meet the above conditions, discharge must cease; or obtain coverage under an individual permit

4. The federal stormwater regulations (40 CFR 122.26(c)) require that your facility be investigated for the presence of non-stormwater discharges. Non-stormwater discharges are any discharges not associated with rain events such as discharges of wash water, boiler blowdown, non-contact cooling water, process wastewater, etc. Certain non-stormwater discharges are authorized under this permit (please see Schedule A, condition 5 of the permit).

   Please describe the method used to evaluate your site for the presence of non-stormwater discharges. Methods may include conducting a visual inspection of activities at the site during periods of dry weather to determine if there is any unusual drainage off the site; inspecting site plans or testing drainage lines to confirm that drains being used for non-stormwater discharges are connected to sanitary sewer (sewage treatment plant); or some combination of the above. By signing the application, you certify that such an investigation has been performed. Indicate if any non-stormwater discharges were found during the investigation that are not authorized by this permit or any other existing DEQ permit. For example, if flow was noted, describe the source of the non-stormwater discharge. At the time the application is reviewed, a determination will be made as to whether the non-stormwater discharge needs a permit.

5. Indicate if any leaks or spills of materials or wastes have occurred at the facility within the last three years.

6. Indicate if there are any other DEQ permits issued for this site. If so, please describe the permits and provide the permit numbers. Indicate if you are using any of the stormwater outfalls on site to discharge wastewater that is authorized under a different permit.

C. LAND USE COMPATABILITY STATEMENT

Land Use Compatibility Statement (LUCS) must be signed by local planning official. If there are any conditions placed on the land use approval, the findings must be included. The LUCS form may be obtained from DEQ at: http://www.oregon.gov/deq/Permits/Pages/LUCS.aspx.

D. SIGNATURE OF LEGALLY AUTHORIZED REPRESENTATIVE

A legally authorized representative must sign the application. The following are authorized to sign the document:

- **Corporation** — President, secretary, treasurer, vice-president, or any person who performs principal business functions; or a manager of one or more facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million that is authorized in accordance to corporate procedure to sign such documents
- **Partnership** — General partner *[list of general partners, their addresses and telephone numbers]*
- **Sole Proprietorship** — Owner(s) *[each owner must sign the application]*
- **City, County, State, Federal, or other Public Facility** — Principal executive officer or ranking elected official
- **Limited Liability Company** — Member
- **Trusts** — Acting trustee *[list of trustees, their addresses and telephone numbers]*

E. APPLICATION SUBMITTAL

Please send the following completed application materials to the appropriate DEQ regional office or Agents office: **Application form; Stormwater Pollution Control Plan (SWPCP); SWPCP checklist; Land Use Compatibility Statement (LUCS), and fees.** If applicable, also send a demonstration that your discharge does not or will not contribute to water quality impairments for any pollutant listed in Table 4, Schedule B.1 of the permit. For more information on preparing a SWPCP, please see DEQ's guidance document, located at http://www.oregon.gov/deq/wq/wqpermits/Pages/Stormwater-Industrial.aspx DEQ has entered into agreements with jurisdictions knows as "Agents" to process the permit applications and administer the permits on DEQ's behalf. If your project is located in one of these areas, please submit your application materials to the Agent, including one electronic and one paper copy of the SWPCP.

DEQ Northwest Region	DEQ Western Region		DEQ Eastern Region		
700 Lloyd Building at 700 NE Multnomah St., Suite #600, Portland, OR 97232 503-229-5438	165 East 7th Avenue, Suite 100 Eugene, OR 97401 541-686-7930		800 SE Emigrant Avenue, Suite 330 Pendleton, OR 97801 541-278-4605		
Clackamas	Benton	Lane	Baker	Hood River	Sherman
Clatsop	Coos	Lincoln	Crook	Jefferson	Umatilla
Columbia	Curry	Linn	Deschutes	Klamath	Union
Multnomah	Douglas	Marion	Gilliam	Lake	Wallowa
Tillamook	Jackson	Polk	Grant	Malheur	Wasco
Washington	Josephine	Yamhill	Harney	Marrow	Wheeler
AGENT OFFICES					
Clean Water Services 2550 SW Hillsboro Highway Hillsboro, OR 97123 503-681-5175 *Includes Banks, Beaverton, Cornelius, Durham, Forest Grove, Gaston, Hillsboro, King City, North Plains, Sherwood, Tigard, Tualatin, and portions of Washington Co.*	**City of Portland** Bureau of Environmental Services Water Pollution Control Laboratory 6543 N. Burlington Ave. Portland, OR 97203-5452 503-823-7584		**City of Eugene** Industrial Source Control 410 River Ave. Eugene, OR 97404 541-682-8616		

DEQ USE ONLY
File #:
Application #:
LLID/RM:
River Mile:
Legal Name Confirmed: ☐
Notes:

DEQ
State of Oregon Department of Environmental Quality

DEPARTMENT OF ENVIRONMENTAL QUALITY APPLICATION FOR NEW NPDES GENERAL PERMIT 1200-Z

DEQ USE ONLY
Date Received:
Amount: $
Check #:
Check Name:
Deposit #:
Receipt #:
Notes:

A. REFERENCE INFORMATION

1. Legal Name: Calico Resources USA Corp.

2. Common Name: Grassy Mountain Mine

3. Facility Physical Address: 17 miles south of Vale, Oregon, off of Russell Road
   City, State, Zip Code: Vale, Oregon 97918
   County: Malheur

4. Site Location by Latitude and Longitude:
   Latitude: 43 /40 / 27 Degrees/Minutes/Seconds
   Longitude: 117 / 21 / 38 Degrees/Minutes/Seconds

5. Primary SIC code and Title: 1041
   Additional SIC Codes:

6. Is the applicant the owner of the facility? ■ Yes ☐ No

7. Legal Contact : Carlo Buffone — Telephone #: 775-625-3600 — Email: carlo@paramountnevada.com
   Mailing Address: 665 Anderson St — City, State, Zip Code: Winnemucca, NV 89445

8. Facility Contact: Nancy J. Wolverson — Telephone #: 775-770-4615 — Email: nancy@paramountnevada.com
   Mailing Address: 665 Anderson St — City, State, Zip Code: Winnemucca, NV 89445

9. Invoice to: Cheryl Evans — Telephone #: 775-625-3600 — Email: cheryl@paramountnevada.com
   Billing Address: 665 Anderson St — City, State, Zip Code: Winnemucca, NV 89445

B. STORMWATER DISCHARGE INFORMATION

1. Briefly describe the various activities that take place on your site that may result in industrial pollutants contaminating stormwater runoff from the site:

See supplemental information page attached.

2. Receiving waterbody: List the name(s) of the water(s) that receive stormwater from your facility: Malheur River

   ☐ Direct Discharge

   ■ Indirect Discharge through a Municipal Storm Sewer System (MS4), infiltration device or other manmade conveyance system

   ☐ Irrigation channel or ditch and owner or operator of irrigation channel

3. Does your facility discharge stormwater to a waterbody that is impaired without a Total Maximum Daily Load (TMDL), based on EPA-approved 303(d) list (Category 5) that is in effect on May 1, 2017: ■ Yes ☐ No

   If you answered 'Yes' to the previous question, your site must meet one of the following conditions to obtain coverage under this permit:

   i. Prevent all pollutants for which the waterbody is impaired from exposure to stormwater and document in the Stormwater Pollution Control Plan (SWPCP) procedures taken to prevent exposure on-site;
   ii. Document in SWPCP that the pollutant(s) for which the waterbody is impaired is not present at the site, or
   iii. Provide data and other technical information that demonstrates that the discharge is not expected to cause or contribute to an exceedance of the water quality standard for which the waterbody is impaired at the point of discharge to the waterbody if the pollutant(s) for which the waterbody is impaired are likely to be present at the site and DEQ has not issued a TMDL for the pollutant(s).

   Has any stormwater analytical data been collected for the site? ☐ Yes (If 'Yes', please attach the Laboratory Results) ■ No

4. Have all stormwater outfalls associated with industrial activities on your site been evaluated for the presence of non-stormwater discharges not otherwise authorized by this permit or another NPDES permit?

There are no existing storm water outfalls on the Project site.

If unauthorized or unpermitted non-stormwater discharges were discovered during the investigation, please list the wastewater source(s):

By signing this application, you certify that this investigation has occurred and there are no unauthorized or unpermitted discharges.

5. Have any leaks or spills or other instances of stormwater contamination occurred at the site within the last three (3) years?
☐ Yes ■ No If Yes, please describe below:

6. Are there other DEQ water quality permits issued for this site? ☐ Yes ■ No If Yes, please describe the permits and provide the permit No(s):

Are you using any stormwater outfalls on site to discharge permitted wastewater? If so, describe:

See supplemental information page attached.

C. LAND USE COMPATABILITY STATEMENT

Attach the *original* and complete Land Use Compatibility Statement (LUCS) signed by the local land use authority. The application will not be processed unless the local land use authority approves it and it meets statewide planning goals.

D. SIGNATURE OF LEGALLY AUTHORIZED REPRESENTATIVE

I hereby certify that the information contained in this application is true and correct to the best of my knowledge and belief. In addition, I agree to pay all permit fees required by Oregon Administrative Rules 340-45. This includes a renewal application fee to renew the permit and a compliance determination fee invoiced annually by DEQ to maintain the permit.

Carlo Buffone	Chief Executive Officer & Treasurer
Name of Legally Authorized Representative (Type or Print)	**Title**
C. Buffone	10/30/2019
Signature of Legally Authorized Representative	**Date**

E. APPLICATION SUBMITTAL

The following application materials must be completed and submitted to the DEQ regional office or to a DEQ Agent (see instructions for list of DEQ regional office and Agents):

☐ Signed Application form.

☐ Land Use Compatibility Statement with signature of the local land use planning official and the LUCS Findings, if applicable.

☐ Stormwater Pollution Control Plan and Checklist.

☐ Application fee. Appropriate fees are available at: http://www.oregon.gov/deq/Rulemaking%20Docs/340-045-0075WQFeeTables.pdf. Both the application and first annual fee must be included with the application materials. An annual fee will be assessed each year coverage is maintained. Make the check payable to DEQ

If you are sending your application to a DEQ Agent, check with the DEQ Agent for the appropriate fees and make check payable to the DEQ Agent.

Grassy Mountain Mine Project
Application for New NPDES General Permit 1200-Z
Supplemental Information

1. All stormwater falling on the process facility, portal entrance, waste rock dump, and tailings storage facility (TSF) will be collected and managed, and not allowed to leave the Project site. This will include areas for storage, unloading, loading, and handling. Leaks or spills may occur on the access and haul roads. Non-contact stormwater runoff from these areas may drain south to north towards the J-H Canal and eventually into the Malheur River.

2. The closest natural receiving water body is the Malheur River. Stormwater drains south to north in drainage channels through Negro Canyon and eventually into the Malheur River. The Owyhee River and Reservoir are closer to the Project site, but Grassy Mountain serves as a natural barrier between the two watersheds, and the surface flow direction is south to north, away from the Owyhee River and Reservoir.

3. Portions of the Malheur River are ranked Category 5 and are impaired without a Total Maximum Daily Load. Stormwater analytical data have not been collected for the site.

6. During Project operations, methods used to ensure non-stormwater discharges for the TSF will include:

   - A visual inspection of the geomembrane-lined containment channels; and
   - A leak detection system will be installed between the TSF, waste rock dump, and Reclaim Pond which will be monitored via riser pipes installed near the reclaim pond.

   The Process Area will utilize geomembrane- and concrete-lined containment areas. If either of these areas are overtopped, all water from the Process Area will be collected within the containment pond so the process water will still not be allowed to leave the site.

Appendix P: OWRD Water Rights

November 13, 2019

Ms. Sarah Lewis
MLRR Program Manager
Oregon Department of Geology and Mineral Industries
Mineral Land Regulation & Reclamation Program
229 Broadalbin St. SW
Albany, Oregon 97321-2246
Direct: (541) 967-2053
Cell: (503) 853-5139
Sarah.Lewis@oregon.gov

RE: Appendix P Water Rights, Consolidated Permit Application (CPA), Grassy Mountain Mine Project

Dear Ms. Lewis:

On March 27, 2019, Calico Resources USA Corp filed an application to amend Permit G-10994. On October 16, 2019, the Oregon Water Resources Department (OWRD) issued a final order approving the requested changes, together with a superseding permit reflecting the changes. On November 12, 2019, OWRD notified Calico that it will be reconsidering the final order and superseding permit issued on October 16, 2019. The purpose of the reconsideration is to issue a correcting order and new superseding permit that more accurately reflect the intended changes described in the application. Calico expects to receive a new final order and superseding permit by early December 2019.

Documentation regarding the process described above is included in Appendix P of the CPA.

Please contact me at 775-770-4615 if you have any questions or need clarification.

Sincerely,

Nancy J. Wolverson
Permitting Coordinator
Calico Resources USA Corp./Paramount Gold Nevada Corp.
(775) 770-4615
nancy@paramountnevada.com

attachments

Oregon Water Resources Department
Water Right Services Division

Water Rights Application
Number G-11847

Final Order
Extension of Time for Permit Number G-10994
Permit Holder: Seabridge Gold Corp

Appeal Rights

This is a final order in other than a contested case. This order is subject to judicial review under ORS 183.484. A request for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either file for judicial review, or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

Application History

Permit G-10994 was issued by the Department on April 5, 1990 to Atlas Precious Metals, Inc. On December 2, 2003, the permit was assigned to Seabridge Gold Corporation. The permit called for completion of construction by October 1, 1992 and complete application of water to beneficial use by October 1, 1993. Five prior permit extensions have been granted for Permit G-10994. The most recent extension request resulted in the completion dates for construction and full application of water being extended from October 1, 1997 to October 1, 2008. On February 8, 2012, Calico Resources USA Corp. on behalf of the permit holder, Seabridge Gold Corp., submitted to the Department an Application for Extension of Time for Permit G-10994. On June 12, 2012, the Department issued a Proposed Final Order proposing to extend the time to complete construction to October 1, 2028 and the time to fully apply water to beneficial use to October 1, 2028. The protest period closed July 27, 2012. No protest was filed.

On November 6, 2012, the Department issued a superceding Proposed Final Order proposing to extend the time to complete construction to October 1, 2028 and the time to fully apply water to beneficial use to October 1, 2028. Comments were received from Martha Pagel, on behalf of Calico Resources USA Corp dated December 5, 2012.
The protest period closed December 21, 2012. No protest was filed.

The Department adopts and incorporates by reference the Proposed Final Order dated November 6, 2012, with the exception of three changes described below:

1: New Finding of Fact Number 12:

Compliance with Conditions *[OAR 690-315-0040(3)(c)]*
The water right permit holder's conformance with the permit or previous extension conditions.

a. The Department has considered the permit holder's compliance with conditions and has not identified any concerns.

Explanation for change in finding: In the November 6, 2012, Proposed Final Order, the Department stated that "the record does not show the maintenance and use of adequate treatment facilities to remove sediment before returning the water to the stream." This concern has been satisfied by the December 5, 2012 letter which explains that there have been no discharges to the stream. This eliminates the necessity for the permit holder to install or maintain treatment facilities.

2: New finding of Fact Number 24:

Unforeseen Events [OAR 690-315-0040(2)(h)]
The Department recognizes that there have been at least two unforeseen events that have contributed to the delay of the development of this project: (1) the bankruptcy of former permit holder Atlas and resulting sale of the property to Seabridge (which occurred during the last extension period, between 1999 and 2003); and (2) a significant drop in the price of gold, which only began to recover near the end of the extension period.

Explanation for change in finding: The December 5, 2012, letter from Ms. Pagel points out, and clarifies, information already in the record relative to the delay in development.

3: Last Extension Condition:

In consultation with Ms. Pagel's office, and consistent with the December 5, 2012 letter, the Department has agreed to a change in condition wording that is clearer and should reduce the potential for confusion in the future:

New Last Extension Condition:

"This is to be the last extension of time granted for Permit G-10994. Any future extensions of time requests will be denied."

The Department concluded that, based on the factors demonstrated by the applicant, the permit may be extended subject to the following conditions:

CONDITIONS

1. **Last Extension Condition**

This is to be the last extension of time granted for Permit G-10994. Any future extensions of time requests will be denied.

2. **Checkpoint Condition**

The permit holder must submit a completed Progress Report Form to the Department by **October 1, 2017, October 1, 2022, and October 1, 2027.** ***A form will be enclosed with your Final Order.***

(a) At each checkpoint, the permit holder shall submit and the Department shall review evidence of the permit holder's diligence towards completion of the project and compliance with terms and conditions of the permit and extension. If, after this review, the Department determines the permit holder has not been diligent in developing and perfecting the water use permit, or complied with all terms and conditions, the Department shall modify or further condition the permit or extension to ensure future compliance, or begin cancellation proceedings on the undeveloped portion of the permit pursuant to ORS 537.260 or 537.410, or require submission of a final proof survey pursuant to ORS 537.250;

(b) The Department shall provide notice of receipt of progress reports in its weekly notice and shall allow a 30 day comment period for each report. The Department shall provide notice of its determination to anyone who submitted comments.

The applicant has demonstrated good cause for the permit extension pursuant to ORS 537.630, 539.010(5) and OAR 690-315-0040(2).

Order

The extension of time for Application G-11847, Permit G-10994, therefore, is approved subject to conditions contained herein. The deadline for completing construction and the deadline for applying water to full beneficial use within the terms and conditions of the permit is extended from October 1, 2008 to October 1, 2028.

DATED: December 26, 2012

Dwight W. French, Water Right Services Administrator, *for*
PHILLIP C. WARD, DIRECTOR

Mailing List for Extension FO Copies

Note: Include a copy of the "Important Notice" document along with the original copy of the Final Order being sent to the permit holder.

FO Date: December _____, 2012 **Copies Mailed**

Application G-11847 By: _____
Permit G-10994 On: _____

Original mailed to permit holder

Seabridge Gold Corp
172 King Street E
Toronto, Ontario, Canada M5A 1J3

Bill Wagener, President and CEO
Calico Resources USA Corp
122 A Street East
PO Box Q
Vale, OR 97918

Copies sent to:

1. WRD - App. File G-11847/ Permit G-10994
2. WRD - Watermaster District 9, Ron Jacobs

Fee paid as specified under ORS 536.050 to receive copy:

3. None

Receiving via e-mail (10 AM Tuesday of signature date)
(DONE BY EXTENSION SPECIALIST)

4. Martha O. Pagel, Schwabe, Williamson & Wyatt, Agent.
   Email: mpagel@schwabe.com

If Progress Reports are included:
(DONE BY EXTENSION SPECIALIST)
Add record to Progress Report tracking sheet.xls Done: by_____Date_____

CASEWORKER: JMS/DWF

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

Extension of Time
Progress Report Form
For Checkpoints

TO THE DIRECTOR OF THE OREGON WATER RESOURCES DEPARTMENT

Permit Holder: Seabridge Gold Corp

Application G-11847
Permit G-10994

Report Due no later than October 1, 2017
DO NOT SUBMIT PRIOR TO 30 DAYS BEFORE DUE DATE

Progress Report Form for 2017

As authorized in ORS 690-315-0050(6), this progress report is required in order to ensure diligence is exercised in the development and perfections of Permit G-10994. **FAILURE TO SUBMIT THIS REPORT WILL MOST LIKELY RESULT IN ANY FUTURE EXTENSION BEING DENIED.**

INSERT DATES	LIST ALL WORK ACCOMPLISHED and FINANCIAL INVESTMENTS For the period of time between October 1, 2008 and October 1, 2017	FINANCIAL INVESTMENT

2. Compliance with terms and conditions of the permit and/or previous extension.

3. Total number of acres irrigated to date= _____ *(if applicable)*

4. Provide the maximum rate, or duty if applicable, of water diverted for beneficial use under this permit, if any, made to date.

Maximum rate used to date = _____**cfs (cubic feet per second), or**

Maximum rate used to date = _____**gpm (gallons per minute), or**

Acre Feet stored to date = _____**AF**

Report the rate in the same units of measurement as specified in the permit, being cfs (cubic feet per second), gpm (gallons per minute) or AF (acre-feet). ***Do not provide daily, monthly or annual water volume totals.***

INCOMPLETE REORTS WILL BE RETURNED. AN ANSWER IS REQUIRED IN EACH ITEM. USE N/A FOR ITEM 3 IF THE USE IS NOT IRRIGATION.

Signature_____ Date_____

For OWRD use only

Diligence Shown ☐ Yes ☐ No Date Public Noticed: _____

Reviewed by: _____ Date: _____

BEFORE THE WATER RESOURCES DEPARTMENT
OF THE
STATE OF OREGON

In the Matter of Permit Amendment T-13157, Malheur County	)	FINAL ORDER APPROVING ADDITIONAL POINTS OF APPROPRIATION, A CHANGE IN POINTS OF APPROPRIATION, AND A CHANGE IN PLACE OF USE

Authority

Oregon Revised Statute (ORS) 537.211 establishes the process in which a water right permit holder may submit a request to change the point of appropriation and/or place of use authorized under an existing water right permit.

Applicant

CALICO RESOURCES USA CORP.
C/O NANCY WOLVERSON
665 ANDERSON ST
WINNEMUCCA, NV 89445

Findings of Fact

1. On March 27, 2019, CALICO RESOURCES USA CORP., C/O NANCY WOLVERSON filed an application for additional points of appropriation, to change the point of appropriation, and a change in place of use under Permit G-10994. The Department assigned the application number T-13157.

2. On October 5, 1996, the Department approved an assignment of the permit from Newmont Grassy Mountain Corporation to Atlas Precious Metals, Inc.

3. On December 26, 2012, the Department approved an extension of time for complete application of water to October 1, 2028.

4. On December 3, 2003, the Department approved an assignment of the permit from Atlas Precious Metals, Inc. to Seabridge Gold Corporation.

5. On March 7, 2013, the Department approved an assignment of the permit from Seabridge Gold Corporation to Calico Resources USA Corp.

6. Notice of the application for the permit amendment was published in the Department's weekly notice on April 9, 2019, and in the Argus Observer newspaper on September 1 and 8, 2019, pursuant to ORS 540.520(5). No comments were filed in response to the notices.

This is a final order in other than contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 and OAR 690-01-0005 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

7. On July 17, 2019, the Department contacted the applicant by written correspondence to notify the applicant and the applicant's agent of deficiencies in the application. The Department requested that the deficiencies be resolved by August 19, 2019.

8. On July 24, 2019, the applicant's agent submitted revised maps.

9. On July 31, 2019, the applicant's agent submitted a revised Land Use Information form, resolving the deficiencies.

10. Permit Amendment Application T-13157 proposes to move the authorized point of appropriation for Well 2 approximately 1.1 miles from the existing point of appropriation to:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
22 S	44 E	WM	8	SW NE	WELL 2 - 43 DEGREES 40 MINUTES 23.24 SECONDS NORTH AND 117 DEGREES 21 MINUTES 15.73 SECONDS WEST

11. Permit Amendment Application T-13157 proposes additional points of appropriation as follows:

Twp	Rng	Mer	Sec	Q-Q	Survey coordinates	Approximate distance from authorized points of appropriation in miles (mi.)	
						WELL 1	WELL 2
21 S	44 E	WM	32	NE NW	WELL 5 - 43 DEGREES 42 MINUTES 19.02 SECONDS NORTH AND 117 DEGREES 21 MINUTES 57.62 SECONDS WEST	1.0 mi.	1.2 mi.
21 S	44 E	WM	32	SE NW	WELL 3 - 43 DEGREES 42 MINUTES 5.28 SECONDS NORTH AND 117 DEGREES 21 MINUTES 56.54 SECONDS WEST	0.7 mi.	0.9 mi.
21 S	44 E	WM	32	SE NW	WELL 4 - 43 DEGREES 42 MINUTES 11.99 SECONDS NORTH AND 117 DEGREES 21 MINUTES 57.01 SECONDS WEST	0.8 mi.	1.0 mi.
21 S	44 E	WM	32	NE SW	WELL 7 - 43 DEGREES 41 MINUTES 55.59 SECONDS NORTH AND 117 DEGREES 21 MINUTES 56.85 SECONDS WEST	0.6 mi.	0.8 mi.
22 S	44 E	WM	5	SW SW	WELL 6 - 43 DEGREES 40 MINUTES 51.62 SECONDS NORTH AND 117 DEGREES 22 MINUTES 7.26 SECONDS WEST	0.8 mi.	0.6 mi.
22 S	44 E	WM	8	SW NE	ENTIRE UNDERGROUND AREA		
22 S	44 E	WM	8	NE SW	ENTIRE UNDERGROUND AREA		
22 S	44 E	WM	8	NW SE	ENTIRE UNDERGROUND AREA		

12. Permit Amendment Application T-13157 also proposes to change the place of use of the permit to:

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
19 S	44 E	WM	22	NE NE	
19 S	44 E	WM	22	SE NE	
19 S	44 E	WM	22	NE SE	
19 S	44 E	WM	23	NW NW	
19 S	44 E	WM	23	SW NW	
19 S	44 E	WM	23	NW SW	
19 S	44 E	WM	23	SW SW	
19 S	44 E	WM	26	NW NE	
19 S	44 E	WM	26	SW NE	
19 S	44 E	WM	26	SE NE	
19 S	44 E	WM	26	NE NW	
19 S	44 E	WM	26	NW NW	
19 S	44 E	WM	26	NE SE	
19 S	44 E	WM	26	SE SE	
19 S	44 E	WM	35	NE NE	
19 S	44 E	WM	36	NW NW	
19 S	44 E	WM	36	SW NW	
19 S	44 E	WM	36	NE SW	
19 S	44 E	WM	36	NW SW	
19 S	44 E	WM	36	SE SW	
20 S	44 E	WM	1	NE NE	1
20 S	44 E	WM	1	SE NE	
20 S	44 E	WM	1	NE SE	
20 S	44 E	WM	1	SE SE	
20 S	44 E	WM	12	NE NE	
20 S	44 E	WM	12	SW NE	
20 S	44 E	WM	12	SE NE	
20 S	44 E	WM	12	NE SW	
20 S	44 E	WM	12	SE SW	
20 S	44 E	WM	12	NW SE	
20 S	44 E	WM	12	SW SE	
20 S	44 E	WM	13	NW 1/4	
20 S	44 E	WM	13	NW SW	
20 S	44 E	WM	13	SW SW	
20 S	44 E	WM	14	NE SE	
20 S	44 E	WM	14	SE SE	
20 S	44 E	WM	23	NE NE	
20 S	44 E	WM	23	SE NE	
20 S	44 E	WM	23	SE SW	
20 S	44 E	WM	23	SE 1/4	
20 S	44 E	WM	26	NW NE	
20 S	44 E	WM	26	NE NW	
20 S	44 E	WM	26	SW NW	
20 S	44 E	WM	26	SE NW	
20 S	44 E	WM	26	NW SW	
20 S	44 E	WM	26	SW SW	
20 S	44 E	WM	27	NE SE	
20 S	44 E	WM	27	SE SE	
20 S	44 E	WM	34	NE NE	

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
20 S	44 E	WM	34	SE NE	
20 S	44 E	WM	34	NE SE	
20 S	44 E	WM	34	SW SE	
20 S	44 E	WM	34	SE SE	
20 S	45 E	WM	6	NW SW	6
20 S	45 E	WM	6	SW SW	7
20 S	45 E	WM	7	NW NW	1
21 S	43 E	WM	36	SE NE	
21 S	43 E	WM	36	NE SE	
21 S	43 E	WM	36	SE SE	
21 S	44 E	WM	3	NE NE	1
21 S	44 E	WM	3	NW NE	2
21 S	44 E	WM	3	SW NE	
21 S	44 E	WM	3	SE NE	
21 S	44 E	WM	3	NE SE	
21 S	44 E	WM	3	NW SE	
21 S	44 E	WM	3	SE SE	
21 S	44 E	WM	10	NE NE	
21 S	44 E	WM	10	SE NE	
21 S	44 E	WM	11	NW NW	
21 S	44 E	WM	11	SW NW	
21 S	44 E	WM	11	NE SW	
21 S	44 E	WM	11	NW SW	
21 S	44 E	WM	11	SW SW	
21 S	44 E	WM	11	SE SW	
21 S	44 E	WM	12	ALL	
21 S	44 E	WM	13	ALL	
21 S	44 E	WM	14	ALL	
21 S	44 E	WM	21	SE SE	
21 S	44 E	WM	22	NE NE	
21 S	44 E	WM	22	NW NE	
21 S	44 E	WM	22	SW NE	
21 S	44 E	WM	22	SE NE	
21 S	44 E	WM	22	NW 1/4	
21 S	44 E	WM	22	SW 1/4	
21 S	44 E	WM	22	SE 1/4	
21 S	44 E	WM	23	ALL	
21 S	44 E	WM	24	ALL	
21 S	44 E	WM	25	ALL	
21 S	44 E	WM	26	ALL	
21 S	44 E	WM	27	ALL	
21 S	44 E	WM	28	ALL	
21 S	44 E	WM	29	SE NE	
21 S	44 E	WM	29	SE SW	
21 S	44 E	WM	29	SE 1/4	
21 S	44 E	WM	31	NE NE	
21 S	44 E	WM	31	SW NE	
21 S	44 E	WM	31	SE NE	
21 S	44 E	WM	31	SE NW	2
21 S	44 E	WM	31	NE SW	3
21 S	44 E	WM	31	SE SW	4

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
21 S	44 E	WM	31	SE 1/4	
21 S	44 E	WM	32	ALL	
21 S	44 E	WM	33	ALL	
21 S	44 E	WM	34	ALL	
21 S	44 E	WM	35	ALL	
21 S	44 E	WM	36	ALL	
21 S	45 E	WM	7	ALL	
21 S	45 E	WM	18	ALL	
21 S	45 E	WM	19	ALL	
21 S	45 E	WM	30	NW NW	1
21 S	45 E	WM	30	SW NW	2
21 S	45 E	WM	30	NW SW	3
21 S	45 E	WM	30	SW SW	4
22 S	43 E	WM	1		1
22 S	43 E	WM	1		2
22 S	43 E	WM	1	SW SW	
22 S	43 E	WM	1	SE SW	
22 S	43 E	WM	1	SE 1/4	
22 S	43 E	WM	12	ALL	
22 S	43 E	WM	13	ALL	
22 S	43 E	WM	24	ALL	
22 S	43 E	WM	25	N 1/2	
22 S	44 E	WM	1	E 1/2	
22 S	44 E	WM	2	NE NW	3
22 S	44 E	WM	2	NW NW	4
22 S	44 E	WM	2	SW NW	
22 S	44 E	WM	2	SE NW	
22 S	44 E	WM	2	SW 1/4	
22 S	44 E	WM	3	ALL	
22 S	44 E	WM	4	ALL	
22 S	44 E	WM	5	ALL	
22 S	44 E	WM	6	ALL	
22 S	44 E	WM	7	ALL	
22 S	44 E	WM	8	ALL	
22 S	44 E	WM	9	ALL	
22 S	44 E	WM	10	ALL	
22 S	44 E	WM	15	NW NE	
22 S	44 E	WM	15	SW NE	
22 S	44 E	WM	15	W 1/2	
22 S	44 E	WM	15	NW SE	
22 S	44 E	WM	15	SW SE	
22 S	44 E	WM	16	ALL	
22 S	44 E	WM	17	ALL	
22 S	44 E	WM	18	ALL	
22 S	44 E	WM	19	ALL	
22 S	44 E	WM	20	N 1/2	
22 S	44 E	WM	20	NE SW	
22 S	44 E	WM	20	NW SW	
22 S	44 E	WM	20	NE SE	
22 S	44 E	WM	20	NW SE	
22 S	44 E	WM	21	N 1/2	

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
22 S	44 E	WM	21	NE SW	
22 S	44 E	WM	21	NW SW	
22 S	44 E	WM	21	NE SE	
22 S	44 E	WM	21	NW SE	
22 S	44 E	WM	30	N 1/2	

Permit Amendment Review Criteria

13. The changes would not result in injury to other water rights.

14. The proposed place of use is owned and/or controlled by the permit holder.

15. The changes do not enlarge the permit.

16. The changes do not alter any other terms of the permit.

17. The proposed place of use is contiguous to the authorized place of use.

Conclusions of Law

The additional points of appropriation, change in point of appropriation, and change in place of use proposed by Permit Amendment Application T-13157 are consistent with the requirements of ORS 537.211.

Now, therefore, it is ORDERED:

1. The additional points of appropriation, change in point of appropriation, and change in place of use proposed by Permit Amendment Application T-13157 are approved.

2. Permit G-18306, in the name of Calico Resources USA Corp., is issued to replace Permit G-10994, and incorporates the amendments approved by this order, the extension of time, and the assignment. Permit G-10994, in the name of CALICO RESOURCES USA CORP., is no longer of any force or effect.

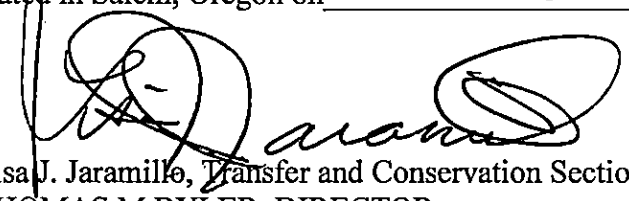
3. The quantity of water diverted at the new point of appropriation (Well 2), together with that diverted at the old point of appropriation (Well 2), shall not exceed the quantity of water lawfully available at the original point of appropriation (Well 2).

4. The combined quantity of water diverted at the new points of appropriation (Wells 3, 4, 5, 6, 7, and underground area), together with that diverted at the old points of appropriation (Wells 1 and 2), shall not exceed the quantity of water lawfully available at the original points of appropriation (Wells 1 and 2).

5. Water shall be acquired from the same aquifer as the original points of appropriation.

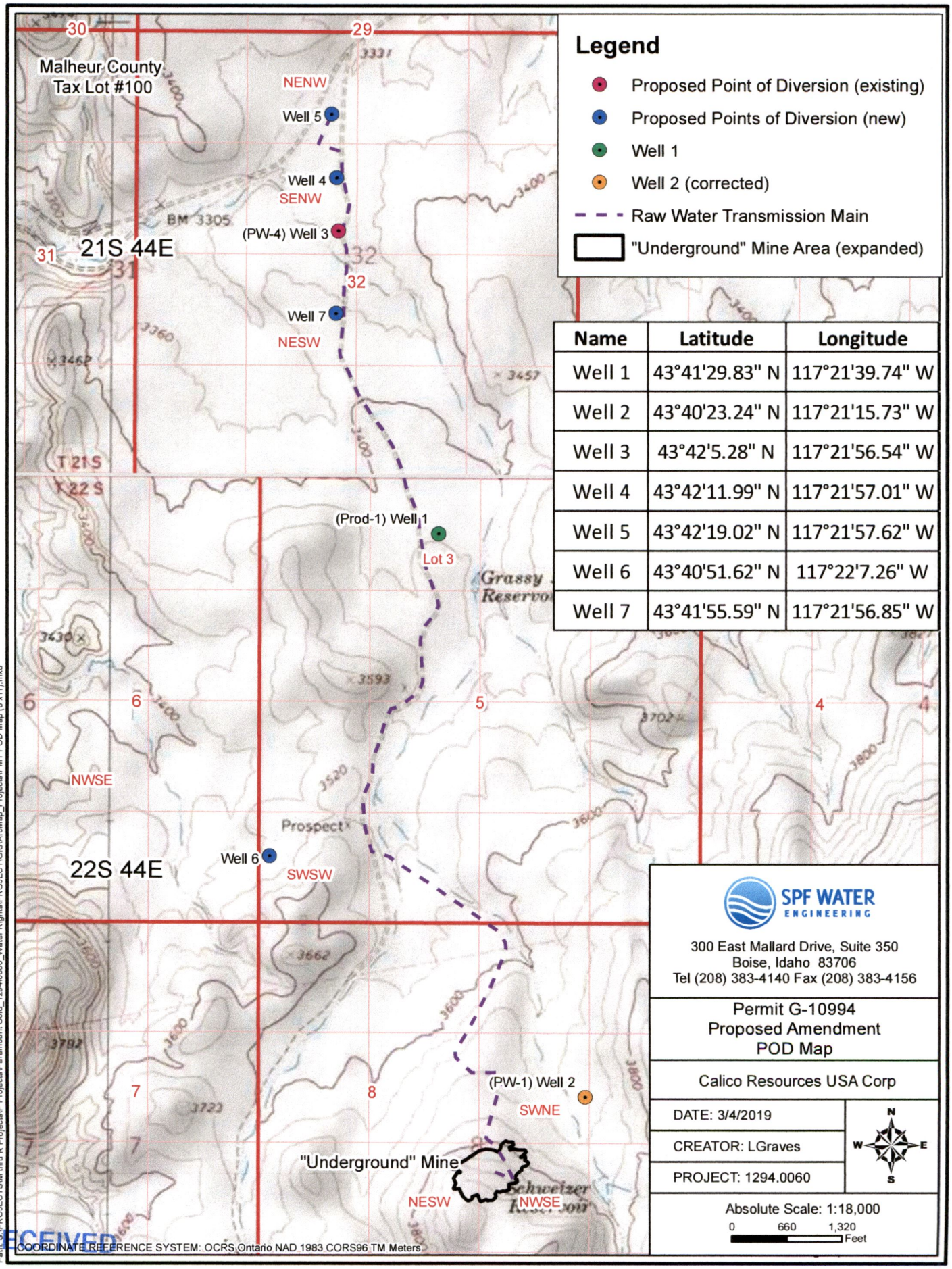
6. All other terms and conditions of Permit G-18306 remain the same.

Dated in Salem, Oregon on OCT 16 2019



Lisa J. Jaramillo, Transfer and Conservation Section Manager, for
THOMAS M BYLER, DIRECTOR
Oregon Water Resources Department

Mailing Date: OCT 17 2019



Name	Latitude	Longitude
Well 1	43°41'29.83" N	117°21'39.74" W
Well 2	43°40'23.24" N	117°21'15.73" W
Well 3	43°42'5.28" N	117°21'56.54" W
Well 4	43°42'11.99" N	117°21'57.01" W
Well 5	43°42'19.02" N	117°21'57.62" W
Well 6	43°40'51.62" N	117°22'7.26" W
Well 7	43°41'55.59" N	117°21'56.85" W

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

Permit G-10994
Proposed Amendment
POD Map

Calico Resources USA Corp

DATE: 3/4/2019
CREATOR: LGraves
PROJECT: 1294.0060

Absolute Scale: 1:18,000
0 660 1,320 Feet

COORDINATE REFERENCE SYSTEM: OCRS Ontario NAD 1983 CORS96 TM Meters

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0060_Water Rights\PROJECT\GIS\ArcMap_Projects\PMT POD Map (8 x11).mxd

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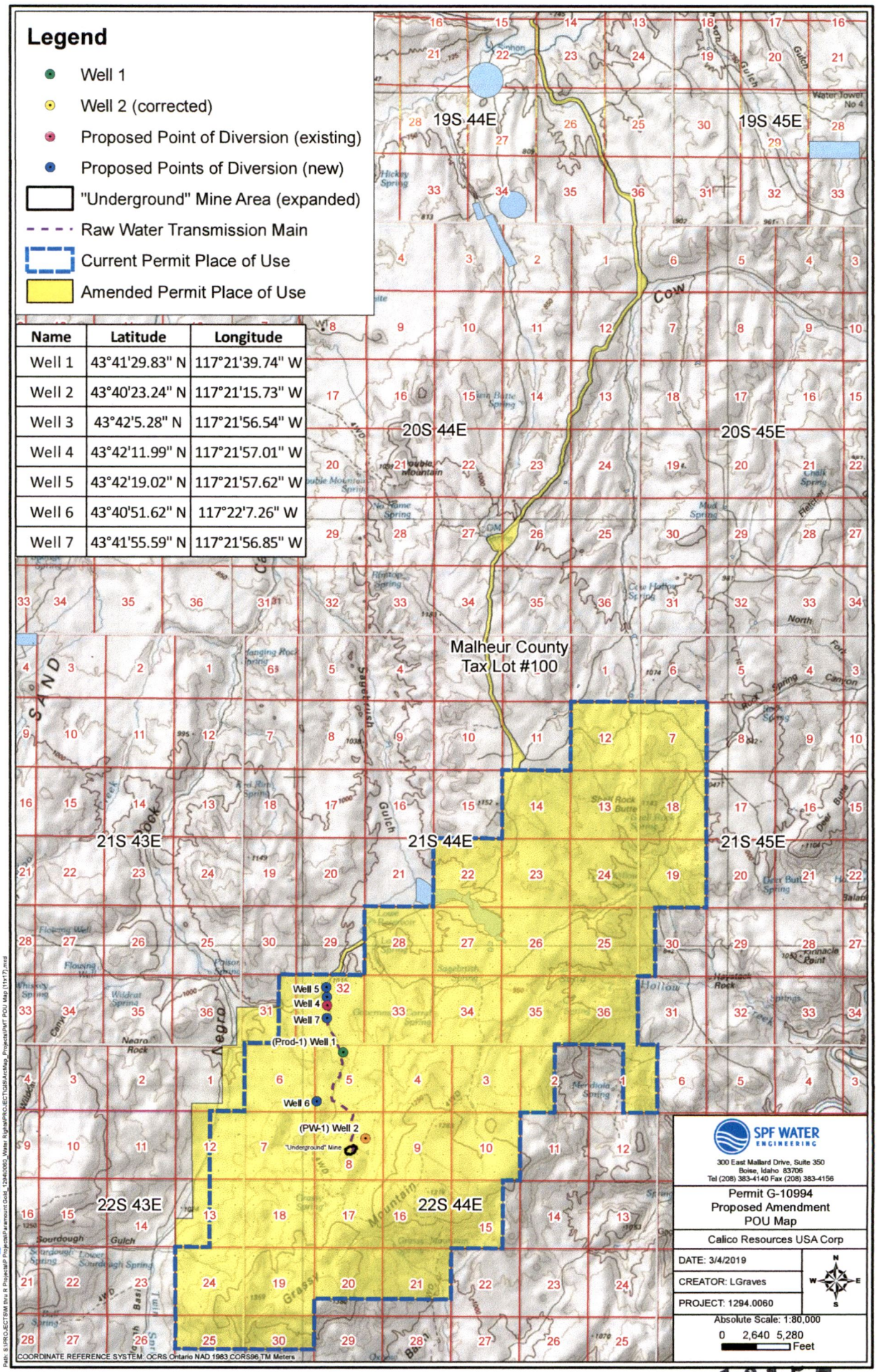

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State of Oregon
Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900

Application for
Permit Amendment
Part 1 of 5 – Minimum Requirements Checklist

This permit amendment application will be returned if Parts 1 through 5 and all required attachments are not completed and included.
For questions, please call (503) 986-0900, and ask for Transfer Section.

Check all items included with this application. (N/A = Not Applicable)

☒ Part 1 – Completed Minimum Requirements Checklist.

☒ Part 2 – Completed Application Map Checklist.

☒ Part 3 – Application Fee, payable by check to the Oregon Water Resources Department, and completed Fee Worksheet, page 3. Try the new online fee calculator at: http://apps.wrd.state.or.us/apps/misc/wrd_fee_calculator. If you have questions, call Customer Service at (503) 986-0801.

☒ Part 4 – Completed Applicant Information and Signature.

☒ Part 5 – Information about Permits to be Amended: **Number of permits to be amended:** 1 **List them here:** G-10994
Please include a separate Part 5 for each permit. (See instructions on page 6)

☒ Completed Permit Amendment Application Map (Does not have to be prepared by a Certified Water Right Examiner).

☐ ☒ N/A Request for Assignment Form and statutory fee. The request for assignment form has to be completed if the applicant is **not** the permit holder of record and needs to be assigned to the permit; **or** the landowner of the proposed place of use is **not** the permit holder of record and needs to be assigned to the permit (the Request for Assignment Form is available online at http://www.oregon.gov/owrd/pubs/docs/forms). Assignment is not needed if the applicant is the permit holder of record.

☐ ☒ N/A Affidavit(s) of Consent are required from all permit holder(s) of record if the permit is not assigned to the applicant **or** other permit holders of record that are not listed as applicants.

☒ ☐ N/A Land Use Information Form with approval and signature (or signed land use form receipt stub). Land use form is not required if any of the following apply:
- ☐ Water is to be diverted, conveyed, and/or used only on federal lands.
- ☐ All of the following apply: a) a change in place of use only, b) no structural changes, c) the use of water is for irrigation only, and d) the use is located within an irrigation district or an exclusive farm use zone.
- ☐ The proposed changes are all located on the property reviewed in Land Use form enclosed in Water Right Application Folder # _____.

☒ ☐ N/A Water Well Report/Well Log for changes in point(s) of appropriation (well(s)) or additional point(s) of appropriation.

(For Staff Use Only)
WE ARE RETURNING YOUR APPLICATION FOR THE FOLLOWING REASON(S):

___ Application fee not enclosed/insufficient
___ Map not included or incomplete
___ Land Use Form not enclosed or incomplete
___ Assignment Form and fee not enclosed/insufficient
___ Additional signature(s) required
Part _____ is incomplete
Other/Explanation _____
Staff: _____ 503-986-0___ Date: ____/____/____

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Your permit amendment application will be returned if any of the map requirements listed below are not met.

Please be sure that the map you submit includes all the items listed below and meets the requirements of OAR 690-380-3100, however, the map does not have to be prepared by a Certified Water Right Examiner. Check all boxes that apply.

☐ ☒ N/A If **more than three** permits are involved, separate maps for each permit.

☒ Permanent quality printed with dark ink on good quality paper.

☒ The size of the map can be 8½ x 11 inches, 8½ x 14 inches, 11 x 17 inches, or up to 30 x 30 inches. For 30 x 30 inch maps, one extra copy is required.

☒ A north arrow, a legend, and scale.

☒ The scale of the map must be: 1 inch = 400 feet, 1 inch = 1,320 feet, the scale of the county assessor map if the scale is not smaller than 1 inch = 1,320 feet, or a scale that has been pre-approved by the Department.

☒ Township, Range, Section, ¼ ¼, DLC, Government Lot, and other recognized public land survey lines.

☒ Tax lot boundaries (property lines) are required. Tax lot numbers are recommended.

☒ Major physical features including rivers and creeks showing direction of flow, lakes and reservoirs, roads, and railroads.

☒ Major water delivery system features from the point(s) of diversion/appropriation such as main pipelines, canals, and ditches.

☒ Existing place of use that includes separate hachuring for each water use permit, priority date, and use including number of acres in each quarter-quarter section, government lot, or in each quarter-quarter section as projected within government lots, donation land claims, or other recognized public land survey subdivisions. If less than the entirety of the permit is being changed, a separate hachuring is needed for the portion of the permit left unchanged.

☒ ☐ N/A If you are proposing a change in place of use, show the proposed place of use with hachuring that includes separate hachuring for each permit, priority date, and use including number of acres in each quarter-quarter section, government lot, or in each quarter-quarter section as projected within government lots, donation land claims, or other recognized public land survey subdivisions.

☒ Existing point(s) of diversion or well(s) with distance and bearing or coordinates from a recognized survey corner. This information can be found in your water use permit.

☒ ☐ N/A If you are proposing a change in point(s) of diversion or well(s), show the proposed location and label it clearly with distance and bearing or coordinates. If GPS coordinates are used, latitude-longitude coordinates may be expressed as either degrees-minutes-seconds with at least one digit after the decimal (example – 42°32'15.5") or degrees-decimal with five or more digits after the decimal (example – 42.53764°).

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FEE WORKSHEET for PERMIT AMENDMENT			
1	Base Fee (includes one type of change to one permit for up to 1 cfs)	*1*	$1,160
2	Types of change proposed: ☒ Place of Use ☒ Point of Diversion/Appropriation Number of above boxes checked = 2 (2a) Subtract 1 from the number in line 2a = 1 (2b) *If only one change, this will be 0* Multiply line 2b by $930 and enter » » » » » » » » » » » » » »	*2*	930
3	Number of permits included in Permit Amendment 1 (3a) Subtract 1 from the number in 3a: 0 (3b) *If only one permit this will be 0* Multiply line 3b by $520 and enter » » » » » » » » » » » » » »	*3*	0
4	Do you propose to add or change a well, or change from a surface water POD to a well? ☐ No: enter 0 » ☒ Yes: enter $410 »	*4*	410
5	Do you propose to change the place of use? ☐ No: enter 0 on line 5 » » » » » » » » » » » » » » » » » » ☒ Yes: enter the cfs for the portions of the permits to be amended (see example below*): 2.0 (5a) Subtract 1.0 from the number in 5a above: 1.0 (5b) If 5b is 0, enter 0 on line 5 » » » » » » » » » » » » » » » » » If 5b is greater than 0, round up to the nearest whole number: 1.0 (5c) and multiply 5c by $350, then enter on line 5 » » » » » » » »	*5*	350
6	Add entries on lines 1 through 5 above » » » » » » » » » Subtotal:	*6*	2850
7	Is this permit amendment: ☐ necessary to complete a project funded by the Oregon Watershed Enhancement Board (OWEB) under ORS 541.932? ☐ endorsed in writing by ODFW as a change that will result in a net benefit to fish and wildlife habitat? If one or more boxes is checked, multiply line 6 by 0.5 and enter on line 7 » If no box is applicable, enter 0 on line 7» » » » » » » » » » » » »	*7*	0
8	Subtract line 7 from line 6 » » » » » » » » **Permit Amendment Fee:**	*8*	2850

*Example for Line 5a calculation to transfer 45.0 acres of Primary Permit S-12345 (total 1.25 cfs for 100 acres) and 45.0 acres of Supplemental Permit S-87654 (1/80 cfs per acre) on the same land:

1. For irrigation calculate cfs for each permit involved as follows:
   a. Divide total authorized cfs by total acres in the permit *(for S-12345, 1.25 cfs ÷100 ac)*; then multiply by the number of acres to be changed to get the application cfs *(x 45 ac= 0.56 cfs)*.
   b. If the water right permit does not list total cfs, but identifies the allowable use as 1/40 or 1/80 of a cfs per acre; multiply number of acres proposed for change by either 0.025 (1/40) or 0.0125 (1/80). *(For S-87654, 45.0 ac x 0.0125 cfs/ac = 0.56 cfs)*
2. Add cfs for the portions of permits on all the land included in the application; however **do not count cfs for supplemental permits on acreage for which you have already calculated the cfs fee for the primary permit on the same land**. The fee should be assessed only once for each "on the ground" acre included in the application. *(In this example, blank 5a would be only 0.56 cfs, since both permits serve the same 45.0 acres. Blank 5b would be 0 and Line 5 would then also become 0).*

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Part 4 of 5 – Applicant Information and Signature

Applicant Information

APPLICANT/BUSINESS NAME			PHONE NO.	ADDITIONAL CONTACT NO.
Calico Resources USA Corp			775-770-4615	
ADDRESS				FAX NO.
c/o Nancy Wolverson, 665 Anderson Street				
CITY	STATE	ZIP	E-MAIL	
Winnemucca	NV	89445		
BY PROVIDING AN E-MAIL ADDRESS, CONSENT IS GIVEN TO RECEIVE ALL CORRESPONDENCE FROM THE DEPARTMENT ELECTRONICALLY. COPIES OF THE FINAL ORDER DOCUMENTS WILL ALSO BE MAILED.				

Agent Information – The agent is authorized to represent the applicant in all matters relating to this application.

AGENT/BUSINESS NAME			PHONE NO.	ADDITIONAL CONTACT NO.
Shonee Langford/Schwabe, Williamson & Wyatt			**503-540-4261**	
ADDRESS				FAX NO.
530 Center St. NE, Suite 730				
CITY	STATE	ZIP	E-MAIL	
Salem	OR	97301	slangford@schwabe.com	
BY PROVIDING AN E-MAIL ADDRESS, CONSENT IS GIVEN TO RECEIVE ALL CORRESPONDENCE FROM THE DEPARTMENT ELECTRONICALLY. COPIES OF THE FINAL ORDER DOCUMENTS WILL ALSO BE MAILED.				

Explain in your own words what you propose to accomplish with this permit amendment; and why: (1) change the authorized POA for Well 2; (2) add five additional POAs; (3) change the POU to include all of the applicant's mining claim boundary and also road areas where water will be applied for dust abatement; and (4) clarify that the permitted supplemental POA described as an "open pit" mine will be an "underground" mine with the intent that the entire underground mine area is a POA.

If you need additional space, continue on a separate piece of paper and attach to the application as "Attachment 1".

☐ Check this box if this project is fully or partially funded by the American Recovery and Reinvestment Act. (Federal stimulus dollars)

Is the applicant the permit holder of record? ☒ Yes ☐ No

If NO, include either:

☐ A completed assignment form (with required statutory assignment fee), assigning all or a portion of the permit to the applicant(s), **OR**

☐ An affidavit of consent from the permit holder(s) of record that gives permission for the applicant to amend the permit.

I understand that prior to Department approval of the permit amendment, I may be required to submit payment to the Department for publication of a notice in a newspaper with general circulation in the area where the permit is located, once per week for two consecutive weeks. If more than one qualifying newspaper is available, I suggest publishing the notice in the following newspaper: Argus Observer.

I (we) affirm that the information contained in this application is true and accurate.

Applicant Signature	Print Name (and Title if applicable)	Date
C.B.	CARLO BUFFONE, CEO	03/15/2019

Applicant Signature — Print Name (and Title if applicable) — Date

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Check <u>one</u> of the following:

☐ The applicant is responsible for completion of change(s). Notices and correspondence should continue to be sent to the applicant.

☒ The permit holder(s) of record will be responsible for completing the proposed change(s) after the final order is issued. Copies of notices and correspondence should be sent to the permit holder(s) of record.

Check the appropriate box, if applicable:

☐ Check here if any of the permits proposed for amendment are or will be located within or served by an irrigation or other water district.

IRRIGATION DISTRICT NAME	ADDRESS	
CITY	STATE	ZIP

☐ Check here if water for any of the permits supplied under a water service agreement or other contract for stored water with a federal agency or other entity.

ENTITY NAME	ADDRESS	
CITY	STATE	ZIP

To meet State Land Use Consistency Requirements, you must list all local governments (each county, city, municipal corporation, or tribal government) within whose jurisdiction water will be diverted, conveyed or used.

ENTITY NAME Malheur County Planning & Zoning	ADDRESS 251 "B" Street West #12	
CITY Vale	STATE OR	ZIP 97918

ENTITY NAME	ADDRESS	
CITY	STATE	ZIP

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INSTRUCTIONS for editing the Application Form

To add additional lines to tables within the forms or to copy and paste additional Part 5 pages, please **save the application form to your computer**. Unlock the document by using one of the following instructions for your Microsoft Word software version:

Once the application has been unlocked, you may:

- add additional rows to tables using the Table tools, and
- select and copy the pages of Part 5 and paste as many additional sets of Part 5 pages as needed at the end of the application.

After editing, re-lock the document to enable checkboxes to work.

Microsoft Word 2003

Unlock the document by one of the following:

- Using the **Tools** menu => click **Unprotect Document;**

OR

- Using the **Forms** toolbar => click on the **Protect/Unprotect** icon.

To relock the document to enable the checkboxes to work, you will need to:

- Using the **Tools** menu => click **Protect Document;**

OR

- Using the **Forms** toolbar => click on the **Protect/Unprotect** icon.

Microsoft Word 2007

- Unlock the document by clicking the **Review** tab, then click **Protect Document**, then click **Stop Protect**
- To relock the document, click **Editing Restrictions**, then click **Allow Only This Type of Editing**, select **Filling In Forms** from the drop-down menu, then check **Yes, Start Enforcing Protection**.

Microsoft Word 2010

- Unlock the document by clicking the **Review** tab, toggle the **Restrict Editing icon** at the upper right, then click **Stop Protect** at the bottom right. Then uncheck the "**Allow only this type of editing** in the document: **Filling in forms**" in the "Editing restrictions" section on the right-hand list of options.
- To relock the document, check the **Editing Restrictions/Allow Only This Type of Editing/Filling In Forms** box from the drop-down menu, then check **Yes, Start Enforcing Protection**. You do not need to assign a password for the editing restrictions.

Other Alternatives:

- Photocopy pages or tables in Part 5, ~~mark-through~~ any non-applicable information, insert/attach photocopied pages to document in the appropriate location, and manually amend page numbers as necessary (e.g. Page ~~5~~ 6 of ~~9~~ 10).
- You may refer to additional attachments that you may include, such as separately produced tables or spreadsheets to convey large numbers of rows of place of use listings, owner/property parcels, etc. You may contact the Department at 503-986-0900 and ask for Transfer Staff if you have questions.

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Part 5 of 5 – Water Use Permit Information

Please use a separate Part 5 for each permit being changed. See instructions on page 6, to copy and paste additional Part 5s, or to add additional rows to tables within the form.

PERMIT # G-10994

Table 1. Location of Authorized and Proposed Point(s) of Diversion (POD) or Appropriation (POA)
(Note: If the POD/POA name is not specified in the permit, assign it a name or number here.)

POD/POA Name or Number	Is this POD/POA Authorized by the permit or is it Proposed?	If POA, OWRD Well Log ID# (or Well ID Tag # L-___)	Twp		Rng		Sec	¼ ¼		Tax Lot, DLC or Gov't Lot	Measured Distances (from a recognized survey corner)
Well 1	☒ Authorized ☐ Proposed	**L-107457**	**22**	**S**	**44**	**E**	**5**	**NE**	**NW**	**Lot 3**	43°41'29.83" N 117°21'39.74" W
Well 2	☒ Authorized ☐ Proposed	**L-109353**	**22**	**S**	**44**	**E**	**5**	**SE**	**NW**		1798' S & 1083' E from S1/4 corner, S32, T21S, R44E
Well 2	☐ Authorized ☒ Proposed	**L-109353**	**22**	**S**	**44**	**E**	**8**	**SW**	**NE**		43°40'23.24" N 117°21'15.73" W
Well 3	☐ Authorized ☒ Proposed	**L-109351**	**21**	**S**	**44**	**E**	**32**	**SE**	**NW**		43°42'5.28" N 117°21'56.54" W
Well 4	☐ Authorized ☒ Proposed		**21**	**S**	**44**	**E**	**32**	**SE**	**NW**		43°42'11.99" N 117°21'57.01" W
Well 5	☐ Authorized ☒ Proposed		**21**	**S**	**44**	**E**	**32**	**NE**	**NW**		43°42'19.02" N 117°21'57.62" W
Well 6	☐ Authorized ☒ Proposed		**22**	**S**	**44**	**E**	**5**	**SW**	**SW**		43°40'51.62" N 117°22'7.26" W
Well 7	☐ Authorized ☒ Proposed		**21**	**S**	**44**	**E**	**32**	**NE**	**SW**		43°41'55.59" N 117°21'56.85" W
Underground Mine	☒ Authorized ☐ Proposed		**22**	**S**	**44**	**E**	**8**	**NW**	**SE**		**POA is the entire underground area**
Underground Mine	☐ Authorized ☒ Proposed		**22**	**S**	**44**	**E**	**8**	**SW**	**NE**		**POA is the entire underground area**
Underground Mine	☐ Authorized ☒ Proposed		**22**	**S**	**44**	**E**	**8**	**NE**	**SW**		**POA is the entire underground area**

☒ Place of Use (POU)
☐ Point of Diversion (POD)
☐ Additional Point of Diversion (APOD)
☒ Point of Appropriation/Well (POA)
☒ Additional Point of Appropriation (APOA)
☐ Surface water POD to Ground Water POA (SW/GW)

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Will all of the proposed changes affect the entire water use permit?

☒ Yes Complete only the proposed ("to" lands) section of Table 2 on the next page. Use the "CODES" listed above to describe the proposed changes.

☐ No Complete all of Table 2 to describe the portion of the permit to be changed.

For a change in place of use:

Does the permit holder of record own or control the land TO which the place of use is being moved?
☒ Yes ☐ No

Note: Before water use begins under the terms of the permit amendment, the applicant will provide evidence of control in the form of written authorization from the landowner.

If NO, the landowner of the land TO which the place of use is being **moved must be assigned to the permit as a permit holder of record** by submitting a completed Request for Assignment form and the required statutory fee for an assignment.

Is the proposed place of use contiguous to the authorized place of use? ☒ Yes ☐ No

The permitted place of use can be moved only to lands that are contiguous to the authorized place of use **unless** the change to non-contiguous lands is in furtherance of mitigation or conservation efforts undertaken for the purposes of benefiting a species listed as sensitive, threatened, or endangered under ORS 496.171 to 496.192 or the federal Endangered Species Act of 1973 (16 U.S.C. 1531 to 1544), as determined by the listing agency. Contiguous land being either adjacent land or land separated from the land to which a permit is authorized by roads, utility corridors, irrigation ditches or publicly owned rights of way.

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Please use and attach additional pages of Table 2 as needed.
See page 6 for instructions.

Do you have questions about how to fill-out the tables?
Contact the Department at 503-986-0900 and ask for Transfer Staff.

Table 2. Description of Changes to Water Use Permit # G-10994

List the change proposed for the acreage in each ¼ ¼. If more than one change is proposed, specify the acreage associated with each change.
If there is more than one POD/POA involved in the proposed changes, specify the acreage associated with each POD/POA.

AUTHORIZED (the "from" or "off" lands) The listing that appears on the certificate BEFORE PROPOSED CHANGES. List only that part or portion of the water right that will be changed.											Proposed Changes (see "CODES" from previous page)	PROPOSED (the "to" or "on" lands) The listing as it would appear AFTER PROPOSED CHANGES are made. (See Attached Table 2)									
Twp	Rng	Sec	¼ ¼	Tax Lot	Gvt Lot or DLC	Acres (if applicable)	POD(s) or POA(s) (name or number from Table 1)	Priority Date		Twp	Rng	Sec	¼ ¼	Tax Lot	Gvt Lot or DLC	Acres (if applicable)	POD(s) or POA(s) to be used (from Table 1)	Priority Date	
EXAMPLE																				
2	**S**	**9**	**E**	**15**	**NE**	**NW**	**100**		**15.0**	**POD #1 POD #2**		**POU/POD**	**2**	**S**	**9**	**E**	**15**	**NW**	**NW**	**100**	**1**	**10.0**	**POD #5**	
"	"	"	"	"	"	"	"	"	**EXAMPLE**	"		"	**2**	**S**	**9**	**E**	**15**	**SW**	**NW**	**200**		**5.0**	**POD #6**	
TOTAL ACRES												TOTAL ACRES												

Additional remarks:

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Are there other water rights certificates, water use permits or ground water registrations associated with the "from" or "to" lands? ☒ Yes ☐ No

If YES, list the other certificate, permit, or ground water registration numbers: **C5019, C5474, C5476, C7662, C58018, C58286, C58620, C62860, C74544, C74585, C74912, C74937**

If the permit(s) are for irrigation or supplemental irrigation use, other water rights existing on the same land for irrigation that are subject to transfer must either change concurrently or be cancelled. Any change to a water right certificate or ground water registration must be filed separately in a water right transfer application or ground water registration modification application, respectively.

For a change in point(s) of appropriation (well(s)) or additional point(s) of appropriation:

☒ Well log(s) are attached for each authorized and proposed well(s) that are clearly labeled and associated with the corresponding well(s) in Table 1 above and on the accompanying application map. (**Tip**: You may search for well logs on the Department's web page at: http://apps2.wrd.state.or.us/apps/gw/well_log/Default.aspx)

AND/OR

☒ Describe the construction of the authorized and proposed well(s) in Table 3 for any wells that do not have a well log. For *proposed wells not yet constructed or built*, provide "a best estimate" for each requested information element in the table. The Department recommends you consult a licensed well driller, geologist, or certified water right examiner to assist with assembling the information necessary to complete Table 3.

Table 3. Construction of Point(s) of Appropriation

Any well(s) in this listing must be clearly tied to corresponding well(s) described in Table 1 and shown on the accompanying application map. Failure to provide the information will delay the processing of your transfer application until it is received. The information is necessary for the department to assess whether the proposed well(s) will access the same source aquifer as the authorized point(s) of appropriation (POA). The Department is prohibited by law from approving POA changes that do not access the same source aquifer.

Proposed or Authorized POA Name or Number	Is well already built? (Yes or No)	If an existing well, OWRD Well ID Tag No. L-____	Total well depth (in feet)	Casing Diameter	Casing Intervals (feet)	Seal depth(s) (intervals)	Perforated or screened intervals (in feet)	Static water level of completed well (in feet)	Source aquifer (sand, gravel, basalt, etc.)	Well - specific rate (cfs or gpm). If less than full rate of water right
Well 1	**Yes**	**L-107457**	**425**	**10", 6"**	**10", +2-99 6", +2-145 6", 255-325 6", 355-380**	**cement, 0-26' volclay bentonite, 0-100'**	**145-255 325-355 380-420**	**artesian**	**alluvial sediments of Grassy Mtn Formation**	**50 gpm**
Well 2	**Yes**	**L-109353**	**420**	**6"**	**6", +2-320 6", 340-400**	**cement, 0-28' volclay bentonite, 0-300'**	**320-340 400-420**	**54**	**same as above**	**25 gpm**

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Proposed or Authorized POA Name or Number	Is well already built? (Yes or No)	If an existing well, OWRD Well ID Tag No. L-____	Total well depth (in feet)	Casing Diameter	Casing Intervals (feet)	Seal depth(s) (intervals)	Perforated or screened intervals (in feet)	Static water level of completed well (in feet)	Source aquifer (sand, gravel, basalt, etc.)	Well - specific rate (cfs or gpm). If less than full rate of water right
Well 3	**Yes**	**L-109351**	**375**	**10", 6"**	**10", 0-40 6", 0-280 6", 300-340**	**cement, 0-40' volclay bentonite, 5-275'**	**280-300 340-360**	**80**	**same as above**	**175 gpm**
Well 4	**No**	proposed	**500**	**10"**	**10", 0-400**	**cement, 0-400'**	**400-500**	**70**	**same as above**	**200 gpm**
Well 5	**No**	proposed	**500**	**10"**	**10", 0-400**	**cement, 0-400'**	**400-500**	**70**	**same as above**	**200 gpm**
Well 6	**No**	proposed	**600**	**10"**	**10", 0-500**	**cement, 0-500'**	**500-600**	**250**	**same as above**	**100 gpm**
Well 7	**No**	proposed	**500**	**10"**	**10", 0-400**	**cement, 0-400'**	**400-500**	**100**	**same as above**	**150 gpm**

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Table 2: Description of Changes to Water Use Permit #G-10994							
CODE	**Twp**	**Rng**	**Sec**	**Tax Lot**	**Gov Lt / QtrQtr**	**POA**	**POU Description**
Current POU (no change), POA, APOA	21S	44E	12	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	12	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	NENW	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	13	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	13	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	SWSW	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	14	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	14	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	22	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	NENE	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	23	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	23	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	SWNW	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	24	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	24	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	NESE	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	25	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	25	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	26	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	SWNE	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	27	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	27	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	NESW	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	28	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	28	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	31	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	31	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	31	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	31	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	SWSW	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	32	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	32	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	33	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	NENE	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	34	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	34	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	SWNW	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	35	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	35	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	NWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SWNW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	NWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SWSW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	NESE	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	44E	36	300	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	44E	36	300	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	7	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	SWNE	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	45E	18	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	18	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	NESW	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	21S	45E	19	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	19	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	30	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	30	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	30	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	21S	45E	30	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	12	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	13	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	13	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	13	100	SWNE	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

13157

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	43E	13	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	13	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	13	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	13	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	13	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	24	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	25	100	NENE	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	43E	25	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	25	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	25	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	25	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	25	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	25	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	43E	25	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	1	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	2	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	2	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	2	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	2	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	2	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	2	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	2	100	SWSW	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

13157

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	2	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	3	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	L 3	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	4	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	4	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	SWSW	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

13157

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	5	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	5	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	L 5	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	L 6	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	L 7	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	6	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	NENE	All	Mining Area

RECEIVED
MAR 27 2019
OWRD

13157

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	7	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	7	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	SWNW	All	Mining Area

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13157

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	8	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	8	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	NESE	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	9	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	9	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	10	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	NENW	All	Mining Area

RECEIVED
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OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	15	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	15	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	NESE	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	16	200	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	16	200	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	17	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	SWNE	All	Mining Area

RECEIVED
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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	18	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	18	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	NESW	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	19	100	L 3	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	L 4	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	SESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	SWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	19	100	SESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	20	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	SWNE	All	Mining Area

RECEIVED
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OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Current POU (no change), POA, APOA	22S	44E	21	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	SWNW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	SENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NESW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NWSW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NESE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	21	100	NWSE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	NENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	NWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	SWNE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	SENE	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	NENW	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	L 1	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	L 2	All	Mining Area
Current POU (no change), POA, APOA	22S	44E	30	100	SENW	All	Mining Area
Additional POU (proposed), POA, APOA	19S	44E	22	600	NENE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	22	600	SENE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	22	600	NESE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	23	901	NWNW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	23	901	SWNW	All	Access Road

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Additional POU (proposed), POA, APOA	19S	44E	23	901	NWSW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	23	901	SWSW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	26	901	NWNE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	26	901	SWNE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	26	901	SENE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	26	901	NENW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	26	901	NWNW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	26	901	NESE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	26	901	SESE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	35	901	NENE	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	36	901	NWNW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	36	901	SWNW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	36	901	NESW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	36	901	NWSW	All	Access Road
Additional POU (proposed), POA, APOA	19S	44E	36	901	SESW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	1	100	L 1	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	1	100	SENE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	1	100	NESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	1	100	SESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	12	100	NENE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	12	300	SWNE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	12	300	SENE	All	Access Road

RECEIVED
MAR 27 2019
OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Additional POU (proposed), POA, APOA	20S	44E	12	300	NWSE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	12	300	SWSE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	12	300	NESW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	12	300	SESW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	13	300	NENW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	13	300	NWNW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	13	300	SWNW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	13	300	SENW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	13	300	NWSW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	13	300	SWSW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	14	300	NESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	14	300	SESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	23	300	NENE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	23	300	SENE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	23	300	NESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	23	300	NWSE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	23	300	SWSE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	23	300	SESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	23	300	SESW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	26	300	NWNE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	26	300	NENW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	26	300	SWNW	All	Access Road

RECEIVED
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13157

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Additional POU (proposed), POA, APOA	20S	44E	26	300	SENW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	26	300	NWSW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	26	300	SWSW	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	27	300	NESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	27	300	SESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	34	300	NENE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	34	300	SENE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	34	300	NESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	34	300	SWSE	All	Access Road
Additional POU (proposed), POA, APOA	20S	44E	34	300	SESE	All	Access Road
Additional POU (proposed), POA, APOA	20S	45E	6	100	L 6	All	Access Road
Additional POU (proposed), POA, APOA	20S	45E	6	100	L 7	All	Access Road
Additional POU (proposed), POA, APOA	20S	45E	7	100	L 1	All	Access Road
Additional POU (proposed), POA, APOA	21S	43E	36	600	SENE	All	Mining Area
Additional POU (proposed), POA, APOA	21S	43E	36	600	NESE	All	Mining Area
Additional POU (proposed), POA, APOA	21S	43E	36	600	SESE	All	Mining Area
Additional POU (proposed), POA, APOA	21S	44E	3	100	L 1	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	3	100	L 2	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	3	100	SWNE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	3	100	SENE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	3	100	NESE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	3	100	NWSE	All	Access Road

RECEIVED
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OWRD

CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Additional POU (proposed), POA, APOA	21S	44E	3	100	SESE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	10	100	NENE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	10	100	SENE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	11	100	NWNW	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	11	100	SWNW	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	11	100	NESW	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	11	100	NWSW	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	11	100	SWSW	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	11	100	SESW	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	21	100	SESE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	29	100	SENE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	29	100	NESE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	29	100	NWSE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	29	100	SWSE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	29	100	SESE	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	29	100	SESW	All	Access Road
Additional POU (proposed), POA, APOA	21S	44E	31	100	SWNE	All	Mining Area
Additional POU (proposed), POA, APOA	21S	44E	31	100	L 2	All	Mining Area
Additional POU (proposed), POA, APOA	21S	44E	31	100	NWSE	All	Mining Area
Additional POU (proposed), POA, APOA	21S	44E	31	100	SWSE	All	Mining Area
Additional POU (proposed), POA, APOA	21S	44E	31	100	L 3	All	Mining Area
Additional POU (proposed), POA, APOA	21S	44E	31	100	L 4	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Additional POU (proposed), POA, APOA	22S	43E	1	100	L 1	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	L 2	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	SWNE	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	SENE	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	NESE	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	NWSE	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	SWSE	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	SESE	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	SWSW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	1	100	SESW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	100	NENW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	100	NWNW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	100	SWNW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	100	SENW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	100	NESW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	101	NWSW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	101	SWSW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	12	301	SESW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	13	301	NENW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	13	300	NWNW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	13	300	SWNW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	13	100	SENW	All	Mining Area

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CODE	Twp	Rng	Sec	Tax Lot	Gov Lt / QtrQtr	POA	POU Description
Additional POU (proposed), POA, APOA	22S	43E	13	100	NESW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	13	300	NWSW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	13	100	SWSW	All	Mining Area
Additional POU (proposed), POA, APOA	22S	43E	13	100	SESW	All	Mining Area

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MAY 1 1989

WATER RESOURCES DEPT. SALEM, OREGON

MAH 2511 22S/44E/5ab 9256

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # 9256

(1) OWNER: Well Number:
Name Atlas Precious Metals
Address 743 Horizin Ct. Suite 202
City Grand Junction State Co Zip 81506

(2) TYPE OF WORK:
☒ New Well ☐ Deepen ☒ Recondition ☐ Abandon

(3) DRILL METHOD
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☒ Other Alger

(4) PROPOSED USE:
☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☐ Depth of Completed Well ft.
Explosives used Yes ☐ No ☒ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0	18				
10	18	425				
			Cement grout	0	26	19

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other
Backfill placed from ft. to ft. Material Bent. & Cement Grout
Gravel placed from 100 ft. to 245 ft. Size of gravel No. 8

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	10"	+2	99	.250	☒	☐	☒	☐
	6"	+2	245	Sch 80	☐	☒	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☒ Screens Type AeroArk Material PVC Sch 80

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
380	420	.020		6"		☐	☐
145	255	325-355				☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
100	40'	300	1 hr.

Temperature of water Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Malheur Latitude ' " Longitude ' "
Township 22S N or S, Range 44E E or W, WM.
Section 5 NW ¼ NE ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address)

(10) STATIC WATER LEVEL:
40' ft. below land surface. Date 12-8-88
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 40'

From	To	Estimated Flow Rate	SWL
140-[illegible]	255	10 gpm	
320	355	50 gpm	
380	415	150 gpm	

(12) WELL LOG: Ground elevation

Material	From	To	SWL
Overburden w/ boulders	0	17	0
Clay brown	17	140	0
Sandstone w/ blue clay	140	255	40
blue clay	255	320	40
Sandstone w/ blue clay	320	355	40
Blue clay	355	380	40
Fruited hard sandstone	380	415	40
Blue clay	415	425	40
=			
12-5-88 - 12-10-88			
+			
Redone surface seal to 26 feet using method 2 referring to letter sent January 9, 1989			
Drilled around 10" casing to the depth of 26' using method C			
pumped 19 sacks of cement down hole			
3-30-89 - 3-31-89			
=			
Incorporated to singel log per state request			

Date started 12-5-88 Completed 3-31-89

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

Signed Bob Doty WWC Number 1202
Date 4-15-89

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief. WWC Number 323 [illegible]

Signed Bob Doty for Bill Doty Date 4/15/89

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STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

WATER RESOURCES DEPT
SALEM, OREGON

Malh 2276

22s/44E/8ad

(START CARD) # W-14816

(1) OWNER: Well Number:
Name Atlas Precious Metals Inc
Address 318 A St.
City Vale State OR Zip 97918

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☑ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 420 ft.
Explosives used ☐ Yes ☑ No Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
14 3/4	0	28	PT Cement	0	28	19
			VOLCLAY	300	SURFACE	40 Sacks
			Bent Pellets	295	300	3 Buckets

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other Tremie
Backfill placed from ft. to ft. Material
Gravel placed from 555 ft. to 295 ft. Size of gravel .030

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+2	320	.250	☑	☐	☑	☐
	6"	340	400	"	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☑ Screens Type Wire wound Material Low Carbon

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
320	340	.030			6"	☐	☑
400	420	.030			6"	☐	☑
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
35		294	1 hr.

Temperature of water 64° F Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Malheur Latitude Longitude
Township 22 S N or S, Range 44E E or W, WM.
Section 8 SE ¼ NE ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address)

(10) STATIC WATER LEVEL:
52 ft. below land surface. Date 12-6-89
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Estimated Flow Rate	SWL
320	340	20	
400	420	20	
		40	

(12) WELL LOG: Ground elevation

Material	From	To	SWL
Soil	0	2	
Clay	2	10	
Basalt	10	28	
Brown Clay	28	55	
Siltstone	55	130	
Clay & Gravel	130	173	
Clay & Sand	173	190	
Basalt	190	315	
Brown Clay	315	323	
Brown Clay & Sand	323	360	
Brown Sandstone	360	395	
Black & Red Sand	395	408	
Sandstone Coarse	408	441	
Clay & Gravel	441	447	
Clay & Sand	447	555	

Date started 11/27/89 Completed 12-1-89

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 544
Signed Larry Burd Date 12/1/89

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JAN 02 1990

WATER RESOURCES DEPT.
SALEM, OREGON

Mail 2306

215/44E/32bd
W-14815

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # W-14814

(1) OWNER:
Well Number: PW-4
Name: ATLAS PRECIOUS METALS
Address: 318 A STREET WEST
City: VALE State: OR Zip: 97918

(2) TYPE OF WORK:
☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☒ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval: Yes ☒ No ☐ Depth of Completed Well 375 ft.
Explosives used: Yes ☐ No ☒ Type _____ Amount _____

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
14 3/4	0	40	PORTLAND CEMENT	0	40	19
9 7/8	40	375	VOLCLAY	5	275	40
			CEMENT	0	5	

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from 375 ft. to 370 ft. Material 10-20 MESH
Gravel placed from 370 ft. to 275 ft. Size of gravel 10-20 MESH

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	10"	0	40	.250	☒	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	6 5/8"	0	280	.250	☐	☐	☐	☐
	6 5/8"	300	340	.250	☒	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☒ Screens Type WIRE WOUND Material Low Carbon Steel

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
280	300	.030		6"		☐	☒
340	360	.030		6"		☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
100		350	1 hr.

Temperature of water 62°F Depth Artesian Flow Found —
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☒ Odor ☐ Colored ☐ Other
Depth of strata: 280 STILL USABLE

(9) LOCATION OF WELL by legal description:
County MALHEUR Latitude _____ Longitude _____
Township 21S N or S, Range 44E E or W, WM.
Section 32 SE ¼ NW ¼
Tax Lot _____ Lot _____ Block _____ Subdivision _____
Street Address of Well (or nearest address) _____

(10) STATIC WATER LEVEL:
81 ft. below land surface. Date 11/17/89
Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:
Depth at which water was first found 280'

From	To	Estimated Flow Rate	SWL
280	360	100 gpm	81

(12) WELL LOG:
Ground elevation ≅ 3350

Material	From	To	SWL
Alluvium	0	25'	
Clay	25	150'	
Sandy clay	150	175	
Sandstone	175	215	
Clay	215	275	
Sandstone	275	305	
Clay	305	325	
Sandstone and Conglomerate	325	365	
Clay.	365	375	

Date started 11/16/89 Completed 11/20/89

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
Signed George Hatfield for John Rugg WWC Number _____ Date 11/20/89

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
Signed Larry Bund WWC Number 544 Date 11-20-89

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Schwabe
WILLIAMSON & WYATT®

March 27, 2019

Shonee D. Langford
T: 503-540-4261
C: 503-807-2082
slangford@schwabe.com

BY HAND DELIVERY

Oregon Water Resources Department
725 Summer Street N.E., Suite A
Salem, Oregon 97301-1271

RE: Application for Permit Amendment (Permit G-10994)
Our File No.: 124158-183676

To Whom It May Concern:

Enclosed for filing on behalf of Calico Resources USA Corp is an Application for Permit Amendment with supporting documentation. Also enclosed is a check in the amount of $2,850.00 to cover the application fee. I will serve as the applicant's agent.

Please note that the signed land use receipt is a scanned copy. I expect to receive the original receipt shortly, and will submit it as soon as possible.

Best regards,

Shonee D. Langford

SDL:asc
Enclosures

cc: Client (*w/Enclosures, via e-mail*)

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For Local Government Use Only

entirely within the city limits. In that case, only the city planning agency must complete this form. This deals only with the local land-use plan. Do not include approval for activities such as building or grading permits.

Please check the appropriate box below and provide the requested information

☐ Land uses to be served by the proposed water uses (including proposed construction) are allowed outright or are not regulated by your comprehensive plan. Cite applicable ordinance section(s):

☐ Land uses to be served by the proposed water uses (including proposed construction) involve discretionary land-use approvals as listed in the table below. (Please attach documentation of applicable land-use approvals which have already been obtained. Record of Action/land-use decision and accompanying findings are sufficient.) **If approvals have been obtained but all appeal periods have not ended, check "Being pursued."**

Type of Land-Use Approval Needed (e.g., plan amendments, rezones, conditional-use permits, etc.)	Cite Most Significant, Applicable Plan Policies & Ordinance Section References	Land-Use Approval:	
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued

Local governments are invited to express special land-use concerns or make recommendations to the Water Resources Department regarding this proposed use of water below, or on a separate sheet.

Name: Eric Evans Title: Planning Director

Signature: _____ Phone: 541-473-5185 Date: _____

Government Entity: Malheur County Planning Department

Note to local government representative: Please complete this form or sign the receipt below and return it to the applicant. If you sign the receipt, you will have 30 days from the Water Resources Department's notice date to return the completed Land Use Information Form or WRD may presume the land use associated with the proposed use of water is compatible with local comprehensive plans.

Receipt for Request for Land Use Information

Applicant name: Calico Resources USA Corp

City or County: Malheur County Staff contact: Eric Evans

Signature: _____ Phone: 541-473-5185 Date: _____

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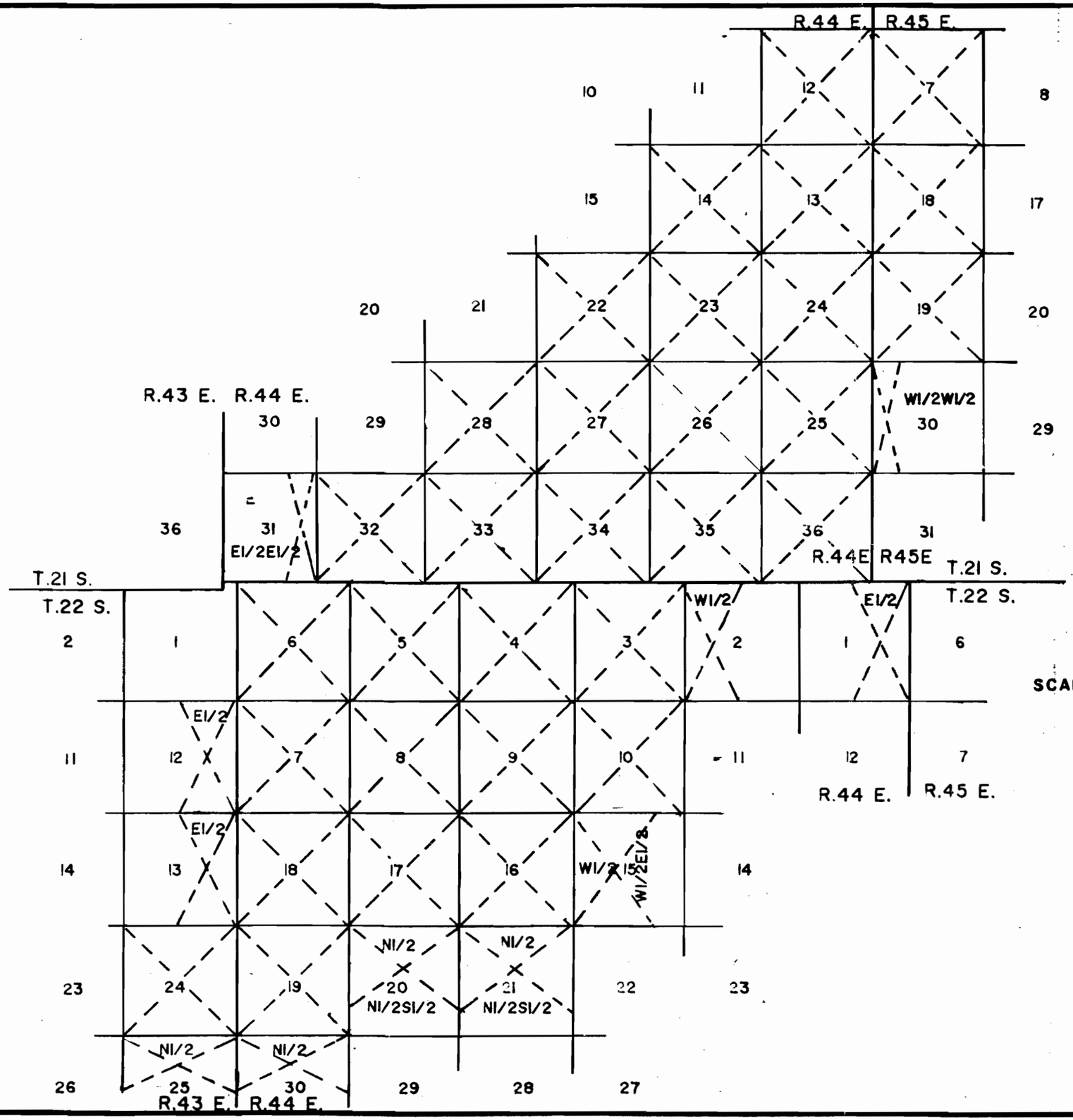

SCALE: 1" = 1 MILE

DISCLAIMER

I, ALBERT GASCHLER, HEREBY CERTIFY: THAT THIS MAP WAS MADE TO BE A PART OF THE APPLICATION FOR A PERMIT TO APPROPRIATE Ground Water, SECTIONAL LINES SHOWN ARE APPROXIMATE AND THIS MAP IS NOT INTENDED FOR ANY OTHER USE AND DOES NOT GUARANTEE LAND OWNERSHIP.

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WATER RESOURCES DEPT
SALEM, OREGON

LEGEND

PRIMARY WATER RIGHT X

Application No. G-11847
Permit No. G10994

Certified Water Right Examiner #068
Albert Gaschler
Albert Gaschler
Nov. 19, 1987
STATE OF OREGON

EXISTING PERMITS: _____

WATER RIGHTS EXAMINERS MAP

FOR: ATLAS PRECIOUS METALS INC.

GASCHLER & ASSOCIATES
ONTARIO, P.O. BOX 412, 889-2101 OREGON

CHECKED BY:	DRAWN BY: Aq.	APPROVED BY:
DATE: 2/8/90	DRAWING NO. A-474	BK ____ PG ____
SHEET 1 OF 1	JOB NO. WO-5888	REVISED:

STATE OF OREGON

COUNTY OF MALHEUR

PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO

ATLAS PRECIOUS METALS, INC.
743 HORIZON COURT, SUITE 202
GRAND JUNCTION, COLORADO 81506

303-243-5800

to use the waters of TWO WELLS, SUPPLEMENTED BY WATERS FROM AN OPEN PIT MINE, in the MALHEUR RIVER BASIN for MINING/INDUSTRIAL USES.

This Permit is issued approving Application G-11847. The date of priority is AUGUST 29, 1988 for the two wells and NOVEMBER 15, 1988 for the open pit mine. The use is limited to not more than 2.0 CUBIC FEET PER SECOND, or its equivalent in case of rotation, measured at the well.

The wells and open pit mine are located as follows:

LOT 3 AND SE 1/4 NW 1/4, SECTION 5, T 22 S, R 44 E, W.M.; NW 1/4 SE 1/4, SECTION 8, T 22 S, R 44 E, W.M.; WELL 1 - 691 FEET SOUTH AND 994 FEET EAST; WELL 2 - 1798 FEET SOUTH AND 1083 FEET EAST, BOTH FROM S 1/4 CORNER, SECTION 32, T 21 S, R 44 E, W.M.; OPEN PIT MINE - 2262 FEET NORTH AND 37 FEET EAST FROM S 1/4 CORNER, SECTION 8, T 22 S, R 44 E.

Although declared herein to be a supplemental supply from the open pit mine, in the interest of prudent use of waters, use from the open pit mine may be exercised at times when water is available at the two wells, provided the total quantity diverted from all sources does not exceed the limitation allowed herein.

This permit is issued subject to the maintenance and use of adequate treatment facilities to remove the sediment before returning the water to the stream.

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the proposed place of use under the permit is as follows:

SECTIONS 12, 13 AND 14

SECTIONS 22, 23, 24, 25, 26, 27, AND 28

E 1/2 E 1/2
SECTION 31

SECTIONS 32, 33, 34, 35 AND 36
TOWNSHIP 21 SOUTH, RANGE 44 EAST, W.M.

SECTIONS 7, 18 AND 19

W 1/2 W 1/2
SECTION 30
TOWNSHIP 21 SOUTH, RANGE 45 EAST, W.M.

E 1/2
SECTIONS 1
TOWNSHIP 22 SOUTH, RANGE 44 EAST, W.M.

E 1/2
SECTIONS 12 AND 13

SECTION 24

N 1/2
SECTION 25
TOWNSHIP 22 SOUTH, RANGE 43 EAST, W.M.

W 1/2
SECTION 2

SECTIONS 3, 4, 5, 6, 7, 8, 9 AND 10

W 3/4
SECTION 15

SECTIONS 16, 17, 18 AND 19

N 3/4
SECTIONS 20 AND 21

N 1/2
SECTION 30
TOWNSHIP 22 SOUTH, RANGE 44 EAST, W.M.

The well shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevations in the well at all times. When required by the department, the permittee shall install and maintain a weir, meter, or other suitable measuring device, and shall keep a complete record of the amount of ground water withdrawn.

Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the department's standards, to the Water Resources Department. The Director may require water level or pump test results every ten years thereafter.

Actual construction work shall begin on or before APRIL 5, 1991, and shall be completed on or before October 1, 1992. Complete application of the water shall be made on or before October 1, 1993.
B+C ext to 10-1-96
Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

This permit is for beneficial use of water without waste. The water user is advised that new regulations may require use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

Issued this date, APRIL 5, 1990.

"B" Extended to October 1, 1993

/s/ WILLIAM H. YOUNG

B+C Ext. 10-1-94, 10-1-95

Water Resources Department
William H. Young
Director

EXT. BC97
C/08

Application G-11847 Water Resources Department PERMIT G-10994
Basin 10 Volume 2A Negro Rock Canyon & Tribs. Wells District 9
~~G-11847.WJO~~

RECORDED, See Misc. Rec., Vol. 7 Page 3423

Legend

- Well 1
- Well 2 (corrected)
- Proposed Point of Diversion (existing)
- Proposed Points of Diversion (new)
- "Underground" Mine Area (expanded)
- Raw Water Transmission Main
- Current Permit Place of Use
- Amended Permit Place of Use

Name	Latitude	Longitude
Well 1	43°41'29.83" N	117°21'39.74" W
Well 2	43°40'23.24" N	117°21'15.73" W
Well 3	43°42'5.28" N	117°21'56.54" W
Well 4	43°42'11.99" N	117°21'57.01" W
Well 5	43°42'19.02" N	117°21'57.62" W
Well 6	43°40'51.62" N	117°22'7.26" W
Well 7	43°41'55.59" N	117°21'56.85" W

19S 44E
19S 45E
20S 44E
20S 45E
21S 43E
21S 44E
21S 45E
22S 43E
22S 44E
Malheur County Tax Lot #100
Well 5
Well 4
Well 7
(Prod-1) Well 1
Well 6
(PW-1) Well 2
"Underground" Mine
Well 2 (currently authorized POA proposed for correction) 1798' S & 1083' E from S1/4 corner, S32, T21S, R44E

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

Permit G-10994
Proposed Amendment
POU Map

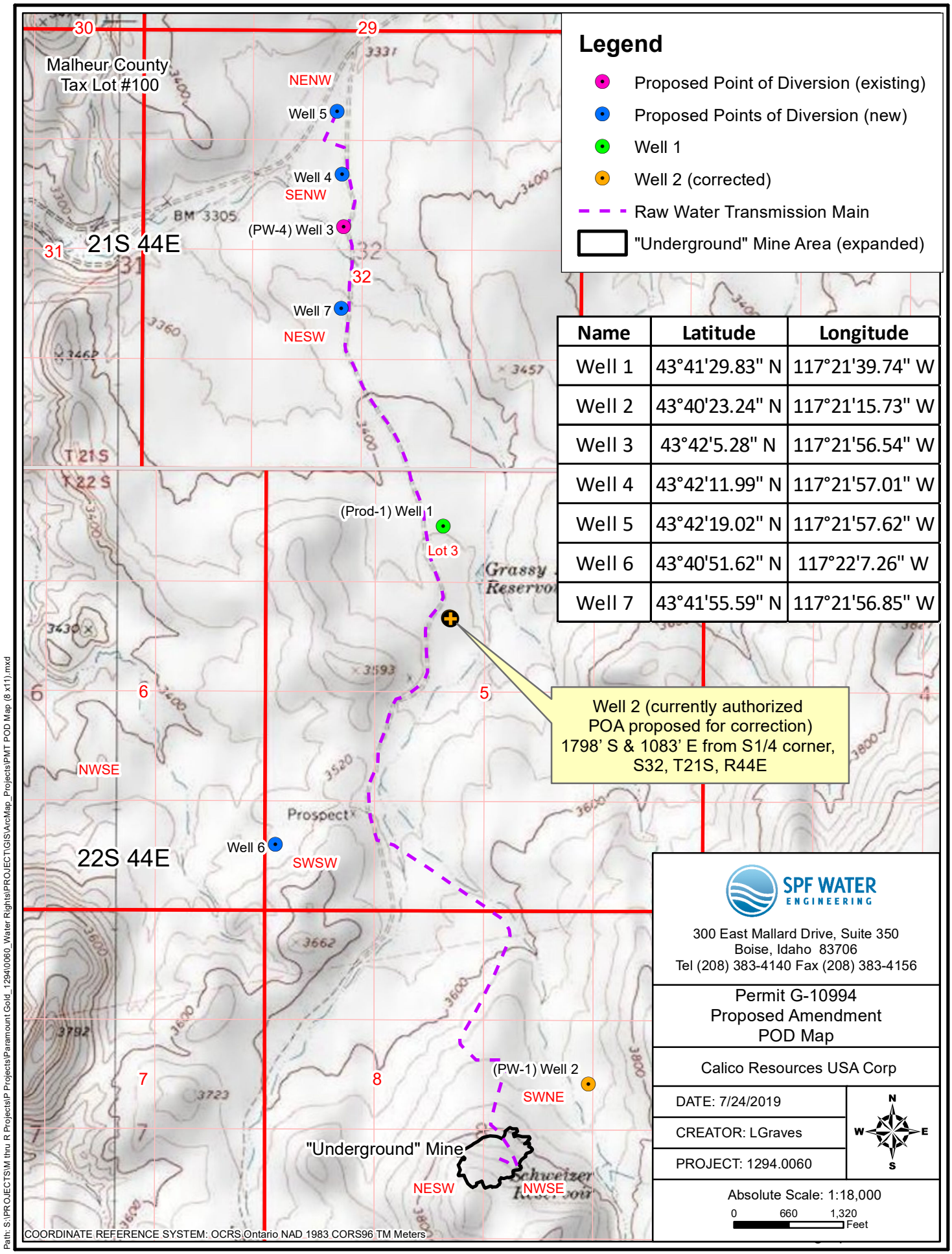
Calico Resources USA Corp

DATE: 7/24/2019
CREATOR: LGraves
PROJECT: 1294.0060

Absolute Scale: 1:80,000
0 2,640 5,280 Feet

COORDINATE REFERENCE SYSTEM: OCRS Ontario NAD 1983 CORS96 TM Meters

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0060_Water Rights\PROJECT\GIS\ArcMap_Projects\PMT POU Map (11x17).mxd



Name	Latitude	Longitude
Well 1	43°41'29.83" N	117°21'39.74" W
Well 2	43°40'23.24" N	117°21'15.73" W
Well 3	43°42'5.28" N	117°21'56.54" W
Well 4	43°42'11.99" N	117°21'57.01" W
Well 5	43°42'19.02" N	117°21'57.62" W
Well 6	43°40'51.62" N	117°22'7.26" W
Well 7	43°41'55.59" N	117°21'56.85" W

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

Permit G-10994
Proposed Amendment
POD Map

Calico Resources USA Corp

DATE: 7/24/2019
CREATOR: LGraves
PROJECT: 1294.0060

Absolute Scale: 1:18,000
0 660 1,320 Feet

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0060_Water Rights\PROJECTGIS\ArcMap_Projects\PMT POD Map (8 x11).mxd

STATE OF OREGON

COUNTY OF MALHEUR

PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO

CALICO RESOURCES USA CORP.
665 ANDERSON STREET
WINNEMUCCA, NV 89445

This superseding permit is issued to describe an amendment for additional points of appropriation, a change in point of appropriation, and a change in place of use proposed under Permit Amendment Application T-13157 and approved by Special Order Vol. 114, Page 133, entered October 16, 2019, and to describe an extension of time for complete application of water approved December 26, 2012, and an assignment approved March 7, 2013. This permit supersedes Permit G-10994.

The specific limits and conditions of the use are listed below.

APPLICATION FILE NUMBER: G-11847

SOURCE OF WATER: SEVEN WELLS, SUPPLEMENTED BY WATERS FROM AN OPEN PIT MINE IN THE MALHEUR RIVER BASIN

PURPOSE OR USE: MINING/INDUSTRIAL USES

RATE OF USE: 2.0 CUBIC FEET PER SECOND

DATE OF PRIORITY: AUGUST 29, 1988 FOR THE SEVEN WELLS AND NOVEMBER 15, 1988 FOR THE OPEN PIT MINE

The wells and open pit mine are located as follows:

Twp	Rng	Mer	Sec	Q-Q	Survey coordinates
21 S	44 E	WM	32	NE NW	WELL 5 - 43 DEGREES 42 MINUTES 19.02 SECONDS NORTH AND 117 DEGREES 21 MINUTES 57.62 SECONDS WEST
21 S	44 E	WM	32	SE NW	WELL 3 - 43 DEGREES 42 MINUTES 5.28 SECONDS NORTH AND 117 DEGREES 21 MINUTES 56.54 SECONDS WEST
21 S	44 E	WM	32	SE NW	WELL 4 - 43 DEGREES 42 MINUTES 11.99 SECONDS NORTH AND 117 DEGREES 21 MINUTES 57.01 SECONDS WEST
21 S	44 E	WM	32	NE SW	WELL 7 - 43 DEGREES 41 MINUTES 55.59 SECONDS NORTH AND 117 DEGREES 21 MINUTES 56.85 SECONDS WEST
22 S	44 E	WM	5	NE NW	691 FEET SOUTH AND 994 FEET EAST FROM THE S1/4 CORNER OF SECTION 32

Twp	Rng	Mer	Sec	Q-Q	Survey coordinates
22 S	44 E	WM	5	SW SW	WELL 6 - 43 DEGREES 40 MINUTES 51.62 SECONDS NORTH AND 117 DEGREES 22 MINUTES 7.26 SECONDS WEST
22 S	44 E	WM	8	SW NE	WELL 2 - 43 DEGREES 40 MINUTES 23.24 SECONDS NORTH AND 117 DEGREES 21 MINUTES 15.73 SECONDS WEST
22 S	44 E	WM	8	SW NE	ENTIRE UNDERGROUND AREA
22 S	44 E	WM	8	NE SW	ENTIRE UNDERGROUND AREA
22 S	44 E	WM	8	NW SE	ENTIRE UNDERGROUND AREA

Although declared herein to be a supplemental supply from the open pit mine, in the interest of prudent use of waters, use from the open pit mine may be exercised at times when water is available at the three original points of appropriation, provided the total quantity diverted from all sources does not exceed the limitation allowed herein.

This permit is issued subject to the maintenance and use of adequate treatment facilities to remove the sediment before returning the water to the stream.

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the proposed place of use under the permit is as follows:

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
19 S	44 E	WM	22	NE NE	
19 S	44 E	WM	22	SE NE	
19 S	44 E	WM	22	NE SE	
19 S	44 E	WM	23	NW NW	
19 S	44 E	WM	23	SW NW	
19 S	44 E	WM	23	NW SW	
19 S	44 E	WM	23	SW SW	
19 S	44 E	WM	26	NW NE	
19 S	44 E	WM	26	SW NE	
19 S	44 E	WM	26	SE NE	
19 S	44 E	WM	26	NE NW	
19 S	44 E	WM	26	NW NW	
19 S	44 E	WM	26	NE SE	
19 S	44 E	WM	26	SE SE	
19 S	44 E	WM	35	NE NE	
19 S	44 E	WM	36	NW NW	
19 S	44 E	WM	36	SW NW	
19 S	44 E	WM	36	NE SW	
19 S	44 E	WM	36	NW SW	
19 S	44 E	WM	36	SE SW	
20 S	44 E	WM	1	NE NE	1
20 S	44 E	WM	1	SE NE	
20 S	44 E	WM	1	NE SE	
20 S	44 E	WM	1	SE SE	
20 S	44 E	WM	12	NE NE	
20 S	44 E	WM	12	SW NE	
20 S	44 E	WM	12	SE NE	
20 S	44 E	WM	12	NE SW	

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
20 S	44 E	WM	12	SE SW	
20 S	44 E	WM	12	NW SE	
20 S	44 E	WM	12	SW SE	
20 S	44 E	WM	13	NW 1/4	
20 S	44 E	WM	13	NW SW	
20 S	44 E	WM	13	SW SW	
20 S	44 E	WM	14	NE SE	
20 S	44 E	WM	14	SE SE	
20 S	44 E	WM	23	NE NE	
20 S	44 E	WM	23	SE NE	
20 S	44 E	WM	23	SE SW	
20 S	44 E	WM	23	SE 1/4	
20 S	44 E	WM	26	NW NE	
20 S	44 E	WM	26	NE NW	
20 S	44 E	WM	26	SW NW	
20 S	44 E	WM	26	SE NW	
20 S	44 E	WM	26	NW SW	
20 S	44 E	WM	26	SW SW	
20 S	44 E	WM	27	NE SE	
20 S	44 E	WM	27	SE SE	
20 S	44 E	WM	34	NE NE	
20 S	44 E	WM	34	SE NE	
20 S	44 E	WM	34	NE SE	
20 S	44 E	WM	34	SW SE	
20 S	44 E	WM	34	SE SE	
20 S	45 E	WM	6	NW SW	6
20 S	45 E	WM	6	SW SW	7
20 S	45 E	WM	7	NW NW	
21 S	43 E	WM	36	SE NE	
21 S	43 E	WM	36	NE SE	
21 S	43 E	WM	36	SE SE	
21 S	44 E	WM	3	NE NE	
21 S	44 E	WM	3	NW NE	
21 S	44 E	WM	3	SW NE	
21 S	44 E	WM	3	SE NE	
21 S	44 E	WM	3	NE SE	
21 S	44 E	WM	3	NW SE	
21 S	44 E	WM	3	SE SE	
21 S	44 E	WM	10	NE NE	
21 S	44 E	WM	10	SE NE	
21 S	44 E	WM	11	NW NW	
21 S	44 E	WM	11	SW NW	
21 S	44 E	WM	11	NE SW	
21 S	44 E	WM	11	NW SW	
21 S	44 E	WM	11	SW SW	
21 S	44 E	WM	11	SE SW	
21 S	44 E	WM	12	NE NE	
21 S	44 E	WM	12	ALL	
21 S	44 E	WM	13	ALL	
21 S	44 E	WM	14	ALL	
21 S	44 E	WM	21	SE SE	

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
21 S	44 E	WM	22	NE NE	
21 S	44 E	WM	22	NW NE	
21 S	44 E	WM	22	SW NE	
21 S	44 E	WM	22	SE NE	
21 S	44 E	WM	22	NW 1/4	
21 S	44 E	WM	22	SW 1/4	
21 S	44 E	WM	22	SE 1/4	
21 S	44 E	WM	23	ALL	
21 S	44 E	WM	24	ALL	
21 S	44 E	WM	25	ALL	
21 S	44 E	WM	26	ALL	
21 S	44 E	WM	27	ALL	
21 S	44 E	WM	28	ALL	
21 S	44 E	WM	29	SE NE	
21 S	44 E	WM	29	SE SW	
21 S	44 E	WM	29	SE 1/4	
21 S	44 E	WM	31	NE NE	
21 S	44 E	WM	31	SW NE	
21 S	44 E	WM	31	SE NE	
21 S	44 E	WM	31	SE NW	2
21 S	44 E	WM	31	NE SW	3
21 S	44 E	WM	31	SE SW	4
21 S	44 E	WM	31	SE 1/4	
21 S	44 E	WM	32	ALL	
21 S	44 E	WM	33	ALL	
21 S	44 E	WM	34	ALL	
21 S	44 E	WM	35	ALL	
21 S	44 E	WM	36	ALL	
21 S	45 E	WM	7	ALL	
21 S	45 E	WM	18	ALL	
21 S	45 E	WM	19	ALL	
21 S	45 E	WM	30	NW NW	1
21 S	45 E	WM	30	SW NW	2
21 S	45 E	WM	30	NW SW	3
21 S	45 E	WM	30	SW SW	4
22 S	43 E	WM	1		1
22 S	43 E	WM	1		2
22 S	43 E	WM	1	SW SW	
22 S	43 E	WM	1	SE SW	
22 S	43 E	WM	1	SE 1/4	
22 S	43 E	WM	12	ALL	
22 S	43 E	WM	13	ALL	
22 S	43 E	WM	24	ALL	
22 S	43 E	WM	25	N 1/2	
22 S	44 E	WM	1	E 1/2	
22 S	44 E	WM	2	NE NW	3
22 S	44 E	WM	2	NW NW	4
22 S	44 E	WM	2	SW NW	
22 S	44 E	WM	2	SE NW	
22 S	44 E	WM	2	SW 1/4	
22 S	44 E	WM	3	ALL	

MINING/INDUSTRIAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
22 S	44 E	WM	4	ALL	
22 S	44 E	WM	5	ALL	
22 S	44 E	WM	6	ALL	
22 S	44 E	WM	7	ALL	
22 S	44 E	WM	8	ALL	
22 S	44 E	WM	9	ALL	
22 S	44 E	WM	10	ALL	
22 S	44 E	WM	15	NW NE	
22 S	44 E	WM	15	SW NE	
22 S	44 E	WM	15	W 1/2	
22 S	44 E	WM	15	NW SE	
22 S	44 E	WM	15	SW SE	
22 S	44 E	WM	16	ALL	
22 S	44 E	WM	17	ALL	
22 S	44 E	WM	18	ALL	
22 S	44 E	WM	19	ALL	
22 S	44 E	WM	20	N 1/2	
22 S	44 E	WM	20	NE SW	
22 S	44 E	WM	20	NW SW	
22 S	44 E	WM	20	NE SE	
22 S	44 E	WM	20	NW SE	
22 S	44 E	WM	21	N 1/2	
22 S	44 E	WM	21	NE SW	
22 S	44 E	WM	21	NW SW	
22 S	44 E	WM	21	NE SE	
22 S	44 E	WM	21	NW SE	
22 S	44 E	WM	30	N 1/2	

Permit Amendment T-13157 Conditions:

The quantity of water diverted at the new point of appropriation (Well 2), together with that diverted at the old point of appropriation (Well 2), shall not exceed the quantity of water lawfully available at the original point of appropriation (Well 2).

The combined quantity of water diverted at the new points of appropriation (Wells 3, 4, 5, 6, 7, and underground areas), together with that diverted at the old points of appropriation (Wells 1 and 2), shall not exceed the quantity of water lawfully available at the original point of appropriation (Wells 1 and 2).

Water shall be acquired from the same aquifer as the original points of appropriation.

Extension of Time Conditions:

Last Extension Condition

This is to be the last extension of time granted for Permit G-10994. Any future extensions of time requests will be denied.

Checkpoint Condition

The permit holder must submit a completed Progress Report Form to the Department by **October 1, 2017, October 1, 2022, and October 1, 2027.** ***A form will be enclosed with your Final Order.***

(a) At each checkpoint, the permit holder shall submit and the Department shall review evidence of the permit holder's diligence towards completion of the project and compliance with terms and conditions of the permit and extension. If, after this review, the Department determines the permit holder has not been diligent in developing and perfecting the water use permit, or complied with all terms and conditions, the Department shall modify or further condition the permit or extension to ensure future compliance, or begin cancellation proceedings on the undeveloped portion of the permit pursuant to ORS 37.260 or 537.410, or require submission of a final proof survey pursuant to ORS 537.250;

(b) The Department shall provide notice of receipt of progress reports in its weekly notice and shall allow a 30 day comment period for each report. The Department shall provide notice of its determination to anyone who submitted comments.

Original Permit Conditions:

The well shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevations in the well at all times. When required by the Department, the permittee shall install and maintain a weir, meter, or other suitable measuring device, and shall keep a complete record of the amount of ground water withdrawn.

Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the Department's standards, to the Water Resources Department. The Director may require water-level or pump-test results every ten years thereafter.

The original permit was issued April 5, 1990. Actual construction work was to begin on or before April 5, 1991. By Extension of Time Final Order dated December 26, 2012, the deadline for completing construction and for complete application of water to use was extended to October 1, 2028.

Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

This permit is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

Issued OCT 16 2019;

Lisa J. Jaramillo, Transfer and Conservation Section Manager, for
THOMAS M BYLER, DIRECTOR
Oregon Water Resources Department

Appendix Q: Monitoring Well Work Proposal

Monitoring Well Work Proposal
Grassy Mountain Project

Prepared for

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Prepared by

SPF Water Engineering, LLC
300 East Mallard, Suite 350
Boise, Idaho 83706
(208) 383-4140

October 7, 2019

SPF WATER ENGINEERING

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1. INTRODUCTION

This report presents a groundwater monitoring proposal for Calico Resources USA Corp's (Calico's) Grassy Mountain Project (Project). This report specifically addresses groundwater monitoring for the tailings storage facility (TSF), waste rock storage facility, and the process plant collection pond. This report intends to meet the requirements of Oregon Administrative Rules (OAR) Chapter 340, Division 40, Groundwater Quality Protection.

The purpose of the groundwater monitoring proposal is to detect any groundwater contamination resulting from these facilities occurring in the uppermost aquifer and any other potentially affected aquifers. The "uppermost aquifer" is defined in OAR 340-040 as the *geologic formation, group of formations, or part of a formation that contains the uppermost potentiometric surface capable of yielding water to wells or springs, and may include fill material that is saturated*.

Both up-gradient and down-gradient monitoring wells will be installed. The up-gradient wells will serve as background monitoring points. The down-gradient monitoring wells will serve as the down-gradient detection monitoring points to determine if the groundwater is being affected by leakage from the TSF, waste rock storage facility, or collection pond. The down-gradient detection monitoring points are expected to serve as the compliance points where groundwater-quality parameters must be at or below the permit-specific concentration limits or the concentration limit variance, unless other compliance points are required by the Oregon Department of Environmental Quality (ODEQ). The concentration limit is the maximum acceptable concentration of a contaminant allowed in groundwater at a compliance point. For new facilities, the permit-specific concentration limits shall be the background water quality for all contaminants.

In addition to the proposed monitoring wells, there are existing wells in the near vicinity of the Project facilities that are proposed be included in the monitoring well network.

This report outlines the purposes of the monitoring proposal, and then describes (1) area and local geological and hydrogeological conditions, (2) proposed monitoring well locations and construction, (3) existing monitoring wells, (4) groundwater monitoring approach and methods, (5) data analysis, and (6) reporting requirements.

2. PROJECT LOCATION

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Figure 2).

The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419

unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM) (Figure 2). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or re-routing and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be 30 feet wide, which includes a 20-foot wide road travel width (10 feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

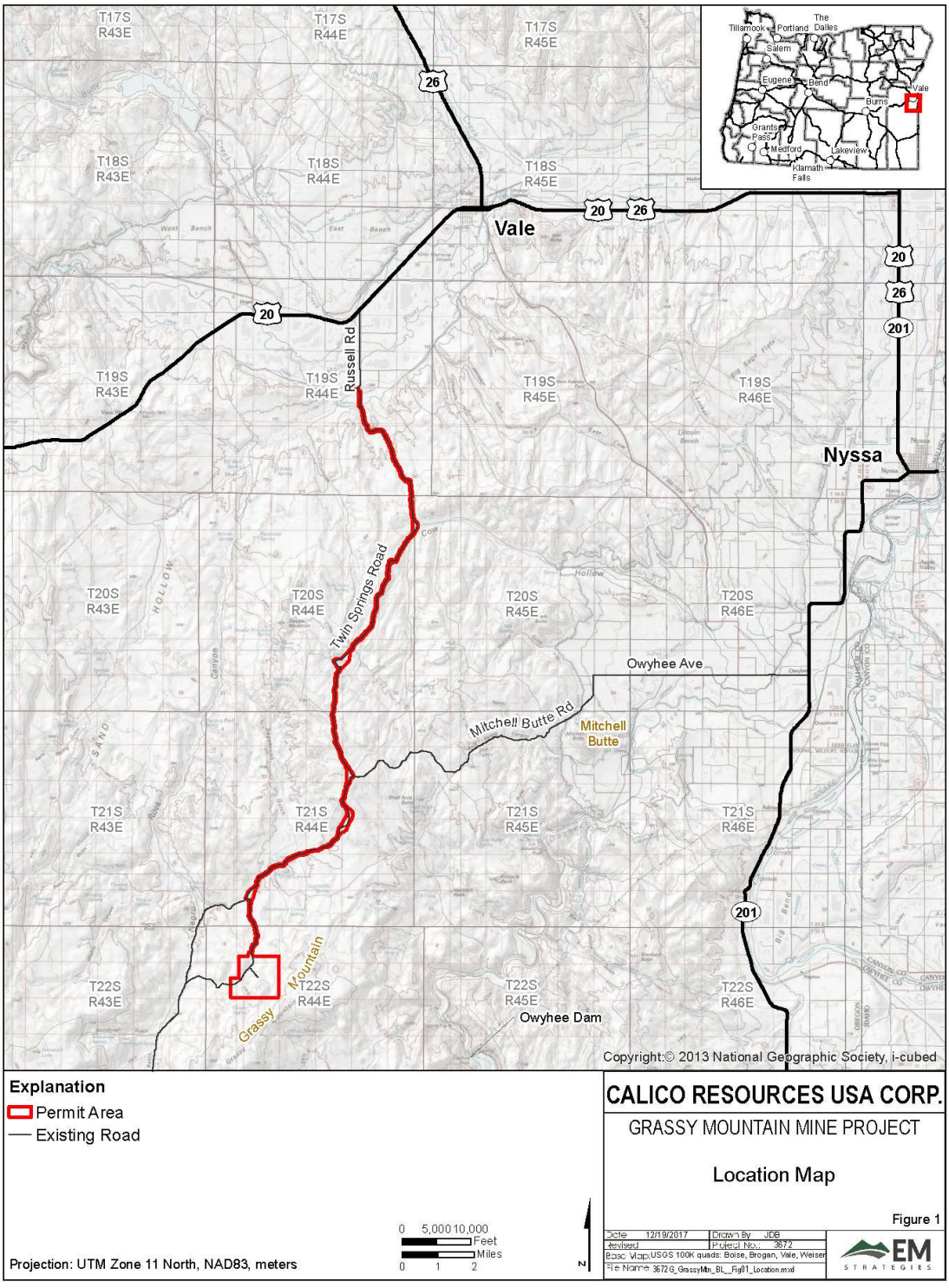

Figure 1. Location map

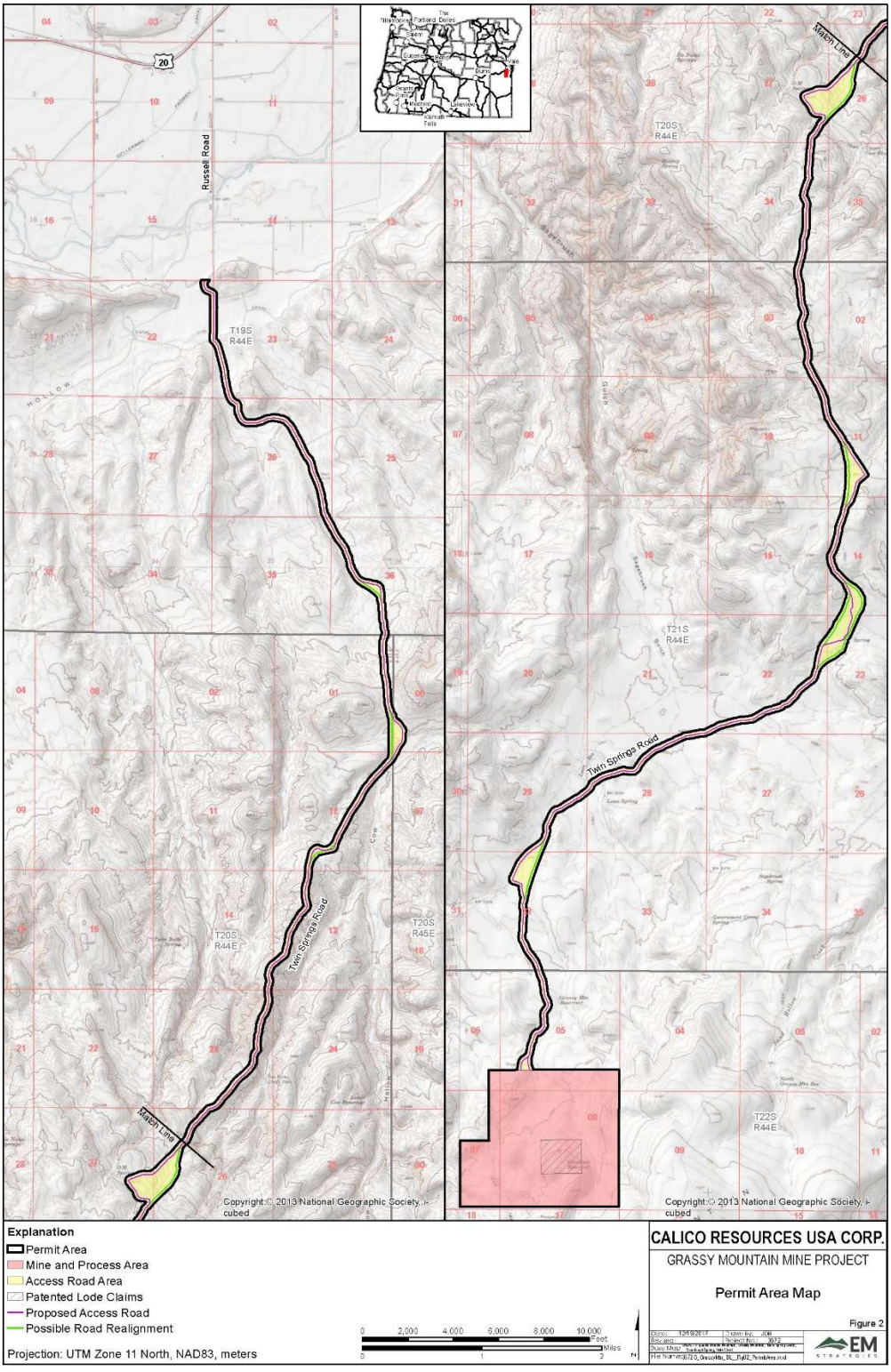

Figure 2. Permit area map

3. FACILITIES

3.1. Tailings Storage Facility

The following description of the TSF was obtained from the Geotechnical Data Report, Grassy Mountain Project, Malheur County, Oregon (Golder 2018) and the Preliminary Feasibility and Technical Report for the Grassy Mountain Gold and Silver Project Malheur County, Oregon (Mine Development Associates, 2018).

The proposed TSF will be located in a drainage northwest of the proposed Grassy Mountain mine site and associated process facilities, refer to the Project site layout map included in Appendix A. The bottom elevation of the TSF is at approximately 3,540 feet, along the base of the north embankment.

The TSF will require embankments on the north, west, and southwest sides of the drainage. The main embankment will be located at the north end. The north embankment will extend east-west across the drainage and will have an approximate maximum height of about 80 feet. The west and southwest embankments will range in height from about 10 feet to about 44 feet. The proposed TSF will cover approximately 110 acres.

The embankments will be constructed in stages with soil and/or rock materials obtained from on-site borrow sources. The TSF impoundment will include a composite lining system, including (from bottom to top): a prepared subgrade, an enhanced geosynthetic clay liner, HDPE geomembrane liner, a drainage layer, and a filter layer. An underdrain collection system consisting of perforated piping will be located within the impoundment drainage layer. The upstream slope of the embankments will utilize the same composite lining system, but without the underdrain collection system, drainage and filter layers.

A reclaim pond will capture all process solution collected in the TSF underdrain collection system. The reclaim pond is proposed north of the TSF. The reclaim pond will be lined, the lining system will consist of (from bottom to top): a prepared subgrade, an HDPE secondary geomembrane liner, an HDPE geonet, and an HDPE geomembrane primary liner. The geonet will serve as the leakage collection and recovery system.

Water collected from the reclaim pond and from the supernatant pool will be returned to the mill for use in the process circuit using independent return-water systems.

The TSF has been designed as a zero-discharge facility, capable of storing the 500-year, 24-hour storm event. Permanent and temporary stormwater diversions will collect and divert a majority of the stormwater runoff around the facility to a natural drainage located on the north side of the TSF.

3.2. Waste Rock Storage Facility

Waste rock from mining will ultimately be used as cemented rock fill (CRF) material. During operation, a stockpile of waste rock will be managed on the surface to be used

as CRF as needed. The waste rock storage facility will be located south and immediately adjacent to the TSF, refer to the Project site layout map included in Appendix A.

The waste rock storage facility will be a lined facility due to the potential sulfides in the waste rock material. The composite lining system will consist of (from bottom to top): prepared subgrade, an enhanced geosynthetic clay liner, an HDPE geomembrane liner, and a drainage layer. A collection system consisting of perforated piping will be installed within the drainage layer to collect any water coming in contact with the waste rock. The collection system will drain by gravity to the TSF reclaim pond.

3.3. Process Plant Collection Pond

The mine process facilities will be situated on a saddle between the proposed mine site and a knoll about 600 feet north of the mine portal. Diversion ditches will be constructed along the perimeter of the process facilities to prevent runoff from entering the facilities. The process facilities pad will include a system of ditches and culverts that will collect any precipitation that falls directly on the pad. Water collected will be directed by gravity towards a collection pond.

The collection pond is proposed northeast of the main process facilities, refer to the plant site general arrangement plan included in Appendix B. The pond volume will be approximately 110,000 ft^3 (823,000 gallons). The pond volume has been designed to accommodate the 100-year, 24-hour storm event while also accounting for sediment accumulation and freeboard. The pond will be double-lined with a fluid evacuation zone between the two liners. The bottom elevation of the pond is 3,675 feet.

4. GEOLOGY

4.1. Area Geology

The Grassy Mountain Geology and Soils Baseline Report (Abrams 2018) describes the surficial geology in the vicinity of the Project. The Mine and Process Area Geology map from the Geology and Soils Baseline Report is shown on Figure 3, along with the TSF and process plant.

The eastern portion of the TSF is underlain by geologic unit *Qal,* identified as Pleistocene and Holocene alluvium, and described as *unconsolidated and generally poorly sorted deposits or gravel, sand and silt accumulated along modern streams, drainages and floodplains* (Abrams 2018).

The western portion of the TSF and the process plant is underlain by geologic units *Tgs* and *Tgsc*, identified as Grassy Mountain Formation - undifferentiated and Grassy Mountain Formation - conglomerate. The Grassy Mountain Formation sedimentary units in the area of the process plant and proposed mine are silicified and strongly indurated (Abrams 2018).

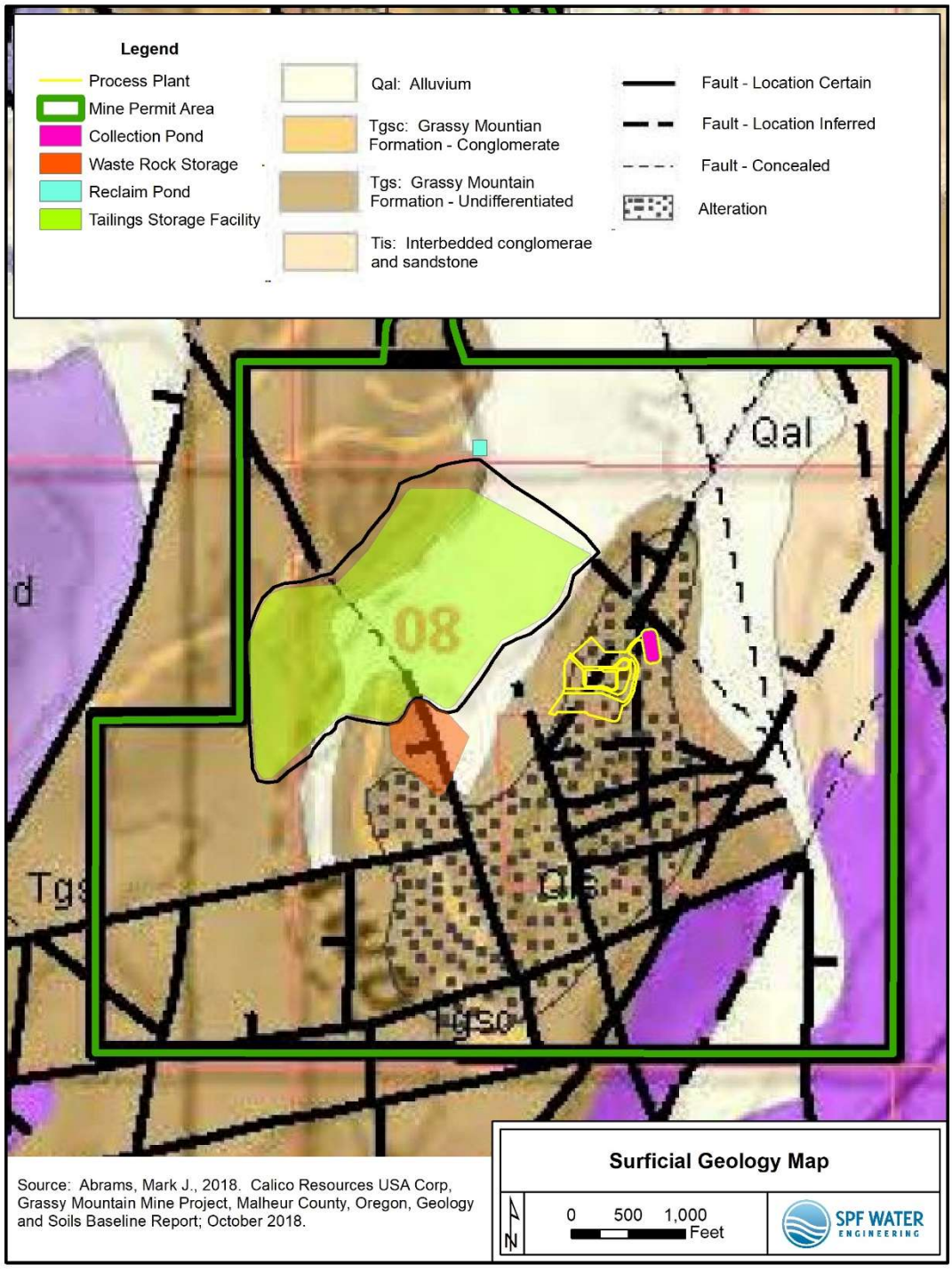

Figure 3. Surficial geology map

Geologic unit *Tgs* (Grassy Mountain Formation – undifferentiated) is described in the Geology and Soils Baseline Report as: *Arkosic sandstones and channel-fill granite clast conglomerates. Mainly white to tan arkosic sandstones. Includes Tgsc, channel fill conglomerates with abundant granite and rhyolite clasts in the upper part of the unit. Uppermost conglomerates locally contain rounded obsidian clasts and rare black chert clasts. Unit Tgs generally becomes finer grained upward and includes white bentonitic clays near the top of the section which, where overlain by unit Tgb often generated large landslide masses. Hot spring activity contemporaneous with the deposition of the arkoses is indicated by sinter beds Tgsn, and sinter boulders containing silicified reeds and wood near the Grassy mountain gold deposit. Unit Tgs is the host for both the Grassy Mountain and Crabgrass gold deposits*

Geologic unit *Tgsc* (Grassy Mountain Formation – conglomerate) is described as conglomerates found in the upper part of geologic unit *Tgs* (Abrams 2018).

A representative stratigraphic column of the geology near the Mine and Process Area from Abrams 2018 is provided as Figure 4. The Quaternary-age alluvium overlies the Grassy Mountain Formation in the lower elevation drainages, with the Grassy Mountain Formation siltstone, sandstone, and conglomerate exposed at the higher elevations in the Mine and Process Area. The Tuff of Kern Basin underlies the Grassy Mountain Formation.

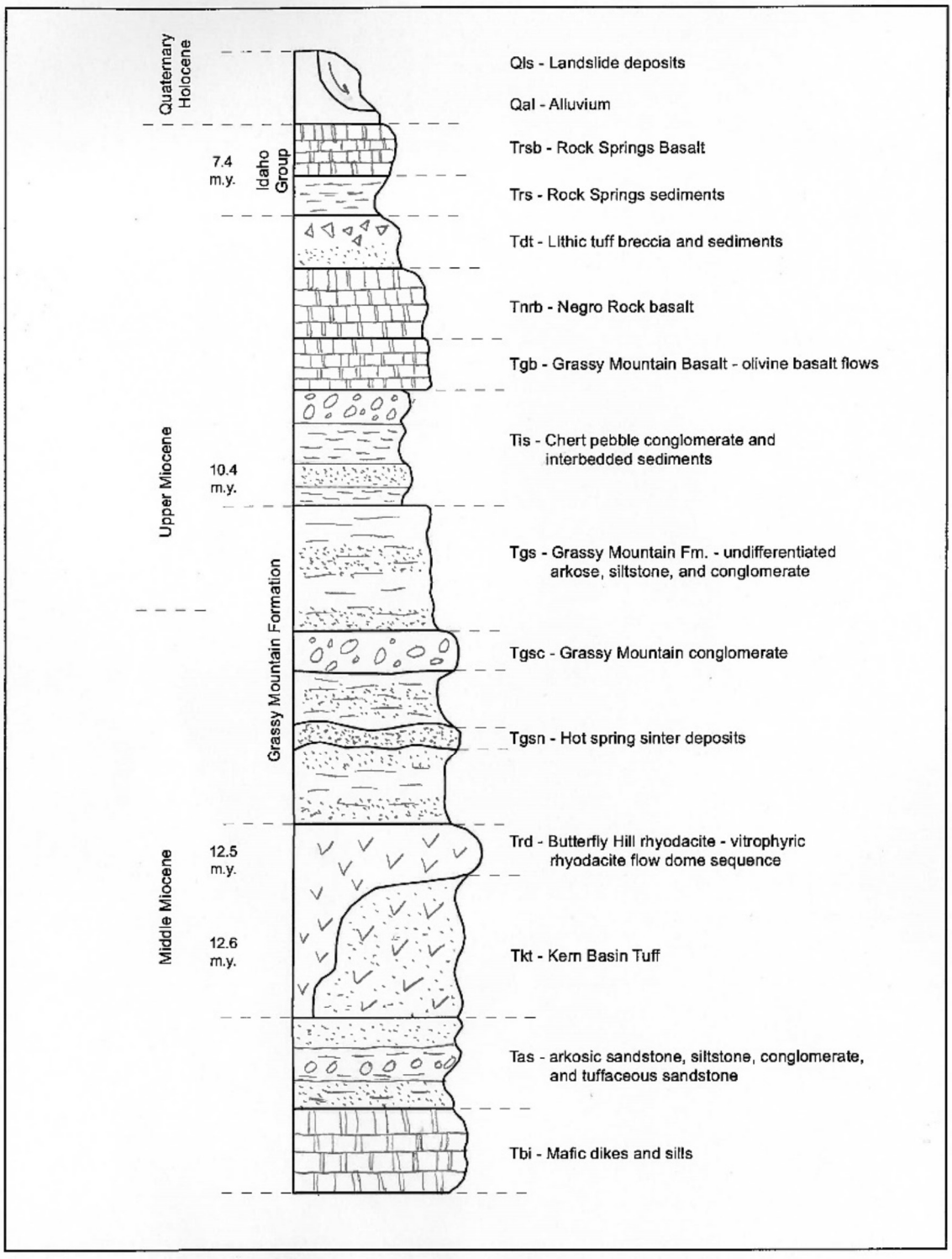

Figure 4. Representative stratigraphic column

4.2. Area Hydrogeology

4.2.1. **Aquifer System**

Groundwater in the general vicinity of the proposed mine site is found primarily within unconsolidated and semi-consolidated sandstone and conglomerate units of the Grassy Mountain Formation. The Grassy Mountain Formation generally strikes from east to west and dips towards the north. Discontinuous lenses of higher permeability sandstone and conglomerate form localized and compartmentalized water-bearing units that are interbedded with thick layers of low-permeability clay and clayey siltstone that impede groundwater flow. These sedimentary rocks are locally capped by basalt, alluvium and colluvium. The Grassy Mountain Formation is underlain by fine-grained lithic tuff, the Tuff of Kern Basin. The Grassy Mountain Formation is the host unit for the Grassy Mountain gold and silver deposit. A more detailed description of principal hydrogeological units can be found in the Grassy Mountain Gold Project Groundwater Characterization Report (SPF 2019b).

The aquifer system in the near vicinity of the proposed mine is typically found in silicified sediments or clay with very low hydraulic conductivity and high hydraulic gradients. Production and monitoring wells near the deposit completed in unconsolidated sediments and fractured basalt typically have short-term yields of less than 50 gpm. Long-term aquifer sustainability appears to be limited by negative hydraulic boundaries such as water-bearing zones of limited spatial extent, faulting, and/or silicification. Wells near the deposit completed in clay or silicified sediments have very low yields, generally less than 5 gpm.

The aquifer hydraulic conductivity increases down-gradient of the proposed mine where the sediments are not silicified. However, aquifer sustainability appears to be still affected by faulting and lithologic variability, with limited data suggesting that the Grassy Mountain Formation thins out moving north from the deposit. The Grassy Mountain fault zone also extends north of the deposit (RQV 2015). This fault zone acts as a barrier to groundwater flow based on testing of nearby wells; the most productive wells in the area are presumably located on the east side of the Grassy Mountain fault zone.

4.2.2. **Groundwater Flow**

Potentiometric surface maps are two-dimensional depictions of groundwater flow. In reality, groundwater flow occurs in three-dimensions. These maps, however, are useful for providing an indication of the overall, general groundwater flow direction and hydraulic gradient. Water-level data collected from the monitoring well network support the development of shallow and deep potentiometric surface maps (SPF 2019b).

The shallow surface can be considered representative of the regional aquifer system. The deep potentiometric surface is based on water-level data from deep wells only located near the deposit, and appears to be a function of high vertical gradient related to silicification, faulting, and steeply dipping beds. The groundwater conceptual model

is based on a single aquifer system that is supported by geology, water quality, potentiometric surface, and water-level data (SPF 2019b).

4.2.2.1. Shallow Potentiometric Surface

A groundwater elevation (potentiometric surface) contour map has been developed using the 2017 average water-level data from the shallow monitoring wells. This map is included as Figure 5. This map is considered representative of groundwater flow in the Project area. Potentiometric surface maps created using water-level data from 2013 through 2016 are included in the Grassy Mountain Gold Project Groundwater Resources Baseline Data Report (SPF 2019a).

Review of the shallow groundwater potentiometric surface maps suggests the following:

- The shallow potentiometric surface has remained relatively constant over the period of monitoring, generally without apparent seasonal influences. The consistent potentiometric surface reflects stable groundwater-level trends measured in individual wells over time.

- Groundwater flow generally occurs from the southeast to the northwest in the vicinity of the Project, from higher elevations along the base of Grassy Mountain (~4,000 feet amsl) to lower elevations along Negro Rock Canyon (~3,200 feet amsl). The groundwater elevations range from approximately 3,700 feet amsl (at well 57-1 southwest of the deposit) to approximately 3,220 feet (at well GW-5 northwest of the deposit).

- Local variations are apparent in the potentiometric surface, attributed to structural and/or spatial contrasts in aquifer permeability and vertical gradients possibly due to silicification. For example, steeper horizontal hydraulic gradients are apparent between wells 57-1 (completed from 108 to 138 feet) and GW-3 (completed from 320 to 350 feet) and between wells 59766 (completed from 25 to 45 feet) and GW-5 (completed from 204 to 224 feet) compared to other areas, likely due to differences in completion depth and resultant vertical gradient.

- Despite the local variations, the shallow well potentiometric surface suggests a single aquifer system. Despite differences in aquifer formation materials and well depths, the groundwater flow to the northwest towards lower elevation follows a relatively consistent pattern.

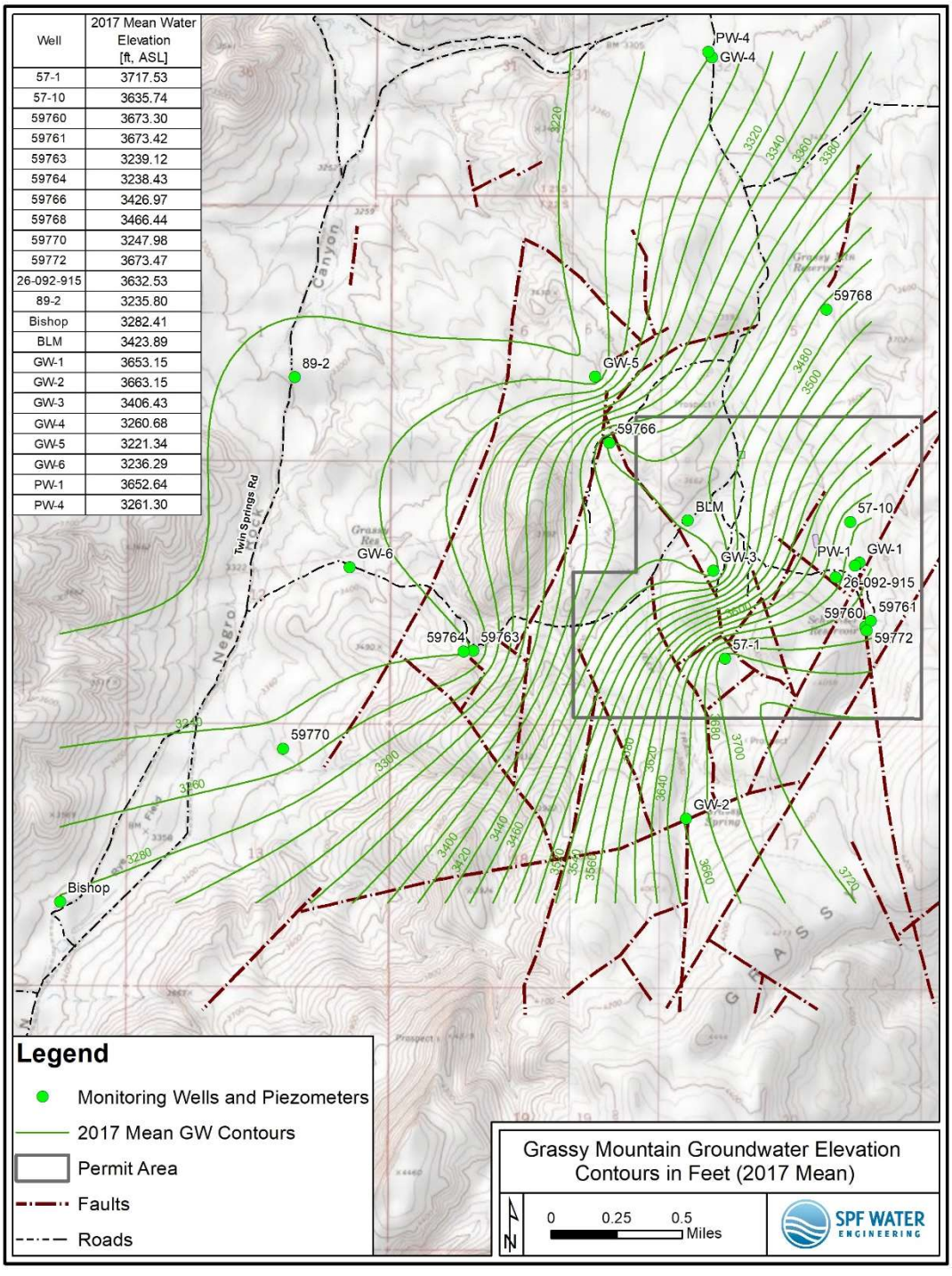

Figure 5. Shallow potentiometric surface

4.2.2.2. Deep Potentiometric Surface

A deep potentiometric surface was developed from water levels measured from two deep well completions (59762 and GMW17-32) and the average[1] of six vibrating wire piezometers (VWPs) installed at deep and intermediate depths (refer to the Grassy Mountain Gold Project Groundwater Resources Baseline Data Report for additional information). This potentiometric surface suggests the direction of groundwater flow in deeper water-bearing intervals is also toward the northwest in the vicinity of the deposit, from higher elevations along the base of Grassy Mountain to lower elevations along Negro Rock Canyon (Figure 6). These groundwater elevations range from approximately 3,150 feet amsl at the deposit to approximately 3,100 feet at the two monitoring wells just northwest of the deposit.

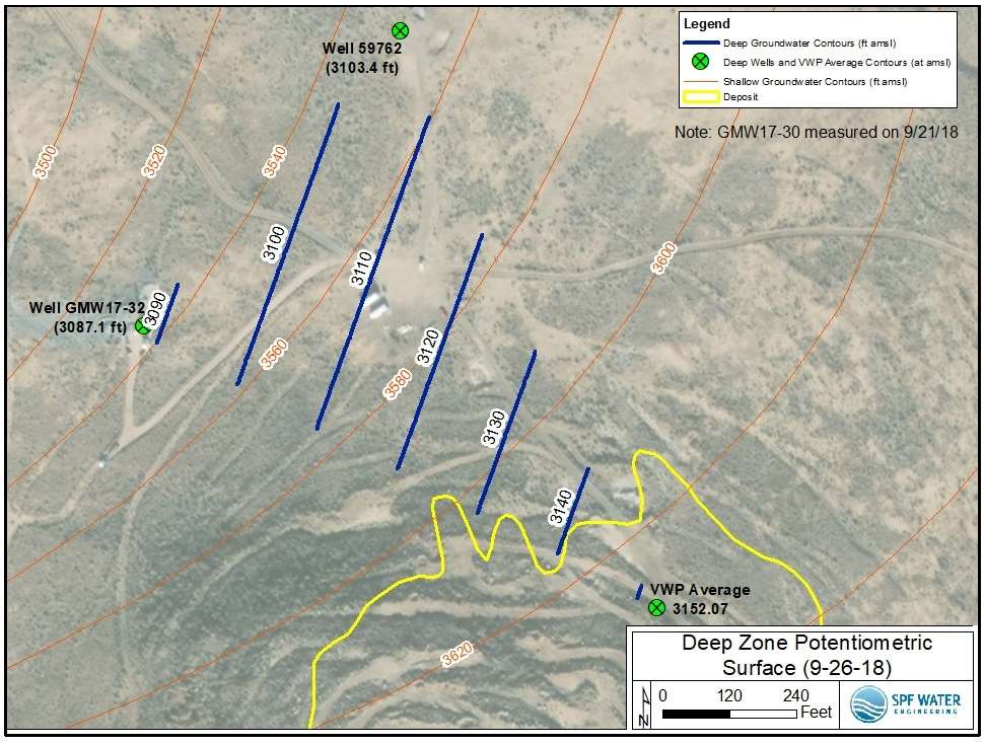

Figure 6. Deep potentiometric surface

[1] Although not a direct measurement of groundwater-level elevation, the average water level from the VWPs is considered to be the best approximation of deep groundwater elevation in the ore body vicinity due to local controls on potentiometric surface.

4.3. Local TSF Geology

4.3.1. **Geotechnical Boreholes**

A geotechnical field exploration program was conducted between November 30 and December 8, 2017, to support pre-feasibility design of the TSF and mine process facilities (Golder 2018). The program included drilling 12 borings to depths ranging from approximately 40 to 100 ft below the ground surface (bgs) at the TSF. An additional 6 borings were drilled at the TSF between March 20 and 26, 2017. These ranged in depth from 50.4 to 121.4 feet bgs. A map showing the borehole locations is included in Appendix C.

Soils were classified in accordance with the Unified Soil Classification System (UCSC) by Golder geologists. The following description of the subsurface conditions is taken from Golder 2018:

- Topsoil: Topsoil was estimated to have an average thickness of ½ foot across a majority of the site. Topsoil was generally comprised of dark brown, silty- to clayey-sands with non-plastic to low plastic fines.
- Quaternary deposits: These deposits include unconsolidated sediments deposited by water (alluvium) and accumulated material on exposed slopes (colluvium). These units are estimated to be Quaternary-age deposits based on Ferns et al, 1993. These materials were encountered across the site and consisted of sands, gravels, clays, and silts with thicknesses ranging from about 2 to 25 feet bgs. Generally, the upper portion of the deposit was classified as fine-grained soils described as lean and fat clay with varying amounts of sand and gravel and were underlain by coarse-grained soils described as clayey- to silty-sand, clayey- to silty-gravel, and poorly- to well-graded sand and gravel.
- Lacustrine deposits: Lacustrine deposits were encountered across a majority of the site and are primarily classified as lean to high plasticity clay with varying sand content. These deposits were not identified by Ferns et al, 1993. However, based on similar units in the region, these units are estimated to be Miocene-age deposits.
- Alluvium and beach deposits: Discontinuous alluvium and beach deposits were observed within the lacustrine clay deposits generally consisting of poorly-graded sand and silty sand. Due to the location of these deposits within the lacustrine clays, these deposits were estimated to be Miocene-age deposits.
- Arkosic sandstone: Part of the Grassy Mountain Formation generally consisting of fine- to coarse grained sands and are mapped as mid-Miocene in age (Ferns et al, 1993).
- Basalt: Upper Miocene olivine basalt flows observed in the hills east of the project area (Ferns et al, 1993).

Water was not noted in any of the boreholes. The soils were generally described as being moist, suggesting potential saturation.

4.3.2. **Cross-Sections**

Using the bore logs and UCSC classification developed by Golder, lithologic cross-sections were created through the TSF to describe subsurface stratigraphy. The bore logs used to create the lithologic cross-sections are included in Appendix D. The cross-sections are included in Appendix E. The cross-sections are labelled with the UCSC classification by Golder, while the color scheme reflects a more generalized classification as clay, gravel, sand, or silt (as interpreted by SPF Water Engineering). A map showing the location of the cross-sections in included as Figure 7.

The cross-sections generally show interbedded layers of clay and sand. At the north end of the TSF near the reclaim pond, there appears to be a clay layer 10 to 20 feet thick at the surface (below a thin layer of topsoil). Below this is a relatively thin layer of clayey sand (approximately 5 to 10 feet thick), underlain by a relatively thick clay zone at least 40 feet thick. Below this clay layer is another clayey sand zone that appears to be about 30 feet thick, underlain by a thin clay zone and then another layer of silty sand.

Moving southeast from the reclaim pond, the upper clay and sand zones appear to thicken, and may dip upwards with topography. South of the reclaim pond, a sand zone caps the upper clay layer observed near the reclaim pond. Through the center of the TSF, there is a surface layer of clayey to silty sand, 10 to 25 feet thick, underlain by a clay zone 25 to 40 feet thick. On the northwest side of the TSF, this clay zone is on the thinner end of that thickness range, and a sand zone is apparent below the clay. These layers appear to generally follow surface topography.

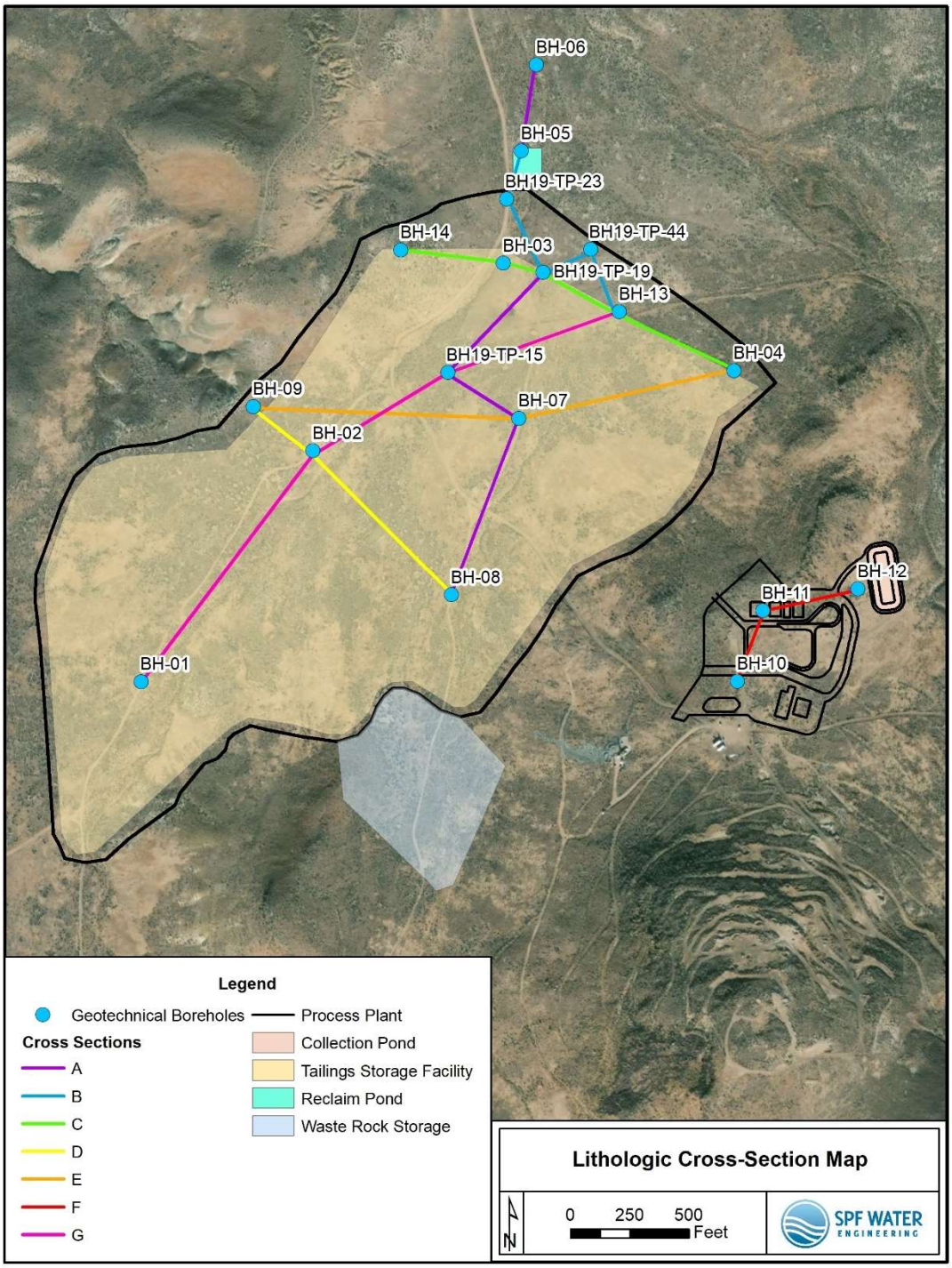

Figure 7. Lithologic cross-section map

4.3.3. **Field Permeability**

Field permeability (falling head) tests were also performed at six boreholes to estimate the hydraulic conductivity of subsurface soils (Golder 2018). Results are summarized on Table 1. The hydraulic conductivity values of the shallow alluvial sands are on the low end for sands, representative of silt and silty sand (Freeze and Cherry 1979).

Table 1. Estimated hydraulic conductivity (Golder 2018)

Borehole ID	Test Interval (feet bgs)	Material Description (UCSC Classification)	Estimated Hydraulic Conductivity (cm/s)
BH-2	20 to 25	Poorly Graded Sand (Beach Deposits)	1.1×10^{-6}
BH-3	2 to 4	Poorly Graded Sand (Overburden)	8.1×10^{-6}
BH-5	10 to 15	Poorly Graded Sand (Overburden)	4.6×10^{-6}
BH-6	22.8 to 24.8	Fat Clay (Lacustrine)	1.2×10^{-7}
BH-7	14.45 to 19.45	Poorly Graded Sand with Clay and Gravel (Overburden)	3.5×10^{-6}
BH-9	3.6 to 8.6	Poorly Graded Sand (Overburden)	5.4×10^{-5}

4.3.4. **Monitoring Wells**

In addition to the geotechnical boreholes, there are existing monitoring wells located in the near vicinity of the TSF that provide information on local hydrogeology. These monitoring wells are shown on Figure 8. Driller's reports are included in Appendix F.

The BLM well is located within the footprint of the TSF. The well is located at an elevation of approximately 3,580 feet. This well was constructed to a total depth of 175 feet. The well log describes clay to a depth of 170 feet and white sand between a depth of 170 and 175 feet. Groundwater was encountered at a depth of 165 feet. The well is reportedly screened from a depth of 159 to 166 feet. This log suggests that the lacustrine deposits encountered in the geotechnical bores extend to a depth of at least 170 feet in his area. The static water level in the well has varied between approximately 156 and 157 feet bgs during the baseline monitoring period (March 2013 through September 2018). This is equivalent to a water surface elevation of approximately 3423 to 3424 feet, refer to Figure 9.

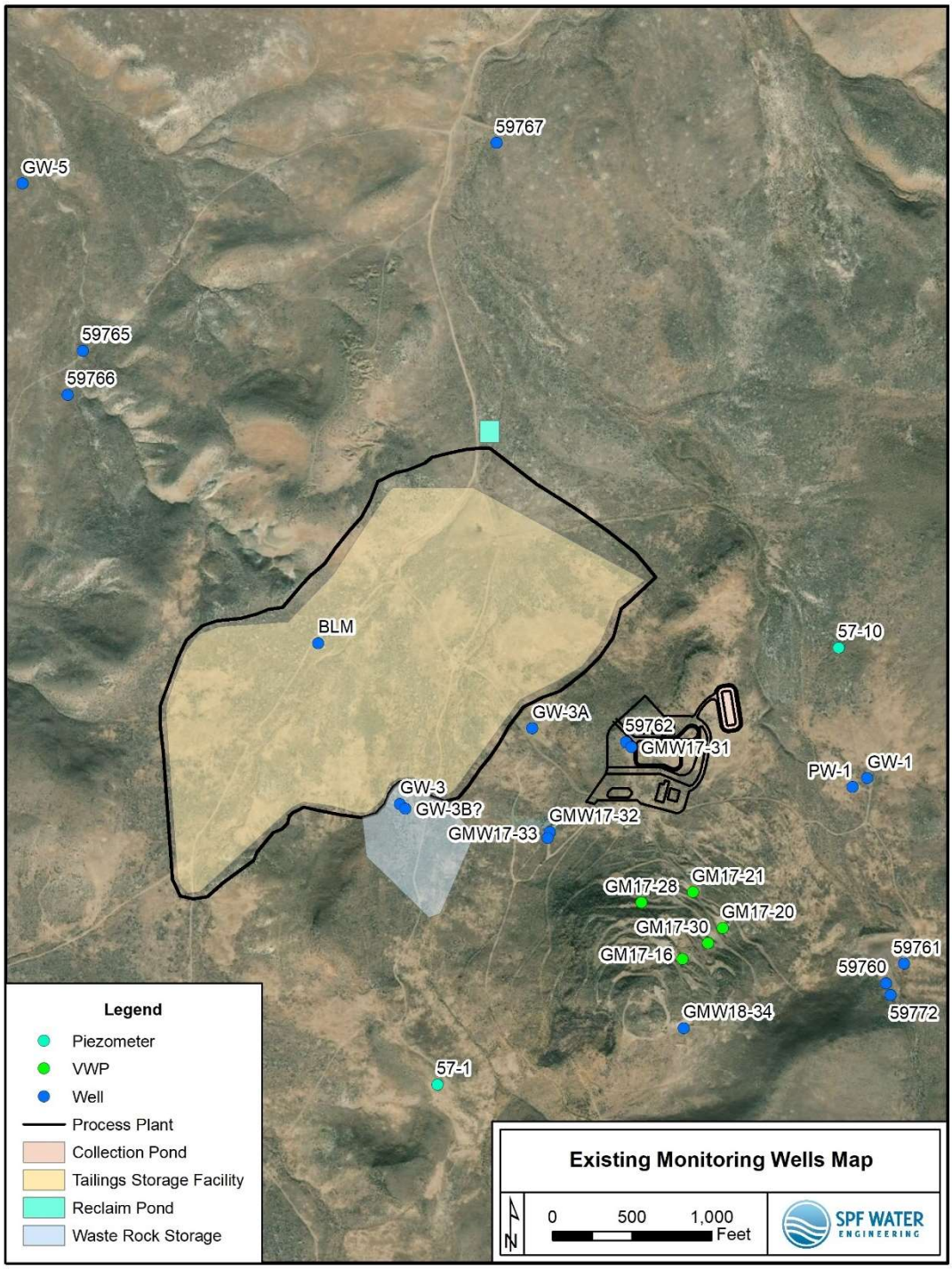

Figure 8. Existing monitoring wells map

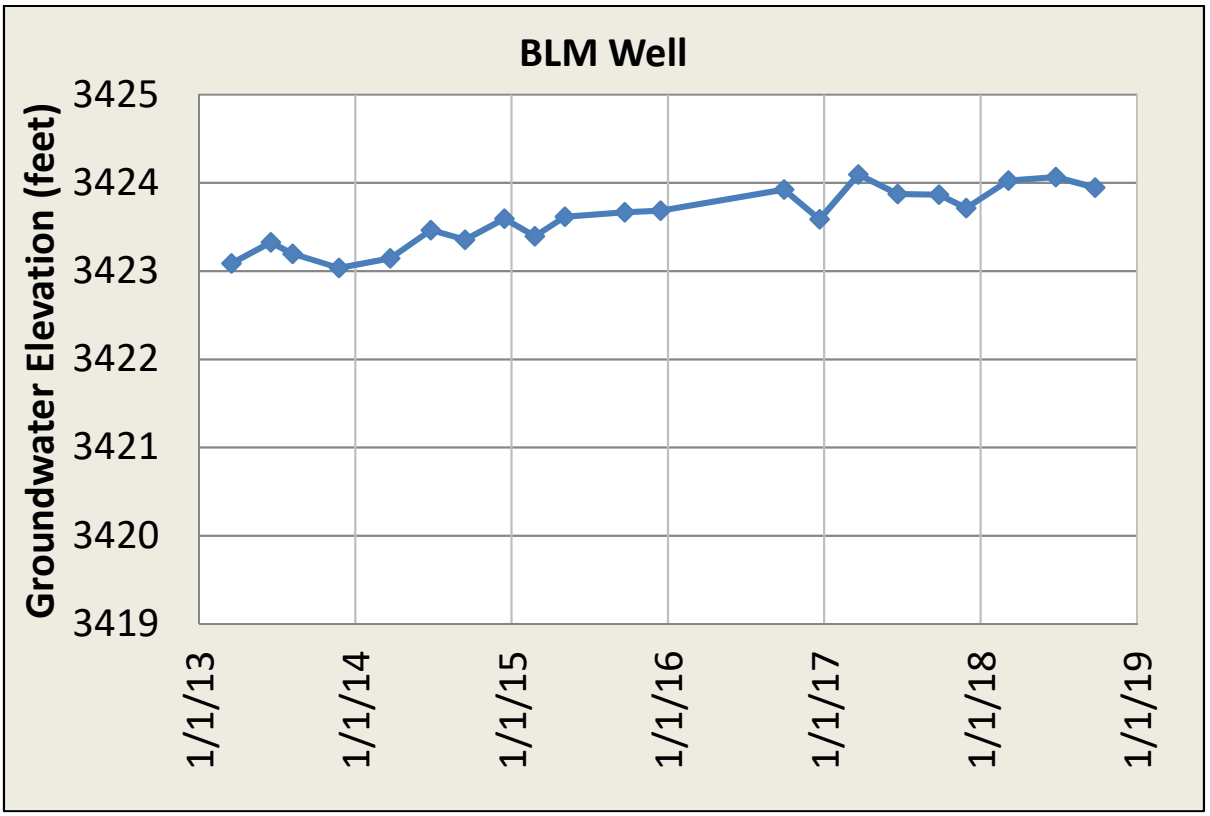

Figure 9. BLM well groundwater elevation

Well GW-3 is located southeast (up-gradient) of the TSF, at an elevation of approximately 3,630 feet. The driller's log describes clay to the total depth of 400 feet. These clay deposits are likely part of the same lacustrine deposits encountered in the geotechnical bores. Groundwater was not encountered during drilling. The well is reportedly screened from a depth of 320 to 350 feet. Groundwater was not observed during drilling of the well in 1989. However, groundwater has since entered the well. Between March 2013 and September 2017, the static water level measured in the well varied between approximately 223 and 224 feet bgs, equivalent to a water surface elevation ranging from 3406 to 3407 feet. Between September 2017 and September 2018, the static water level varied between approximately 224 and 228 feet bgs, equivalent to a water surface elevation ranging from about 3402 to 3406 feet. Figure 10 is a plot of groundwater elevation.

Well GW-3A is also located southeast (up-gradient) of the TSF and northeast of GW-3, at an elevation of approximately 3,640 feet. GW-3A was constructed to a total depth of 420 feet, encountering clay with silt and tuff to a depth of 300 feet and clay with silt and sandstone to total depth. The well is reportedly screened from a depth of 360 to 400 feet. Groundwater was not encountered during drilling nor following construction.

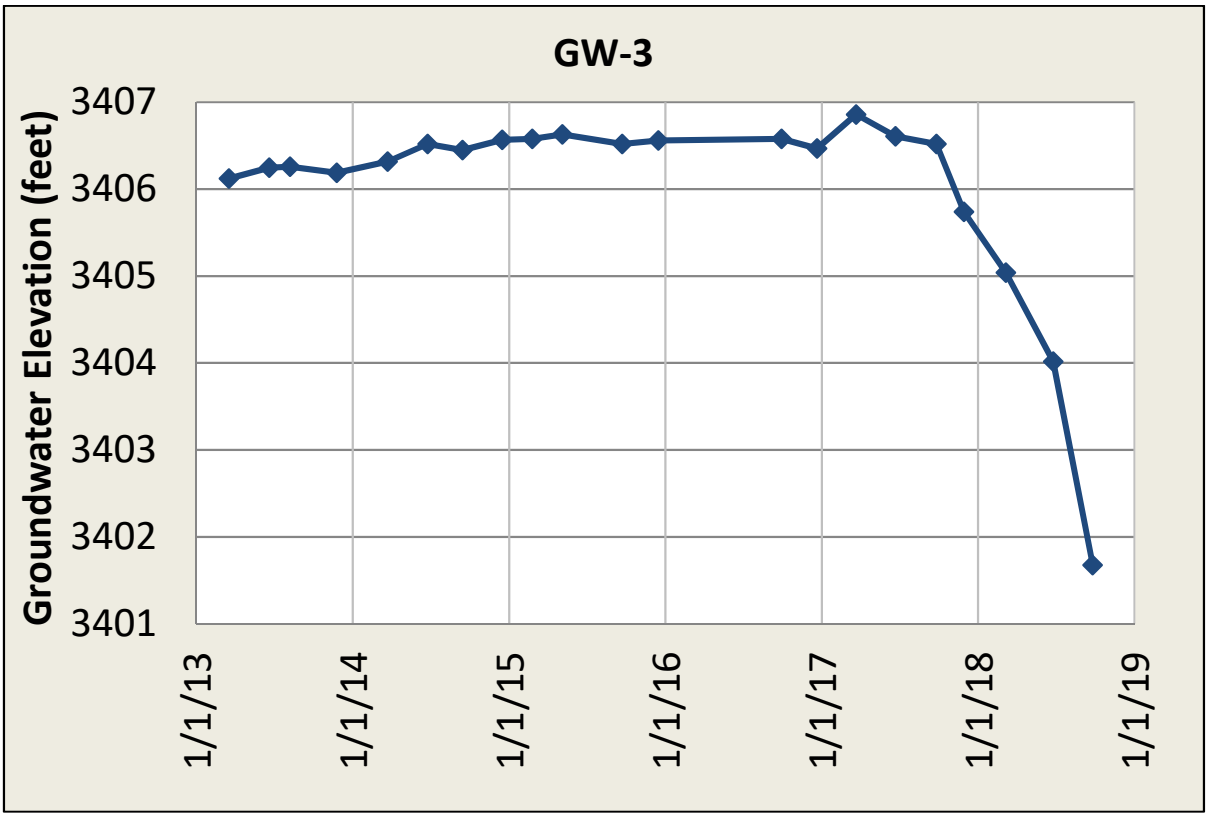

Figure 10. GW-3 groundwater elevation

Well 59766 is located northwest (down-gradient) of the TSF, at an elevation of approximately 3,457 feet. This well was constructed to a total depth of 76.5 feet. The well log describes layers of siltstone and sandstone to total depth, presumably sediments of the Grassy Mountain Formation. The alluvial and lacustrine deposits identified in the TSF geotechnical bores were not encountered. The well is reportedly screened from a depth of 25 to 45 feet. Groundwater was not observed during drilling of the well in 1993. However, groundwater has since entered the well. Between March 2013 and September 2018, the static water level measured in the well varied between approximately 27 and 30 feet bgs, equivalent to a water surface elevation ranging from 3427 to 3430 feet. Figure 11 is a plot of groundwater elevation.

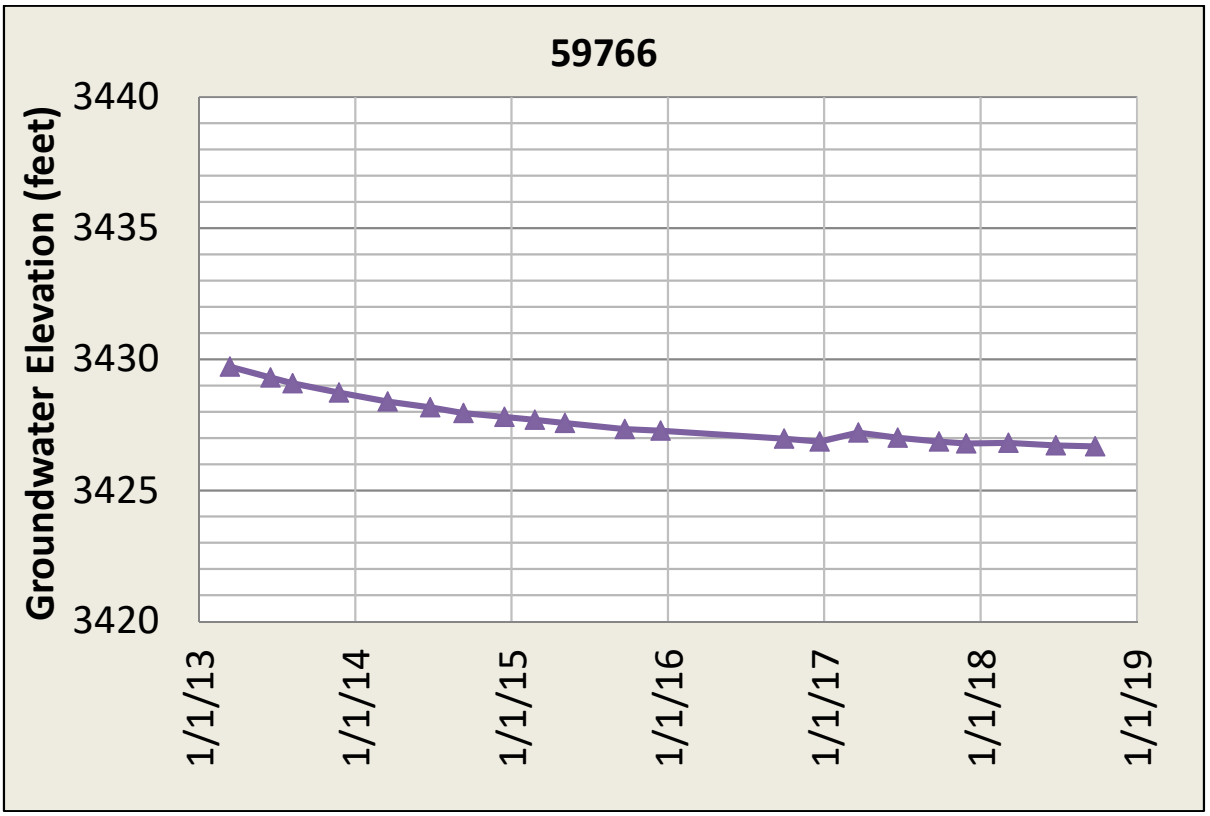

Figure 11. 59766 groundwater elevation

Well 59765 is also located northwest (down-gradient) of the TSF, about at an elevation of approximately 3,445 feet. This well was constructed to a total depth of 37 feet, with layers of siltstone and sandstone (Grassy Mountain Formation) to total depth. The alluvial and lacustrine deposits identified in the TSF geotechnical bores were not encountered. The well is reportedly screened from a depth of 28 to 36 feet. Groundwater was not observed during drilling of the well in 1993 nor following construction.

4.3.5. **Conclusions**

The geology near the TSF can be described as shallow alluvial deposits of sand and clay, underlain by lacustrine clay deposits with interbedded alluvial sand zones. The dip of the sediments generally appears to follow surface topography. The shallow sands do not appear to be water-bearing, but may be saturated to some degree. The alluvial sands have a relatively low hydraulic conductivity, on the order of 10^{-6} cm/s. Drilling of the BLM well, located in the TSF footprint, indicates that a sand zone at a depth of 170 feet is water-bearing. The BLM well has a static water level of approximately 154 and 155 feet bgs, or a water surface elevation of approximately 3423 to 3424 feet. This water surface elevation is over 100 feet lower in elevation than the bottom of the TSF.

4.4. Local Geology at Collection Pond

4.4.1. **Geotechnical Boreholes**

The geotechnical field exploration program described in Section 4.3.1 included drilling three (3) borings to depths ranging from 20 to 40 ft bgs at the mine process facilities, including the collection pond. A map from Golder (2018) showing the borehole locations is included in Appendix C. Soils were classified in accordance with the Unified Soil Classification System (UCSC) by Golder geologists.

4.4.2. **Cross-Sections**

One lithologic cross-section was developed through the process plant and collection pond (Cross Section F in Appendix E and on Figure 7). This section shows a clay layer at the surface, nearly 10 feet thick southwest of the pond, and about 30 feet thick just west of the pond. Below the clay layer is a sand zone at least 10 feet thick.

4.4.3. **Field Permeability**

None of the boreholes near the collection pond were field tested for permeability. However, testing of other boreholes indicates that the shallow alluvial sands in the area have a relatively low hydraulic conductivity, on the order of 10^{-6} cm/s.

4.4.4. **Monitoring Wells**

There are two monitoring wells constructed about 600 feet east of the collection pond (see Figure 8). These wells are not up-gradient or down-gradient of the pond but provide information on local hydrogeology. Driller's reports are included in Appendix F.

Well 59762 is located at an elevation of approximately 3,723 feet. This well was constructed to a total depth of 700 feet. The well log describes surface alluvium and then layers of siltstone and sandstone to a depth of 94 feet and clayey siltstone to total depth. The siltstone is described as silicified from a depth of 180 to 355 feet. These sediments are presumably sediments of the Grassy Mountain Formation. The well is reportedly screened from a depth of 537.5 to 657.5 feet.

Groundwater was not observed during drilling of the well in 1993. However, groundwater has since entered the well. Between March 2013 and September 2018, the static water level measured in the well varied between approximately 617 and 619 feet bgs, equivalent to a water surface elevation ranging from 3103 to 3105 feet. Figure 12 is a plot of groundwater elevation.

Well GMW17-31 is located at an elevation of approximately 3,720 feet. This well was constructed to a total depth of 520 feet in August 2017. The well bore log describes layers of sandstone, arkose, sinter, siltstone, tuff, and clay to the completion depth. Traces of silicified siltstone were observed as shallow as 41 feet and were encountered sporadically throughout the rest of the lithology. No water was encountered during the drilling. The well was screened from a depth of 458 to 498 feet.

A groundwater static water level has been measured in the well since March 2018, at a depth of approximately 497.6 feet bgs, equivalent to a water surface elevation of about 3,222.6 feet.

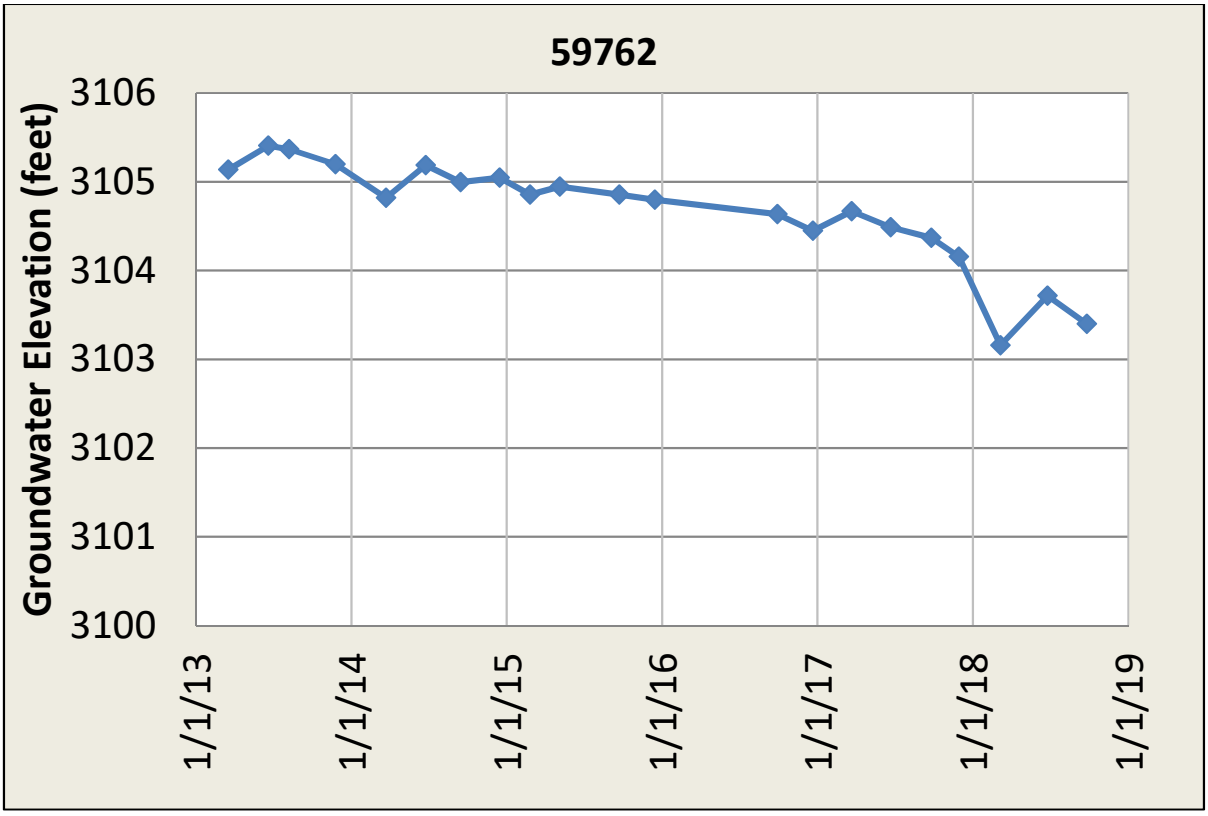

Figure 12. 59762 groundwater elevation

4.4.5. **Conclusions**

The geology near the collection pond can be described as shallow Quaternary-age alluvial deposits of sand and clay, underlain by Miocene-age lacustrine clay deposits with interbedded alluvial sand zones. Below the alluvial and lacustrine deposits are layers of siltstone, sandstone, and clayey siltstone of various degrees of silicification, to a depth of at least 700 feet. The Grassy Mountain Formation in this area has limited water-bearing potential, with an estimated hydraulic conductivity of 10^{-6} to 10^{-7} cm/s (SPF 2019b). The static water level in the near vicinity of the collection pond appears to be 500 to 600 feet bgs, or an elevation of between 3,100 and 3,200 ft asl. The water surface elevation is at least 475 feet below the bottom of the pond, although it is possible that saturated, non-water-bearing materials are present at shallower depths.

5. PROPOSED MONITORING WELLS

5.1. Introduction

New monitoring wells are proposed down-gradient of the TSF to detect contamination of any potentially affected aquifers resulting from this facility. The wells will also serve to detect contamination resulting from the TSF reclaim pond and the waste rock storage facility.

Wells are also proposed down-gradient of the process plant collection pond. The down-gradient well will be used to detect contamination of any potentially affected aquifers resulting from the collection pond.

A new deep up-gradient monitoring well is proposed to serve as a background water-quality monitoring point for the entire Project, including the TSF and the collection pond. This well will target the regional deep aquifer system; existing up-gradient wells will be used to monitor the regional shallow aquifer system up-gradient of the entire Project.

5.2. Location

The locations of the proposed monitoring wells are shown on Figure 13. There are six (6) proposed wells located down-gradient of the TSF. The six wells are proposed in two clusters, with a four-well cluster located down-gradient of the main north embankment and reclaim pond and a two-well cluster located down-gradient of the secondary west embankment. The wells in each cluster will be installed to target different depths to target potentially separate water-bearing zones.

One well is proposed down-gradient of the collection pond as shown on Figure 13. One well is proposed up-gradient of the entire Project, as shown on Figure 13.

5.3. Design Approach

5.3.1. **TSF Wells**

Available information on subsurface lithology indicates two (2) relatively shallow sand layers in the vicinity of the reclaim pond (refer to Figure 7 and lithologic cross-sections in Appendix E). One monitoring well (GMW19-2) will target a shallow sand zone, 5 to 10 feet thick, expected to occur at a depth of 20 feet bgs. Another monitoring well (GMW19-1) will target the deeper of the shallow sand zones, anticipated to be about 30 feet thick and found at a depth of 70 feet bgs. These sand zones are expected to be saturated, but with a relatively low hydraulic conductivity. Even though these wells are expected to have very low yields and may not produce adequate groundwater for sample collection, these shallow sand zones are considered to be where any leakage from the TSF or reclaim pond would be detected first. Water-level monitoring would detect the leakage, and this water could potentially be sampled.

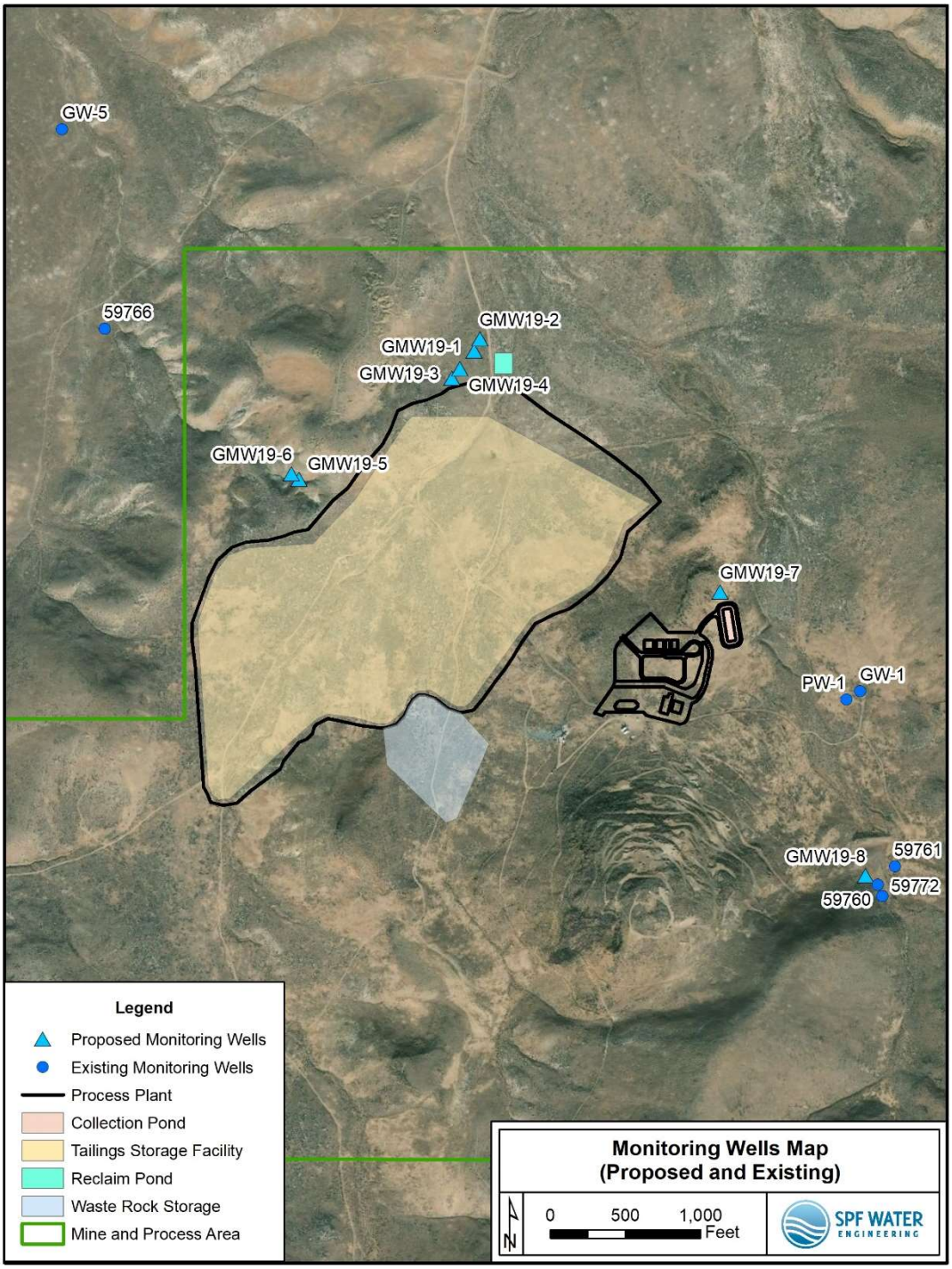

Figure 13. Monitoring wells map (proposed and existing)

A third well (GMW19-3) will target the regional shallow aquifer system, expected to occur in a sand layer at a depth of approximately 170 feet bgs. A well completed in this aquifer should produce adequate water for groundwater sampling. Given the extensive clay zones and elevation difference of over 100 feet between the bottom the TSF and the aquifer, it is unlikely that this aquifer could become contaminated by leakage from the TSF. However, a down-gradient well that can be sampled is an important component of the monitoring program.

A fourth well (GMW19-4) will be constructed to target the regional deep aquifer system, expected to occur at a depth of approximately 600 feet bgs. This depth is based on an estimated water surface elevation of about 3,000 feet for the deep aquifer system (refer to Figure 6). Monitoring of the deep aquifer is contemplated even though it is very unlikely that this aquifer could become contaminated by leakage from the TSF. There are extensive confining layers and an elevation difference of over 500 feet between the bottom the TSF and the deep aquifer.

Two other monitoring wells are proposed down-gradient of the secondary west embankment. One of these wells (GMW19-5) will target a shallow sand zone expected to occur from near ground surface to a depth of 25 feet bgs. The other well (GMW19-6) will target a deeper sand zone expected to be encountered at a depth of 50 feet bgs, and estimated to be about 20 feet thick.

These sand layers are expected to be saturated, but appear unlikely to yield appreciable groundwater. However, any leakage from the TSF would be expected to flow into one or both of these sand zones, where it could be detected by water-level monitoring and potentially sampled.

5.3.2. **Collection Pond Wells**

The subsurface lithology near the process plant collection pond appears to consist of a surface layer of clay, about 10 feet thick southwest of the pond and at least 30 feet thick near the pond (refer to Figure 7 and lithologic cross-sections in Appendix E). This clay layer is underlain by a sand zone at least 10 feet thick southwest of the pond and at least 20 feet thick west of the pond. The down-gradient well GMW19-7 will target this sand layer.

This sand zone is expected to be saturated, but is unlikely to yield appreciable groundwater due to a relatively low hydraulic conductivity. However, any leakage from the collection pond would be expected to flow into this sand zone, where it could be detected by water-level monitoring and potentially sampled to assess contamination. The silicified siltstone and sandstone underlying the surface sediments in the area of the collection pond has a very low hydraulic conductivity and is unlikely to yield adequate groundwater for sampling.

5.3.3. **Up-Gradient Wells**

One new up-gradient well is proposed to serve as background water-quality monitoring points for the entire Project, including the TSF and the collection pond. This well will be located where groundwater quality should not be affected by Project facilities (see Figure 13). The proposed well (GMW19-8) will be constructed to target the regional deep aquifer system, expected to occur at a depth of approximately 560 feet bgs. This depth is based on an estimated water surface elevation of about 3,200 feet for the deep aquifer system (refer to Figure 6). Background water-quality monitoring of the deep aquifer is anticipated even though this aquifer is unlikely to be contaminated by leakage from the TSF or collection pond. The presence of extensive confining layers and the elevation difference between the Project facilities and the deep aquifer should prevent any contamination.

Existing monitoring wells are proposed to serve as up-gradient background water-quality monitoring points for the entire Project. Additional information on these wells is provided in Section 6.4.

5.3.4. **Summary**

Monitoring well location, elevation, proposed depth, and proposed screen length are summarized in Table 2.

Table 2. Monitoring well information

Name	Location	Northing (UTM NAD83 Zone 11, Meters)	Easting (UTM NAD83 Zone 11, Meters)	Elevation (ft, amsl)	Proposed Depth (ft)	Proposed Screen Length (ft)
GMW19-1	down-gradient TSF	4,836,335.9	470,678.6	3,540	100	20
GMW19-2	down-gradient TSF	4,836,360.6	470,690.6	3,536	30	10
GMW19-3	down-gradient TSF	4,836,281.0	470,633.6	3,558	200	20
GMW19-4	down-gradient TSF	4,836,300.0	470,649.7	3,550	600	50
GMW19-5	down-gradient TSF	4,836,075.7	470,323.5	3,570	30	10
GMW19-6	down-gradient TSF	4,836,087.2	470,308.5	3,570	100	20
GMW19-7	down-gradient pond	4,835,847.2	471,177.9	3,682	50	20
GMW19-8	up-gradient Project	4,835,271.8	471,472.3	3,756	600	50

5.4. Conceptual Design

The proposed monitoring wells will be constructed with nominal 5-inch diameter PVC casing and screen. The well casing diameter will be adequate to allow for the installation of a 4-inch submersible pump for groundwater sampling.

Monitoring well construction will comply with State of Oregon monitoring well construction standards (Oregon Administrative Rules Chapter 260, Division 240, dated July 1, 2015). The contractor selected to construct the monitoring wells will have an Oregon Monitoring Well Constructor's License. The contractor shall provide notice to the Oregon Water Resources Department (OWRD) using a start card

Specific well construction details include:

- Monitoring wells will be constructed with a borehole diameter at least 4 inches larger than the nominal casing and screen diameter.
- Monitoring well casing and screen will be PVC, which is non-reactive with groundwater. PVC casing shall be spline-locking design, conforming to ASTM F-480. The casing shall be Schedule 40 for well depths of less than 100 feet and Schedule 80 for well depths of more than 100 feet.
- Casing diameter will be adequate to accommodate a 4-inch submersible pump for well testing and sampling.
- Screen slot size will be selected to be compatible with the filter pack grain size. Length of screen will depend on water-bearing formations encountered. Based on other monitoring wells in the area, it is anticipated that 0.020-inch slot screen will be used with No. 10-20 Colorado silica sand. Screen and filter pack size will be verified after drilling and examination of the drill cuttings.
- Centralizers will be installed to center well casing and screen in the borehole. Centralizers will be installed at the top and bottom of the screened interval and opposite the well casing every 20 to 50 feet depending upon total well depth.
- Filter pack (Colorado silica sand or equal) will be placed around the PVC screen. The filter pack will be clean, chemically inert, and well-rounded. The filter pack shall extend not more than 3 feet above the top of the screen and 1 foot below the bottom of the screen. Filter pack will be installed with a tremie pipe for uniform placement and to prevent bridging.
- Above the filter pack, at least 2 feet of fine-grained clean sand and/or at least 3 feet of hydrated granular bentonite will be placed to serve as a filter pack seal.
- An annular seal will be placed above the filter pack seal to ground surface, installed from the bottom through a grout (tremie) pipe. The seal material will be cement-bentonite grout, mixed at no more than 3.75 pounds of bentonite per 94-lb sack of cement (up to 5% bentonite by dry weight) with up to 7.8 gallons of water (5.2 gallons of water per 94-lb sack of cement plus 0.7 gallons of water per pound of bentonite). The water and bentonite will be mixed first, then the cement added to the slurry. The cement-bentonite grout will be weighed using ASTM Test Method

D-4380-84, and this weight must be within 10% of the specified 14.1 pounds per gallon before placing the grout.

- The annular seal will be placed in maximum 200-foot lifts to avoid excessive external pressure on well casing.
- The well seal shall be allowed to cure for 24 hours prior to well development.
- The top of the well casing will extend at least 18 inches above ground surface and be fitted with a vented, removable sanitary well cap.
- A protective steel shelter (12-inch mild steel casing, standard wall thickness) will be installed over the top of the PVC well casing. The steel shelter will include a locking cap or lid. The protective surface casing shall extend 6 inches above the top of the well casing and at least 3 feet into the ground.
- A well identification label with the start card number will be permanently attached to the surface casing in a visible location.
- A reinforced concrete pad (3 feet square, 4 inches thick) will be poured around the well head shelter. Three protective bollards will be placed around the well shelter. Each bollard shall be a metal post with a minimum diameter of 3 inches, set in and filled with concrete, and extending at least 3 feet above and 3 feet below ground surface. The bollards will be arranged in a triangular pattern, at least 2 feet from the surface casing.
- The monitoring well locations and elevations will be professionally surveyed soon after completion.

A conceptual monitoring well diagram is included in Appendix G.

5.5. Drilling Approach and Observations

The monitoring wells will be drilled by the air-rotary method, without temporary casing, if the borehole is stable. If the borehole is unstable then the well could be drilled either by the air-rotary method with temporary casing to maintain hole stability or by the mud-rotary method. If mud-rotary drilling is used, then geophysical logging will be used to identify sand zones.

Drill cuttings will be disposed of on patented land (private property). The expected source of water for drilling will be the existing on-site production wells PW-1, Prod-1, and PW-4.

The deepest well down-gradient of the TSF (GMW19-4) will be drilled first to gather information on subsurface lithology prior to drilling the other down-gradient wells.

During well drilling, a geologist will collect and evaluate drill cuttings for geologic interpretation. Formation samples will be collected at 5-foot intervals and at each significant change in lithology. Well driller observations and an examination of cuttings will be used to characterize the lithology, identify screen size and placement, and select filter pack. If the wells are drilled by mud-rotary, geophysical logging will be used to verify screen placement.

During air-rotary drilling, the presence of water can be detected when groundwater is encountered during drilling. All water-bearing zones encountered by the borehole will be noted by the supervising geologist. A rough estimate of water produced can be made by measuring the discharge of water during drilling.

5.6. Development

Following well completion, each well will initially be developed by air-lifting to remove drill water and fines, stabilize and settle the filter pack, and maximize well efficiency and capacity. Following air-lifting, any well that produces appreciable groundwater will be further developed with a test pump to document well capacity and production. Each well will be developed until the water produced is clear and free from sediment.

5.7. Monitoring Well Driller and Equipment

The selected well driller will have an Oregon Monitoring Well Constructor's License or work under the supervision of a licensed Monitoring Well Constructor. The selected well driller will have at least 5 years of experience drilling monitoring wells. All wells will be constructed under a bond. The well driller shall notify the Oregon Water Resources Department (OWRD) with a start card prior to starting well construction. The well driller will prepare and sign a monitoring well report for each monitoring well and submit to the OWRD within 30 days of well completion.

6. EXISTING MONITORING WELLS

6.1. Introduction

There are existing wells in the vicinity of the TSF and collection pond (Figure 8). Some of these wells are recommended to be used as additional down-gradient monitoring points to detect groundwater contamination. There are also existing wells located up-gradient of the Project facilities that are proposed to be used for background monitoring of the regional shallow aquifer system. The wells near the proposed facilities are described below, along with a recommendation for future use. The existing wells proposed for future monitoring are shown on Figure 13. Driller's reports are included in Appendix F.

6.2. TSF Wells

6.2.1. **BLM Well**

There has been baseline groundwater data (seven quarterly events) collected from the BLM well. The BLM well is located in the footprint of the TSF, and will be abandoned in accordance with State standards prior to construction of the TSF. Therefore, while it cannot be used as a future monitoring well, the quarterly data already collected does provide background water quality data in the near vicinity of the TSF.

6.2.2. **59766**

Well 59766 is located about 1,800 feet down-gradient of the TSF, at an elevation of approximately 3,457 feet. This well has a total depth of 76.5 feet, and a screened interval of 25 to 45 feet bgs. This well is completed in the Grassy Mountain Formation siltstone and sandstone.

The top and bottom of the screen are at elevations of 3,432 and 3,412 feet amsl, or over 100 feet below the bottom of the TSF. Given the distance and difference in elevation, well 59766 is not considered an ideal down-gradient monitoring location. However, it is still recommended that this well serve as a long-distance monitoring location. This well was included in the groundwater baseline monitoring program, with water-quality data collected during seven (7) different quarters in 2013 and 2014 (SPF 2019a). This well is equipped with a dedicated submersible pump for water-quality sampling.

6.2.3. **GW-5**

Well GW-5 is located about 3,000 feet down-gradient of the TSF, at an elevation of about 3,411 feet amsl. This well was drilled to a total depth of 265 feet, with tuff and clay reported on the bore log. The well was constructed with 2-inch Schedule 40 and 80 PVC casing and Schedule 80 PVC screen, screened from a depth of 203.5 feet to 223.5 feet (elevation of 3,207.5 feet amsl and 3,187.5 feet amsl respectively). The top of the screened interval is over 300 feet below the bottom of the TSF. The main water-bearing zone is reportedly between a depth of 220 and 265 feet bgs. The bore log and well as-built schematic is included in Appendix F.

A groundwater static water level has been measured in the well since September 2014, at a consistent depth of approximately 190 feet bgs, equivalent to a water surface elevation of about 3,221 feet. This water surface elevation is over 300 feet deeper that the bottom of the TSF.

GW-5 was reportedly sampled for water quality in the early 1990s (JMM 1991), but there is no evidence of more recent sampling. GW-5 was not included in the baseline water-quality monitoring well network.

It is recommended that GW-5 serve as a down-gradient monitoring well because of its location and because it apparently can yield adequate groundwater for sample collection. However, given its distance from the TSF, the difference in elevation, and differences on geology, the currently proposed new wells are also needed to provide better monitoring locations. GW-5 will need to be equipped with a 2-inch dedicated submersible pump for sampling.

6.3. Collection Pond Wells

6.3.1. **59762**

Well 59762 is located about 600 feet east of the collection pond. This well was constructed to a total depth of 700 feet, in silicified and non-silicified siltstone and

sandstone. The well is screened from a depth of 537.5 to 657.5 feet. The groundwater elevation in the well has varied from 3,103 to 3,105 feet amsl, over 500 feet below the bottom of the collection pond. Testing of this well in 2017 indicated a well yield of less than 1 gpm (SPF 2019b). Given the difference in elevation between the static water level in this well and the collection pond and the poor well yield, the usefulness of this well for detecting groundwater contamination from the pond is limited. It is recommended that this well not be included in the collection pond monitoring well network.

6.3.2. **GMW17-31**

Well GMW17-31 is located near 59762, about 600 feet east of the collection pond. This well was constructed to a total depth of 520 feet and screened from a depth of 458 to 498 feet bgs in silicified and non-silicified siltstone and claystone and tuff. No water was encountered during the drilling, but the well has a current groundwater elevation of about 3,222.6 feet amsl. This well does not have enough water to test and therefore should not be included in the collection pond monitoring well network.

6.4. Up-Gradient Wells

6.4.1. **59760**

Well 59760 is proposed to serve as an up-gradient background monitoring well (Figure 13). This well is located about 1,000 feet up-gradient of the proposed mine, at an elevation of approximately 3,755 feet. This well has a total depth of 205 feet, and a screened interval of 163 to 203 feet bgs. This well is completed in the regional shallow aquifer system, found locally in the Grassy Mountain Basalt (Abrams 2018). Between March 2013 and September 2018, the static water level measured in the well varied between approximately 85 and 87 feet bgs, equivalent to a water surface elevation ranging from 3,672 to 3,674 feet (see Figure 14).

Well 59760 was included in the groundwater baseline monitoring program, with water-quality data collected during seven (7) different quarters in 2013 and 2014 (SPF 2019a). This well is equipped with a dedicated submersible pump for water-quality sampling.

It is recommended that well 59760 serve as an up-gradient monitoring well because of its location, adequate yield to support groundwater sampling, and sampling history.

6.4.2. **59761**

Well 59761 is also located about 1,000 feet up-gradient of the proposed mine, near well 59760 (Figure 13). This well is proposed to serve as another up-gradient background monitoring well. This well has a total depth of 120 feet, and a screened interval of 97 to 117 feet bgs. This well is completed in the regional shallow aquifer system that occurs locally in the Grassy Mountain Basalt. The well's static water level varied between approximately 85 and 87 feet bgs between March 2013 and September 2018, equivalent to a water surface elevation ranging from 3,672 to 3,674 feet (see Figure 14).

Well 59761 was also included in the groundwater baseline monitoring program, with seven (7) different quarters of water-quality data collected in 2013 and 2014 (SPF 2019a). This well is equipped with a dedicated submersible pump for water-quality sampling. Well 59761 is proposed to serve as an up-gradient monitoring well.

6.4.3. **59772**

Well 59772 is also located near wells 59760 and 59761, up-gradient of the proposed mine (Figure 13). This well has a total depth of 207 feet, and a screened interval of 146 to 206 feet bgs. This well also targets the shallow aquifer system. The static water level measured in the well varied between approximately 91 and 93 feet bgs between March 2013 and September 2018, equivalent to a water surface elevation ranging from 3,672 to 3,674 feet (see Figure 14).

Well 59772 was also included in the groundwater baseline monitoring program, with seven (7) quarters of water-quality data. This well is equipped with a dedicated submersible pump. It is recommended that well 59772 serve as an up-gradient monitoring well.

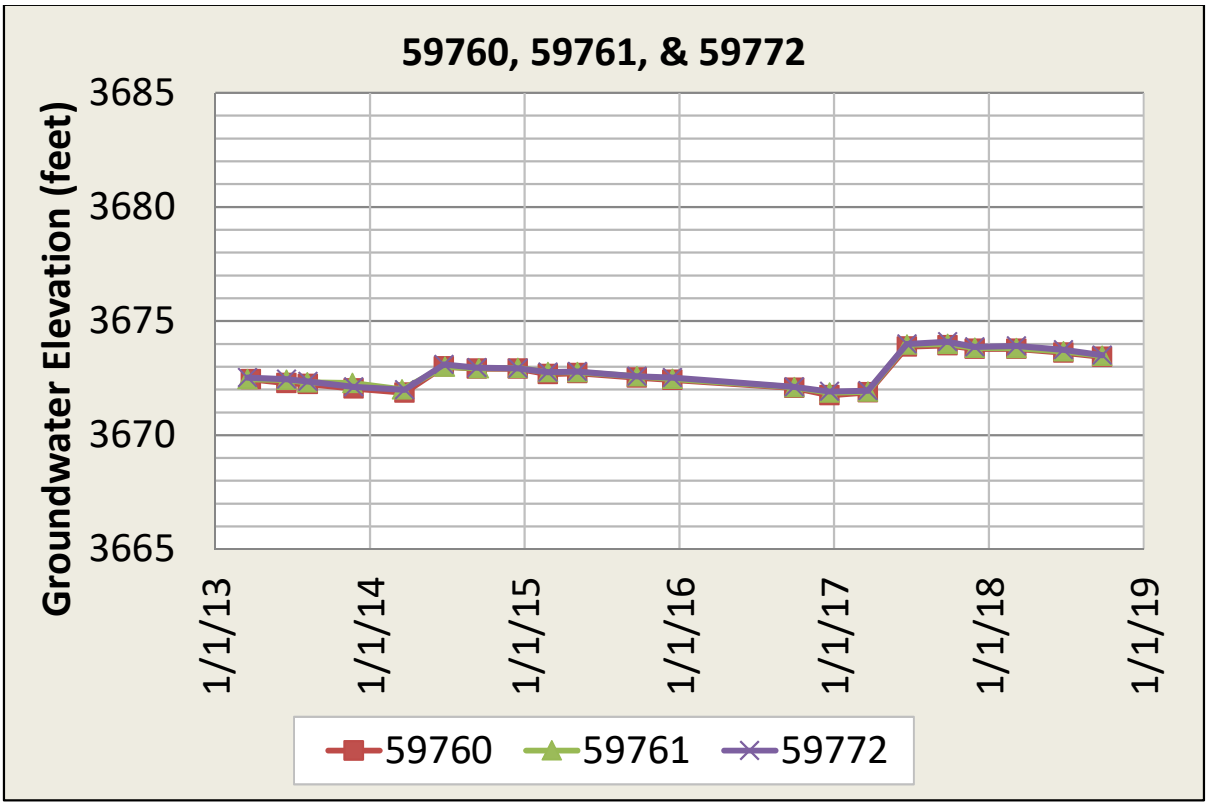

Figure 14. 59760, 59761, and 59772 groundwater elevations

6.4.4. **PW-1**

Well PW-1 is proposed to serve as an up-gradient background monitoring well (Figure 13). This well is located about 800 feet up-gradient of the proposed collection pond, at an elevation of approximately 3,702 feet. This well has a total depth of 555 feet, and a screened interval of 320 to 340 feet and 400 to 420 feet bgs. This well is completed in the regional shallow aquifer system, found locally in sediments of the Grassy Mountain Formation (Abrams 2018). Between March 2013 and September 2018, the static water level measured in the well varied between approximately 51 and 60 feet bgs, equivalent to a water surface elevation ranging from 3,655 to 3,646 feet (see Figure 14). The lower static water level observed between September 2016 and March 2018 was due to the well being used for drill water supply. The recent "normal" water surface elevation in the well is at an elevation of approximately 3,655 feet.

Well PW-1 was included in the groundwater baseline monitoring program, with water-quality data collected during seven (7) different quarters in 2013 and 2014 (SPF 2019a). This well is equipped with a submersible pump that can be used for water-quality sampling.

It is recommended that well PW-1 serve as an up-gradient monitoring well because of its location, adequate yield to support groundwater sampling, and sampling history.

6.4.5. **GW-1**

Well GW-1 is also proposed to serve as an up-gradient background monitoring well (Figure 13). This well is located near PW-1, about 850 feet up-gradient of the proposed collection pond, at an elevation of approximately 3,703 feet. This well has a total depth of 160 feet, and a screened interval of 135.5 to 155.5 feet bgs. This well is completed in the regional shallow aquifer system, found locally in sediments of the Grassy Mountain Formation (Abrams 2018). Between March 2013 and September 2018, the static water level measured in the well varied between approximately 51 and 55 feet bgs, equivalent to a water surface elevation ranging from 3,654 to 3,650 feet (see Figure 14). The lower static water level observed between September 2016 and March 2018 was due to pumping interference from PW-1. The recent "normal" water surface elevation in the well is at an elevation of approximately 3,654 feet.

Well GW-1 was included in the groundwater baseline monitoring program, with water-quality data collected during seven (7) different quarters in 2013 and 2014 (SPF 2019a). This well is equipped with a dedicated submersible pump used for water-quality sampling. Well GW-1 is recommended to be used as an up-gradient monitoring well.

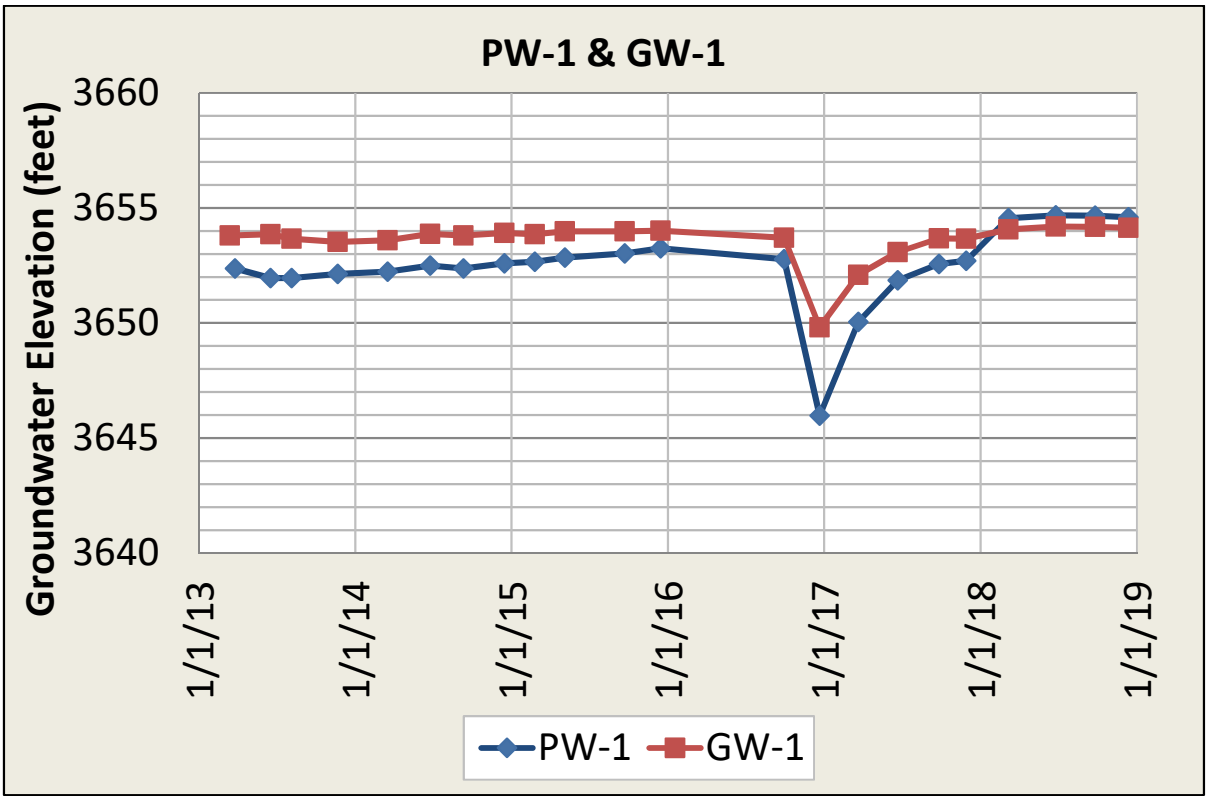

Figure 15. PW-1 and GW-1 groundwater elevations

7. GROUNDWATER MONITORING

7.1. Water-Level Monitoring

At each of the monitoring wells, the static water level will be manually measured and recorded prior to pumping (if sampled) using a non-stretch electric-line well sounder. To ensure consistency of water-level measurements, measurement points will be clearly identified on both the sampling form and physically on the well casing. For any dry wells, the sounder will be lowered to the bottom of the well. The deep well down-gradient of the TSF (GMW19-3) that will be constructed to target the regional shallow aquifer system will be equipped with a water-level transducer to continuously monitor and record water-level data.

Any wells that are in close proximity to each other (i.e. less than 500 feet) will all be measured for static water level prior to pumping any of the wells to eliminate any interference effects from pumping.

7.2. Water-Quality Sampling Approach

7.2.1. **Dedicated Pumps and Sampling Manifold**

Dedicated submersible pumps and water-level sounding tubes will be installed in each monitoring well that produces adequate water for sampling (at least 1 gpm). Dedicated pumps will eliminate the potential for cross contamination of water-quality samples. Pumps will be selected based on available well capacity as determined through development pumping. For any wells that are initially dry but eventually produce at least 1 gpm, temporary sampling pumps may be used until it can be confirmed that the wells are reliable producers and dedicated pumps are warranted.

Water-quality samples will be collected using a sampling manifold constructed of PVC and stainless steel. The manifold will allow for non-filtered sample collection, field-filtered samples for metals, and continuous monitoring of field water-quality parameters.

The existing wells PW-1, GW-1, 59766, 59760, 59761, 59772, and GW-5 are recommended for inclusion in the groundwater-quality sampling program. All of these wells except for GW-5 are already equipped with sampling pumps. Well GW-5 will need to be equipped with a pump.

7.2.2. **Purge Pumping**

All of the monitoring wells will be purged a minimum of three (3) casing volumes of water prior to sampling; purging is a standard practice to remove stagnant water prior to ground water sample collection. Purge water will be discharged to waste at the well site. During purge pumping, the pumping rate will be measured using a five-gallon bucket and stopwatch and recorded on the field data collection form. The appearance and odor of the purged water will be noted.

During purge pumping, field water-quality parameters (pH, temperature, electrical conductivity, specific conductance, and dissolved oxygen) will be continuously monitored. These field parameters will be monitored continuously during purging to ensure parameters are stable prior to sampling, indicating that the well is producing stable groundwater representative of the aquifer.

Field parameters are considered stable when consecutive measurements taken one (1) casing volume apart meet the following conditions: temperature within one (1) degree Celsius, pH within 0.3 standard pH units, and specific conductance measurements within 10% of each other (ODEQ 2009). At least three measurements of field water-quality data will be measured and recorded on the data collection form. The field equipment will be calibrated according to manufacturer recommendations each day of sampling. Personnel performing equipment calibration will be adequately trained. Results of calibration will be recorded on calibration forms.

7.2.3. **Water-Quality Sampling**

Where applicable, sampling procedures will follow the ODEQ Field Sampling Reference Guide (ODEQ 2010) and the ODEQ Water Monitoring and Assessment Mode of Operations Manual (ODEQ 2009).

Water-quality samples will be collected after purging at least three (3) casing volumes from the well and after field water-quality parameters have stabilized. For dissolved samples, samples will be filtered in the field using a disposable high-capacity field filter with 0.45 µm membrane.

Samples will be collected in bottles supplied by the laboratory with the appropriate preservative as required by the testing method. Samples will be collected by field personnel wearing nitrile gloves discarded after each use. Following collection, sample bottles will be properly labeled and immediately packed in a cooler with ice packs. Samples will be mailed to the laboratory with proper chain-of-custody documentation and procedures. This laboratory will be accredited by NELAP (National Environmental Laboratory Accreditation Program) for water analysis. Analytical methods will meet ODEQ reporting and detection limits.

7.2.4. **Quality Assurance / Quality Control**

Quality assurance and quality control (QA/QC) protocols will be implemented as described in the ODEQ Water Monitoring and Assessment Mode of Operations Manual (ODEQ 2009) and the ODEQ Quality Manual (ODEQ 2011). Specific QA/QC methods could include collection of equipment blanks, transfer blanks, and duplicate samples. The laboratory will perform internal QA/QC procedures, with results provided with the analytical results as a Level 2 analytical report. The Level 2 analytical report also typically includes a case narrative, analytical results, data qualifiers, sample receipt checklist, and chain of custody forms.

7.3. Water-Quality Analytes

Water-quality samples will be collected from all new monitoring wells that produce appreciable water. The proposed water-quality analytes are the same analytes that were sampled for during the groundwater baseline monitoring (SPF 2019a). The analytes include primarily metals (total and dissolved) and general geochemical parameters. A list of proposed analytes along with the laboratory testing method, the laboratory detection limit, and the reporting limit (five times the detection limit) are summarized in Table 3.

Table 3. Proposed list of water-quality analytes

Parameter	Laboratory Method of Analyses	Detection Limit	Reporting Limit	Sample Type
Aluminum, Al	EPA 200.7	0.03 mg/L	0.15 mg/L	total and dissolved
Total Arsenic	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Barium, Ba	EPA 200.7	0.003 mg/L	0.015 mg/L	total and dissolved
Cadmium Low	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Calcium, Ca	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Chromium Low	EPA 200.8	0.0005 mg/L	0.002 mg/L	total and dissolved
Copper Low	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Iron, Fe	EPA 200.7	0.02 mg/L	0.05 mg/L	total and dissolved
Lead Low	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Magnesium, Mg	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Manganese Low	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Mercury, Hg (Low Level)	1631E	0.2 ng/L	0.5 ng/L	total and dissolved
Nickel Low	EPA 200.8	0.0006 mg/L	0.003 mg/L	total and dissolved
Potassium, K	EPA 200.7	0.3 mg/L	1.5 mg/L	total and dissolved
Selenium Low	EPA 200.8	0.0001 mg/L	0.00025 mg/L	total and dissolved
Silver Low	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Sodium, Na	EPA 200.7	0.3 mg/L	1.5 mg/L	total and dissolved
Zinc, Zn	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Antimony	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Beryllium	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Bismuth	EPA 200.7	0.04 mg/L	0.2 mg/L	total and dissolved
Boron	EPA 200.8	0.0005 mg/L	0.001 mg/L	total and dissolved
Cobalt	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Gallium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Lithium	EPA 200.7	0.02 mg/L	0.1 mg/L	total and dissolved
Molybdenum	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Scandium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Strontium	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Thallium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Tin	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Titanium	EPA 200.7	0.005 mg/L	0.025 mg/L	total and dissolved
Vanadium	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Uranium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Nitrate+Nitrite (as N)	EPA 353.2	0.02 mg/L	0.1 mg/L	total
Ammonia Direct (as N)	EPA 350.1	0.05 mg/L	0.5 mg/L	total
Alkalinity	SM 2320B	2 mg/L	20 mg/L	total
Bicarbonate	SM 2320	2 mg/L	20 mg/L	total
Carbonate	SM 2320	2 mg/L	20 mg/L	total
Chloride, Cl	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Conductivity	SM 2510B	1 umhos/cm	10 umhos/cm	total
Cyanide, Total	EPA 335.4	0.003 mg/L	0.01 mg/L	total
Cyanide, WAD	SM 4500	0.003 mg/L	0.01 mg/L	total
Fluoride, F	EPA 300.0	0.1 mg/L	0.5 mg/L	total
Hardness	SM 2340 B	calc	calc	total
pH	SM 4500-H B	0.1 C	0.1 C	total
Sulfate, SO4	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Total Dissolved Solids	SM 2540C	10 mg/L	20 mg/L	total
Total Suspended Solids	SM 2540D	5 mg/L	20 mg/L	total
Total Phosphorus	EPA 365.1	0.01 mg/L	0.05 mg/L	total

7.4. Monitoring Frequency and Duration

The proposed water level and water-quality sampling will be conducted on a quarterly basis, with the first event conducted shortly after well construction and development. Background monitoring will occur at all new wells and at GW-5 for at least a year prior to any facility use to develop a reliable background water-quality signature. For the existing wells PW-1, GW-1, 59766, 59760, 59761, and 59772, seven (7) quarters of baseline groundwater-quality data have already been collected. This data is considered adequate to describe background water quality at these locations. For existing well GW-5, there are no recent water-quality data so this well will be monitored at the same frequency as the new wells.

Monitoring at all wells identified in this proposal (proposed and existing) will occur throughout operation of the mine. Monitoring will also be conducted after the mining operation as ceased, for a period of time determined by the permitting entity.

8. WATER-QUALITY DATA ANALYSIS

8.1. Water-Quality Standards

The permit-specific concentration limit is defined as the maximum acceptable concentration of a contaminant allowed in groundwater at a compliance point (down-gradient well). For new permitted facilities, the concentration limits are the background water quality (OAR 340-040). Water-quality sampling from the monitoring well network prior to mining activity will be used to establish background water quality.

8.2. Data Analysis Procedure

Background water-quality sampling results will be analyzed to develop the permit-specific concentration limit. Enough samples will be collected to conduct statistical analysis of the data points, including mean, median, and standard deviation. Sampling will adequately describe natural variability and establish reliable thresholds to determine if groundwater contamination is occurring.

A statistically significant increase in a water-quality parameter above the background concentration could indicate that the groundwater is being affected by leakage from the TSF, waste rock storage facility, or collection pond.

As with water-quality data, groundwater-level data will be recorded and analyzed statistically (mean, median, and standard deviation). The data will be plotted to identify trends and changes.

9. REPORTING REQUIREMENTS

9.1. Well Completion Reports

Following construction and testing of the new monitoring wells, a report will be prepared describing well drilling, construction, development, static groundwater level, and initial water-quality results. The reports will be transmitted to ODEQ for review and comment.

9.2. Scheduled Reporting

Following each monitoring event, water-quality data will be reported to ODEQ, in a format acceptable to the agency. The transmittal will include all data collected to date, with updated statistics including mean, median, and standard deviation. Background water-quality sampling prior to mining will be used to establish and recommend the maximum acceptable concentration of a contaminant allowed in groundwater at a monitoring well. Any sampling results collected during or after mining activity that significantly exceed the permit-specific concentration limit will be noted. Any significant changes in up-gradient water quality will also be identified. Data will be transmitted to ODEQ as soon as practical after receiving the analytical results from the laboratory.

Water-level data with statistical summaries will also be reported to ODEQ following each monitoring event. Updated plots of all water-level data will be included in the transmittal. Any statistically significant changes in water levels will be noted. Any wells that were previously dry but had measurable groundwater will be noted.

An annual report will be prepared summarizing the water-quality sampling and water-level monitoring results. The report will describe the wells monitored, the sampling and water-level measurement approaches, raw data, statistical summaries, data plots and trends, QA/QC results, and statistically significant changes potentially indicating groundwater contamination.

10. ACTION REQUIREMENTS

If monitoring indicates a significant increase in one or more water-quality parameters above the established concentration limit, the monitoring well will be immediately resampled following receipt and analysis of the water-quality results. If the resampling results also exceed the concentration limit, the following actions will be taken:

1. ODEQ will be notified of the results within 10 days of receipt of the laboratory analytical results; and
2. A Preliminary Assessment Plan (PAP) will be prepared within 30 days of receipt of the laboratory analytical results (unless an alternative schedule is approved by ODEQ). The PAP will evaluate the source and extent of the identified contaminant, and predict potential migration of the contaminant. The PAP will also assess what action, if any, is needed to prevent additional groundwater contamination as required

by ODEQ. A schedule will be presented for implementation of investigative activities.

ODEQ will review the PAP and may require a remedial investigation and/or feasibility study to protect groundwater quality, public health and safety, or the environment. The investigation will characterize the extent and nature of groundwater contamination, and provide information on the need for and selection of one or more remedial actions.

11. LIST OF PREPARERS

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12. REFERENCES

Abrams, Mark J., 2018. Calico Resources USA Corp, Grassy Mountain Mine Project, Malheur County, Oregon, Geology and Soils Baseline Report. October 2018.

Freeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice Hall, New Jersey. 604 p.

Ferns, M.L., H.C. Brooks, J.G. Evans, and M.L. Cummings. 1993. Geologic Map of the Vale 30 x 60 Minute Quadrangle, Malheur County, Oregon, and Owyhee County, Idaho. DOGAMI Geological Map Series GMS-77. Oregon Department of Geology and Mineral Industries, U.S. Geological Survey, and Portland State University.

Golder Associates, Inc., 2018. Geotechnical Data Report, Grassy Mountain Project, Malheur County, Oregon. June 6, 2018.

J.M. Montgomery Consulting Engineers, Inc. (JMM), 1991. Phase I Hydrogeologic Report on the Grassy Mountain Mine Project, Malheur County, OR. August 1991.

Mine Development Associates (MDA), 2018. Preliminary Feasibility Study and Technical Report for the Grassy Mountain Gold and Silver Project. July 9, 2018.

Oregon Department of Environmental Quality, 2009. Water Monitoring and Assessment Mode of Operations Manual, March 2009.

Oregon Department of Environmental Quality, 2010. Field Sampling Reference Guide, January 2010.

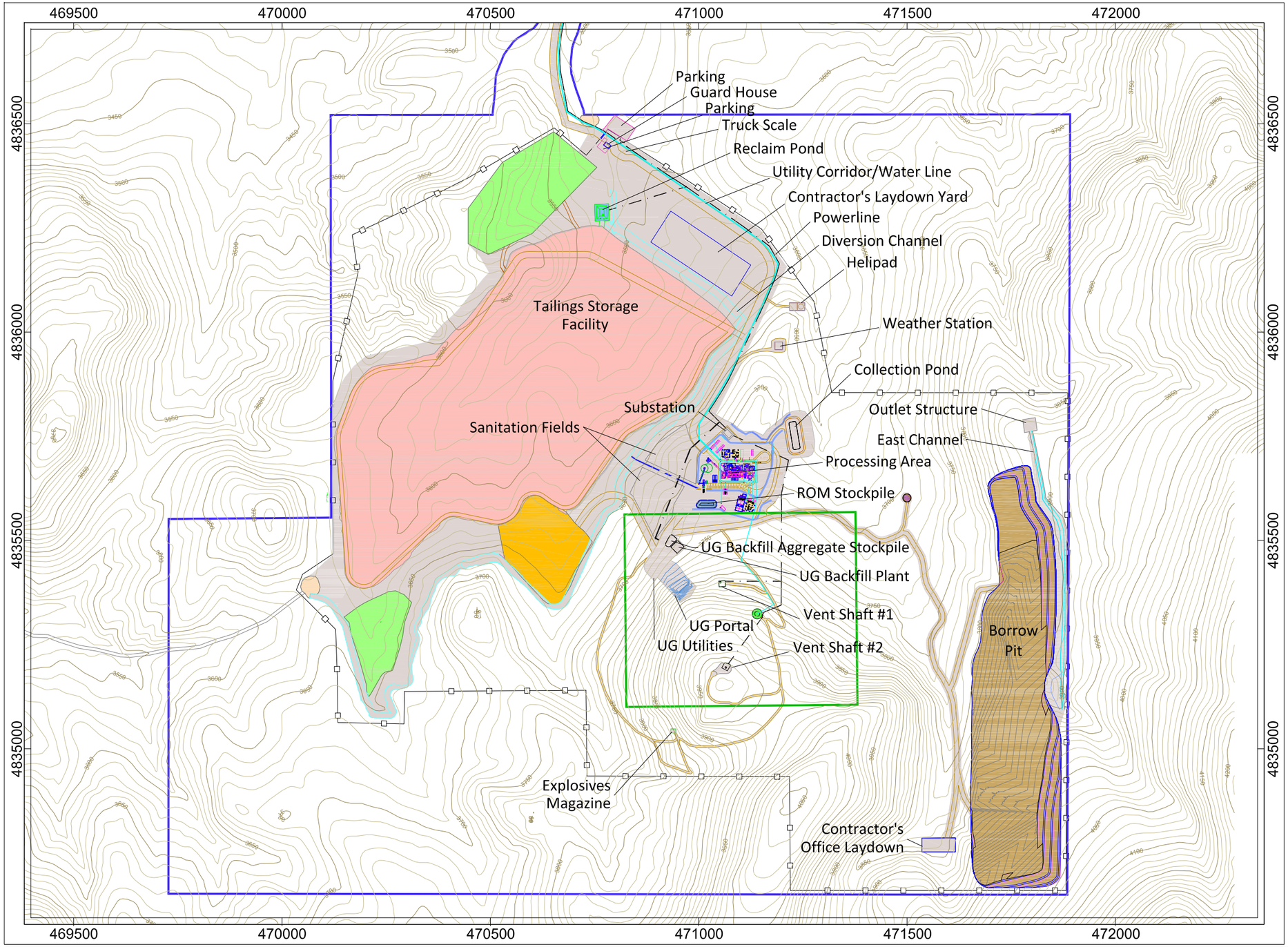
Oregon Department of Environmental Quality, 2011. Quality Manual, May 2011.

Red Quill Ventures, LLC (RQV), 2015. Calico Resources USA Corp, Grassy Mountain Project, Geology and Soils Baseline Study; February 2015.

SPF Water Engineering (SPF), 2019a. Grassy Mountain Gold Project Groundwater Resources Baseline Data Report. Prepared by SPF, Boise, Idaho. February 19, 2019.

SPF Water Engineering (SPF), 2019b. Draft Grassy Mountain Gold Project Groundwater Characterization Report. Prepared by SPF, Boise, Idaho.

Appendix A
Project Site Layout Map



Coordinate System:
NAD 83 UTM Zone 11N
Units: Meters
Elevation: US Feet

- Permit Area
- Patented (Private) Land
- Topsoil Storage
- Disturbed Area
- Sediment Basin
- Waste Rock Storage
- Fence Line
- Power Line
- Water Line
- Diversion Channel
- Road
- Water Tank
- Water Well
- Contours (10-ft contour intervals)

0 200 400 Meters

N

MINE DEVELOPMENT ASSOCIATES

CALICO RESOURCE USA CORP.
GRASSY MOUNTAIN PROJECT
Site Layout Map

22-July-2019 Scale: as shown

Appendix B
Plant Site General Arrangement Plan

SEPTIC TANK
CULVERT
DITCH
PARKING
PLANT OFFICES & CHANGE HOUSE
LABORATORY
ADMINISTRATION BUILDING
PLANT WORKSHOP & WAREHOUSE
COLLECTION POND VOL: 110,000 ft³
CULVERT
CULVERT
DITCH
TP-B1
TP-B2
TP-B3
TP-B4
TP-B5
TP-B6
TP-A1
TP-A2
TP-A3
TP-A4
TP-A5
TP-A6
TP-C1
TP-C2
TP-C3
TP-C4
TP-C5
TP-C6
TP-C7
TP-C8
STOCKPILE & RECLAIM AREA
GOLDROOM
ELUTION AREA
REAGENT AREA
WATER SERVICE AREA
PAD EL. 3710' (NOM.)
GRINDING AREA
CIL AREA
DITCH
CRUSHING AREA
PAD EL. 3730' (NOM.)
TRUCK WASH
SUMP
ROM STOCKPILE
FUEL STORAGE
FUEL STORAGE
TRUCK WORKSHOP & WAREHOUSE
MINE OFFICE & CHANGE HOUSE
TO UG PORTAL

PRELIMINARY

50' 0 50' 100' 150' 200'
SCALE: 1"=50'

Safety in all we do

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PARAMOUNT GOLD Nevada

REF.	DRAWING No.	REFERENCE DRAWING	No.	BY	DATE	REVISION DETAILS	CHKD	ENG	APPR
			E	LB	21JUN19	ISSUED FOR CLIENT REVIEW	LK		
			D	LB	08MAY19	ISSUED FOR CLIENT REVIEW	LK		
			C	LB	10APR2019	ISSUED FOR CLIENT REVIEW	LK		
			B	RK	05APR2019	ISSUED FOR CLIENT REVIEW	JTR		
			A	RK	04DEC2018	ISSUED FOR INTERNAL REVIEW	JTR		

DRAWN	RK	16NOV2018
DWG. CHECKED		
DESIGNED	JTR	16NOV2018
DES. APPR.		
PROJ. APPR.		

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CLIENT PARAMOUNT GOLD NEVADA

TITLE GRASSY MOUNTAIN PROJECT
PLANT SITE
GENERAL ARRANGEMENT PLAN

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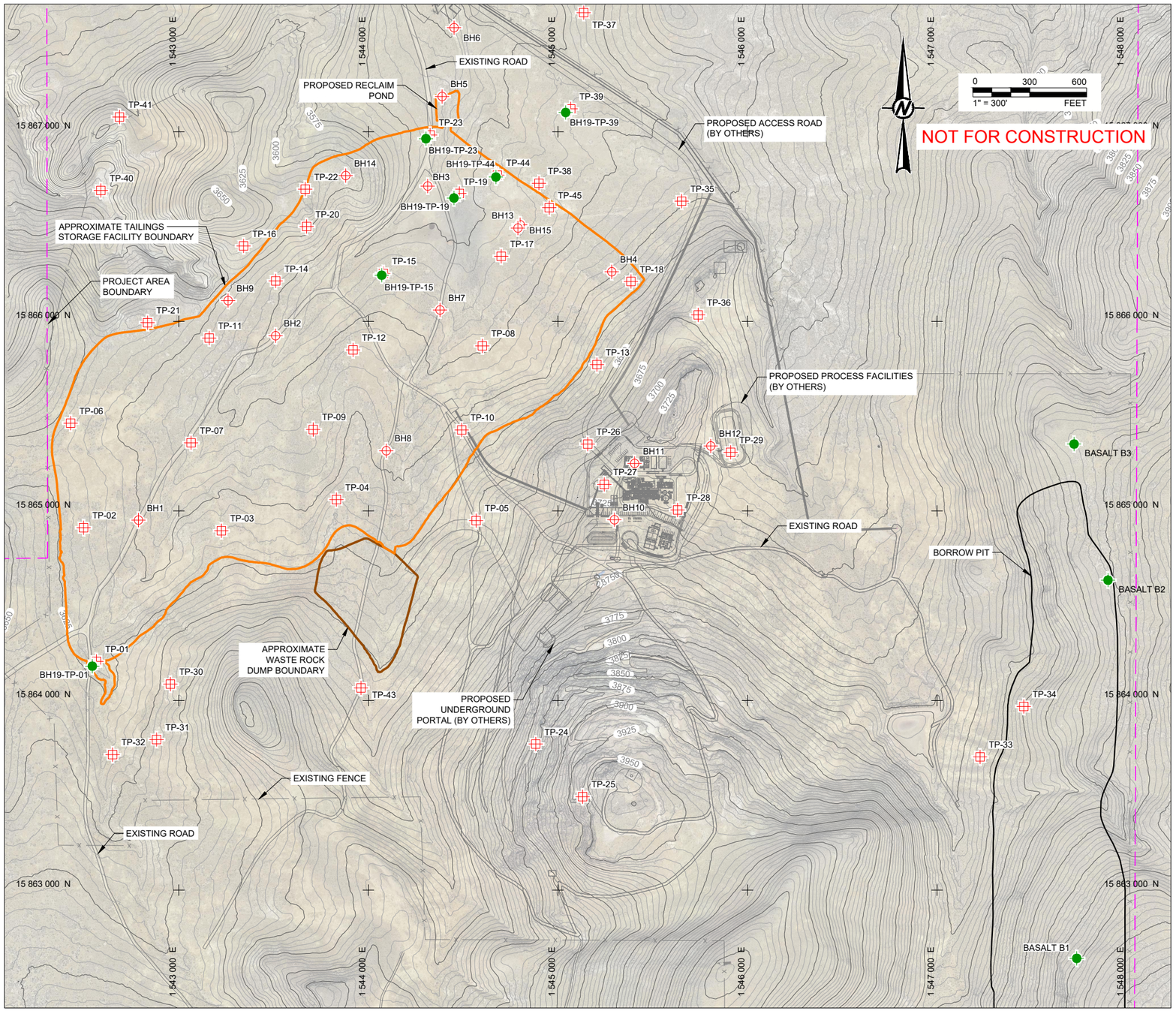
PROJECT No.	SCALE	SIZE
101768	1" = 50'	D

DRAWING No. 101768-0000-G-102 REV E

Appendix C
Geotechnical Exploration Location Map



TEST PIT COORDINATES (UTM, ft)			
TEST PIT	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
TP-01	1,542,565.3	15,864,206.7	3,617.7
TP-02	1,542,497.3	15,864,911.7	3,616.6
TP-03	1,543,224.2	15,864,895.8	3,609.4
TP-04	1,543,831.2	15,865,060.3	3,614.1
TP-05	1,544,568.3	15,864,949.2	3,647.7
TP-06	1,542,428.9	15,865,463.4	3,617.3
TP-07	1,543,064.2	15,865,359.6	3,622.4
TP-08	1,544,601.4	15,865,870.8	3,572.8
TP-09	1,543,708.8	15,865,429.6	3,586.3
TP-10	1,544,492.0	15,865,427.3	3,607.3
TP-11	1,543,160.2	15,865,912.4	3,594.6
TP-12	1,543,919.3	15,865,849.8	3,586.1
TP-13	1,545,205.8	15,865,772.3	3,633.8
TP-14	1,543,510.8	15,866,213.8	3,581.6
TP-15	1,544,078.8	15,866,253.4	3,564.9
TP-16	1,543,341.5	15,866,398.0	3,616.9
TP-17	1,544,700.6	15,866,343.7	3,559.1
TP-18	1,545,385.1	15,866,210.6	3,610.8
TP-19	1,544,479.8	15,866,675.2	3,546.4
TP-20	1,543,674.3	15,866,500.6	1,099.2
TP-21	1,542,835.0	15,865,993.0	3,618.5
TP-22	1,543,666.7	15,866,697.8	3,615.4

TEST PIT COORDINATES (UTM, ft)			
TEST PIT	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
TP-23	1,544,325.5	15,866,983.4	3,541.1
TP-24	1,544,882.5	15,863,770.9	3,840.0
TP-25	1,545,130.2	15,863,492.7	3,942.5
TP-26	1,545,157.0	15,865,352.9	3,696.7
TP-27	1,545,244.9	15,865,140.2	3,718.5
TP-28	1,545,631.3	15,865,005.4	3,722.2
TP-29	1,545,911.0	15,865,309.8	3,680.3
TP-30	1,542,955.5	15,864,086.8	3,659.2
TP-31	1,542,882.5	15,863,794.1	3,656.6
TP-32	1,542,650.3	15,863,714.5	3,636.5
TP-33	1,547,227.2	15,863,702.5	3,788.9
TP-34	1,547,457.6	15,863,968.9	3,825.7
TP-35	1,545,652.6	15,866,634.2	3,596.6
TP-36	1,545,739.5	15,866,034.1	3,669.1
TP-37	1,545,135.8	15,867,628.8	3,562.5
TP-38	1,544,899.7	15,866,728.7	3,562.8
TP-39	1,545,067.3	15,867,121.1	3,565.4
TP-40	1,542,588.5	15,866,690.6	3,501.3
TP-41	1,542,686.7	15,867,078.2	3,549.6
TP-43	1,543,961.0	15,864,066.5	3,661.9
TP-44	1,544,680.1	15,866,771.8	3,554.4
TP-45	1,544,954.0	15,866,599.5	3,564.4

BOREHOLE COORDINATES (UTM, ft)			
BOREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BASALT B1	1,547,737.0	15,862,640.0	3,978.0
BASALT B2	1,547,902.0	15,864,635.0	3,904.0
BASALT B3	1,547,723.0	15,865,353.0	3,890.0
BH-01	1,542,786.9	15,864,951.6	3,599.7
BH-02	1,543,510.4	15,865,924.4	3,571.3
BH-03	1,544,312.6	15,866,713.9	3,530.9
BH-04	1,545,283.9	15,866,261.9	3,597.7
BH-05	1,544,388.7	15,867,186.2	3,528.2
BH-06	1,544,451.9	15,867,549.3	3,529.8
BH-07	1,544,377.8	15,866,060.4	3,566.9
BH-08	1,544,094.4	15,865,317.8	3,596.8
BH-09	1,543,260.0	15,866,109.6	3,596.8

BOREHOLE COORDINATES (UTM, ft)			
BOREHOLE	EASTING (FT)	NORTHING (FT)	ELEVATION (FT)
BH-10	1,545,297.7	15,864,953.6	3,732.8
BH-11	1,545,404.4	15,865,250.8	3,718.0
BH-12	1,545,806.0	15,865,342.4	3,691.2
BH-13	1,544,800.6	15,866,509.9	3,557.6
BH-14	1,543,880.5	15,866,769.4	3,600.8
BH-15	1,544,788.8	15,866,492.4	3,558.1
BH19-TP-01	1,542,543.4	15,864,181.3	3,617.7
BH19-TP-15	1,544,070.2	15,866,243.5	3,564.9
BH19-TP-19	1,544,451.3	15,866,650.7	3,546.4
BH19-TP-23	1,544,303.6	15,866,963.8	3,541.1
BH19-TP-39	1,545,040.8	15,867,102.0	3,565.4
BH19-TP-44	1,544,672.9	15,866,761.8	3,554.4

LEGEND

- PROJECT AREA BOUNDARY
- APPROXIMATE TAILINGS STORAGE FACILITY BOUNDARY
- 3600 EXISTING GROUND (5 FT CONTOURS) (NOTE 1)
- EXISTING ROAD
- BH-01 GOLDER 2017 BOREHOLE LOCATIONS (NOTE 4)
- TP-02 GOLDER 2017 TEST PIT LOCATIONS (NOTE 4)
- BH19-TP-01 GOLDER 2018 BOREHOLE LOCATIONS (NOTE 4)
- APPROXIMATE LIMIT OF BORROW PIT
- APPROXIMATE WASTE ROCK DUMP BOUNDARY

NOTE(S)

1. EXISTING GROUND TOPOGRAPHY PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf".
2. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".
3. EXISTING GROUND CONTOURS AND EXPLORATION LOCATIONS PRESENTED ARE IN NAD83 DATUM, ZONE 11.
4. LOCATIONS OF BOREHOLES AND TEST PITS WERE RECORDED USING A HAND-HELD GPS UNIT.
5. TP-42 WAS NOT EXCAVATED DUE TO ACCESS ISSUES AND IS NOT SHOWN IN SITE PLAN.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2019-04-19	ISSUED FOR CLIENT REVIEW	JRP	JRP	MDB	CJM

SEAL

CLIENT
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CALICO RESOURCES

CONSULTANT

GOLDER

GOLDER ASSOCIATES INC.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
USA
[+1] (775) 828-9604
www.golder.com

PROJECT
GRASSY MOUNTAIN
TAILINGS STORAGE FACILITY
DETAILED DESIGN

TITLE
GEOTECHNICAL EXPLORATION LOCATION MAP

PROJECT NO. 1663241 | REV. A | 3 of 28 | FIGURE G2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 1 in

Path: \\vern\data\MDA\1663241 Grassy Mountain PFS\600_Drawings\PRODUCTION\CONSOLIDATED PERMIT\ | File Name: 1663241_G_001_Geotechnical drilling and site layout.dwg | Last Edited By: mstelngraeber Date: 2019-06-05 Time:3:52:22 PM | Printed By: MStelngraeber Date: 2019-06-07 Time:12:15:29 PM

Appendix D
Bore Logs

RECORD OF BOREHOLE BH-01

SHEET: 1 of 3

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 10:00
DRILLING END: December 6, 2017 15:45
COORDINATES: N: 15,864,952 E: 1,542,787

GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SP), SAND, fine to medium sand, yellow brown and tan, trace low plasticity fines, homogeneous; dense, moist; estimated 5% fines, 95% sand (ALLUVIUM/COLLUVIUM)	SP		SS S1	11-19-22 **(41)**	14/18	41			
10		10.0	(CL), LEAN CLAY, few fine sand, gray-olive to brown, homogeneous; hard, moist; estimated 90% fines, 10% sand (LACUSTRINE)	CL		SS S2	13-43-49 **(92)**	19/18	92		10: Sample S2: %Fines = 89; %Sand = 11; PI = 25; LL = 46; %MC = 16	
15						SS S3	19-25-29 **(54)**	18/18	54			
20		20.0	(CH), FAT CLAY, trace fine sand, blue-gray to brown, homogeneous; very stiff to hard, moist; estimated 99% fines, 1%sand (LACUSTRINE)	CH		SS S4	5-7-13 **(20)**	20/18	20			
25						SS S5	9-12-18 **(30)**	22/18	30			
30						SS S6	6-10-12 **(22)**	24/18	22			
35												
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 5/1/18 17:51
C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\GRASSYMOUNTAINBORINGLOGS.GPJ

RECORD OF BOREHOLE BH-01

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 10:00
DRILLING END: December 6, 2017 15:45
COORDINATES: N: 15,864,952 E: 1,542,787

SHEET: 2 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, trace fine sand, blue-gray to brown, homogeneous; hard, moist; estimated 99% fines, 1%sand (LACUSTRINE) *(continued)*	CH		SS S7	9-14-50/1" **(64/7")**	20 / 13		100		
45												
50						SS S8	8-15-38 **(53)**	22 / 18		53		
55												
60						SS S9	12-23-38 **(61)**	20 / 18		61		
65												
70						SS S10	38-50/1" **(50/1")**	7 / 7		100		
75												
80												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 5/1/18 17:51
C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\GRASSYMOUNTAINBORINGLOGS.GPJ

RECORD OF BOREHOLE BH-01

SHEET: 3 of 3

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 10:00
DRILLING END: December 6, 2017 15:45
COORDINATES: N: 15,864,952 E: 1,542,787

GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0									
	Hollow Stem Auger		(CH), FAT CLAY, trace fine sand, blue-gray to brown, homogeneous; hard, moist; estimated 99% fines, 1%sand (LACUSTRINE) *(continued)*	CH		SS S11	13-19-21 **(40)**	24 / 18	40		
85											
90						SS S12	9-13-47 **(60)**	20 / 18	60		
95											
100						SS S13	13-19-35 **(54)**	20 / 18	54		
		101.5	Bottom of borehole at 101.5 ft.								
105											
110											
115											
120											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 5/1/18 17:51
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RECORD OF BOREHOLE BH-02

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 08:40
DRILLING END: December 6, 2017 09:30
COORDINATES: N: 15,865,924 E: 1,543,510

SHEET: 1 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SP), POORLY GRADED SAND WITH GRAVEL, fine to coarse sand, little fine to coarse subrounded to subangular gravel, trace high plasticity fines, light brown, heterogeneous, iron oxide staining; very dense, moist; estimated 5% fines, 70% sand, 25% gravel (ALLUVIUM/COLLUVIUM)	SP		SS S1	12-22-33 **(55)**	18/18	55		
10		10.0	(SC), CLAYEY SAND, tan, friable; very dense, moist; estimated 15% fines, 85% sand (ALLUVIUM/COLLUVIUM)	SC		SS S2	15-24-43 **(67)**	19/18	67		
15		15.0	(CH), FAT CLAY, trace fine sand, tan-gray to pink-brown, homogeneous; very stiff to hard, moist; estimated 99%fines, 1% sand (LACUSTRINE)	CH		SS S3	9-9-15 **(24)**	18/18	24		
20						SS S4	5-5-10 **(15)**	22/18	15		
25		25.0	(SP), POORLY GRADED SAND, fine to medium sand, trace low plasticity fines, very light gray, homogeneous; very dense, moist; estimated 3% fines, 97%sand (BEACH DEPOSITS)	SP		SS S5	8-24-37 **(61)**	20/18	61		
30		31.0	(CH), FAT CLAY, trace fine sand, light pink-brown to light tan, moderately fissured; hard, moist; estimated 99%fines, 1% sand (LACUSTRINE)	CH		SS S6	7-15-18 **(33)**	20/18	33		
35											
40											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-02

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 08:40
DRILLING END: December 6, 2017 09:30
COORDINATES: N: 15,865,924 E: 1,543,510

SHEET: 2 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40		40.0									
		41.5		CH		SS S7	14-24-29 **(53)**	22 / 18	53		
			Bottom of borehole at 41.5 ft.								
45											
50											
55											
60											
65											
70											
75											
80											

DRAFT

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-03

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 5, 2017 08:40
DRILLING END: December 5, 2017 14:30
COORDINATES: N: 15,866,714 E: 1,544,313

SHEET: 1 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0									
		0.5	TOPSOIL								
			(SP), POORLY GRADED SAND, fine to medium sand, few fine rounded to subrounded gravel, trace high plasticity fines, light brown, heterogeneous; medium dense, moist; estimated 5% fines, 85% sand; 10% gravel (ALLUVIUM/COLLUVIUM)	SP		SS S1	3-6-10 **(16)**	16/18	16		
5											
		8.0								8: Driller observed a change in material based on drill action	
			(CH), FAT CLAY WITH SAND, little fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist; estimated 80% fines, 20% sand (LACUSTRINE)			SS S2	12-15-14 **(29)**	18/18	29	10: Sample S2: %Fines = 78; %Sand = 22; PI = 55; LL = 89; %MC = 29.9	
10											
15						SS S3	6-8-11 **(19)**	18/18	19		
20						SS S4	7-7-15 **(22)**	14/18	22		
25				CH		SS S5	8-7-10 **(17)**	18/18	17		
30						SS S6	8-13-16 **(29)**	20/18	29		
35											
40		40.0								40: Sample S7: %	

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-03

SHEET: 2 of 3

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 5, 2017 08:40
DRILLING END: December 5, 2017 14:30
COORDINATES: N: 15,866,714 E: 1,544,313

GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, trace to few fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist; estimated 95% fines, 5%sand (LACUSTRINE)	CH		SS S7	7-11-18 **(29)**	480 / 18	29		Fines = 96; % Sand = 4; PI = 99; LL = 124; %MC = 34.7	
45												
50						SS S8	8-14-25 **(39)**	20 / 18	39		50: Sample S8: %Fines = 93; %Sand = 7; PI = 198; LL = 227; %MC = 34.5	
55												
60						SS S9	8-14-20 **(34)**	22 / 18	34			
65												
70						SS S10	13-25-49 **(74)**	20 / 18	74			
75												
80												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-03

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 5, 2017 08:40
DRILLING END: December 5, 2017 14:30
COORDINATES: N: 15,866,714 E: 1,544,313

SHEET: 3 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
80		80.0									
	Hollow Stem Auger		(CH), FAT CLAY, trace to few fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist; estimated 95% fines, 5%sand (LACUSTRINE) *(continued)*			SS S11	20-41-50/5" **(91/11")**	20 / 17	100		
85											
90				CH		SS S12	48-50/2" **(50/2")**	12 / 8	100		
95											
100		100.2				SS S13	50/2" **(50/2")**	2 / 2	100		
			Bottom of borehole at 100.2 ft.								
105											
110											
115											
120											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-04

SHEET: 1 of 2

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 14:40
DRILLING END: December 1, 2017 17:45
COORDINATES: N: 15,866,262 E: 1,545,284

GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SP), POORLY GRADED SAND, fine to medium sand, few fine rounded to subrounded gravel, trace high plasticity fines, light brown, heterogeneous; dense, moist; estimated 5% fines, 85% sand; 10% gravel	SP								
		3.5	(CH), FAT CLAY, light tan and light brown, moderately fissured, iron oxide staining; very stiff to hard, moist; estimated 100% fines (LACUSTRINE)			SS S1	6-7-16 **(23)**	18/18	23			
5												
10				CH		SS S2	4-11-19 **(30)**	19/18	30			
15						SS S3	4-11-19 **(30)**	11/18	30			
20		20.0	(CH), FAT CLAY, few fine to medium sand, light tan and gray, homogeneous; hard, moist; estimated 90%fines, 10% sand (LACUSTRINE)			SS S4	15-15-17 **(32)**	20/18	32			
25						SS S5	11-22-41 **(63)**	20/18	63			
30				CH		SS S6	5-12-15 **(27)**	20/18	27			
35						SS S7	10-22-28 **(50)**	20/18	50			
40											40: Sand content	

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-04

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 14:40
DRILLING END: December 1, 2017 17:45
COORDINATES: N: 15,866,262 E: 1,545,284

SHEET: 2 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, few fine to medium sand, light tan and gray, homogeneous; hard, moist; estimated 90%fines, 10% sand (LACUSTRINE) *(continued)*	CH		SS S8	19-40-50/5" **(90/11")**	20 / 17	100	increases with depth	
45						SS S9	9-18-35 **(53)**	20 / 18	53		
50		51.5				SS S10	5-10-17 **(27)**	20 / 18	27		
			Bottom of borehole at 51.5 ft.								
55											
60											
65											
70											
75											
80											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-05

SHEET: 1 of 2

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 16:00
DRILLING END: December 6, 2017 17:30
COORDINATES: N: 15,867,186 E: 1,544,389

GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0									
		0.5	TOPSOIL (CH), FAT CLAY, trace sand, brown, heterogeneous; hard, moist; estimated 95% fines, 5%sand (LACUSTRINE)	CH		SS S1	9-13-18 **(31)**	12/18	31		
10		10.0	(SP), POORLY GRADED SAND, fine to coarse sand, few fine rounded to subrounded gravel, trace high plasticity fines, light brown, heterogeneous; dense, moist; estimated 5% fines, 85% sand, 10% gravel (ALLUVIUM/COLLUVIUM)	SP		SS S2	15-20-25 **(45)**	0/18	45		
						SS S3	10-18-20 **(38)**	19/18	38		
20		20.0	(CH), FAT CLAY, few fine to medium sand, dark tan and brown, homogeneous, iron oxide staining; very stiff to hard, moist; estimated 90% fines, 10% sand (LACUSTRINE)			SS S4	6-11-17 **(28)**	26/18	28		
25						SS S5	11-16-24 **(40)**	20/18	40		
30				CH		SS S6	7-14-14 **(28)**	26/18	28		
35											
40											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

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RECORD OF BOREHOLE BH-05

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 6, 2017 16:00
DRILLING END: December 6, 2017 17:30
COORDINATES: N: 15,867,186 E: 1,544,389

SHEET: 2 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40		40.0									
		41.5	CH	CH		SS S7	20-31-30 **(61)**	19 / 18	61		
			Bottom of borehole at 41.5 ft.								
45											
50											
55											
60											
65											
70											
75											
80											

DRAFT

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

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RECORD OF BOREHOLE BH-06

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 15:00
DRILLING END: December 7, 2017 15:45
COORDINATES: N: 15,867,549 E: 1,544,452

SHEET: 1 of 1
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0		0.0									
		0.5	TOPSOIL								
			(SP), POORLY GRADED SAND WITH GRAVEL, fine to coarse sand, little fine to coarse, subangular to angular gravel, trace low plasticity fines, brown, heterogeneous; very dense, moist; estimated <5% fines, 70% sand, 25% gravel (ALLUVIUM/COLLUVIUM)								
5				SP		SS S1	30-50/3" **(50/3")**	11 / 9	100		
10	Hollow Stem Auger	10.0									
			(CH), FAT CLAY, tan to olive, homogeneous, iron oxide staining; hard, dry to moist; estimated 100% fines (LACUSTRINE)			MC S2	16-14-16 **(30)**	18 / 18	30		
				CH							
15		15.0									
			(CH), FAT CLAY WITH SAND, little fine to medium sand, tan to light brown, homogeneous, iron oxide staining; hard, moist; estimated 85% fines, 15% sand (LACUSTRINE)			MC S3	14-20-26 **(46)**	20 / 18	46		
20				CH		SS S4	18-23-20 **(43)**	18 / 18	43		
25		25.0									
			(CH), FAT CLAY, olive-green, homogeneous, iron oxide staining; hard, dry to moist; estimated 100% fines (LACUSTRINE)	CH		MC S5	9-11-23 **(34)**	18 / 18	34		
		26.5	Bottom of borehole at 26.5 ft.								
30											
35											
40											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-06
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RECORD OF BOREHOLE BH-07

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 11:40
DRILLING END: December 1, 2017 13:10
COORDINATES: N: 15,866,060 E: 1,544,378

SHEET: 1 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0										
		0.5	TOPSOIL									
			(SP-SC), POORLY GRADED SAND WITH GRAVEL AND CLAY, fine to coarse sand, little fine to coarse, subrounded to subangular gravel, few low plasticity fines, light tan to gray, heterogeneous, iron oxide staining; very dense, dry to moist; estimated 10% fines, 70% sand, 20% gravel (ALLUVIUM/COLLUVIUM)	SP-SC		SS S1	19-25-27 **(52)**	12 / 18	52			
5												
						SS S2	25-29-33 **(62)**	18 / 18	62			
10												
						SS S3	19-29-36 **(65)**	17 / 18	65		15: : stained red from 15 to 25 feet:	
15												
						SS S4	23-28-30 **(58)**	20 / 18	58			
20												
		25.0										
			(CH), FAT CLAY, few fine sand, light gray-green to red-brown, moderately fissured, iron oxide staining; hard, moist; estimated 90% fines, 10% sand (LACUSTRINE)	CH		SS S5	13-18-20 **(38)**	20 / 18	38		25: Samples S5/S6/S7: %Fines = 91; %Sand = 9; PI = 45; LL = 66	
25												
						SS S6	9-11-19 **(30)**	20 / 18	30			
30												
						SS S7	8-12-24 **(36)**	22 / 18	36			
35												
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-07

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 11:40
DRILLING END: December 1, 2017 13:10
COORDINATES: N: 15,866,060 E: 1,544,378

SHEET: 2 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40		40.0									
		41.5		CH		SS S8	13-25-29 **(54)**	20 / 18	54		
			Bottom of borehole at 41.5 ft.								
45											
50											
55											
60											
65											
70											
75											
80											

DRAFT

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-08

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 08:36
DRILLING END: December 1, 2017 10:50
COORDINATES: N: 15,865,318 E: 1,544,094

SHEET: 1 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL (SC), CLAYEY SAND WITH GRAVEL, fine to coarse sand, little fine subrounded to subangular gravel, some high plasticity fines, brown, heterogeneous; medium dense, moist; estimated 20% fines, 50% sand, 30% gravel (ALLUVIUM/COLLUVIUM)	SC		SS S1	6-11-6 **(17)**	12/18	17			
10		10.0	(CH), FAT CLAY WITH SAND, little fine to medium sand, olive-brown brown, heterogeneous; very stiff to hard, moist; estimated 80% fines, 20% sand (LACUSTRINE)			SS S2	5-8-10 **(18)**	18/18	18			
15						SS S3	8-10-14 **(24)**	20/18	24			
20						SS S4	6-10-14 **(24)**	19/18	24			
25				CH		SS S5	7-16-26 **(42)**	19/18	42			
30						SS S6	6-10-10 **(20)**	20/18	20			
35						SS S7	8-13-17 **(30)**	20/18	30			
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-08

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 1, 2017 08:36
DRILLING END: December 1, 2017 10:50
COORDINATES: N: 15,865,318 E: 1,544,094

SHEET: 2 of 2
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40		40.0									
	Hollow Stem Auger		(CH), FAT CLAY WITH SAND, little fine to medium sand, olive-brown brown, heterogeneous; very stiff to hard, moist; estimated 80% fines, 20% sand (LACUSTRINE) *(continued)*	CH		SS S8	8-17-19 **(36)**	20 / 18	36		
45						SS S9	7-11-15 **(26)**	20 / 18	26		
50		51.5				SS S10	9-23-26 **(49)**	20 / 18	49		
			Bottom of borehole at 51.5 ft.								
55											
60											
65											
70											
75											
80											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

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RECORD OF BOREHOLE BH-09

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 08:30
DRILLING END: December 7, 2017 14:30
COORDINATES: N: 15,866,110 E: 1,543,260

SHEET: 1 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0									
		0.5	TOPSOIL								
			(SP), POORLY GRADED SAND, fine to medium sand, few high plasticity fines, tan and dark brown, homogeneous, iron oxide staining; dense to very dense, dry to moist; estimated 10% fines, 90% sand (ALLUVIUM/COLLUVIUM)	SP		SS S1	27-34-40 **(74)**	16/18	74		
5											
10						SS S13	9-13-33 **(46)**	20/18	46		
15						SS S3	50/2" **(50/2")**	1/2	100		
20						SS S4	41-50/5" **(50/5")**	14/11	100		
25		25.0									
			(CH), SANDY FAT CLAY, some fine to coarse sand, brown-yellowish and pink-brown, moderately fissured, iron oxide staining; very stiff, moist; estimated 70%fines, 30% sand (LACUSTRINE)			SS S5	9-11-13 **(24)**	17/18	24	25: Sample S5: %Fines = 68; %Sand =32; PI = 62, LL = 96	
30				CH		SS S6	8-11-13 **(24)**	20/18	24		
35											
40											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-09

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 08:30
DRILLING END: December 7, 2017 14:30
COORDINATES: N: 15,866,110 E: 1,543,260

SHEET: 2 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), SANDY FAT CLAY, some fine to coarse sand, brown-yellowish and pink-brown, moderately fissured, iron oxide staining; very stiff, moist; estimated 70%fines, 30% sand (LACUSTRINE) *(continued)*	CH		SS S7	6-10-14 **(24)**	26 / 18	24			
45												
50		50.0	(SP), POORLY GRADED SAND, fine to medium sand, trace low plasticity fines, tan, homogeneous; very dense, moist; estimated 3% fines, 97%sand (BEACH DEPOSITS)	SP		SS S8	17-35-46 **(81)**	20 / 18	81			
55												
60						SS S9	48-50/5" **(50/5")**	12 / 11	100			
65												
70		70.0	(CL), SANDY LEAN CLAY, some fine to medium sand, gray and blue-gray, homogeneous, iron oxide staining; hard, moist; estimated 70% fines, 30% sand (LACUSTRINE)	CL		SS S10	17-24-29 **(53)**	20 / 18	53			
75												
80		80.0										

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-09

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 7, 2017 08:30
DRILLING END: December 7, 2017 14:30
COORDINATES: N: 15,866,110 E: 1,543,260

SHEET: 3 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0									
	Hollow Stem Auger		(CH), FAT CLAY, light blue-gray and dark blue-gray, homogeneous; hard, dry to moist; estimated 100% fines (LACUSTRINE)			SS S11	50/5" **(50/5")**	6 / 5	100		
85											
90				CH		SS 12	12-19-30 **(49)**	20 / 18	49		
95											
100						SS S13	9-13-33 **(46)**	20 / 18	46		
		101.5	Bottom of borehole at 101.5 ft.								
105											
110											
115											
120											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-10

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: November 30, 2017 11:15
DRILLING END: November 30, 2017 12:45
COORDINATES: N: 15,864,954 E: 1,545,298

SHEET: 1 of 1
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p — W — W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0		0.0	TOPSOIL									
		1.0	(CL), LEAN CLAY WITH SAND, little fine sand, trace fine subrounded to subangular gravel, light tan, homogeneous; hard, moist; estimated 80% fines, 15%sand, 5% gravel (ALLUVIUM/ COLLUVIUM)			S1	0-0					
5	Hollow Stem Auger			CL		SS S2	10-15-18 **(33)**	16 / 18	33			
10		10.0	(SM), SILTY SAND, fine to coarse sand, some low plasticity fines, light gray, heterogeneous, iron oxide staining; very dense, moist; 15% fines, 85% sand (WEATHERED ARKOSIC SANDSTONE)			SS S3	12-19-33 **(52)**	16 / 18	52			
15				SM		SS S4	26-50/2" **(50/2")**	8 / 8		100		
20		20.2				SS	50/2" **(50/2")**	1 / 2		100		
			Bottom of borehole at 20.2 ft.									
25												
30												
35												
40												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

BH-10
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RECORD OF BOREHOLE BH-11

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: November 30, 2017 13:20
DRILLING END: November 30, 2017 15:00
COORDINATES: N: 15,865,251 E: 1,545,404

SHEET: 1 of 1
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0		0.0									
		0.5	TOPSOIL								
			(CH), SANDY FAT CLAY, some fine to coarse sand, trace fine subrounded to subangular gravel, light tan to olive, homogeneous; stiff to hard, moist; estimated 60% fines, 37% sand, 3% gravel (ALLUVIUM/COLLUVIUM)								
5						SS S1	7-5-8 **(13)**	20 18	13	5: Sample S2: %Fines = 60; %Sand = 37; %Gravel = 3%; PI = 62, LL = 97	
10				CH		SS S2	12-13-19 **(32)**	19 18	32	10: S2 mottled with evaporite deposits but deposits do not react to HCL	
15						SS S3	12-14-15 **(29)**	18 18	29		
20	Hollow Stem Auger	20.0									
			(SC), CLAYEY SAND, fine to coarse sand, some high plasticity fines, light green-gray and, heterogeneous; very dense, moist; estimated 15% fines, 85%sand (ALLUVIUM/COLLUVIUM)	SC		SS S4	50 **(50/")**	7 6			100
25		25.0									
			(SP-SM), POORLY GRADED SAND WITH GRAVEL AND CLAY, fine to coarse sand, little fine subangular to angular gravel, few high plasticity fines, light brown, heterogeneous; very dense, moist; estimated 8% fines, 70% sand, 22% gravel (ALLUVIUM/COLLUVIUM)			SS S5	50 **(50/")**	8 6		25: No recovery from 25 to 39 feet, grab samples of cuttings taken at about 30 and 39 feet	100
30				SP-SM		SS S6	50/1" **(50/1")**	0 1			100
35						SS S7	50/1" **(50/1")**	0 1			100
		39.0				S8					
40			Bottom of borehole at 39.0 ft.								

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-12

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: November 30, 2017 15:40
DRILLING END: November 30, 2017 16:40
COORDINATES: N: 15,865,342 E: 1,545,806

SHEET: 1 of 1
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0									
		0.5	TOPSOIL								
			(CH), FAT CLAY, trace fine to medium sand, gray to very dark gray, moderately fissured, iron oxide staining; very stiff to hard, moist; estimated 98% fines, 2%sand (LACUSTRINE?)								
5						SS S1	12-12-11 **(23)**	10/18	23		
10						SS S2	5-10-13 **(23)**	19/18	23		
15			Color change to gray to dark gray.	CH		SS S3	9-13-14 **(27)**	22/18	27		
20						SS S4	10-14-17 **(31)**	19/18	31		
25						SS S5	11-12-16 **(28)**	21/18	28		
30						SS S6	9-14-18 **(32)**	20/18	32	30: Sample S6: %Fines = 97; %Sand = 3; PI = 62, LL = 103	
		31.5	Bottom of borehole at 31.5 ft.								
35											
40											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

Golder Associates

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RECORD OF BOREHOLE BH-13

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 2, 2017 08:30
DRILLING END: December 2, 2017 16:00
COORDINATES: N: 15,866,510 E: 1,544,801

SHEET: 1 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
0		0.0										
		0.5	(CH), FAT CLAY WITH SAND, little fine to medium sand, tan, moderately fissured, iron oxide staining; very stiff, moist; 85% fines, 15% sand (LACUSTRINE)									
5	Hollow Stem Auger			CH		SS S1	7-9-11 **(20)**	18/18	20		5: Sample S1: %Fines = 86; %Sand = 14; PI = 63; LL = 92	
10		10.0	(CH), SANDY FAT CLAY, some fine to coarse sand, heterogeneous, iron oxide staining; very stiff to hard, olive to gray, moist; estimated 60% fines, 40% sand (LACUSTRINE)			SS S2	11-16-22 **(38)**	19/18	38			
15						SS S3	10-11-16 **(27)**	20/18	27		15: Sample S3: %Fines = 52; %Sand = 48; PI = 62; LL = 85	
20						SS S4	16-50/5" **(50/5")**	12/11		100		
25				CH		SS S5	10-12-18 **(30)**	24/18	30		25: Sample S5: %Fines = 67; %Sand = 33; PI = 55; LL = 77	
30		30.0	(CH), FAT CLAY, trace fine to coarse sand, heterogeneous, olive, iron oxide staining; very stiff to hard, moist; estimated 95% fines, 5% sand (LACUSTRINE)			MC S6	10-12-18 **(30)**	18/18	30		30: Sample S6: %Fines = 97; %Sand = 3; PI = 62, LL = 103	
35						SS S7	6-10-18 **(28)**	20/18	28			
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

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RECORD OF BOREHOLE BH-13

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 2, 2017 08:30
DRILLING END: December 2, 2017 16:00
COORDINATES: N: 15,866,510 E: 1,544,801

SHEET: 2 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	NOTES	ADDITIONAL LAB TESTING
40	Hollow Stem Auger	40.0	(CH), FAT CLAY, trace fine to coarse sand, heterogeneous, olive, iron oxide staining; very stiff to hard, moist; estimated 95% fines, 5% sand (LACUSTRINE) *(CONTINUED)*	CH		SS S8	8-13-23 **(36)**	20 / 18	36		
45		45.0	(SM), SILTY SAND, fine to medium, some low plasticity fines, tan, friable, iron oxide staining; very dense, moist,;45% fines, 55% sand (ALLUVIUM/COLLUVIUM)	SM		SS S9	8-4-50/4" **(54/10")**	20 / 16	100		
50						SS S10	22-49-50/2" **(99/8")**	18 / 14	100		
55						SS S11	18-47-50/5" **(97/11")**	24 / 17	100		
60						SS S12	18-38-50/5" **(88/11")**	20 / 17	100		
65		65.0	(CH), FAT CLAY, gray and dark blue-gray, homogeneous; hard, moist; estimated 100% fines (LACUSTRINE)	CH		SS S13	9-13-47 **(60)**	20 / 18	60		
70											
75						SS S14	13-27-34 **(61)**	20 / 18	61		
80											

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

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RECORD OF BOREHOLE BH-13

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 2, 2017 08:30
DRILLING END: December 2, 2017 16:00
COORDINATES: N: 15,866,510 E: 1,544,801

SHEET: 3 of 3
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb & 340 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
80		80.0	(CH), FAT CLAY, gray and dark blue-gray, homogeneous; hard, moist; estimated 100% fines (LACUSTRINE) *(continued)*								
85	Hollow Stem Auger			CH		SS 15	28-34-38 **(72)**	24 / 18	72		
90											
95											
100						SS S16	11-18-34 **(52)**	20 / 18	52		
		101.5	Bottom of borehole at 101.5 ft.								
105											
110											
115											
120											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Clay Johnson
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

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RECORD OF BOREHOLE BH-14

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: December 8, 2017 08:45
DRILLING END: December 8, 2017 09:30
COORDINATES: N: 15,866,769 E: 1,543,881

SHEET: 1 of 1
GS ELEV.:
TOC ELEV.: na
DATUM:

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (Automatic hammer 140 lb Hammer, 30 inch drop)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	NOTES	ADDITIONAL LAB TESTING
0	Hollow Stem Auger	0.0	0.5 TOPSOIL								
			(SW-SM), WELL-GRADED SAND WITH SILT, fine to medium, few fine subangular gravel, little low plasticity fines, tan, homogeneous, iron oxide staining; dense to very dense, moist; estimated 15% fines, 78% sand, 7% gravel (WEATHERED ARKOSIC SANDSTONE)	SW-SM		SS S0					
5						SS S1	31-38-43 **(81)**	17/18	81		
10						SS S2	15-18-27 **(45)**	14/18	45		
15						SS S3	8-14-15 **(29)**	12/18	29		
20						SS S4	13-15-21 **(36)**	14/18	36		
25		26.1				SS S5	19-29-38 **(67)**	13/18	67	25: S5 mottled with calcite deposits (reacts to HCL)	
			Bottom of borehole at 26.1 ft.								
30											
35											
40											

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Colin Bloom
CHECKED: Margaret Pryor
REVIEWED: Russ Browne

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RECORD OF BOREHOLE TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 26 09:15
DRILLING END: 2019 March 26 15:45
COORDINATES: Not Surveyed

SHEET: 1 of 4
GS ELEV.: 3595.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	GRAIN SIZE Gravel Sand Fines	ADDITIONAL LAB TESTING
0		0.0	**(SM) SILTY SAND WITH GRAVEL,** fine to coarse, little non plastic fines, few fine gravels, yellow-brown, dry, loose to dense Density increasing with depth	3595.0	SM		SS 1	16-20-30 **(50)**	16/18	50		
10		10.5	**(CH) FAT CLAY**, medium to high plasticity, trace fine sand, gray and white, w<PL, hard, *possible lacustrine* Sand content decreasing with depth	3584.5	CH		MC 2	8-16-25 **(41)**	13/18	25.7 41		A, M, G
15							MC 3	17-29-38 **(67)**	17/18	18.9 67	PI = 38, PL = 28	
20							MC 4	13-38-48 **(86)**	16/18	13.6 86	PI = 30, PL = 22	A, M, G
25		25.0		3570.0								
		26.0	**(SM) SILTY SAND**, fine, non plastic fines, some fine sands, light gray mottled orange, dry, very dense, finer with depth	3569.0	SM		MC 5	19-23-28 **(51)**	17/18	15.0 51	PI = 40 PL = 22	A, M, G
30			**(CL) LEAN CLAY**, low plasticity, trace fine sand, light gray with orange stain on surfaces, w < PL, hard Mottled orange		CL		MC 6	17-28-45 **(73)**	16/18	13.4 73	PI = 29, PL = 19	A, M, G
		30.7		3564.3								
35			**(SC) CLAYEY SAND**, fine, some medium plasticity fines, light gray, damp. very dense Some vertical stratification, approximately 20-30% orange mottle		SC		MC 7	29-48-50/3" **(98/9")**	15/15	9.6 100	PI = 21, PL = 14	A, M, G
40		40.0		3555.0								

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB EMUDT - 19/6/6 08:59

RECORD OF BOREHOLE TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 26 09:15
DRILLING END: 2019 March 26 15:45
COORDINATES: Not Surveyed

SHEET: 2 of 4
GS ELEV.: 3595.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (ASTM D1586, 140 lb hammer, 30 inch drop, Automatic hammer)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	GRAIN SIZE (Gravel / Sand / Fines)	ADDITIONAL LAB TESTING
40		40.0		3555.0								
		40.5	**(CL) LEAN CLAY**, low plasticity, trace fine sand, light gray and light yellow, w < PL, hard	3554.5	CL		MC 8	15-31-45 **(76)**	15/18	11.6 ○ 76 ■	PI = 17, PL = 18	
		41.0	**(SC) CLAYEY SAND**, fine to coarse, light gray and light yellow, dry, very dense	3554.0	SC							
45			**(CL) LEAN CLAY**, low plasticity, trace fine sand, light brown-gray and dark brown, laminated, w < PL, hard, *possible lacustrine*									
			Medium plasticity		CH		MC 9	12-20-28 **(48)**	18/18	48 ■		A, M, G
50			Mottled orange (~30%), increasing with depth				MC 10	8-17-28 **(45)**	18/18	32.3 ○ 45 ■	PI = 62, PL = 25	A, M, G
		51.0	**(ML) SILT**, non plastic, trace fine sand, brown-gray mottled orange, w < PL, hard	3544.0								
55					ML							
60		60.0		3535.0								
			(CH) FAT CLAY, medium plasticity, few fine sands, gray with black, w < PL, hard				MC 11	12-17-28 **(45)**	18/18	45 ■		A, M, G
65												
70			High plasticity, dark brown, stratified, w ~ PL, *possible lacustrine*		CH		MC 12	17-26-28 **(54)**	18/18	54 ■ 47.9 ○	PI = 78, PL = 38	A, M, G
75												
80												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-MAIL - 19/6/6 09:00

RECORD OF BOREHOLE TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 26 09:15
DRILLING END: 2019 March 26 15:45
COORDINATES: Not Surveyed

SHEET: 3 of 4
GS ELEV.: 3595.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (ASTM D1586, 140 lb hammer, 30 inch drop, Automatic hammer)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft; WATER CONTENT (%)	GRAIN SIZE (Gravel / Sand / Fines)	ADDITIONAL LAB TESTING
80		80.0		3515.0								
		81.5		3513.5	CH		MC 13	17-27-40 **(67)**	18/18	67		
			(SM) SILTY SAND, fine, some non-plastic fines, dark blue-gray, damp, very dense More fine sand with depth		SM							
85												
90		90.0		3505.0								
			(CH) FAT CLAY, medium plasticity, dark blue-gray, white clay fleck and vein scattered throughout, w < PL, hard		CH		MC 14	21-43-50/5" **(93/11")**	17/17	36.5	100 PI = 65, PL = 36	A, M, G
95												
100		100.3		3494.7								
		101.3	**(SC) CLAYEY SAND**, fine, some non-plastic fines, dark blue gray, dry, very dense	3493.7	SC		MC 15	17-28-32 **(60)**	18/18	60		
			(CH) FAT CLAY, high plasticity, gray-blue and white fleck scattered throughout, w ~ PL, hard		CH		MC 16	18-28-50/5" **(78/11")**	17/17	33.6	100 PI = 64, PL = 26	A, M, G
105												
110												
115			Medium plasticity, trace fine sand, w > PL									
120												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB EMUGU - 19/6/6 09:00

RECORD OF BOREHOLE TP-15

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 26 09:15
DRILLING END: 2019 March 26 15:45
COORDINATES: Not Surveyed

SHEET: 4 of 4
GS ELEV.: 3595.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft 20 40 60 80 / WATER CONTENT (%) W_p W W_l 20 40 60 80	GRAIN SIZE Gravel Sand Fines 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB TESTING
120		120.0		3475.0								
		121.4		3473.6	CH		MC 17	18-27-50/5" **(77/11")**	17/17	24.6 ○ 100 ■	PI = 43, PL = 23	A, M, G
			Bottom of borehole at 121.4 ft. Backfilled with bentonite chips.									
125												
130												
135												
140												
145												
150												
155												
160												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

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RECORD OF BOREHOLE TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 14:45
DRILLING END: 2019 March 23 13:45
COORDINATES: Not Surveyed

SHEET: 1 of 4
GS ELEV.: 3535.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) W_p W W_l (20 40 60 80)	GRAIN SIZE Gravel Sand Fines (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
0		0.0	0-1 ft ~ Topsoil **(CL) LEAN CLAY,** low plasticity, gray and light gray, w < PL, very stiff, *possible lacustrine* Density increasing with depth	3535.0	CL		SS	8-11-13 **(24)**	12/18	24		
10		10.0	**(ML) SILT,** low plasticity, light gray-green; white fleck scattered throughout with orange stain, w < PL, stiff	3525.0	ML		MS SS	4-8-11 **(19)**	22/24 14/18	19		A, M, G
15		15.4	**(CH) FAT CLAY** medium to high plasticity, yellow-brown with white specks and orange stain, w < PL, very stiff	3519.6	CH		MC	9-11-13 **(24)**	14/18	24 ○ 34.4	PI = 100, PL = 33	A, M, G
20							MS SS	4-7-9 **(16)**	24/24 18/18	16		A, M, G
25			Hard 25.7-26.7ft - heavy orange stain				MC	10-24-28 **(52)**	18/18	23.2 ○ 52	PI = 135, PL = 23	A, M, G
30		30.0	**(SC) CLAYEY SAND,** fine to medium, little high plasticity fines, light yellow-brown, w < PL, very dense	3505.0	SC		MC	19-24-28 **(52)**	18/18	27.1 ○ 52	PI = 101, PL = 26	A, M, G
35			37-42ft - trace gravels				MC	16-32-32 **(64)**	18/18	26.3 ○ 64	PI = 117, PL = 20	A, M, G
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-MAIL - 19/6/6 10:46
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RECORD OF BOREHOLE TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 14:45
DRILLING END: 2019 March 23 13:45
COORDINATES: Not Surveyed

SHEET: 2 of 4
GS ELEV.: 3535.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) W_p W W_l (20 40 60 80)	GRAIN SIZE Gravel Sand Fines (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
40		40.0		3495.0								
		40.5	40ft - trace fine gravel	3494.5			MC	19-21-25 **(46)**	18/18	46 / 45.5	PI = 117, PL = 24	A, M, G
		41.5	**(CL-ML) SILTY CLAY,** very low plasticity, little fine sand, trace fine gravel, light gray with some orange mottle, w < PL, hard Sand content decreasing	3493.5	CL-ML							
			(CH) FAT CLAY, high plasticity, light brown-gray, w ~ PL, very stiff		CH							
45		45.0		3490.0			MC	28-50 **(50/")**	12/12	100		
			(ML) SANDY SILT, non plastic, some fine sand, olive-gray, damp, hard Sand content increasing with depth Orange stain (~50%)		ML							
50		50.0		3485.0								
			(CH) FAT CLAY, high plasticity fines, little fine sands, yellow-brown, w ~ PL, hard				MC	10-19-22 **(41)**	18/18	41 / 42.2	PI = 179, PL = 27	A, M, G
55												
60			Medium plasticity, dark gray, w ~ PL, hard		CH		MC	25-48-50 **(98)**	18/18	22.1 / 98	PI = 51, PL = 22	A, M, G
65												
70			More fine sands, gray, moist, very dense				MC	20-29-50 **(79)**	18/18	30.3 / 79	PI = 61, PL = 28	A, M, G
		71.5	**(CL) SILTY CLAY,** low plasticity, some fine sand, gray, moist, hard	3463.5	CL							
75		75.0		3460.0								
			(CH) FAT CLAY, high plasticity, dark gray, w < PL, hard		CH							
80												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

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01 - GOLDER - BOREHOLE RECORD - UP STD US LAB E-MLGUI - 19/6/6 11:03

RECORD OF BOREHOLE TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 14:45
DRILLING END: 2019 March 23 13:45
COORDINATES: Not Surveyed

SHEET: 3 of 4
GS ELEV.: 3535.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (ASTM D1586, 140 lb hammer, 30 inch drop, Automatic hammer)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft	WATER CONTENT (%)	GRAIN SIZE	ADDITIONAL LAB TESTING
80		80.0	**(CH) FAT CLAY**, medium plasticity, dark gray, w < PL, hard *(continued)*	3455.0	CH		MC	21-39-50 **(89)**	18/18		20.9	PI = 41, PL = 21	A, M, G
85			87.5-88.5ft - Rig chatter in rock, no recovery										
90			90-90.5ft - Rig chatter in rock, no recovery				MC	50/4" **(50/4")**	4/4				
		92.0	**(SP-SM) POORLY GRADED SAND WITH SILT**, fine, little non plastic fines, trace gravel, light gray, dry, very dense, homogeneous	3443.0									
95													
100					SP-SM		MC	49-50/3" **(50/3")**	9/9				
105													
		108.0	**(CL) LEAN CLAY**, low plasticity, gray, w ~ PL, hard, stratified with black on layer surfaces	3427.0									
110			Evident swelling of clays		CL		MC	28-38-50/3" **(88/9")**	15/15		17.8	PI = 24, PL = 24	A, M, G
			Difficult drilling, sucking										
115		115.0		3420.0									
			(CH) FAT CLAY, medium plasticity, some fine sands, gray, dry, very dense		CH								
120													

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB EMGDT - 19/6/6 11:03
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RECORD OF BOREHOLE TP-19

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 14:45
DRILLING END: 2019 March 23 13:45
COORDINATES: Not Surveyed

SHEET: 4 of 4
GS ELEV.: 3535.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE: Depth	DESCRIPTION	SOIL PROFILE: Elev	USCS	GRAPHIC LOG	SAMPLES: SAMPLE TYPE & NUMBER	SAMPLES: BLOWS per 6 in (ASTM D1586, 140 lb hammer, 30 inch drop, Automatic hammer)	SAMPLES: REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	GRAIN SIZE (Gravel, Sand, Fines) (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
120		120.0		3415.0								
		121.4		3413.6	CH		MC	25-45-50/5" **(95/11")**	17 / 17	20.9 ○ — 100 ■	PI = 37, PL = 22	A, M, G
			Bottom of borehole at 121.4 ft. Backfilled with bentonite chips.									
125												
130												
135												
140												
145												
150												
155												
160												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-MAIL.GDT - 19/6/6 11:03
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RECORD OF BOREHOLE TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 20 13:30
DRILLING END: 2019 March 21 11:15
COORDINATES: Not Surveyed

SHEET: 1 of 4
GS ELEV.: 3550.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) W_p W W_l (20 40 60 80)	GRAIN SIZE Gravel Sand Fines (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
0		0.0	**(CH) FAT CLAY WITH GRAVEL**, medium plasticity, little coarse gravel, trace fine sand, light brown-gray, dry, soft	3550.0	CH							
5		5.0		3545.0			SS 1	12-50/4" **(50/4")**	10/10	100		
10		10.5	**(GC) CLAYEY GRAVEL**, coarse subrounded to subangular, little medium plasticity fines, trace fine sand, gray, dry, dense, logged from auger return (drill chatter)	3539.5	GC		SS 2	16-9-10 **(19)**	18/18	19		
15			**(CH) FAT CLAY**, high plasticity, trace fine gravels, gray, w ~ PL, very stiff *possible lacustrine*				MS 3		24/24			A, M, G
20			Gray-green, excavates blocky		CH		SS 4	5-6-6 **(12)**	18/18	12		
							MS 5		24/24			A, M, G
25							SS 6	5-8-10 **(18)**	18/18	18		
		26.5		3523.5			MS 7		20/20			A, M, G
30		30.0	**(SC) CLAYEY SAND**, fine, some low plasticity fines, light gray mottled orange, heterogeneous, iron oxide and black stain on surfaces, damp, medium dense, *possible lacustrine*	3520.0	SC		SS 8	5-8-10 **(18)**	18/18	18		
			(CH) FAT CLAY, high plasticity, green-gray, w ~ PL, hard				MC 9	17-25-18 **(43)**	18/18	43 41.7	PI = 68, PL = 31	A, M, G
35					CH		MC 10	10-20-25 **(45)**	17/18	45 41.7	PI = 101, PL = 34	A, M, G
40												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

TP-23

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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-MAIL - 19/6/6 11:05

RECORD OF BOREHOLE TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 20 13:30
DRILLING END: 2019 March 21 11:15
COORDINATES: Not Surveyed

SHEET: 2 of 4
GS ELEV.: 3550.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLE TYPE & NUMBER	BLOWS per 6 in (ASTM D1586 140 lb hammer 30 inch drop Automatic hammer)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	GRAIN SIZE (Gravel Sand Fines) (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
40		40.0	**(CH) FAT CLAY**, high plasticity, green-gray, w ~ PL, hard *(continued)* Orange iron oxide mottle, increasing with depth Pink gray, w < PL	3510.0	CH		MC 11	12-15-50/4" **(65/10")**	16/16	29.4	100 PI = 58, PL = 24	A, M, G
45		45.0	**(CL) LEAN CLAY**, medium plasticity, light gray mottled orange, w ~ PL, hard Dark gray and dark red Pink gray	3505.0	CL		MC 12	15-28-48 **(76)**	18/18	22.8	76 PI = 26, PL = 23	
50		50.0	**(CH) FAT CLAY**, high plasticity, dark gray, w ~ PL, hard Trace fine sand	3500.0	CH		MC 13	30-38-50/4" **(88/10")**	16/16	19.5	100 PI = 50, PL = 20	A, M, G
55												
60		60.5	Orange mottle	3489.5								
		61.5	**(MH) ELASTIC SILT** non-plastic, light gray, w < PL, hard	3488.5	ML		MC 14	35-49-50 **(99)**	18/18	26.0	99 PI = 21, PL = 32	A, M, G
65			**(CH) FAT CLAY**, high plasticity, gray, w < PL, hard		CH							
70		70.0		3480.0								
			(SC) CLAYEY SAND, fine, some non-plastic fines, light gray, dry, very dense				MC 15	50/5" **(50/5")**	0/5		100	
75					SC							
80												

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-MAIL - 19/6/6 11:05

RECORD OF BOREHOLE TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 20 13:30
DRILLING END: 2019 March 21 11:15
COORDINATES: Not Surveyed

SHEET: 3 of 4
GS ELEV.: 3550.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) W_p W W_l (20 40 60 80)	GRAIN SIZE Gravel Sand Fines (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
80		80.0	**(SC) CLAYEY SAND,** fine, some non-plastic fines, light gray, dry, very dense *(continued)*	3470.0	SC		MC 16	49-50/4" **(50/4")**	10/10	100		
85												
90							MC 17	50/4" **(50/4")**	4/4	100		
95		98.0		3452.0								
100			**(CH) FAT CLAY**, high plasticity, dark brown, w < PL, hard, stratified Some gray		CH		MC 18	14-21-24 **(45)**	18/18	45		A, M, G
105												
110		110.0		3440.0			MC 19	37-50/3" **(50/3")**	9/9	100		
115			**(SP-SM) POORLY GRADED SILTY SAND,** fine, poorly graded, little non-plastic fines, light gray, damp, very dense		SP-SM							
120		120.0		3430.0								

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

S:\MDA\1663241 GRASSY MOUNTAIN PFS\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM AND LAB TESTING\BORING LOGS\GRASSYMOUNTAINBORINGLOGS 3-29-2011 - COPY.GPJ
01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-MAIL - 19/6/6 11:05

RECORD OF BOREHOLE TP-23

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 20 13:30
DRILLING END: 2019 March 21 11:15
COORDINATES: Not Surveyed

SHEET: 4 of 4
GS ELEV.: 3550.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft 20 40 60 80 / WATER CONTENT (%) W_p W W_l 20 40 60 80	GRAIN SIZE Gravel Sand Fines 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB TESTING
120		120.0		3430.0								
		121.3	**(CH) FAT CLAY**, high plasticity, light gray, w ~ PL, hard Dark brown, laminated	3428.7	CH		MC 20	17-37-50/4" **(87/10")**	16 16	25.1 100	PI = 40, PL = 24	A, M, G
			Bottom of borehole at 121.3 ft. Backfilled with bentonite chips.									
125												
130												
135												
140												
145												
150												
155												
160												

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-MAIL - 19/6/6 11:05
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RECORD OF BOREHOLE TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 08:00
DRILLING END: 2019 March 22 14:00
COORDINATES: Not Surveyed

SHEET: 1 of 4
GS ELEV.: 3608.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) W_p W W_l (20 40 60 80)	GRAIN SIZE Gravel Sand Fines (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
0		0.0	**(ML) SILT,** non plastic, little fine to coarse subrounded to subangular gravel, light yellow-brown, dry, loose to medium dense	3608.0	ML								
5		5.0	**(SP) POORLY GRADED SAND,** fine, poorly graded, little non plastic fines, white and brown-gray, dry, medium dense Fines content increasing with depth	3603.0	SP		SS 1	9-11-12 **(23)**	12/18	23			
10		9.0 10.0	**(SC) CLAYEY SAND,** fine, some medium plasticity fines, yellow-brown, damp, medium dense	3599.0 3598.0	SC								
			(CL) SANDY LEAN CLAY, low to medium plasticity, and some sand, red-brown, w ~ PL, stiff		CL		MS 2		24/24				A, M, G
		13.5	Yellow brown, w < PL Red brown, w ~ PL	3594.5			SS 3	5-6-7 **(13)**	16/18	13			
15			**(ML) SILT WITH SAND,** non-plastic, few fine sand, gray-brown mottled orange, w ~ PL, hard		ML		MC 4	40-50/3" **(50/3")**	9/9		100		
20		20.0	Yellow brown, more sands	3588.0									
			(CH) FAT CLAY, high plasticity fines, few fine sands, yellow-brown, white clay fleck scattered throughout, w ~ PL, very stiff		CH		MS 5		24/24				A, M, G
							SS 6	9-8-10 **(18)**	17/18	18			
25							MC 7	8-12-14 **(26)**	17/18	26	36.7	PI = 62, PL = 30	A, M, G
			Stain and white speckling increases										
30							MS 8		24/24				A, M, G
							SS 9	8-9-11 **(20)**	18/18	20			
35			Brown grey				MC 10	11-16-21 **(37)**	18/18	37	39.8	PI = 74, PL = 29	A, M, G
		38.0		3570.0									
40					SC								

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

S:\MDA\1663241 GRASSY MOUNTAIN PFS\400_ENGINEERING\414_GEOTECH PROGRAM\2019 FIELD PROGRAM AND LAB TESTING\BORING LOGS\GRASSYMOUNTAINBORINGLOGS 3-29-2011 - COPY.GPJ
01 - GOLDER - BOREHOLE RECORD - DF STD US LAB EM.GDT - 19/6/6 11:43

RECORD OF BOREHOLE TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 08:00
DRILLING END: 2019 March 22 14:00
COORDINATES: Not Surveyed

SHEET: 2 of 4
GS ELEV.: 3608.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80) / WATER CONTENT (%) W_p W W_l (20 40 60 80)	GRAIN SIZE Gravel Sand Fines (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
40		40.0	**(SC) CLAYEY SAND,** fine, little medium plasticity fines, yellow-brown, moist, very dense *(continued)*	3568.0	SC		MC 11	16-24-29 **(53)**	18/18	28.3 ○ 53 ■	PI = 58, PL = 26	A, M, G
45			Few medium plasticity fines, trace fine gravel				MC 12	29-47-50 **(97)**	15/18	17.8 ○ 97 ■	PI = 33, PL = 22	A, M, G
50			Some medium plasticity fines Grades finer with depth				MC 13	15-32-40 **(72)**	18/18	22.5 ○ 72 ■	PI = 52, PL = 27	A, M, G
55												
60							MC 14	20-37-43 **(80)**	18/18	21.0 ○ 80 ■		A, M, G
65			Light gray with orange staining, trace fine gravel									
70		70.0		3538.0								
			(CH) FAT CLAY, medium plasticity, some fine to coarse sand, brown-gray mottled orange-red, w < PL, hard		CH		MC 15	17-27-50/5" **(77/11")**	17/17	30.7 ○ 100 ■	PI = 62, PL = 24	A, M, G
75			High plasticity, White clay fleck scattered throughout									
80		80.0		3528.0								

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB EM.GDT - 19/6/6 11:43
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RECORD OF BOREHOLE TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 08:00
DRILLING END: 2019 March 22 14:00
COORDINATES: Not Surveyed

SHEET: 3 of 4
GS ELEV.: 3608.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in (ASTM D1586 140 lb hammer 30 inch drop Automatic hammer)	REC / ATT (in)	PENETRATION RESISTANCE BLOWS / ft (20 40 60 80)	WATER CONTENT (%) (W_p W W_l) (20 40 60 80)	GRAIN SIZE (Gravel Sand Fines) (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB TESTING
80		80.0	**(CL) LEAN CLAY,** low to medium plasticity, some fine to coarse sand, dark gray with white clay scattered throughout, w ~ PL, hard	3528.0	CL		MC 16	17-29-33 **(62)**	18/18	24.9	62	PI = 40, PL = 21	A, M, G
85													
90		91.4		3516.6			MC 17	37-38-50 **(88)**	18/18	26.3	88	PI = 48, PL = 24	A, M, G
95			**(CH) FAT CLAY,** medium plasticity, some fine to coarse sand, black brown and stratified with white clay flecks throughout, w < PL, hard, *lacustrine*		CH								
100		100.0		3508.0			MC 18	41-50/3" **(50/3")**	6/9		100		
105			**(CL) LEAN CLAY,** low plasticity, trace fine sand, very light gray, dry, hard		CL								
110							MC 19	35-42-50 **(92)**	18/18	17.9	92	PI = 16, PL = 25	A, M, G
115													
120													

Log continued on next page

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

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01 - GOLDER - BOREHOLE RECORD - DF STD US LAB EM.GDT - 19/6/6 11:43

RECORD OF BOREHOLE TP-44

PROJECT: Grassy Mountain
PROJECT NO.: 1663241
LOCATION: Vale, Oregon

DRILLING START: 2019 March 22 08:00
DRILLING END: 2019 March 22 14:00
COORDINATES: Not Surveyed

SHEET: 4 of 4
GS ELEV.: 3608.0
TOC ELEV.: na
DATUM: Geodetic

DEPTH (ft)	BORING METHOD	SOIL PROFILE Depth	DESCRIPTION	Elev	USCS	GRAPHIC LOG	SAMPLES SAMPLE TYPE & NUMBER	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop Automatic hammer	REC ATT (in)	PENETRATION RESISTANCE BLOWS / ft 20 40 60 80	WATER CONTENT (%) W_p W W_l 20 40 60 80	GRAIN SIZE Gravel Sand Fines 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB TESTING
120		120.0		3488.0							100		
		120.4		3487.6			MC 20	50/5" **(50/5")**	0 5				
			Bottom of borehole at 120.5 ft. Backfilled with bentonite chips.										
125													
130													
135													
140													
145													
150													
155													
160													

DRILLING CO.: Haz Tech
DRILLER: Jerod Willard
DRILL RIG: CME-75, Truck Mount

LOGGED: Brenda Borer
CHECKED: KDP
REVIEWED: SAM

GOLDER

01 - GOLDER - BOREHOLE RECORD - DF STD US LAB E-M.GDT - 19/6/6 11:43
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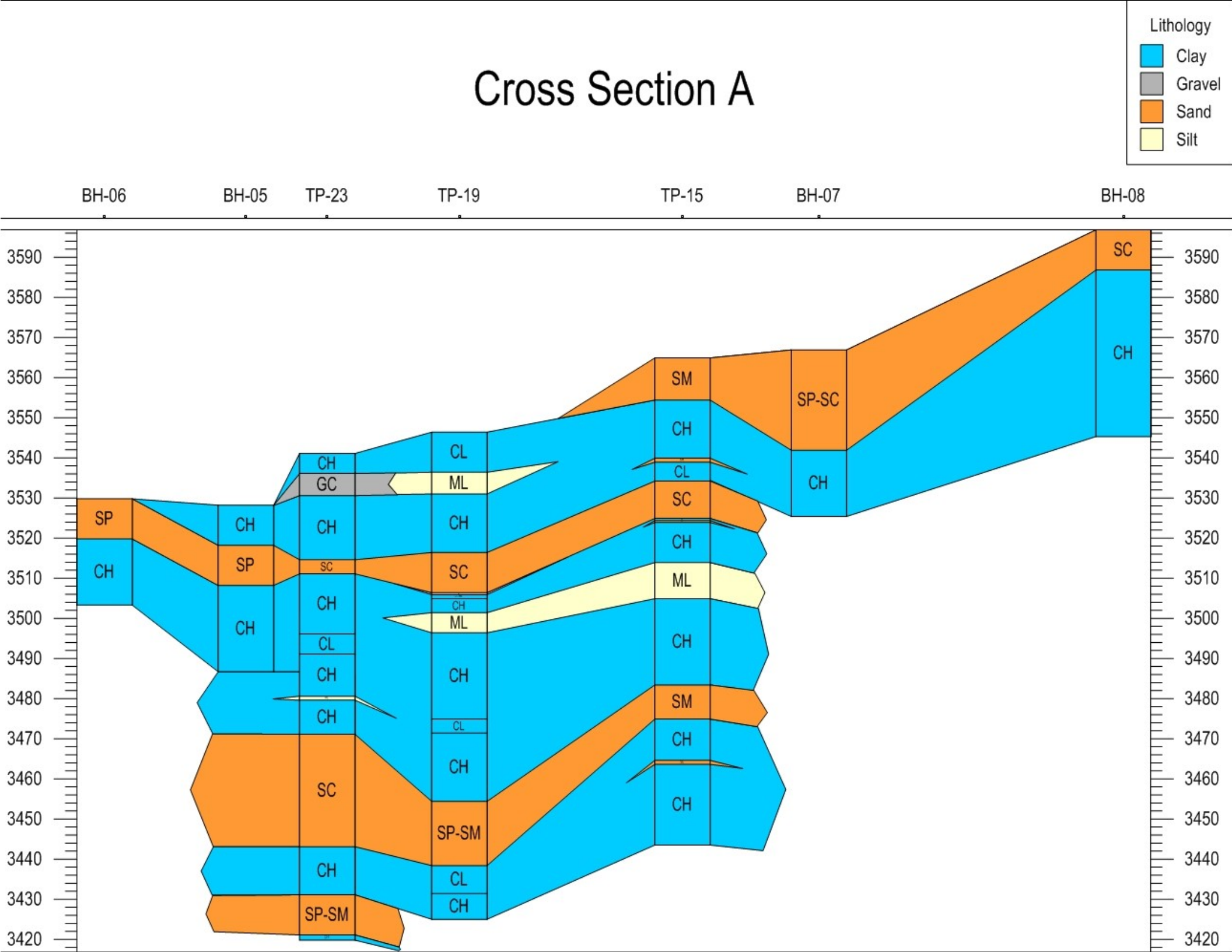
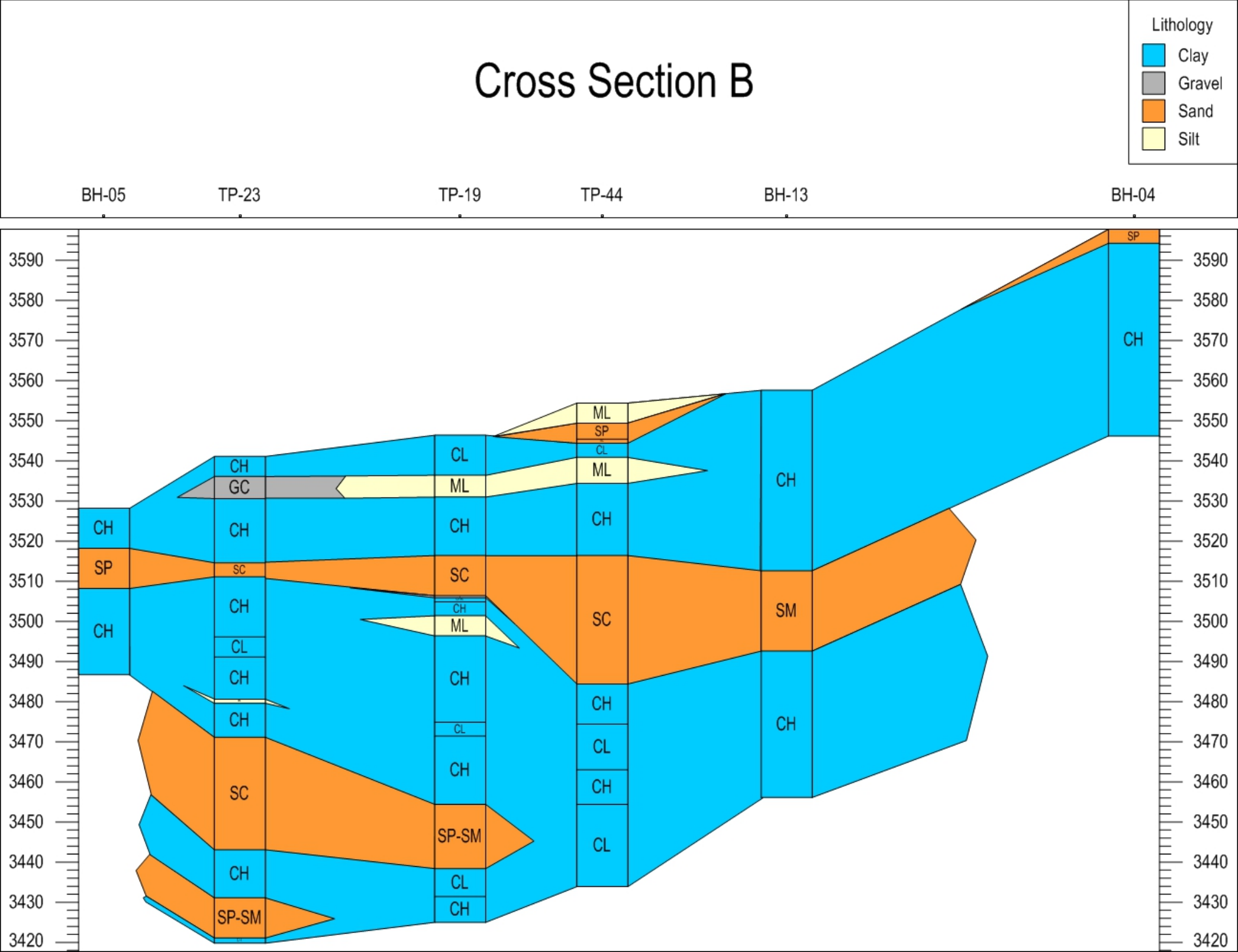
Appendix E
Lithologic Cross-Sections

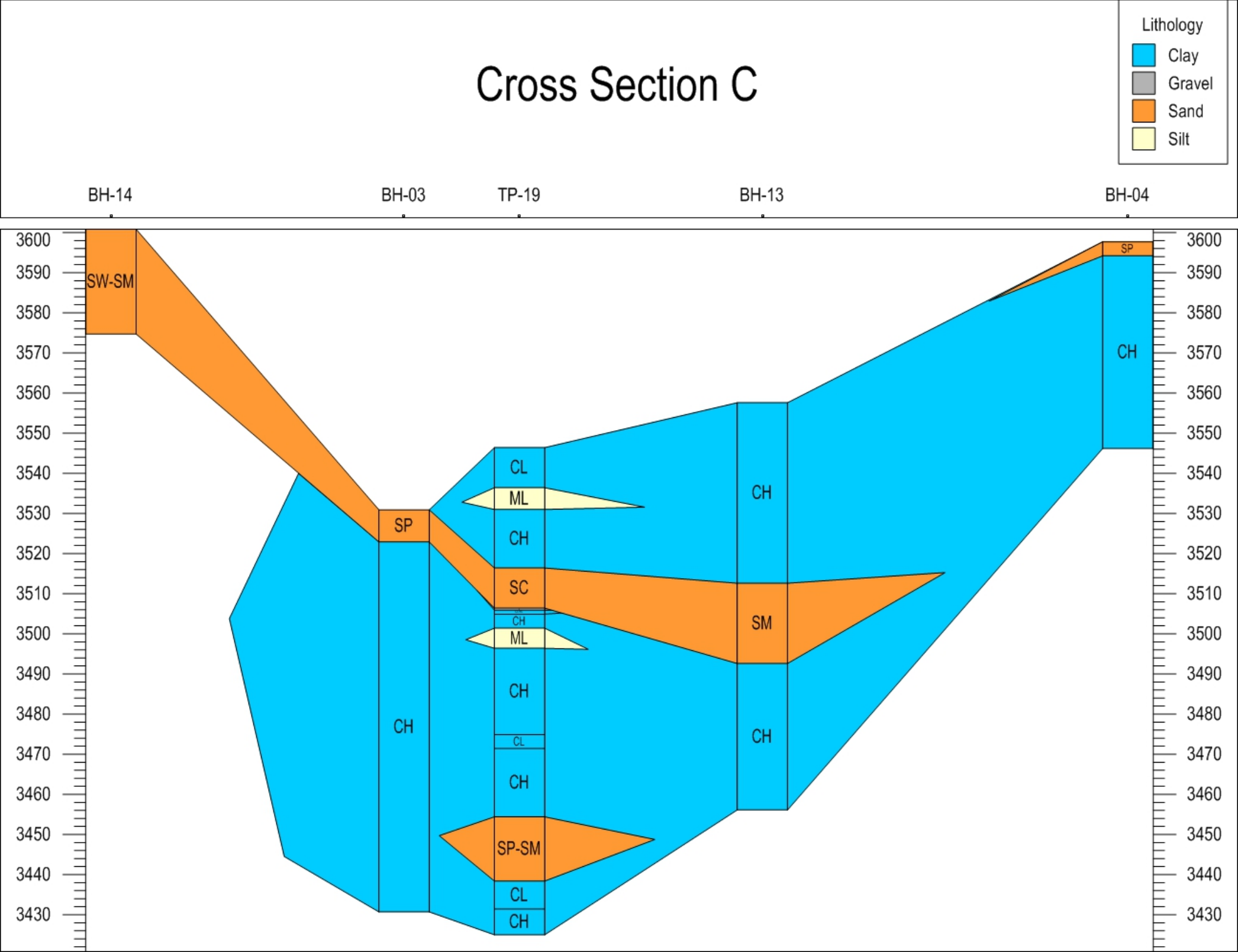
Cross Section A



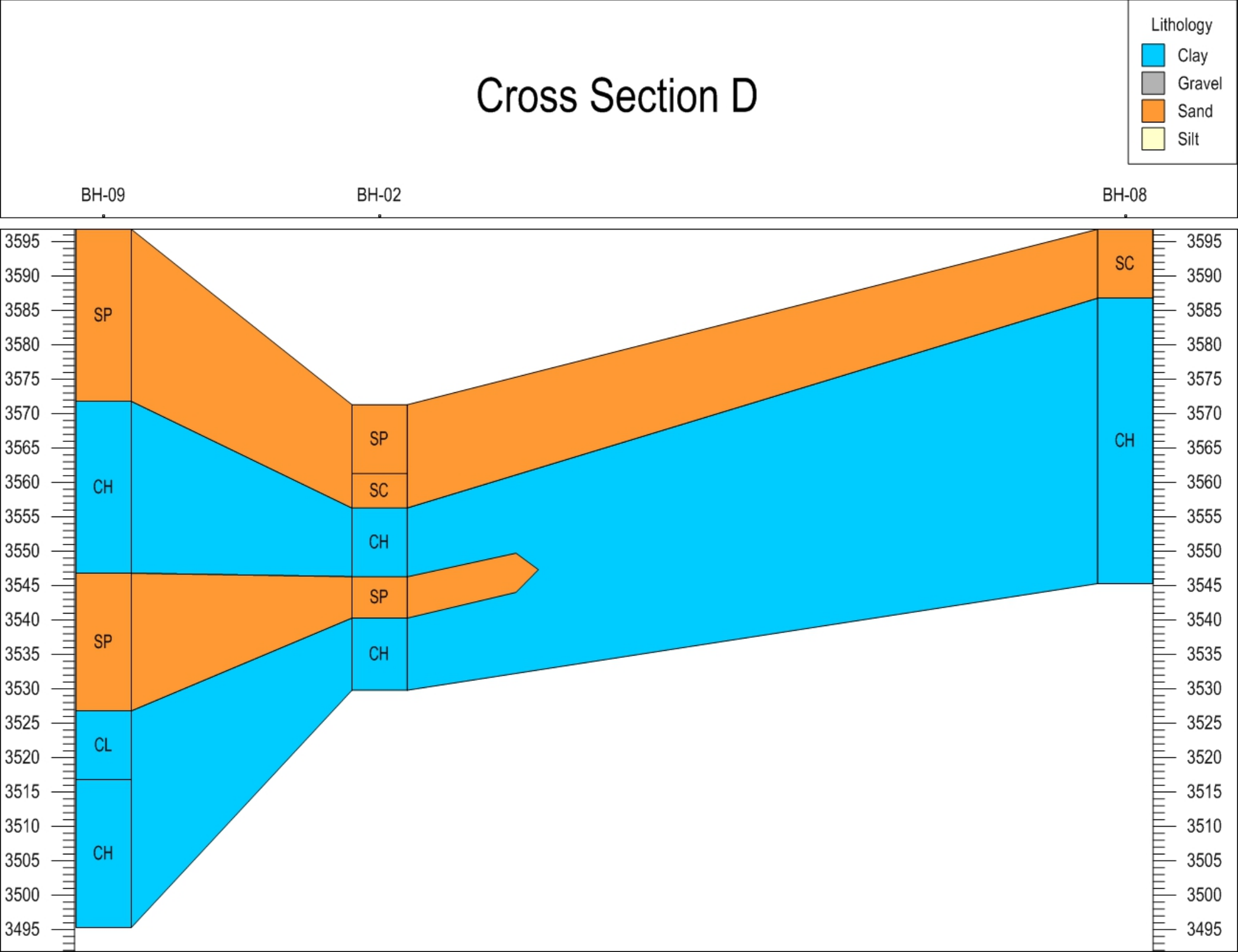
Cross Section B



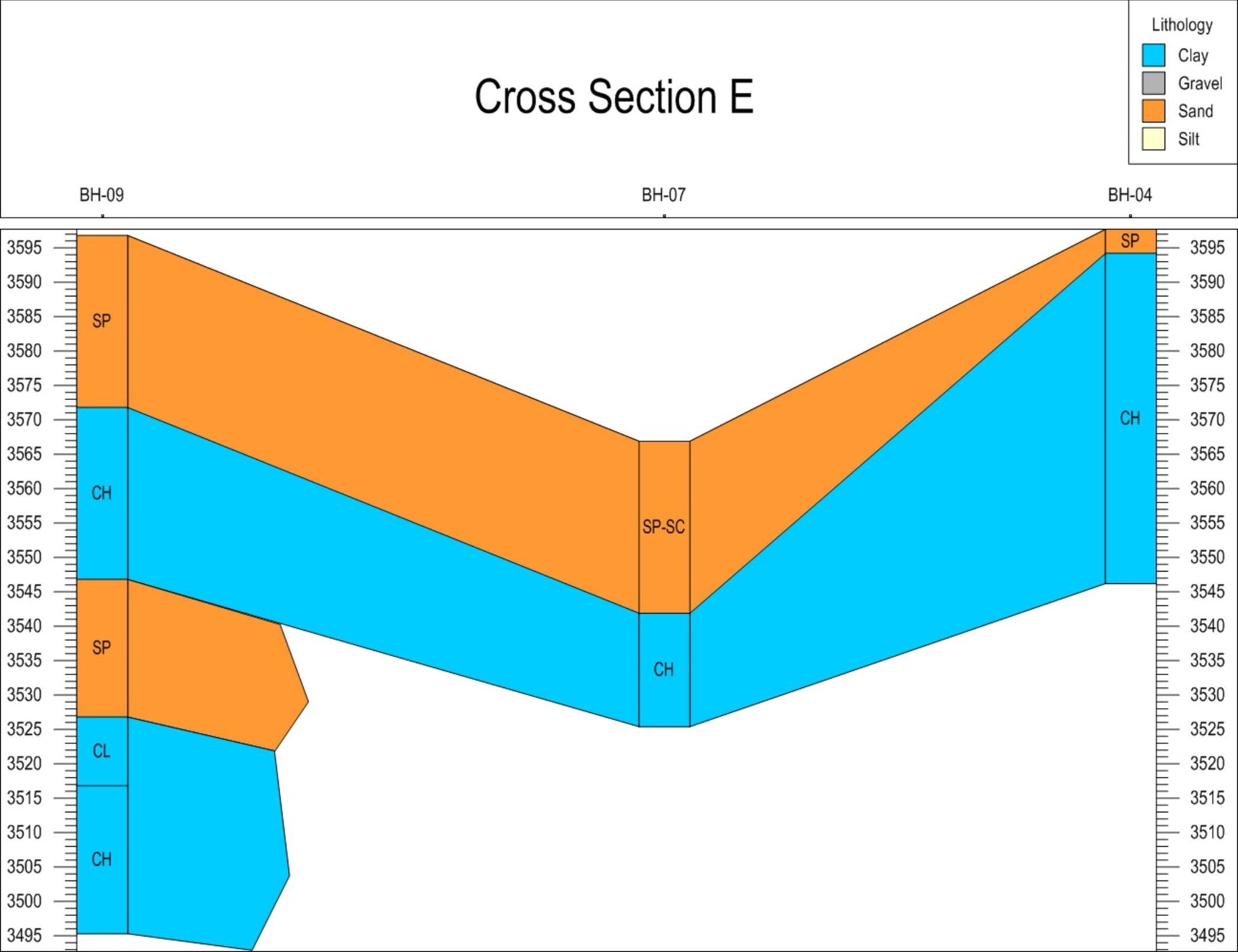
Cross Section C



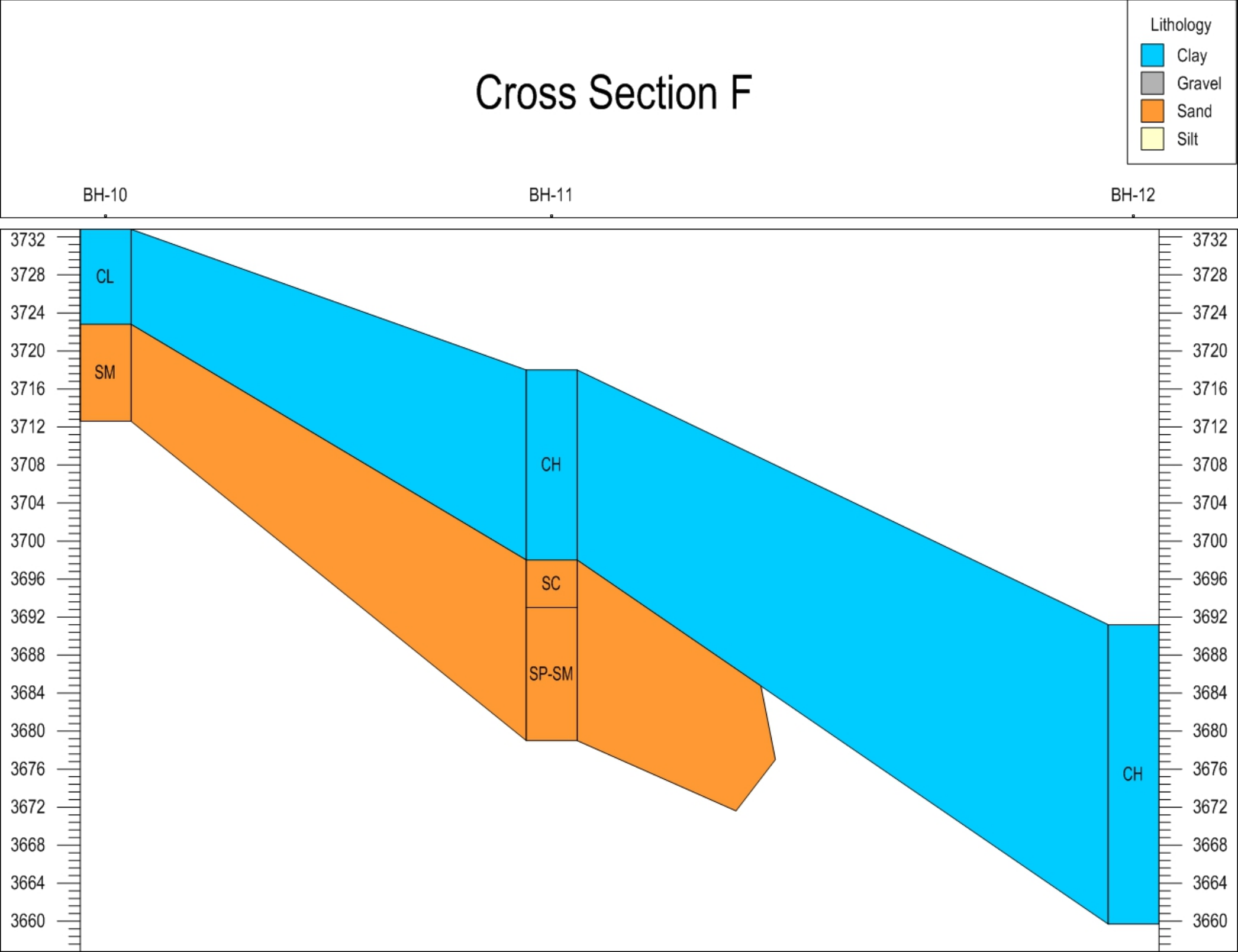
Cross Section D



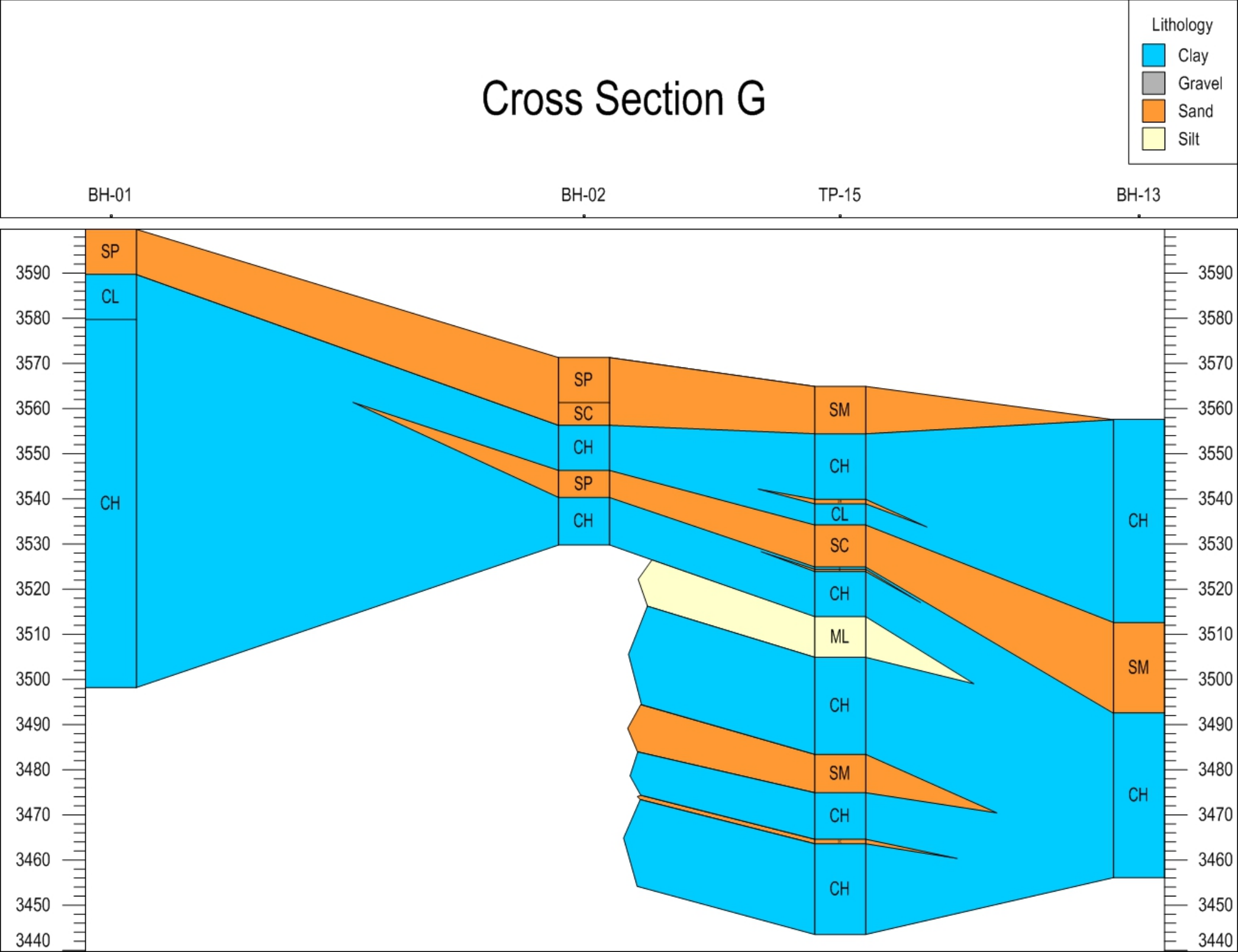
Cross Section E



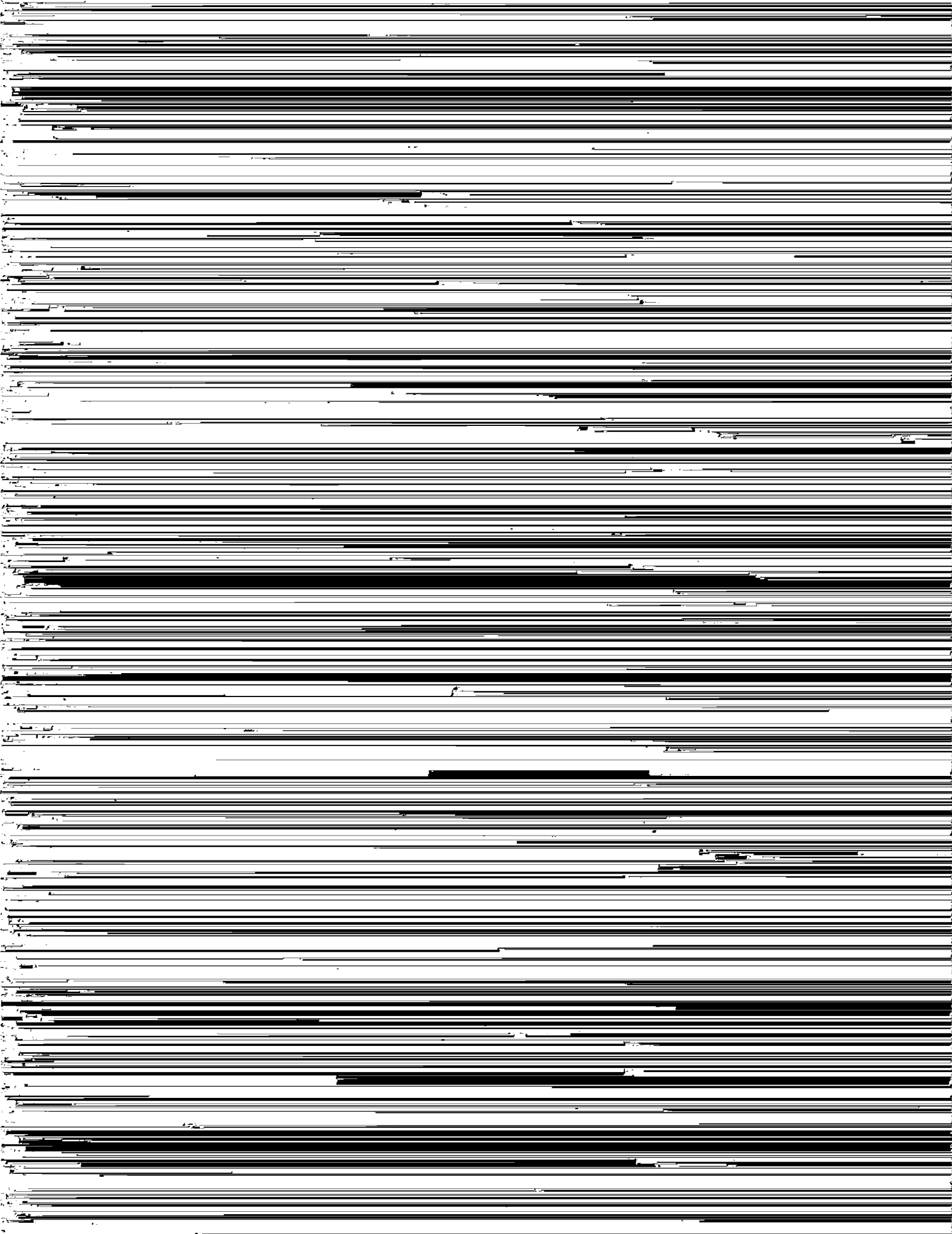
Cross Section F

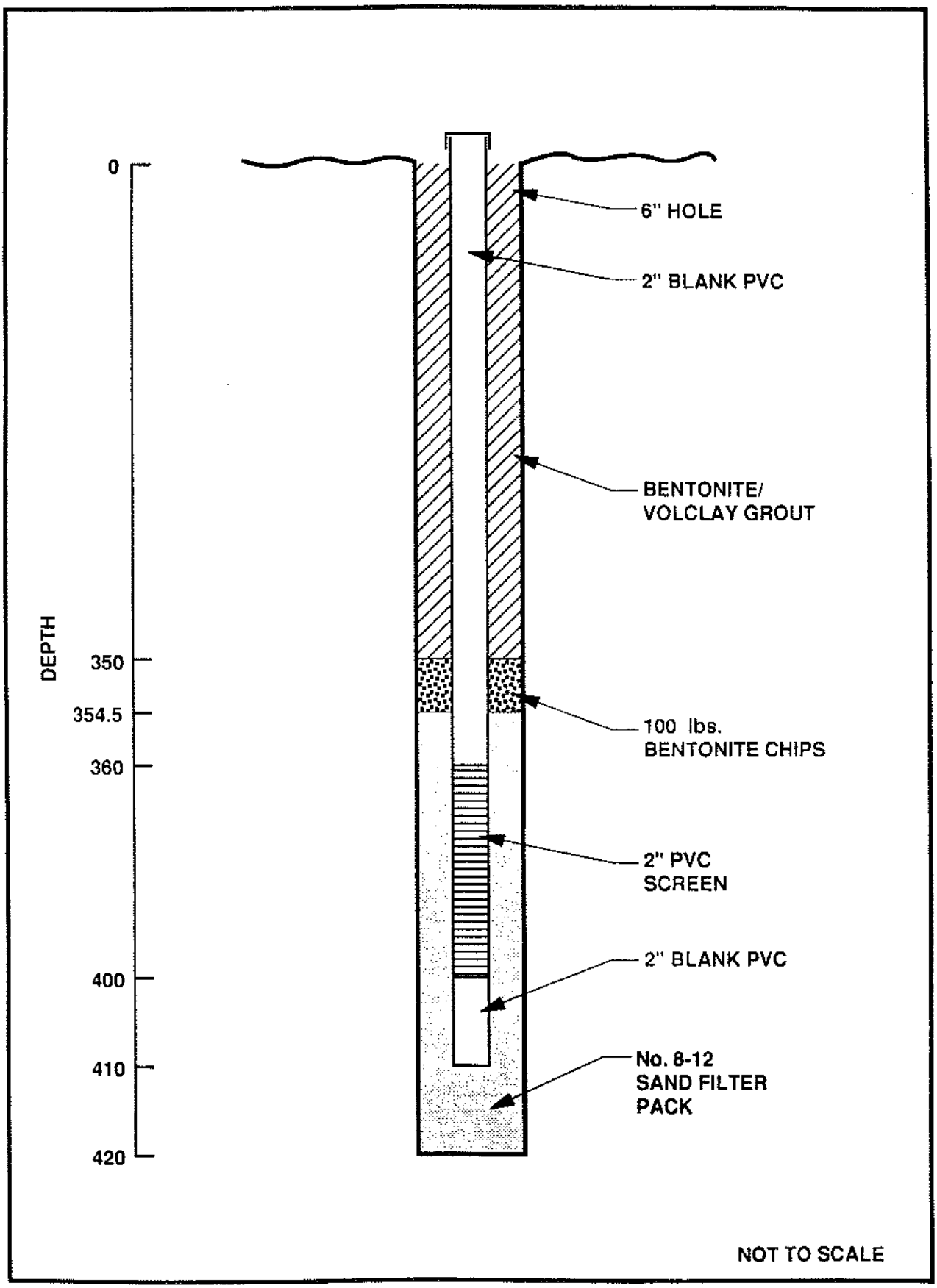


Cross Section G



Appendix F
Well Driller's Reports





ATLAS PRECIOUS METALS, GRASSY MTN. PROJECT

MONITOR WELL GW-3A

SPF 16.2

STATE OF OREGON
MONITORING WELL REPORT

(as required by ORS 537.765 & OAR 690-240-095)

Start Card # 59766

(1) OWNER/PROJECT:

WELL NO. MWS-8

Name Newmont Gold

Address 318 A. Street

City West Vale State OR Zip 97018

(2) TYPE OF WORK:

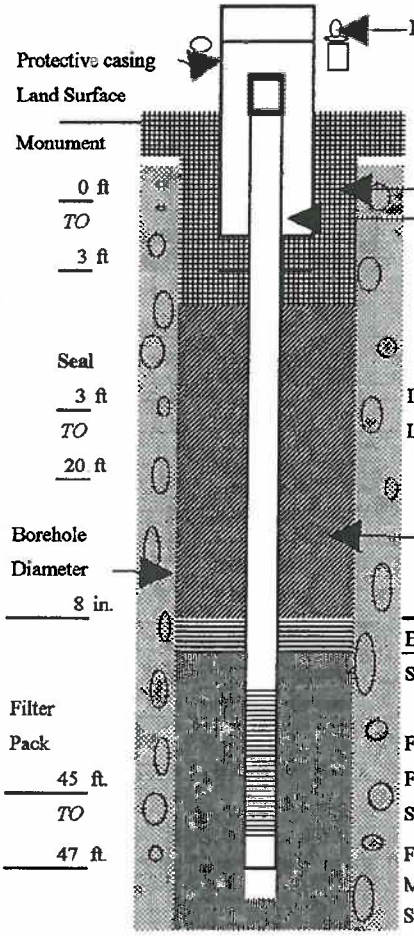
[X] New Construction [ ] Repair [ ] Recondition
[ ] Conversion [ ] Deepening [ ] Abandonment

(3) DRILLING METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable
[ ] Hollow Stem Aug. [ ] Other

(4) BORE HOLE CONSTRUCTION

Special Standards Yes [ ] No [X] Depth completed well 45 ft.



Casing diameter 4 in. material PVC
Welded [ ] Threaded [X] Glued [ ]

Liner Diamter in.
Liner material
Welded [ ] Threaded [ ] Glued [ ]

Well Seal
Material cement-bent
Amount 4 bags
Bentonite plug >2 ft. thick

Screen Material
interval(s):
From: 25 To: 45
From: To:
Slot Size .020 in.

Filter Pack:
Material: Colorado Silica
Size 10-20 in.

(5) WELL TEST:

[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian
Permeability Yield N/A GPM
Conductivity pH
Temperature of water F/C Depth artesian flow found ft.
Was water analysis done? [ ] Yes [X] No
By whom?
Depth of strata to be analyzed. From To ft.
Remarks: bottom hole backfilled w/pellets&sand 47-76.5'
Name of supervising Geologist/Engineer M. Pappolardo

(6) LOCATION OF WELL By legal description

Well Location: County MALHEUR
Township 22S (N/S) Range 44E (W/E) Section 6
1. SE 1/4 of SE 1/4 of above section.
2. Street address of well location GRASSY MOUNTAIN
VALE, OREGON
3. Tax lot number of well location N/A
4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:

Dry to 45.5 Feet below land surface. Date: October 2, 1993
Artesian Pressure lb/sq.in. Date

(8) WATER BEARING ZONES:

Depth at which was first found

From	To	Estimated Flow Rate	SWL

(9) WELL LOG:

Ground elevation

Material	From	To	SWL
Gravely sandy loam, med. gray brown	0	10	
dry.			
Siltstone tan-gray	10	29	
Sandstone-yellow-tan	29	32.5	
Sandstone - orange	32.5	33.5	
Sandstone, yellow-tan	33.5	46.5	
Clayey siltstone, gray and tan with sand	46.5	48	
Sandstone, tan-brown	48	59	
Clayey siltstone w/sand, tan-gray	59	62	
Sandstone, yellow-tan	62	64	
Carbonaceous shale	64	68	
Siltstone, med. gray-brown			
Sandstone, tan-orange	68	71	
Sandstone, light tan	71	76.5	

Date Started 10-1-93 Completed 10-2-93

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oergon well construction standards. Materials used and information reported above are true to the best knowledge and belief. MWC Number 10098
Signed [signature] Date 1/12/94

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction , alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief. MWC Number 10096
Signed [signature] Date 1-12-94

SPF 16-1

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)

Start Card # 59765

(1) OWNER/PROJECT:

WELL NO. MW-6

Name Newmont Gold

Address 318 A Street

City West Vale State OR Zip 97918

(2) TYPE OF WORK:

[X] New construction [ ] Repair [ ] Recondition
[ ] Conversion [ ] Deepening [ ] Abandonment

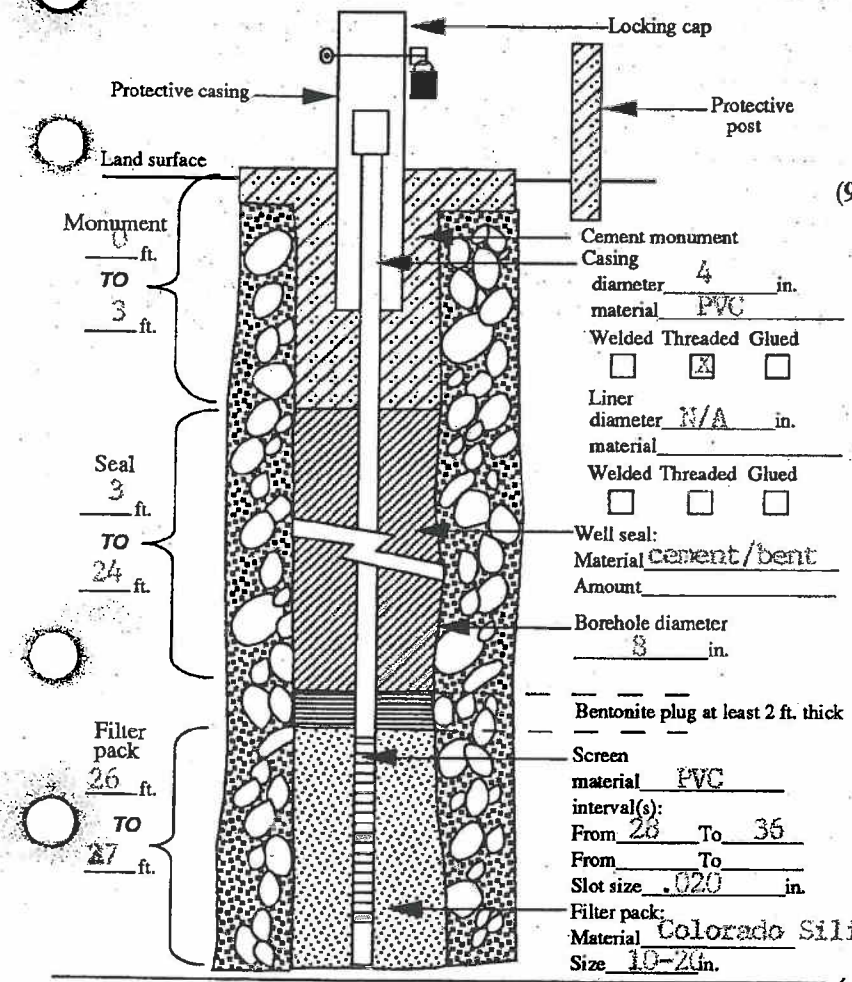
(3) DRILLING METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable
[ ] Hollow Stem Auger [ ] Other

(4) BORE HOLE CONSTRUCTION

Special Standards Yes [ ] No [X]

Depth of completed well 36 ft.



Cement monument

Casing diameter 4 in. material PVC
Welded [X] Threaded [ ] Glued [ ]

Liner diameter N/A in. material
Welded [ ] Threaded [ ] Glued [ ]

Well seal: Material cement/bent Amount

Borehole diameter 8 in.

Bentonite plug at least 2 ft. thick

Screen material PVC interval(s): From 28 To 36 From To Slot size .020 in.

Filter pack: Material Colorado Silica Size 10-20 in.

(5) WELL TEST:

[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian

Permeability — Yield — GPM

Conductivity — PH —

Temperature of water Dry °F/C Depth artesian flow found — ft.

Was water analysis done? [ ] Yes [X] No

By whom? —

Depth of strata to be analyzed. From — ft. to — ft.

Remarks: Wet but no measurable water

Name of supervising Geologist/Engineer Mike Pappalardo

(6) LOCATION OF WELL By legal description

Well Location: County Malheur

Township 22S (N or S) Range 44E (E or W) Section 6

1. SE 1/4 of SE 1/4 of above section.
2. Street address of well location Grassy Mountain, Vale
3. Tax lot number of well location Unknown
4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:

23 Ft. below land surface. Date 10/04/93

Artesian Pressure lb/sq. in. Date

(8) WATER BEARING ZONES:

Depth at which water was first found —

From	To	Est. Flow Rate	SWL

(9) WELL LOG:

Ground elevation —

Material	From	To	SWL
Soil	0	2	
Sandy siltstone medium	2		
tan brown		5	
Silty sandstone medium	5		
brown silt green			
tinge friable		20	
Sandstone silty olive	20		
brown		26.5	
Clayey sandstone med.	26.5		
gray brown		29	
Sandstone medium gray	29		
brown		35	
Siltstone dark gray	35	36	
Clayey siltstone med	36		
dark gray		37	

Date started 10/03/93 Completed 10/04/93

(unbonded) Monitor Well Constructor Certification:

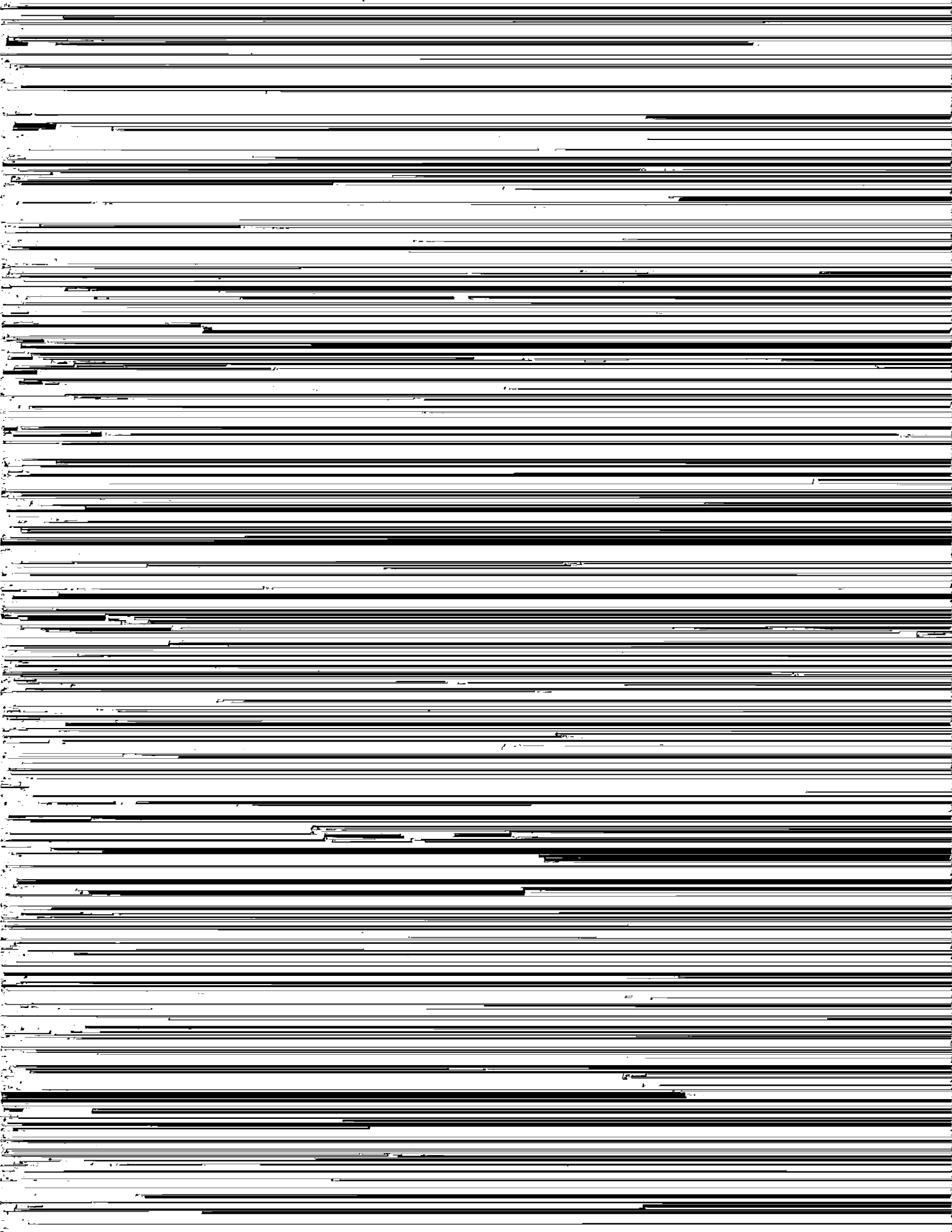
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.

Signed [signature] MWC Number 10718 Date 1/12/94

(bonded) Monitor Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

Signed [signature] MWC Number 10046 Date 1-12-94



STATE OF OREGON
MONITORING WELL REPORT

(as required by ORS 537.765 & OAR 690-240-0395)

WELL I.D. LABEL# L 125168

START CARD # 1035606

(1) LAND OWNER

Owner Well I.D. GMW-17-31

First Name _____ Last Name _____

Company CALICO RESOURCES USA CORP.

Address P O BOX Q

City VALE State OR Zip 97918

(2) TYPE OF WORK

☒ New ☐ Deepening ☐ Conversion ☐ Alteration (repair/recondition) ☐ Abandonment

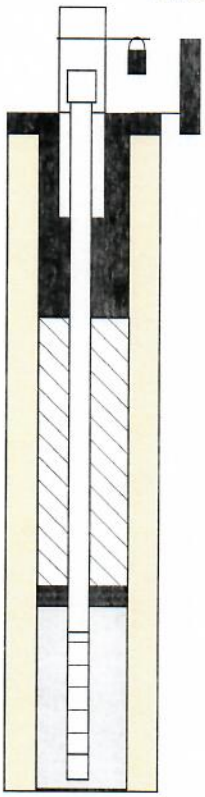
(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Hollow Stem Auger ☐ Cable Mud ☐ Reverse Rotary ☐ Other _____

(4) CONSTRUCTION

Piezometer Well ☐

Depth of Completed Well 498.00 ft. Special Standard ☐



MONUMENT/VAULT Above Ground From _____ To _____

BORE HOLE Diameter 16 From 0 To 98

CASING Dia. 12 From ☒ 3 To 98 Gauge .250 Wld Thrd Material ◉ Steel ○ Plastic ☒ ☐

LINER Dia. _____ From ☐ _____ To _____ Gauge _____ Wld Thrd Material ○ Steel ○ Plastic ☐ ☐

SEAL From 0 To 38 Material Bentonite Chips Amount 36 Sacks Grout weight _____

SCREEN Casing/Liner Casing Material PVC Diameter 5 From 458 To 498 Slot Size 0.020

FILTER From 453 To 455 Material SAND SEAL Size of pack 20/40

(5) WELL TESTS

○ Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature _____ °F Lab analysis ☐ Yes By _____

Supervising Geologist/Engineer SPF Water Engineering

Water quality concerns? ☐ Yes (describe below)

From	To	Description	Amount	Units

(6) LOCATION OF WELL (legal description)

County MALHEUR Twp 22.00 S N/S Range 44.00 E E/W WM

Sec 8 SE 1/4 of the NW 1/4 Tax Lot 100

Tax Map Number _____ Lot _____

Lat ° ' " or 43.67387000 DMS or DD

Long ° ' " or -117.35963000 DMS or DD

○ Street address of well ◉ Nearest address

REFER TO GPS

(7) STATIC WATER LEVEL

	Date	SWL(psi)	+ SWL(ft)
Existing Well / Predeepening			
Completed Well			

Flowing Artesian? ☐ Dry Hole? ☒

WATER BEARING ZONES Depth water was first found _____

SWL Date	From	To	Est Flow	SWL(psi)	+ SWL(ft)

(8) WELL LOG

Ground Elevation 3711.00

Material	From	To
soft brown clay-top soil	0	3
brown decomposed sand & gravel	3	8
soft light brown sandstone	8	17
hard green sandstone	17	22
med. hard green sandstone	22	28
hard green sandstone	28	41
soft orange sandstone	41	47
soft red sandstone	47	55
sticky red clay	55	60
soft red clay some white clay strips	60	82
hard dark red strips of claystone	82	107
soft red & white clay	107	122
soft tan & red clay	122	142
med. hard red claystone	142	147
hard grey sandstone	147	157
med. hard orange, tan & red claystone	157	177
hard red yellow claystone	177	197
soft red clay	197	202
broken black basalt	202	212

Date Started 8/1/2017 Completed 11/30/2017

(unbonded) Monitor Well Constructor Certification

I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon monitoring well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 1896 Date 12/14/2017

Password : (if filing electronically) _____

Signed TONY HACKETT (E-filed)

(bonded) Monitor Well Constructor Certification

I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon monitoring well construction standards. This report is true to the best of my knowledge and belief.

License Number 1899 Date 12/14/2017

Password : (if filing electronically) _____

Signed SAM P KINGREY (E-filed)

Contact Info (optional) _____

ORIGINAL - WATER RESOURCES DEPARTMENT

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

Form Version:

MONITORING WELL REPORT -
continuation page

WELL I.D. LABEL# L 125168

START CARD # 1035606

(4) CONSTRUCTION

BORE HOLE

Dia	From	To
10	98	520

FILTER PACK

From	To	Material	Size
455	499	SILICA SAND	8/12

SEAL

Material	From	To	Amt	sacks/ lbs	grout weight
C5	0	453	200	S	14.1
Cement	38	98	41	S	15.6
Cement	499	520	9	S	15.6

CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
◉	○	5	☒	2	458	sch80	○	◉		☒
○	○						○	○		
○	○						○	○		
○	○						○	○		
○	○						○	○		
○	○						○	○		
○	○						○	○		
○	○						○	○		
○	○						○	○		
○	○						○	○		

SCREENS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn size/ slot width	Slot length	# of slots	Tele/ pipe size

(5) WELL TESTS

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(7) STATIC WATER LEVEL

Water Bearing Zones

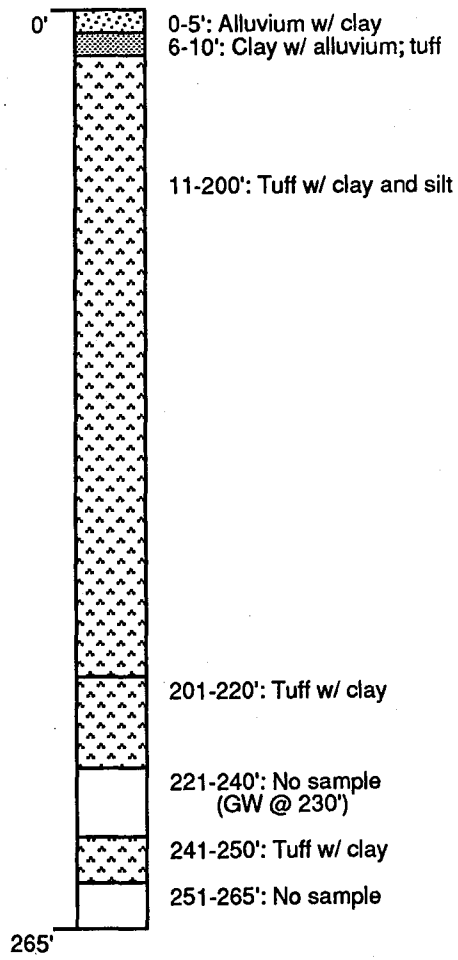
SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(8) WELL LOG

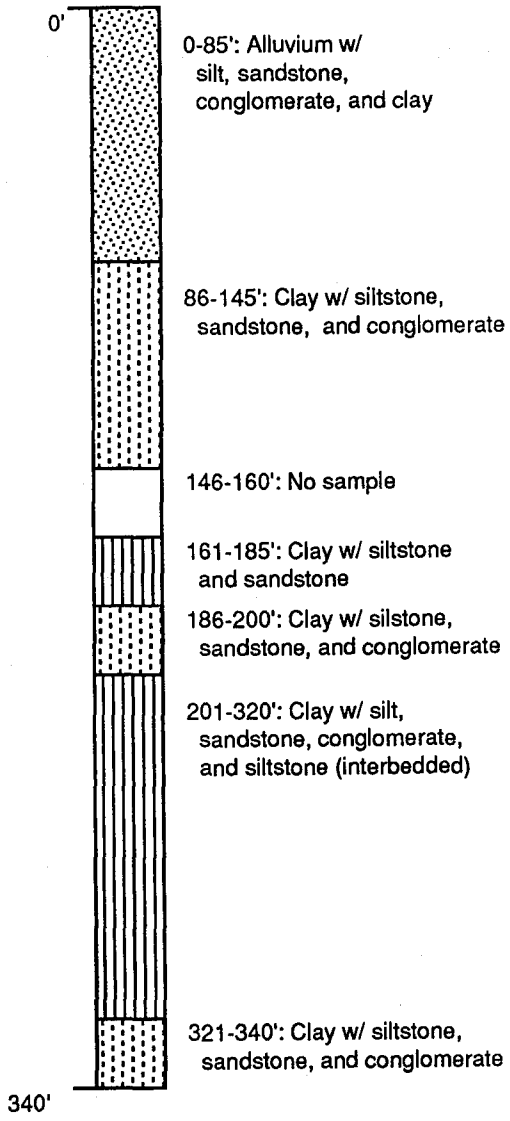
Material	From	To
med. hard multicolored sandstone	212	217
soft yellow orange grey clay	217	242
hard layers sandstone grey	242	258
soft tan clay	258	269
strips of grey clay & grey sandstone	269	309
hard brown glassy rock	309	319
soft tan & grey clay	319	336
hard brown glassy rock	336	337
soft tan clay	337	342
hard fractured brown rock	342	351
hard layers brown sandstone w/clay strip	351	385
hard brown rock	385	397
hard int. lyrs sndstne/clay in 1' strips	397	446
brown clay	446	454
hard brown sandstone	454	456
soft brown clay	456	459
hard layers brown sandstone	459	465
brown clay	465	481
hard sandstone brown	481	498
sticky brown clay	498	520

Comments/Remarks

additional drillers 1)Jake Kingrey _____
2)David Dutcher _____

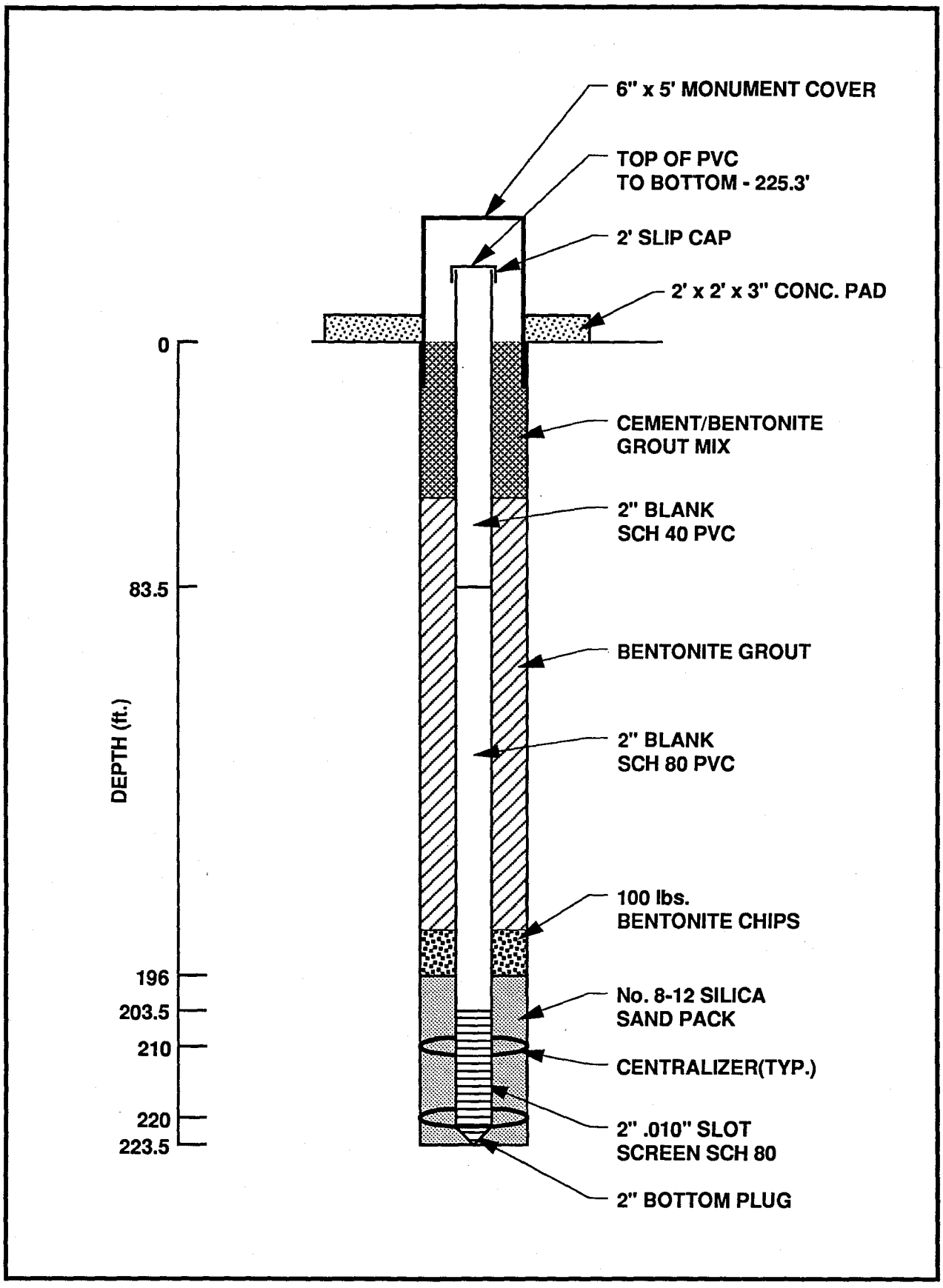


GW-5



GW-6

NOT TO SCALE



ATLAS PRECIOUS METALS, GRASSY MTN. PROJECT

MONITOR WELL GW-5

MACH 2974

RECEIVED JAN 18 1994 WATER RESOURCES DEPT. SALEM, OREGON

22S/44E/8dd

STATE OF OREGON
MONITORING WELL REPORT

(as required by ORS 537.765 & OAR 690-240-095)

Start Card # 59760

(1) OWNER/PROJECT:

WELL NO. TW-1

Name Newmont Gold

Address 318 A. Street

City West Vale State OR Zip 97018

(2) TYPE OF WORK:

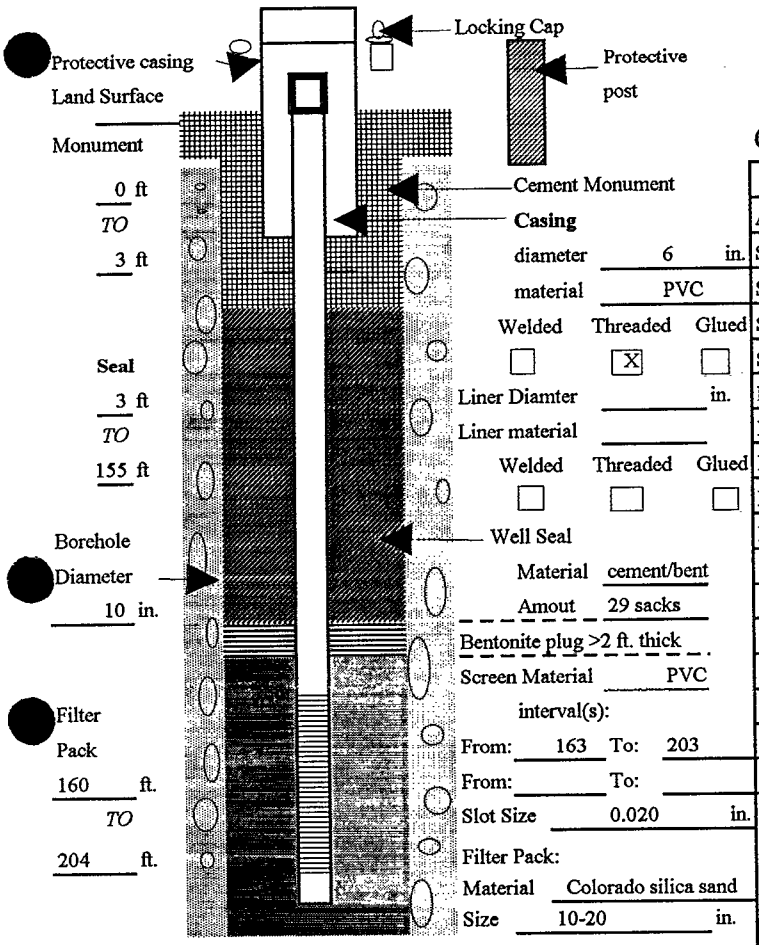
[X] New Construction [ ] Repair [ ] Recondition
[ ] Conversion [ ] Deepening [ ] Abandonment

(3) DRILLING METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable
[ ] Hollow Stem Aug. [ ] Other

(4) BORE HOLE CONSTRUCTION

Special Standards Yes [ ] No [X] Depth completed well 203 ft.



Casing
diameter 6 in.
material PVC
Welded [ ] Threaded [X] Glued [ ]

Liner Diamter ____ in.
Liner material ____
Welded [ ] Threaded [ ] Glued [ ]

Well Seal
Material cement/bent
Amout 29 sacks
Bentonite plug >2 ft. thick

Screen Material PVC
interval(s):
From: 163 To: 203
From: ____ To: ____
Slot Size 0.020 in.

Filter Pack:
Material Colorado silica sand
Size 10-20 in.

(5) WELL TEST:

[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian
Permeability ____ Yield 45 GPM
Conductivity ____ pH ____
Temperature of water 56 F/C Depth artesian flow found ____ ft.
Was water analysis done? [ ] Yes [X] No
By whom? ____
Depth of strata to be analyzed. From ____ To ____ ft.
Remarks: ____
Name of supervising Geologist/Engineer M. Pappalardo

(6) LOCATION OF WELL By legal description

Well Location: County MALHEUR
Township 22S (N/S) Range 44E (W/E) Section 8
1. NW 1/4 of SE 1/4 of above section.
2. Street address of well location GRASSY MOUNTAIN, VALE, OR
3. Tax lot number of well location UNKNOWN
4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:

88 Feet below land surface. Date October 11, 1993
Artesian Pressure ____ lb/sq.in. Date ____

(8) WATER BEARING ZONES:

RECEIVED FEB 4 1994 WATER RESOURCES DEPT. SALEM, OREGON

Depth at which was first found

From	To	Estimated Flow Rate	SWL
160	205	45-50	88

(9) WELL LOG:

Ground elevation

Material	From	To	SWL
Alluvial silt with basalt float	0	11	
Siltstone, brown, with basalt pebbles	11	15	
Siltstone, Brown	15	40	
Siltstone, Brown, with basalt cobbles	40	65	
Siltstone, brown w/ increasing basalt	65	90	
Basalt, Red with 40% brown siltstone	90	109	
Basalt, Red and Black, vesicular, fine grained	109	160	
Basalt, vesicular w/clay in vesicles	160	185	
Basalt w/increased oxidation	185	200	
Basalt w/20% clays	200	205	

Date Started October 4, 1993 Completed October 11, 1993

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oergon well construction standards. Materials used and information reported above are true to the best knowledge and belief. MWC Number 10098
Signed [signature] Date 1/12/94

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction , alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief. MWC Number 10096
Signed [signature] Date 1-12-94

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-0050)

JAN 26 1994
WATER RESOURCES DEPT.
SALEM, OREGON

Malh 993

22S/44E/8aa

Start Card # 59761

9

(1) OWNER/PROJECT:

WELL NO. MW-2

Name Newmont Gold
Address 318 A Street
City West Vale State OR Zip 97918

(2) TYPE OF WORK:

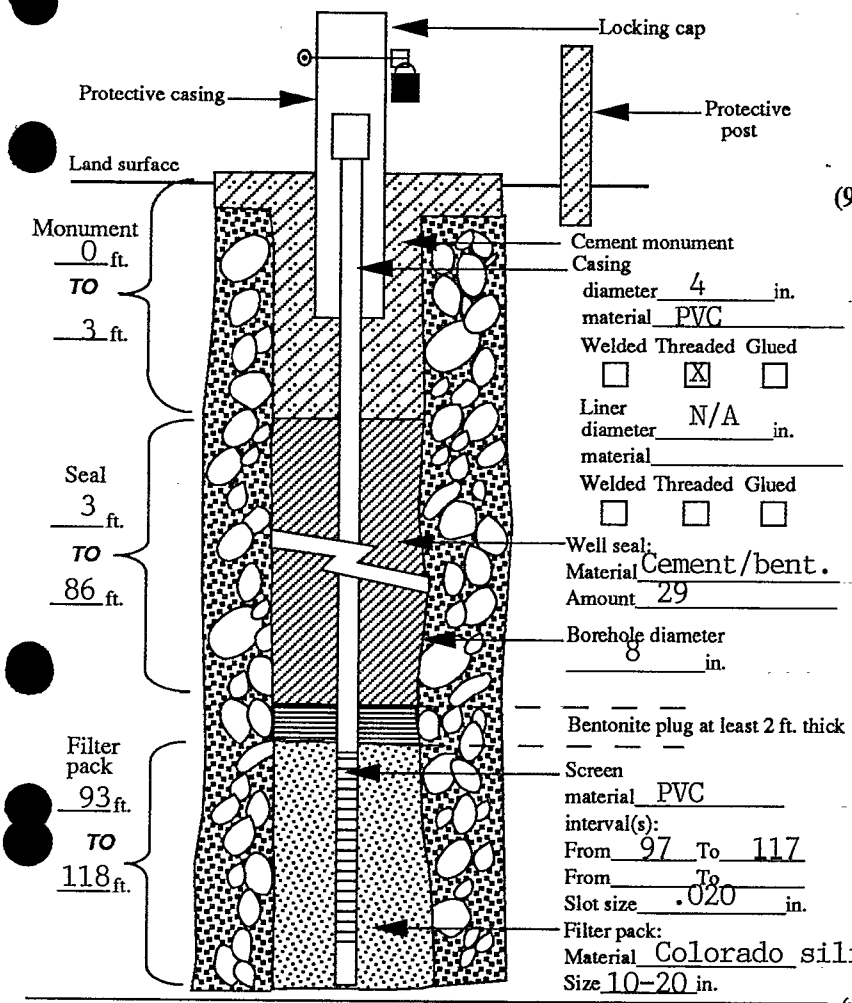
[X] New construction [ ] Repair [ ] Recondition
[ ] Conversion [ ] Deepening [ ] Abandonment

(3) DRILLING METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable
[ ] Hollow Stem Auger [ ] Other

(4) BORE HOLE CONSTRUCTION

Special Standards Yes [ ] No [X] Depth of completed well 118 ft.



Cement monument
Casing diameter 4 in. material PVC
Welded [X] Threaded [ ] Glued [ ]
Liner diameter N/A in. material
Welded [ ] Threaded [ ] Glued [ ]
Well seal: Material Cement/bent. Amount 29
Borehole diameter 8 in.
Bentonite plug at least 2 ft. thick
Screen material PVC
interval(s): From 97 To 117
From To
Slot size .020 in.
Filter pack: Material Colorado silica Size 10-20 in.

(5) WELL TEST:

[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian
Permeability — Yield — GPM
Conductivity — PH —
Temperature of water 56 °F/C Depth artesian flow found — ft.
Was water analysis done? [ ] Yes [ ] No
By whom? —
Depth of strata to be analyzed. From — ft. to — ft.
Remarks: —

Name of supervising Geologist/Engineer Mike Pappalardo

(6) LOCATION OF WELL By legal description

Well Location: County Malheur
Township 22 (N or S) Range 44E (E or W) Section 8
1. NE 1/4 of NE 1/4 of above section.
2. Street address of well location Grassy Mountain, Vale
3. Tax lot number of well location Unknown
4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:

88 Ft. below land surface. Date 10/04/93
Artesian Pressure — lb/sq. in. Date —

(8) WATER BEARING ZONES:

Depth at which water was first found 100

From	To	Est. Flow Rate	SWL
100	120	60	88

(9) WELL LOG:

Ground elevation —

Material	From	To	SWL
Aluvian silt & cobbles	0	13	
Clayey siltstone brn	13	15	
Siltstone brown	15	36	
Clayey siltstone brn	36	65	
Siltstone with basalt	65	70	
Basalt with some	70		
siltstone		72.5	
Basalt	72.5	80	
Basalt with some	80		
calcite filling			
vesicles		92	
Basalt with fractures	92	105	
Basalt with clay seams	105	120	

Date started 10/02/93 Completed 10/04/93

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.

Signed [signature] MWC Number 1098 Date 1/12/94

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

Signed [signature] MWC Number 1096 Date 1/12/94

#19

MAIH RECEIVED 2984 JAN 18 1994 WATER RESOURCES DEPT. SALEM, OREGON

22S/44E/8dd

STATE OF OREGON
MONITORING WELL REPORT

(as required by ORS 537.765 & OAR 690-240-085) Start Card # 59772

(1) OWNER/PROJECT:

WELL NO. MWS-13

Name Newmont Gold

Address 318 A. Street

City West Vale State OR Zip 97018

(2) TYPE OF WORK:

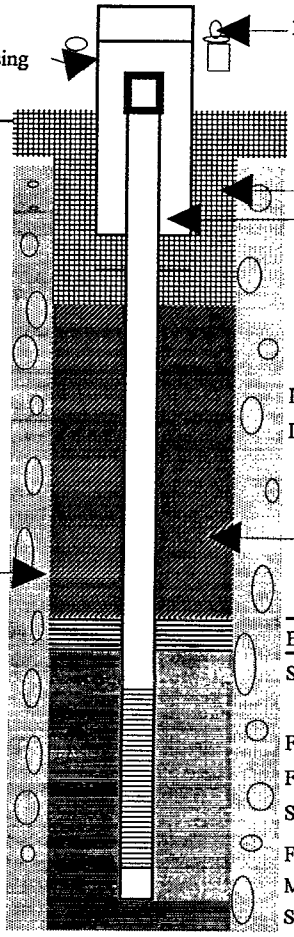
[X] New Construction [ ] Repair [ ] Recondition
[ ] Conversion [ ] Deepening [ ] Abandonment

(3) DRILLING METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable
[ ] Hollow Stem Aug. [ ] Other

(4) BORE HOLE CONSTRUCTION

Special Standards Yes [ ] No [X] Depth completed well 207 ft.



Casing
diameter 4 in.
material PVC
Welded [ ] Threaded [X] Glued [ ]

Liner Diamter in.
Liner material
Welded [ ] Threaded [ ] Glued [ ]

Well Seal
Material Cement-bent
Amount 35
Bentonite plug >2 ft. thick

Screen Material PVC
interval(s):
From: 146 To: 206
From: To:
Slot Size .020 in.

Filter Pack:
Material: Colorado Silica
Size 10-20 in.

(5) WELL TEST:

[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian
Permeability Yield GPM
Conductivity pH
Temperature of water 51e F/C Depth artesian flow found ft.
Was water analysis done? [ ] Yes [X] No
By whom?
Depth of strata to be analyzed. From To ft.
Remarks:
Name of supervising Geologist/Engineer M. Pappolardo

(6) LOCATION OF WELL By legal description

Well Location: County MALHEUR
Township 22S (N/S) Range 44E (W/E) Section 8
1. SE 1/4 of SE 1/4 of above section.
2. Street address of well location GRASSY MOUNTAIN
VALE, OREGON
3. Tax lot number of well location N/A

RECEIVED

4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:

FEB 4 1994

95 Feet below land surface. Date OCTOBER 19, 1993

Artesian Pressure lb/sq.in. Date

WATER RESOURCES DEPT. SALEM, OREGON

(8) WATER BEARING ZONES:

Depth at which was first found

From	To	Estimated Flow Rate	SWL
125	207	35	95'

(9) WELL LOG:

Ground elevation

Material	From	To	SWL
Brown silt and clayey silt	0	9	
with cobbles			
Brown siltstone with basalt	9	27	
pebbles			
Brown siltstone with some	27	137	
some claystone			
Basalt weathered and	137	156	
fractured			
Basalt, very weathered	156	165	
Basalt	165	207	

Date Started 10-18-93 Completed 10-19-93

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oergon well construction standards. Materials used and information reported above are true to the best knowledge and belief. MWC Number 10098
Signed [signature] Date 1/12/94

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction , alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief. MWC Number 10096
Signed [signature] Date 1-12-94

JAN 0 2 1990

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

WATER RESOURCES DEPT
SALEM, OREGON

Malh 2276

22s/44E/8ad

(START CARD) # W-14816

(1) OWNER:
Well Number:
Name Atlas Precious Metals Inc
Address 318 A St.
City Vale State OR Zip 97818

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☑ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 420 ft.
Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
14 3/4	0	28	PT CEMENT	0	28	19
			VOLCLAY	300	SURFACE	40 Sacks
			BENT PELLETS	295	300	3 BUCKETS

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other TREMIE
Backfill placed from ft. to ft. Material
Gravel placed from 555 ft. to 295 ft. Size of gravel .030

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+2	320	.250	☑	☐	☑	☐
	6"	340	400	"	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☑ Screens Type WIRE WOUND Material LOW CARBON

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
320	340	.030			6"	☐	☑
400	420	.030			6"	☐	☑
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
35		294	1 hr.

Temperature of water 64° F Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Malheur Latitude ' " Longitude ' "
Township 22S N or S, Range 44E E or W, WM.
Section 8 SE ¼ NE ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address)

(10) STATIC WATER LEVEL:
52 ft. below land surface. Date 12-6-89
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Estimated Flow Rate	SWL
320	340	20	
400	420	20	
		40	

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
SOIL	0	2	
CLAY	2	10	
BASALT	10	28	
BROWN CLAY	28	55	
SILTSTONE	55	130	
CLAY & GRAVEL	130	173	
CLAY & SAND	173	190	
BASALT	190	315	
BROWN CLAY	315	323	
BROWN CLAY & SAND	323	360	
BROWN SANDSTONE	360	395	
BLACK & RED SAND	395	408	
SANDSTONE COARSE	408	441	
CLAY & GRAVEL	441	447	
CLAY & SAND	447	555	

Date started 11/27/89 Completed 12-1-89

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 544
Signed Larry Burd Date 12/1/89

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 3/88

STATE OF OREGON

WATER WELL REPORT

(as required by ORS 537.765)

RECEIVED

FEB 16 1989

22S/4E/17cc

(START CARD) # 9258

(1) OWNER:

Well Number: 47-1 NAT

Name: Atlas Precious Metals

Address: 2025 Century Way

City: Boise, State: Id Zip: 83709

(2) TYPE OF WORK:

☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable

☐ Other

(4) PROPOSED USE:

☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☒ Other Monitoring

(5) BORE HOLE CONSTRUCTION:

Special Construction approval ☒ Yes ☐ No Depth of Completed Well 155.5 ft.

Explosives used ☐ Yes ☒ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12 1/4	160	122	Colo. Sand	160	122	9 sacks
12 1/4	122	115	Enviro Plug	122	115	2 sacks
12 1/4	115	+1	cement grout	115	+1	432 sacks

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E

☐ Other

Backfill placed from ____ ft. to ____ ft. Material see above

Gravel placed from ____ ft. to ____ ft. Size of gravel 8-12 sand

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	12"	+2	8	250	☒	☐	☐	☐
					☐	☐	☐	☐
	4	+2	155.5	sch80	☐	☒	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) no shoe screw on plug

(7) PERFORATIONS/SCREENS:

☐ Perforations Method ____

☒ Screens Type Aardvark Material PVC

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
135.5	155.5	.020		4"		☒	☐
135.5	+2			4" PVC		☒	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
	NA		1 hr.
60		160	

Temperature of water NA Depth Artesian Flow Found 140

Was a water analysis done? ☐ Yes By whom ____

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____

Depth of strata: ____

(9) LOCATION OF WELL by legal description:

SALEM, Malheur

County ____ Latitude ____ Longitude ____

Township 22S N or S, Range 44E E or W, WM.

Section 17 NW ¼ NW ¼

Tax Lot ____ Lot ____ Block ____ Subdivision ____

Street Address of Well (or nearest address) NA

(10) STATIC WATER LEVEL:

49 ft. below land surface. Date 1/21/89

Artesian pressure na lb. per square inch. Date ____

(11) WATER BEARING ZONES:

Depth at which water was first found 140- 160

From	To	Estimated Flow Rate	SWL
140	160	60	49

(12) WELL LOG:

Ground elevation 3698

Material	From	To	SWL
Brown Clay	0	35	0
Brown clay w/gravely sand	35	56	0
Blue Clay	56	122	0
Blue Clay & Gravel	122	140	?
Gravel	140	160	49

Date started 12/14/89 Completed 1/18/89

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number 1202

Signed Robert W. Doty Date 2-13-89

(bonded) Water Well Constructor Certification:

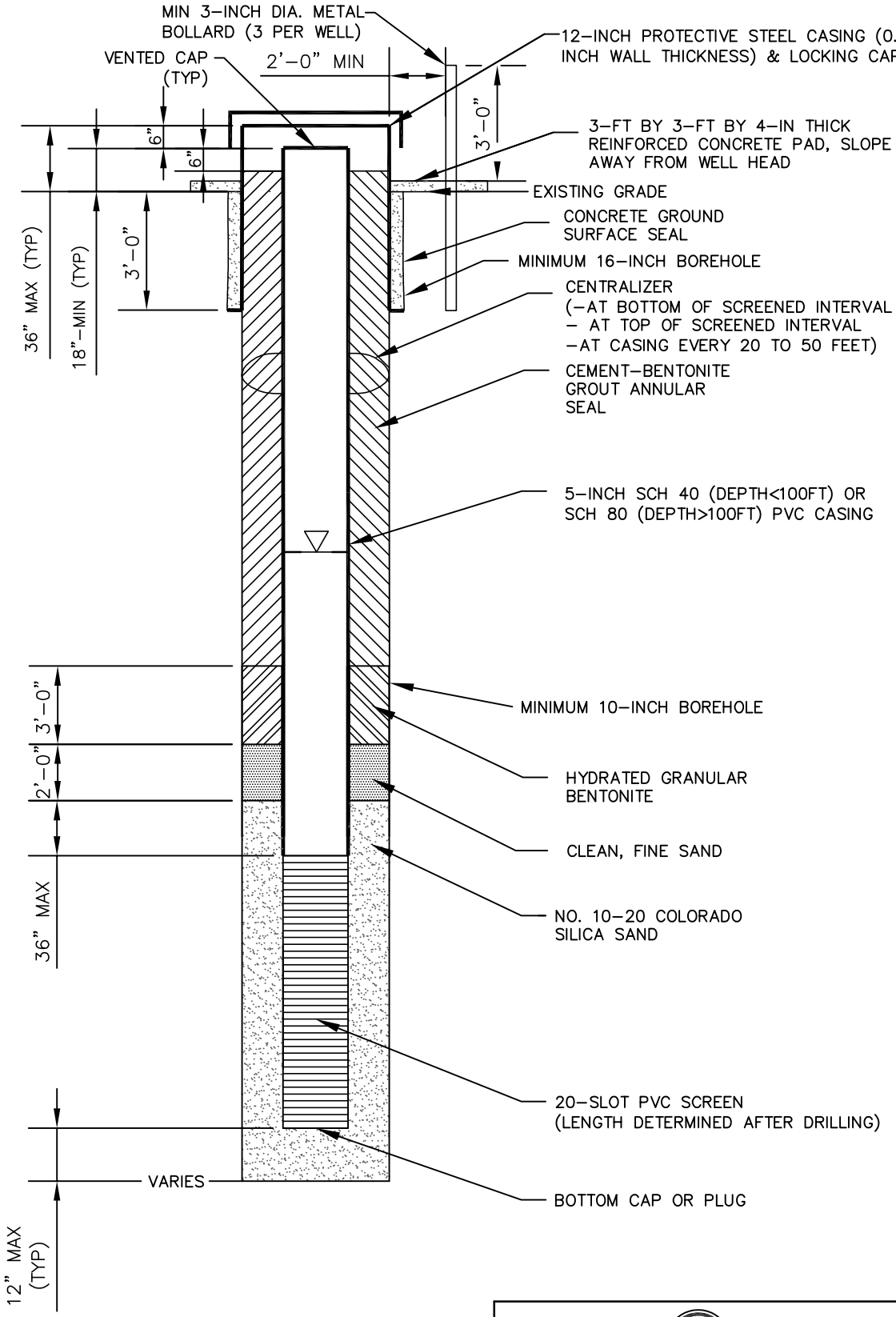
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 325

Signed Robert W. Doty for William E. Doty Date 2-15-89

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 3/88

Appendix G
Conceptual Monitoring Well Diagram



SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MONITORING WELL CONCEPTUAL DESIGN

SCALE: NTS
DRAWN BY: EAM
PROJ.# 1294.0050

Appendix R: Malheur County Land Use Compatibility Statement (LUCS)

Oregon Department of Environmental Quality

Land Use Compatibility Statement

State of Oregon Department of Environmental Quality

What is a land use compatibility statement?

A LUCS is a form developed by DEQ to determine whether a DEQ permit or approval will be consistent with local government comprehensive plans and land use regulations.

Why is a LUCS required?

DEQ and other state agencies with permitting or approval activities that affect land use are required by Oregon law to be consistent with local comprehensive plans and have a process for determining consistency. DEQ activities affecting land use and the requirement for a LUCS may be found in Oregon Administrative Rules (OAR) Chapter 340, Division 18.

When is a LUCS required?

A LUCS is required for nearly all DEQ permits and certain approvals of plans or related activities that affect land use prior to issuance of a DEQ permit or approval. These permits and activities are listed in section 1.D on p. 2 of this form. A single LUCS can be used if more than one DEQ permit or approval is being applied for concurrently.

Permit modifications or renewals also require a LUCS when any of the following applies:

1. Physical expansion on the property or proposed use of additional land;
2. Alterations, expansions, improvements or changes in method or type of disposal at a solid waste disposal site as described in OAR 340-093-0070(4)(b);
3. A significant increase in discharges to water;
4. A relocation of an outfall outside of the source property; or
5. Any physical change or change of operation of an air pollutant source that results in a net significant emission rate increase as defined in OAR 340-200-0020.

How to complete a LUCS:

Step	Who Does It?	What Happens?
1	Applicant	Applicant completes Section 1 of the LUCS and submits it to the appropriate city or county planning office.
2	City or County Planning Office	City or county planning office completes Section 2 of the LUCS to indicate whether the activity or use is compatible with the acknowledged comprehensive plan and land use regulations, attaches written findings supporting the decision of compatibility, and returns the signed and dated LUCS to the applicant.
3	Applicant	Applicant submits the completed LUCS and any supporting information provided by the city or county to DEQ along with the DEQ permit application or approval request.

Where to get help:

For questions about the LUCS process, contact the DEQ staff responsible for processing the permit or approval. DEQ staff may be reached at 1-800-452-4011 (toll-free, inside Oregon) or 503-229-5630. For general questions, please contact DEQ land use staff listed on our Land Use Compatibility Statement page online.

***CULTURAL RESOURCES PROTECTION LAWS**: Applicants involved in ground-disturbing activities should be aware of federal and state cultural resources protection laws. ORS 358.920 prohibits the excavation, injury, destruction, or alteration of an archeological site or object or removal of archeological objects from public and private lands without an archeological permit issued by the State Historic Preservation Office. 16 USC 470, Section 106, National Historic Preservation Act of 1966 requires a federal agency, prior to any undertaking, to take into account the effect of the undertaking that is included on or eligible for inclusion in the National Register. For further information, contact the State Historic Preservation Office at 503-378-4168, ext. 232.*

Land Use Compatibility Statement

SECTION 1 - TO BE COMPLETED BY APPLICANT

1A. Applicant Name: Nancy Wolverson	**1B. Project Name:** Grassy Mountain Gold Mine
Contact Name: Garrett Stephenson	**Physical Address:** N/A
Mailing Address: 1211 SW Fifth Avenue, Suite 1900	**City, State, Zip:** Vale, OR 97918
City, State, Zip: Portland, OR 97304	**Tax Lot #:** 101
Telephone: (503) 796-2893	**Township:** 22S **Range:** 44E **Section:**
Tax Account #:	**Latitude:**
	Longitude:

1C. Describe the project, include the type of development, business, or facility and services or products provided (attach additional information if necessary):

Gold and silver mine on an approximately 62-acre parcel. Parcel is under Malheur County jurisdiction and is surrounded by federal land.

1D. Check the type of DEQ permit(s) or approval(s) being applied for at this time.

- ☐ Air Quality Notice of Construction
- ☐ Air Contaminant Discharge Permit *(excludes portable facility permits)*
- ☐ Air Quality Title V Permit
- ☐ Air Quality Indirect Source Permit
- ☐ Parking/Traffic Circulation Plan
- ☐ Solid Waste Land Disposal Site Permit
- ☐ Solid Waste Treatment Facility Permit
- ☐ Solid Waste Composting Facility Permit (includes Anaerobic Digester)
- ☐ Conversion Technology Facility Permit
- ☐ Solid Waste Letter Authorization Permit
- ☐ Solid Waste Material Recovery Facility Permit
- ☐ Solid Waste Energy Recovery Facility Permit
- ☐ Solid Waste Transfer Station Permit
- ☐ Waste Tire Storage Site Permit
- ☐ Pollution Control Bond Request
- ☐ Hazardous Waste Treatment, Storage, or Disposal Permit
- ☐ Clean Water State Revolving Fund Loan Request
- ☐ Wastewater/Sewer Construction Plan/Specifications *(includes review of plan changes that require use of new land)*
- ☐ Water Quality NPDES Individual Permit
- ☐ Water Quality WPCF Individual Permit *(for onsite construction-installation permits use the DEQ Onsite LUCS form)*
- ☐ Water Quality NPDES Stormwater General Permit *(1200-A, 1200-C, 1200-CA, 1200-COLS, and 1200-Z)*
- ☐ Water Quality General Permit *(all general permits, except 600, 700-PM, 1700-A, and 1700-B when they are mobile.)*
- ☐ Water Quality 401 Certification for federal permit or license

1E. This application is for: ☐ Permit Renewal ☐ New Permit ☐ Permit Modification ☐ Other:

SECTION 2 - TO BE COMPLETED BY CITY OR COUNTY PLANNING OFFICIAL

Instructions: Written findings of fact for all local decisions are required; written findings from previous actions are acceptable. For uses allowed outright by the acknowledged comprehensive plan, DEQ will accept written findings in the form of a reference to the specific plan policies, criteria, or standards that were relied upon in rendering the decision with an indication of why the decision is justified based on the plan policies, criteria, or standards.

2A. The project proposal is located: ☐ Inside city limits ☐ Inside UGB ☒ Outside UGB

2B. Name of the city or county that has land use jurisdiction (the legal entity responsible for land use decisions for the subject property or land use): Malheur County

SECTION 2 - TO BE COMPLETED BY CITY OR COUNTY PLANNING OFFICIAL	
Applicant Name: Nancy Wolverson	**Project Name:** Grassy Mountain Gold Mine

2C. Is the activity allowed under Measure 49 (2007)? ☒ No, Measure 49 is not applicable ☐ Yes; if yes, then check one:

- ☐ Express; approved by DLCD order #:
- ☐ Conditional; approved by DLCD order #:
- ☐ Vested; approved by local government decision or court judgment docket or order #:

2D. Is the activity a composting facility?
☒ No ☐ Yes; Senate Bill 462 (2013) notification requirements have been met.

2E. Is the activity or use compatible with your acknowledged comprehensive plan as required by OAR 660-031?
Please complete this form to address the activity or use for which the applicant is seeking approval (see 1.C on the previous page). If the activity or use is to occur in multiple phases, please ensure that your approval addresses the phases described in 1.C. For example, if the applicant's project is described in 1.C as a subdivision and the LUCS indicates that only clearing and grading are allowed outright but does not indicate whether the subdivision is approved, DEQ will delay permit issuance until approval for the subdivision is obtained from the local planning official.

- ☐ The activity or use is specifically exempt by the acknowledged comprehensive plan; explain:
- ☐ **Yes**, the activity or use is pre-existing nonconforming use allowed outright by *(provide reference for local ordinance)*:
- ☐ **Yes**, the activity or use is allowed outright by *(provide reference for local ordinance)*:
- ☐ **Yes**, the activity or use received preliminary approval that includes requirements to fully comply with local requirements; findings are attached.
- ☒ **Yes**, the activity or use is allowed; findings are attached.
- ☐ **No**, see 2.C above, activity or use allowed under Measure 49; findings are attached.
- ☐ **No**, *(complete below or attach findings for noncompliance and identify requirements the applicant must comply with before compatibility can be determined)*:
  Relevant specific plan policies, criteria, or standards:
  Provide the reasons for the decision:

Additional comments (attach additional information as needed):

Planning Official Signature: [signature] **Title:** Planning Director

Print Name: Eric Evans **Telephone #:** 541-473-5185 **Date:** 7/30/19

If necessary, depending upon city/county agreement on jurisdiction outside city limits but within UGB:

Planning Official Signature: **Title:**

Print Name: **Telephone #:** **Date:**

BEFORE THE PLANNING COMMISSION

FOR MALHEUR COUNTY, OREGON

In the Matter of Applications for Conditional Use Permit pursuant to the Malheur County Code ("MCC") and Sage Grouse Rule Permit pursuant to OAR 660-023-0115, to establish an underground gold mine on property identified as tax lot 101 of Malheur County Assessor's Map 22S 44E.	**FINAL FINDINGS OF FACT AND CONCLUSIONS OF LAW**

I. INTRODUCTION

Calico Resources USA Corp. ("Calico") proposes an underground gold and silver mine on private land zoned for Exclusive Range Use ("ERU"), and is known as the "Grassy Mountain Gold Project" (the "Project"). Conditional Use Permit ("CUP") and Sage Grouse Permit ("SGP") applications (together, the "Applications") were submitted on January 14, 2019. The project is proposed on an approximately 62-acre parcel (the "Patent Parcel") located roughly 22 miles south of Vale, which is surrounded by federal land administered by the Bureau of Land Management ("BLM"). The Patent Parcel is identified as tax lot 101 of Malheur County Assessor's Map 22S 44E. The Patent Parcel is coterminous with Calico's patented mining claims and is the subject of the Application. The Patent Parcel is accessed via Russel Road, Cow Hollow Road, and Twin Springs Road.

The Project is described in the Application as follows:

> "The Project will involve several elements: the mine site itself and its entry portal, which are located on the Patent Parcel; a processing facility; a tailings storage facility; a waste rock storage facility; borrow pits for production of backfill rock; and various support and administrative buildings. The entire Project Area will be fenced. Of these facilities, only the mine portal and related elements will be located on the Patent Parcel surface (the mine itself will be located beneath the Patent Parcel).
>
> [***]

> "[D]evelopment on the Patent Parcel will primarily involve construction of a mine portal near the northwest corner, improved gravel surface roadways that will allow access to the mine portal/decline, ventilation shafts, and laydown/storage areas." App. at 2-3.

The Applicant submitted a site plan showing the Project and proposed facilities on the Patent Parcel. App. Ex. 2.

The Planning Commission (the "Commission") held a duly-noticed public hearing on March 28, 2019, which was continued to April 25, 2019. At the conclusion of the hearing, the Commission voted unanimously to approve the Applications.

II. PROCEDURAL HISTORY

The Applications were submitted on January 14, 2019 and deemed complete on February 13, 2019. Public Notice of the March 28 hearing was sent to the BLM, project opponents, and state and local agencies on March 4, 2019. Public notice of the March 28 hearing and its April 25 continuation were also posted on the County's website, and published in the Ontario Argus Observer on April 5th. All application materials were made available in hard copy at the Planning Department offices and published on the County's website.

A letter clarifying the positions of the Oregon Department of Fish and Wildlife and Department of Land Conservation and Development (together, the "State Agencies") was received on March 25, 2019. On March 27, a 21-page letter and 563 pages of exhibits were submitted by the Oregon Natural Desert Association and 1000 Friends of Oregon (together, the "Opponents"). Opponents requested that the Commission deny the Applications, or, in the alternative, continue the hearing and/or hold the record open for fourteen days.

On March 28, the Planning Commission declared a quorum, opened the public hearing on the Applications, and read the disclosures required by ORS 197.763. No commissioner declared any ex parte contacts, biases, or conflicts of interest. No person challenged the qualifications of any commissioner to consider the Applications. Three individuals offered oral testimony in favor of the Application and one person testified in opposition. At the conclusion of the Applicant's rebuttal testimony, the Applicant requested that the hearing be continued to the next scheduled Planning Commission. The Commission closed public testimony, deliberated on the continuance request, and announced that the hearing would be continued to April 25, 2019.

On April 22, the Applicant submitted a 26-page letter and approximately 300 pages of exhibits in response to Opponent's submittal. On April 23, the Applicant submitted bios and curricula vitae for its consultants. The same day, the County Road Master submitted a letter revising his recommendations for county road improvement. The Snake River Economic Development Alliance submitted a letter in support of the Application on April 24. The Commission received no other written testimony on the Applications.

At the continued hearing on April 25, 2019, the required declarations were re-read and the Commission re-affirmed its qualifications to consider the Applications. No person challenged a commissioner's qualifications to consider the Applications. The Commission accepted oral testimony from the Applicant and one individual who testified in favor of the Application. The Commission then closed the public hearing and asked further questions of staff. The Commission then deliberated on the Applications and unanimously voted to adopt staff's recommendation for approval, with conditions recommended by Staff.

III. DECISION

A. The requested Conditional Use Permit is APPROVED, subject to the following conditions:

1. *The Applicant will subscribe to the Vale Rangeland Fire Protection Association.*

2. *The Applicant shall collaborate with the Malheur County Sheriff's Office in regards to a security plan as well as law enforcement and emergency response plans.*

3. *Any road improvements necessary to serve the Project must be constructed according to County design standards to the satisfaction of the County Road Master.*

4. *The Applicant shall obtain approval for its reclamation plan from Oregon Department of Geology and Mineral Industries (DOGAMI) prior to beginning mining operations. Unless otherwise prohibited by DOGAMI, the Applicant may conduct pre-construction and construction activities prior to obtaining approval of its reclamation plan.*

B. The Commission hereby recommends that the County Court APPROVE the Sage Grouse Permit, subject to the following condition:

1. *The applicant shall comply with OAR Chapter 660, Division 023 and OAR Chapter 635, Division 140. The applicant must coordinate with ODFW and apply the mitigation hierarchy of avoidance, minimization and compensatory mitigation to address direct and indirect impacts of the development to low-density habitat for sage grouse. A compensatory mitigation plan shall be developed by the applicant and approved by the ODFW through DOGAMI's consolidated permit process (OAR Chapter 632, Division 37) and other applicable rules, including OAR Chapter 635, Division 420 and OAR Chapter 635, Division 415, prior to any construction or ground disturbing activities.*

IV. FINDINGS OF FACT AND CONCLUSIONS OF LAW

A. Compliance with Applicable Criteria

The Commission hereby adopts and incorporates as part of its findings the Staff Report (**Exhibit 1**) and Application Narrative (**Exhibit 2**), and finds that these sufficiently explain how the Applications satisfy all applicable criteria. The Commission also hereby adopts and incorporates the Applicant's April 22 letter in response to Opponent's March 27 letter and oral testimony. **Exhibit 3**.

B. Response to Public Testimony

1. State Agency Testimony.

The State Agencies' March 25 letter raised the following concerns. Each concern is identified below and followed by the Commission's responsive finding(s).

a. "Compensatory mitigation requirements consistent OAR Chapter 635, Division 140 must be attached to the County Decision as a condition of approval."

FINDING: The Commission finds that it need not accept or reject the above assertion because the Applicant voluntarily accepted the State Agencies' proposed condition, as follows:

"*The applicant shall comply with OAR Chapter 660, Division 023 and OAR Chapter 635, Division 140. The applicant must coordinate with ODFW and apply the mitigation hierarchy of avoidance, minimization and compensatory mitigation to address direct and indirect impacts of*

the development to low-density habitat for sage grouse. A compensatory mitigation plan shall be developed by the applicant and approved by the ODFW through DOGAMI's consolidated permit process (OAR Chapter 632, Division 37) and other applicable rules, including OAR Chapter 635, Division 420 and OAR Chapter 635, Division 415, prior to any construction or ground disturbing activities."

The Commission observes that there appears to be insufficient evidence in the record to support a finding that sage grouse mitigation is necessary on the Patent Parcel for the reasons explained on page 22 of Applicant's April 22 letter. However, to the extent ODFW determines that mitigation is required on the Patent Parcel, the Commission finds that such a requirements will be adequately enforced by the above condition.

b. "The CUP application [...] does not sufficiently demonstrate how OAR 660-023-0115(10) and OAR 635-140-0025(2) and -0025(3) are satisfied."

FINDING: The Commission finds that all applicable criteria in OAR 660-023-115(10) are satisfied as explained in the Staff Report. In addition, the Commission makes the following summary findings:

- There are no reasonable alternatives to locating the mine on the Patent Parcel because the resources sought to be mined are located beneath the Patent Parcel.

- The Project cannot avoid some limited impacts to the identified low-density habitat for the same reason.

- The proposed mine is dependent on geographic features found on the Patent Parcel – in this case, the resource geology of the Patent Parcel – and these features are not common at other locations. The Applicant has demonstrated based on substantial evidence, that the Patent Parcel contains the highest concentrations of valuable mineral resources within the Project Area and indeed, within all nearby mining claims, as explained on pages 41–55 of Application Exhibit 1. Furthermore, there is no evidence in the record of mineral resources of comparable value located entirely outside of mapped sage grouse habitat.

- The Proposed Mine and its related improvements (mine portal, ventilation shafts, circulation areas, backfill stockpile, backfill plant, and utilities) cannot be relocated to minimize impacts on low-density sage grouse habitat

because those locations are necessary to facilitate use of the mine design presented in the Application at Exhibit 1, pages 71–78. In this instance, relocating proposed facilities could involve changing the location of the mine portal and related backfill areas, existing and proposed circulation routes, and mine ventilation portals. The Commission observes that the mine's proposed drift and fill dimensions "were defined to ensure underground stability" (Application Ex. 1, p. 71) and that the location of the above-mentioned facilities is related to the planned underground layout of the mine. The Commission finds that, in light of the obvious need to ensure the stability of the mine for safety reasons and, given the lack of evidence in the record demonstrating that a different mine design is feasible or appropriate, it is not feasible to further relocate proposed facilities on the Patent Parcel to minimize direct or indirect impacts on Sage Grouse.

In addition, the Commission adopts the following statement from the Applicant's March 26 letter:

> "For purposes of this Application, the County must apply the sage grouse rule to the Patent Parcel only. The patent parcel contains only a small sliver of "low-density" sage grouse habitat along its western edge. The Applicant's Wildlife Report found no evidence of any sage grouse habitat within two miles of the boundary of the larger Project Area. The Application explains that [the] mine site may not be relocated to avoid the small low density habitat area, nor can it be developed differently to minimize impacts on that area. This is because the mineral resources are located only within the Patent Parcel.
>
> The primary structure on the patent parcel, the mine portal, cannot be relocated because it must face the area where processing is proposed to be conducted. Therefore, there is no basis for a finding that the underground mine can be redesigned to "minimize" impact on sage grouse habitat. Moreover, the substantial evidence in the record demonstrates that the small portion of "low density" habitat on the Patent Parcel is not actually occupied by any sage grouse."

In conclusion, the Commission finds that the SGP application satisfies OAR 660-023-0115(10) for the above reasons.

The Commission finds that ODFW regulations set forth in OAR 635-140-0025(2) and -0025(3) are not directly applicable to land use applications in the

County because OAR chapter 635 is not part of the rules implementing the Statewide Planning Goals, set forth in OAR chapter 660, and is not incorporated into the County's land use regulations. The Commission also finds that any project design or approval criteria that OAR chapter 635 might impose were not expressly incorporated into the County's land use regulations or OAR 660-023-0115(10). Indeed, the only provision in the Sage Grouse Rules that references chapter 635 is related to mitigation, which according to those rules, is imposed at the discretion of ODFW. OAR 660-023-0115(9)(b)(B).

c. "The Applicant did not conduct a pre-application conference."

FINDING: The Commission finds that OAR 660-023-0115(8) provides only that an Applicant "should" conduct a pre-application conference, it does not *require* such a conference. The Commission further finds that the Applicant effectively conducted such a conference as explained in the Applicant's March 26 letter.

d. "The access road bisects ODFW designated "big game winter range" for approximately five miles on the north end."

"ODFW recommends a condition of approval that requires bussing from Vale."

FINDING: The Commission adopts as its finding the following excerpt from the Applicant's March 26 letter:

> "All roads leading to the Patent Parcel are already in place and a proposal for reconstruction of that road is not currently before the Commission. While Calico does intend to provide shuttles, potential changes to the processing area may make this more or less difficult. The Applicant's trip generation estimate is conservatively based on a "worst case scenario" in which each employee drives his or her own vehicle. Even under this scenario, trip generation is anticipated to be no more than 250 average daily trips, which is far below the County's 400 trip threshold for requiring a full transportation impact analysis. The state agencies have not identified any County criterion that the Application fails to meet that could only be met with this condition; therefore, the Commission can find that such condition is unnecessary."

The Commission does not recommend ODFW's requested condition for the above reasons.

e. "ODFW and DLCD recommend the County include a condition of approval that Calico reapply to the County if there are inconsistencies identified or significant modifications."

FINDING: The Commission does not recommend such a condition of approval for the reasons stated in the Applicant's March 26 letter, excerpted below:

> "[T]he agencies have not identified any basis in the County's Plan or land use regulations to require "reapplication." Similarly, they have not identified any provisions of the County's Plan or land use regulations that would require such a condition. [...].
>
> Moreover, the condition is unnecessary: if the activity on the Patent Parcel changes with respect to any of the applicable County land use regulations, the County can review and approve a modification of the conditional use permit, provided that the permit is still valid."

The Commission also finds that such a condition would inappropriately delegate County authority to the State Agencies, which may or may not have the authority to unilaterally require changes to the Project during its review. The CUP application is subject to County land use standards. Unless project changes are of such magnitude so as to significantly change or diminish how the Application satisfies the County's applicable land use regulations, mitigation or other design modifications required by State Agencies should not serve to automatically invalidate permits issued by the County.

f. "It is important to note that the [the Applicant's] Wildlife Resources Baseline Report is a draft report and has not yet been accepted [...] as part of the DOGAMI consolidated permitting process."

FINDING: The Commission finds that the Applicant's Wildlife Report is the best and indeed only site-specific evidence in the record demonstrating the nature and extent of wildlife and wildlife habitat on the Patent Parcel and the larger Project Area. The Commission finds that, because the Wildlife Report is site

specific and was updated a number of times based on field surveys conducted in 2013, 2014, 2017, and 2018 (Application Ex. 7 at 22), it is a more reliable depiction of onsite habitat than the GIS data upon which ODFW's habitat mapping is based. The fact that the State Agencies have not yet accepted the Wildlife Report is irrelevant to the criteria and does not reflect on the Report's value as substantial evidence supporting a conditional use approval. The Commission also observes that the State Agencies offered no evidence to rebut the Report's findings.

g. "The CUP application includes narratives or statements that propose compliance or findings of fact to support County approval. DCLD and ODFW believe that the proposed actions are not sufficient, and recommend that the county adopt specific standards and conditions."

FINDING: The Commission rejects this argument for several reasons. First, it fails to identify any CUP criteria which the Application fails to meet. Second, it fails to identify which "proposed actions are not sufficient," and why. Third, it fails to explain which specific standards the County should adopt to ensure the Application meets the CUP criteria.

2. Opponent Testimony.

The Opponents' (Oregon Natural Desert Association and 1000 Friends of Oregon) March 27 letter raised a number of concerns. Each concern is identified below and followed by the Commission's responsive finding(s). In addition to those findings, the Commission adopts the Applicant's April 22, 2019 letter to the Commission as part of these findings. **Exhibit 3**.

a. Scope of the Application

Opponents argue that Applicant improperly constrains its responses to application criteria to activities on the Patent Parcel, and does not address the remainder of the Project Area. "ONDA and 1000 Friends suggest that the Planning Commission must consider the likely range of environmental and social impacts from all aspects of the proposed mining operation." In so arguing, Opponents cite the purpose of the MCC as including "promotion of a high quality environment and promotion of public health, safety and welfare." Opponents also argue that MCC 6-6-7-E and F require the Commission to evaluate the "effect of the proposed use on the stability of the community's social and economic characteristics and that a proposed use not interfere with traditional fish and wildlife use of habitats determined critical or sensitive in the fish and wildlife

protection plan for Malheur County," and that "the applicant must provide additional and more detailed information about the entire project for the planning commission to adequately consider the suitability of the proposed use."

FINDING: The Commission finds that the uses proposed in the Applications are on the Patent Parcel. The County does not have land use planning jurisdiction over federal lands, which are managed by the Bureau of Land Management ("BLM") under the Federal Land Policy and Management Act (FLPMA), which imposes its own mandate for land use planning for BLM lands. 43 USC §1712. As the County does not have land use permitting jurisdiction on federal lands, the Applications' approval would neither authorize nor prohibit processing and support activities on surrounding federal land.

Nonetheless, the Commission finds that the processing facilities shown on Application Exhibit 2 and discussed in the Application would likely satisfy the applicable criteria for several reasons, not the least of which is the sheer geographic isolation from any nearby occupied parcel. Indeed, evidence in the record demonstrates that the nearest private structure is over five miles away and separated from the site by substantial intervening geography, including Grassy Mountain itself. See App. at 30, Applicant's April 22 letter at 15.

And, the Project as a whole would satisfy most if not all applicable CUP criteria as explained in the Application. Virtually every one of the Applicant's responses apply to the Project generally. For example, responses to the Specific Criteria to Evaluate Suitability set forth in MCC 6-6-8 were based on the project as a whole. App. 30–35. So too were the Applicant's responses to applicable Comprehensive Plan goals and policies (particularly those related to Goals 9, 11, and 12), with the possible exception of certain discussions of soil type and other Goal 5 resources, which are necessarily site-specific. App. 15–28. However, based on the Applicant's Wildlife Report (App. Ex. 7) and Applicant's April 22 letter at pages 19–22, the Commission finds that the Project as a whole satisfies 6-6-7-F and the County's Goal 5 policies. Finally, the Commission finds that the project as a whole would satisfy all remaining General Criteria to Evaluate Suitability set forth in MCC 6-6-7 for the reasons stated in **Exhibits 1, 2,** and **3**.

The Commission finds that the purpose statement of MCC 6-1-2 is not an applicable criterion.

As noted above, the Commission finds that the Application satisfies MCC 6-6-7-E and F as explained in the Staff Report (**Exhibit 1**), Application (**Exhibit 2**), and Applicant's April 22 letter (**Exhibit 3**).

b. Application Completeness

The Commission finds that it has sufficient information upon which to find that the applicable criteria are met, including:

- A site plan (App. Ex. 2);
- A Wildlife Report (App. Ex. 7);
- Supporting GIS maps that identify the nearest apparently occupied dwellings and intervening topography;
- A water rights certificate;
- Excerpts of the Applicant's Preliminary Feasibility Study, which addresses geology, mining methods, Project design, utilities, water quality, and fire risk management (App. Ex. 1);
- A summary of the Applicant's operation, closure, and reclamation plans (App. Ex. 3);
- A TSF summary and study (Applicant's April 22 letter, Ex. 9 and 10);
- A geochemistry Summary and Report (Applicant's April 22 letter, Exs. 6 and 7);
- Information on the affected livestock allotment (Applicant's April 22 letter, Exs. 3 and 4);
- Detailed information on chemical processing, chemical waste management, and acid mine drainage prevention (Applicant's April 22 letter, Exs. 7, 8, 14, 15, and 16);
- Data on the potential social and economic effects of the Project (App. at 21-22, Applicant's April 22 letter at 15–18, Ex. 12);
- Written communications from the Vale Rangeland Fire Protection Association, County Environmental Health Department, Sheriff's Office, Road Master and Engineer, and Vector Control District.

c. Comprehensive Plan Goals and Policies

FINDING: the Commission adopts the Applicant's response to Opponents' arguments concerning Comprehensive Plan Goals and Policies stated on pages 9–

14. As explained therein, the Commission finds that the Application is consistent with the following Goals and Policies raised by Opponents, or that such Goals and Policies do not apply:

- Goal 3, Policies 1 and 2 are legislative mandates for County planning and do not apply to a quasi-judicial land use application.

- Goal 3, Policy 8 is satisfied for several reasons. First, there are no farming activities on or around the Project Area, and there is no evidence the record that any of the soils on the Patent Parcel or Project Area are suitable for farming. Second, the County finds that Opponents have not identified any legal basis upon which the County must consider either impacts to grazing uses on the Patent Parcel, which is owned by the Applicant, or the surrounding federal lands, which under FLPMA are managed for multiple uses (not just farm and grazing uses).

  Even if the County must consider impacts of the project on surrounding grazing uses on federal land, it finds that the Project will neither force a significant change nor significantly increase the costs of such grazing operations. The project as a whole could potentially displace, at most, 0.7 percent of the maximum cattle and 0.75 maximum sheep Animal Unit Months ("AUMs") in the Nyssa Grazing Allotment. Applicant's April 22 letter at 10–11, Ex. 4. The Commission finds that such a worst-case scenario would have an insignificant effect on allowable grazing activities throughout the Nyssa Allotment.

  The Commission also finds that the proposed fencing and water quality management methods will ensure that sheep and cattle do not stray into the Project Area and that their water sources will not be contaminated by the Project. This latter point is supported by the Applicant's geochemical studies, water quality information discussed on pages 12–14 of the Applicant's April 22 letter, and the Applicant's oral testimony at the continued hearing on April 25, in which the Applicant clarified that the water table directly below the mine is below the lowest level of proposed mining.

  Finally, to the extent that Policy 8 could be read to prohibit use of BLM open range for mining processing uses, it would likely be preempted by federal law.

- Goal 5, Policy 3, requires the County to "cooperate with other government agencies in the enforcement of mining regulations." The County finds that approval of this Application does not affect how other government agencies will enforce their mining regulations and that DOGAMI did not submit any written or oral testimony claiming otherwise.

- Goal 5, Policy 1, which provides that "the county will continue to cooperate with local, state and federal agencies to identify the location, quality and quantity of fish and wildlife habitat" is a general land use planning policy and does not require any specific action or finding with respect to a conditional use permit application.

- Goal 5, Policy 4 provides that "the County will notify and consult with appropriate state agencies during review of development proposals that might affect surface or groundwater quality." The Commission finds that the Application satisfies this Policy for the reasons stated in Applicant's April 22 letter and observes that no state agency complained of a lack of notice of the Application.

- Goal 11, Policy 1 provides that the "County, in considering land use proposals, will ensure that the physical characteristics of land that affect sewage disposal, water supply, and water quality are carefully considered." The Commission finds that the Application contains more than enough information for it to carefully consider the issues listed above, and it did so.

d. Specific Plan Applicability

FINDING: The Commission finds that there are no specific County plans applicable to the Patent Parcel and observes that Opponents did not identify any.

e. Viewpoints

FINDING: MCC 6-6-7-C requires the Commission to consider "existing development and viewpoints of property owners in the surrounding area." The Commission finds that the project will not have any adverse impacts to views from existing development and property owners in the surrounding area for the reasons stated in the Application at page 25 and Applicant's April 22 letter at 15.

f. Services and Utilities

FINDING: MCC 6-6-7-D requires the Commission to consider the "availability of services and utilities." The Commission finds that the Applicant has sufficient water rights to provide adequate process water, based on the water rights certificate in the record. The Commission finds that Idaho Power has committed to providing service to the Patent Parcel based on a power purchase agreement referenced in the Staff Report. The Commission finds that testimony from the County Public Health Division indicates that the Applicant will be required to provide a septic system to treat any wastewater generated on the Project. The Commission finds that there is sufficient information in the record to demonstrate that the Project will be served by the Vale Rangeland Fire Protection Association and that the Project will have an on-site fire suppression system which includes fire hydrants, standpipes, and sprinkler systems. App. Ex. 1 at 91. Finally, the Commission finds that road access to the Patent Parcel is already in place, and that to the extent that the Project will require upgrading of County Roads, Condition 3 ensures that those improvements will be constructed to the satisfaction of the County Road Master. In so finding, the Commission relies on the written comments of the Road Master dated February 4 and April 23.

The Commission rejects Opponents' assertions that the new power line extension will "entail significant impacts to wildlife and other resources" and that if "new right-of-way permits are sought and/or considered they must evaluate impacts to wildlife species and habitat along their length." There is nothing in MCC 6-6-7-D which requires consideration of habitat areas, and certainly not habitat areas that are not designated in the County's plan. And, Opponents make no attempt to identify a basis in the MCC or Comprehensive Plan supporting the premise that MCC 6-6-7-D requires a conditional use application to analyze the habitat impacts of linear infrastructure to be extended to serve the Project.

The Commission also rejects Opponents' comments that joining the fire protection association may not be sufficient to address fires that might release cyanide because such comments do not appear to acknowledge the Applicant's proposed onsite fire suppression system or explain how that system may be insufficient.

g. Social and Economic Effects

FINDING: The Commission finds that the Project is likely to have positive social and economic effects on Malheur County because it is anticipated to create approximately 110 mining jobs for the duration of the mine (14 years) and approximately 150 construction jobs. App. 27. The Commission also finds that these jobs are likely to lead to indirect job creation and other economic multipliers.

Applicant's April 22 letter at 16, Ex. 12. The Commission further finds that the Project is likely to have beneficial social and economic effects because of the jobs created and the relatively high wages of these jobs indicated by the Applicant.[1]

These positive effects are necessarily balanced against any harmful environmental externalities potentially caused by the Project. However, the Commission finds that the environmental risks are relatively low given the closed-circuit chemical process proposed to be utilized, the water capture and treatment techniques proposed to be used, the methods required to prevent acid mine drainage (April 22 letter at 24–25), the proposed reclamation measures, and the sheer geographical separation of the Project from any population centers. See Applicant's April 22 letter, Exs. 7–10, 14–16.

Stated simply, the Commission finds nothing in the record which gives it a reason to believe that the Project will have negative health impacts on the County's populated areas. For these reasons, the Commission finds that on balance, the Project will have positive social and economic effects.

The Commission rejects Opponents' contrary arguments regarding MCC 6-6-7-E, which concern the "effect of the proposed use on the stability of the community's social and economic characteristics" for the reasons stated on pages 15–18 of the Applicant's April 22 letter. In so doing, the Commission finds that evidence offered by Opponents concerning the "boom and bust" impacts of mining dependent communities is not persuasive because there is no evidence that Malheur County is a "mining dependent community." In fact, evidence offered by Applicant indicates the opposite: as of 2016, Malheur County had only 24 employees in the mining industry. Applicant's April 22 letter at 16. The Commission specifically finds that the Freudenburg and Wilson article has little or no applicability in Malheur County for these reasons. Further, the Commission finds no evidence that the increase in these jobs by the 100 plus jobs potentially created by the Project will turn the County into a mining dependent community. And, the Commission finds that a positive economic impact is beneficial to the community even if it exists for a discrete amount of time (in this case, approximately 14 years). On the other hand, Opponents have not explained how the absence of the mine's positive economic effects will be more beneficial to the community.

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[1] The Commission does not find Opponent's arguments that average wages anticipated by the Applicant cannot be relied upon because they are higher than the average wages for mining jobs; the Commission finds that the Applicant is the best source for information concerning the wages it intends to pay.

The Commission does not agree that the Project will cause affordable housing displacement for three reasons. First, there is no evidence that the Project will require all employees to be imported to the County—indeed, the Applicant's stated intention is to establish workforce training in the County to provide opportunities for County residents. Although Opponents argued that the lack of mining jobs in Malheur County indicates the need to import employees from other markets, the County finds that workforce training would likely mitigate this.

Second, even if all employees come from outside of the County, the Commission finds no evidence that 110 new jobs will exacerbate a shortage of affordable housing and indeed, the average wage that the Applicant proposes to pay is unlikely to create an increased demand for subsidized housing because it exceeds the median household income of the County by more than $40,000. Applicant's April 22 letter at 18.

Third, the Commission finds that increased housing demand is not necessarily a negative socioeconomic impact to the extent that increased housing production constitutes a positive economic multiplier.

h. Fish and Wildlife Impacts

FINDING: MCC 6-6-7.F provides that conditional uses may not "interfere with traditional fish and wildlife use of habitats determined to be critical or sensitive in the fish and wildlife habitat protection plan for Malheur County." ONDA argues that Calico has not "met its burden of showing that the proposal will not have a significant permanent adverse impact on fish or wildlife habitat."

As an initial matter, the Commission agrees with the Applicant that "the question is not whether the Application will have a significant impact on fish and wildlife, it is whether it will affect habitats determined by the County to be critical or sensitive in its fish and wildlife protection plan." Applicant April 22 letter at 19.

The Commission also finds that the County does not have a "fish and wildlife habitat protection plan" and that the Comprehensive Plan does not designate any critical or sensitive habitats on the Patent Parcel or Project Area. Therefore, the Commission finds that the above criterion does not apply.

Even if the Criterion did apply, the Commission finds that the Wildlife Report submitted by the Applicant demonstrates that there is no evidence of critical or sensitive wildlife habitat on the Patent Parcel that would otherwise be designated by the Comprehensive Plan. In fact, the Commission finds that the only habitat area on the Project Area designated by ODFW is greater sage grouse, the

protection of which is not required by the Comprehensive Plan or Land Use Regulations, and is separately addressed by OAR 660-023-0115.[2]

As noted by the Applicant in its April 22 letter, Opponent's arguments regarding ODFW's designated big game winter range are irrelevant because none of that range is identified on the Patent Parcel or Project Area, and Opponents have not explained why public improvements outside of the Project Area must be analyzed for impacts on winter range. Similarly, the Commission finds that the criteria do not require analysis of federal wildlife issues related to the Migratory Bird Treaty Act or pygmy rabbits.

Finally, the Commission finds that ODFW's mitigation policy set forth in OAR 635 division 415 is not an applicable criterion for each of the reasons stated on page 20 of the Applicant's April 22 letter.

i. Sage Grouse Permit

FINDING: Opponents argue that "the Wildlife Report uses an inapplicable procedure for characterizing sage-grouse habitat within the Project Area" and that the Applicant should have been required to apply ODFW's "Sage Grouse Development Siting Tool." The Commission rejects this argument for the reasons stated in its response to the State Agencies' comments regarding the Application's consistency with the Sage Grouse Rules, above. The Commission also finds that nothing in the findings required by OAR 660-023-0115(10) require the County to apply ODFW's Sage Grouse Development Siting Tool.

j. Specific Criteria to Evaluate Suitability

FINDING: Opponents raised a number of arguments concerning the Specific Criteria to Evaluate Suitability in MCC 6-6-8-4, which require that "submitted plans and specifications shall contain sufficient information to allow the planning commission to set standards" concerning a number of issues, which are addressed below. In considering the matters listed in MCC 6-6-8-4, the Commission need not find that the Application meets any specific criterion. Rather, the question before the Commission is two-fold: first, the Commission must decide whether specific standards regarding the listed development issues are necessary, and second, if it wishes to set such standards, the Commission must

[2] ODFW's March 25 letter identified only big game winter range north as a designated habitat area, but noted that it is located north of the Project Area, and only potentially impacted by improvement and use of existing roads.

determine whether there is enough information in the record for the Commission to do so.

The Commission's response to these factors is below.

1. Noise, dust, traffic and visual screening.

FINDING: The Commission finds that the geographical separation of the project from any nearby developed or inhabited property (explained in App. at page 30), coupled with a fugitive dust control plan to be approved by the Oregon DEQ (explained in App. at page 31), and the limited number of vehicle trips generated by the Project under a reasonable worst scenario (see App. Ex. 9), adequately protect other properties from dust, traffic, and visual impacts. The Commission also finds that the underground mining method chosen for the Project will limit most blasting noises, as explained in the Application at Page 31, and geographic separation of the Project from developed areas will further limit noise impacts. For these reasons, the Commission finds that additional standards related to noise, dust, traffic, or visual screening are unwarranted.

2. Setbacks from property lines.

FINDING: The Commission finds that the geographic separation of the Project from the nearest developed areas, explained on page 30 of the Application, obviates the need for the Commission to set additional standards related to setbacks.

3. Location of vehicular access points.

FINDING: The Commission finds that the geographic separation of the Project from the nearest developed areas, explained on page 30 of the Application, as well as the limited number of daily trips that it could generate (App. Ex. 9), the low speeds traveled on BLM roads, and the absence of traffic near the Project Area obviate the need for the Commission to set additional standards related to vehicular access points.

4. Fencing needs.

FINDING: The Commission finds that the proposed fencing around the Patent Parcel, described on Application page 33, is sufficient to address any fencing needs, and notes that Opponents did not explain why this fencing would be insufficient. For these reasons, the Commission finds that additional fencing standards are unwarranted.

5. Prevention of the collection and stagnation of water at all stages of the operation.

FINDING: The Commission finds that this consideration is related to vector control. The Commission finds that no additional standards concerning collection and stagnation of water are warranted because of the geographical separation of the Project from populated areas, as explained by the letter from the Malheur County Vector Control District, noted as Exhibit 6 of the Staff Report.

6. Rehabilitation of the land upon termination of the operation.

FINDING: Opponents argue that the Application is deficient because it includes excerpts of a preliminary, rather than final, mine reclamation plan. The Commission finds that there is no County criterion requiring a final reclamation plan; the County need only decide (1) whether it needs to set standards pertaining to "rehabilitation of the land upon termination of the operation," and (2) if so, whether it has enough information in the record to do so.

The Commission finds a complete reclamation plan will be required by the Oregon Department of Geology and Mineral Industries ("DOGAMI") according to detailed state regulations, as explained in the Applicant's April 22 letter at Page 23, and set forth in OAR 632-037-0130. There is no evidence in the record that such regulations would be insufficient to ensure safe termination of the mining operation and adequate rehabilitation of the land. Further, the Applicant has provided a summary of its current draft reclamation plans (App. Ex. 3) and substantial detail on its tailings facility design (Applicant's April 22 letter, Exhibit 9 and 10). For the above reasons, the Commission finds that applicable DOGAMI regulations will ensure adequate rehabilitation of the land upon termination and the Applicant has offered substantial evidence that it can satisfy those regulations.

To ensure that an adequate reclamation plan is in place prior to the start of mining activities, the Commission imposes the following condition of approval:

"The Applicant shall obtain approval for its reclamation plan from Oregon Department of Geology and Mineral Industries (DOGAMI) prior to beginning mining operations. Unless otherwise prohibited by DOGAMI, the Applicant may conduct pre-construction and construction activities prior to obtaining approval of its reclamation plan."

k. Financial Assurance

FINDING: The Commission finds MCC 6-6-11 does not obligate the County to require financial assurance for mine closure and reclamation. However, the Commission finds that OAR 632-037-0135 requires that "[a] reclamation bond or alternative security acceptable to the Department shall be posted before the start of any construction, excavation or other ground disturbing activity associated with mining operations, other than baseline data collection." This amount must include the actual cost of reclamation and environmental protection costs in the event of an incident and must be reviewed annually for adequacy. Id. The Commission finds no reason to require an additional guarantee and notes that Opponents have not explained either how this guarantee requirement is not sufficient or what additional financial guarantees the County should require.

Finally, the Commission finds that the financial guarantee required by OAR 632-037-0135 must be in place before mining can begin, which makes unnecessary Opponent's argument that the Application should not be approved until financial security is in place. DOGAMI has represented that an approved CUP is required before the Applicant can apply for its consolidated permit, thus it is probably not possible for DOGAMI to determine the final bonding level(s) before the County grants a CUP. Applicant's April 22 letter at 3–4.

l. Cyanide Leach Chemical Processing and Acid Mine Drainage

FINDING: Opponents argue that "[t]he application and any review by the Planning Commission of the impacts of the project are necessarily incomplete because the application does not include any information about potential impacts of chemical process mining or acid mine drainage." As an initial matter, the Commission rejects this argument for two jurisdictional reasons. First, it finds that there are no conditional use criteria addressing specific mining methods and technologies. Second, to the extent that this argument addresses ore processing, it finds that processing activities are proposed on federal land which are not under the County's jurisdiction.

With regard to the potential relevance of the mining and processing methods proposed and acid mine drainage to the significant change/significant cost tests in ORS 215.296 and MCC 6-6-7, the Commission finds the following:

- There is no legal basis upon which the Commission must apply the above sections to activities on BLM land.

- There is no evidence in the record that the proposed chemical processes and acid mine drainage treatment techniques will significantly change or significantly increase the costs of accepted farm activities on private or federal land.

- The Commission finds that no person engaged in accepted farm activities has raised any objections to the Applications.

- The Commission finds that the proposed cyanide leach mining process is entirely enclosed within vessels and is conducted through a closed-loop system. App. at 10–11, Ex. 1. The Commission finds that all reaction tanks will be constructed upon catch basins sufficient to contain 110 percent of the volume of the tank, in case a tank fails. Id. The Commission also finds that all system pipes will be constructed within lined ditches capable of preventing leakage from percolating into the ground. Applicant's April 22 letter at 13.

- The Commission finds that the lowest proposed level of the mine is above the identified ground water level. Applicant's April 22 letter at 13.[3] The Commission also finds that the mine itself will be dewatered as needed if ground water intrudes and to remove any collected process water. Id.

- The Commission finds that the Applicant has developed a complete ground water monitoring plan designed to characterize the base-line ground water quality. Ex. 6, pages 21–46

- The Commission finds that the tailings storage facilities and waste rock facilities will be adequately lined, will have adequate water drainage, and will be sufficiently reclaimed to ensure protection of ground water, as explained in the Applicant's April 22 letter at 13–14 and the Application at Ex. 3.

- Acid neutralization of mined material is required by state regulations. OAR 340-043-0130. The Applicant's April 22 letter provides a detailed explanation of how the Project has characterized the acid-generating characteristics of waste rock and ore, and has explained how the Project will avoid acid mine drainage as follows:

[3] The Commission notes that ground water in some areas of the Project Area is above the lowest level of the mine. However, oral testimony at the April 25, 2019 continued hearing explained that the ground level underneath the mine itself is lower than the proposed bottom level of the mine.

"All material that will be put on the Tailings Site Facility or backfilled into the mine will be neutralized to at least the levels required by the regulations stated above.

"Prior to neutralization, acid generating material will be in full containment (see Tailings Design Report summary).

"Tests have also been conducted (or are in progress) to determine the NAG on the borrow material that will be backfilled into the mine and used for construction purposes. These tests are still in progress, but no acid generating borrow material will be used for mine backfill, unless it is neutralized in compliance with Oregon regulations (as stated above)."

Applicant's April 22 letter at Exhibit 7.

- The Applicant has provided evidence of water rights to serve the Project. Staff Report Ex. 2. To the extent that Project could impact surrounding water quantity available for range uses, such considerations are under the jurisdiction of the Oregon Water Resources Department, not the County. *Ashland Drilling, Inc. v. Jackson County*, 168 Or App 624 (2000).

- The Applicant proposes to relocate any stock watering facilities that might be included within the fenced area. Applicant's April 22 letter at 11.

Even if ORS 215.296 and MCC 6-6-7 could be construed to turn on issues of mine processing technology or acid mine drainage, in light of the facts above the Commission finds in the alternative that those issues will not force a significant change to accepted farm practices surrounding the Project Area. To summarize, this is because the Project includes adequate measures to ensure ground water quality and protection against acid mine drainage.

V. CONCLUSION

Based upon the parties' arguments and evidence in the whole record, the Planning Commission finds that the Applications meet all applicable criteria.

VI. ORDER

The Commission hereby approves the Applicant's Conditional Use Permit application and recommends approval of the Applicant's Sage Grouse Permit application, with the conditions identified above. These findings constitute the Commission's decision on the Applications, which decision is adopted by vote of the Commission as affirmed by the signature of the Planning Commission chairperson or acting chairperson below. The Commission's decision is effective upon the date indicated below.

Dated this 23 day of May, 2019.

By: Kathy Clavich

Malheur County Planning Commission Chair

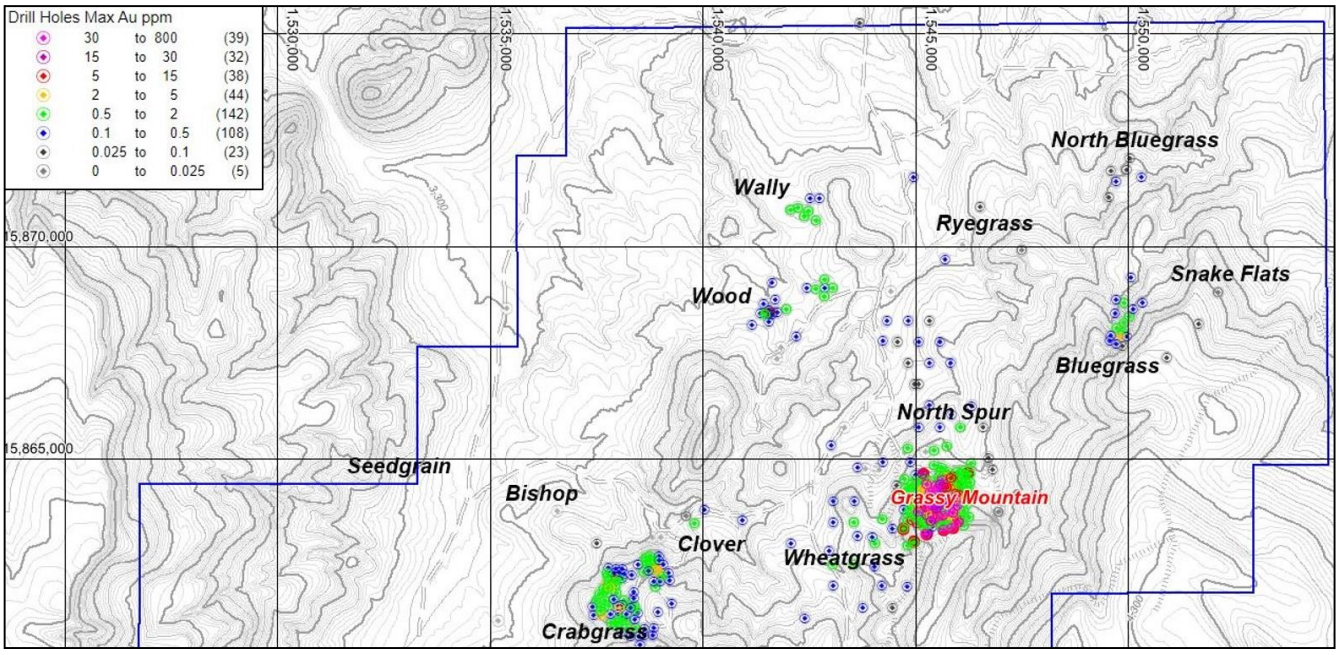
Appendix S: Portal Design Report

Grassy Mountain Project

Stability Analysis of the Portal Design

Submitted to

Calico Resources USA Corp.



Report prepared by

GEOTECHNICAL MINE SOLUTIONS

GM052019

Grassy Mountain Project

Stability Analysis of the Portal Design

Rev3

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August, 2019.

GEOTECHNICAL MINE SOLUTIONS

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1. INTRODUCTION

Calico Resources USA Corp (Calico) has requested Geotechnical Mine Solutions (GMS) carried out the mine portal stability analysis for the Grassy Mountain Gold Project (Grassy Mountain), Malheur County, Oregon. The portal has been designed during the Pre-Feasibility Study (PFS).

To carried out the stability analysis, GMS evaluated each cut slope at the portal and incorporated the empirical support design carried out during the PFS (Mine Development Associates, 2019) by Ausenco (2018). GMS also evaluated the available information, including geological mapping and drill core (GM 16-04). GMS believes that drill hole GM 16-04 is the most representative hole based on its location.

2. SCOPE

The scope of the study includes the following:

- Stability analysis of portal design, considering rock mass strength properties and geotechnical characteristics.
- Stability analysis of portal design, incorporating empirical support elements defined during the PFS of the project.

3. OVERALL TERMS

The geological and geotechnical characteristics in the portal area were estimated from a geological cross section of the decline ramp provided by Calico geologists, and from an evaluation of cores from drill hole GM16-04. These characteristics were evaluated according to the Rock Mass Rating system (Bieniawski, 1989).

The results of this study are considered preliminary and should be re-evaluated upon receipt of additional information from work recommended in this report.

The results of the stability analysis will ensure the stability of the portal slopes, depending on the resulting safety factor and complying with the acceptability criteria established for the project.

4. AVAILABLE INFORMATION

The available background information used in this study:

- NI 43-101 - Preliminary Feasibility Study and Technical Report for the Grassy Mountain Gold and Silver Project, Malheur County, Oregon, USA. July 9, 2018 (Mine Development Associated, 2018).
- Grassy Mountain Project, Consolidated Permits, Geotechnical Design. May 23, 2019 (Geotechnical Mine Solutions, 2019).
- Grassy Mountain Project, Main Access Portal, Excavation Design and Support Plan, General Plan and Sections GM022019-01. April 11, 2019 (Geotechnical Mine Solutions, 2019).
- Grassy Mountain Project, Main Access Portal, Excavation Design and Support Plan GM022019-03. April 11, 2019 (Geotechnical Mine Solutions, 2019).
- Site Layout Map, Calico Resource USA Corp. Grassy Mountain Project. August 2, 2019.
- Geological cross section of the decline ramp axis in the portal area. May 15, 2019 (Calico Resources USA Corp, 2019).
- Topography “Updated Grassy Site Plan” (contour 10 ft). March 13, 2019.

5. GENERAL OVERVIEW

The portal is designed to allow access to the underground mine facilities while providing adequate space for equipment and vehicles.

The portal is located uphill and approximately 750 feet south of the primary crusher at an approximate elevation of 3749 fasl. The portal pad has been designed with a 1% inclination towards the outside, to allow the flow of stormwater away from the portal and towards the stormwater drainage ditches. The portal pad will have sufficient area for installation of the required ventilator infrastructure to be used during the excavation of the decline ramp and to allow the safe transit of the development equipment. The portal will have a waste rock excavation volume of 2,283,146 tons.

Figure 5-1 shows a plan view of the portal general layout related to the main infrastructure that surrounds it and Figure 5-2 shows a plan view (a) and a frontal perspective (b) of the portal location as example.

UTM coordinates and the dimensions of the entry portal are indicated in Table 5.1.

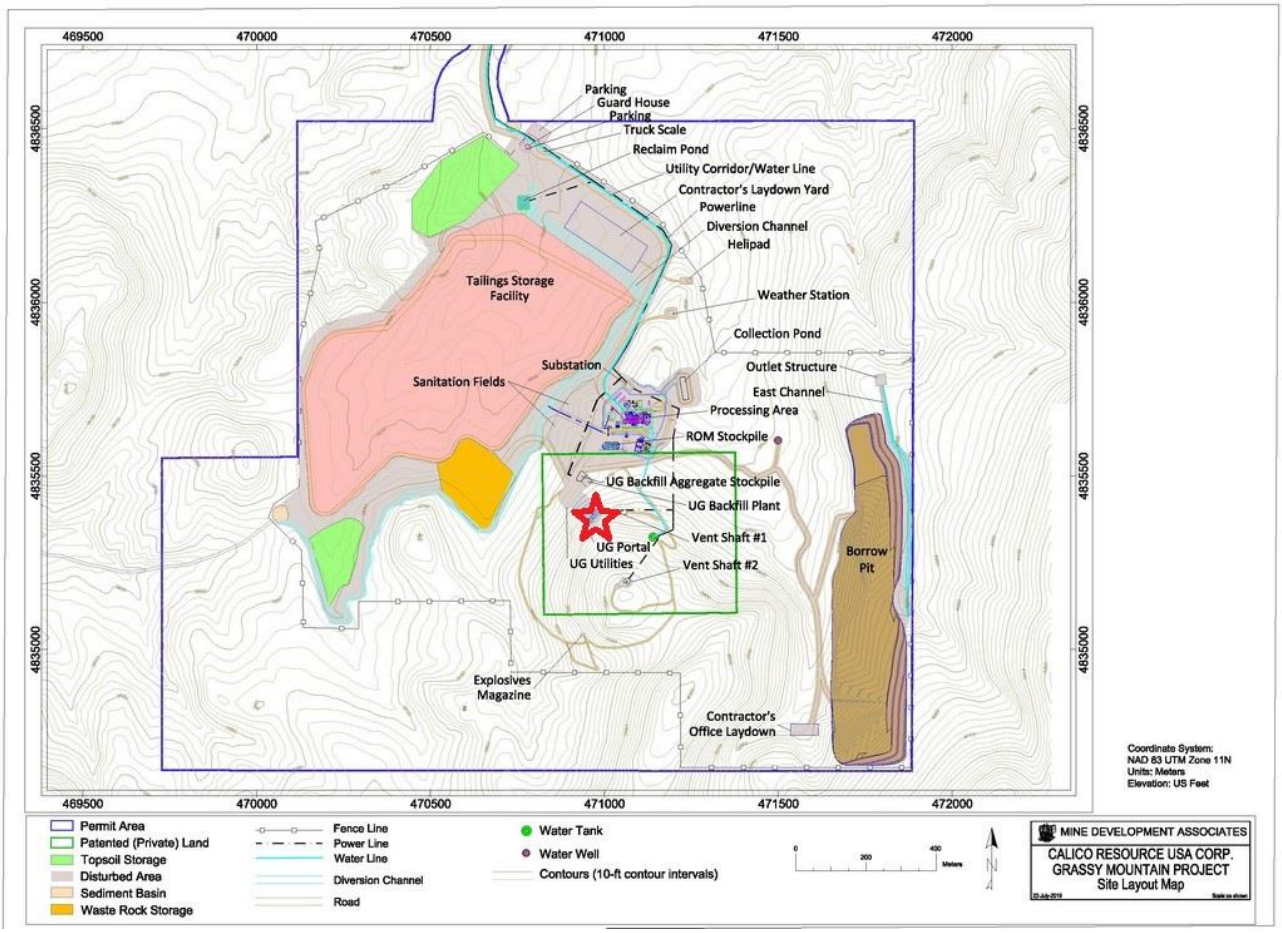


Figure 5-1 General site layout - portal related to the main infrastructure.

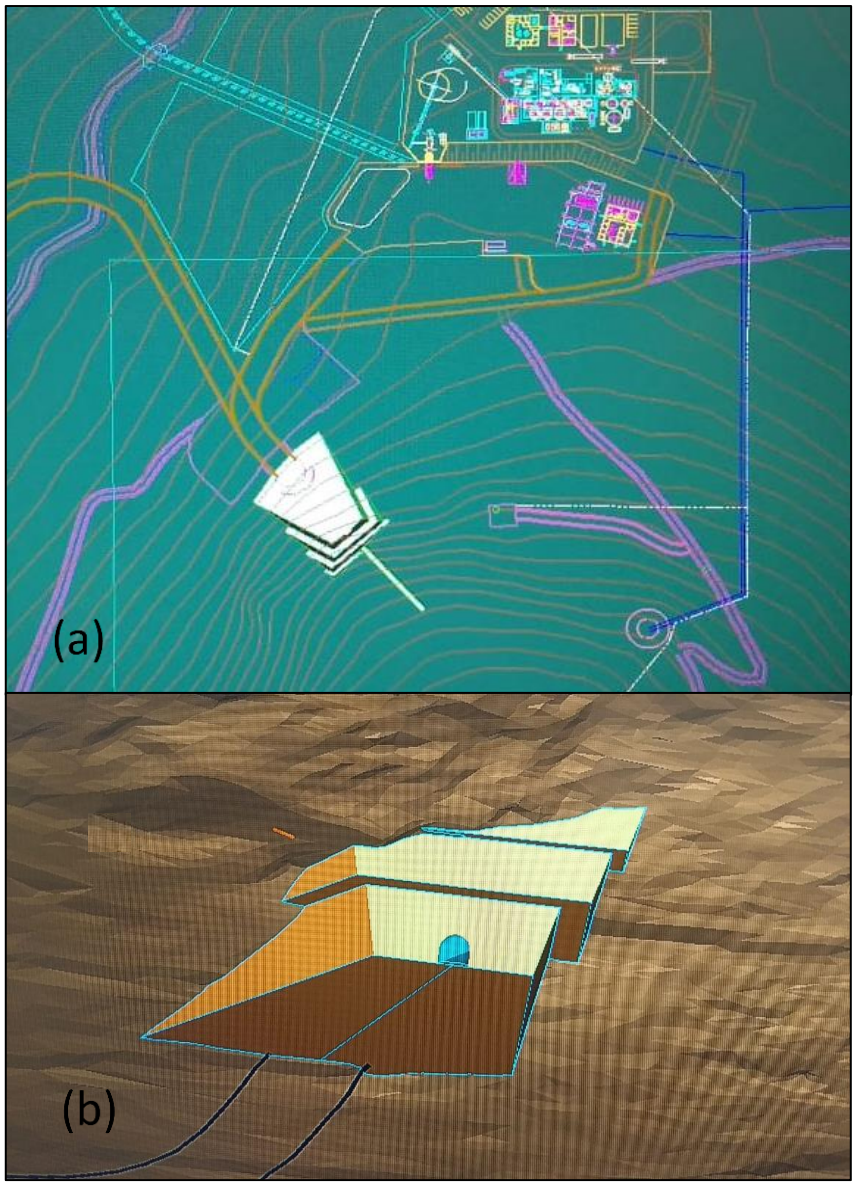


Figure 5-2 Plan view (a) and frontal perspective (b) of the portal location.

Table 5.1 Portal location (UTM NAD83, Zone 11).

Portal	Coordinates		Elevation [fasl]	Pad Area [ft^2]
	North	East		
Entry	15864312	1544950	3750	3.322,293

The preliminary design shown in drawing GM022019-03 shows a bench height of 32.81 feet and berm width of 13.12 feet for the slope face at the portal opening. The upper bench will have a bench height of 22.97 feet and berm width of 6.56 feet. The bench face slope angle is 72º, and 59º global slope angle (see Figure 5-3).

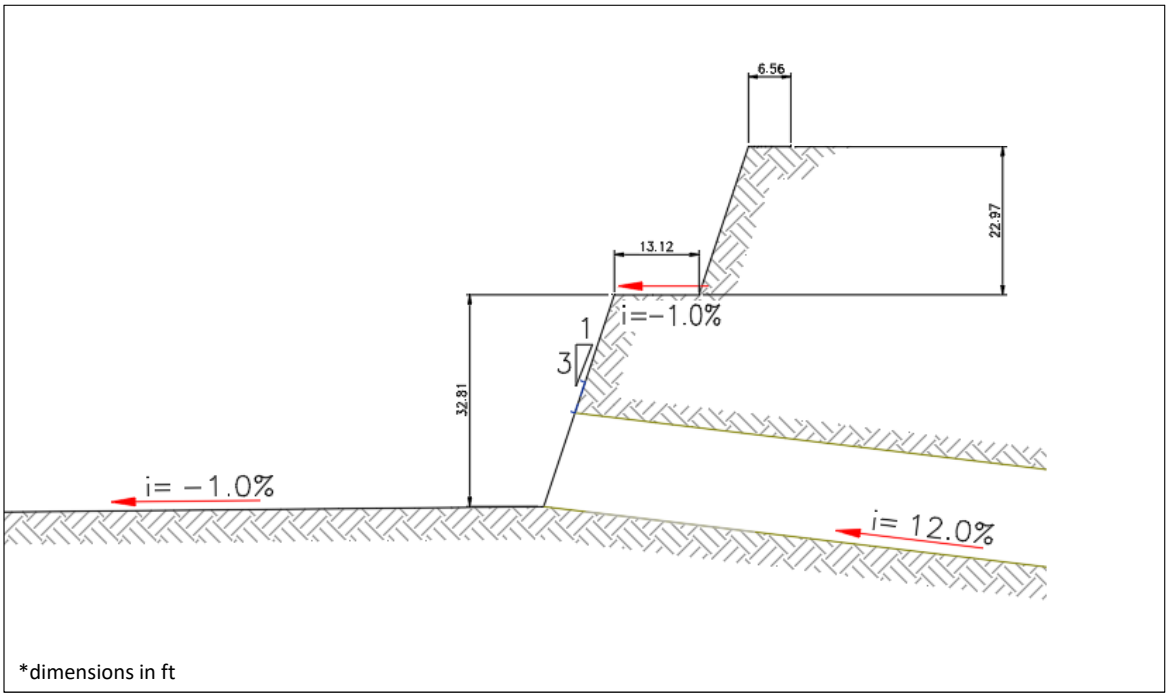


Figure 5-3 Geometric configuration of the portal slopes.

6. GEOTECHNICAL CHARACTERIZATION

The site geology was studied by Calico geologists using a cross section in the decline ramp location (Figure 6-1). The results of the study provided the lithologies present in the portal area according to:

- Colluvium (Non-consolidated material present on surface);
- Sandstone/Arkose;
- Siltstone;
- Clay and;
- Sinter

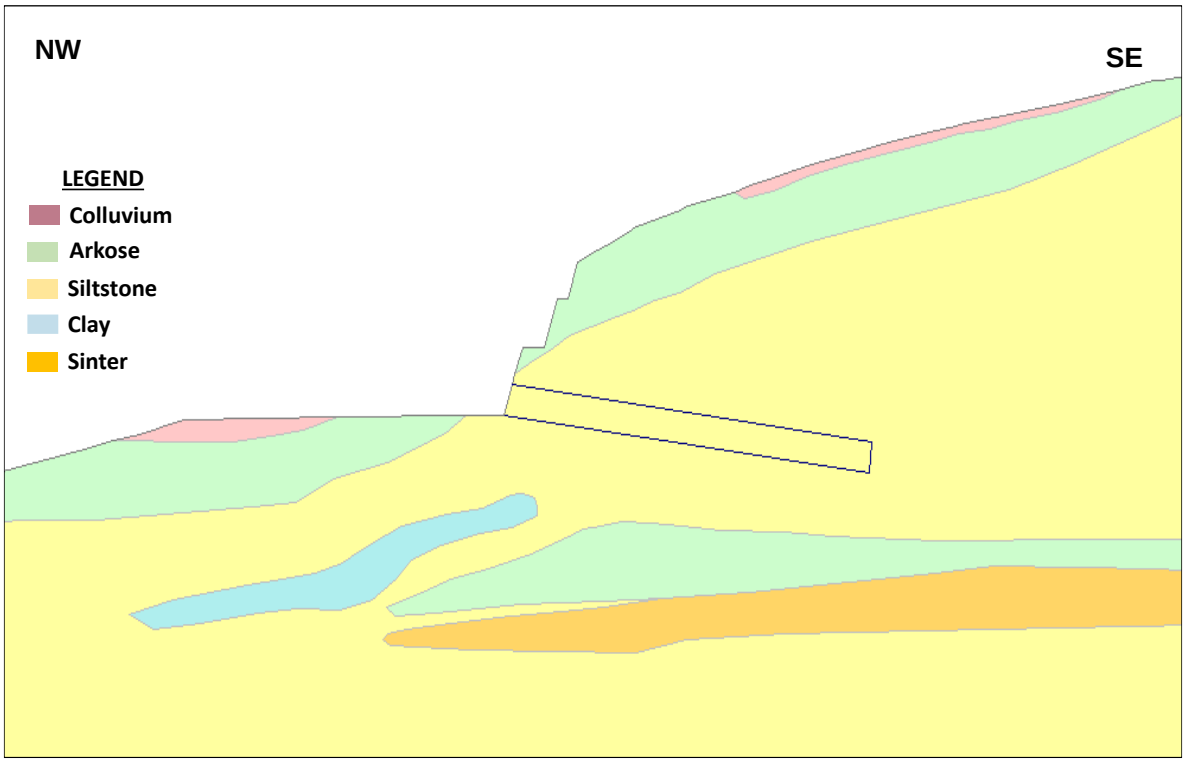


Figure 6-1 Geological cross section, decline ramp at portal.

In order to characterize the rock mass in the portal area, the available geotechnical drilling in the vicinity of the portal site was evaluated. The closest and most representative drill hole in the area is GM16-04, which is a diamond drill hole. The cores were re-logged (quicklog) for geotechnical parameters and then compared with the available Calico drill database to define the geotechnical qualities.

The re-logging methodology consisted of recording the physical characteristics of each structural discontinuity such as the spacing of the fractures, frequency, thickness, type of filling, estimated resistance, presence of water, etc. These were used for the subsequent geotechnical characterization of the rock mass at the portal area.

Due to the lack of outcrops and the strong weathering of the surface rock in the portal area, it was not possible to define the surface structural pattern. Therefore, this variable was not assessed in the stability analysis.

6.1. Rock Mass Classification

The use of geotechnical classification systems for technical support allows estimation of the geotechnical parameters that characterize the rock mass. This estimation, along with the experience of the authors in materials and projects with similar characteristics, allow the definition of the parameters to be adopted in the subsequent stability analysis.

The characterization of the rock mass utilized the RMR (Rock Mass Rating) system (Bieniawski, 1989), which is approximately equivalent to the GSI (Geological Strength Index) system (Hoek, 1995). The use of this system allows inclusion of geological information in the Hoek - Brown generalized failure criterion (Hoek – Brown, 1980) for rock mass, as shown in Equation 1.

$$GSI = RMR_{1989} - 5 \quad \text{(Equation 1)}$$

The relevant physical characteristics considered in the classification and definition of the rock mass parameters, are as follow:

- **Non-Weathered Rock Strength:** Field estimation for non-weathered rock strength (Table 6.1) is based on analysis of triaxial tests results of intact rock samples (Hoek, 1983; Doruk, 1991; and Hoek et al, 1992).

- **RQD:** The Rock Quality Designation is an approximation of the degree of jointing or fracture in a rock mass. It is measured as the percentage of the drill core in lengths of 10 cm or more, therefore, the RQD is defined in Equation 2**.**

$$\text{RQD}\,(\%) = \frac{\sum \text{Rock Pieces} > 100\,(\text{mm})}{\text{Core Run Total Length}} \times 100 \quad \text{(Equation 2)}$$

On surface exposures the measurement of the RQD is estimated by extending a measuring tape along the exposed surface, "simulating" a drill core and estimating the length of the pieces that would be obtained if it was a drill core.

Table 6.1 Field estimation of compressive strength for intact rock samples.

Grade (*)	Term	Uniaxial Comp. Strength [MPa]	Point Load Index [MPa]	Field estimate of strength	Examples
R6	Extremely Strong	> 250	>10	Specimen can only be chipped with a geological hammer	Fresh basalt, chert, diabase, gneiss, granite, quartzite
R5	Very strong	100 - 250	4 - 10	Specimen requires many blows of a geological hammer to fracture it	Amphibolite, sandstone, basalt, gabbro, gneiss, granodiorite, limestone, marble, rhyolite, tuff
R4	Strong	50-100	2-4	Specimen requires more than one blow of a geological hammer to fracture it.	Limestone, marble, phyllite, sandstone, schist, shale
R3	Medium strong	25-50	1-2	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single blow from a geological hammer.	Claystone, coal, concrete, schist, shale, siltstone
R2	Weak	5-25	(***)	Can be peeled with a pocket knife with difficulty, shallow indentation made by firm blow with point of a geological hammer	Chalk, rocksalt, potash
R1	Very weak	1-5	(***)	Crumbles under firm blows with point of a geological hammer, can be peeled by a pocket knife.	Highly weathered or altered rock
R0	Extremely weak	0.25-1	(***)	Indented by thumbnail	Stiff fault gouge

(*) Grade according to Brown (1981).
(**) Point load tests on rocks with a uniaxial compressive strength below 25 MPa are likely to yield highly ambiguous results.

- **Spacing Discontinuities:** The spacing of fractures can be characterized both in drill core and in exposed rock surfaces by measuring the distance between the fractures.

- **Condition of Discontinuity:** The condition of the discontinuities can have a significant impact on the behavior of the rock mass. This parameter includes evaluation of the length between fractures, type of fracture filling and the roughness and alteration of the discontinuity surfaces.

- **Water Condition:** Evaluation of the influence of the flow of water on the stability. It considers the flow observed, the relationship between the water pressure in the discontinuities and the field stress. It also considers the general qualitative observation related to groundwater.

Figure 6-2 shows the Rock Mass Rating (RMR `89), classification parameters and their ratings.

A. CLASSIFICATION PARAMETERS AND THEIR RATINGS

Parameter			Range of values						
1	Strength of intact rock material	Point-load strength index	>10 MPa	4-10 MPa	2-4 MPa	1-2 MPa	For this low range - uniaxial compressive test is preferred		
		Uniaxial comp. strength	>250 MPa	100-250 MPa	50-100 MPa	25-50 MPa	5-25 MPa	1-5 MPa	< 1 MPa
	Rating		15	12	7	4	2	1	0
2	Drill core Quality *RQD*		90%-100%	75%-90%	50%-75%	25%-50%	< 25%		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		> 2 m	0.6-2 . m	200-600 mm	60-200 mm	< 60 mm		
	Rating		20	15	10	8	5		
4	Condition of discontinuities (See E)		Very rough surfaces Not continuous No separation Unweathered wall rock	Slightly rough surfaces Separation < 1 mm Slightly weathered walls	Slightly rough surfaces Separation < 1 mm Highly weathered walls	Slickensided surfaces or Gouge < 5 mm thick or Separation 1-5 mm Continuous	Soft gouge >5 mm thick or Separation > 5 mm Continuous		
	Rating		30	25	20	10	0		
5	Ground water	Inflow per 10 m tunnel length (l/m)	None	< 10	10-25	25-125	> 125		
		(Joint water press)/ (Major principal σ)	0	< 0.1	0.1,-0.2	0.2 0.5	> 0.5		
		General conditions	Completely dry	Damp	Wet	Dripping	Flowing		
	Rating		15	10	7	4	0		

RMR BIENAWSKI (1989) = Sum of Scores 1 + 2+ 3+ 4+ 5					
Class	I	II	III	IV	V
Quality	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock
Rating	100 - 81	80 - 61	60 - 41	40 - 21	20 - 0

Figure 6-2 Rock mass classification Bieniawski 1989 (RMR`89).

Therefore, based on the parameters evaluated and applied to the GM16-04 drill core, the geotechnical quality of the rock mass in the portal area is estimated using a depth between 117 and 182 feet in the referenced drill hole.

Table 6.2 shows the estimated geotechnical qualities compared with the available Calico drill database and Table 6.3 shows the rock mass classification for the geotechnical qualities estimated in the portal area.

Table 6.2 RMR '89, GM16-04 drill hole.

Calico, 2017				GMS, 2019			
From [ft]	To [ft]	RMR	Class	From [ft]	To [ft]	RMR	Class
117	122	61	II	115	126	70	II
122	127	37	IV	126	127	10	V
127	132	36	IV	127	137	50	III
132	135	38	IV	137	139	10	V
135	140	27	IV	139	145	65	II
140	145	74	II	145	158	85	I
145	150	63	II	158	169.8	55	III
150	152	82	I	169.8	179.5	65	II
152	157	77	II	177	189	70	II
157	160	41	III				
160	162	82	I				
162	167	50	III				
167	172	35	IV				
172	177	50	III				
177	182	36	IV				

Table 6.3 Classification of rock mass, RMR '89 of portal area.

Classification	Median Score	Minimum Score	Maximum Score	Rock Quality
RMR	65	10	85	Good to Fair

From the estimated RMR'89 values presented in Table 6.3, and using Equation 1, the GSI of the portal area was calculated (determined empirically). (Table 6.4).

Table 6.4 Classification of rock mass, GSI of portal area.

Classification	Median Score	Minimum Score	Maximum Score	Rock Quality
GSI	60	5	80	B-VB/G-F(*)

B: Blocky; VB: Very Blocky; G: Good; F: Fair.

6.2. Estimation of Rock Mass Properties

The estimation of the strength properties was made based on the geotechnical characteristics, the technical literature and the experience of the authors in materials with similar characteristics.

Table 6.5 indicates the estimated strength properties for the portal stability study.

Table 6.5 Strength properties estimated for stability analysis.

Lithology	Friction Angle[°]	Cohesion [kPa]	Unit Weight [ton/m3]
Sandstone/Arkose	37	350	2.3
Siltstone	39	400	2.5
Clay	35	200	2.2
Sinter	35	350	2.2
Coluvium	37	50	2.0

7. SUPPORT DESIGN

The support design was carried out during the PFS study (Mine Development Associates, 2018), by Ausenco, using the empirical methodology proposed by Barton (1974 and 1980) and base on their experience with similar projects.

The proposed support for the portal slopes and the initial stretch of the decline ramp is presented in Table 7.1.

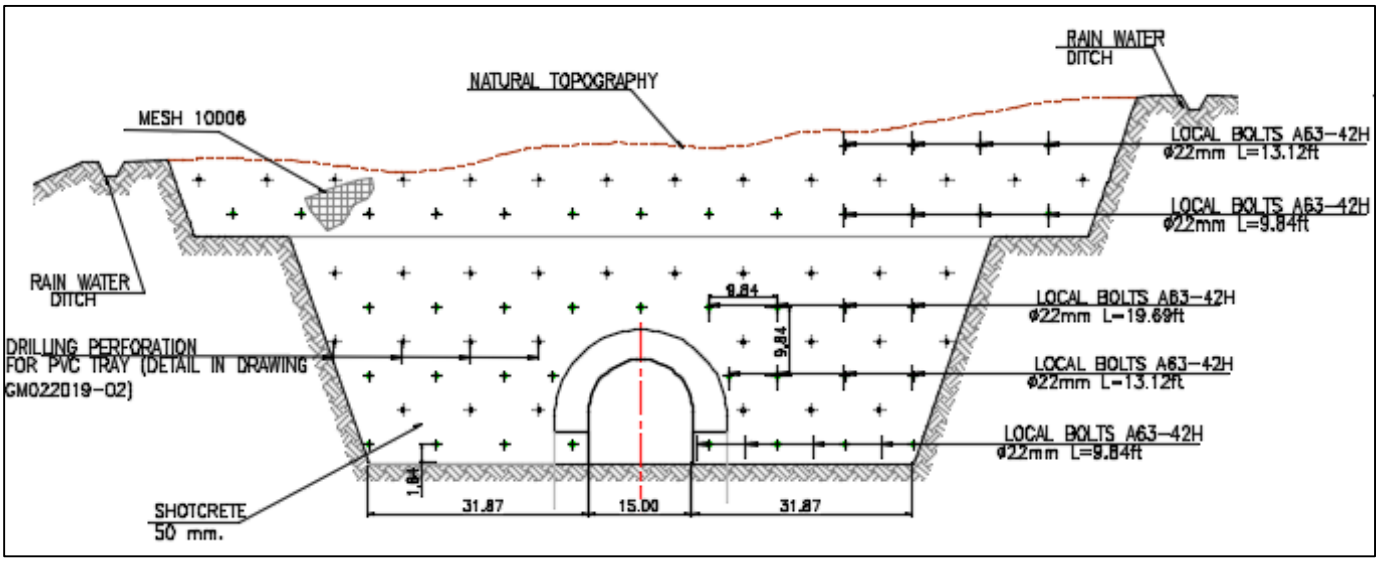
Table 7.1 Support design of the portal entry.

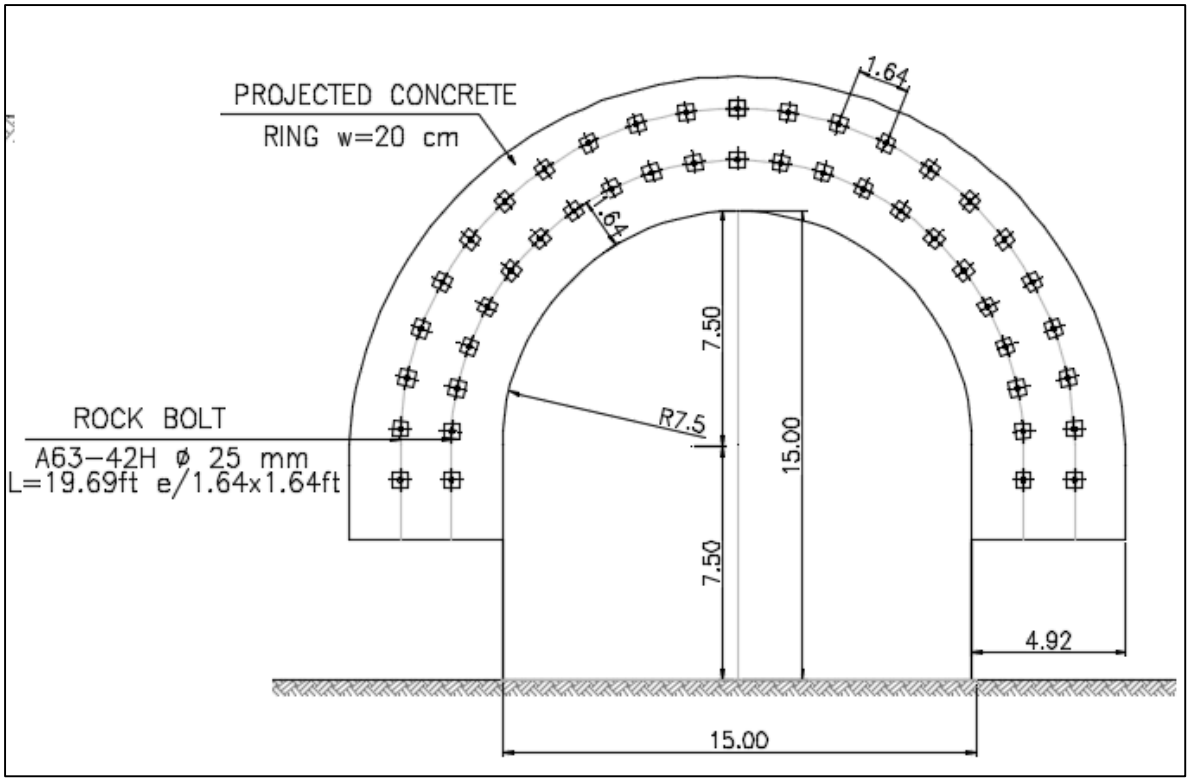
Infrastructure	Support	Diameter [mm]	Length [ft] (*)	Shotcrete [mm]
Portal Slopes	Bolt A63-42H	22	9.84 (3 m); 13.12 (4 m); 19.69 (6 m)	50
Decline Ramp (**)	Bolt A63-42H	25	9.84 (3 m)	200
	Reticulated Frames	22	61.58 (19 m)	25

(*) According to drawing GM022019-03.
(**) Support for the initial 61.58 ft. length.

The performance of the proposed bolts will be evaluated in the current stability analysis of the portal slopes.

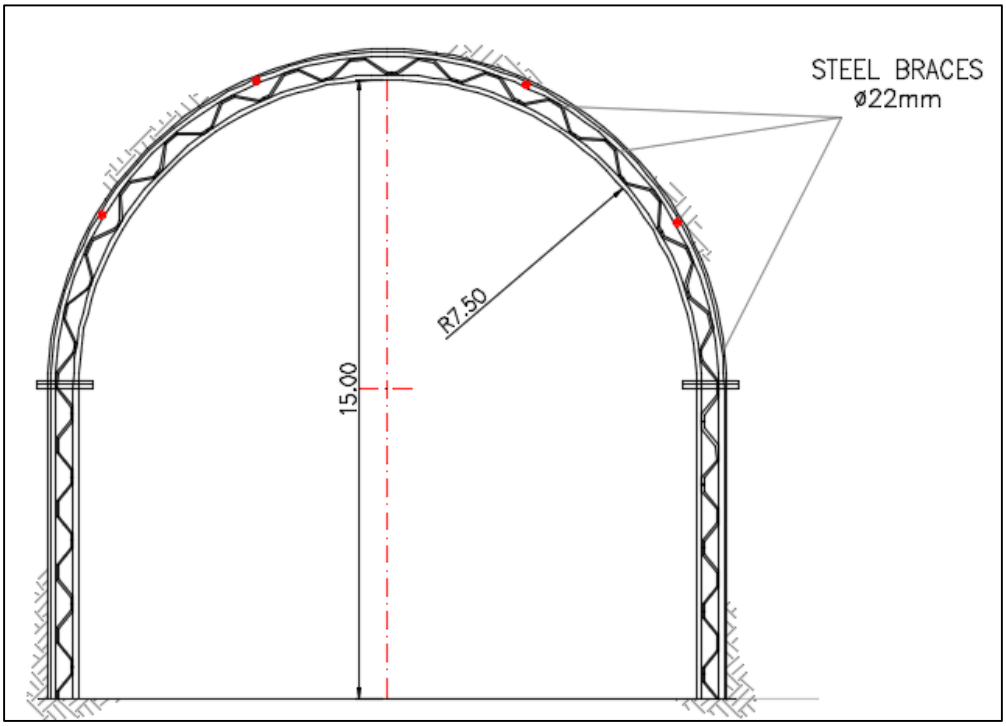
Figure 7-1 is a frontal view of the portal slopes support, Figure 7-2 is a side view of the bolts and reticulated frames in the decline ramp and Figure 7-3 is a 3D frontal perspective of the portal slopes and the proposed support elements.





Source: GM022019-02.

Figure 7-1 Support design of the portal slopes and portal entry.



Source: GM022019-03.

Figure 7-2 Support design of the initial stretch of the decline ramp.

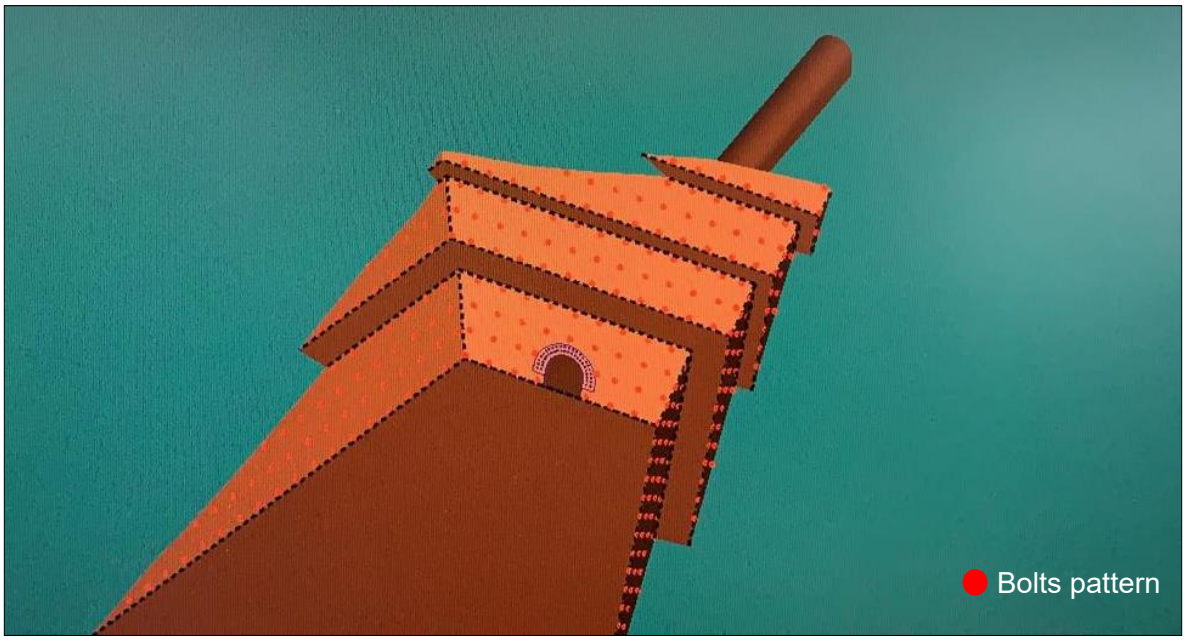


Figure 7-3 Supported portal slopes – Frontal perspective (3D).

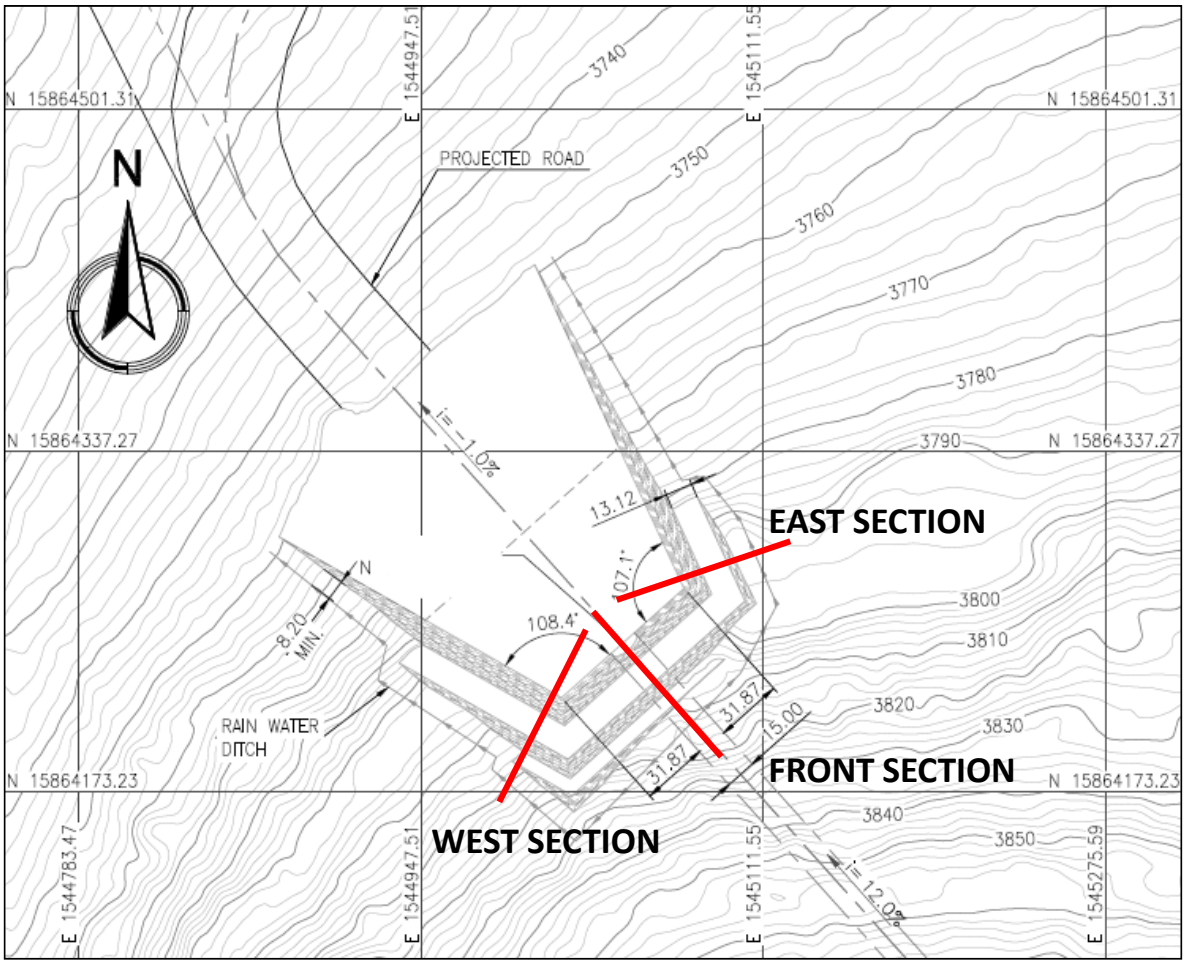
Source: (a), (b), (c) www.grupoemo.com; (d) www.portalminero.com

Figure 7-4 Examples of mine portals constructed; (a) and (b) Cochise Mine, Guatemala; (c) La Hamaca Mine, Guatemala; (d) Chuquicamata Underground, Chile.

8. STABILITY ANALYSIS

The portal area stability is based on the estimated geotechnical characterization and the degree of fractured rock mass present in the portal area. The stability analysis has considered modes of instability that occur at rock mass level; without structural control.

To carry out the analysis, three representative perpendicular and transversal sections were selected in the portal as shown in Figure 8-1.



Source: GM022019-01, 2019.

Figure 8-1 Location of analysis sections.

The stability analysis is based on the geology shown in Figure 6-1. The geological cross section was provided by Calico.

The stability analyses were completed using limit equilibrium methods, which assigns a safety factor for a potential slip surface based on a defined geometry. The safety factor depends on the geometry

of the potential slip surface, on the strength properties of the materials and on the site conditions analyzed (pore pressures, surface loads and seismic forces).

Calculations were carried out using the Slide v6.0 program of Rocscience, which allows for determination of safety factors associated with a large number of potential slide surfaces. The safety factors were calculated using the Morgenstern-Price method (Generalized Limit Equilibrium, GLE), which is based on an analysis that considers the balance of forces and moments.

A Safety Factor ≥ 1.8 was assumed as acceptability criterion for the static analysis.

The results of the stability analyses are presented in Table 8.1, considering the frontal, east and west slope orientations, with and without the support design.

Table 8.1 Slope stability analyses results.

Slope	Static Safety Factor	Static Safety Factor Supported
Frontal	2.12	2.13
East	2.72	2.74
West	2.32	2.36

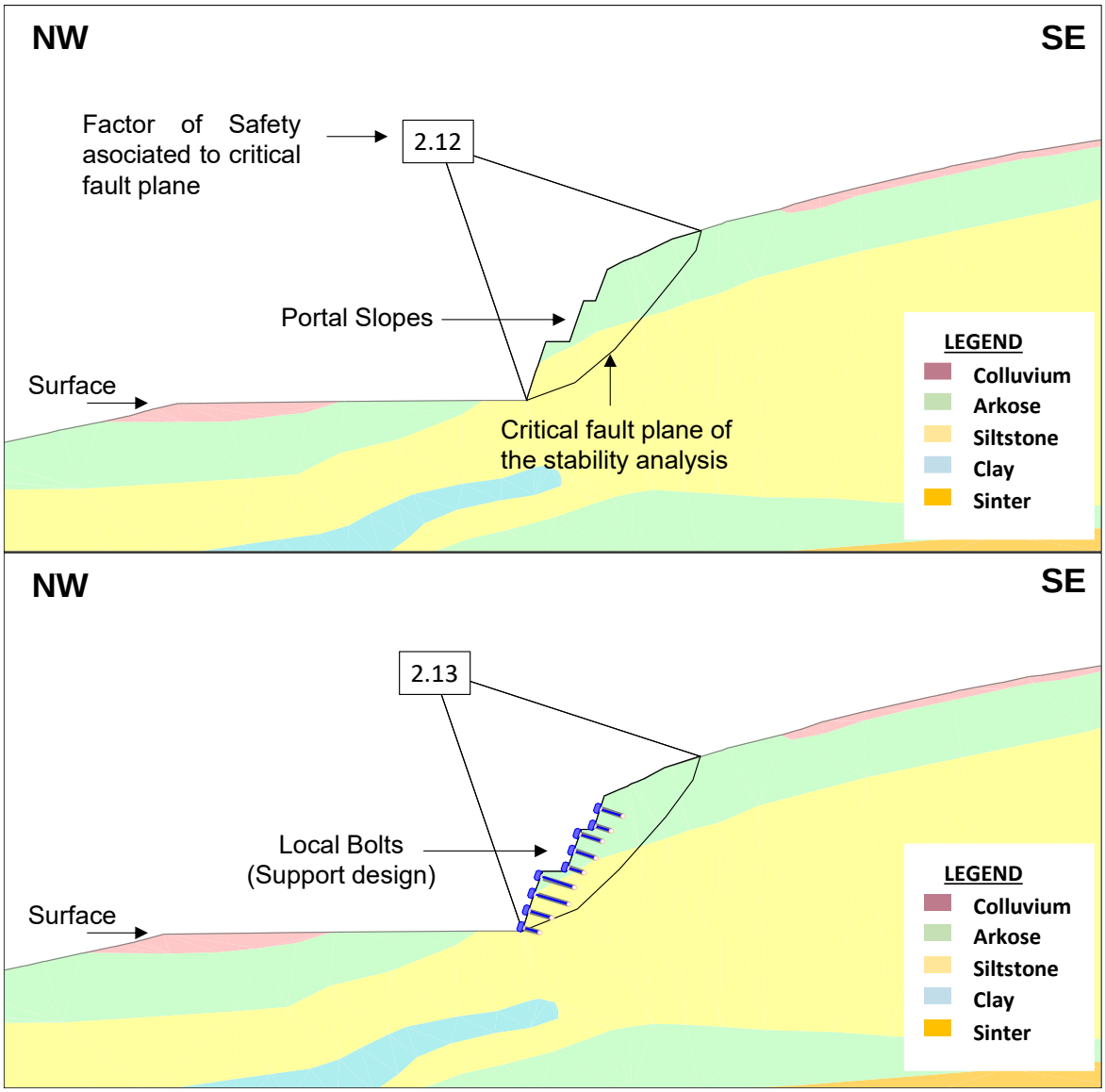


Figure 8-2 Slope stability analyses – Frontal Section.

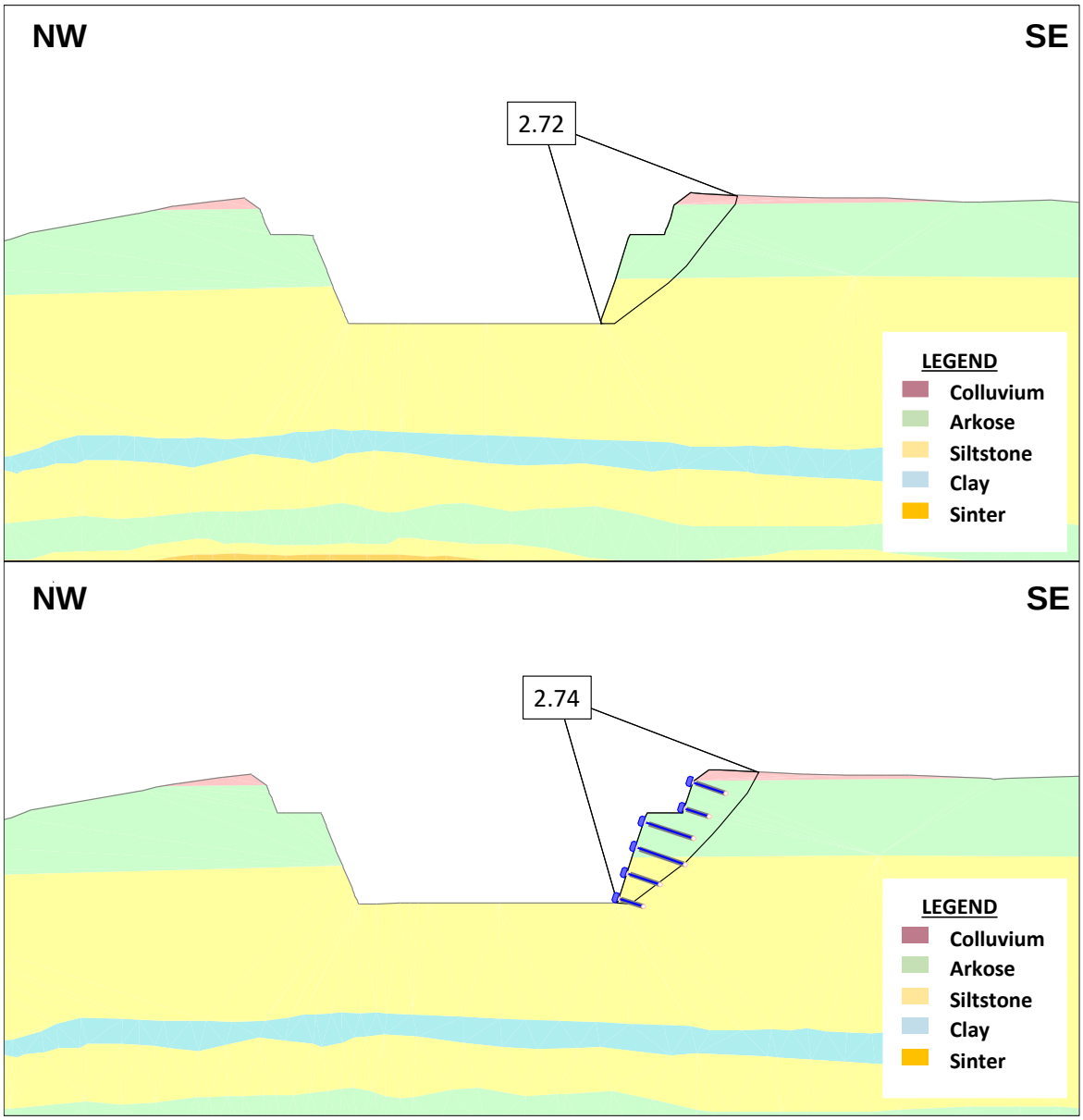


Figure 8-3 Slope stability analyses – East Section.

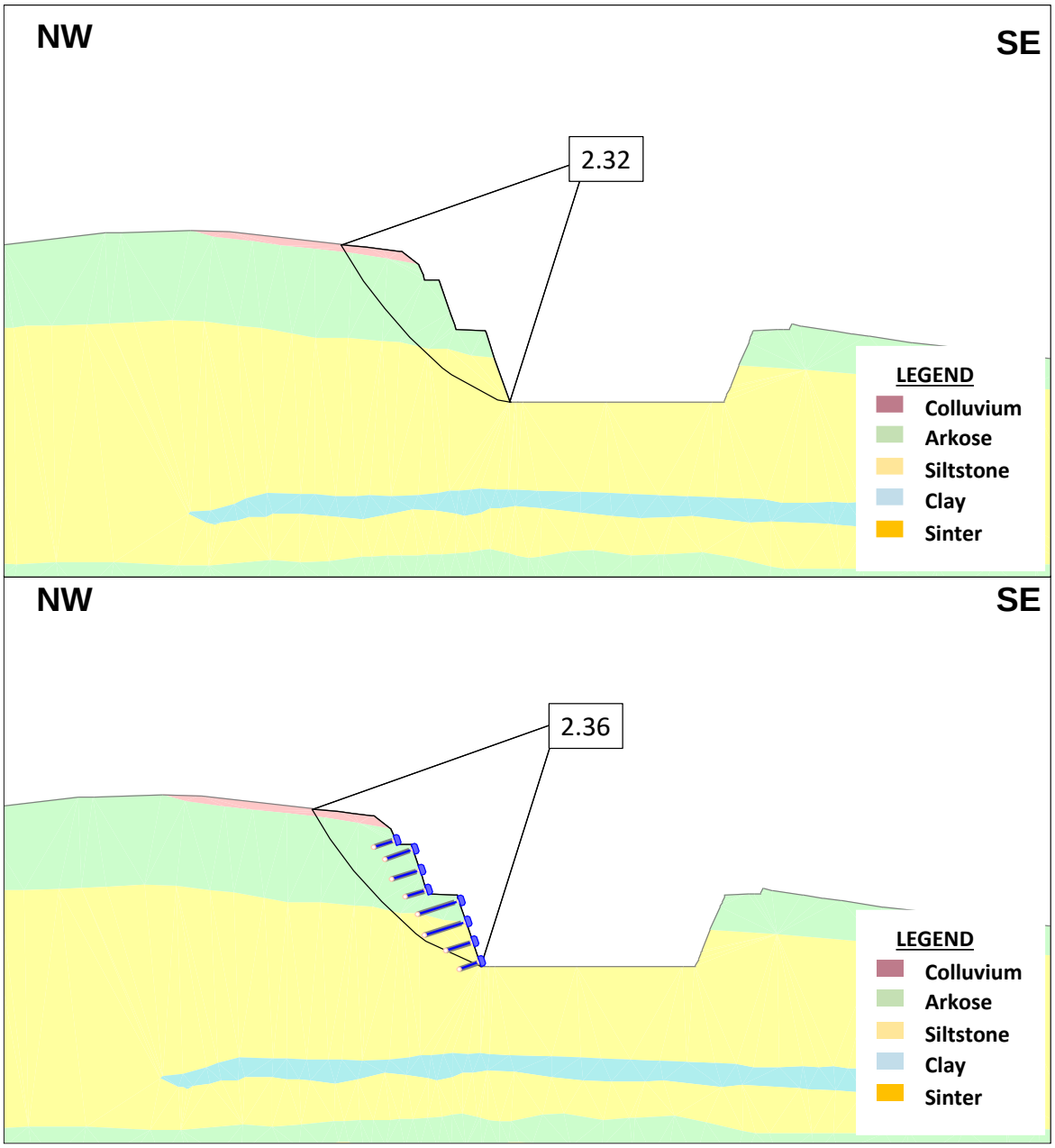


Figure 8-4 Slope stability analyses – West Section.

9. CONCLUSIONS

Based on the results, the most relevant conclusions are:

- Rock mass characterization in the portal area was based on detailed geological interpretation provided by Calico´s geologist and the closest drill hole GM16-04.

- The geotechnical characterization of drill hole GM16-04, using a zone of influence between 117 feet and 182 feet deep, indicates a median of 53 points according to the RMR '89 classification. This corresponds to the geotechnical quality of *Good* rock.

- The estimation of the rock mass strength properties was based on the geotechnical characterization of the drill cores (GM16-04), using technical literature and the experience of the authors in materials of similar characteristics.

- Detailed geological information from surface mapping and nearby drill holes indicates that the front slope of the portal contains almost 50% of colluvium. Therefore, it was necessary to increase the portal excavation size to reduce the amount presence of colluvium in the portal slopes. The portal base evaluation was modified from 3750 feet to 3749 feet.

- Slopes that contain colluvium in their upper bench have been modified to equal the angle for unconsolidated materials.

- Stability analyses were carried out using the Slide v6.0 program from Rocscience. The reported safety factors were calculated using the Morgenstern-Price method (Generalized Limit Equilibrium, GLE), which is based on an analysis that considers the balance of forces and moments.

- Support design for portal stability was made using empirical methods during the PFS and that method was also used in this study.

- The water variable has not been incorporated in the study because there was no water encountered at or near the surface in the portal area.

- The safety factors evaluated for the slopes in the design are adequate for the acceptability criterion adopted for the project.

10. RECOMMENDATIONS

As a result of the present study, the following is recommended:

- Detailed structural geology information should be revised to incorporate wedges, planes and toppling. The design should then be revised if necessary, to ensure stability and safely.

- The portal slopes have a slope angle H: V / 1: 3, a bench height of 32.81 feet and berm width of 13.12 feet for the portal opening and a bench height of 22.97 feet and berm widths of 6.56 feet for the upper benches. The bench face angle is 72° and 59° equivalent global slope angle. Based on the geotechnical conditions, it is recommended that the geometric configuration does not exceed these specifications.

- The support application must be carried out for safety reasons in the excavation process, the sequence must be from top to bottom as the excavation is generated. At the same time, the berms and benches must be cleaned before applying the support elements.

- The following support is recommended for the portal in order to ensure the local and global stability of the slopes during the life of the project:

    - A #10006 mesh is required on the entire slope surface, anchored 5 feet from the slope face and dropping the rest of the mesh, with an overlap of 1 foot, fastened to the berm by bolts 9.84 feet long and spaced at 4,9 feet.

    - A63-42H quality steel bolts, 22 mm in diameter and 9.84, 12.13 and 19.69 feet in length.

    - 200 mm x 200 mm x 4 mm plate and spherical nut.

    - Place 50 mm shotcrete thickness on the entire slope and upper berms.

    - In addition, drainage tubes should be placed in a grid of 9.84 feet x 9.84 feet when shotcrete is placed.

- The following support is recommended for the inner reinforcement section, in order to ensure the stability of the first 32.8 feet of the decline ramp excavation:

    - Reticulated steel frames, spaced every 3.28 feet.

    - A63-42H steel bolts, 25 mm in diameter and 9.84 feet in length, placed on the roof and walls, spaced at 4.9 feet.

    - Shotcrete of 200 mm thickness placed in roof and walls, armed with electro-welded grid mesh 150mm x 150 mm and 9.2 mm wire.

- The portal area is a designed for the mine life, will require constant evaluation and if necessary, revision to ensure stability and safety.

11. REFERENCES

Mine Development Associates, 2019, *Preliminary Feasibility Study and Technical Report for the Grassy Mountain Gold and Silver Project, Malheur County, Oregon, USA*, July 9, 2019.

Barton, N.; Lien, R. & Lunde, J., 1974, *Engineering classification of rock masses for the design of tunnel support*, Rock Mechanics: Vol. 6, N° 4.

Barton, N., 2002, *Some new Q-value correlations to assist in site characterization and tunnel design*: Int. J Rock Mech and Min Sci, (39), p. 185-21.

Bieniawski, Z.T. 1976. *Rock mass classification in rock engineering*. In Exploration for rock engineering, proc. of the symp., (ed. Z.T. Bieniawski) 1, 97-106. Cape Town: Balkema.

Bieniawski, Z.T. 1989. *Engineering rock mass classifications*. New York: Wiley.

Brady, B.H. & Brown, E.T. (2004): *ROCK MECHANICS FOR UNDERGROUND MINING*, 3rd Ed. Kluwer Academic Publishers, Netherlands.

Deere D.U. 1968. Chapter 1: *Geological considerations*. In Rock Mechanics in Engineering Practice (eds. Stagg K.G. and Zienkiewicz, O.C.), 1-20. London: John Wiley and Sons.

Gonzalez de Vallejo (2004), *Ingeniería Geológica*: Pearson Educación, Madrid.

Hoek, E. 1983. *Strength of jointed rock masses*, 23rd. Rankine Lecture. Géotechnique 33(3), 187-223.

Hoek, E. 1994. *Strength of rock and rock masses*, ISRM News J, 2(2), 4-16.

Hoek, E. and Brown, E.T. 1980a. *Underground excavations in rock*. London: Instn Min. Metall.

Hoek, E. and Brown, E.T. 1980b. *Empirical strength criterion for rock masses*. J. Geotech. Engng Div., ASCE 106(GT9), 1013-1035.

Hoek, E. and Brown, E.T. 1988. *The Hoek-Brown failure criterion - a 1988 update*. In Rock engineering for underground excavations, proc. 15th Canadian rock mech. symp., (ed. J.C. Curran), 31-38. Toronto: Dept. Civ. Engineering, University of Toronto.

Hoek, E., Marinos, P. and Benissi, M. 1998. *Applicability of the Geological Strength Index (GSI) classification for very weak and sheared rock masses*. The case of the Athens Schist Formation. Bull. Engng. Geol. Env. 57(2), 151-160.

Hoek, E. and Brown, E.T. 1997. *Practical estimates or rock mass strength*. Int. J. Rock Mech. Min.g Sci. & Geomech. Abstr. 34(8), 1165-1186.

Hoek, E. and Bray, J. (1981) *Rock Slope Engineering*, 3rd edn, IMM, London.

Rocscience Inc. – Slide v6.0 (2015): Slope Stability Analysis for Rock and Soil Slopes, Canada.

Proyecto Mina Cochise, San Marcos, Guatemala (2013-2014). http://www.grupoemo.com

Proyecto Mina La Hamaca, San Marcos Guatemala (2016). http://www.grupoemo.com

Portal Minero, Noticias/Principal. http://www.portalminero.com

Appendix T: Ecological Risk Assessment

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Technical Memorandum

To:	Nancy Wolverson	**Date:**	November 12, 2019
Company:	Calico Resources USA Corp.	**From:**	Rob Bowell
Copy to:	Rich DeLong, EM Strategies	**Reviewed by:**	Amy Prestia
Subject:	Numerical Prediction of Tailings Supernatant Pond Chemistry for the Grassy Mountain Project	**Project #:**	506800.030

1. Introduction

On behalf of Calico Resources USA Corp. (Calico), SRK Consulting U.S., Inc. (SRK) has developed a geochemical model that predicts the operational tailings supernatant pond chemistry for the Grassy Mountain Gold Project (Project) in Oregon. The purpose of the predictive calculations is to determine if the water exposed within the tailings impoundment during operations poses an ecological risk to wildlife.

This technical memorandum has been prepared to describe the model approach, inputs and present the model results. The characterization work completed for the Grassy Mountain Project, on which this predictive model based is reported in the *2019 Baseline Geochemical Characterization Report for the Grassy Mountain Project* (SRK, 2019).

2. Background

2.1 Project Description

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale and will include construction, operation, reclamation, and closure of the underground and precious metal milling operation. The proposed mining and precious metal processing operations will consist of underground mine and ore processing facilities, including a conventional mill and tailings storage facility, and waste rock storage areas, as well as other support facilities (Figure 2-1).

Calico proposes to mine approximately 3 million tons of mill-grade ore and 0.2 million tons of waste rock (total of 3.2 million tons). The material (both ore and waste) will be extracted from the underground mine using conventional underground mining techniques of drilling, blasting, mucking, loading, and hauling. Calico will use hydraulic loaders to load the ore and waste into the haul trucks. The haul trucks will transport the waste rock to the waste rock disposal areas near the tailings facility and transport the ore to the ROM stockpile adjacent to the crushing and milling facilities. The ore will be leached in a carbon-in-leach processing plant to recover the precious metals into a “pregnant” leach solution. The pregnant solution will then be processed for metal recovery and further off-site refining.

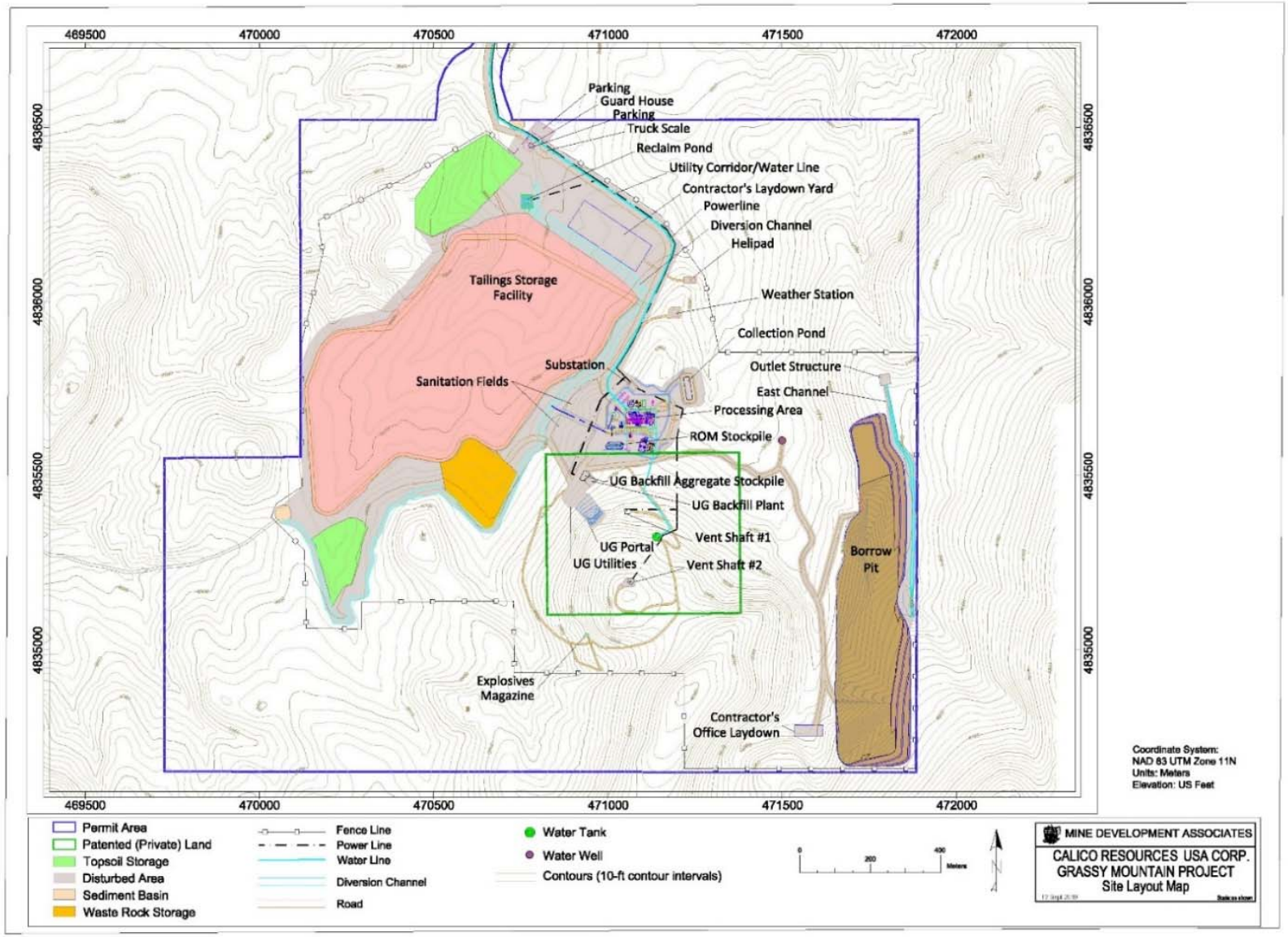

Figure 2-1: Grassy Mountain Site Layout

2.2 Topographic Setting and Climate

The Grassy Mountain property is located in the semi-arid plateau region of eastern Oregon. The local landscape is typical of a high mountain desert environment and range land. Terrain is gentle to moderate throughout the majority of the project study area, with elevations ranging from 3,330 to 4,300 feet above mean sea level (amsl).

Local weather data indicate a mean annual temperature of 52°F for the Project site, with daily temperatures ranging from an extreme low of -20°F in the winter to extreme highs of +100°F in the summer. Annual precipitation is approximately 9.8 inches, roughly half of which falls as snow between November and March. Winter and wet weather occasionally limit access to the Project site, but operations can typically be carried out year-round.

The data presented below in Table 2-1 are sourced from Golder (2019), where average monthly precipitation data for the Project area were compiled based on regression analysis of daily data from three nearby weather stations obtained from the Western Regional Climate Center (WRCC). Lake evaporation using the Combination Method of Penman was calculated using daily temperature, humidity, and wind speed from the Owyhee Ridge RAWS weather station (Golder, 2019). To obtain the one in one hundred (1:100) wet and dry year average monthly precipitation and lake evaporation values, a frequency analysis was performed on the annual precipitation and lake evaporation data from 1999 through 2017 and from 1999 through 2018, respectively. A three parameter log-normal distribution was used to generate the extreme annual rates (Golder, 2019)

Table 2-1: Grassy Mountain Site Precipitation and Lake Evaporation Data (Golder, 2019)

Month	Average Annual Precipitation	Average Annual Lake Evaporation	1:100 Wet Year Precipitation	1:100 Wet Year Lake Evaporation	1:100 Dry Year Precipitation	1:100 Dry Year Lake Evaporation
	in	in	in	in	in	in
January	0.93	0.85	1.50	0.79	0.27	1.07
February	0.62	1.31	1.00	1.21	0.18	1.65
March	0.97	2.69	1.56	2.49	0.29	3.39
April	1.14	3.81	1.83	3.52	0.34	4.8
May	1.49	5.28	2.40	4.88	0.44	6.65
June	0.89	6.37	1.43	5.89	0.26	8.02
July	0.51	8.16	0.82	7.54	0.15	10.27
August	0.31	7.04	0.50	6.51	0.09	8.86
September	0.46	4.39	0.74	4.06	0.14	5.53
October	0.83	2.95	1.33	2.73	0.24	3.71
November	0.73	1.31	1.17	1.21	0.22	1.65
December	0.89	0.79	1.43	0.73	0.26	0.99
Total	**9.77**	**44.97**	**15.71**	**41.55**	**2.88**	**56.59**

2.3 Tailings Geochemical Characterization

Geochemical characterization of material representative of tailings from the Grassy Mountain project has been completed and is described in the *Baseline Geochemical Characterization Report for the Grassy Mountain Project* (SRK, 2019). As part of this program, one sample of tailings material was collected from the metallurgical testing program conducted in 2015 at Resource Development Inc. The metallurgical test was conducted on a sample collected from core that consisted of a range of lithologies and gold grades (i.e., average ore grade and composition). The tailings sample was collected after Inco cyanide destruction using sodium bisulfite as a SO_2 source. Due to the consistent nature of the geology of the deposit and the fact that the deposit has been oxidized, major shifts in the ore (and tailings) geochemistry are not anticipated. Therefore, this sample is considered representative of unamended tailings material that will be generated as part of operations.

In 2018, three additional test residues were generated from metallurgical testing representative of the tailings material. These samples consist of a mixture of the primary lithologies that comprise the bulk of the ore and underwent cyanide destruction prior to geochemical testing to be consistent with OAR 340-043-0130 (1). Two buckets of tailings slurry per sample were submitted to McClelland Laboratories (MLI) for sample preparation and testing. The samples were allowed to settle and a sample of decant solution was collected from each of the six buckets for analysis. Following collection of the decant solution sample, the material from the first bucket (1 of 2) for each sample was air dried and each sample was individually blended and split to obtain samples.

The tailings geochemical characterization results indicate that despite low sulfide sulfur, the tailings material has a potential to generate acid due to the low neutralization potential (NP) of the material. The potential for tailings material to generate acid and leach metals was confirmed by the HCT results for the unamended tailings sample from the 2015 metallurgical test program. Under low pH conditions, iron, manganese and copper were mobile at concentrations greater than the Oregon Groundwater Quality Guidelines (OGWQG, OAR 340-40-020). In addition, there was an initial flush of several other constituents, including sulfate, aluminum, cadmium, fluoride, nickel, selenium, sulfate and zinc which likely reflects the removal of soluble oxidation products from the tailings material surfaces. Decant solution samples had slightly alkaline pH and exceeded the OGWQG for arsenic, selenium, sulfate and TDS.

ABA test results from the 2018 metallurgical samples were used to determine the amount of lime required to neutralize the tailings to meet the regulatory requirement of a Neutralization Potential Ratio (NPR) > 3 and a Net Neutralization Potential (NNP) > 20 kg $CaCO_3$/t. The ABA results for the tailings material demonstrate that there is some inherent variation in the sulfide sulfur and NP content of the tailings materials that is likely to occur during mining operations. In order to take into account the slight variation in NP and sulfide sulfur in the tailings material, the amount of lime amendment needs to exceed the minimum amount required to ensure that the neutralization criteria specified in the OAR 340-043-0130 (2) is met. Based on the testing conducted to date, the lime amendment rate needs to include the amount of lime required to neutralize the tailings to meet the regulatory guideline plus an additional 20%.

The amended tailings samples were submitted for the Synthetic Precipitation Leaching Procedure (SPLP) modified to use a water to solid ratio of 1:1 and distilled water for the lixiviant. The test results indicate that selenium is leached under alkaline conditions at concentrations above the OGWQG. Sulfate and chromium were also slightly elevated above the OGWQG for one sample and all other parameters were below the OGWQG.

3. Geochemical Model

3.1 General Approach

A predictive geochemical model has been developed to predict the Grassy Mountain tailings supernatant pond chemistry. The model assumes that tailings seepage flowing into the reclaim pond will consist of underdrain solution that is represented by SPLP data from the amended tailings samples that has been scaled to the tonnage of tailings material in the tailings impoundment, which varies over time. Based on the water balance, the water input to the mill consists of a blend of supernatant water, reclaim pond water and fresh make-up water. Supernatant pond water chemistry is assumed to be similar to this predicted mill water input chemistry. Evapoconcentration or dilution is applied to the supernatant pond water as a function of the balance of evaporation and precipitation occurring in the tailings storage facility. Modeling was completed for three phases of the mining operations under dry, wet and average precipitation conditions. The geochemical model has been developed from site-specific hydrological, geochemical and hydrochemical data. A description of the model inputs and assumptions are provided below.

3.2 Water Balance

A deterministic water balance model has been developed by Golder (2019) to evaluate water management of the proposed Grassy Mountain TSF including:

- Predicting the volume of the supernatant pool located at the southern boundary of the facility.
- Sizing the Reclaim Pond at the base of the facility
- Estimating make-up water requirements
- Estimating return water flow rates from the supernatant pool to the mill
- Estimating return water flow rates from the underdrain pond to the mill

The water balance accounts for inflows and outflows to the process and tailings disposal system as shown in Figure 3-1. Inflows to the system include precipitation falling on lined facilities, runoff from an upstream basin reporting to the TSF and fresh make-up water. Outflows include evaporation from the tailings surface, supernatant pool and reclaim pond plus water lost in the void spaces of the stored tailings.

The Golder (2019) water balance is based on (1) tailings testing results provided by Golder's Denver, Colorado Geotechnical Laboratory; (2) Data provided by Ausenco in the Grassy Mountain Prefeasibility Study Mass Balance report updated on March 29, 2018 (Doc. No. 101768-MB-0001); and (3) assumptions based on climatically and operationally similar mine sites in Nevada. The starting values that Golder used in their water balance include the following:

- Tailings are deposited in the TSF at a rate of 680 tons per day
- Tailings settled dry density of 80 lb/ft^3 at a saturation of 90 percent
- Tailings have a specific gravity of 2.65
- Tailings slurry contains 46 percent solids
- The dry beach area will make up 84% of the total exposed tailings area
- The wet beach area will make up 16% of the total exposed tailings area
- Evaporation rates from wet and dry tailings beach areas (presented in Table 3-1) were developed using the tailings testing data performed in the Denver, Colorado Golder geotechnical laboratory
- Underdrain rates are constant and vary by stage

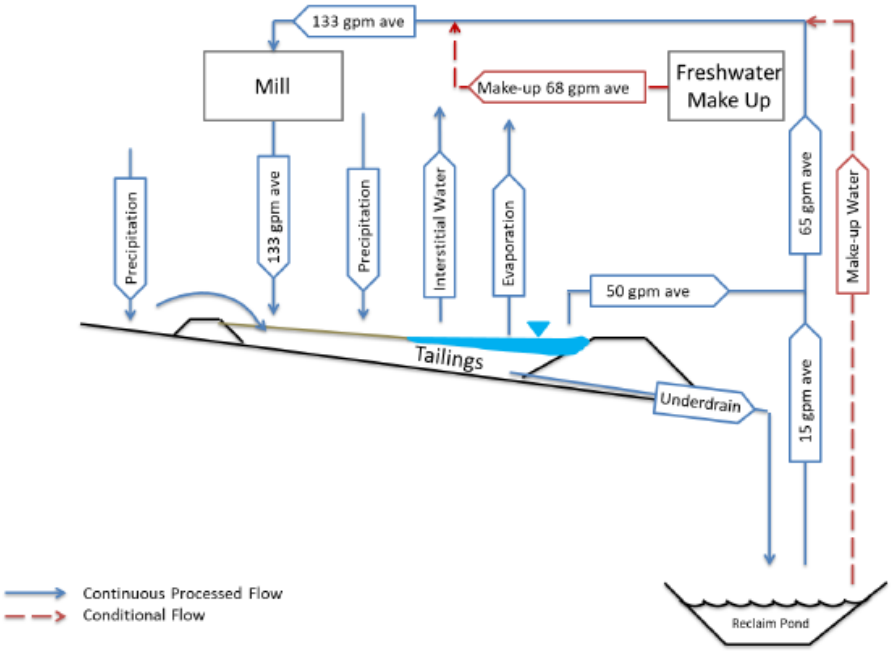

Figure 3-1: Process Flow Diagram (Golder, 2019)

Table 3-1: Tailings Beach Evaporation Rates

Stage	Wet Beach Evaporation Coefficient	Dry Beach Evaporation Coefficient
	% of ET	% of ET
1	92	48
2	93	38
3	94	33

The assumptions that Golder included in their water balance are:

- Pool evaporation is 75 percent of the evapotranspiration rate
- Tailings have a runoff coefficient of 100 percent
- Upstream basins reporting to the TSF have a runoff coefficient of 40 percent
- No seepage through the underlying geomembrane liner
- The surface area of the supernatant pool corresponds to a minimum pool depth of 5-feet required for normal reclaim pump operations
- The area of the supernatant pool for each stage was held constant assuming that all solution above the 5-foot operating pool would be removed monthly
- Water losses in the mill are negligible and are not considered in this analysis

Golder determined the reclaim rate after calculating the losses and gains to the tailings impoundment. If in a given month there was excess water in the supernatant pool, then the reclaim rate to the mill would be equal to the rate at which water is reporting to the TSF in the tailings slurry. Conversely, if there was a monthly deficit of water in the TSF, only the minimum amount of water necessary to maintain the 5-ft minimum supernatant pool depth would be removed from the supernatant pool. The remaining water demand of the mill to be satisfied by make-up water.

Given that the water demands of the Grassy Mountain TSF Mill are unknown, the make-up water required for mill operations was defined as the rate of evaporation from the tailings beach and supernatant pool plus interstitial water loss minus precipitation. The make-up water rate is less than or equal to the rate that water is reporting to the TSF in the tailings slurry. The results of the Golder (2019) water balance are shown in Table 3-2 for the average, wet year and dry year and indicate that the average reclaim rate from the supernatant pool is 54 gallons per minute (gpm) for Stages 1 through 3. The calculations used to produce these values are provided in Golder (2019).

Table 3-2: Reclaim Rates to Mill (gpm)

Month	Stage 1			Stage 2			Stage 3		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
January	71	106	117	69	111	118	67	118	119
February	54	84	117	49	84	118	42	85	119
March	32	77	117	19	73	118	5	71	119
April	8	65	117	0	58	118	0	51	119
May	0	57	110	0	46	118	0	35	119
June	0	8	43	0	0	39	0	0	72
July	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0
September	0	21	41	0	5	29	0	0	16
October	24	65	93	10	60	93	0	54	95
November	57	89	113	52	90	118	47	92	119
December	71	105	117	70	110	118	69	117	119
Minimum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Maximum	**71**	**106**	**117**	**70**	**111**	**118**	**69**	**118**	**119**
Average	**27**	**56**	**82**	**22**	**53**	**82**	**19**	**52**	**85**

3.3 Tailings Tonnages

The lined tailings areas and tailings capacity used in the Golder (2019) water balance and the geochemical modeling are summarized in Table 3-3 for each phase of mining.

Table 3-3: Total Lined Areas

Stage	Lined Area	Minimum Tailings Capacity
	ft^2	Million Tons
1	1,949,200	0.9
2	2,983,900	1.8
3	4,011,100	3.2

3.4 Solution Inputs

3.4.1 Rainwater chemistry

The rainwater chemistry used in the numerical predictions is mean rainwater chemistry data for Oregon, taken from Bormann et al. (1989). The rainwater chemistry was used to represent the make-up water added to the mill process as defined by the water balance. The average values used are shown below in Table 3-4.

Table 3-4: Average Rainwater Chemistry in Oregon

Parameter	Value
Temp (°C)	5
pH (s.u.)	4.88
pe (mV)	2
Alkalinity as HCO_3	0.05
Calcium	0.095
Chloride	2.34
Potassium	0.17
Magnesium	0.16
Nitrite	0.05
Nitrate	0.18
Sodium	1.33
Sulfate	0.64

Units in mg/L unless otherwise noted.

3.4.2 Tailings Supernatant Chemistry

For the purposes of this study, the initial tailings supernatant water was assumed to be similar to average SPLP results from the lime amended tailings samples at a liquid:solid ratio of 1:1 (Table 3-5). To estimate the tailings supernatant pond chemistry that is returned to the mill, evapoconcentration or dilution was applied to the SPLP chemistry as a function of the balance of evaporation and precipitation occurring in the tailings storage facility.

3.4.3 Tailings Underdrain Chemistry

Based on the water balance, tailings underdrain solution is the primary solution reporting to the reclaim pond. In order to simulate the underdrain chemistry, the average SPLP data from the amended tailings samples were scaled to the tonnage of tailings material in the tailings impoundment for each phase of mining and under minimum, maximum and average precipitation conditions.

Only a portion of the total mass of tailings within the facility will be effectively leached due to factors such as preferential fluid flow pathways and also due to reactive mass effects in which mass within larger particles is effectively encapsulated and therefore resistant to weathering. Based on supporting literature, the reactive fine content of the tailings has been estimated to be 60% (e.g. Benzaazoua et al., 2004; Erguler and Erguler, 2015). In addition, flow within the facility is assumed to be restricted to movement along preferential flow paths. The surface in contact with water represents 50% of the tailings volume. This therefore equates to a reactive mass of 60% of the tailings mass contacted within 50% of the facility (i.e., 60% of 50% = 30% reactive mass effectively leached). Using these assumptions, the average SPLP data were scaled to the mass of tailings and volume of mixed water to generate chemistry representative of underdrain water that reports to the reclaim pond. The results of these calculations are summarized in Table 3-5.

Table 3-5: Tailings Underdrain/Reclaim Pond Water Chemistry

Parameter	Average SPLP Chemistry	Tailings Underdrain/Reclaim Pond Water Chemistry								
		Phase 1			Phase 2			Phase 3		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Alkalinity	96.7	234.2	59.1	100.1	198.2	50	81.6	164.5	41.5	67.6
Aluminum	0.043	0.104	0.026	0.045	0.088	0.022	0.036	0.073	0.018	0.03
Antimony	0.101	0.245	0.062	0.105	0.207	0.052	0.085	0.172	0.043	0.071
Arsenic	0.427	1.034	0.261	0.442	0.875	0.221	0.36	0.727	0.183	0.298
Barium	0.057	0.138	0.035	0.059	0.117	0.029	0.048	0.097	0.024	0.04
Beryllium	0.0001	0.00024	0.00006	0.00010	0.00021	0.00005	0.00008	0.00017	0.00004	0.00007
Boron	0.028	0.068	0.017	0.029	0.057	0.014	0.024	0.048	0.012	0.02
Cadmium	0.0002	0.0005	0.0001	0.0002	0.0004	0.0001	0.0002	0.0003	0.00009	0.0001
Calcium	231	560	141	239	474	120	195	393	99	161
Chloride	12.3	29.8	7.52	12.74	25.22	6.36	10.38	20.93	5.28	8.6
Chromium	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.002	0	0.001
Cobalt	0.118	0.286	0.072	0.122	0.242	0.061	0.1	0.201	0.051	0.082
Copper	0.0207	0.05	0.013	0.021	0.042	0.011	0.017	0.035	0.009	0.014
Cyanide	0.028	0.068	0.017	0.029	0.057	0.014	0.024	0.048	0.012	0.02
Fluoride	0.28	0.678	0.171	0.29	0.574	0.145	0.236	0.477	0.12	0.196
Iron	0.028	0.069	0.017	0.029	0.058	0.015	0.024	0.048	0.012	0.02
Lead	0.0006	0.0015	0.0004	0.0006	0.0012	0.0003	0.0005	0.0010	0.0003	0.0004
Lithium	0.094	0.228	0.057	0.097	0.193	0.049	0.079	0.16	0.04	0.066
Magnesium	3.45	8.36	2.11	3.57	7.07	1.79	2.91	5.87	1.48	2.41
Manganese	0.036	0.087	0.022	0.037	0.074	0.019	0.03	0.061	0.015	0.025
Mercury	0.013	0.031	0.008	0.013	0.027	0.007	0.011	0.022	0.006	0.009
Molybdenum	0.085	0.206	0.052	0.088	0.174	0.044	0.072	0.145	0.037	0.059
Nickel	0.004	0.008	0.002	0.004	0.007	0.002	0.003	0.006	0.002	0.002
Nitrate	0.215	0.521	0.131	0.223	0.441	0.111	0.181	0.366	0.092	0.15
pH (s.u.)	8.22	8.22	8.22	8.22	8.22	8.22	8.22	8.22	8.22	8.22
Phosphorous	0.011	0.027	0.007	0.011	0.023	0.006	0.009	0.019	0.005	0.008
Potassium	40.38	97.8	24.7	41.8	82.8	20.9	34.1	68.7	17.3	28.2
Selenium	0.045	0.109	0.028	0.047	0.092	0.023	0.038	0.077	0.019	0.031
Silver	0.00035	0.00085	0.00021	0.00036	0.00072	0.00018	0.00030	0.00060	0.00015	0.00024
Sodium	461	1117	282	478	945	239	389	785	198	322
Strontium	0.654	1.584	0.4	0.677	1.341	0.338	0.552	1.113	0.281	0.457
Sulfate	1463	3544	894	1515	2999	757	1234	2490	628	1022
Thallium	0.002	0.004	0.001	0.002	0.004	0.001	0.002	0.003	0.001	0.001
Tin	0.04	0.097	0.024	0.041	0.082	0.021	0.034	0.068	0.017	0.028
Titanium	0.007	0.017	0.004	0.007	0.014	0.004	0.006	0.012	0.003	0.005
Uranium	0.014	0.034	0.009	0.015	0.029	0.007	0.012	0.024	0.006	0.01
Vanadium	0.0007	0.0017	0.0004	0.0007	0.0014	0.0004	0.0006	0.0012	0.0003	0.0005
Zinc	0.02	0.048	0.012	0.021	0.041	0.01	0.017	0.034	0.009	0.014

Units in mg/L unless otherwise noted.

3.5 Model Code

Numerical predictive calculations were developed using the USGS thermodynamic code PHREEQC and the Minteq.v4 thermodynamic database supplied with the v3.5.0-14000 version of PHREEQC (released November 9, 2017). This thermodynamic database is widely used for geochemical modeling and was selected for this study because it is publicly and freely available and includes the full range of elements for consideration in this water quality prediction as well as key sorption reactions for iron oxyhydroxides.

The PHREEQC model consists of several components including the input data file, the thermodynamic database, the executable code and the output file. The input file will consist of a series of logic statements and commands that define each of the components of the system and explains how these components interact. The input file is read by the executable code and commands are executed in a stepwise manner. Influent component waters are speciated and mixed to generate a series of intermediate waters, solid phases, and adsorbed phases. Selected outputs are specified and organized in various output files for analysis of results. PHREEQC operates on the basis of one kilogram (kg), which is equivalent to one liter of solution (in dilute systems).

3.6 Solubility Controls and Trace Element Adsorption

It is assumed that water within the system will mix evenly and completely. Under these conditions, the solutes in solution will react with each other and may form chemical precipitates if the concentrations and geochemical conditions (Eh, pH, pCO_2, pO_2, and ionic strength) allow minerals to become oversaturated. The geochemical model requires the specification of a number of equilibrium phases that are allowed to precipitate if they become oversaturated. The suite of minerals chosen for the geochemical model was based on the geology and mineralogy of the deposit and an assessment of mineral phases that are close to saturation based on the initial model iterations. The mineral phases allowed to form in the geochemical model are listed in Table 3-6. An equilibrium with atmospheric partial pressure of CO_2 and O_2 was maintained throughout the model.

Table 3-6: Mineral Phases Included in the Geochemical Models

Equilibrium Phase	Ideal Formula
Anglesite	$PbSO_4$
Barite	$BaSO_4$
Calcite	$CaCO_3$
Cerussite	$PbCO_3$
Diaspore	AlO(OH)
Ferrihydrite	$5Fe_2O_3.9H_2O$
Fluorite	CaF_2
Gypsum	$CaSO_4.2H_2O$
Malachite	$Cu_2(CO_3)(OH)_2$
Quartz	SiO_2
Rhodochrosite	$Mn^{2+}CO_3$
$SnSO_4$	$SnSO_4$

Once formed, it is assumed that these mineral precipitates are no longer available for geochemical reactions. This is a reasonable assumption unless the pH or redox conditions change substantially. Such significant changes in pH are considered unlikely based on the neutral effluent chemistry observed from the lime amended tailings.

In solution, trace element concentrations are mostly controlled by adsorption onto common mineral phases or are removed from solution through a process of co-precipitation. In the geochemical models used for this Project, it was assumed that trace metals may be removed from solution via sorption onto freshly generated mineral precipitates such as iron oxides. Ferrihydrite ($5Fe_2O_3.9H_2O$) represents the primary sorption surface. Ferrihydrite ($5Fe_2O_3.9H_2O$) was selected as a sorption surface because it is a common sorption substrate in oxygenated natural waters and because the trace element sorption thermodynamic properties of these reactions are well defined by numerous empirical studies. Adsorption of soluble phases to hydrous ferric oxides (HFO) is highly pH dependent as is the solubility of HFO itself. Below a pH of around 4.5 s.u., only minimal sorption of most dissolved metal species is observed (Stumm and Morgan, 1996). The mass of ferrihydrite used in the models is assumed to be identical to the mass of the mineral phase ferrihydrite precipitated in the previous model reaction step and is controlled by the chemistry of the system.

The model assumes that the ferrihydrite is characterized by both strong (HFO_s) and weak (HFO_w) surface adsorption sites. In order to be consistent with the properties of ferrihydrite published by Dzombak and Morel (1990) the geochemical models assume a surface site density of 0.2 moles of weak sites and 0.005 moles of strong sites per mole of ferrihydrite. Any HFO/ferrihydrite will therefore originate from the precipitation of oversaturated mineral phases that develop upon solution mixing.

As with mineral phase precipitation, the mass of trace elements removed through adsorption is assumed to be permanently removed from the system following incorporation and co-precipitation with the HFO phase, because it is unlikely that desorption due a major shift in pH or redox conditions will occur. The models rely on an external database of thermodynamic constants for mineral phase precipitates and sorbed surface complexes that are valid at 25°C and 1 atmosphere of pressure.

4. Geochemical Model Results

The predicted water chemistry for the supernatant pond under dry, average and wet conditions is summarized in Table 4-1 for each phase of mining. In general, the supernatant pond chemistry is predicted to have an alkaline pH due to the addition of lime to the tailings. Under these high pH conditions, metals content is generally low with the exception of arsenic. Although some arsenic is adsorbed, no arsenic phases were predicted to be saturated in the model. Wet years tend to yield higher concentrations of sulfate and metals presumably due to flushing of the tailings by rainwater and less make-up water being added to the mill process. As shown in Table 4-1, the predicted supernatant pond chemistry is comparable for the three phases of mining.

Table 4-1: Predicted Supernatant Pond Chemistry

Parameter	Phase 1			Phase 2			Phase 3		
	DRY	AVG	WET	DRY	AVG	WET	DRY	AVG	WET
Alkalinity	21.1	34.9	44.1	12.9	32.9	44.2	11.7	33.8	44.0
Aluminum	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002
Antimony	0.030	0.049	0.072	0.019	0.046	0.073	0.016	0.045	0.075
Arsenic	0.127	0.207	0.304	0.079	0.194	0.305	0.068	0.190	0.315
Barium	0.0049	0.0040	0.0034	0.0064	0.0041	0.0034	0.0070	0.0041	0.0034
Beryllium	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Boron	0.008	0.014	0.020	0.005	0.013	0.020	0.004	0.012	0.021
Cadmium	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001
Calcium	69	113	162	43	106	163	37	103	166
Chloride	5.41	7.37	9.70	4.26	7.07	9.77	4.01	6.96	10.02
Chromium	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001
Cobalt	0.035	0.058	0.084	0.022	0.054	0.085	0.019	0.053	0.087
Copper	0.005	0.007	0.007	0.003	0.007	0.007	0.003	0.007	0.007
Cyanide	0.008	0.014	0.020	0.005	0.013	0.020	0.004	0.012	0.021
Fluoride	0.083	0.137	0.200	0.052	0.128	0.201	0.045	0.125	0.207
Iron	0.0003	0.0002	0.0001	0.0005	0.0002	0.0001	0.0006	0.0002	0.0001
Lead	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003
Lithium	0.028	0.046	0.067	0.017	0.043	0.068	0.015	0.042	0.070
Magnesium	1.15	1.78	2.53	0.77	1.67	2.54	0.69	1.64	2.62
Manganese	0.011	0.018	0.026	0.007	0.016	0.026	0.006	0.016	0.027
Mercury	0.004	0.006	0.009	0.002	0.006	0.009	0.002	0.006	0.010
Molybdenum	0.025	0.041	0.061	0.016	0.039	0.061	0.014	0.038	0.063
Nickel	0.001	0.002	0.003	0.001	0.002	0.003	0.001	0.002	0.003
Nitrate	1.24	1.39	1.56	1.16	1.38	1.59	1.14	1.36	1.58
pH (s.u.)	7.76	7.97	8.07	7.56	7.95	8.07	7.52	7.96	8.07
Phosphorous	0.003	0.005	0.008	0.002	0.005	0.008	0.002	0.005	0.008
Potassium	12.2	19.8	28.9	7.6	18.5	29.1	6.6	18.1	30.0
Selenium	0.013	0.022	0.032	0.008	0.021	0.032	0.007	0.020	0.033
Silica	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Silver	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003
Sodium	138	226	330	86	211	332	75	206	342
Strontium	0.195	0.319	0.467	0.121	0.299	0.470	0.105	0.292	0.484
Sulfate	436	713	1044	271	668	1050	235	652	1083
Thallium	0.001	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Tin	0.012	0.020	0.029	0.007	0.018	0.029	0.006	0.018	0.030
Titanium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Uranium	0.004	0.007	0.010	0.003	0.006	0.010	0.002	0.006	0.010
Vanadium	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001
Zinc	0.006	0.010	0.014	0.004	0.009	0.014	0.003	0.009	0.015

Units in mg/L unless otherwise noted.

5. Ecological Risk

The estimated reclaim pond and supernatant pond water qualities summarized in Table 3-5 and Table 4-1, respectively, were screened against site-specific mammalian and avian wildlife ecological risk benchmark criteria following guidance provided in the Guidelines for Ecological Risk Assessment (EPA, 1998) and the Guide for Performing Screening Ecological Risk Assessments at DOE Facilities (Suter, 1995). Information regarding wildlife receptors that could potentially be exposed to the water in the two ponds was obtained from the Calico Resources USA Corp Grassy Mountain Mine Project Malheur County, Oregon Wildlife Resources Baseline Report (EM Strategies, 2019).

An analysis of consumption of pond waters by selected site fauna using conservative exposure assumptions and no-observed-adverse-effect level (NOAEL) toxicological dose information indicates that harmful effects from the Supernatant Pond and Reclaim Pond water are not likely (Hazard Quotients < 1.0).

The conservative NOAEL denotes the level of exposure of an organism, found by experiment or observation, at which there is no biologically or statistically significant increase in the frequency or severity of any adverse effects of the tested protocol. Combined with conservative exposure assumptions for the wildlife receptors yields confidence in this conclusion.

6. References

Benzaazoua M., Bussière B., Dagenais A.M., Archambault, M. 2004. Kinetic tests comparison and interpretation for prediction of the Joutel tailings acid generation potential. Environ. Geol., 46, 1086–1101.

Bormann B.T.,Tarrant R.F., McClellan H.F., and Savage, T. 1989. Chemistry of Rainwater and Cloud Water at Remote Sites in Alaska and Oregon. Journal of Environmental Quality, 18, 149-152.

Dzombak, D.A. and Morel, F.M.M., 1990, Surface Complexation Modeling: Hydrous Ferric Oxide.

EM Strategies, 2019. Calico Resources USA Corp. Grassy Mountain Mine Project Malheur County, Oregon. Wildlife Resources Baseline Report. April, 2018. Revised October 2018. Revised January 2019.

Environmental Protection Agency (EPA), 1998, Guidelines for ecological risk assessment: document prepared by Risk Assessment Forum, EPA/630/R-95/002F, April 30, 1998,122 p., 2 appendices, accessed 28 October 2018 at https://www.epa.gov/sites/production/files/2014-11/documents/eco_risk_assessment1998.pdf.

Erguler Z.A., Erguler G.K. 2015. The effect of particle size on acid mine drainage generation: Kinetic column tests. Minerals Engineering, 76, 154–167

Golder, 2019. Grassy Mountain TSF Water Balance. Draft Technical Memorandum.

Parkhurst, D.L., Appelo, C.A.J. 2010. Users Guide to PhreeqC (Version 2)—A Computer Program for Speciation Batch-Reaction, One-Dimensional Transport and Inverse Geochemical Calculations. Distributed with PHREEQC Interactive Version 2.17.5.4799. USGS.

SRK Consulting, 2019. Baseline Geochemical Characterization Report for the Grassy Mountain Project.

Stumm, W. and Morgan, J.J. 1996. Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters.

Sutter, G.W., 1995. Guide for performing screening ecological risk assessments at DOE facilities: Technical memorandum prepared by Environmental Restoration Risk Assessment Program for U.S. Department of Energy, Office of Environmental Management and Lockheed Martin Energy Systems, Inc., ES/ER/TM-153, September 1995, 10 p., accessible at https://rais.ornl.gov/documents/tm153.pdf.

Appendix U: Inadvertent Discovery Plan

Inadvertent Discovery Plan for Cultural Resources

Grassy Mountain Mine Project

Calico Resources USA Corp **proposes to** construct, operate, reclaim, and close an underground mining and precious metal milling operation. In general, the proposed mining and precious metal processing operations will consist of an underground mine and ore processing facilities, including a conventional mill and tailings storage facility (TSF) and a waste rock storage area (WRSA), as well as other support facilities. The Project will include the following major components:

- One underground mine;
- One WRSA;
- One carbon-in-leach (CIL) processing plant;
- One borrow pit area;
- One TSF;
- Run-of-mine ore stockpile;
- One reclaim pond;
- A water supply well field and pipeline, associated water delivery pipelines, and power;
- A power substation and distribution system;
- One ventilation shaft;
- Access and haul roads;
- Ancillary facilities that include the following: haul, secondary, and exploration roads; truck workshop; warehouse; stormwater diversions; sediment control basins; reagent and fuel storage; storage and laydown yards; explosive magazines; fresh water storage; monitoring wells; meteorological station; an administration/security building; borrow areas; growth media stockpiles; and solid and hazardous waste management facilities to manage wastes; and
- Reclamation and closure, including the potential development of an evaporation cell for the TSF.

The Inadvertent Discovery Plan (IDP) should be followed if cultural materials including human remains are encountered during construction.

<u>Protocol for Coordination in the Event of Inadvertent Discovery:</u>

- In the event of an inadvertent discovery of possible cultural materials, including human remains, all work will stop immediately in the vicinity of the find. A 30-meter buffer should be placed around the discovery with work being able to proceed outside of this buffered area unless additional cultural materials are encountered.

- The area will be secured and protected.

- The Project Manager/Land Manager will be notified. The project/land manager will notify the State Historic Preservation Office (SHPO). If possible human remains are encountered, the Oregon State Police, Commission on Indian Services (CIS), SHPO, and appropriate Tribes will also be notified.

  Oregon State Police: Chris Allori 503-731-4717
  CIS: Karen Quigley 503- 986-1067
  Appropriate Tribes: As designated by CIS
  SHPO: Dennis Griffin 503-986-0674, John Pouley 503-986-0675, or Matt Diederich 503-986-0577.

- No work may resume until consultation with the SHPO has occurred and a professional archaeologist is able to assess the discovery.

- If human remains are encountered, do not disturb them in any way. *Do not call 911*. Do not speak with the media. Secure the location. Do not take Photos. The location should be secured and work will not resume in the area of discovery until all parties involved agree upon a course of action.

- A professional archaeologist may be needed to assess the discovery and they will consult with SHPO and appropriate Tribal Governments to determine an appropriate course of action.

- Archaeological excavations may be required. This is handled on a case by case basis by the professional archaeologist and Project Manager, in consultation with SHPO and appropriate Tribes.

When to Stop Work:

Construction work may uncover previously unidentified Native American or Euro-American artifacts. This may occur for a variety of reasons, but may be associated with deeply buried cultural material, access restrictions during project development, or if the area contains impervious surfaces throughout most of the project area which would have prevented standard archaeological site discovery methods.

Work must stop when the following types of artifacts and/or features are encountered:

Native American artifacts may include (but are not limited to):

- Flaked stone tools (arrowheads, knives scrapers etc.);
- Waste flakes that resulted from the construction of flaked stone tools;
- Ground stone tools like mortars and pestles;
- Layers (strata) of discolored earth resulting from fire hearths. May be black, red or mottled brown and often contain discolored cracked rocks or dark soil with broken shell;
- Human remains;
- Structural remains- wooden beams, post holes, fish weirs.

Euro-American artifacts may include (but are not limited to):

- Glass (from bottles, vessels, windows etc.);
- Ceramic (from dinnerware, vessels etc.);
- Metal (nails, drink/food cans, tobacco tins, industrial parts etc.);
- Building materials (bricks, shingles etc.);
- Building remains (foundations, architectural components etc.);
- Old Wooden Posts, pilings, or planks (these may be encountered above or below water);
- Remains of ships or sea-going vessels, marine hardware etc.;
- Old farm equipment may indicate historic resources in the area;
- Even what looks to be old garbage could very well be an important archaeological resource.

When in doubt, call it in!

Proceeding with Construction:

- Construction can proceed only after the proper archaeological inspections have occurred and environmental clearances are obtained. This requires close coordination with SHPO and the Tribes.

- After an inadvertent discovery, some areas may be specified for close monitoring or 'no work zones.' Any such areas will be identified by the professional archaeologist to the Project Manager, and appropriate Contractor personnel.
- In coordination with the SHPO, the Project Manager will verify these identified areas and be sure that the areas are clearly demarcated in the field, as needed.

Appendix V: Aggregate Application

May 2, 2019 18111356.004.L.REV0

Bob Brinkmann, RG
Oregon Department of Geology and Minerals Industries
229 Broadalbin St. SW
Albany, Oregon 97321

ABBREVIATED OPERATING PERMIT APPLICATION – GRASSY MOUNTAIN BASALT BORROW QUARRY

Dear Mr. Brinkmann,

Golder Associates, Inc. (Golder) is pleased to submit this abbreviated Operating Permit Application (OPA) on behalf of Calico Resources USA Corp (Calico) for the basalt borrow quarry at the proposed Grassy Mountain Mine. Submittal of this abbreviated OPA was recommended by the Oregon Department of Geology and Minerals Industries (DOGAMI) because the basalt borrow quarry will be situated within the Division 37 permit area (Permit Area) for the proposed chemical process mine.

The information and responses provided in this abbreviated OPA are related to the basalt borrow quarry area and not the entirety of the Division 37 Permit Area. This permit application specifically relates to surface mining operations under Division 30 Rules. We understand that this abbreviated OPA will be reviewed by DOGAMI; however, a Division 30 permit will not be issued. This OPA will be submitted as an appendix of the Consolidated Division 37 Permit Application for the entire Grassy Mountain Mine Project.

If you have any questions or require additional information, please contact the undersigned.

Respectfully,
Golder Associates Inc.

Jeremy Jones, RG
Senior Project Geologist

Tom Wythes
Associate, Senior Engineer

JJ/TW/kg

Golder Associates Inc.
9 Monroe Parkway, Suite 270, Lake Oswego, Oregon, USA 97035 T: +1 503 607-1820 F: +1 503 607-1825

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CC: Nancy Wolverson (Calico)
Glen Van Treek (Calico)
Chris MacMahon (Golder)

Attachments: Operating Permit Application Form
Operating and Reclamation Plan Set (Figures 1-6)
Groundwater Supplemental Form
Wetland Supplemental Form

https://golderassociates.sharepoint.com/sites/35151g/proposal project management/400_ engineering/dogami operating permit application/operating permit application/final/18111356.004.l.rev0 operating permit application.docx

Operating Permit Application Form

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation and Reclamation Program
229 Broadalbin Street SW
Albany, OR 97321-2246
(541) 967-2039
Fax (541) 967-2075

Operating Permit Application Form Division 30 & Division 35*

*DOGAMI may require additional information for Division 35 applications.

CONFIDENTIALITY NOTICE
Any production records, mineral assessments and trade secrets submitted by a mine operator or landowner to the State Department of Geology and Mineral Industries shall be confidential. [1999 c.492 §10 (enacted in lieu of ORS 517.900)]

Primary Point of Contact

To ensure effective communications and timely processing, a Primary Point of Contact (PPC) is recommended for this application. The PPC should be a representative of the applicant with signature authority or a designated agent. Documentation of signature authority and/or designated agent is required for all applicants registered to do business in the state of Oregon. DOGAMI specific Designated Agent and Signature Authority forms are available on our website.

Section 1: Contact Information

1a. Applicant / Proposed Permittee			
Name of Applicant: **Calico Resources USA Corp**			
Mailing Address: **665 Anderson Street**	City: **Winnemucca**	State: **NV**	Zip: **89445**
Telephone: **775-625-3600**	Fax: **N/A**	Email: **nancy@paramountnevada.com**	
Preferred method of contact ☐ Telephone ☒ Email			
1b. Primary Contact for the Application			
Name: **Nancy J. Wolverson – Calico Resources USA Corp**			
Mailing Address: **665 Anderson Street**	City: **Winnemucca**	State: **NV**	Zip: **89445**
Telephone: **775-770-4615**	Fax: **N/A**	Email: **nancy@paramountnevada.com**	
Preferred method of contact ☐ Telephone ☒ Email			
1c. Application Prepared By			
Name: **Tom Wythes - Golder Associates, Inc.**			
Mailing Address: **9 Monroe Parkway, Suite 270**	City: **Lake Oswego**	State: **OR**	Zip: **97035**
Telephone: **503-607-0831**	Fax: **N/A**	Email: **tom_wythes@golder.com**	
Preferred method of contact ☐ Telephone ☒ Email			
1d. Operator Information			
Name: **Calico Resources USA Corp**			
Mailing Address: **665 Anderson Street**	City: **Winnemucca**	State: **NV**	Zip: **89445**
Telephone: **775-625-3600**	Fax: **N/A**	Email: **nancy@paramountnevada.com**	
1e. Contact Person for Field Visits			
Name: **Michael McGinnis**	Preferred method of contact ☐ Telephone ☒ Email		
Telephone: **719-332-8253**	Fax: **N/A**	Email: **mmcginnis@paramountnevada.com**	
1f. Landowner Information			
Name of Landowner (1): **Bureau of Land Management, Vale District Office**			
Mailing Address: **100 Oregon Street**	City: **Vale**	State: **OR**	Zip: **89445**
Telephone: **541-473-3144**	Fax: **N/A**	Email: **blm_or_vl_mail@blm.gov**	
Name of Landowner (2):			
Mailing Address:	City:	State:	Zip:
Telephone:	Fax:	Email:	
1g. Mineral Estate Owner Information – If Split Estate			
Name of Mineral Estate Owner (1): **See Division 37 Consolidated Permit Application for complete mineral estate ownership information**			
Mailing Address:	City:	State:	Zip:
Telephone:	Fax:	Email:	
Name of Mineral Estate Owner (2):			
Mailing Address:	City:	State:	Zip:
Telephone:	Fax:	Email:	

Section 2: Project Description

2a. Location Information

Address and/or highway and milepost of surface mine:

See attached Operating and Reclamation Plan Set for Site Location

Distance from the nearest named community: **22** mile(s) from **Vale, Oregon**

Directions to site (from the nearest town or major intersection):

See attached Operating and Reclamation Plan Set for Site Location

Legal Description:

County: **Malheur**

Township:	**22S**	Range:	**44E**	Section:	**8**	Tax Lot(s):	_____
Township:	_____	Range:	_____	Section:	_____	Tax Lot(s):	_____
Township:	_____	Range:	_____	Section:	_____	Tax Lot(s):	_____
Township:	_____	Range:	_____	Section:	_____	Tax Lot(s):	_____

Latitude/Longitude: **43.669826/-117.351660**

Site Name: **Grassy Mountain Basalt Borrow Quarry**

Does this site have a current DOGAMI Operating Permit, Exploration Permit, Exclusion Certificate, or Grant of Limited Exemption, or has it been permitted in the past? ☐ yes ☒ no

If yes: Specify DOGAMI ID#

Is there an approved Limited Exemption Closure Plan on file with DOGAMI? ☐ yes ☒ no

2b. Application Type

Please indicate the purpose of this application:

☐ New Operating Permit – skip to 2c.

☐ Amendment to a current Operating Permit

If you are applying for an Amendment to a current Operating Permit, please describe in detail the intended modifications:

This is an abbreviated Operating Permit Application for the basalt borrow quarry at the Grassy Mountain project. The basalt borrow quarry will be situated within the Division 37 permit boundary (Permit Area); however, this permit application specifically relates to surface mine operations under Division 30 regulations. This abbreviated application and Operating and Reclamation Plan set will be submitted as an appendix of the Consolidated Division 37 Permit Application. The Division 37 Permit Area and location of the basalt borrow quarry are shown on Figure 1.

The information and responses provided in this abbreviated application are related to the basalt borrow quarry and not the entirety of the Division 37 Permit Area.

The Proposed Operating and Reclamation Plans in this Amendment will (check one):

☐ Replace the existing approved plan(s) on file with DOGAMI and apply to the entirety of the site upon completion of this Amendment.

☐ Pertain only to the Amendment area and are in addition to the existing approved plan(s) on file with DOGAMI.

2c. Third Party Permits and Approvals

Do you know of any state, federal or local government permits or approvals that will be required for this mining operation? ☒ yes ☐ no

If yes: Please list any state, federal or local government permits or approvals and describe the status:

This is an abbreviated permit application in support of the basalt borrow quarry for the Consolidated Division 37 Permit Application. This application will be submitted as an appendix to the Consolidated Division 37 Permit Application.

*Note: DOGAMI can only issue an Operating Permit if all required state, federal, and local government approvals have been obtained, otherwise a Provisional Operating Permit will be issued. POP's are not applicable to Operating Permit Amendment applications.

2d. Permit Acreage and Boundaries

Specify the approximate total number of acres to be covered under the Operating Permit	**Borrow Area only ~ 50-acres** acres

Does the proposed permitted acreage coincide with the area approved by the local land use jurisdiction? ☒ yes ☐ no

If no: Explain: **The basalt borrow quarry is located solely on BLM land within the Division 37 Permit Area (Figure 1)**

Have the boundaries of the proposed permit area been marked on the ground with temporary or permanent boundary markers? ☐ yes ☒ no

If yes: Describe boundary markers: **Permit boundary to be established as part of Division 37 Permit Area (Figure 1)**

What is the total number of acres to be affected by mining related activities in the 12 months following permit issuance (include excavation, processing, stockpiling and land clearing)? **Upon issuance of Division 37 permit, 50** acres

2e. Site Conditions

General Topography in the vicinity of the permit area (check all that apply):

☒ mountains ☒ hills/buttes ☒ valleys ☐ plains ☐ badlands
☐ floodplain ☐ other: _____ ☐ other: _____

Site Specific Topography (describe the topography within the permit area): **The basalt borrow quarry is located in the semi-arid plateau of eastern Oregon and local landscape is typical of high mountain desert environment and rangeland. The terrain is gentle to moderate with relatively low relief. Elevation ranges from ~4,050 feet msl at the southeastern corner of the quarry area to ~3,800 feet along western quarry area.**

Current Land Use(s) for all tax lots or parcels within the permit area (check all that apply):

☒ range/open space ☐ forestry ☐ industrial ☐ wildlife/wetland ☐ recreation
☒ other: **C-A2 Exclusive Range Use (Malheur County)**
☐ residential ☐ commercial ☐ agriculture ☐ other: _____

Structures, Facilities & Surface Disturbances:

☐ none ☐ residential ☐ farm/ranch
☐ industrial/commercial ☒ roads ☐ overhead power lines or facilities
☐ underground utilities (e.g. electrical, fiber optic, water, sewer, etc.) ☐ oil/gas structures or pipelines ☐ other: _____

Additional Description (optional): **No structures currently present within the footprint of the basalt borrow quarry. Two-track dirt roads from resource evaluation are present (Figure 1).**

Vegetation (general description of the dominant grasses, forbs, shrubs and trees located within the permit area):

Terrestrial vegetation is cold desert type. Vegetation communities include big sagebrush/bunchgrass community, crested wheat grass/annual community, and annual grassland community. Invasive species such as cheatgrass and/or medusahead dominate most of the vegetation communities (*Terrestrial Vegetation Baseline Study, Grassy Mountain Exploration Project, Calico Resources USA Corp., Malheur County, Oregon, May, 2014, HDR Engineering, Inc.*)

No wetlands occur in the vicinity of the basalt borrow quarry or within the Division 37 Permit Area (*See attached Wetland Supplemental Form*).

Listed sensitive, threatened or endangered fish and/or wildlife species (within the permit area and nearby water ways):

Wildlife species and encounters within the Study Area are discussed in the *Wildlife Resources Baseline Report, EM Strategies, Inc., October 2018*.

Surface Water Features within or near the permit area (includes features that may contain water at any time, including seasonal and stormwater runoff):

☐ none ☐ river _____ ☐ stream/creek _____ ☐ spring
☒ lake/pond ☐ irrigation ditch/canal ☒ ephemeral drainage ☐ wetlands*

***The DOGAMI Wetland Supplemental Form may be required to be submitted with this application package.**
(*See attached Wetland Supplemental Form*)

2f. Surrounding Area Conditions

Land Use(s) within 1,500 feet of the permit area (check all that apply):

☒ range/open space ☐ forestry ☐ industrial ☐ wildlife/wetland ☐ recreation
☐ residential ☐ commercial ☐ agriculture ☒ other: **C-A2 Exclusive Range Use (Malheur County)** ☐ other: _____

Structures, Facilities & Surface Disturbances within 1,500 feet of the permit area (check all that apply):

☐ none ☐ residential ☐ farm
☐ industrial/commercial ☒ roads ☒ overhead power lines or facilities
☐ underground utilities (e.g. electrical, fiber optic, water, sewer, etc.) ☐ oil/gas structures or pipelines ☒ other: **Schweizer Reservoir (Cattle Pond)**

What is the distance to the nearest structure not owned by the permittee? **~200' south of Division 37 Permit Area (overhead powerline right-of-way)** feet

Surface Water Features within 1,500 feet of the permit area (check all that apply):

☐ none ☐ river _____ ☐ stream/creek _____ ☐ spring
☒ lake/pond ☐ irrigation ditch/canal ☒ ephemeral drainage ☐ wetlands*

***The DOGAMI Wetland Supplemental Form may be required to be submitted with this application package.**
(*See attached Wetland Supplemental Form*)

Section 3: Proposed Operating Plan

3a. Development Plans & Equipment

What type of surface mine will be developed?

- ☐ single bench
- ☒ multiple bench
- ☒ sidehill cut
- ☐ hilltop removal
- ☐ open pit
- ☐ pond excavation
- ☐ other: _____
- ☐ other: _____

What is the primary commodity? (Select One)

- ☐ lava
- ☐ decomposed granite
- ☐ pumice
- ☐ topsoil
- ☒ borrow/fill
- ☐ diatomaceous earth
- ☐ sand and gravel
- ☐ bentonite
- ☐ cinder
- ☐ dredge tailings
- ☐ shale
- ☒ other: **Cover and drainage material**

What is the primary use? (Select One)

- ☐ asphalt aggregate
- ☐ concrete aggregate
- ☐ landscaping materials
- ☐ other: _____
- ☒ base rock aggregate
- ☒ construction fill
- ☐ rip rap

What is the general deposit type?

- ☒ bedrock
- ☐ river/floodplain (alluvial)*
- ☐ river channel terrace
- ☐ talus
- ☒ other: **Basalt bedrock**
- ☐ unknown

***The DOGAMI Floodplain Supplemental Form may be required to be submitted with this application package**.

Check all mining methods and on-site activities that apply:

- ☒ drilling and blasting
- ☐ ripping and loading
- ☒ crushing
- ☐ washing
- ☒ screening
- ☒ shovel/loader/scraper
- ☐ material recycling
- ☒ stockpiling
- ☐ other: _____
- ☐ other: _____

Equipment to be used for mining and processing includes (check all that apply):

- ☒ loaders
- ☒ dozers
- ☒ excavators
- ☒ trucks
- ☒ screeners
- ☒ crushers
- ☒ drilling equipment
- ☐ other: _____
- ☐ other: _____

Date to begin mining activities: **2021** Expected duration (in years): **7**

3b. Water Management

Indicate the proposed use(s) of water (check all that apply):

- ☐ wash plant
- ☐ asphalt plant
- ☐ concrete batch plant
- ☒ dust control
- ☐ crusher
- ☐ other: _____

Note: A DEQ permit will be required for process water generated and stored on site.

If applicable: Is the water source within 300 feet of the permit area? ☐ yes ☒ no

If yes: Identify the source of water to be used and show its location on a map:

- ☐ irrigation ditch
- ☐ pond
- ☐ pit
- ☐ groundwater well
- ☐ other:

Note: A water right may be required by the Oregon Water Resource Department.

Will water be stored on site? ☐ yes ☒ no

If yes: What will the water be stored in?

- ☐ detention/retention pond
- ☐ lined detention/retention pond
- ☐ water storage tank
- ☐ other: _____

What is the approximate depth that groundwater is first encountered? **No monitoring wells are constructed in the basalt resource or in the quarry area. Groundwater was encountered in basalt Boreholes B-2 and B-3 during resource evaluation. Groundwater levels were estimated by drillers at 126 feet bgs in B-2 (3,778 feet msl) and 143 feet bgs in B-3 (3,747 feet msl). The groundwater was encounted in the chert pebble conglomerate/siltstone underlying the basalt bedrock and were not static water levels. The minimum proposed quarry floor elevation is 3,790 feet msl and will not extend below base of basalt. Quarry plan provides at least 5 feet of basalt to be left at the base of the quarry floor above the chert pebble conglomerate/siltstone.**

Depth to groundwater is about 94-97 feet below ground surface (bgs) in shallow aquifer wells ~350 feet west of the quarry (59760, 59761, 59772). Historic groundwater elevations in these wells range between 3,671 to 3,674 feet msl.

Groundwater monitoring well and basalt borrow area resource evaluation coreholes are shown on Figures 1 and 2. See atttached *Groundwater Supplemental Form* for additional information.

feet below ground surface

What source or method was used to determine depth to groundwater? **Monitoring, Driller Observations**

Have monitoring wells been constructed on site or are monitoring wells proposed? ☒ yes ☐ no

Monitoring wells are installed in the Division 37 Permit Area (Figure).

If yes: A DOGAMI Groundwater Supplemental Form must be submitted with this application.

(See atttached Groundwater Supplemental Form)

Will excavation operations be conducted below groundwater level? ☐ yes ☒ no

Will dewatering be conducted at this site? ☐ yes ☒ no

If yes: A DOGAMI Groundwater Supplemental Form must be submitted with this application and a DEQ Permit may be required.

Has a DEQ water quality permit been obtained for the site? **A DEQ water quality permit will be obatined for the Division 37 Permit Area which will cover the basalt borrow quarry operations.**

If yes: DEQ Permit #

3c. Designated Setbacks

Will surface mining operations require crossing external property lines? ☐ yes ☒ no

What will be the minimum undisturbed property line setback for:

Excavation operations: **50** feet wide

Processing operations: **50** feet wide

Stockpiling operations: **50** feet wide

If proposing disturbances within the setbacks (such as visual berms or roads), explain: **Surface water diversion channels and surface water run-on diversion berms as shown in Figures 2 through 6. These features will be removed and reclaimed during final reclamation grading. Some reclamation grading may extend into the setback area during final reclamation.**

Specify the minimum undisturbed setback(s) between mining operations and:

Overhead utilities (poles or towers): _____ feet wide

Underground utilities (e.g. electrical, fiber optic, water, sewer, etc.): _____ feet wide

Right-of-Way/Easement Road: _____ feet wide

Other: _____ _____ feet wide

☒ not applicable (none of the above-listed items are present within the proposed permit area)

Are setbacks shown on the attached map(s)? ☒ yes ☐ no

If no: Explain:

Have setbacks been marked on the ground with permanent or temporary boundary markers? ☐ yes ☒ no

If no: Explain: **Setbacks will be marked prior to commencement of mining operations. Mining setbacks will include minimum 50-foot setback from the Division 37 Permit Area (*See attached Operating and Reclamation Plan Set*).**

3d. Designated Buffers

Does a naturally vegetated area (buffer) exist along a river, stream or natural drainage? ☐ not applicable ☐ yes ☒ no

If no or not applicable, skip to 3e.

What are the minimum undisturbed buffers for the following:
River (Ordinary High Water Line): _____ feet wide
Stream (Ordinary High Water Line): _____ feet wide
Natural drainage: _____ feet wide
Riparian Vegetation: _____ feet wide

Have the undisturbed buffers been marked on the ground with permanent or temporary boundary markers? ☐ yes ☒ no

Have conservation/protection buffers been established? ☒ not applicable ☐ yes ☐ no

If yes: check all that apply:

☐ unstable slopes ☐ wildlife habitat ☐ water quality ☐ other: _____

Describe the nature and configuration of the conservation buffer(s):

3e. Visual Screening

Does a natural landform or vegetative screen currently exist?

Along the **permit** boundary ☐ yes ☒ no

Within the **permit** boundary ☐ yes ☒ no

Along the **property** boundary ☐ yes ☒ no

Within the **property** boundary ☐ yes ☒ no

If yes to any of the above: Describe:

Will a berm be constructed along the permit boundaries to develop a visual screen? ☐ yes ☒ no

If yes: The average height of the constructed screen/berm will be _____ feet tall and _____ feet wide.

Will a vegetative screen be established along the permit boundaries to develop a visual screen? ☐ yes ☒ no

If yes: If planting trees, what is the estimated height at maturity? _____ feet tall

Please describe (include species and planting densities):

Will a fence be installed along the permit boundary for safety or visual screening? ☒ yes ☐ no

Will the screening/fencing/berm be maintained for the life of the surface mine? ☐ not applicable ☒ yes ☐ no

If no: Explain:

3f. Vegetation

Will vegetation be removed sequentially from areas to be mined to prevent unnecessary erosion? ☒ yes ☐ no

If no: Explain:

Will small trees and other transplantable vegetation be salvaged for use in revegetating other phases? ☐ yes ☒ no

Wood and other organic debris will be (check all that apply):

☐ recycled ☐ removed from site ☐ chipped ☐ burned ☐ buried

☒ piled and composted on site for growth medium or mulch ☐ other: _____ ☐ other: _____

Note: A DEQ permit is generally required for burial of debris and may be required for burning.

Will coarse wood (logs, stumps) and other large debris be salvaged for fish and wildlife habitat? ☒ not applicable ☐ yes ☐ no

3g. Soil and Overburden Salvage and Stabilization

Identify and characterize the type(s) of soil present within the site area per NRCS Web Soil Survey:

NRCS Web Soil Survey data not available for Permit Area, data provided from *Geology and Soils Baseline Report, Mark J. Abrams, October 2018*.

The Farmell-Chartodon (extremely stony soil, 4-15% slopes) and Ruckles (very stony loam, 8-30% slopes) are present within the footprint of the basalt borrow quarry (*Geology and Soils Baseline Report, Mark J. Abrams, October 2018*).

Will growth medium and overburden materials be salvaged? ☒ yes ☐ no

Explain: **Per the Geology and Soil Baseline Report, the Farmell-Chartodon soil is considered unsuitable for use as growth medium and will only be salvaged for on-site construction use. The Ruckles soil is of marginal suitability for reclamation and only the upper 0.5 feet is reported to be suitable for salvage as growth medium. The remainder of the Ruckles material will be salvaged for on-site construction use.**

Based on the Final Quarry Grading Plan shown on Figure 2 and the Geology and Soils Baseline Report, there is approximately 8 acres of Ruckles soil, and 22 acres of Farmell-Chartodon soil within the quarry disturbance area. Growth medium and overburden salvage estimates noted below assume maximum thickness of soil overlying bedrock. Actual available salvage volumes are anticipated to be less.

Will growth medium and overburden materials be segregated and stored separately during stripping operations? ☒ yes ☐ no

Explain proposed stripping, handling, and storage of growth medium and overburden materials: **Areas will be stripped sequentially in advance of mining to reduce potential for erosion. Approximately 0.5 feet of the Ruckles loam will be stripped and stored as growth medium. The remainder of the overburden will be stripped and used for on-site construction use and is not planned to be stored. The growth medium stockpile area is shown on Figure 2.**

For the areas to be stripped:

Thickness of growth medium averages **0.5** ☐ inches ☒ feet

Thickness of overburden averages **Less than 40** ☒ inches ☐ feet

Depth to bedrock is approximately **Less than 40** ☒ inches ☐ feet (below ground surface).

Total volume of growth medium available within the permit area is **6,500** cubic yards.

Total volume of stored growth medium is **6,500** cubic yards and will require **0.5** acres for storage.

Total volume of stored overburden is **0** cubic yards and will require **0** acres for storage.

Will growth medium and overburden materials be moved directly to mined out portions of the site for concurrent reclamation? ☐ yes ☒ no

Will the storage areas be cleared of all vegetation and organic matter prior to stockpiling? ☒ yes ☐ no

If no: Explain:

Will subsurface drainage for the storage area be established prior to material placement? ☒ yes ☐ no

Explain: **Growth medium stockpile sites will be cleared of all vegetation and the growth medium placed in areas that allow natural drainage of water from stockpiles (Figure 2). Erosion control BMPs will be used as necessary to reduce erosion and sediment loss.**

Will growth medium and overburden materials be stabilized with vegetation to prevent water and wind erosion if stored for more than one season? ☒ yes ☐ no

If no: Explain:

Are the storage areas delineated on the attached map(s)? ☒ yes ☐ no

3h. Surface Mine Excavations

What is the total number of acres to be affected by mining related activities (include excavation, processing, stockpiling and land clearing)? **Approximately 50** acres

What is the maximum vertical depth to be mined below the existing topographic grade? **125** feet

What will be the lowest elevation of the excavated mine relative to mean sea level? **3,790** feet

What will be the highest elevation of the excavated mine relative to mean sea level? **4,050** feet

Will benches be developed as mining operations advance? ☒ yes ☐ no

If yes: The average dimensions of the benches will be approximately:

40 foot vertical faces separated by **60** foot horizontal benches resulting in an interim sloping configuration of **1.5**H: **1**V (e.g. 1½H:1V, 2H:1V)

Quarry floor will be developed in single benches that will be flattened to 1.5H to 1V at reclamation (Figure 5).

If no: The interim sloping configuration of the excavation slopes will be: _____H: _____V (e.g. 1½H:1V, 2H:1V).

Will excavation operations result in the creation of ponds/water-filled excavation areas? ☐ yes ☒ no

If yes: The interim sloping configuration of the in-water slopes will be _____H: _____V (e.g. 3H:1V).

Will oversize be generated on site? ☐ yes ☒ no

If yes: Specify the location for storage:

Will any waste products such as tailings or crusher fines be generated during mining? ☒ yes ☐ no

If yes: Specify the location for storage: **Crusher fines will be used as construction material and not permanently stockpiled.**

Are the storage/stockpile areas delineated on the attached map(s)? ☒ yes ☐ no

3i. Best Management Practices and Stormwater Controls

Will all stormwater runoff be contained on site? ☒ yes ☐ no

All stormwater will be managed under the Site-Wide Surface Water Management Plan for the Division 37 Permit Area.

A surface water diversion channel will be constructed along the eastern boundary of the quarry excavation to divert stormwater from entering the quarry area. Upgradient stormwater will be diverted to the north of the quarry and managed under the Site-Wide Surface Water Management Plan for the Division 37 Permit Area (Figure 2). A surface water run-on diversion berm will also be constructed along the eastern and southern quarry excavation boundaries to divert stormwater around the quarry. Precipitation that falls into the quarry footprint will be managed within the quarry using internal sloping, retention berms, and a stormwater management sump (Figure 2). Additional BMPs will be implemented to minimize erosion and sedimentation as noted below.

If no: A DEQ (NPDES)Permit may be required.

Methods to control erosion and minimize sedimentation within the permit area include (check all that apply):

☒ minimize the areas stripped	☒ divert natural runoff around the site	☒ graveled roads and working areas
☒ internal sloping	☒ conveyance ditches	☒ rock check dams
☐ water bars	☐ settling/infiltration ponds	☒ retention berms
☒ seeding and mulching	☐ other: _____	☐ other: _____

Section 4: Reclamation Plan

4a. Post-Mining Land Use

Subsequent Land Use(s) of the permit area (check all that apply):

☒ range/open space ☐ forestry ☐ industrial ☐ wildlife/wetland ☐ recreation
☐ residential ☐ commercial ☐ agriculture ☐ other: _____ ☐ other: _____

If more than one post-mining land use is selected provide a map delineating where each use is applicable.

What will be the average elevation of the reclaimed mine floor relative to mean sea level? **3,850** feet

Is the proposed post-mining land use compatible with the existing local land use jurisdiction? ☒ yes ☐ no

If no: Explain:

Is the final local land use approval for surface mining attached? ☐ yes ☒ no

If no: Explain: **BLM post-mining land use**

4b. Reclamation Schedule

Will reclamation activities be conducted concurrently with mining? ☐ yes ☒ no

If no: How many days after mining is completed will reclamation operations begin? **Per ORS 517.820(1), reclamation to begin no greater than 3 years after mining is complete.**

If yes: Has the permit area been divided into cells/phases for sequential mining? ☐ yes ☒ no

4c. Final Excavation Slopes

Will final excavation slopes be constructed using the benching method? ☐ yes ☒ no

If yes: The average dimensions of the final benches will be approximately __ foot vertical faces separated by __ foot horizontal benches resulting in an interim sloping configuration of ___H: __V (e.g. 1½H:1V, 2H:1V).

Will final slopes be constructed via a continuous slope? ☐ yes ☒ no

If yes: The completion of Section 4d is required.

Will reclamation blasting be used to reduce the entire highwall to a scree or rubble slope less than 2H:1V? ☒ yes ☐ no

If yes: Will access to benches be maintained for reclamation blasting? ☒ yes ☐ no

Will selective blasting will be used to remove benches and walls and to create chutes, buttresses, spurs, scree slopes, and rough cliff faces that appear natural or blend in with surrounding topography? ☒ yes ☐ no

Will final excavation slopes be steeper than 1½H:1V? ☐ yes ☒ no

If yes: The DOGAMI Slope Stability Supplemental Form must be submitted with this application.

Will small portions of benches or vertical faces be left to provide habitat for raptors and other cliff-dwelling birds? ☒ yes ☐ no

Will the final excavation slopes vary in steepness? ☐ yes ☒ no

If yes: Explain:

Are cross-sections of the final excavation slopes attached? (may be required) ☒ yes ☐ no

Will measures be taken to limit access to the top and bottom of hazardous slopes? ☒ yes ☐ no

Explain: **Fencing around perimeter of Permit Area (Figure 1,3).**

4d. Final Fill Slopes

Will above-water final fill slopes be constructed on site? ☐ yes ☒ no

If no: Skip to 4e.

Will final fill slopes be steeper than 2H:1V or exceed 100 lineal feet in length? ☐ yes ☐ no

What will be the final sloping configuration of fill slopes? _____H: _____V (e.g. 2H:1V)

If yes: The DOGAMI Slope Stability Supplemental Form must be submitted with this application.

Will the final fill slopes vary in steepness? **If yes:** Explain:	☐ yes ☐ no
Will fill slopes have a sinuous appearance in both profile and plan view? **If no:** Explain:	☐ yes ☐ no
Will the final grouser tracks of equipment be preserved and oriented to trap moisture, growth medium, and seeds, to encourage seed germination and inhibit erosion (track walking)?	☐ yes ☐ no

4e. Working Floors	
Will flat working areas be formed into gently rolling hills to blend in with the surrounding area? **If yes:** Give details: **Quarry Floor will be devloped in single benches, and overall quarry slopes will be flattened to 1.5H:1V or flatter at reclamation. Quarry floor will be graded to drain to re-established drainages and drainage swales before discharging to natural drainage (Tributary 2a) west of reclaimed quarry (Figures 3,6).**	☒ yes ☐ no
Will the working floor be gently graded into sinuous drainage channels to preclude sheet-wash erosion during heavy rain events? **If yes:** Give details: **Quarry Floor will be devloped in single benches, and overall quarry slopes will be flattened to 1.5H:1V or flatter at reclamation. Quarry floor will be graded to drain to re-established drainages and drainage swales before discharging to natural drainage (Tributary 2a) west of reclaimed quarry (Figures 3,6).**	☒ yes ☐ no
Will the working floor and other compacted areas be, plowed, ripped, or blasted to decompact the upper surface prior to spreading growth mediums to foster revegetation? Explain (If yes, include depth of decompaction):	☐ yes ☒ no

4f. Imported Fill	
Will imported materials be necessary to complete reclamation? **If no:** Skip to 4g. **If yes:** Give volumes needed to meet reclamation plan: _____	☐ yes ☒ no
Are the locations for fill stockpiling and permanent placement shown on the map(s)?	☐ yes ☐ no
How will the quality of imported fill be monitored to ensure it meets DEQ clean fill standards? _____	
Will the backfill materials be mixed or screened to ensure uniformity for compaction and stability?	☐ yes ☐ no

4g. Backfilling Operations	
Will an excavation area be located below natural grade requiring backfilling? **If no:** Skip to 4h	☐ yes ☒ no
What will be the total depth of backfilled materials? _____ feet.	
Will backfilling be conducted in lifts? **If yes:** Specify the average depth of the lifts: _____ feet.	☐ yes ☐ no
Will the backfilled slopes be compacted? Explain:	☐ yes ☐ no
Will compaction testing be conducted under supervision/direction of an Oregon Certified Engineering Geologist or Geotechnical Engineer to determine the compaction percentage? (may be required subject to post-mining land use)	☐ yes ☐ no
Will backfilling be completed utilizing on site overburden materials? **If yes:** Explain:	☐ yes ☐ no
Will you be backfilling into water? **If no:** Skip to 4h	☐ yes ☐ no

Will dewatering be necessary for the backfilling operations? ☐ yes ☐ no

If yes: A DOGAMI Groundwater Supplemental Form is required to be submitted with this application and a DEQ NPDES Permit may be required.

Will backfilling be limited to the dry season or otherwise conducted under dry conditions? ☐ yes ☐ no

If no: A DOGAMI Slope Stability Supplemental Form may be required.

Will the excavation pit/pond be *entirely* backfilled to natural ground surface elevation? ☐ yes ☐ no

If no: The completion of Section 4h is required for in-water sloping configurations.

4h. Ponds and Wetlands

Will stormwater controls or excavation operations intersect the groundwater table resulting in the creation of ponds and/or wetlands? ☐ yes ☒ no

If no: Go to Section 4i.

Specify the construction method and dimensions for each settling/infiltration pond to remain on site:

Pond #1 will be approximately _____ acres in size and approximately _____ feet deep and constructed via:

☐ excavation ☐ retention berms ☐ combination of both

Pond #2 will be approximately _____ acres in size and approximately _____ feet deep and constructed via:

☐ excavation ☐ retention berms ☐ combination of both

All in-water sloping configurations will be constructed at _____ H: _____ V or flatter to a minimum depth of _____ feet below the low-water level of the ponds(s).

Per OAR 632-030-0027(5), all in-water sloping configurations must be established at 3H:1V or flatter from the ordinary high-water level to six feet below the ordinary low-water level for permanent water impoundments.

If not already present, will soils, silts, and clay-bearing materials be placed below water level to enhance revegetation for fish and wildlife habitat? ☐ yes ☐ no

If yes: Give details:

Will wetlands be constructed on site? ☐ yes ☐ no

If yes: Give details:

Will wildlife and fish habitat/enhancements be developed? ☐ yes ☐ no

If yes: Check all that apply:

☐ varied water depths ☐ islands ☐ peninsulas ☐ fish structures

☐ shallow areas (<18 inches deep) ☐ sinuous/irregular shorelines ☐ other: _____ ☐ other: _____

What species are the habitat/enhancements intended to benefit?

Will final pond(s) be utilized for agriculture, forestry or supply water (impoundment)? ☐ yes ☐ no

If no: Skip to 4i.

Has approval from other agencies with jurisdiction to regulate impoundment of water been obtained? ☐ yes ☐ no

If yes: Attach written approval.

What measures will be taken to prevent seepage from the site from adversely affecting the stability of impoundments and adjacent slopes? (check all that apply):

☐ monitoring ☐ relief drains ☐ weep holes

☐ compaction ☐ grouting ☐ installing upstream blanket

☐ none

Give details:

What measures have been taken to design impoundments to resist seismic hazards?

4i. Growth Medium Replacement	
Will the importation of growth medium be required to complete reclamation?	☐ yes ☒ no
Explain (if yes, describe source):	
Will growth medium materials be replaced on all above-water slopes and/or benches?	☐ yes ☒ no
If no: Explain: **Growth medium will be strategically placed on quarry floor to allow for revegetation using BLM-approved seed mix. Quarry floor will be graded to drain to re-established drainages and drainage swales before discharging to natural drainage (Tributary 2a) west of reclaimed quarry (Figures 3,6).**	
Will growth medium be distributed evenly over the site?	☐ yes ☒ no
If no: Specify: **Growth medium will be strategically placed on quarry floor to allow for revegetation. Quarry floor will be graded to drain to re-established drainages and drainage swales before discharging to natural drainage (Tributary 2a) west of quarry (Figures 3,6).**	
Soil will be replaced on the mine floor to an approximate depth of **1.0** ☐ inches ☒ feet Soil will be replaced on established benches to an approximate depth of **0** ☒ inches ☐ feet	
If growth medium is in short supply, will it be strategically placed to conserve moisture and promote revegetation?	☒ yes ☐ no
If no: Explain:	
Will growth medium be moved when conditions are exceptionally wet or dry?	☐ not applicable ☐ yes ☒ no
If yes: Explain:	
If applicable: will clay/silt from settling ponds be used to supplement the growth medium materials?	☐ yes ☒ no
Will any additional materials be utilized as a growth medium substitute to complete revegetation (e.g. reject fines)?	☐ not applicable ☐ yes ☒ no
If yes: Explain:	
Will all growth medium be replaced with equipment that will minimize compaction, or will growth medium be plowed, disced, or ripped following placement?	☒ yes ☐ no
If no: Explain:	
Will all replaced growth medium be stabilized in a timely manner with vegetation and/or mulch to prevent loss by erosion, slumping, or crusting?	☒ yes ☐ no
If no: Explain:	

4j. Revegetation	
The average precipitation on site is **9.7 inches (average of climate data [*Grassy Mountain Climate Data, May 21, 2018, Golder Associates Inc.*])** inches per year.	
Will the site be revegetated?	☒ yes ☐ no
If no: The site will not be revegetated because: ☐ Demonstration plots and areas will be used to show that active revegetation is not necessary. ☐ Revegetation is inappropriate for the approved subsequent use of this surface mine.	
Will revegetation activities start during the first proper growing season (e.g. fall for grasses, fall or late winter for trees and shrubs) following restoration of slopes?	☒ yes ☐ no
If yes: Give details: **Revegetation will consist of BLM-approved seed mix and will be planted in the fall or per BLM recommendations. Seed mix to be consistent with Division 37 Permit Area.** **If no:** Explain:	
Will vegetation test plots be used to determine optimum vegetation plans?	☐ yes ☒ no

4k. Planting and/or Seeding Techniques and Specifications

Describe the method and time of year for planting and/or seeding: **Revegetation will consist of BLM-approved seed mix and will be planted in the fall or per BLM recommendations. Seed mix to be consistent with Division 37 Permit Area.**

Give seeding details (lbs/acre of grass, legume, or forb mixture): **A BLM-approved seed mix will be broadcast in the reclaimed quarry floor areas where growth medium has been strategically placed (Figure 3, 6). The specific details of the seed mixture, rate of broadcast, and other details to be confirmed with BLM during Division 37 permitting or at time of reclamation.**

Give planting details (stems/acre of trees and shrubs, size and type of plant stock): **N/A**

Additional planting/seeding techniques include:

- ☐ ripping, discing and/or tilling
- ☐ irrigation
- ☐ importation of clay or organic-rich growth medium
- ☐ other: _____
- ☐ blasting to create permeability
- ☐ fertilization
- ☐ other growth medium conditioners or amendments
- ☐ mulching
- ☐ planting dormant trees and shrubs
- ☐ seeds to be protected with growth medium or mulch

Describe the noxious weed and invasive plant control measures:

4l. Drainage and Stormwater Controls

Will the reclaimed surface mine site be internally drained? ☒ yes ☐ no

Will natural runoff be directed to a natural drainage or safe outlet upon completion of reclamation? ☐ not applicable ☒ yes ☐ no

If applicable: Explain: **The surface water diversion channel will be decommissioned and revegetated during reclamation. Stormwater will be returned to re-established drainages and drainage swales prior to discharging to the natural drainage channel (Tributary 2a) west of the reclaimed quarry (Figures 3,6).**

Will the construction of ditches and channels be necessary to limit erosion and siltation? ☒ yes ☐ no

If applicable: Explain: **Drainage swales will be constructed on the floor of the reclaimed quarry to limit erosion and siltation prior to discharge of stormwater (Figures 3,6).**

Will conveyance ditches and channels be lined with vegetation or riprap? ☐ not applicable ☒ yes ☐ no

If applicable: Explain: **Ditches and swales will be lined with vegetation and/or riprap as necessary to control erosion.**

Will it be necessary to stabilize or rehabilitate stream channels or banks? ☐ yes ☒ no

If yes: Give details:

4m. Site Cleanup

Will all mining-related equipment be removed from the site? ☒ yes ☐ no

If no: Explain:

Will all structures and buildings be removed from the site? ☒ yes ☐ no

If no: Explain:

Will all visual and/or retention berms be removed from the site? ☒ yes ☐ no

If no: Explain:

Will all debris, refuse, and/or hazardous material be removed from the site? ☒ yes ☐ no

If no: Explain:

Will all stockpiles be sold, graded, and or removed from the site? ☒ yes ☐ no

If no: Explain:

Will all oversize be sold, reduced, or removed from the site? ☒ yes ☐ no

If no: Explain:

Signature Page

APPLICANT

I am applying for an Operating Permit under ORS 517.790. My signature below attests that the information provided in this application is accurate and true to the best of my knowledge. Any misrepresentation in these materials will be considered grounds for denial for an Operating Permit.

CARLO BUFFONE
Applicant's Printed Name

C. BF
Applicant's Signature

CEO
Title

April 30, 2019
Date

PREPARED BY

I prepared this application for the applicant above. My signature below attests that the information provided in this application is accurate and true to the best of my knowledge. Any misrepresentation in these materials will be considered grounds for denial for an Operating Permit.

Tom Wythes
Preparer's Printed Name

Preparer's Signature

Associate
Title

May 2, 2019
Date

LANDOWNER(S)

I have read, understand, and acknowledge receipt of all information provided in this application. By signing this form, I am granting consent to the mining activities as outlined in this application on my property.

See Division 37 Permit Application
Landowner (1) Printed Name

Landowner (1) Signature

Title

Date

Landowner (2) Printed Name

Landowner (2) Signature

Title

Date

MINERAL ESTATE OWNER(S)

I have read, understand, and acknowledge receipt of all information provided in this application. By signing this form, I am granting consent to the mining activities as outlined in this application on my property.

See Division 37 Permit Application
Mineral Estate Owner (1) Printed Name

Mineral Estate Owner (1) Signature

Title

Date

Mineral Estate Owner (2) Printed Name

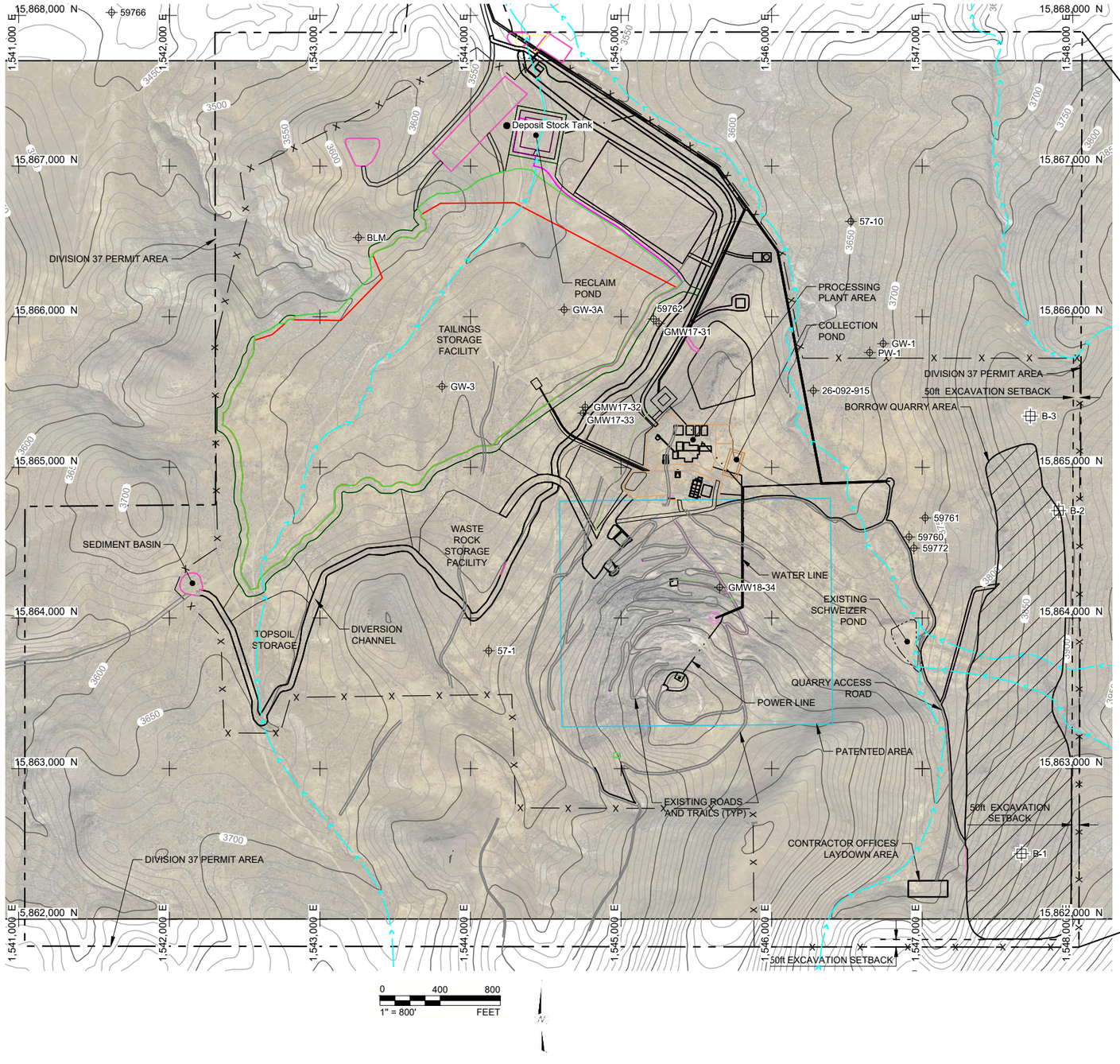
Mineral Estate Owner (2) Signature

Title

Date

Attach additional signature pages as necessary

Operating and Reclamation Plan Set (Figures 1-6)

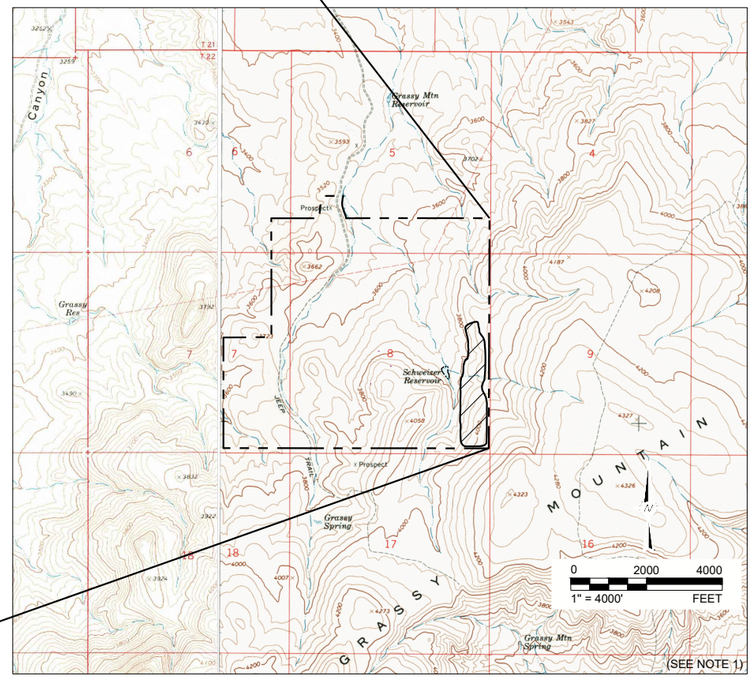


LEGEND

- 4100 — EXISTING GROUND TOPOGRAPHY (10-FOOT CONTOUR INTERVAL)
- 50-FOOT EXCAVATION SETBACK (MINIMUM)
- X PROPOSED FENCE LINE
- EXISTING DRAINAGE
- DIVISION 37 PERMIT AREA
- PATENTED AREA
- 59761 GROUNDWATER MONITORING WELL / PIEZOMETER LOCATION
- B-1 BASALT BORROW RESOURCE EVALUATION COREHOLE
- PROPOSED BORROW QUARRY AREA

NOTE

1. THE PERMIT AREA IS LOCATED IN PORTIONS OF SECTIONS 5, 6, 7, AND 8, TOWNSHIP 22 SOUTH, RANGE 44 EAST OF THE WILLAMETTE PRINCIPAL MERIDIAN. THE PROPOSED BORROW QUARRY IS LOCATED IN SECTION 8, TOWNSHIP 22 SOUTH, RANGE 44 EAST OF THE WILLAMETTE MERIDIAN.
2. GROUND TOPOGRAPHY SHOWN INCLUDES EXISTING GROUND TOPOGRAPHY PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf" AND PROPOSED SURFACE WATER DIVERSION CHANNEL GRADES.
3. SITE LINEWORK PROVIDED BY MINE DEVELOPMENT ASSOCIATES ON MARCH 13th, 2019.
4. USGS MAPS WERE DOWNLOADED FROM https://ngmdb.usgs.gov/topoview/viewer/#12/43.6645/-117.3414, AND ARE THE SOURDOUGH SPRINGS AND THE GRASSY MOUNTAIN 1967 24K SCALE TOPOGRAPHICAL MAPS.



REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-04-08	OPERATING AND RECLAMATION PLAN	LRC	MSW	JMJ	CJM

PERMITTEE
CALICO RESOURCES

CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

GOLDER ASSOCIATES
9 MONROE PARKWAY, SUITE 270
LAKE OSWEGO, OREGON
USA
1+(503) 607-1820
www.golder.com

PROJECT
OPERATING AND RECLAMATION PLAN
BASALT BORROW QUARRY

TITLE
SITE LAYOUT PLAN

PROJECT NO. 18111356
REV. 0
1

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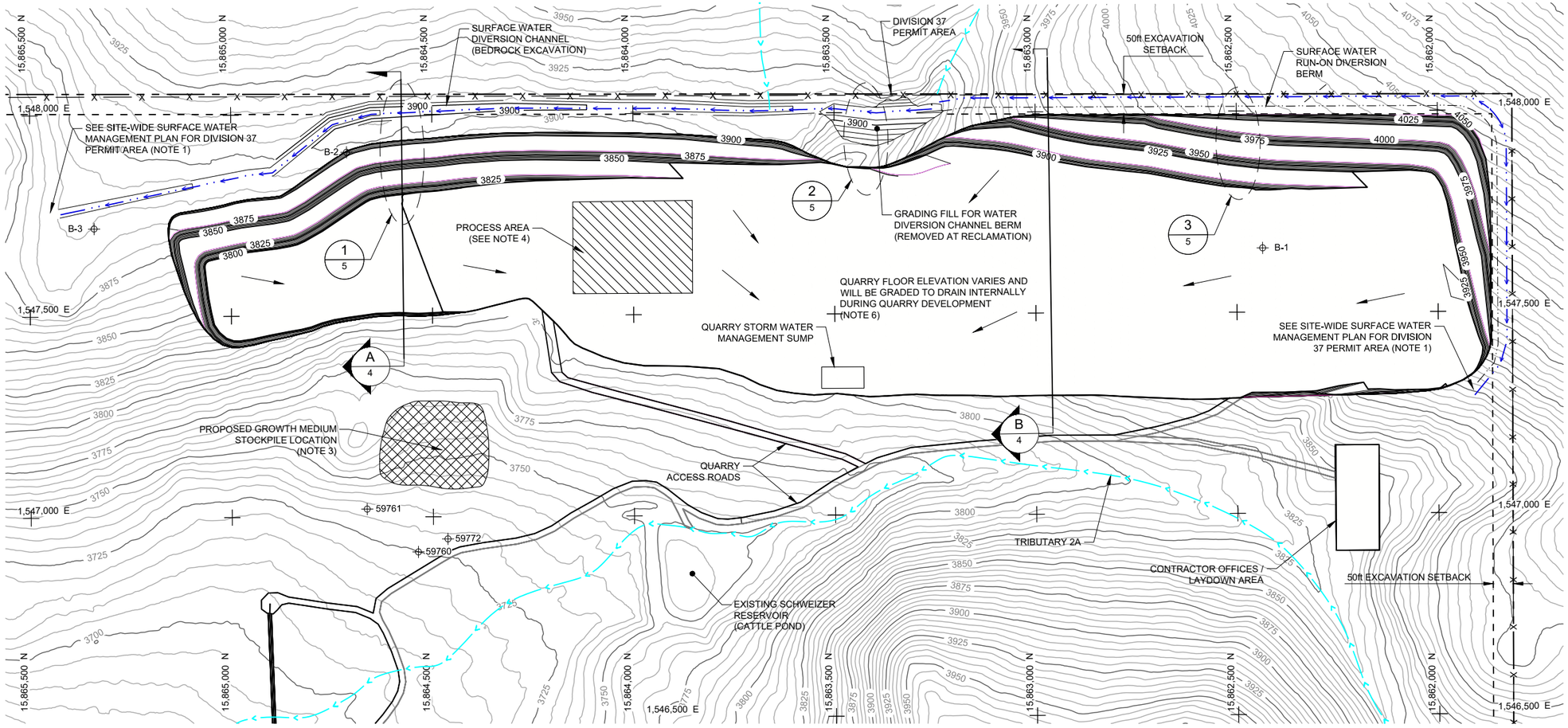

LEGEND

- EXISTING GROUND TOPOGRAPHY (5-FOOT CONTOUR INTERVAL)
- PROPOSED GRADING (5-FOOT CONTOUR INTERVAL)
- 50-FOOT EXCAVATION SETBACK (MINIMUM)
- PROPOSED SURFACE WATER RUN-ON DIVERSION BERM
- PROPOSED SURFACE WATER DIVERSION FLOW DIRECTION
- EXISTING DRAINAGE
- PROPOSED FENCE LINE
- GROUNDWATER MONITORING WELL / PIEZOMETER LOCATION
- BASALT BORROW RESOURCE EVALUATION COREHOLE
- DIVISION 37 PERMIT AREA

NOTES

1. STORMWATER RUN ON WILL BE DIVERTED AROUND THE QUARRY FOOTPRINT USING THE SURFACE WATER DIVERSION CHANNEL AND BERMS. STORMWATER THAT ENTERS THE DIVISION 37 PERMIT AREA WILL BE MANAGED UNDER THE DIVISION 37 SITE-WIDE SURFACE WATER MANAGEMENT PLAN TO BE SUBMITTED WITH THE CONSOLIDATED PERMIT APPLICATION.
2. DURING OPERATIONS, PRECIPITATION THAT FALLS WITHIN THE QUARRY FOOTPRINT WILL BE MANAGED WITHIN THE QUARRY.
3. THE GROWTH MEDIUM STOCKPILE SLOPES WILL BE CONSTRUCTED WITH OUTSLOPE ANGLES THAT ALLOW REVEGETATION AND LIMITS EROSION AND SOIL LOSS, AS OPERATIONS ALLOW. BMPS WILL BE ESTABLISHED DOWNGRADIENT AT THE TOE OF THE STOCKPILE TO CONTROL SEDIMENT LOSS.
4. THE PROCESS AREA WILL BE ESTABLISHED WITHIN THE QUARRY FOOTPRINT AND WILL BE RELOCATED AS NECESSARY WITHIN THE QUARRY FOOTPRINT.
5. INTERNAL SLOPING, DIVERSION BERMS AND ROCK CHECK DAMS WILL BE INSTALLED AS NECESSARY TO MINIMIZE EROSION. ACCESS ROAD AND LAYDOWN AREAS WILL BE GRAVELLED AS NECESSARY.
6. QUARRY FLOOR ELEVATION VARIES BASED ON RESOURCE THICKNESS. MINIMUM OF 5 FEET OF BASALT TO BE LEFT ON QUARRY FLOOR . FINAL QUARRY FLOOR WILL BE GRADED TO DRAIN INTERNALLY TO THE NORTH. MINIMUM QUARRY FLOOR ELEVATION 3,790 FT.

REFERENCE

1. GROUND TOPOGRAPHY SHOWN INCLUDES EXISTING GROUND TOPOGRAPHY PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf" AND PROPOSED SURFACE WATER DIVERSION CHANNEL GRADES.
2. SITE LINEWORK PROVIDED BY MINE DEVELOPMENT ASSOCIATES ON MARCH 13th, 2019.

0 150 300
1" = 300' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-04-08	OPERATING AND RECLAMATION PLAN	LRC	MSW	JMJ	CJM

PERMITTEE
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
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PROJECT
OPERATING AND RECLAMATION PLAN
BASALT BORROW QUARRY

TITLE
FINAL QUARRY GRADING PLAN

PROJECT NO. 18111356
REV. 0
2

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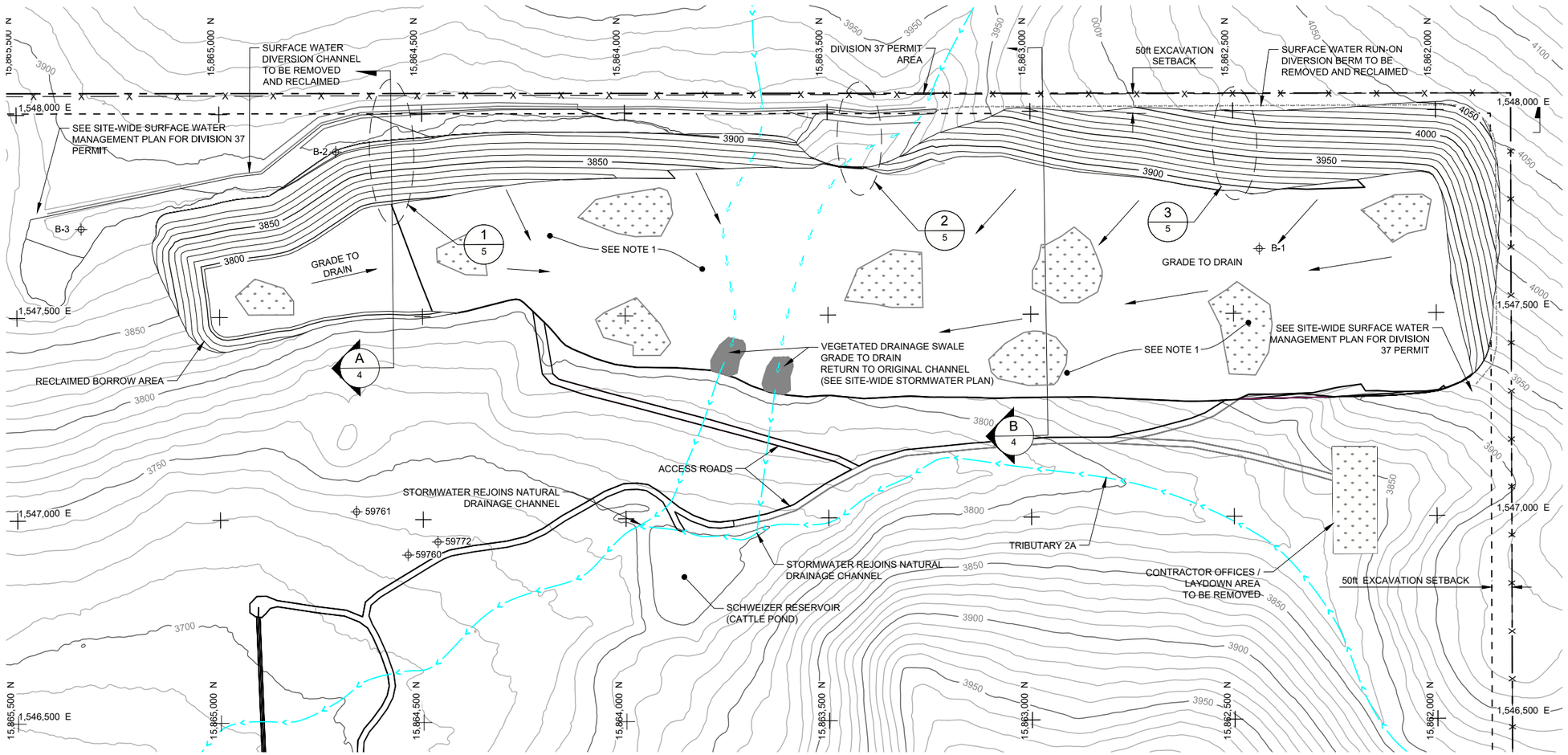

LEGEND

- 4100 — EXISTING GROUND TOPOGRAPHY (10-FOOT CONTOUR INTERVAL)
- 4100 — PROPOSED RECLAMATION GRADING (10-FOOT CONTOUR INTERVAL)
- 50-FOOT BUFFER OFFSET
- SURFACE WATER RUN-ON DIVERSION BERM - TO BE REMOVED DURING RECLAMATION
- EXISTING DRAINAGE
- RE-ESTABLISHED DRAINAGE
- PROPOSED FENCE LINE
- DIVISION 37 PERMIT AREA
- QUARRY FLOOR REVEGETATION
- 59761 — GROUNDWATER MONITORING WELL / PIEZOMETER LOCATION
- B-1 — BASALT BORROW RESOURCE EVALUATION COREHOLE

NOTES

1. A BLM APPROVED SEED MIX WILL BE BROADCAST IN QUARRY FLOOR AREAS WHERE GROWTH MEDIUM HAS BEEN STRATEGICALLY PLACED. SPECIFIC DETAILS OF SEED MIX, RATE OF BROADCAST AND OTHER RECLAMATION DETAILS TO BE CONFIRMED DURING DIVISION 37 CONSOLIDATED PERMIT APPLICATION OR AT TIME OF RECLAMATION.
2. DURING RECLAMATION, THE SURFACE WATER DIVERSION CHANNEL AND RUN-ON DIVERSION BERM WILL BE REMOVED AND EXISTING DRAINAGES WILL BE RETURNED TO RE-ESTABLISHED DRAINAGES. THE QUARRY FLOOR WILL BE GRADED TO RE-ESTABLISH DRAINAGES AND DIRECTED TO A VEGETATED DRAINAGE SWALE PRIOR TO DISCHARGE TO TRIBUTARY 2A. NO AREAS OF PONDED WATER WILL BE PRESENT IN THE RECLAIMED QUARRY FLOOR AREA.
3. SLOPED QUARRY FLOOR WILL BE DEVELOPED IN SINGLE BENCHES THAT WILL BE FLATTENED TO 1.5V:1V AT RECLAMATION.

REFERENCE

1. GROUND TOPOGRAPHY SHOWN INCLUDES EXISTING GROUND TOPOGRAPHY PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf" AND PROPOSED SURFACE WATER DIVERSION CHANNEL GRADES.
2. SITE LINEWORK PROVIDED BY MINE DEVELOPMENT ASSOCIATES ON MARCH 13th, 2019.

0 150 300
1" = 300' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-04-08	OPERATING AND RECLAMATION PLAN	LRC	MSW	JMJ	CJM

PERMITTEE
CALICO RESOURCES

CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

GOLDER ASSOCIATES
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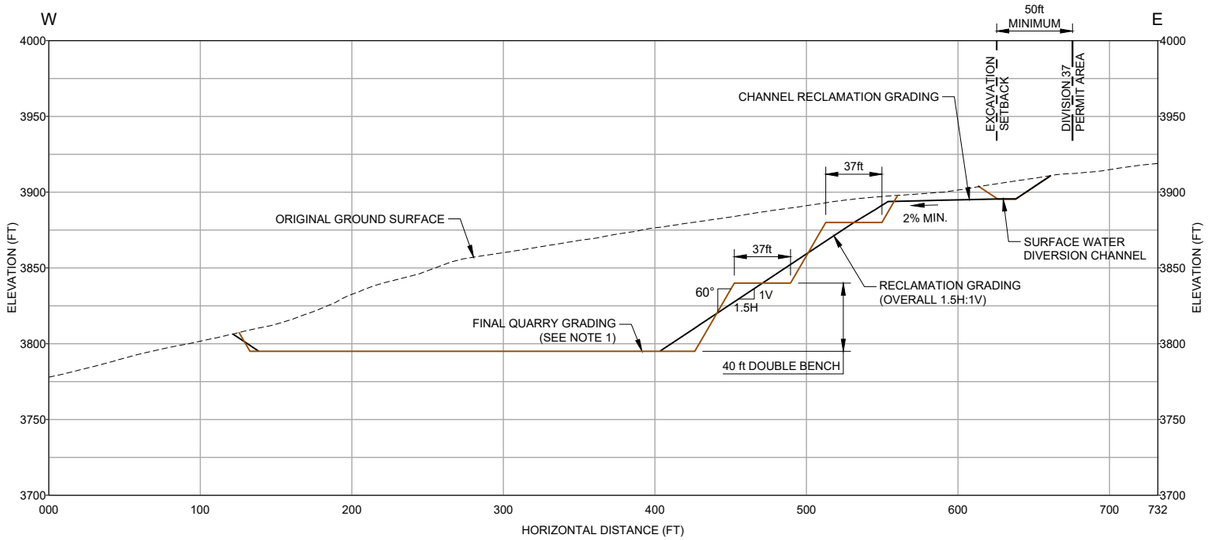
LAKE OSWEGO, OREGON
USA
1+(503) 607-1820
www.golder.com

PROJECT
OPERATING AND RECLAMATION PLAN
BASALT BORROW QUARRY

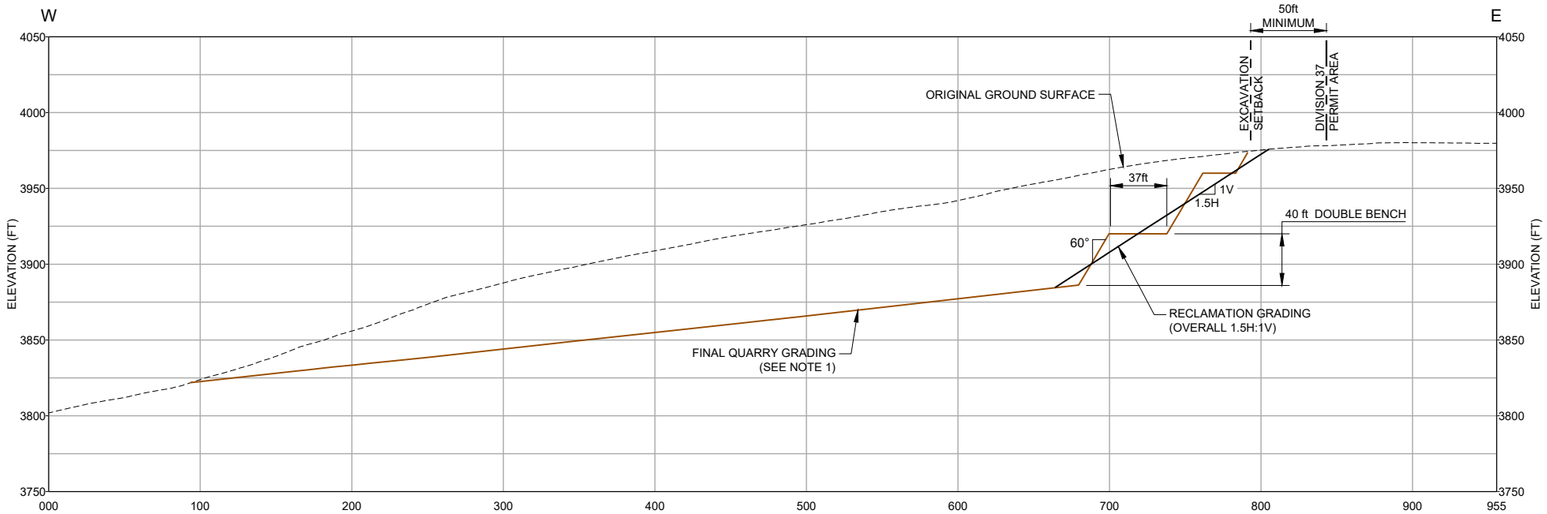
TITLE
CONCEPTUAL QUARRY RECLAMATION PLAN

PROJECT NO. 18111356
REV. 0

Path: H:\Paramount_Calico\Grassy Mountain\99_PROJECTS\18111356_Quarry\0100\02_PRODUCTION\DWG\ | File Name: 18111356-01002-0103.dwg | Last Edited By: mwinters Date: 2019-04-08 Time:4:35:46 PM | Printed By: MWinters Date: 2019-04-08 Time:4:41:13 PM



SCALE 1" = 100' A 2 / 3 SECTION A



SCALE 1" = 100' B 2 / 3 SECTION B

NOTE

1. SLOPED QUARRY FLOOR WILL BE DEVELOPED IN SINGLE BENCHES THAT WILL BE FLATTENED TO 1.5H:1V AT RECLAMATION.

0 50 100
1" = 100' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-04-08	OPERATING AND RECLAMATION PLAN	LRC	MSW	JMJ	CJM

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MALHEUR COUNTY, OREGON

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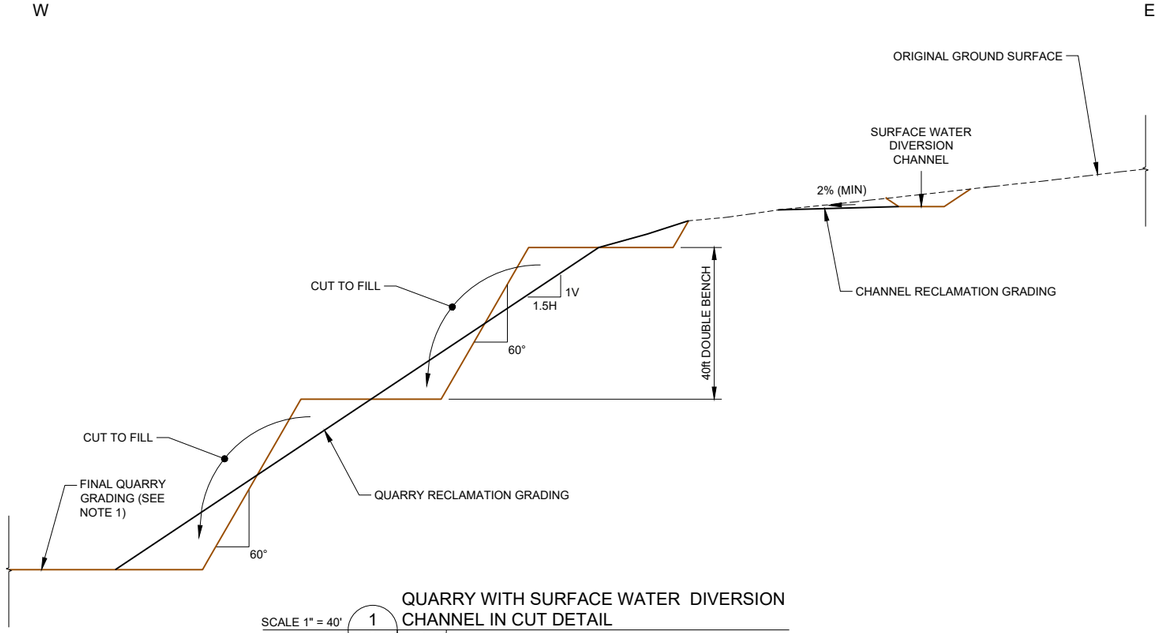
PROJECT
OPERATING AND RECLAMATION PLAN
BASALT BORROW QUARRY

TITLE
FINAL QUARRY GRADING AND CONCEPTUAL RECLAMATION GRADING CROSS SECTIONS A AND B

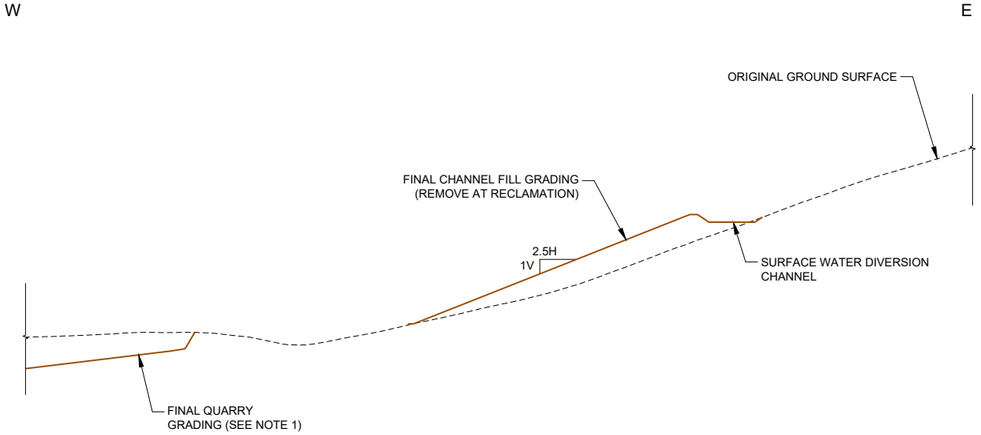
PROJECT NO. 18111356
REV. 0

Path: H:\Paramount_Calico\Grassy Mountain\99_PROJECTS\18111356_Quarry\010000_PRODUCTION\DWGS | File Name: 18111356-0100-0104.dwg | Last Edited By: mwinters Date: 2019-04-08 Time:2:01:36 PM | Printed By: MWinters Date: 2019-04-08 Time:4:41:31 PM



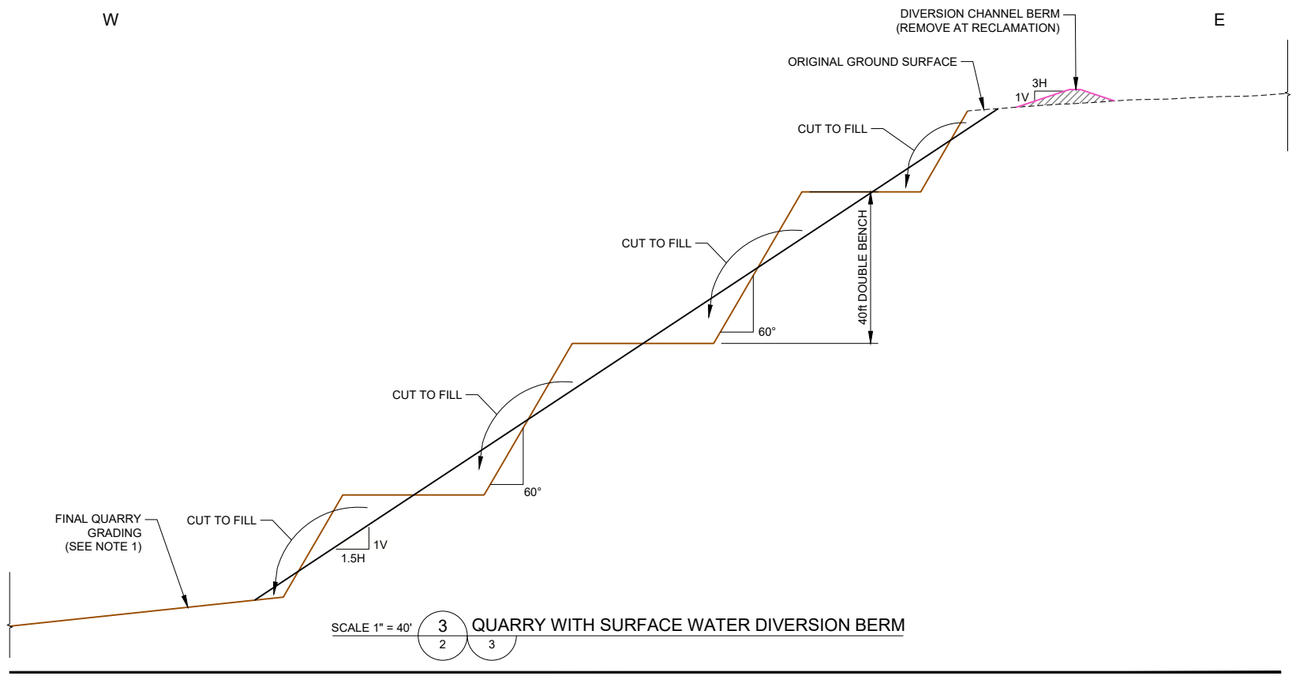
SCALE 1" = 40' (1/2) (3)

QUARRY WITH SURFACE WATER DIVERSION CHANNEL IN CUT DETAIL



SCALE 1" = 40' (2/2) (3)

QUARRY WITH SURFACE WATER DIVERSION CHANNEL IN FILL DETAIL



SCALE 1" = 40' (3/2) (3)

QUARRY WITH SURFACE WATER DIVERSION BERM

NOTES

1. SLOPED QUARRY FLOOR WILL BE DEVELOPED IN SINGLE BENCHES THAT WILL BE FLATTENED TO 1.5H:1V AT RECLAMATION.
2. BENCHES WILL BE BLASTED DURING RECLAMATION TO CREATE SCREE SLOPES. SMALL PORTIONS OF BENCHES AND VERTICAL FACES TO BE LEFT INTACT FOR WILDLIFE HABITAT.

0 20 40
1" = 40' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-04-08	OPERATING AND RECLAMATION PLAN	LRC	MSW	JMJ	CJM

PERMITTEE
CALICO RESOURCES
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

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LAKE OSWEGO, OREGON
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PROJECT
OPERATING AND RECLAMATION PLAN
BASALT BORROW QUARRY

TITLE
FINAL QUARRY GRADING AND CONCEPTUAL RECLAMATION GRADING DETAILS

PROJECT NO. 18111356
REV. 0

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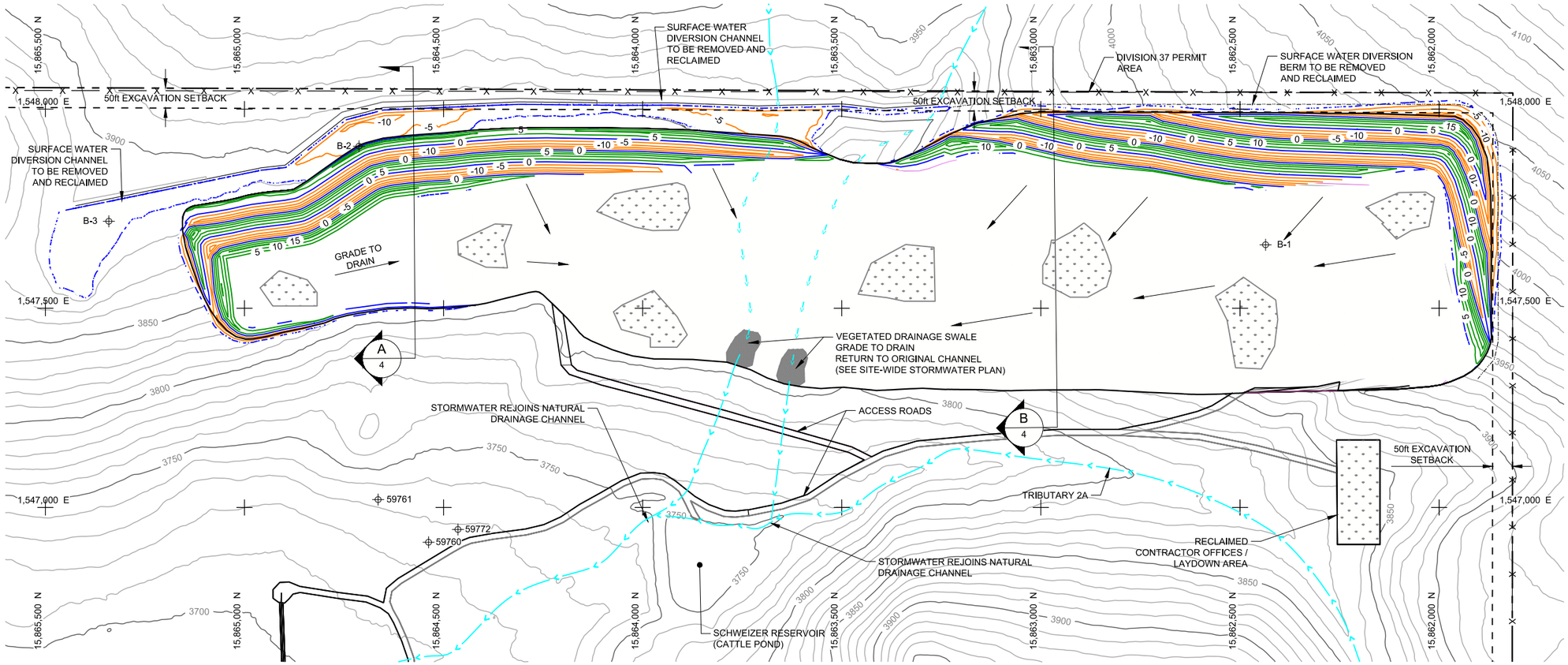

LEGEND

- 4100 — EXISTING GROUND TOPOGRAPHY (10-FOOT CONTOUR INTERVALS)
- -10 — RECLAMATION ISOPACH CUT CONTOUR
- 0 — RECLAMATION ISOPACH CONTOUR AT GRADE
- 10 — RECLAMATION ISOPACH FILL CONTOUR
- X — PROPOSED FENCE LINE
- DIVISION 37 PERMIT AREA
- EXISTING DRAINAGE
- RE-ESTABLISHED DRAINAGE
- QUARRY FLOOR REVEGETATION
- 59761 — GROUNDWATER MONITORING WELL / PIEZOMETER LOCATION
- B-1 — BASALT BORROW RESOURCE EVALUATION COREHOLE

NOTES

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2. DURING RECLAMATION, THE SURFACE WATER DIVERSION CHANNEL AND RUN-ON DIVERSION BERM WILL BE REMOVED AND EXISTING DRAINAGES WILL BE RETURNED TO RE-ESTABLISHED DRAINAGES. THE QUARRY FLOOR WILL BE GRADED TO RE-ESTABLISH DRAINAGES AND DIRECTED TO A VEGETATED DRAINAGE SWALE PRIOR TO DISCHARGE TO TRIBUTARY 2A. NO AREAS OF PONDED WATER WILL BE PRESENT IN THE RECLAIMED QUARRY FLOOR AREA.

REFERENCE

1. GROUND TOPOGRAPHY SHOWN INCLUDES EXISTING GROUND TOPOGRAPHY PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf" AND PROPOSED SURFACE WATER DIVERSION CHANNEL GRADES.
2. SITE LINEWORK PROVIDED BY MINE DEVELOPMENT ASSOCIATES ON MARCH 13th, 2019.

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1" = 300' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2019-04-08	OPERATING AND RECLAMATION PLAN	LRC	MSW	JMJ	CJM

CLIENT
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GRASSY MOUNTAIN PROJECT
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PROJECT
OPERATING AND RECLAMATION PLAN
BASALT BORROW QUARRY

TITLE
ISOPACH - COMPARISON OF FINAL QUARRY GRADING TO CONCEPTUAL RECLAMATION GRADING

PROJECT NO. 18111356
REV. 0

Path: H:\Paramount_Calico\Grassy Mountain\99_PROJECTS\18111356_Quarry\0100\02_PRODUCTION\DWGS\ | File Name: 18111356-0100-0107.dwg | Last Edited By: mwinters Date: 2019-04-08 Time:4:35:23 PM | Printed By: MWinters Date: 2019-04-08 Time:4:42:14 PM

Attachments

Groundwater Supplemental Form

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation and Reclamation Program
229 Broadalbin Street SW
Albany, OR 97321-2246
(541) 967-2039
Fax (541) 967-2075

Groundwater Supplemental Form

DOGAMI has a statutory directive to avoid or minimize adverse impacts to air, water, land, and wildlife resources from surface mining operations. Groundwater is a natural resource that can be affected by mining and as a result, dewatering is regulated by this department. Permittees should be aware that dewatering is generally allowed only if it is specified in their permit. DOGAMI defines dewatering to be the withdrawal of groundwater with a resultant decline in the water table or hydraulic head within an aquifer.

To ensure the protection of groundwater, it is necessary for permittees to consider certain issues prior to conducting this activity. These issues are both regulatory and technical in nature and include permitting, collection of baseline data, monitoring and/or modeling. This form is to be used as a component of a DOGAMI Operating Permit or Amendment application for proposed surface mining operations which will involve encountering and/or impacting groundwater resources.

Section 1: Contact & Site Information

1a. Applicant / Proposed Permittee

Name: **Calico Resources USA Corp**			
Mailing Address: **665 Anderson Street**	City: **Winnemucca**	State: **NV**	Zip: **89445**
Telephone: **775-625-3600**	Fax: **N/A**	Email: **nancy@paramountnevada.com**	
Preferred method of contact ☐ Telephone ☒ Email			

1c. Site Identifier

Legal Description

County: **Malheur**

Township: **22S**	Range: **44E**	Section: **8**	Tax Lot(s): _____
Township: _____	Range: _____	Section: _____	Tax Lot(s): _____

Site Name: **Grassy Mountain Basalt Borrow Quarry**

DOGAMI ID# **This supplemental form is part of an abbreviated Operating Permit Application for the basalt borrow quarry at the Grassy Mountain mine. The basalt borrow quarry will be situated within the Division 37 permit boundary (Permit Area); however, this supplemental form specifically relates to surface mine operations under the Division 30 regulations. This supplemental form will be submitted with the abbreviated Operating Permit Application and Operating and Reclamation Plan set as an Appendix to the Consolidated Division 37 Permit Application. The Division 37 Permit Area and location of the basalt borrow quarry are shown on Figure 1.**

The information and responses provided in this supplemental form are related to the basalt borrow quarry and not the entirety of the Division 37 Permit Area.

The groundwater level information provided in this supplemental form is based on information presented in the Groundwater Resources Baseline Report, SPF Engineering, LLC., February 19, 2019 and observations made by drillers during basalt quarry resource evaluation. Based on the report, two aquifer zones are identified in the vicinity of the Grassy Mountain Mine; shallow and deep aquifer zones. These zones are pertinent in the context of well completion depth; the current groundwater conceptual model identifies a single heterogeneous and locally complex aquifer system. This aquifer system is characterized by various water-bearing zones, with water levels strongly influenced by vertical gradients. The groundwater level information provided herein is focused on the data available for the shallow wells near the basalt quarry as shown on Figure 1. The wells are screened at depths of less than 200 feet in a variety of lithologies.

There are no monitoring wells within the footprint of the proposed basalt borrow quarry. Three coreholes were advanced to a depth from 131 to 171 feet bgs in the footprint of the quarry in December 2018 as shown on Figure 1 and 2. Groundwater levels were estimated by drillers below the base of the basalt resource in Coreholes B-2 and B-3. Groundwater was not observed in Corehole B-1.

Groundwater is not anticipated to be encountered in the proposed basalt quarry excavation based on the resources reviewed.

Section 2: Groundwater Information

- The seasonal high water table is the highest level that water typically rises to each year.
- The seasonal low water table is the lowest level that water typically falls to each year.

The seasonal high water table level is: **3,674 (based on period of record for shallow aquifer wells nearest quarry [59760, 59761, and 59772])** feet ☒ relative to mean sea level ☐ below original ground surface ☐ unknown

The seasonal low water table level is: **3,671 (based on period of record for shallow aquifer wells near quarry [59760, 59761, and 59772])** feet ☒ relative to mean sea level ☐ below original ground surface ☐ unknown

Estimated annual fluctuation of water table is **3** feet from seasonal high to low ☐ unknown

Direction of groundwater flow: **Groundwater in the shallow aquifer generally follows surface topography and flows from topograhical highs to lows. Overall flow direction is to the northwest.** ☐ unknown

How did you determine the seasonal high and low water table levels?

☐ well logs ☒ piezometer ☐ other_____

☐ field observation(s)-Describe:

☐ landowner observation(s)-Describe:

Have monitoring wells been constructed on-site? ☐ yes ☒ no

If yes: What is the average depth of static groundwater measured in the well? **No monitoring wells are constructed in the basalt quarry area. Depth to water measurements range from about 45 to 97 feet below top of casing (btoc) in shallow aquifer wells west of the quarry (59760, 59761, 59772, PW-1, GW-1, 57-10) as shown on Figures 1 and 2. These wells are screened in the shallow aquifer in different lithologies (fractured basalt, sandstone, gravel) and in an area with significant fault structures. Depth to water in piezometers nearest to the quarry (59760, 59761, and 59772) ranges from about 94 to 97 feet bgs or (3,671 to 3,674 feet msl).**

Groundwater was encountered in basalt Coreholes B-2 and B-3 during quarry resource evaluation. Groundwater levels were estimated by drillers at 126 feet bgs in B-2 (3,778 feet msl) and 143 feet bgs in B-3 (3,747 feet msl) during drilling. The groundwater was encounted in the chert pebble conglomerate/siltstone (Tis) underlying basalt bedrock (Tgb) and were not static or measured groundwater levels, only groundwater levels estimated during drilling. The minimum proposed quarry floor elevation is 3,790 feet msl and will not extend below base of bedrock. The mining plan provides at least 5 feet of basalt be left at the base of the quarry floor.

Are there off-site groundwater supply wells within 1,500-feet of the permit boundary? ☒ yes ☐ no

Prod-1 is located approximately 100 feet outside the Division 37 Permit Area. Supply wells PW-1 and BLM are located within the Division 37 Permit Area.

☐ not applicable ☒ yes ☐ no

If yes: Are well logs attached?

The proposed surface mine site is in or within one mile of a:

☐ critical aquifer recharge area ☐ sole source aquifer ☐ public water supply watershed

☐ wellhead protection area ☐ special protection area ☐ designated aquifer protection area

☐ critical groundwater area ☐ vulnerable groundwater quantity resource area

☐ classified groundwater restricted area ☐ other_____ ☒ none

The site is underlain by: ☒ multiple aquifers ☐ complex hydrogeology ☐ neither ☐ unknown

The shallowest aquifer is: ☐ confined ☒ unconfined ☐ unknown

Section 3: Mining Information

The maximum depth of proposed mining is: **3,790** feet ☒ relative to mean sea level ☐ below original ground surface ☐ unknown

The site will be mined: ☐ wet ☒ dry ☐ both

Describe mining method (e.g. drilling and blasting, ripping and loading, etc.): **Drill and blast**

Will mining/excavation operations be sequenced/phased? ☐ yes ☒ no

If yes: Please attach map.

Is dewatering necessary or proposed for the excavation operations? ☐ yes ☒ no

If yes: Groundwater will be conveyed or pumped to:

☐ on-site trench ☐ on-site pond ☐ on-site ditch
☐ depleted cell ☐ off-site location ☐ waters of the state*
☐ other: _____ ☐ other: _____

*** A DEQ National Pollution Discharge Elimination System (NPDES) Permit may be required.**

Is the area receiving dewatering water shown on a map? ☒ not applicable ☐ yes ☐ no

If yes: Please attach map.

Depth groundwater will be lowered to: _____ feet ☐ relative to mean sea level ☐ below original surface ☐ unknown ☒ not applicable

Has a Groundwater Study been completed? ☒ yes ☐ no

If yes: Please attach report.

Dewatering Plan

If the proposed surface mining operations have the potential to impact water quality and quantity through a resultant decline in the water table or hydraulic head within an aquifer a written dewatering plan may be needed. The scope of the required information will be based on site characteristics and project scale. Basic elements of a dewatering plan may include collection of baseline data and analysis, mine plan sequence, development and restrictions, groundwater modeling, on-site or off-site monitoring and/or mitigation that the planned activity will not adversely affect other groundwater users. Information required may include:

1. Identification, review and submittal of adjacent well logs.
2. Inventory of adjacent water rights and water use.
3. Measure static water levels in adjacent wells and survey in well head locations.
4. Determination of the current potentiometric surface.
5. Drilling data and completion of one or more monitoring wells.
6. Definition and/or delineation of presence/absence of confining bed(s).
7. A groundwater monitoring program during mining.
8. Development of an area groundwater budget and projection of mining impacts thereon.
9. Design and construction of a groundwater recharge structure (i.e. trench) following approval by the department.

Please note that DOGAMI will review the information presented in the completed form to determine if a written dewatering plan is required for the proposed surface mining operations.

RECEIVED

MAY 1 1989

WATER RESOURCES DEPT.

MAH 2511

22S/44E/5ab

(START CARD) # 9256

STATE OF OREGON

WATER WELL REPORT

(as required by ORS 537.765)

(1) OWNER:

Well Number: SALEM, OREGON

Name Atlas Precious Metals

Address 743 Horizin Ct. Suite 202

City Grand Junction State Co Zip 81506

(2) TYPE OF WORK:

☒ New Well ☐ Deepen ☒ Recondition ☐ Abandon

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable

☒ Other Auger

(4) PROPOSED USE:

☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval ☐ Yes ☐ No Depth of Completed Well ____ ft.

Explosives used ☐ Yes ☒ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0	18				
10	18	425				
			Cement grout	0	26	19

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E

☐ Other

Backfill placed from ____ ft. to ____ ft. Material Ft. 's Cement Grout

Gravel placed from 100 ft. to 245 ft. Size of gravel No. 8

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	10"	+2	99	.250	☒	☐	☒	☐
	6"	+2	245	Sch 80	☐	☒	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:

☐ Perforations Method

☒ Screens Type Aardvark Material PVC Sch 80

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
380	420	.020		6"		☐	☐
145	255	325-355				☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
100	40'	300	1 hr.

Temperature of water ____ Depth Artesian Flow Found ____

Was a water analysis done? ☐ Yes By whom ____

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____

Depth of strata: ____

(9) LOCATION OF WELL by legal description:

County Malheur Latitude ____ Longitude ____

Township 22S N or S, Range 44E E or W, WM.

Section 5 NW ¼ NE ¼

Tax Lot ____ Lot ____ Block ____ Subdivision ____

Street Address of Well (or nearest address) ____

(10) STATIC WATER LEVEL:

40' ft. below land surface. Date 12-8-88

Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:

Depth at which water was first found 40'

From	To	Estimated Flow Rate	SWL
140-~~255~~	255	30 gpm	
320	355	50 gpm	
380	415	150 gpm	

(12) WELL LOG:

Ground elevation ____

Material	From	To	SWL
Overburden w/ boulders	0	17	0
Clay brown	17	140	0
Sandstone w/ blue clay	140	255	40
blue clay	255	320	40
Sandstone w/ blue clay	320	355	40
Blue clay	355	380	40
Fruited hard sandstone	380	415	40
Blue clay	415	425	40
=			
12-5-88 - 12-10-88			
+=			
Redone surface seal to 26 feet using method 2 referring to letter sent January 9, 1989			
Drilled around 10" casing to the depth of 26' using method C pumped 19 sacks of cement down hole			
3-30-89 - 3-31-89			
=			
Incorporated to singel log per state request			

Date started 12-5-88 Completed 3-31-89

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

Signed Bob Doty WWC Number 1202

Date 4-10-89

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief. WWC Number 325 [redacted]

Signed Bob Doty for Bill Doty Date 4/15/89

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 3/88

Wetland Supplemental Form

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation and Reclamation Program
229 Broadalbin Street SW
Albany, OR 97321-2246
(541) 967-2039
Fax (541) 967-2075

Wetland Supplemental Form

DOGAMI has a statutory directive to avoid or minimize adverse impacts to air, water, land, and wildlife resources from surface mining operations. Wetlands are defined as areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of the year. Due to soil variations, topography, climate, hydrology, water chemistry, vegetation and other factors, including human disturbance, wetlands can vary widely. Non-tidal wetlands are most commonly found along rivers and streams, along the margins of ponds and lakes, within isolated depressions surrounded by dry land, or in other low-lying areas where the groundwater intercepts the soil surface or where precipitation saturates the soils.

Although many wetlands are seasonal and may only be wet periodically, the function of a wetland and its role in the environment is significant. Wetlands provide numerous benefits to both humans and the environment including improving water quality via filtering out pollutants and providing critical habitat for both terrestrial and aquatic wildlife species, some of which are adapted to breeding or living a portion of their life cycle exclusively in these environments. To ensure the protection of wetlands and any wildlife that reside or travel in those areas, it is necessary for applicants to consider certain issues prior to conducting surface mining activities within an area that may contain wetlands. These issues are both regulatory and technical in nature and include permitting, collection of baseline data, monitoring, mapping and/or mitigation. This form is to be used as a component of a DOGAMI Operating Permit or Amendment application for proposed surface mining operations which will involve any mining operations that contain wetlands.

Section 1: Contact & Site Information

1a. Applicant / Proposed Permittee

Name: **Calico Resources USA Corp**			
Mailing Address: **665 Anderson Street**	City: **Winnemucca**	State: **NV**	Zip: **89445**
Telephone: **775-625-3600**	Fax: **N/A**	Email: **nancy@paramountnevada.com**	
Preferred method of contact ☐ Telephone ☒ Email			

1c. Site Identifier

Legal Description

County: **Malheur**

Township: **22S**	Range: **44E**	Section: **8**	Tax Lot(s): _____
Township: _____	Range: _____	Section: _____	Tax Lot(s): _____

Site Name: **Grassy Mountain Basalt Borrow Quarry**

DOGAMI ID# **This supplemental form is part of an abbreviated Operating Permit Application for the basalt borrow quarry at the Grassy Mountain mine. The basalt borrow quarry will be situated within the Division 37 permit boundary (Permit Area); however, this supplemental form specifically relates to surface mine operations under the Division 30 Rules. This supplemental form will be submitted with the abbreviated Operating Permit Application and Operating and Reclamation Plan set as an Appendix to the Consolidated Division 37 Permit Application. The Division 37 Permit Area and location of the basalt borrow quarry are shown on Figure 1.**

The information and responses provided in this supplemental form are related to the basalt borrow quarry and not the entirety of the Division 37 Permit Area.

The wetland information provided in this supplemental form is based on information presented in the *Wetland Delineation Report for the Grassy Mountain Mine Project, Malhuer County, EM Strategies, Inc.* and the *Department of State Lands (DSL) concurrence letter (WD #2018-0115) dated May 3, 2018*. Based on the letter, no wetlands are present within the vicinity of the basalt borrow quarry. Tributary 2a and the Schweizer Reservoir are within the vicinity of the basalt borrow quarry, but are exempt from OAR 141-085-0515(3 and 7) and are not subject to Removal-Fill requirements per the DSL concurrence letter.

No wetlands are present within the vicinity of the basalt borrow area, and therefore no impacts are anticipated.

Section 2: Wetland Information

The proposed surface mine site is located along, within, or adjacent to the following:

- ☐ river or stream
- ☐ margin of a lake or pond
- ☐ floodplain*
- ☐ marsh or wet meadow
- ☐ swamp
- ☐ none
- ☒ other: **Tributary 2a**
- ☒ other: **Schweizer Reservoir (cattle pond)**

***A DOGAMI Floodplain Supplemental Form may be required to be submitted with this application.**

Are there any known wetlands or wetland like features present within or adjacent to the proposed permit boundary? ☐ unknown ☐ yes ☒ no

How did you evaluate the site or otherwise determine if the site may contain wetlands?

- ☐ National Wetland Inventory (NWI) Map
- ☐ local wetland survey
- ☒ wetland delineation
- ☐ Environmental Impact Statement (EIS)
- ☐ stream gage data
- ☐ county soil surveys
- ☐ FEMA flood insurance rate map
- ☐ USGS quadrangle map
- ☐ other topographic map of the area
- ☐ local land use department
- ☐ other: _____
- ☐ other: _____

What is the general type of wetland found within the site?

- ☐ tidal
- ☐ freshwater forested
- ☐ shrub wetland
- ☐ bog
- ☐ fen
- ☐ freshwater springs
- ☐ freshwater emergent
- ☐ swamp
- ☐ geothermal
- ☐ alpine
- ☐ marsh
- ☐ human made
- ☐ other: _____
- ☐ other: _____
- ☒ none
- ☐ vernal pools

Section 3: Studies, Reports and Analyses

Has a Wetland Delineation been completed? ☒ yes ☐ no

If yes: A wetland delineation report including the following is attached:

- ☐ topography
- ☐ plant communities
- ☐ soils mapped and found
- ☐ hydrology information
- ☐ existing wetland mapping
- ☐ field data sheets
- ☒ types of wetlands identified
- ☒ aerial photography
- ☐ data collection point map
- ☒ evaluation area map
- ☐ other: _____
- ☐ other: _____

Has the wetland delineation been submitted to Department of State Lands (DSL) for concurrence? ☒ yes ☐ no

If yes: Provide DSL Concurrence # **WD #2018-0115**

If no: Explain:

Has the wetland delineation been submitted to the Army Corps of Engineers for concurrence? ☐ yes ☒ no

If yes: Provide USACE Concurrence #

If no: Explain: **Not submitted to USACE (no federal jurisdiction)**

Will any streams, creeks, or drainages be excavated, filled or relocated? ☒ yes ☐ no

Is the planned surface mining operation proposing to impact jurisdictional wetlands? ☒ not applicable* ☐ yes ☐ no

If yes: Has a DSL permit been ☐ applied for ☐ obtained ☐ yes ☐ no

If yes: Please attach approved permit, application or File#.

*No jurisdictional wetlands were identified during the delineation

Section 4: Mapping

Is a high resolution topographic or lidar map of the existing conditions and surrounding lands at an appropriate scale available? If yes: Please attach ☒ yes ☐ no

Is a soil survey map delineating the hydric soils attached? ☒ not applicable (no wetlands were identified during the delineation) ☐ yes ☐ no

Has any of the following information been mapped? If yes: Please attach ☒ yes ☐ no

	☐ plant communities	☐ soils mapped and found	☐ hydrology information
☐ existing wetland mapping	☐ field data sheets	☒ types of wetlands identified	☒ aerial photography
☐ data collection point map	☒ evaluation area map	☒ proposed permit boundary	☐ other: _____

Section 5: Mining Information

The maximum depth of proposed mining is: **3,790** feet: ☒ relative to mean sea level ☐ below original ground surface ☐ unknown

The site will be mined: ☐ wet ☒ dry ☐ both

Describe all proposed mining methods (e.g. drilling and blasting, ripping and loading, etc.): **Drill and blast**

Will mining/excavation operations be sequenced/phased? ☐ yes ☒ no

If yes: Attach map.

Is dewatering necessary or proposed for the excavation operations? ☐ yes ☒ no

If yes, a DOGAMI Groundwater Supplemental Form is required to be submitted with this application, and a DEQ National Pollution Discharge Elimination System (NPDES) Permit may be required.

Check all proposed on-site activities that apply:

☒ excavation	☐ filling	☒ grading
☒ crushing	☒ stockpiling	☐ washing
☐ material recycling	☐ other: _____	☐ other: _____

If applicable, will all interim and final *in-water* cut-slopes be constructed at sloping configurations of 3H:1V or flatter to a minimum depth of six feet below the low-water level of the pond(s)? ☐ yes ☐ no

If no: What will be the final sloping configuration of the *in-water* slopes? _____H:_____V (e.g. 5H:1V)

Per ORS 632-030-0027(3)(f): final above-water fill slopes can only be placed over cut slopes that are 3H:1V, or flatter, unless the Department agrees in writing to a different ratio based on a determination that the flood potential is very low.

Wetland Assessments and Reports

The scope of information required by DOGAMI will be based on site specific characteristics, the scale and configuration of the proposed mining operation, and the proposed reclamation plan. It is important to note that many mining operations require other state and federal permits; therefore, DOGAMI highly recommends a pre-application consultation and site visit with the applicable natural resource agencies be conducted, if possible. DOGAMI can only issue an Operating Permit if all required state, federal, and local government approvals have been obtained, otherwise a Provisional Operating Permit will be issued. All data collection and analysis techniques should be coordinated in advance with DOGAMI's Floodplain Reclamationist (Vaughn Balzer 541-967-2082; vaughn.balzer@oregon.gov).

Please note that DOGAMI will review the information presented in the completed form above to determine if additional reports, studies, maps and/or analysis are required for the proposed surface mining operations. Information required may include:

1. Preliminary data collection and synthesis.
2. Historic aerial photographs and surveys, including topographic and inventory maps.
3. County soil survey maps and site specific hydric soil characteristics, profiles, and classifications.
4. Site hydrology; including annual groundwater fluctuations, inundated or saturated soil conditions, precipitation, stratigraphy, soil permeability, and plant cover.
5. A description of hydrophytic vegetation, including classification and prevalence.
6. Indicators of wetland hydrology, including drainage patterns, drift lines, sediment deposition, water marks, stream gage data, historic records, and visual observations.

Appendix W: Alternatives Support Documents

TECHNICAL MEMORANDUM

DATE September 13, 2019 1663241_043_TM_Rev1

TO Ms. Nancy Wolverson
Calico Resources USA Corp.

CC

FROM Golder Associates Inc. **EMAIL Chris_MacMahon@golder.com**

GRASSY MOUNTAIN PROJECT – TAILINGS STORAGE FACILITY

TAILINGS STORAGE FACILITY LOCATION OPTIONS ANALYSIS

Calico Resources USA Corp (Calico) retained Golder Associates Inc. (Golder) to prepare an options analysis to identify a preferred location for the tailings storage facility (TSF) at the Grassy Mountain Project located in Malheur County in southeastern Oregon. The request stems from discussions during the December 18, 2018 meeting in The Dalles, Oregon, where representatives for the Oregon Department of Environmental Quality (ODEQ) and Department of Geology and Mineral Industries (DOGAMI) requested that the original siting and trade-off study be revised and expanded to include all five (5) option locations that had been previously presented by past owners of the Project. At the request of the ODEQ and DOGAMI, the five option locations evaluated in this analysis include the three options presented in the 2015 Preliminary Economic Assessment (PEA), the current proposed TSF location, and an option for a TSF located on Bishop's property. A qualitative discussion is also presented on the best practicable technologies for tailings storage in semi-arid, relatively-low seismicity areas similar to the Grassy Mountain Project.

This technical memorandum presents a brief description of each layout and a comparison of the five locations.

1.0 INTRODUCTION

In late 2016, Golder prepared a trade-off study to evaluate two potential TSF locations. Option 1, located east of the underground portal, was one of three locations presented in the 2015 PEA. Golder determined that the other two locations presented in the 2015 PEA were unfavorable due to project economics, property restrictions, and/or long-term stormwater management. The second location evaluated in Golder's 2016 study was identified during Golder's August 2016 site visit. This second location, referred to as Option 2, was located immediately northwest of the proposed mine portal. A comparison of Options 1 and 2 was presented in Golder's original 2016 trade-off study. The intent of the original trade-off study, summarized for the ODEQ in a letter dated October 2018, was to provide sufficient information for Calico to evaluate the two potential TSF locations and select a preferred concept for further design and evaluation.

This letter is intended to supersede Golder's original 2016 trade-off study by presenting a comparison of five TSF location options, the two presented in the original study in addition to the locations requested by the ODEQ and DOGAMI. Section 2.0 also includes a brief discussion on the decision to utilize conventional slurry tailings at the Grassy Mountain Project.

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2.0 TAILINGS MANAGEMENT OPTION ANALYSIS

Golder has been providing engineering and design support services for the Grassy Mountain Project since August 2016. Engineering support included a review of past data and evaluation of various tailings management options to provide Calico with a recommendation regarding tailings management at the site.

Tailings are the term used in the mining industry for mineral waste created from grinded and milling ore for precious metal removal. The milling reduces the ore to a material with a particle-size distribution typical of a silt and fine sand, and the remaining “barren” minerals (tailings) exist in the form of a slurry after metal removal. The tailings are then sent to permanent storage in a repository which is ultimately reclaimed and closed for environmental stability. Based on the information presented in the Plan of Operations prepared in July 2015 by RTR Resource Management, Inc., the produced mill tailings would be dewatered to produce a thickened tailings or “paste.” The plan stated that a total of 3.2 million tons of tailings would be produced with approximately 70% (2.6 million tons) of the tailings stored in the a TSF. The remaining 30% would be placed as backfill in the mine workings.

During the project review in 2016 with Calico and Mine Development Associates (MDA) regarding the pre-feasibility level design of the TSF, different levels of pre-disposal dewatering technologies were considered including:

- Conventional tailings slurry (25 to 60% solids, by weight, w/w); a pumpable slurry
- Filtered tailings (75-85% solids w/w); vacuum or pressure filtration removes water to create the consistency of a solid material
- Paste or high-density thickened tailings (50-80% solids w/w); paste tailings are dewatered to a non-segregating but pumpable slurry that typically has minor bleed water after placement

The conventional slurry and high-density slurry is typically pumped to a lined storage facility behind an earth-fill or rock-fill dam where the tailings drain and form a solid; the drained water is recycled in the milling and processing circuit.

The filtered and paste tailings options would require the construction of additional infrastructure to mechanically dewater the tailings prior to storage. Storage of the filtered and paste tailings is similar to conventional slurry in that those options would still require the following components and/or attributes, similar to the TSF presented in the 2018 PFS Design Report:

- A large above-ground waste disposal area
- Construction of a continuous dual containment lining system in accordance with the OAR Division 43
- Geotechnical and stability risks that would drive the design
- Stormwater management and construction of diversions structures to prevent run-on of stormwater into the storage facility
- Closure and reclamation planning and design

During the project kick-off meeting in August 2016, and subsequent discussions with the Design Team, it was determined that mechanically dewatering tailings to a paste or filtered condition prior to permanent disposal

provided a negligible benefit to the project and that the design for the Grassy Mountain Project would incorporate tailings stored in a conventional slurry TSF. Due to the relatively small quantity of tailings and short life of mine, it was judged that the high cost of producing dewatered tailings was detrimental to the project's economic feasibility; it would be cost prohibitive to construct and operate a filtration dewatering system. Additionally, mechanical dewatering of the tailings would likely create net excess water scenario that would require water treatment prior to discharge.

Golder also evaluated the use of paste backfill at a conceptual level and determined that the construction and operation of a paste backfill plant would also be cost prohibitive. In accordance to the Oregon Administrative Rules (OAR), the process water used in the paste backfill would likely require water treatment prior to being placed within the underground workings. Since conventional tailings are not suitable for structural backfill in the underground mine workings, it was decided that all mill tailings would be stored above ground in the TSF. Accordingly, the TSF locations and layouts evaluated in this option analysis were designed to contain 100% of the produced tailings; approximately 3.2 million dry short tons.

3.0 BASIS OF DESIGN

A conservative basis of design was used to develop conceptual facility layouts. The basis of design is based on Golder's interpretation of the OAR for Chemical Mining (Division 43) and Dam Safety (Division 20), information provided by Calico and the Design Team, information obtained during the completion of the PFS level design through engineering analyses, and geotechnical characterization of the site through site subsurface investigations and geotechnical laboratory testing, as well as Golder's experience designing and construction TSFs in similar conditions that include climate, seismicity, permitting, and operating philosophy.

Existing topography was considered in order to minimize the quantity of earthwork required to build the TSF to the greatest extent possible. Existing topography was generated from 2-ft contours provided by Calico for the area immediately surrounding Option 2, and from USGS 7.5-minute digital elevation models in UTM11 NAD83 coordinate system for all other options. Table 1 presents the design criteria for the conceptual design of the 5 TSF location options:

Table 1: Design Criteria

Parameter	Value
Capacity	3.2 million tons
Life of Mine	13 years
Average Tailings Deposition Rate	248,346 tons/year (680 tons/day)
Settled Tailings Density	70 pcf*
Dam Construction Method	Staged Downstream Construction
Dam Crest Width	50 ft minimum
Dam Embankment Slopes	3H:1V (horizontal to vertical)
Slope of Tailings Surface	Conceptual – no slope assumed
Freeboard Above Tailings Beach	2 feet against dam embankment

In addition to the above parameters, the following key factors were considered when comparing options:

- Human and environmental safety and protection
- Location of existing drainages
- Geotechnical and slope stability risks for the dam
- Operational risks created by steep terrain
- Closure requirements
- Availability and location of construction material borrow areas
- Tailings transport and distribution system routing
- Surface water management and diversion
- Process water management/reclaim system location and routing

The assumptions presented herein for the design of the proposed layouts are sufficient and applicable for site selection.

4.0 TSF LOCATION OPTION ANALYSIS

The TSF location options analysis included an evaluation of the following 5 locations presented on Figure 1:

- Option 1 – TSF located east of the proposed underground portal (included in the 2015 PEA)
- Option 2 – TSF located northwest of the underground portal
- Option 3 – TSF located southwest of the underground portal (Included in the 2015 PEA)
- Option 4 – TSF located south and further west of the underground portal in a separate ephemeral drainage than the other options (included in the 2015 PEA)
- Option 5 – TSF located on Bishop’s property about 3 miles southwest of the underground portal

Table 2 below presents a summary of the general site characteristics and conceptual level volumetrics for each option.

Table 2: Site Characteristics Summary

Parameter		Option 1	Option 2	Option 3	Option 4	Option 5
Embankment Volume (cy)		2,226,000	913,000	3,003,400	1,642,100	2,690,000
Stage 1 Starter Dam Maximum Height (ft)		107	53	116	92	70
Ultimate Embankment Maximum Height (ft)		145	83	160	100	105
Disturbance Area (sf)		2,700,000	4,126,000	2,779,000	3,303,000	3,302,000
Tailings Rate of Rise (ft/yr)	Year 1	40	37	42	31	28
	Year 2	13	7	13	8	8
	Years 3, 4	9	5	9	6	7
	Year 5+	5	3	7	3	5
Groundwater Depth (ft)*		85-125	90-165	50-220	80-265	260-295
Tailings Surface Elevation	Min.	3,740	3,546	3,631	3,611	3,412
	Max	3,852	3,616	3,750	3,670	3,498
Process Facility Elevation (ft)		3,715	3,715	3,715	3,715	3,715
Within Project Boundary		Yes	Yes	Yes	Yes	No

* - Groundwater elevations were approximated using the 2017 Q4 Grassy Mountain Groundwater Elevation Contour map presented in the *Groundwater Resources Baseline Data Report, Grassy Mountain Gold Project,* dated February 19, 2019, prepared by SPF Water Engineering, LLC.

Preparation of the impoundment area for all options would be similar, and would include stripping and stockpiling of topsoil, and preparation of the subgrade for the lined areas and dam footprint(s). Therefore, site preparation is not addressed in detail in this study. The following sections summarize the proposed layouts, key features, advantages, disadvantages, and risks of the options.

4.1 TSF Option Comparison

Golder prepared a ranking matrix that evaluates Options 1 through 5 to consolidate the advantages and disadvantages of each option to support the selection of a preferred option. The ranking matrix focused on attributes falling into two categories, Technical Criteria and Human Safety and Environmental Protection.

The Technical Criteria considered were:

- Volume of earthworks material (Embankment Fill)
- Ease of construction
- Complexity and reliability of stormwater management
- Efficiency of pumping and piping of the tailings to the TSF and return water back to the mill
- Tailings rate of rise (lower rate if rise allows for increased solidification of tailings and increased water for re-use in milling/processing circuit)

The key factors evaluated for Human Safety and Environmental Protection were:

- Disturbance area (impact to environment)

- Zero discharge facility (potential to impact ground water)
- Geotechnical stability of the facility (safety and environmental risks to downstream receptors)
- Public access around Project site (impact to public access)
- TSF location within Project boundary
- Post-closure reclamation (potential to affect long-term post-closure use and reliability)

Each attribute listed above was assigned a percentage weighting factor based on Golder's judgement of the importance of each attribute to developing a successful project. For each attribute the options were scored from 1 to 5 depending on favorability, with 5 being the most favorable. The total score for each of the main categories was calculated by multiplying the weighting factor (percentage) by the score (1 to 5) for each attribute and adding them together, resulting in total scores ranging between 1 and 5. Each of the main categories received a weighting factor as well with a greater emphasis being placed on Human Safety and Environmental Protection (60%) versus Technical Criteria (40%). The highest overall score was selected as the preferred option.

The ranking matrix is presented in Attachment A.

4.1.1 Technical Criteria

The following subsections present brief summaries comparing the technical criteria of each option.

4.1.1.1 Volume of Earthworks Material (Embankment Fill)

A lower volume of embankment fill results in lower energy consumption during construction and lower cost. The volume of embankment fill required varies greatly between the options due to the differences in the native topography at each of the locations. Option 2 has the lowest required embankment fill volume as a result of being located within a broad valley allowing it to utilize a larger surface area for tailings storage. This also allows Option 2 to predominantly utilize the natural topography to retain the tailings on the east, south and west sides requiring minimal embankment fill in these areas. Option 2 has the lowest starter dam and lowest ultimate embankment heights of 60 and 85 feet, respectively. The other options are constructed in steeper terrain requiring more embankment fill and maximum embankments heights ranging between 105 and 160 feet to achieve the desired storage capacity.

4.1.1.2 Ease of Construction

Ease of construction was evaluated by considering the distance from the embankment fill borrow source and the native terrain at each potential location. This analysis assumed that all embankment fill will be sourced from the basalt borrow located near the eastern edge of the Project boundary as shown on Figure 1.

Options 1 through 4 are all located within one mile of the borrow. Option 1 is located nearest to the borrow, partially overlapping it on the eastern edge, would require an additional borrow area to be identified. Option 5 is located southwest of the borrow with an approximate haulage distance of 4 miles between the borrow and the embankment. This additional haul distance would significantly affect the construction costs, potentially requiring an additional borrow area to be identified closure to the TSF.

The flatter terrain of the Options 2 and 4 provides the most favorable topography for site preparation and composite lining system installation. The basin areas within Options 2 and 4 would require minimal regrading and allow for the use of smooth geomembrane. Options 1, 3 and 5, are located in narrower valleys, or adjacent to

steep native topography with slopes up to 2H:1V. Any existing slope steeper than 2.5H:1V would need to be graded to 2.5H:1V or flatter and potentially require the use of textured geomembrane to allow for safe installation of the proposed composite liner system. This additional earthwork would increase both the duration and costs of construction.

4.1.1.3 Stormwater Management

Stormwater management is a critical component to the proper operation of a TSF. The intent of the design for the Grassy Mountain TSF is to be a zero-discharge facility, meaning that once water has entered the process circuit it will remain in the circuit or be lost through evaporation. Maintaining a zero-discharge facility is aided by diverting as much stormwater as possible from areas tributary to the TSF around the TSF to prevent adding additional water to the process circuit.

None of the options are located at the head of a natural drainage where little to no stormwater diversion would be required; therefore, stormwater will be collected and diverted around the TSF sites using stormwater channels to maintain the integrity of all TSF options. Golder considered the existing topography and size of upstream tributary area when evaluating the stormwater management at each location. Stormwater diversion channels are typically more reliable and easily constructed on flatter slopes. Steeper slopes will require additional earthwork and will limit access with conventional construction equipment. For this reason, it will be most difficult to construct stormwater diversion around Option 1. Options 3 and 5 have small tributary areas upstream of the TSF so the total quantity of stormwater runoff will be less, requiring less stormwater management than the other Options. Options 2 and 4 were both rated the same, with average ratings, as both locations have native slopes surrounding the TSF that are relatively flat. This allows stormwater generated from the upstream ephemeral drainages tributary to the TSF locations to be easily routed around the TSF. The large tributary area south of the TSF for Option 2 was not considered detrimental to the project since it can be easily diverted into an existing drainage west of the TSF.

4.1.1.4 Pumping and Piping

The pumping and piping rating for each location was developed considering the elevation of the tailings deposition system, the elevation of the process facility and the proximity of the TSF to the process facilities (length of piping). A lower elevation difference and shorter pipeline result in higher energy efficiency and lower cost.

Options 2 and 3 are the preferred locations when taking into consideration the close proximity to the process facilities and the fact that both locations may allow for gravity distribution of tailings during portions of the operation (higher energy efficiency). Of the two, Option 2 was rated higher due to having a greater elevation drop between the process facilities and the tailings deposition system, potentially decreasing pumping efforts during operation. Additionally, having the TSF located at an elevation lower than the process facility may allow for the emergency overflow from the process facility to gravity drain to the TSF and eliminate the need for a separate containment facility. Option 4, while located lower in elevation than the process facility, would require two reclaim ponds to manage underdrain flows, so it was rated less favorable than Options 2 and 3.

Options 1 and 5 were rated the lowest in favorability for either being higher in elevation than the process facility or for the long distance between the process facility (Option 1) and TSF (Option 5). Both options would require increased energy and larger pumps for tailings delivery.

4.1.1.5 Tailings Rate of Rise

The tailings rate of rise drives the rate of consolidation of the tailings, affecting the settled density of the tailings during operation, the quantity of water that can be re-used during operation, and the long-term settlement of the tailings after operation (affecting the time to closure). A lower rate of rise will provide:

- greater consolidation for the tailings, increasing the overall settled density and potentially reducing the size of the dam and TSF,
- increased reclaim water return from the TSF back to the mill/process plant to lessen the need for make-up water (higher water re-use during operation), and
- reducing the volume of entrained water in the tailings at the end of operation, thereby reducing long-term water management and speeding reclamation and closure.

The rate of rise of the tailings is related to the geometry of the basin; a larger and flatter basin will have a lower rate of rise. In Year 1, the rate of rise of the 5 TSF options ranged between 28 and 42 feet, with the rate of rise dropping each year as the area of deposition within the impoundment increases. Due to the steep terrain associated with the Options 1 and 3 sites, those facilities would experience the greatest rate of rise. Options 2, 4 and 5 have similar rates of rise over the life of the facility, with Option 2 having the overall lowest rate of rise. This is to be expected since the Option 2 basin is the largest of the 5 options.

4.1.2 Human Safety and Environmental Protection Criteria

The following subsections present brief summaries comparing the human safety and environmental protection criteria of each option.

4.1.2.1 Disturbance Area

The disturbance area considered in this evaluation included both the embankment footprint and the lined area of the TSFs. The options would likely have disturbance areas outside of the TSF to accommodate access and for construction staging and accommodate the installation of the tailings delivery and reclaim water pipelines. However, for this study, the footprint of each TSF was considered suitable for comparison at the conceptual design level. Smaller disturbance areas generally correspond with the taller embankments and faster rates of rise of the tailings, so the disturbance area is often considered in conjunction with the technical criteria to strike a balance that meets the design criteria.

The total lined disturbance areas ranged between 2,700,000 square feet (62 acres) for Option 5 to 4,126,000 square feet (95 acres) for Option 2.

4.1.2.2 Potential Impact to Surface and Ground water

The Grassy Mountain TSF will be designed as a zero-discharge facility. However, if the facility were to leak or overtop, there is the potential that the process water could impact the surface and ground water. The Surface Water Baseline Report prepared by SPF Water Engineering found that, "*there are no perennial surface water features located within the immediate vicinity of the proposed mine and process areas*." The nearest perennial surface water body is the Negro Canyon Creek located just over two miles northwest of the project boundary. Due to the distance to the nearest surface water body, all options were considered to have low potential impact to surface water.

The potential impact to ground water was evaluated by examining depth to ground water at each option location. The range of ground water depths are presented in Table 2, and range between 50 feet below Option 3 (shallowest) and between 260 and 295 feet beneath Option 5 (deepest). Deeper ground water is more favorable as it provides an increased barrier to flow and a larger vadose zone often provides increased attenuation capacity to remove metals. Groundwater elevations were approximated using the 2017 Q4 Grassy Mountain Groundwater Elevation Contour map presented in the report prepared by SPF Water Engineering, LLC, dated February 19, 2019, and titled *Groundwater Resources Baseline Data Report, Grassy Mountain Gold Project*.

4.1.2.3 Geotechnical Risks

The Grassy Mountain TSF will utilize downstream construction so each of the options considered was conceptually designed using that methodology. This construction method is considered the most conservative (safest) with respect to geotechnical risks when compared with other methods currently used for TSF construction. The geotechnical risk factors for this analysis were applied by considering the ultimate maximum height and the known subsurface foundation conditions. A greater height is generally considered to have a greater geotechnical risk; however, that factor must be paired with subsurface conditions to determine if a facility poses a serious geotechnical risk. As summarized in Table 1, the ultimate maximum height ranges between 85 feet for Option 2 (lowest) and 160 feet for Option 3 (highest).

Historic drill holes located near or beneath the Options 1 through 4 sites encountered natural clay deposits. Clay materials can have low strengths and are susceptible to consolidation settlements when loaded. The subsurface conditions at these locations would need to be thoroughly characterized when designing a TSF. No information for the subsurface beneath Option 5 was available when this analysis was completed. Therefore, Option 5 was assigned a geotechnical risk rating of 3 for this analysis.

4.1.2.4 Impact to Public Access

The county road leading to the Grassy Mountain Project is a public road, so any required re-routing of this road was considered to be less favorable. Options 2, 4, and 5 would all require a re-routing of portions of the county road. Options 1 and 3 are both located east of the county road and would not require any re-routing.

4.1.2.5 Located Within Project Boundary

Options 1 through 4 are all located completely within the existing project boundary. Option 5 is located approximately 2 miles west of the project boundary on private land (Bishop's Property). For the safety of the public and security, it was considered most favorable to have the TSF located within the existing project boundary. This keeps all mining activities in close proximity where it will be easier to restrict public access to the mining operation.

4.1.2.6 Reclamation and Closure

Reclamation and closure risk ratings were developed by considering the effect of long term draindown of the tailings, long-term consolidation settlement of the tailings, tailings surface area (closure area) and stormwater management.

Options 2, 4 and 5 have similar rates of rise, that are slower than Option 1 and 5. The slower rates of rise will allow for:

- shorter duration of long-term drain down water management,

- shorter drying period of the tailings surface allowing placement of a closure cover earlier in the closure period,
- A shorter post-operation settlement period for the tailings surface that will shorten the post-operation management period prior to reclamation.

The TSFs with the greatest rate of rise and tailings thickness, Options 1 and 3, will experience longer post-operation water management delaying the final closure of the TSF.

With respect to closure cover area, Option 3 has the smallest total area while Option 2 has the largest. Option 2 will have the largest capital cost for construction of the final closure cover however some of these costs will be offset by the savings in operating and management costs by allowing for installation of the closure cover more quickly after the active mining has ceased.

Stormwater management was factored into the post closure reclamation risk rating by evaluating the contributing area upstream of the TSF and the potential for maintenance of the stormwater diversion channels into closure. Options 3 and 5 would be the most favorable for long-term stormwater management due to small contributing areas and relatively flat slopes where the perimeter stormwater diversions would be constructed. During closure, Options 2 and 4 will have to manage larger stormwater flows around or over the closed facility. Option 1 is considered the worst of the options from a stormwater management perspective due to the steep surrounding slopes and relatively large upstream tributary area.

5.0 CONCLUSION

Option 2 received the best overall ranking in addition to having the best total ranking for both Technical Criteria and Human Safety and Environmental Protection. Option 2 is the only option located in a broad valley which offers significant benefits over the other alternatives including:

- The lowest volume of embankment fill material due to the large impoundment area and existing topography that only requires embankments along the north and west sides;
- Construction in the broad valley close to the borrow will allow for relatively short haul distances and limited grading within the basin to accommodate the installation of the composite lining system;
- Option 2 is located lower in elevation and close to the proposed process facilities which will decrease the pumping and piping requirements compared to the other options;
- A low tailings rate of rise, which has numerous benefits including greater consolidation, increased reclaim water return to the process circuit and a reduced long-term water management period during closure.

Additional testing on the tailings since this completion of this study indicate that settled tailings densities will be higher than 70 pcf, however that will not affect Golder's recommendation for Option 2 as the preferred location for the TSF. An increase in tailings density will allow for a smaller impoundment, better consolidation of the tailings and an increase in reclaim water that can be used in the process circuit.

6.0 CLOSING

Golder is pleased to present this technical memorandum summary of the options analysis completed for the TSF location at the Grassy Mountain Project. If you have any questions or comments regarding the information presented herein, please contact the undersigned at (775) 828-9604.

Sincerely,

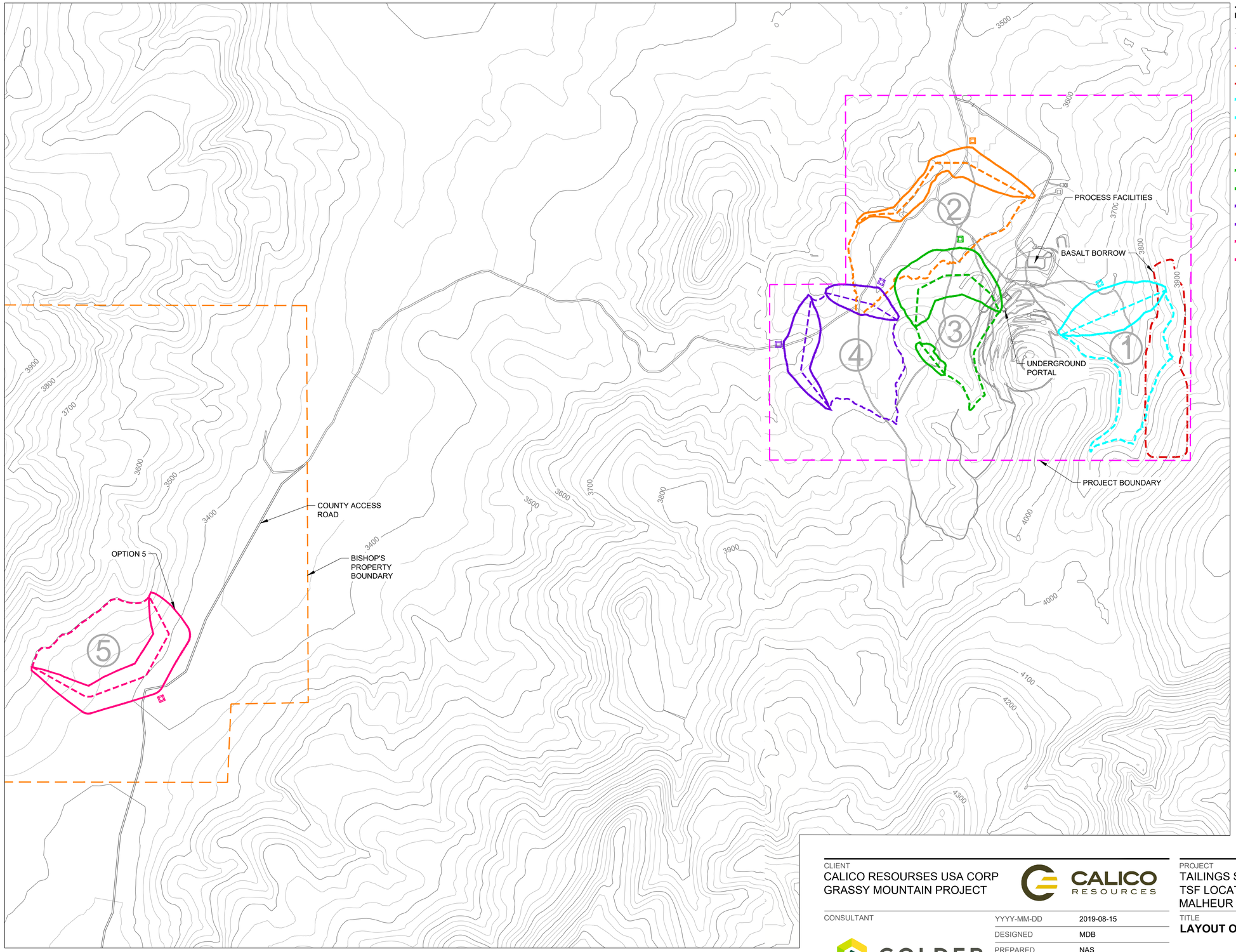
Christopher MacMahon, PE
Senior Engineer, Associate

Russ Browne
Practice Leader, Principal

MDB/CJM/RAB/kg

https://golderassociates.sharepoint.com/sites/17031g/1663241 grassy mountain tsf/500_reporting/520_letters/534_tm trade-off study summary for deq/revised for consolidated permit/final/1663241_043_tm_rev1.docx

Figures



LEGEND

- 3630 EXISTING GROUND TOPOGRAPHY (20 FT CONTOURS) (NOTE 1)
- PROJECT BOUNDARY
- BISHOP'S PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF BASALT BORROW
- LIMIT OF OPTION 1 IMPOUNDED TAILINGS
- LIMIT OF OPTION 1 EMBANKMENT
- LIMIT OF OPTION 2 IMPOUNDED TAILINGS
- LIMIT OF OPTION 2 EMBANKMENT
- LIMIT OF OPTION 3 IMPOUNDED TAILINGS
- LIMIT OF OPTION 3 EMBANKMENT
- LIMIT OF OPTION 4 IMPOUNDED TAILINGS
- LIMIT OF OPTION 4 EMBANKMENT
- LIMIT OF OPTION 5 IMPOUNDED TAILINGS
- LIMIT OF OPTION 5 EMBANKMENT

NOTES

1. EXISTING TOPOGRAPHY PRESENTED WAS DEVELOPED USING SHAPE AND DEM FILES DOWNLOADED FROM THE USGS WEBSITE TITLED "ned10m43117f4.shx" AND "Grassy Mountain.dem". ELEVATIONS SHOWN ARE IN FEET.

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0 800 1600
1" = 800' FEET

CLIENT
CALICO RESOURSES USA CORP
GRASSY MOUNTAIN PROJECT

CALICO RESOURCES

CONSULTANT
GOLDER

YYYY-MM-DD	2019-08-15
DESIGNED	MDB
PREPARED	NAS
REVIEWED	CJM
APPROVED	RAB

PROJECT
TAILINGS STORAGE FACILITY
TSF LOCATION ALTERNATIVE ANALYSIS
MALHEUR COUNTY, OREGON

TITLE
LAYOUT OF ALL OPTIONS

PROJECT NO.	REV.	FIGURE
1663241	0	1

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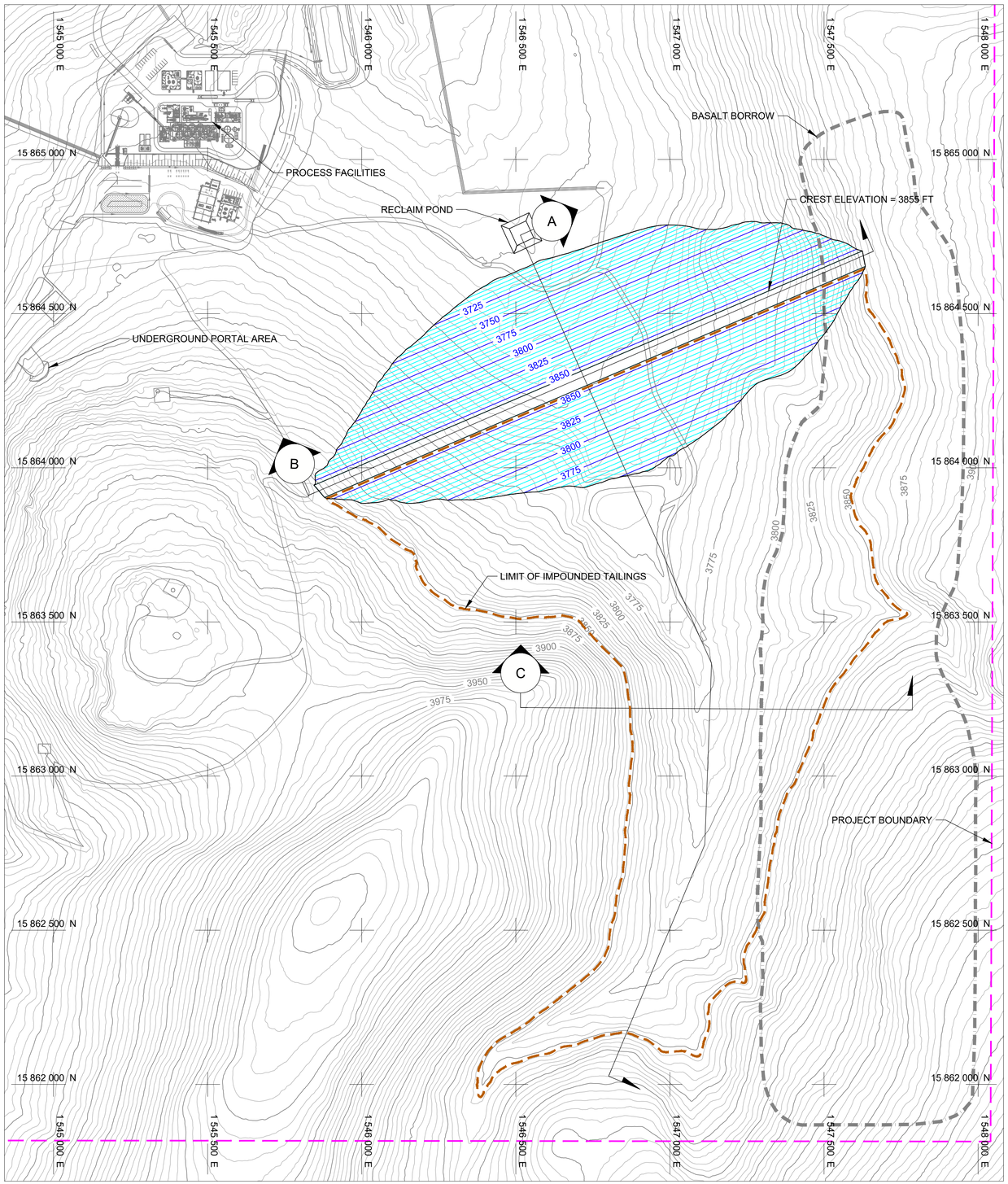

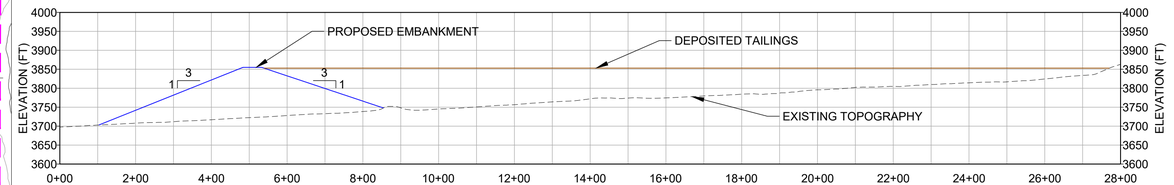

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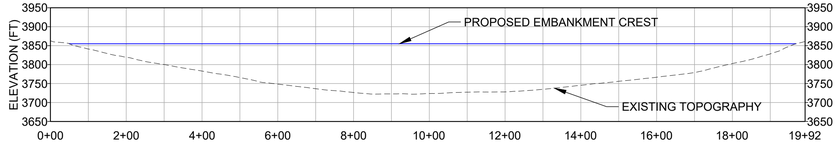

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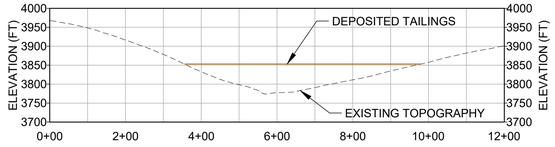

SCALE 1"=200' C SECTION THROUGH TAILINGS BASIN

LEGEND

- 3630 EXISTING GROUND TOPOGRAPHY
- 3630 PROPOSED TAILINGS DAM GRADING
- LIMIT OF IMPOUNDED TAILINGS
- PROJECT BOUNDARY

REFERENCE

EXISTING TOPOGRAPHY PROVIDED BY CALICO RECOURSES USA CORP IN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.zip" ON MARCH 29, 2017.

ELEVATIONS SHOWN ARE IN FEET A.S.L.

0 200 400
1" = 200' FEET

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REVIEWED	CJM
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PROJECT
TAILINGS STORAGE FACILITY
TSF LOCATION ALTERNATIVE ANALYSIS
MALHEUR COUNTY, OREGON

TITLE
LAYOUT AND SECTIONS
OPTION 1

PROJECT NO.	REV.	FIGURE
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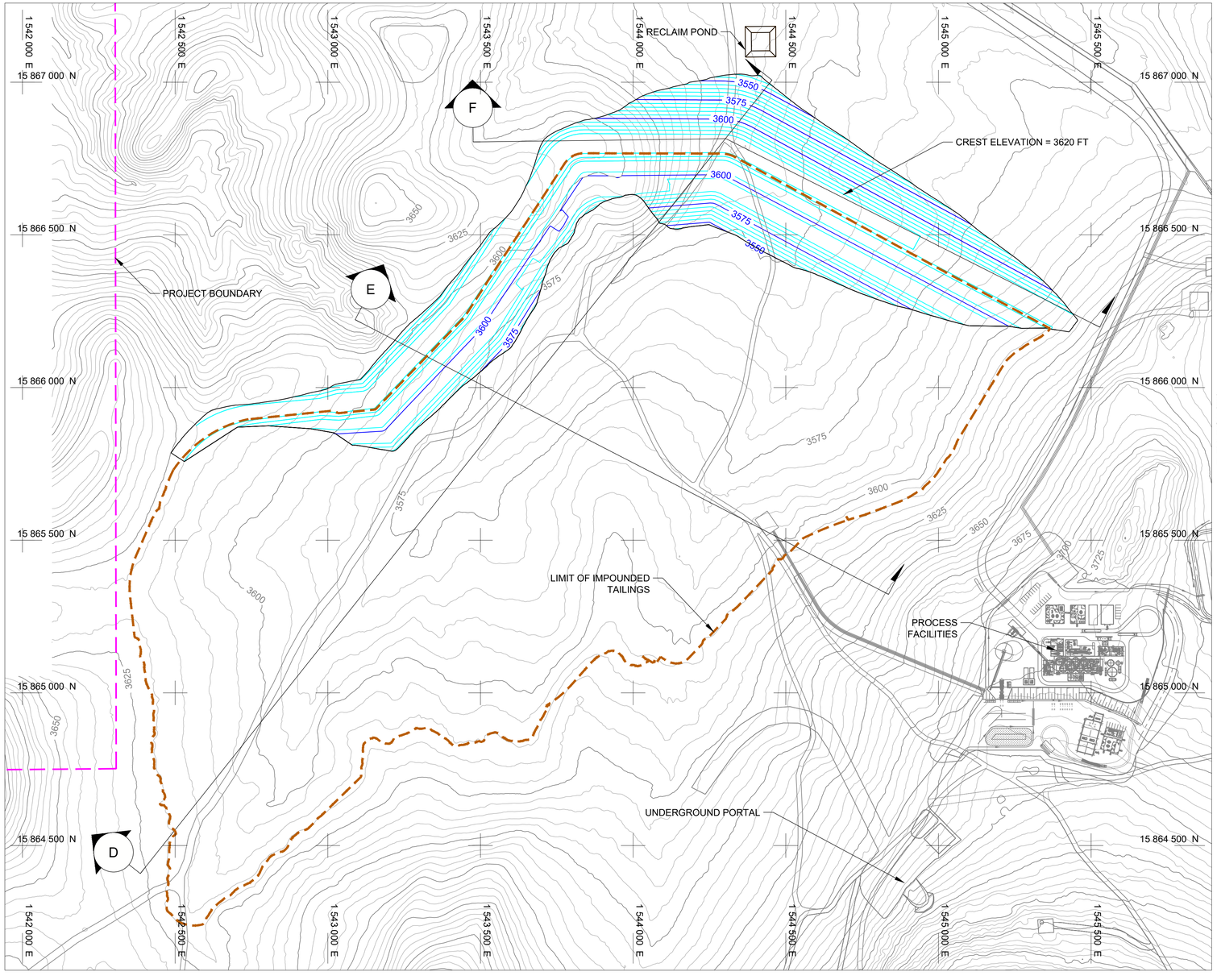

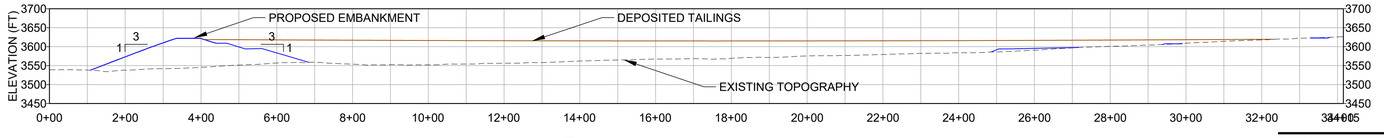

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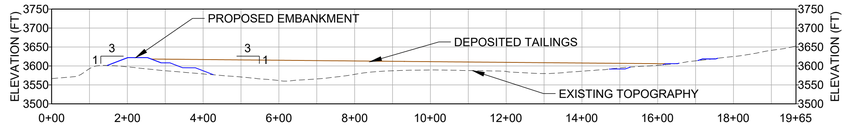

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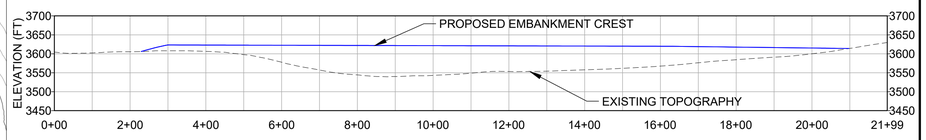

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LEGEND

- 3630 EXISTING GROUND TOPOGRAPHY
- 3630 PROPOSED TAILINGS DAM GRADING
- LIMIT OF IMPOUNDED TAILINGS
- PROJECT BOUNDARY

REFERENCE

EXISTING TOPOGRAPHY PROVIDED BY CALICO RECOURSES USA CORP IN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.zip" ON MARCH 29, 2017.

ELEVATIONS SHOWN ARE IN FEET A.S.L.

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1" = 200' FEET

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GRASSY MOUNTAIN PROJECT

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CONSULTANT

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PREPARED	NAS
REVIEWED	CJM
APPROVED	RAB

PROJECT
TAILINGS STORAGE FACILITY
TSF LOCATION ALTERNATIVE ANALYSIS
MALHEUR COUNTY, OREGON

TITLE
LAYOUT AND SECTIONS
OPTION 2

PROJECT NO.	REV.	FIGURE
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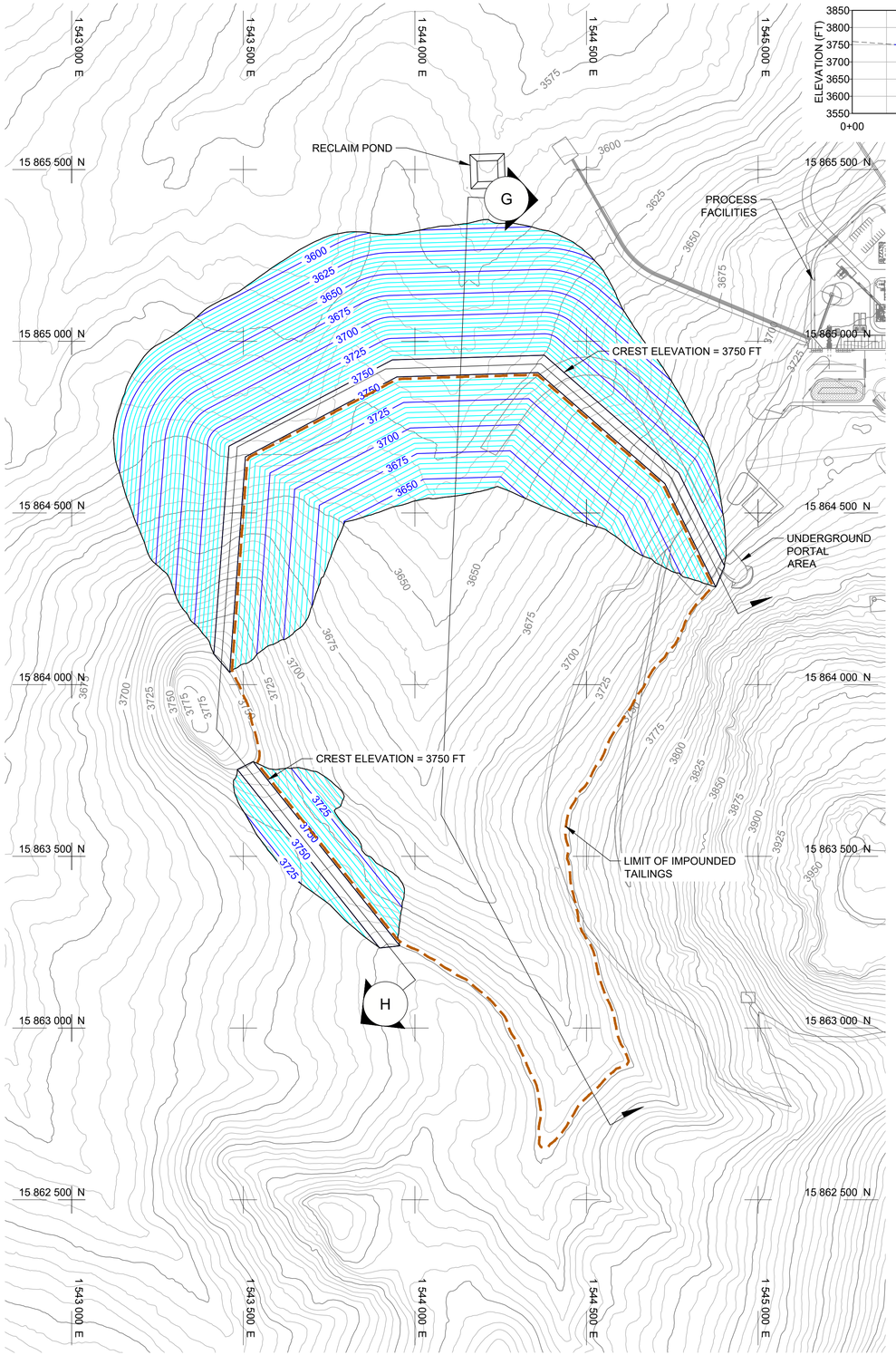

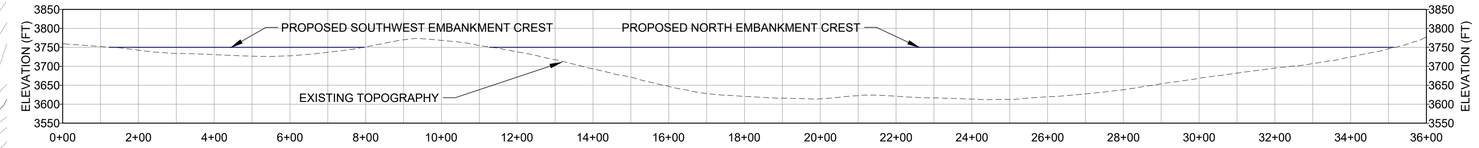

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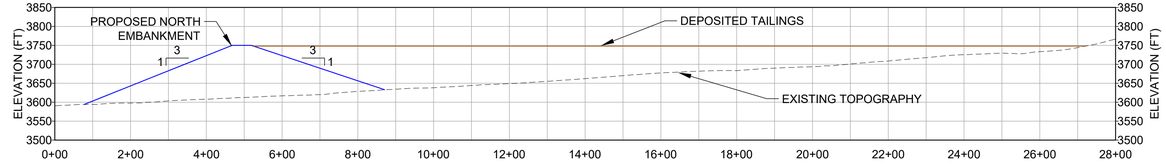

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LEGEND

- 3630 EXISTING GROUND TOPOGRAPHY
- 3630 PROPOSED TAILINGS DAM GRADING
- LIMIT OF IMPOUNDED TAILINGS

REFERENCE

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1" = 200' FEET

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PREPARED	NAS
REVIEWED	CJM
APPROVED	RAB

PROJECT
TAILINGS STORAGE FACILITY
TSF LOCATION ALTERNATIVE ANALYSIS
MALHEUR COUNTY, OREGON

TITLE
LAYOUT AND SECTIONS
OPTION 3

PROJECT NO.	REV.	FIGURE
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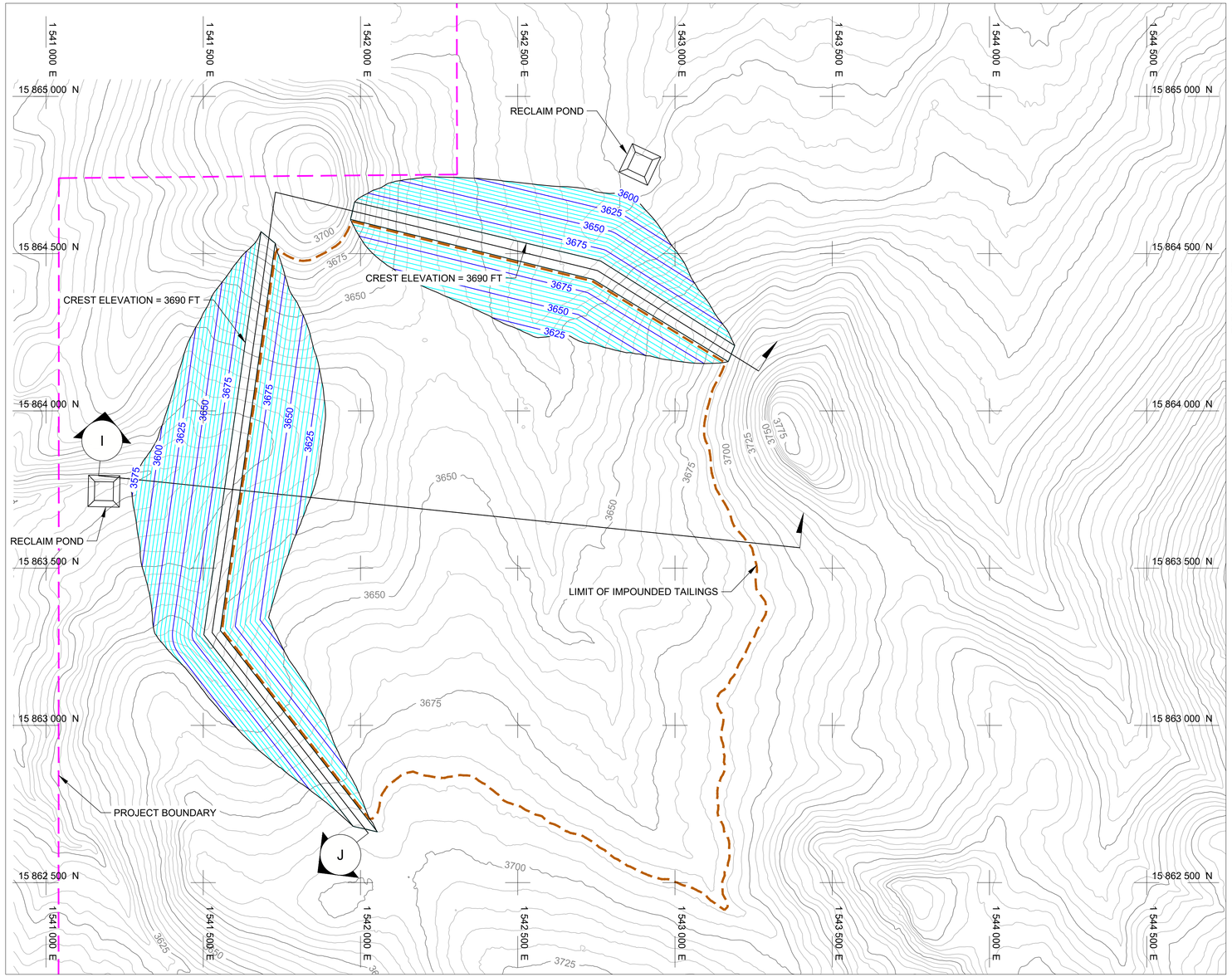

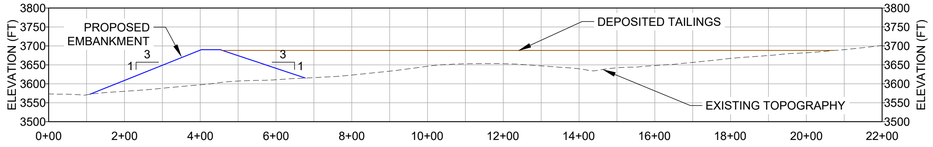

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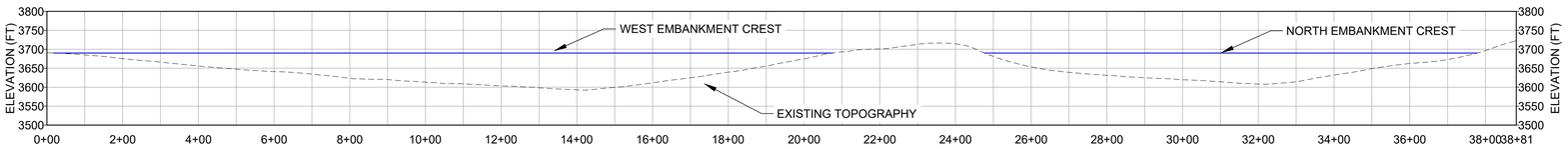

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LEGEND

- 3630 EXISTING GROUND TOPOGRAPHY
- 3630 PROPOSED TAILINGS DAM GRADING
- LIMIT OF IMPOUNDED TAILINGS
- PROJECT BOUNDARY

REFERENCE

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0 200 400
1" = 200' FEET

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GRASSY MOUNTAIN PROJECT

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GOLDER

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DESIGNED	MDB
PREPARED	NAS
REVIEWED	CJM
APPROVED	RAB

PROJECT
TAILINGS STORAGE FACILITY
TSF LOCATION ALTERNATIVE ANALYSIS
MALHEUR COUNTY, OREGON

TITLE
LAYOUT AND SECTIONS
OPTION 4

PROJECT NO.	REV.	FIGURE
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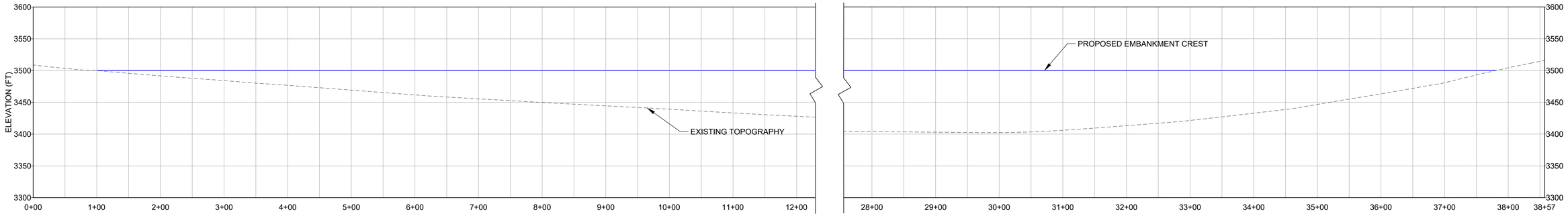

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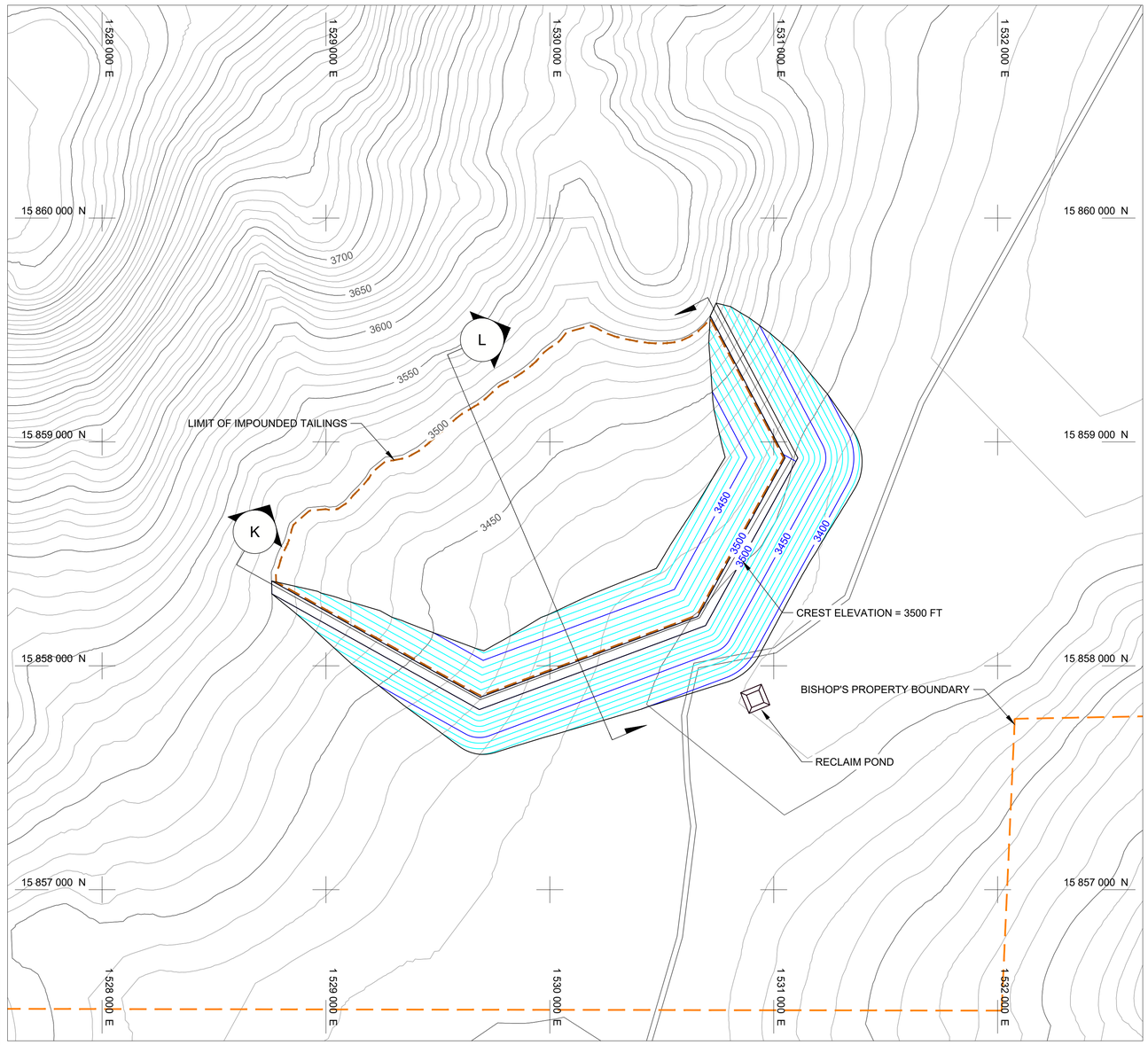

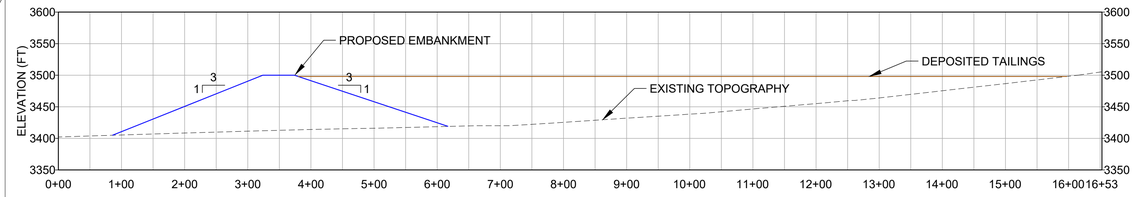

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LEGEND

- 3630 EXISTING GROUND TOPOGRAPHY
- 3630 PROPOSED TAILINGS DAM GRADING
- LIMIT OF IMPOUNDED TAILINGS
- BISHOP'S PROPERTY BOUNDARY

REFERENCE

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1" = 300' FEET

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DESIGNED	MDB
PREPARED	NAS
REVIEWED	CJM
APPROVED	RAB

PROJECT
TAILINGS STORAGE FACILITY
TSF LOCATION ALTERNATIVE ANALYSIS
MALHEUR COUNTY, OREGON

TITLE
LAYOUT AND SECTIONS
OPTION 5

PROJECT NO.	REV.	FIGURE
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Attachment A
Ranking Matrix

GOLDER

Grassy Mountain Project - TSF Siting Alternatives Ranking Matrix

Aspect Under Consideration (Rated 1 to 5, 1 - Less Favorable and 5 - Most Favorable)	Weighting Factor	Option 1		Option 2		Option 3		Option 4		Option 5	
		Score	Product	Score	Product	Score	Product	Score	Product	Score	Product
Technical Criteria	**40%**										
Volume of Earthworks (Embankment Fill)	15%	3	0.45	5	0.75	1	0.15	4	0.60	2	0.30
Ease of Construction	15%	4	0.60	5	0.75	3	0.45	2	0.30	1	0.15
Stormwater Management	30%	1	0.3	3	0.9	4	1.2	3	0.9	5	1.5
Pumping and Piping	15%	3	0.45	5	0.75	4	0.60	2	0.30	2	0.30
Tailings Rate of Rise	25%	2	0.5	5	1.25	1	0.25	4	1	3	0.75
TOTAL	100%		2.30		4.40		2.65		3.10		3.00
Human Safety and Environmental Protection	**60%**										
Distrurbance Area	10%	5	0.50	1	0.10	4	0.40	2	0.20	3	0.30
Potential Impact to Surface and Groundwater	20%	3	0.60	4	0.80	1	0.20	2	0.40	5	1.00
Geotechnical Risks	20%	2	0.40	3	0.60	2	0.40	3	0.60	3	0.60
Impact to Public Access	5%	5	0.25	3	0.15	5	0.25	3	0.15	3	0.15
Located Within Project Boundary	20%	5	1.00	5	1.00	5	1.00	5	1.00	1	0.20
Reclamation and Closure	25%	1	0.25	4	1.00	4	1.00	2	0.50	5	1.25
TOTAL	100%		3.00		3.65		3.25		2.85		3.50
OVERALL	**100%**		**2.72**		**3.95**		**3.01**		**2.95**		**3.30**

Grassy Mountain Mine Project
On-Site Power Generation Alternative
Projected Air Emissions

Operating Hours	**Units**	**Peak Ops**
Op Hrs per Day	Hrs	24
Days per Month	Days	30
Hrs per Month	Hrs/Mth	720
Power Requirements		
Const. Power	Kw	
Plant	Kw	3200
UG Operations	Kw	500
Total	Kw	3700
Const. Power	MwHrs	0
Plant	MwHrs	10240
UG Operations	MwHrs	1600
Total	MwHrs	11840

Gen Model	HP	Max eKw	# Units	Annual Hours	Back up	Max eKw	# Units	Annual Hours
C32 (60hz)	1198	1250	3	8640	C32 (60hz)	1250	1	500
C18 (60hz) T4	778	500	1	8640	C18 (60hz) T4	500	1	500

			Emissions (pounds/hour)								**Emissions (tons/year)**							
Unit	**Type**	**Hr/Yr**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**NOx**	**SO_2**	**CO**	**VOC**	**CO_2e**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**NOx**	**SO_2**	**CO**	**VOC**	**CO_2e**
Gen 1	C32 (60hz)	8640	0.110231707	0.110231707	0.110231707	9.645274367	0.01453773	9.645274367	0.84459	1389.68	0.476201	0.476201	0.476201	41.667585	0.062803	41.667585	3.6486288	6003.4176
Gen 2	C32 (60hz)	8640	0.110231707	0.110231707	0.110231707	9.645274367	0.01453773	9.645274367	0.84459	1389.68	0.476201	0.476201	0.476201	41.667585	0.062803	41.667585	3.6486288	6003.4176
Gen 3	C32 (60hz)	8640	0.110231707	0.110231707	0.110231707	9.645274367	0.01453773	9.645274367	0.84459	1389.68	0.476201	0.476201	0.476201	41.667585	0.062803	41.667585	3.6486288	6003.4176
Gen 4	C32 (60hz)	500	0.110231707	0.110231707	0.110231707	9.645274367	0.01453773	9.645274367	0.84459	1389.68	0.0275579	0.0275579	0.0275579	2.4113186	0.0036344	2.4113186	0.2111475	347.42
Gen 5	C18 (60hz) T4	8640	0.033069512	0.033069512	0.033069512	0.738552437	0.00944103	3.858109747	0.54849	902.48	0.1428603	0.1428603	0.1428603	3.1905465	0.0407852	16.667034	2.3694768	3898.7136
Gen 6	C18 (60hz) T4	500	0.033069512	0.033069512	0.033069512	0.738552437	0.00944103	3.858109747	0.54849	902.48	0.0082674	0.0082674	0.0082674	0.1846381	0.0023603	0.9645274	0.1371225	225.62
			0.507065852	**0.507065852**	**0.507065852**	**40.05820234**	**0.07703298**	**46.29731696**	**4.47534**	**7363.68**	**1.6072885**	**1.6072885**	**1.6072885**	**130.78926**	**0.2351889**	**145.04564**	**13.663633**	**22482.006**

Emission Factors (g/kw-hr)unless noted				
	C32 (60hz)		**C18 (60hz) T4**	
PM	0.04	ARB-Cert	0.03	ARB-Cert
PM_{10}	0.04	ARB-Cert	0.03	ARB-Cert
$PM_{2.5}$	0.04	ARB-Cert	0.03	ARB-Cert
NOx	3.5	ARB-Cert	0.67	ARB-Cert
SO_2	0.000012135	lb/hp-hr	0.000012135	lb/hp-hr
CO	3.5	ARB-Cert	3.5	ARB-Cert
VOC	0.000705	lb/hp-hr	0.000705	lb/hp-hr
CO_2e	1.16	lb/hp-hr	1.16	lb/hp-hr

Diesel Emission Factors (EFs) from Table 3.4-1 of AP-42 for large Ind. Eng. (>600 HP) and Caterpillar Manufacturing Specifications

Appendix X: Mining Claim Information

Patented Mining Claims, Grassy Mountain Mine Project, Permit Area						
Patent Number	**Claim Name**	**Oregon Mineral Survey**	**Case Type**	**Location Date**	**Patent Date**	**Owner**
36-2001-0141	Poison Springs 24	No. 1004	Patented	5/4/1984	8/17/2001	Calico Resources USA
36-2001-0141	Poison Springs 25	No. 1004	Patented	5/3/1984	8/17/2001	Calico Resources USA
36-2001-0141	Poison Springs 35	No. 1004	Patented	4/5/1985	8/17/2001	Calico Resources USA

Unpatented Mining Claims, Grassy Mountain Mine Project, Permit Area					
BLM Serial Number	**Claim Name**	**County Number**	**Case Type**	**Location Date**	**Owner**
ORMC74971	POISON SPRINGS #7	84-121756	LODE	05/01/1984	Calico Resources USA
ORMC74972	POISON SPRINGS #8	84-121757	LODE	05/01/1984	Calico Resources USA
ORMC74973	POISON SPRINGS #9	84-121758	LODE	05/01/1984	Calico Resources USA
ORMC74974	POISON SPRINGS #10	84-121759	LODE	05/01/1984	Calico Resources USA
ORMC74975	POISON SPRINGS #11	84-121760	LODE	05/01/1984	Calico Resources USA
ORMC74977	POISON SPRINGS #13	84-121762	LODE	05/02/1984	Calico Resources USA
ORMC74978	POISON SPRINGS #14	84-121763	LODE	05/02/1984	Calico Resources USA
ORMC74979	POISON SPRINGS #15	84-121764	LODE	05/02/1984	Calico Resources USA
ORMC74982	POISON SPRINGS #18	84-121767	LODE	05/03/1984	Calico Resources USA
ORMC74983	POISON SPRINGS #19	90-6119	LODE	05/03/1984	Calico Resources USA
ORMC74984	POISON SPRINGS #20	90-6120	LODE	05/03/1984	Calico Resources USA
ORMC74985	POISON SPRINGS #21	90-6121	LODE	05/03/1984	Calico Resources USA
ORMC74986	POISON SPRINGS #22	84-121771	LODE	05/03/1984	Calico Resources USA
ORMC74987	POISON SPRINGS #23	88-22375	LODE	05/03/1984	Calico Resources USA
ORMC74990	POISON SPRINGS #26	84-121775	LODE	05/25/1984	Calico Resources USA
ORMC74996	POISON SPRINGS #32	84-121781	LODE	05/25/1984	Calico Resources USA
ORMC76751	WINTER CLAIM 32	84-122580	LODE	07/10/1984	Cryla LLC (Nickich et al)
ORMC82455	POISON SPRINGS #36	88-22384	LODE	04/05/1985	Calico Resources USA
ORMC82456	POISON SPRINGS #37	90-6130	LODE	04/05/1985	Calico Resources USA
ORMC104797	FROG #1	88-18804	LODE	05/06/1988	Calico Resources USA
ORMC104798	FROG #2	88-18805	LODE	05/06/1988	Calico Resources USA
ORMC104801	FROG #5	88-18808	LODE	05/06/1988	Calico Resources USA
ORMC104803	FROG #7	88-18809	LODE	05/06/1988	Calico Resources USA
ORMC104805	FROG #9	88-18811	LODE	05/06/1988	Calico Resources USA
ORMC104807	FROG #11	88-18813	LODE	05/06/1988	Calico Resources USA
ORMC104812	FROG #16	88-18819	LODE	05/06/1988	Calico Resources USA
ORMC104814	FROG #18	88-18821	LODE	05/06/1988	Calico Resources USA
ORMC104821	FROG #25	88-18828	LODE	05/07/1988	Calico Resources USA
ORMC104822	FROG #26	88-18829	LODE	05/07/1988	Calico Resources USA
ORMC104823	FROG #27	88-18830	LODE	05/07/1988	Calico Resources USA
ORMC104824	FROG #28	88-18831	LODE	05/07/1988	Calico Resources USA
ORMC104831	FROG #35	90-3396	LODE	05/07/1988	Calico Resources USA
ORMC104832	FROG #36	88-18839	LODE	05/07/1988	Calico Resources USA
ORMC104833	FROG #37	88-18840	LODE	05/07/1988	Calico Resources USA
ORMC104834	FROG #38	88-18841	LODE	05/07/1988	Calico Resources USA
ORMC104835	FROG #39	88-18842	LODE	05/07/1988	Calico Resources USA
ORMC104902	FROG #109	88-18909	LODE	05/20/1988	Calico Resources USA
ORMC104905	FROG #112	88-18912	LODE	05/19/1988	Calico Resources USA
ORMC104926	FROG #133	88-18933	LODE	05/20/1988	Calico Resources USA
ORMC104927	FROG #134	88-18934	LODE	05/20/1988	Calico Resources USA
ORMC104928	FROG #135	88-18935	LODE	05/20/1988	Calico Resources USA
ORMC104929	FROG #136	88-18936	LODE	05/20/1988	Calico Resources USA
ORMC104940	FROG #147	88-18947	LODE	05/22/1988	Calico Resources USA
ORMC105000	FROG #207	88-19007	LODE	05/29/1988	Calico Resources USA
ORMC105913	FROG #252	88-19861	LODE	07/21/1988	Calico Resources USA
ORMC106700	WINTER CLAIM 33	88-20087	LODE	08/01/1988	Cryla LLC (Nickich et al)
ORMC108077	DON #1	88-22025	MILLSITE	09/28/1988	Calico Resources USA

Unpatented Mining Claims, Grassy Mountain Mine Project, Permit Area					
BLM Serial Number	**Claim Name**	**County Number**	**Case Type**	**Location Date**	**Owner**
ORMC108078	DON #2	88-22026	MILLSITE	09/28/1988	Calico Resources USA
ORMC108079	DON #3	88-22027	MILLSITE	09/28/1988	Calico Resources USA
ORMC108080	DON #4	88-22028	MILLSITE	09/28/1988	Calico Resources USA
ORMC108081	DON #5	88-22029	MILLSITE	09/28/1988	Calico Resources USA
ORMC108082	DON #6	88-22030	MILLSITE	09/28/1988	Calico Resources USA
ORMC108083	DON #7	88-22031	MILLSITE	09/28/1988	Calico Resources USA
ORMC108084	DON #8	88-22032	MILLSITE	09/28/1988	Calico Resources USA
ORMC108085	DON #9	88-22033	MILLSITE	09/28/1988	Calico Resources USA
ORMC108087	FROG #25A	88-22229	LODE	09/27/1988	Calico Resources USA
ORMC108088	FROG #26A	88-22230	LODE	09/27/1988	Calico Resources USA
ORMC108089	FROG #35A	88-22231	LODE	09/27/1988	Calico Resources USA
ORMC126210	FROG #3	89-39554	LODE	10/29/1989	Calico Resources USA
ORMC146322	POISON SPRING 7A	93-6064	LODE	07/18/1993	Calico Resources USA
ORMC146323	POISON SPRING 8A	93-6065	LODE	07/18/1993	Calico Resources USA
ORMC146324	POISON SPRING 9A	93-6066	LODE	07/19/1993	Calico Resources USA
ORMC146325	POISON SPRING 11A	93-6067	LODE	07/19/1993	Calico Resources USA
ORMC146326	POISON SPRING 14A	93-6068	LODE	07/18/1993	Calico Resources USA
ORMC146327	POISON SPRING 18A	93-6069	LODE	07/18/1993	Calico Resources USA
ORMC146328	POISON SPRING 22A	93-6070	LODE	07/18/1993	Calico Resources USA
ORMC146329	POISON SPRING 26A	93-6071	LODE	07/18/1993	Calico Resources USA
ORMC146330	POISON SPRING 27A	93-6072	LODE	07/19/1993	Calico Resources USA
ORMC146331	POISON SPRING 38A	93-6073	LODE	07/18/1993	Calico Resources USA
ORMC155920	WINTER #2	2001-1032	LODE	02/18/2001	Cryla LLC (Nickich et al)
ORMC155921	WINTER #3	2001-1033	LODE	02/18/2001	Cryla LLC (Nickich et al)
ORMC155923	WINTER #5	2001-1035	LODE	02/18/2001	Cryla LLC (Nickich et al)
ORMC155925	WINTER #7	2001-1037	LODE	02/18/2001	Cryla LLC (Nickich et al)
ORMC155926	WINTER #8	2001-1038	LODE	02/18/2001	Cryla LLC (Nickich et al)
ORMC158878	CRYLA #3	2004-2070	LODE	03/13/2004	Cryla LLC (Nickich et al)
ORMC158883	CRYLA #8	2004-2075	LODE	03/13/2004	Cryla LLC (Nickich et al)
ORMC164791	LUCKY LUCY #3	2009-3237	LODE	04/12/2009	Cryla LLC (Nickich et al)
ORMC164792	LUCKY LUCY #4	2009-3238	LODE	04/12/2009	Cryla LLC (Nickich et al)
ORMC168148	GM 5974	2011-3940	LODE	09/21/2011	Calico Resources USA
ORMC168149	GM 5975	2011-3941	LODE	09/21/2011	Calico Resources USA
ORMC168150	GM 5976	2011-3942	LODE	09/21/2011	Calico Resources USA
ORMC168162	GM 6070	2011-3954	LODE	09/21/2011	Calico Resources USA
ORMC168163	GM 6071	2011-3955	LODE	09/21/2011	Calico Resources USA
ORMC168205	GM 6271	2011-3997	LODE	09/20/2011	Calico Resources USA
ORMC174050	PGM 3	2017-2064	LODE	03/31/2017	Calico Resources USA
ORMC174051	PGM 4	2017-2065	LODE	03/30/2017	Calico Resources USA
ORMC174052	PGM 5	2017-2066	LODE	03/30/2017	Calico Resources USA
ORMC174057	PGM 10	2017-2071	LODE	03/30/2017	Calico Resources USA
ORMC174058	PGM 11	2017-2072	LODE	03/29/2017	Calico Resources USA
ORMC174059	PGM 12	2017-2073	LODE	03/29/2017	Calico Resources USA
ORMC174060	PGM 13	2017-2074	LODE	03/29/2017	Calico Resources USA
ORMC174061	PGM 14	2017-2075	LODE	03/29/2017	Calico Resources USA
ORMC174062	PGM 15	2017-2076	LODE	03/29/2017	Calico Resources USA
ORMC174063	PSR 1	2017-2056	LODE	03/30/2017	Calico Resources USA

Unpatented Mining Claims, Grassy Mountain Mine Project, Permit Area					
BLM Serial Number	**Claim Name**	**County Number**	**Case Type**	**Location Date**	**Owner**
ORMC174064	PSR 2	2017-2057	LODE	03/29/2017	Calico Resources USA
ORMC174065	PSR 3	2017-2058	LODE	03/29/2017	Calico Resources USA
ORMC174066	PSR 4	2017-2059	LODE	03/29/2017	Calico Resources USA
ORMC174067	PSR 5	2017-2060	LODE	03/29/2017	Calico Resources USA
ORMC174068	PSR 6	2017-2061	LODE	03/29/2017	Calico Resources USA

Appendix Y: Stormwater Management Plan

REPORT

Stormwater Pollution Control Plan

Grassy Mountain Mine

Malheur County, Oregon

Submitted to:

Calico Resources USA Corp.
665 Anderson St.
Winnemucca, Nevada 89445

Submitted by:

Golder Associates Inc.
595 Double Eagle Court, Suite 1000
Reno, Nevada, USA 89521

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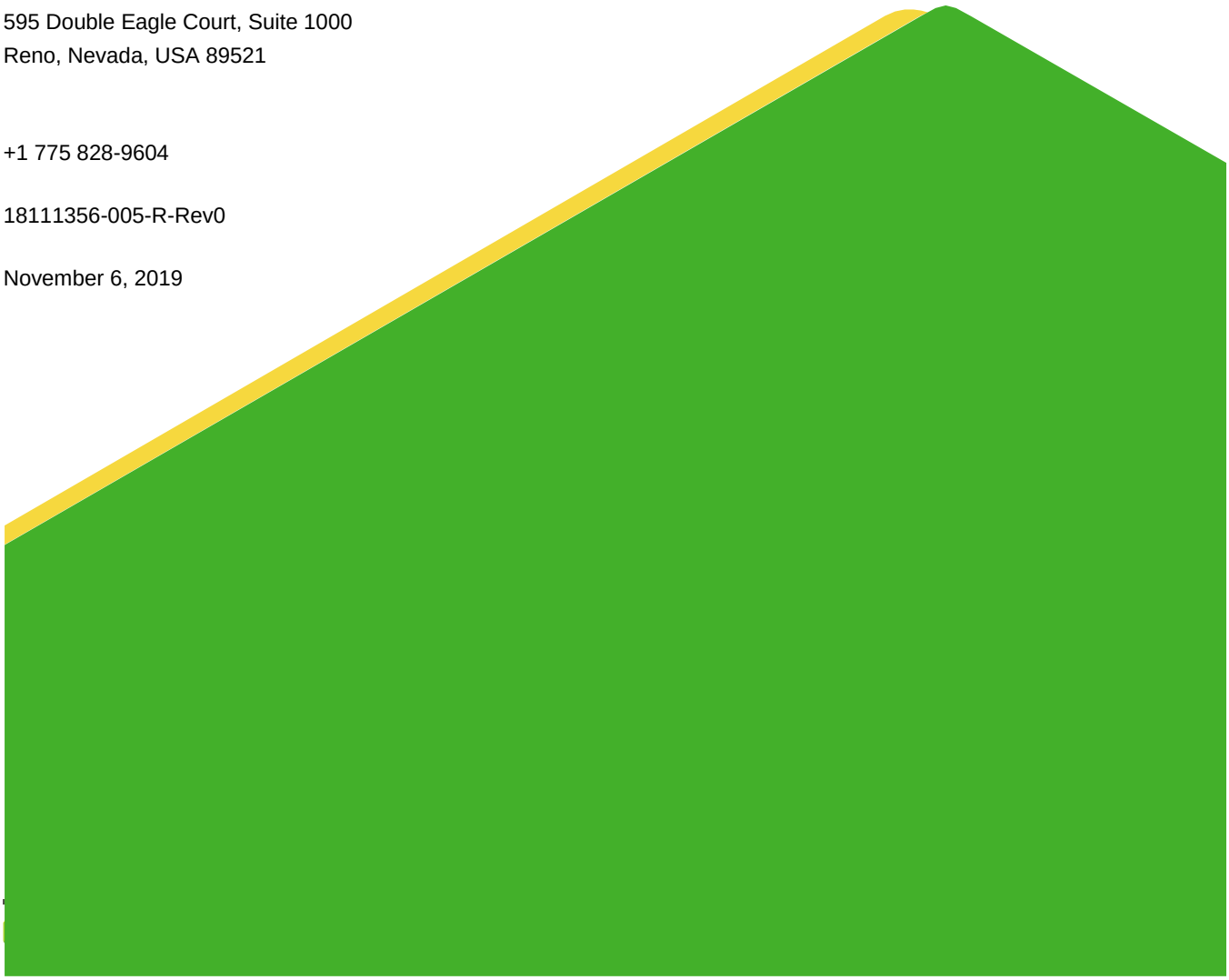
18111356-005-R-Rev0

November 6, 2019



Stormwater Pollution Control Plan

Grassy Mountain Mine

Malheur County, Oregon

The following Stormwater Pollution Control Plan presented to Calico Resources USA Corp. has been prepared by the staff of Golder Associates Inc. under the professional supervision of the engineers whose signatures appear herein.

This Stormwater Pollution Control Plan has been prepared in general accordance with the Oregon Department of Environmental Quality Industrial Stormwater General Permit 1200-Z, Industrial Stormwater Guidance for National Pollutant Discharge Elimination System, and Sector-specific Controls for Mining activities (Section E, Sector G).

Golder Associates Inc.

Christopher J. MacMahon, PE
Associate, Senior Engineer

Russel A. Browne
Principal, Senior Tailings Practice Leader

Document Revisions

Date	Revision	Comment
November 6, 2019	0	Issued Final

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FIGURES

Figure 1 Grassy Mountain Mine Site Location and Drainage Map

Figure 2 Site Layout Map

APPENDICES

APPENDIX A
Oregon Industrial Stormwater General Permit (1200-Z)

APPENDIX B
ODEQ Stormwater Pollution Control Plan Check List

ACRONYMS/DEFINITIONS

amsl	Above Mean Sea Level
AST	Above-ground Storage Tank
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CFR	Code of Federal Regulations
COC	Chain-of-Custody
ft	foot/feet
Grab Sample	Individual discrete sample collected over a period of time not to exceed 15 minutes
Impaired Water	Waters identified by Oregon or EPA as not meeting applicable Oregon water quality standards
MDL	Method Detection Limit
mg/L	milligrams per liter
ug/L	micrograms per liter
Month	Calendar Month
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
ODEQ	Oregon Department of Environmental Quality
ppm	Parts Per Million (by volume, equivalent to milligrams per liter)
QL	Quantitation Level
Quarter	January through March, April through June, July through October, or October through December
RAWS	Remote Automated Weather Station
SIC	Standard Industrial Classification
SWPCP	Stormwater Pollution Control Plan
TBD	To be Determined
TMDL	Total Maximum Daily Load
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
UST	Underground Storage Tank
Week	Calendar week of Sunday through Saturday

1.0 GENERAL INFORMATION

This document is the Stormwater Pollution Control Plan (SWPCP) for Calico Resources USA Corp.'s (Calico's) Grassy Mountain Mine located approximately 20 miles south of Vale, Oregon in Malheur County, Oregon as shown on Figure 1. This SWPCP has been prepared in accordance with Oregon Industrial Stormwater General Permit 1200-Z (the Permit, Appendix A), which becomes effective at a date determined by the Oregon Department of Environmental Quality (ODEQ). This SWPCP has been prepared considering ODEQ's Industrial Stormwater Guidance for National Pollutant Discharge Elimination System (NPDES) 1200-Z General Permits (ODEQ 2012).

The purpose of the 1200-Z Permit is to protect surface water quality by reducing the amount of pollutants in stormwater runoff. Preparation of this SWPCP does not guarantee compliance with the ODEQ Permit. It is the responsibility of Calico to implement the necessary Best Management Practices (BMPs), monitoring plan, reporting, and recommendations set forth in this document. A copy of the Permit is provided in Appendix A. This SWPCP has been prepared by Golder Associates Inc. (Golder) for the exclusive use of Calico at the Grassy Mountain Mine.

This SWPCP is intended to assist Calico in controlling stormwater pollution. This SWPCP shall be accessible at the Grassy Mountain Mine at all times and submitted to ODEQ along with a permit renewal application prior to the required Permit renewal deadlines. This SWPCP should be updated in accordance with ODEQ procedures as described in the 1200-Z Permit whenever there is a change in design, construction, raw materials, operation or maintenance of the Mining Facilities which may impact stormwater quality.

The main text of this SWPCP includes important information regarding industrial activities conducted at the Grassy Mountain Mine, potential pollutants, and BMPs for minimizing stormwater pollution. The appendices provide supporting documentation, such as a copy of the 1200-Z Permit, tabs for maintaining inspection documents, benchmark exceedance corrective action plans, and other information required to be maintained by the permit.

Once Calico receives a permit assignment letter, this should be placed with the general permit in Appendix A and any additional parameter monitoring and limits noted in Table 1. The laboratory responsible for analysis of stormwater samples must be notified of the changes and new parameters (including required "minimum levels" of detection) before the first sampling event occurs.

1.1 Project and Contact Information

Table 1: General Information

General Information	
Facility Name	*Grassy Mountain Project*
Site Operator	*Calico Resources USA Corp.*
Type of Operation	Gold Mining

General Information	
Standard Industrial Classification (SIC) Codes	1041
Date of Initial Operation and Hours of Operation	TBD
Location of Facility	Eastern Oregon, 20 miles south of Vale
Latitude/Longitude	43.674° N latitude and 117.362° W longitude
Location Telephone Number	TBD
Designated Person Responsible for Spill Prevention and Storm Water Quality (Phone Number and Email)	Mine Manager (TBD)
Prepared by:	Chris MacMahon, PE and Jen Pepe Golder Associates Inc.
Contact Person for this Permit	Nancy Wolverson, Calico Resources USA Corp. 775-770-4615

Golder has prepared this SWPCP for Calico's Grassy Mountain Mine (the Project) in Malheur county, Oregon to satisfy the following requirements:

- SWPCP required pursuant to Condition A.1 of the General Stormwater NPDES Discharge Permit (1200-Z) to be issued by the ODEQ, including mining sector specific requirements under Schedule E, Sector G. The general permit 1200-Z is provided in Appendix A. An ODEQ SWPCP permit requirement's cross-reference checklist is provided in Appendix B.

1.2 Site Description

The Grassy Mountain Mine is a planned underground gold mining operation in Malheur County, Oregon (Figure 1). The Project is located within Sourdough Basin/Negro Rock Canyon watershed, which drains to the north to the Malheur River Basin. The site will be covered under the 1200-Z general permit for a new discharge to impaired waters. Processing areas include a Tailings Storage Facility (TSF), waste rock dump (WRD), ore processing area, underground portal, and a basalt quarry.

The SWPCP has been developed under the Oregon General NPDES Stormwater Discharge Permit. Stormwater will be collected and routed around the non-discharging process areas to natural drainages and will not come into contact with manufacturing or processing materials.

The basalt quarry is included with this SWPCP under 1200-Z. An operating permit application (OPA) for the basalt quarry has also been developed for the quarry.

The purpose of the 1200-Z Permit is to protect surface water quality by reducing the amount of pollutants in stormwater runoff. Operating under the permit is conditional on implementation of the necessary controls, monitoring plan, reporting, and recommendations set forth in this document. This SWPCP is intended to assist Calico in controlling stormwater pollution and will be accessible at the Grassy Mountain mine during operations. This SWPCP should be updated in accordance with ODEQ procedures as described in the 1200-Z Permit Schedule A.8, whenever there is a change in design, construction, raw materials, operation or maintenance which may impact stormwater quality, a change in discharge points, or change in the site contact. Once Calico receives a permit assignment letter, it should be placed with the general permit in Appendix A and any additional parameter monitoring and limits noted in Section 3.2 The laboratory responsible for analysis of stormwater samples must be notified of the changes and new parameters (including required “minimum levels” of detection) before the first sampling event occurs.

This SWPCP will be supported by Calico’s spill prevention plan that will be developed for the site.

1.2.1 Facilities and Activities

The Grassy Mountain property encompasses approximately 885 acres in Malheur County, Oregon. The geographical center of the property is located at 73.674 degrees latitude and 117.362 degrees longitude with the principle zone of mineralization located in Section 8 of the Township 22 South, Range 44 East, Willamette Meridian.

The Project site is located in the semi-arid plateau of eastern Oregon and local landscape is typical of high mountain desert environment and rangeland. The terrain is gentle to moderate with relatively low relief. Elevation ranges from approximately 4,050 feet above mean sea level (amsl) at the southeastern corner of the Basalt quarry area to 3,520 feet amsl north of the TSF reclaim pond. Drainage at the site is generally to the north in ephemeral natural drainages. No perennial streams or wetlands exist at the site.

Currently there are no mining operations on site and all facilities described in this SWPCP are planned, not existing. Planned facilities at the property are shown in Figure 2, and include:

- TSF Area (107.4 acres)
  - Geomembrane lined TSF with underdrain system and supernatant pond
  - Waste Rock Dump
  - Reclaim pond (16,000 ft^2) that pumps back to the mill
  - Temporary contractor laydown yard
- Process Pad and Portal Pad Area (11.5 acres total)
  - Mill
  - Lined Run of Mine Stockpile
  - Truck Shop
  - Truck Wash

- Fueling Station
- Admin Offices
- Laboratory
- Contact Stormwater Containment Pond that pumps back to the processing facilities
- Portal Pad

- Basalt Quarry with crushing and screening plant contained within the pit (38.8 acres)

These Grassy Mountain Mine facilities meet the definition of Standard Industrial Classification (SIC) code 1041, Gold Mining. Each of the three process areas are designed as zero-discharge areas.

The Project will produce gold by mining ore form the underground workings and processing the ore at the process plant. Tailings slurry will be pumped to the geomembrane line tailings storage facility (TSF). The TSF is designed to incorporate a dual containment system in accordance with Oregon Administrative Rules (OAR) Division 43 – *Chemical Mining* guidelines. Water (process and precipitation) on the tailings surface is collected in the supernatant pool and returned to the mill for reuse. The TSF reclaim pond at the north toe of the TSF collects water flowing through the tailings mass to the underdrain system installed above the TSF basin geomembrane liner and is recirculated to the mill for reuse. The tailings slurry and reclaim pipelines are located in secondary containment between the plant area and TSF as shown on Figure 2.

The process area includes a dual containment contact water pond to collect stormwater from the process area and pump it back to the mill for reuse. Figure 2 shows the location of diversion channels routing stormwater around these facilities.

Once ore has been removed, the underground workings ill be backfilled with cement and limed amended waste rock and aggregate supplied from the Basalt Quarry shown on Figure 1. Basalt from the quarry will also be used to construct the TSF embankments. The basalt quarry floor will be developed in single benches and all stormwater will be managed within the quarry during operations. Water collected within the quarry will be collected and recirculated back to the mill for reuse. Operations at the quarry include excavation, loading, crushing, and screening.

1.2.2 Climate and Hydrology

The Grassy Mountain Mine is located in the semi-arid plateau of eastern Oregon. Climate data for the site was developed using nearby weather station data, regression analyses, and elevation of the proposed TSF. Daily recorded data from two Remote Automated Weather Stations (RAWS), one Cooperative Observer Network (COOP) station, and PRISM Climate spatial data were used as the base climate data sets. The overlapping data set between all stations was January 1, 1987 through December 31, 2017.

Golder used statistical regression analyses to develop a factor based on measured annual average precipitation and station elevation for each of the three data sets in relation to the project site. That factor was used to predict the average monthly precipitation for the project site used for hydrologic analyses. Based on available data and unknown properties of the future supernatant pool, evapotranspiration data was used to predict average monthly evaporation used for the TSF water balance (Golder 2019).

A regression function estimated from the average annual precipitation and elevations of the Owhyee Ridge RAWS, Kelsay Butte RAWS, and Owhyee Dam COOP, the Owhyee Ridge RAWS has the best monthly average precipitation correlation to the Grassy Mountain Mine location. Therefore, the Owyhee Ridge RAWS station's average monthly precipitation values were multiplied by 1.01 to obtain the predicted average monthly precipitation values for the Grassy Mountain Mine (Golder 2019).

Monthly climate data from the Owhyee Ridge RAWS was used to calculate evaporation rates using the Penman-Montieth equation for the available data set between April 1998 and May 2019.

Table 2: Factor-predicted Grassy Mountain Average Monthly Climate Data

Month	Precipitation (in)	Evaporation (in)
January	0.93	0.85
February	0.62	1.31
March	0.97	2.69
April	1.14	3.81
May	1.49	5.28
June	0.89	6.37
July	0.51	8.16
August	0.31	7.04
September	0.46	4.39
October	0.83	2.95
November	0.73	1.31
December	0.89	0.79
Annual	**9.77**	**44.97**

The National Oceanic and Atmospheric Administration (NOAA) Atlas 2 was used to develop the probabilistic-based synthetic storm events for the calculation of the peak flows. Atlas 2, Volume 10 (Oregon) contains precipitation frequency estimates for the western United States. Atlas 2 generates the precipitation frequency estimates based on analysis of previously recorded weather patterns. The precipitation frequency estimates for Grassy Mountain were obtained using the latitudinal/longitudinal coordinates of N 43.669819° and W 117.35926°.

A frequency analysis was conducted to determine annual extreme daily rainfall depths for the 1 in 25-year, 24-hour and 1 in 500-year, 24-hour storm events that were not presented in the NOAA Atlas 2. Thirty-three years of maximum daily annual precipitation data.

from 1986 through 2018 was obtained from the Owyhee Ridge Oregon RAWS weather stations that is located approximately 8 miles southeast of the project site. Table 1 presents the precipitation data for the storms used in this analysis.

1.2.3 Watershed and Stormwater Drainage

The Grassy Mountain Project site is located approximately 6.5-miles northwest of Lake Owyhee, Oregon. The Project site is divided into three main hydrologic catchment areas. Each catchment area was used to size diversion channels that route water around the zero-discharge process areas. These catchment areas are defined as follows:

- TSF Area – All western hydrologic catchment areas draining to the TSF area
- Process Pad and Portal Pad Area – All interior hydrologic catchment areas draining to the Processing Area and Portal
- Site Wide Area – All eastern hydrologic catchment areas draining to the quarry (borrow area) and the catchment for the existing natural drainage immediately west of the quarry

The overall Project site catchment area has a total tributary area covering approximately 1,350 acres. Hydrologic catchments areas were developed based on existing topographic features and identifying areas where calculated peak flows will be required for hydraulic design of drainage improvements. A summary of the non-contact hydrologic catchment areas is provided below in Table 3.

Table 3: Non-Contact Hydrologic Catchment Areas

Hydrologic Catchment	Total Area (Acres)
TSF Area	688
Process Pad and Portal Pad Area	12.4
Site Wide Area	664

To support construction-level design of the TSF and WRD, hydrologic and hydraulic analyses were completed using the Hydrologic Modeling System (HEC-HMS) software, with weighted average soil characteristic curve numbers (CNs) and time of concentrations developed using the Technical Release Win TR-55 software. This model developed flows from each sub-basin for the 25- year, 24-hour, 100-year, 24-hour, and the 500-year, 24-hour storm events. Detailed hydrologic analyses and design details for the catchments are included in Golder's detailed TSF Design Report (Golder 2019).

These flows were used to design the surface water diversion and contact water collection channels, culverts, and outlet aprons. The 25-year, 24-hour event was used to size temporary stormwater conveyance systems. Permanent diversions channels ditches were designed to convey the 100-year, 24-hour storm event with 0.75-ft of freeboard and to convey 500-year, 24-hour storm event within this freeboard allowance. All culverts on the project site were designed to only be in place during operation and were therefore designed to convey the 25-year, 24-hour storm event. Non-contact water runoff from the Project site is designed to flow into natural drainages downstream of the site to unnamed tributaries of Negro Rock Canyon which in turn discharges to the lower Malheur River.

1.3 Pollutant Sources

Industrial activities at the Grassy Mountain Mine within the TSF and process areas will not discharge pollutants to stormwater. Activities occurring outside the TSF, WRD, process area, and the quarry that may be sources of pollutants include:

- Delivery, loading, unloading, and transfer of raw materials and product
- Outdoor Material Storage
- Mining and construction equipment spills

1.3.1 Delivery, Loading, Unloading, and Transfer of Raw Material and Product

Quarried basalt will be loaded at the quarry and unloaded at the TSF for construction TSF embankments, WRD pad, and potentially at the Portal for mine backfill. Finished products are shipped from the process plant offsite to market. The following potential pollutant sources may be present in loading and unloading areas:

Table 4: Raw Material and Product Potential Pollutant Sources

Source	**Potential Risk to Stormwater**
Diesel fuel, lube oil, and waste oil	Spills and leaks of petroleum hydrocarbons
Tracked fines from the quarry or portal areas, or from shipment of concentrate offsite	Total Suspended Solids, metals

1.3.2 Outdoor Material Storage

The TSF surface and quarries have the potential to periodically contribute fugitive dust outside the zero-discharge areas. The following potential pollutant sources may be present in fugitive tailings dust and quarry dust:

Table 5: Outdoor Material Storage Potential Pollutant Sources

Source	**Potential Risk to Stormwater**
Fugitive Tailings	Metals, Total Suspended Solids, pH changes
Dust from Quarry Activities	Total Suspended Solids, pH changes

1.3.3 Mining and Construction Equipment

Mining and construction equipment have the potential to release hydrocarbon chemical in the event of a fluid release due to equipment failure. The following potential pollutant sources may be present in fugitive tailings dust and quarry dust:

Table 6: Mining and Construction Equipment Potential Pollutant Sources

Source	Potential Risk to Stormwater
Diesel fuel, lube oil, and waste oil	Spills and leaks of petroleum hydrocarbons

1.3.4 Non-Stormwater Discharges

Non-stormwater discharges may include watering of roads for dust control. Water used for dust control would pumped from a groundwater source.

2.0 CONTROL MEASURES

The 1200-Z Permit requires the implementation of site controls appropriate for the site to eliminate or minimize the exposure of pollutants to stormwater or to remove pollutants from stormwater before it discharges to surface waters. The 1200-Z Permit identifies eleven types of controls, "narrative technology-based effluent limits", that must be addressed in the SWPCP and describe the specific components of each control:

- Minimize Exposure
- Oil and Grease
- Waste Chemicals and Material Disposal
- Erosion and Sediment Controls
- Debris Controls
- Dust Generation and Vehicle Tracking of Industrial Materials
- Housekeeping
- Spill Prevention and Response Procedures
- Preventative Maintenance
- Employee Education
- Non-stormwater Discharges

These controls are most relevant in the process areas where stormwater is contained but are listed here as best management practices for all areas of the mine.

2.1 Technology-based Effluent Limitations

2.1.1 Minimizing Exposure

Calico will minimize exposure of processing, material storage and handling including loading, unloading, disposal, cleaning, maintenance and fixed fueling areas to rain, snow, snowmelt, and runoff. Exposure will be limited by implementation of the following:

- Prevent discharge to surface waters by use of site grading, berms or curbing to provide containment of impacted water or process solutions

- Locating materials and activities to the greatest extent practicable indoors with storm-resistant covers
- Store all process, chemical, and hazardous substances in vessels to that prevent leaks and spills and within secondary containment facilities
- Locate materials, equipment, and activities above secondary containment or on areas where diversion structures prevent run-off from contacting surface waters
- Use drip pans or absorbents under and around leaking or leak-prone vehicles/equipment or store indoors above appropriate containment facilities
- Perform cleaning operations in such a way as to prevent run-off, run-on, and overspray from contacting surface waters
- Clean spills or leaks promptly with absorbents or other effective methods to prevent pollutants from contacting surface waters
- Manage all wash water in containment facilities and discharged into a closed-look sanitary sewer/septic system that prevents the wash water from contacting surface waters

2.1.2 Oil and Grease

Oil and grease will predominantly be used in the process facility and truck shop where secondary containment facilities are in place. Calico will implement oil/water separators, skimmers, booms, or other methods to prevent oil and grease contaminants from contacting surface waters.

2.1.3 Waste Chemicals and Material Disposal

Waste chemicals and materials will be temporarily stored in appropriate storage vessels on site in the process area. Stored waste containers will be located at all times above secondary containment. Waste chemicals will be permanently disposed of at an appropriate off-site landfill or other disposal facility.

2.1.4 Erosion and Sediment Control

Calico will implement structural and non-structural controls to minimize erosion of soil and sediment transport in all areas that have been disturbed due to mining-related activities. Detailed erosion and sediment BMPs are discussed in detail in Section 2.3. In general, controls include:

- Vegetating exposed areas with seed mix designs in accordance with OAR and BLM guidelines
- Gravel surfacing on travel ways
- Run-off detention facilities
- Vegetated filter strips, bioswales
- Flow dissipation structures
- Any other controls required by the local municipality

2.1.5 Debris Control

Calico will employ screens, booms, and other controls to minimize or eliminate waste, garbage and floatable debris from contacting surface waters.

2.1.6 Dust Generation and Vehicle Tracking of Contaminants

Calico will minimize dust generation, off-site tracking of contaminants, and discharge of soil/sediment, and waste materials through the use of travel way dust suppression and washing of on-site vehicle/equipment bodies and undercarriages at the wash bay prior to leaving the site. Washing of off-site vehicles entering the Project for routine deliveries or transport is not required unless they come in contact with deleterious materials that would pose a threat to receive surface waters.

2.1.6.1 House Keeping

All areas that contain materials, chemicals, or soils that could adversely impact surface waters will be inspected, cleaned and maintained to prevent discharge. These areas are designed to provide containment of contaminants through the use of berms, lined channels, swales, or secondary containment facilities. Outlets to these areas will be properly maintained to perform as designed at all times.

2.1.7 Spill Prevention and Response Procedures

To prevent or respond to spills, leaks, and other releases, Calico will develop a management plan and strategies that include methods for spill prevention, clean-up, and notification procedures. At a minimum, these measures will include:

- Clear and proper labeling of containers, vessels, and pipelines
- Proper handling procedures for both routing handling and clean-up
- Preventative measures including secondary containment, barriers between material storage and traffic areas including curbing, berms, and barricading
- Procedures for expediate response in stopping, containing, and cleaning up spills, leaks and other releases. Personnel who have the potential to be impacted or impact the response to spill prevention will be appropriately trained and have the necessary clean-up material on-site and readily available

2.1.8 Preventative Maintenance

Calico will regularly inspect, clean, maintain, and repair all equipment, systems, and material handling/storage areas that have the potential to impact receiving surface waters. All management control measures including stormwater structures, catch basins, treatment facilities will be repaired and maintained in proper working order to perform as designed at all times.

2.1.9 Employee Education

Calico will develop and maintain an employee orientation and education program to inform all personnel of the pertinent components and goas of this Stormwater Pollution Control Plan. This training must include the following:

- Specific control measures used to achieve the above technology-based effluent limits
- Monitoring, inspection, reporting, and documentation requirements
- Facility specific training to include:
  - Personnel responsible for design, installation, maintenance, or repair of controls including pollution prevention and treatment measures

- Personnel responsible for the storage and handling of chemicals and materials that could contribute to pollutants to stormwater
- Personnel responsible for conducting or documenting monitoring or inspections as required in Section 3.2
- Personnel responsible for conducting and documenting corrective actions

Education and training must occur no later than 30 calendar days after date of hire or change of duties and annually thereafter. Education and training documentation will be retained on-site and be made available to ODEQ upon request.

2.1.10 Non-stormwater Discharges

Calico will not discharge any non-stormwater solutions or waters from the Grassy Mountain Mine, with the exception of unimpacted groundwater used for dust control on haul roads. Unimpacted groundwater is an authorized discharge under the 1200-Z Permit.

2.2 Basalt Quarry Area

The basalt quarry area is included in this SWPCP as it is part of a proposed Grassy Mountain Mine and its sole development purpose is for mining operation and construction. However, control measures for technology-based effluent limits included in this SWPCP are consistent with 1200-A Permit control measures for crushed rock quarries. The quarry area is designed to be zero-discharge area during operation.

A surface water diversion channel will be constructed along the eastern boundary of the quarry excavation to divert stormwater from entering the quarry area. Upgradient stormwater will be diverted to the north of the quarry and will flow to a natural drainage (Figure 2). A surface water run-on diversion berm will also be constructed along the eastern and southern quarry excavation boundaries to diver stormwater around the quarry. Precipitation that falls into the quarry footprint will be managed within the quarry using internal slopping, retention berms, and a stormwater management sump (Figure 2). Additional BMPs will be implemented to minimize erosion and sedimentation including:

- Minimizing areas stripped
- Internal sloping
- Seeding and mulching
- Diverting natural runoff around the site
- Conveyance ditches
- Graveled roads and working areas
- Retention berms

2.3 Metal Mining Sector-specific Requirements

Sector-specific requirements for metals mining (Section E, Sector G) apply to stormwater discharges associated with industrial activities at metals mine facilities. Sector-specific requirements will be applied to stormwater discharges for active and inactive areas outside the zero-discharge areas at the Grassy Mountain mine area. It

should be noted that the Grassy Mountain Mine is in an area defined as “arid” in Schedule D, with less than 10 inches of precipitation per year. Evaporation far exceed the average annual precipitation. The controls discussed below account for requirements in Schedule G for mine areas in arid areas.

2.3.1 Requirements Applicable to Earth-disturbing Activities Conducted Prior to Mining Activities.

Stormwater discharges from all earth-disturbing activities prior to active mining activities will be covered by the 1200-Z Permit. Activities that occur prior to stabilization of these areas do not need to comply with technology based effluent limits, Schedule B requirements in Section 2.1, or the monitoring or inspection frequencies in Section 3.2.

2.3.2 Requirements for all earth-disturbing activities conducted prior to active mining activities

- Erosion and sediment control installation requirements
  - Sediment controls will be installed and made operational downgradient by the time construction activities commence or as soon as practical
- Maintenance requirements
  - Erosion and sediment controls will be maintained in effective operating condition
  - When a problem is identified, maintenance will be performed by the end of the following day
  - When a control must be replaced or significantly repaired, installation will be completed within 7 days
- Perimeter controls
  - Sediment controls will be installed around the perimeter of the disturbance and sediment will be removed before it accumulates to one-half of the above ground height of the control. Sediment Track-out.
  - For construction vehicles exiting the site directly onto paved roads, sediment controls will be installed around the perimeter of the disturbance and sediment will be removed before it accumulates to one-half of the above ground height of the control.
- Soil or sediment stockpiles
  - Temporary covers will be used where feasible.
  - Stormwater run on from causing erosion to piles will be minimized (e.g., by diverting flows around stockpile)
  - Sediment from stormwater runoff will be minimized using sediment controls.
- Sediment basins
  - If sediment basins are used, storage for the 2-year, 24-hour storm, or 3,600 cubic feet per acre drained will be provided.
  - Erosion of basin embankments using stabilization controls and of the inlet and outlet points will be prevented using erosion controls and velocity dissipation devices.

- Minimize dust
  - Dust will be minimized with water or dust suppressant application.
- Restrictions on use of treatment chemicals
  - If sediment treatment chemicals are used, they will be used according to state and federal regulation, manufacturers specifications and best engineering practices. Chemicals will be safely stored in the non-discharge areas. Chemicals will be selected based on site conditions and conventional erosion and sediment controls will be used prior to and after application.
- Site stabilization for earth-disturbing activities for purposes of mine site preparation
  - Temporary stabilization of disturbed areas
  - When pre-mining earth-disturbing activities temporarily cease, disturbed areas will be immediately stabilized if feasible using erosion control blankets or a seed base and tackifiers. Temporary vegetation will be established as soon as practical given the arid environment.
- Final stabilization of disturbed areas
  - When pre-mining earth-disturbing activities permanently ceases, disturbed areas will be immediately stabilized if feasible using erosion control blankets or a seed base and tackifiers. Final vegetation stabilization measures will be established as soon as practical given the arid environment.

2.3.3 Site Stabilization for Construction of Staging Areas for Structures and Access Roads

- Area of disturbance:
  - The amount of soil exposed will be minimized during construction activities.
- Erosion and sediment control design requirements
  - Erosion and sedimentation controls will be installed and maintained to account for the following factors:
    - The expected amount, frequency, and duration of precipitation
    - The nature of runoff and run-on at the site (impervious surfaces, slopes, and site drainage features)
    - The range of soils particle sizes at the site
  - Discharges from stormwater controls will be directed to vegetated areas to the extent practical. Velocity dissipators will be used if necessary
  - Erosion and sediment controls will be used to control peak flowrates and total stormwater volume to minimize erosion and scour in the vicinity of discharge points from channelized flow
  - Conveyance channels will be designed to avoid unstabilized areas if feasible. Channels will be designed to minimize erosion of channels and their embankments, outlets and adjacent streams, slopes and downstream waters during discharge conditions.
- Natural barriers and buffers

- Natural barriers of 50 feet will be maintained between a water of the United States (U.S.), or if stormwater discharges from earth-disturbing activities occur within 50 feet of a water of the U.S., one or more of the following BMPs will be used to control and treat sediment and turbidity:
  - Compost berms, blankets or socks, erosion control mats, and/or tackifiers
  - Approved water treatment by electro-coagulation, flocculation, or filtration
  - Other substantially equivalent control approved by ODEQ or agent.
- Natural buffers should be delineated and marked off.

- Soil and sediment stockpile
  - Any soil or sediment stockpile will be located outside the 50-foot natural barrier
- Sediment basins
  - Sediment basins will be located outside the 50-foot natural barrier
- Native topsoil preservation
  - Topsoil will be preserved during earth-disturbing activities and stockpiled if feasible, for use in reclamation
- Steep slopes
  - Disturbance of slopes steeper than 3 horizontal to 1 vertical (3H:1V) will be minimized
- Soil compaction
  - Vehicle use will be restricted in areas where vegetative stabilization or infiltration will be practiced unless soil compaction is integral to the functionality of the site or the facility
- Dewatering practices
  - Groundwater or stormwater removed from points of accumulation will not be discharged unless it has been managed by appropriate controls. Uncontaminated, non-turbid dewatering water can be discharged without being routed to a control. Discharge requirements include:
    - No discharge of visible floating solids or foam
    - Oil and grease must be removed via an oil-water separator or filtration device
    - Upland vegetated areas should be used to the extent possible to infiltrate dewatering water
    - Velocity dissipators will be used where dewatering water is discharged
    - Backwash water will be hauled for disposal or returned to the beginning of the treatment process
    - Filter media will be cleaned or replaced when the pressure differential exceeds the manufacturers specifications
- Pollution prevention

- No prohibited discharges listed in 1200-Z Subsection E.G.4.2.10 will be discharged to stormwater
- Exposure will be minimized by locating pollution sources away from surface water drainages and construction products and wash water in the zero-discharge areas

- Construction staging areas (arid areas)
  - Within 14 days of stopping construction work in an area necessary nonvegetative stabilization measures will be installed
  - Vegetative stabilization will be initiated as soon as conditions on site allow
  - A schedule will be documented for initiating and completing vegetative stabilization
  - Planted and/or seeded areas will be covered with bio or photo degradable erosion controls

2.3.4 Water Quality-based Requirements Applicable to Earth-disturbing Activities Conducted Prior to Mining Activities

Water Quality-based requirements applicable to earth-disturbing activities conducted prior to mining activities apply to sites that discharge to impaired waters that are listed for turbidity or sedimentation or have an EPA-approved TMDL for sedimentation or turbidity. The Grassy Mountain Mine stormwater ultimately discharges to the Lower Malheur River, which is not impaired for sedimentation or turbidity based on the 2012 Integrated Report Assessment Database and 303(d) List (https://www.ODEQ.state.or.us/wq/assessment/rpt2012).

2.3.5 Inspection Requirements Applicable to Earth-disturbing Activities Conducted Prior to Mining Activities

Sector-specific inspections for earth-disturbing activities conducted prior to active mining at the Grassy Mountain Mine are listed below.

- Calico will perform inspections at the following frequencies:
  - Calico will inspect disturbed areas at least once every 7 days, or once every 14 calendar days within 24 hours of a storm event of 0.25 inches or more
  - For activities performed during seasonally dry months, inspections will be performed monthly or within 24 hours of a storm event of 0.25 inches or more
  - Once stabilization has been completed for an area, Calico will reduce inspection frequency to once every month
  - Calico will suspend inspections during frozen conditions
- At a minimum, Calico will inspect:
  - Disturbed areas
  - Stormwater controls and pollution prevention measures
  - Areas that have been stabilized
  - Material, waste, borrow, or equipment storage and maintenance areas

  - Areas where stormwater flows
  - Discharge points
- At a minimum, Calico will inspect:
  - Whether all stormwater controls are installed and operating properly
  - Whether new or modified stormwater controls are needed
  - For conditions that would lead to a spill or leak
  - For visual signs of erosion or sedimentation at discharge points
  - If discharge is occurring, controls and quality of the discharge will be checked
- Calico will complete an inspection report within 24 hours of an inspection. Each report will be signed and kept at the mine site, and will include:
  - Inspection data
  - Name and title of inspectors
  - Summary of findings
  - Rainfall amount that triggered the inspection, if applicable
  - Unsafe conditions preventing the inspection, if applicable

2.4 Technology-based Effluent Limits for Active Mining Activities

Technology-based effluent limits that apply to active mining operations, in addition to requirements in 1200-Z Schedule A, include additional employee training, stormwater controls, and discharge testing.

Calico will conduct training at least annually at active and temporarily inactive areas of the Grassy Mountain Mine. Annual training will specifically be conducted for operations outside the zero-discharge areas, and operations within the zero-discharge areas that may impact other areas due to fugitive dust, tracking, or spills.

Calico will implement additional stormwater controls needed to minimize pollutant discharges in addition to 1200-Z Schedule A requirements, including:

- Calico will comply with air permitting required by ODEQ or country air quality permits, constituting compliance with dust control limits in Schedule A.1.f.
- Stormwater will be diverted around the TSF, Process, and Quarry areas as shown on Figures 1 and 2 in engineered channels.
- Source material will be capped when necessary to minimize pollutant discharged to stormwater. Source materials being capped, and the capping material will be identified.
- Active or passive treatment will be used, if necessary and feasible, to protect water quality.

Discharge Testing will be performed at any identified discharge points for specific mine-related discharges, such as adits or seeps, or comingled discharges. However, none of these discharge points have been identified.

2.5 Additional SWPCP Requirements for Mining Operations

Additional requirements for mining operations not addressed in the previous sections are listed below.

- SWPCP Requirement E.G.6.1 - Nature of Industrial Activities
  - The Grassy Mountain Mine is located remotely in the eastern Oregon, and stormwater discharges will not affect major transportation routes or local communities. Stormwater discharges from the site will be routed to natural ephemeral stream channels tributary to Negro Rock Canyon. Stormwater leaving the site is largely non-contact stormwater, with impacts only from vehicle traffic at the mine and potentially fugitive dust from mine operations.
- SWPCP Requirement E.G.4.6.2: - Site Map
  - Figures 1 and 2 includes the site features required by E.G.4.6.2. Detailed facilities layouts within the process pad area are not included, because the area is designed to be contained by the containment pond; however, all site boundaries, facilities, roads, diversion ditches and discharge points outside the zero-discharge area are included in the site maps.
- SWPCP Requirement E.G.4.6.3 - Potential Pollutant Sources
  - Potential pollutant sources specific to the Grassy Mountain site that are not contained within the zero-discharge areas would include natural mineralization of the native ground. A surface water baseline study was conducted in 2018 to characterize surface water quality prior to mining (SPF Water Engineering, LLC, SPF, 2018). Four locations were sampled in the area, including one location in Negro Rock Canyon approximately 4 miles to the north of the site where intermittent stream flow allowed sample collection. Sample were collected biannually in 2013 and 2014. All locations sampled, including the Negro Rock Canyon creek location, had arsenic levels that exceeded the human health risk limit of .0021 milligrams per liter (mg/L). Sector specific stormwater discharge benchmark for arsenic is 0.15 mg/L (Section 3.2). No other exceedance of standards was identified at any of the sites (SPF 2018).
- SWPCP Requirement E.G.4.6.4 - Documentation of Control Measures
  - Calico will document all control measures implemented at the site, including controls that are not specifically required, and including dust control requirements and how they were achieved.
- SWPCP Requirement E.G.4.6.5 - Employee Training
  - Calico will document all employee training in the SWPCP when it is developed.
- SWPCP Requirement E.G.4.6.6 - Certification of Permit Coverage for Commingled Non-stormwater Discharges
  - Calico will not discharge commingled non-stormwater discharges.

3.0 STORMWATER MONITORING

Permittees must demonstrate compliance with all benchmarks established in 1200-Z Schedule B, all assigned impairment pollutant reference concentrations, and any sector-specific benchmarks contained in 1200-Z Schedule E. If the permittee can demonstrate through four consecutive quarters of sampling that all sample results are below all statewide benchmarks, sector-specific benchmarks, and reference concentrations, a stormwater

monitoring waiver can be obtained by submitting a formal request to ODEQ. Monthly visual observations, however, are not subject to the waiver and must be documented in Calico's annual report to ODEQ.

3.1 Stormwater Discharge Points and Monitoring Locations

There are five locations identified at the Grassy Mountain Mine where non-contact stormwater discharges to natural drainages downgradient of mine operations. These discharge points are numbered Discharge Points (DP) 001 through 005 (Figure 2) and are described below by hydrologic catchment.

- DP 001 discharges from the TSF western diversion ditch the flows around the south end of the TSF Area and discharges diverted water from the upgradient catchment.
- DP 002 is located at the access road culvert outlet north of the reclaim pond, and discharges stormwater from the diversion ditch that flows around the eastern side of the TSF Area, WRD, TSF reclaim pond, and runoff from the TSF embankments.
- DP 003 discharges channelized flow from the east side of the access road north of the TSF.
- DP 004 is located in the natural drainage adjacent to, and downgradient from, the process area. DP 004 discharges stormwater from around the process plant area, portal pad, and the natural drainage between the process area and the basalt quarry.
- DP 005 discharges diverted flow from upgradient catchment east of the basalt quarry.

All discharge points will be sampled inspected monthly. All discharge points will be sampled quarterly, if water is present at the discharge point.

3.2 Monitoring Requirements and benchmarks

The 1200-Z Permit requires stormwater discharges from the Grassy Mountain Mine to be sampled four times per year (quarterly). The Oregon ODEQ has established benchmark concentration guidelines which must be met all times to demonstrate the effectiveness of site BMP's. If one or more benchmarks are exceeded, the Facility must conduct a series of corrective action steps which are further described in Section 3.8.

The Permit requires Calico to collect stormwater samples four times per year and within the first 12 hours of the storm event. The stormwater monitoring year is from July 1 to June 30 of following year. For benchmark and any sector-specific pollutants, two samples must be collected on or before December 31 and two samples collected on or after January 1. The Facility is not required to collect samples outside of normal business hours or during unsafe conditions. Stormwater samples must be collected at least 14 days apart.

Discharges will be monitored for benchmark and sector-specific requirements in Table 7 as well as impaired pollutants discussed in Section 3.3. A monitoring waiver may be obtained for individual parameters after four consecutive samples are equal to or below the benchmarks or determined to be due to background natural concentrations

Table 7: Statewide Benchmark and Sector Specific Monitoring Requirements

Parameter[1]	Frequency[3]	Benchmark[2]
Statewide Benchmarks:		
Total Copper	4/year	0.020 mg/L
Total Lead	4/year	0.040 mg/L
Total Zinc	4/year	0.12 mg/L
pH	4/year	5.5 – 9.0 SU
Total Suspended Solids	4/year	100 mg/L
Total Oil & Grease	4/year	10 mg/L
Floating Solids (associated with industrial activity)	4/year	No visible discharge
Oil & Grease Sheen	4/year	No visible sheen
Sector Specific Requirements (Sector G, SIC # 1041):		
Turbidity	4/year	50 NTU
pH	4/year	6 – 9.0 SU
Total Antimony	4/year	0.64 mg/L
Total Arsenic	4/year	0.15 mg/L
Total Beryllium	4/year	0.13 mg/L
Total Iron	4/year	1.0 mg/L
Total Mercury	4/year	0.0014 mg/L
Total Nickel	4/year	0.05 mg/L
Total Selenium	4/year	0.005 mg/L
Total Silver	4/year	0.0005 mg/L

Notes:

1. Parameters should be analyzed on samples collected from the same storm event and within the first 12 hours of the event.
2. Benchmarks are guideline concentrations for determining the effectiveness of BMPs; they are not permit limitations.
3. Samples will be collected at least 14 days apart.

3.3 Discharge to Impaired Waters

The Lower Malheur River is listed as impaired for the following pollutants: toxics (DDT and Dieldrin), dissolved oxygen (DO), arsenic, and iron. The Grassy Mountain Mine will not be a source of the agricultural toxics, and they are therefore not included in monitoring requirements. Arsenic and iron are minerals associated with the natural mineralization of the native ground in the area of the Grassy Mountain mine.

Based on results from the surface water baseline sampling in Negro Rock Canyon Creek, approximately 4 mile to the north and downstream of the site, and three locations in the area within the Owyhee River drainage basin, background arsenic concentrations are elevated above the human health risk limit of 0.0021 mg/L but are consistently at least an order of magnitude below the aquatic criterion maximum concentrations (CMC) for aquatic life (0.34 mg/L). At the Negro Rock Canyon Creek sampling location, the total arsenic concentrations were consistent, ranging from 0.0237 to 0.0268 mg/L.

Iron concentrations in the baseline samples did not exceed human health or aquatic risk limits for samples collected in the Negro Rock Canyon Creek location. Two sample collected in the Owyhee River drainage exceeded the criterion continuous concentration (CCC) of 1 mg/l, at concentrations ranging from 1.15 to 1.45 mg/L.

3.4 Water Quality Based (Non-numeric) Effluent Limits

The Facility must not discharge stormwater which may cause or contribute to a violation of any instream water quality standard as established in OAR 340-041. If the Facility becomes aware, or ODEQ determines, that the discharge is causing or contributing to an exceedance of a standard, the Facility will be required to take corrective actions as described in Section 3.8 and Schedule A.10 through A.12 of the Permit. If the exceedance cannot be controlled by reasonable corrective actions, ODEQ may impose additional limitations or require the Facility or require it to obtain coverage under an individual NPDES permit.

3.5 Technology-Based Effluent Limitations

The Facility must meet the following “narrative” technology based effluent limits where applicable and technologically available and economically achievable in light of best industry practice.

- Minimize exposure – Minimize exposure of raw and process materials to stormwater, including use of grading, berms, or curbing to divert stormwater away from these areas, locating materials equipment in containment systems, use of drip pans, draining fluids from equipment prior to storage, performing cleaning operations indoors, etc.
- Oil & grease – Employ oil/water separators, booms, skimmers, etc.
- Waste chemicals – Recycle or properly dispose of wastes, cover all waste contained in bins or dumpsters.
- Erosion/sediment control – Stabilize exposed areas, contain runoff using structural and/or nonstructural controls, use vegetation, gravel, paving to minimize soil loss from the site, use sedimentation basins, Bioswales to capture stormwater and allow for settling.
- Debris control – Use screens, booms, settling ponds to capture floating debris in catchment basins.
- Dust generation – Minimize dust and off-site tracking of raw, final, or waste materials.

- Housekeeping – Keep exposed areas clean using sweeping, litter pick up, and by keeping materials orderly and labeled, prompt cleanup of spills, leaks, and maintain vehicles and stowing materials in closed containers.
- Spill prevention and response procedure – Minimize potential for leaks, spills, and releases and develop plans that address prevention, clean up and notification procedures. A Spill Prevention, Control and Countermeasure (SPCC) Plan prepared and implemented in accordance with 40 CFR 112 meets this requirement.
- Preventative maintenance – Inspect, clean, maintain and repair equipment and systems exposed to stormwater, inspect and clean stormwater control structures (i.e., catch basins, grates, screens, oil/water separators, sedimentation basins).
- Employee education – Maintain employee orientation and training program designed to communicate the goals of the SWPCP.

Section 2.0 of this SWPCP describes these measures in more detail as they apply to the Grassy Mountain Mine site.

3.6 Sector Specific Technology-Based Effluent Limitations

Additional technology-based effluent limits that apply to active mining operations, in addition to requirements in 1200-Z Schedule A, include additional employee training, stormwater controls, and discharge testing as described in Section 2.5.

3.7 Sampling Procedure

3.7.1 Grab Samples

Stormwater samples are collected by placing a laboratory-prepared container (with preservatives as appropriate) directly into the flow, permitting a slow flow of water to enter the container. The sampler is cautious not to overfill or lose any preservatives from the sample container. If necessary, another clean sample collection container is lowered into the stormwater and used to fill the laboratory-prepared containers during heavy flow.

Following sample collection, the sample is placed in a cooler with ice and transported to a certified laboratory under chain-of-custody protocol. The chain-of-custody is completed indicating the project name, sample name, and desired analytical methods.

On site testing for pH is required. A field pH instrument properly maintained and calibrated is required. If DO will be measured at the site due to its impairment status, a field DO meter will be used, maintained and calibrated. Instrument calibration records, including the date of last calibration, serial number, and the name of the operator performing the calibration, are maintained with the field notes. Two-point calibrations are highly recommended. Buffer solutions used for calibration must not exceed expiration dates printed on the label.

Samples will be representative of stormwater flow from each hydrologic catchment that is discharged off-site. Each discharge point will be individually sampled.

Discharges will be monitored within 12 hours of the discharge event, if possible. If a discharge cannot be monitored within 12 hours of the event, a sample will be collected a soon as practical and documentation will include the reasons it was not practical.

Samples will be collected at the frequency indicated in Table 7. Calico may collect additional samples, but all qualifying samples will be included in the Discharge Monitoring Report. If no sample was collected during a quarter due to no storm events of sufficient magnitude to produce run-off during business hours and/or safe sampling conditions, Calico will request a variance by February 15 and August 15. Supporting data and analysis demonstrating why the monitoring did not occur at the time of the Data Monitoring Report submission.

3.8 Corrective Action Triggers

Corrective actions are triggered when benchmarks, sector-specific benchmarks, or reference concentrations of impairment pollutants are exceeded.

- Tier I Corrective Action Response (exceeds State-wide benchmarks in Schedule A.9)
- Tier II Corrective Action Response (second monitoring year geometric mean, exceeds state-wide benchmarks in Schedule A.9)

3.8.1 Tier I Corrective Action

If benchmark levels are exceeded for any benchmark parameter identified in Table 5 or reference concentrations associated with the impaired pollutant list provided to Calico by ODEQ, the Facility must within 30 calendar days of receiving the lab result:

- Investigate the cause of the elevated pollutant level
- Review this SWPCP and the selection, design, installation and implementation of control measures
- Determine if changes to control measures are needed

The results of the above analysis must be summarized in a Tier I report to ODEQ and describe corrective actions taken or to be taken, including the date the action was completed or expected to be completed, and determine whether a revision to the SWPCP is necessary.

If Calico believes that corrective action is not necessary, a basis for this determination will be provided. If Calico believes the exceedance is attributed to the presence of natural background concentration for the pollutant, a natural background waiver report to support this determination will be submitted to support this determination. The Tier I report will be submitted to ODEQ within 30 calendar days of obtaining the initial monitoring results.

Further details regarding what must be considered in the benchmark exceedance review and Tier I Plan are described in Schedule A.10 of the 1200-Z Permit.

3.8.2 Tier II Corrective Action

Calico will calculate the geometric mean of monitoring data collected during the second year of permit coverage (four quarterly sampling events) to determine whether any statewide benchmark listed in Table 5 has been exceeded. This information must be reported in the Discharge Monitoring Report by August 15th following the second year of permit coverage.

If the geometric mean of the second year of monitoring data (four samples) exceeds one or more benchmarks, Calico will submit one of the following responses no later than December 31 of the third year of permit coverage, along with the revised SWPCP:

- A Tier II Report will describe corrective actions and will include a proposal for active or passive treatment. Treatment may include a combination of source removal, control, or treatment measures, with the goal of achieving benchmarks.
- A Tier II mass reduction waiver request may be requested if volume reduction measures have been implemented that have or will reduce the mass load of pollutants in the discharge to below the mass equivalent of the applicable benchmarks.
- A Tier II natural background waiver request may be requested if the benchmark exceedance is attributed solely to the presence of the pollutant in natural background.

Further details regarding what must be considered in the Tier II Reports are described in Schedule A.11 of the 1200-Z Permit.

3.9 Inspections

Visual inspections of stormwater controls and discharge points will be performed monthly by trained Calico personnel. Visual monitoring will occur at the discharge points and at all points where contaminants may become entrained with stormwater. Inspections will be documented based on sector specific requirements as described in Section 2.3.5. Inspections will be documented in reports retained on site. Inspection documentation will include any previously unidentified source of pollutants, the nature of the discharge (snow or rain), and any corrective action taken.

4.0 REPORTING AND RECORDKEEPING

4.1 Reporting Monitoring Data

The stormwater sample results, along with monthly visual observations, are reported annually to ODEQ in an approved Discharge Monitoring Report (DMR) by July 31st of the subsequent year. Minimum detection levels and analytical methods for the parameters analyzed will be reported. Non-detects will be reported as “ND” with the detection limit in mg/L in parentheses, e.g., “ND (0.05 mg/L)”.

At the conclusion of the second year of monitoring, the geometric mean of the stormwater sampling results will be compared to the effluent benchmark concentrations and impairment pollutant reference concentrations. In calculating the geometric mean, any “non-detects” must be calculated using one-half of the detection limits indicated on the analytical report.

If a stormwater sample results exceed one or more of the benchmarks or reference concentrations, Calico will take the corrective action steps described in Section 3.8.

The geometric mean is calculated as follows:

$$G = (Y_1 \bullet Y_2 \bullet \ldots Y_n)^{1/n}$$

If a waiver has been obtained from monitoring for one or more discharge point and/or parameters, the letter “M” will be entered in each of the columns as appropriate. If there was no discharge during a given monitoring period, or if Calico was unable to collect a sample, “NS” is entered in each column of the discharge monitoring report.

4.2 Recordkeeping Procedures

Calico will retain the following records on site for at least 3 years and make records available to ODEQ upon request:

- A copy of the SWPCP and the 1200-Z Permit.
- Copies of the permit assignment letter and coverage documents from ODEQ for the permit term.
- Copies of corrective action and inspection reports.
- Inspection, maintenance, repair, and education activities.
- Spill or leaks that have impacted or have had the potential to impact stormwater or surface water. Corrective actions to clean up spills and leaks and measures to prevent future problems.
- Documentation of any status change for facilities at the Grassy Mountain Mine.
- Discharge Monitoring Reports, laboratory reports and field sampling notes.
- Employee education materials and records of training.

5.0 REFERENCES

Golder 2019. *Draft Grassy Mountain Project – Tailings Storage Facility and Waste Rock Dump Detailed Design Report*. Prepared for Calico Resources USA Corp. by Golder Associates Inc. October 2019

HEC 2015. Hydrologic Engineering Center – Hydrologic Modeling Software (HEC-HMS), Version 4.1, Build 1628, Date 31 July 2015. Developed by U.S. Army Corp of Engineers (USACE)

NOAA 1973. Precipitation Frequency Data Server. NOAA Atlas 2 1973. *Precipitation Frequency Atlas of the Western United States – Volume X, Oregon*. National Oceanic and Atmospheric Administration. Hydrometeorological Design Studies Center; GIS grids and an on-line look-up function. http://www.nws.noaa.gov/ohd/hdsc/noaaatlas2.htm. Accessed: August 2019.

ODEQ 2012. *Water Quality Assessment - Oregon's 2012 Integrated Report* Assessment Database and 303(d) List. Oregon Department of Environmental Quality. https://www.ODEQ.state.or.us/wq/assessment/rpt2012/search.asp

ODEQ, NPDEQ *1200-Z Industrial Stormwater General Permit, Applying for Permit Coverage and Developing your Stormwater Pollution Control Plan.* October 2018.

RAWS, 2019. Owyhee Ridge Remote Automated Weather Station, Owyhee, Oregon. NWS ID 353614. Western Regional Climate Center. https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?orOOWY. Accessed: August 2019.

SPF 2018. *Grassy Mountain Gold Project Surface Water Baseline Report*. Prepared for Calico Resources USA Corp. by SPF Water Engineering, LLC. Dated August 14, 2018.

USDA 2011. WinTR-55 Small Watershed Hydrology, Technical Release 55. Version 1.00.10 Compiled on 1 April 2011. Developed by US Department of Agriculture (USDA), National Resource Conservation Society (NRCS).

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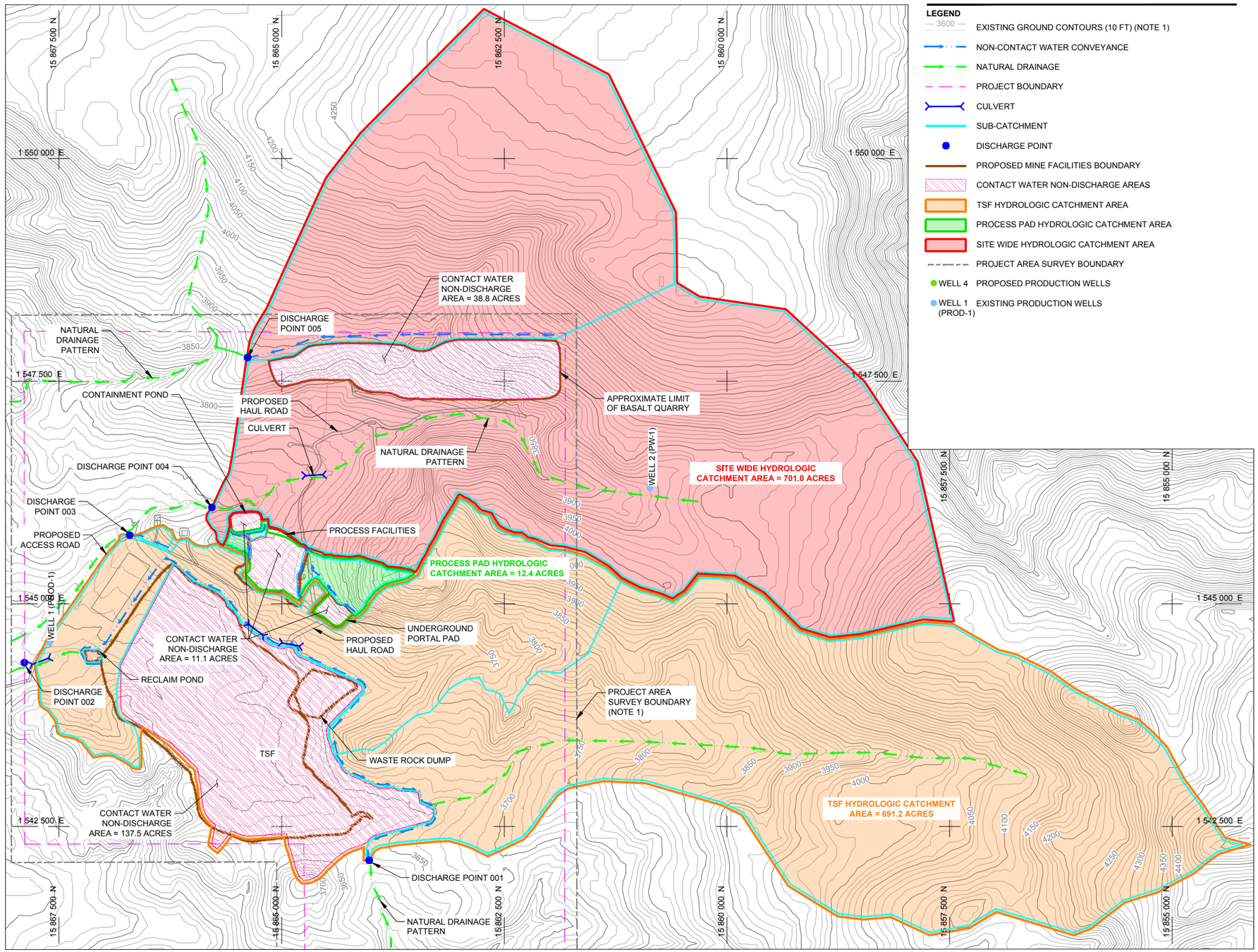
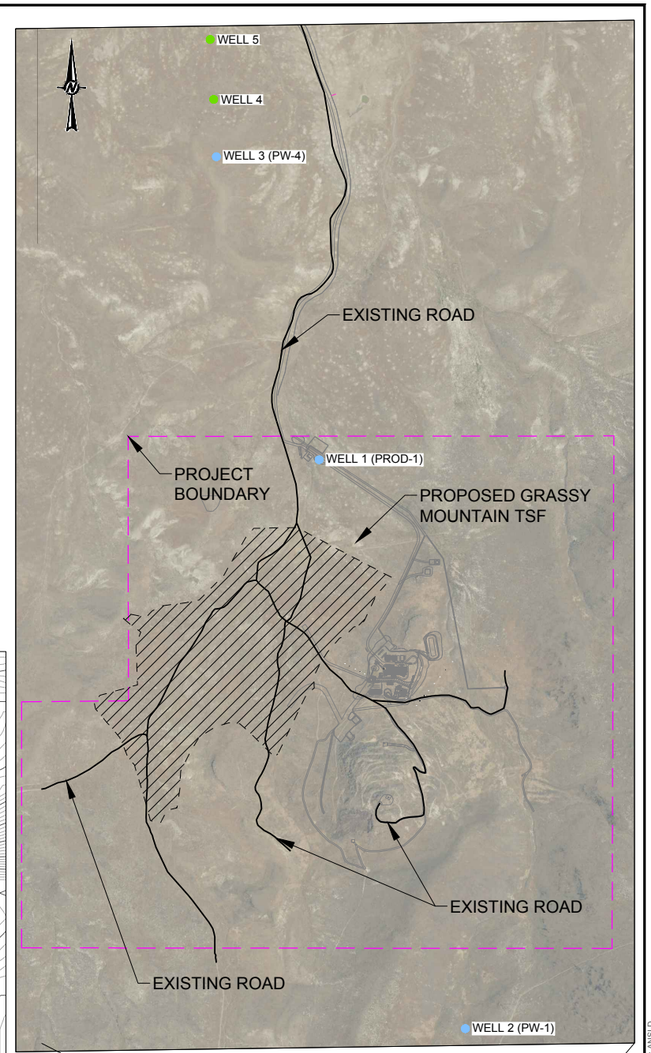
Figures

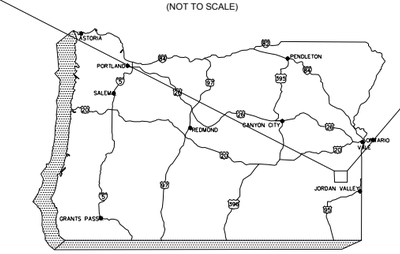


LEGEND

- 3600 — EXISTING GROUND CONTOURS (10 FT) (NOTE 1)
- NON-CONTACT WATER CONVEYANCE
- NATURAL DRAINAGE
- PROJECT BOUNDARY
- CULVERT
- SUB-CATCHMENT
- DISCHARGE POINT
- PROPOSED MINE FACILITIES BOUNDARY
- CONTACT WATER NON-DISCHARGE AREAS
- TSF HYDROLOGIC CATCHMENT AREA
- PROCESS PAD HYDROLOGIC CATCHMENT AREA
- SITE WIDE HYDROLOGIC CATCHMENT AREA
- PROJECT AREA SURVEY BOUNDARY
- WELL 4 — PROPOSED PRODUCTION WELLS
- WELL 1 (PROD-1) — EXISTING PRODUCTION WELLS



SITE LOCATION MAP
(NOT TO SCALE)



STATE OF OREGON
(NOT TO SCALE)

NOTE(S)

1. EXISTING GROUND TOPOGRAPHY WITHIN THE PROJECT AREA SURVEY BOUNDARY WAS PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf". TOPOGRAPHY OUTSIDE THE PROJECT AREA SURVEY BOUNDARY WAS AVAILABLE FROM WEBGIS DIGITAL ELEVATION MODELS WITH 30 m RESOLUTION.
2. AERIAL IMAGERY PERFORMED BY CALICO RESOURCES USA CORP. AND PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "Orthophoto_1ft_ExpandedArea.tif".
3. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".

0 600 1200
1" = 600' FEET

CLIENT
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	JRP
PREPARED	JRP
REVIEWED	JP
APPROVED	CJM

PROJECT
GRASSY MOUNTAIN
STORMWATER DISCHARGE
GENERAL PERMIT 1200-Z

TITLE
GRASSY MOUNTAIN MINE SITE LOCATION AND DRAINAGE MAP

PROJECT NO.	REV.	FIGURE
18111356	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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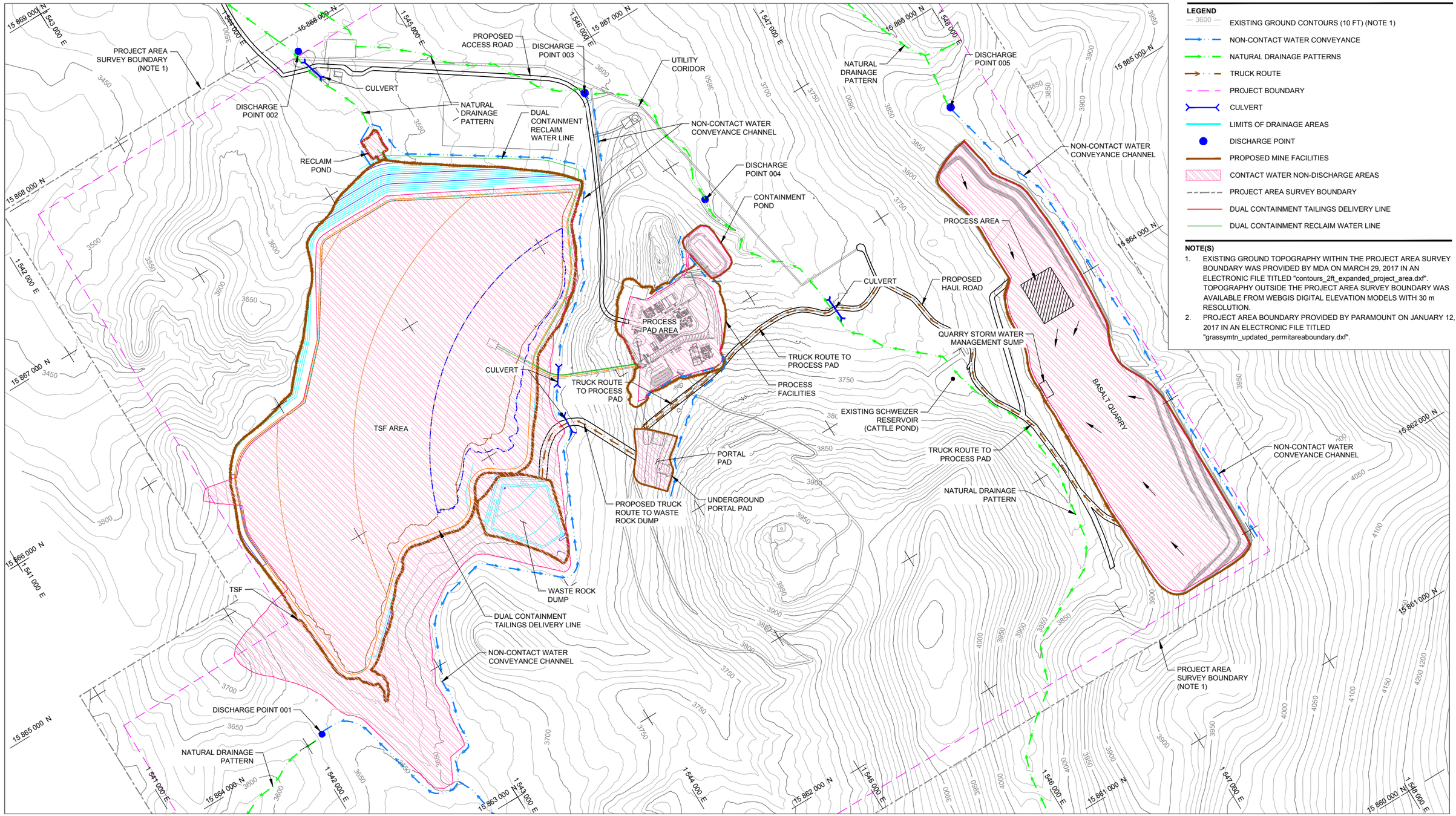

LEGEND

- EXISTING GROUND CONTOURS (10 FT) (NOTE 1)
- NON-CONTACT WATER CONVEYANCE
- NATURAL DRAINAGE PATTERNS
- TRUCK ROUTE
- PROJECT BOUNDARY
- CULVERT
- LIMITS OF DRAINAGE AREAS
- DISCHARGE POINT
- PROPOSED MINE FACILITIES
- CONTACT WATER NON-DISCHARGE AREAS
- PROJECT AREA SURVEY BOUNDARY
- DUAL CONTAINMENT TAILINGS DELIVERY LINE
- DUAL CONTAINMENT RECLAIM WATER LINE

NOTE(S)

1. EXISTING GROUND TOPOGRAPHY WITHIN THE PROJECT AREA SURVEY BOUNDARY WAS PROVIDED BY MDA ON MARCH 29, 2017 IN AN ELECTRONIC FILE TITLED "contours_2ft_expanded_project_area.dxf". TOPOGRAPHY OUTSIDE THE PROJECT AREA SURVEY BOUNDARY WAS AVAILABLE FROM WEBGIS DIGITAL ELEVATION MODELS WITH 30 m RESOLUTION.
2. PROJECT AREA BOUNDARY PROVIDED BY PARAMOUNT ON JANUARY 12, 2017 IN AN ELECTRONIC FILE TITLED "grassymtn_updated_permitareaboundary.dxf".

0 300 600
1" = 300' FEET

CLIENT
CALICO RESOURCES USA CORP
GRASSY MOUNTAIN PROJECT
MALHEUR COUNTY, OREGON

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-06
DESIGNED	JRP
PREPARED	JRP
REVIEWED	JP
APPROVED	CJM

PROJECT
GRASSY MOUNTAIN
STORMWATER DISCHARGE
GENERAL PERMIT 1200-Z

TITLE
SITE LAYOUT MAP

PROJECT NO.	REV.	FIGURE
18111356	0	2

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APPENDIX A

Oregon Industrial Stormwater General Permit (1200-Z)

GENERAL PERMIT
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
STORMWATER DISCHARGE GENERAL PERMIT No. 1200-Z

Department of Environmental Quality
700 NE Multnomah St., Suite #600 Portland, OR 97232
Telephone: (503) 229-5630 or 1-800-452-4011 toll free in Oregon

Issued pursuant to ORS 468B.050 and the Federal Clean Water Act

ISSUED TO:

SOURCES COVERED UNDER THIS PERMIT:

A facility that may discharge industrial stormwater to surface waters or to conveyance systems that discharge to surface waters of the state and

1. The stormwater is associated with an industrial activity identified in Table 1: Sources Covered or listed in Table 2: Additional Activities Covered; or
2. The facility is notified in writing by the Director that coverage under this permit is required for its stormwater discharges (see Note 1 below).

Note 1:

1. The Director designates the facility as requiring stormwater permit pursuant to 40 CFR §122.26(a)(9)(i)(D).
2. Facilities may apply for conditional exclusion from the requirement to obtain coverage under this permit if there is no exposure of industrial activities and materials to stormwater pursuant to 40 CFR §122.26(g); see Permit Coverage and Exclusion from Coverage.
3. The following are not eligible to obtain coverage under this permit:
    i. Construction activities; Primary Standard Industrial Classification codes 2951 and 3273, including mobile asphalt and concrete batch plants; and Standard Industrial Classification code 14, Mining and Quarrying of Nonmetallic Minerals, Except Fuels. These activities are covered under a separate general permit.
    ii. Any source that has obtained an individual NPDES permit for the discharge, unless the source is otherwise eligible for coverage under this permit and DEQ has approved the source's application for coverage under this general permit.
    iii. Any source that discharges to a sanitary sewer system and the discharge is approved by the sanitary sewer operator.

_____

Justin Green, Administrator
Water Quality Division

Issuance Date: August 1, 2017
Reissuance: October 22, 2018

PERMITTED ACTIVITIES

Until this permit expires, is modified or revoked, the permit registrant is authorized to construct, install, modify, or operate stormwater treatment or control facilities, and to discharge stormwater and non-stormwater discharges specifically authorized by the permit to public surface waters in conformance with all the requirements, limitations, and conditions set forth in the following schedules:

PERMIT COVERAGE AND EXCLUSION FROM COVERAGE 5
SCHEDULE A 10
TECHNOLOGY BASED EFFLUENT LIMITATIONS 10
WATER QUALITY BASED EFFLUENT LIMITATIONS 14
STORMWATER POLLUTION CONTROL PLAN 15
STORMWATER DISCHARGE BENCHMARKS 18
CORRECTIVE ACTIONS FOR IMPAIRMENT POLLUTANT AND BENCHMARK EXCEEDANCES 19
SCHEDULE B 22
MONITORING REQUIREMENTS 22
INSPECTIONS 27
REPORTING AND RECORDKEEPING REQUIREMENTS 28
SCHEDULE D 32
SPECIAL CONDITIONS 32
SCHEDULE E 37
SECTOR-SPECIFIC REQUIREMENTS 37
SCHEDULE F 118
NPDES GENERAL CONDITIONS 118

Unless specifically authorized by this permit, by regulation issued by EPA, by another NPDES permit, or by Oregon Administrative Rule, any other direct or indirect discharge to waters of the state is prohibited, including non-stormwater discharges to an underground injection control system.

Schedule F contains General Conditions that are included in all general permits issued by DEQ. Schedule E contains sector-specific federal requirements. Should conflicts arise between Schedule F or Schedule E and any other schedule of the permit, the requirements in Schedule F or Schedule E may not apply.

Table 1: Sources Covered

Types of Industrial Sources Covered Under this Permit
Facilities with the following primary Standard Industrial Classification (SIC) codes: 10 Metal Mining 12 Coal Mining 13 Oil and Gas Extraction 20 Food and Kindred Products 21 Tobacco Products 22 Textile Mill Products 23 Apparel and Other Finished Products Made From Fabrics and Similar Material 24 Lumber and Wood Products, Except Furniture (Activities with SIC 2411 Logging that are defined in 40 CFR §122.27 as silvicultural point source discharges are covered by this permit.) 25 Furniture and Fixtures 26 Paper and Allied Products 27 Printing, Publishing and Allied Industries 28 Chemicals and Allied Products Manufacturing and Refining (excluding 2874: Phosphatic Fertilizers) 29 Petroleum Refining and Related Industries (excluding 2951, covered by 1200-A) 30 Rubber and Miscellaneous Plastics Products 31 Leather and Leather Products 32 Glass, Clay, Cement, Concrete and Gypsum Products (excluding 3273, covered by 1200-A) 33 Primary Metal Industries 34 Fabricated Metal Products, Except Machinery and Transportation Equipment 35 Industrial and Commercial Machinery and Computer Equipment 36 Electronic and Other Electrical Equipment and Components, Except Computer Equipment 37 Transportation Equipment 38 Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks 39 Miscellaneous Manufacturing Industries 4221 Farm Product Warehousing and Storage 4222 Refrigerated Warehousing and Storage 4225 General Warehousing and Storage 5015 Motor Vehicle Parts, Used 5093 Scrap and Waste Materials
Facilities with the following primary SIC codes that have vehicle maintenance shops (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, or airport deicing operations: 40 Railroad Transportation 41 Local and Suburban Transit and Interurban Highway Passenger Transportation 42 Trucking and Courier Services, Except Air (excluding 4221, 4222, and 4225) 43 United States Postal Service 44 Water Transportation 45 Transportation by Air 5171 Petroleum Bulk Stations and Terminals, except petroleum sold via retail method.
Steam Electric Power Generation including coal handling sites
Landfills, land application sites and open dumps
Hazardous Waste Treatment, storage and disposal facilities
Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage, recycling, and reclamation of municipal or domestic sewage (including land dedicated to the disposal of sewage sludge that are located within the confines of the facility) with the design flow capacity of 1.0 mgd or more, or required to have a pretreatment program under 40 CFR §403.

In addition to the industrial sources listed in Table 1, facilities that discharge stormwater into the Columbia Slough or Portland Harbor that is exposed to any of the industrial activities listed in Table 2 below, are eligible to obtain permit coverage under the NPDES 1200-Z.

Table 2: Additional Industrial Activities Covered

Discharges to Columbia Slough and Portland Harbor
Maintenance of vehicles, machinery, equipment, and trailers (including repairs, servicing, washing, testing and painting)
Storage of vehicles, machinery, equipment (including disposal/refuse containers stored by a disposal/refuse contractor/vendor), and trailers (including rental, sales, wrecked vehicles, fleet, and general storage)
Materials storage (including raw materials; bulk fuels, chemicals, detergents, and plastic pellets; finished materials; lumber and food products; wholesale gravel, sand, and soil stockpiles; and bulk liquids other than water)
Waste handling (including recycled product storage, composting, tires, and bulk hazardous waste)
Commercial animal operations (such as kennels, race tracks, and veterinarians not covered under a Confined Animal Feeding Operation permit)
Fuel distribution and sales (including bulk stations, fuel oil dealers, manned and unmanned retail stations, fleet fueling, mobile fueling, and truck stops)
Any former activity that resulted in significant materials (as defined in Schedule D) remaining on-site

PERMIT COVERAGE AND EXCLUSION FROM COVERAGE

1. **New Discharger to Impaired Waters** (see Schedule D.3, Definitions)
   a. A new discharger to an impaired water without a Total Maximum Daily Load (TMDL), based on the EPA-approved 303(d) list (Category 5) that is in effect on May 1, 2017, for pollutant(s) must meet one of the following conditions to obtain coverage under this permit:
      i. Prevent all pollutants for which the waterbody is impaired from exposure to stormwater and document in the Stormwater Pollution Control Plan (SWPCP) procedures taken to prevent exposure on-site; or
      ii. Document in SWPCP that the pollutant(s) for which the waterbody is impaired are not present at the site; or
      iii. Provide data and other technical information that demonstrates that the discharge is not expected to cause or contribute to an exceedance of the water quality standard for which the waterbody is impaired at the point of discharge to the waterbody if the pollutant(s) for which the waterbody is impaired are likely to be present at the site and DEQ has not issued a TMDL for the pollutant(s).
   b. Prior to granting permit coverage to a new discharger to impaired waters without a TMDL, DEQ or agent will make a determination and document that one of the conditions in paragraph 1.a. has been satisfied.
   c. A new discharger that is unable to meet one of the conditions in paragraph 1.a. is ineligible for coverage under this permit; either the discharge must cease or the new discharger will be required to obtain coverage under an individual NPDES permit.
   d. A new discharger to an impaired water with a TMDL (based on the EPA-approved TMDLs as of May 1, 2017) may receive permit coverage under this permit under one of the following circumstances:
      i. The TMDL does not establish industrial stormwater wasteload allocations, the compliance with the terms and conditions of the permit is presumed consistent with the TMDL.
      ii. If the TMDL establishes industrial stormwater wasteload allocations, and if DEQ or agent determines that there are sufficient remaining wasteload allocations in the TMDL to allow for the new industrial stormwater discharge, then the new discharge may be authorized by this permit.
   e. If a new discharge to impaired waters is authorized by DEQ under this permit, DEQ or agent will establish any additional monitoring, site controls or compliance schedules as necessary.
   f. Instead of granting permit coverage to a new discharge under paragraph 1.d., DEQ may determine that coverage under an individual NPDES permit is necessary.
   g. Conditions 1.a and 1.f above do not apply if the waterbody is impaired for:
      i. Biological communities and no pollutant, including indicator or surrogate pollutants, is specified as causing the impairment; or
      ii. Temperature, hydrologic modifications, or impaired hydrology.

2. **New Application for Permit Coverage Requirements**
   a. The following conditions apply to:

i. New facility: Submit a complete application to DEQ or agent (see Schedule D.4 for description of agent) at least 60 calendar days before initiating the activity that requires permit coverage, unless DEQ or agent approved a later date.
ii. Existing facility with stormwater discharges associated with industrial activities identified in Table 1 and operating without coverage under any NPDES permit for those discharges: Immediately submit a complete application to DEQ or agent, unless DEQ or agent approved a later date.
iii. Existing facility with stormwater discharges associated with industrial activities identified in Table 2 operating without coverage under any NPDES permit for those discharges: No later than 60 calendar days from written notification by DEQ or agent that permit coverage is required, submit a complete application to DEQ or agent.
iv. Existing facility that is designated by the Director as needing a stormwater permit pursuant to 40 CFR §122.26(a)(9)(i)(D): No later than 60 calendar days of being notified by DEQ that permit coverage is required, submit a complete application to DEQ or agent.
v. Existing facility operating under permit coverage that intends to change industrial processes at the site to a new primary industrial sector: Submit a complete application to DEQ or agent at least 60 calendar days before initiating the planned change, unless DEQ or agent approved a later date.
vi. Existing facility whose stormwater discharges are authorized by an individual NPDES permit and seeks coverage under this permit: Submit a complete application to DEQ or agent and a copy of the individual NPDES permit.
vii. A complete application must include the following:
(1) Applicable permit fees;
(2) DEQ-approved application form;
(3) A determination, on a DEQ-approved form, from the local government agency with land use jurisdiction that states the use is compatible with acknowledged local land use plans and;
(4) One paper copy and one electronic pdf copy of the SWPCP.

b. Permit Coverage
i. Prior to granting the applicant coverage under this permit, DEQ will provide a 30 calendar day public review period on the applicant's SWPCP and the proposed permit assignment letter. DEQ or agent will respond in writing to any applicable public comments.
ii. DEQ will notify the applicant in writing if coverage is granted or denied. When coverage is granted, DEQ or agent will establish monitoring year and outline monitoring requirements in the permit assignment letter (see Schedule D.3, Definitions).

c. If coverage is denied or the applicant does not wish to be regulated by this permit, the applicant must apply for an individual permit in accordance with OAR 340-045-0030 or cease discharge.

3. Existing Facilities Covered Under the 1200-COLS or 1200-Z NPDES General Permits

a. To ensure uninterrupted permit coverage for industrial stormwater discharges, an owner or operator of a facility covered under the 1200-Z permit that expired on June 30, 2017, must have submitted a DEQ-approved renewal application form to DEQ or agent, by January 3, 2017, unless DEQ or agent approved a later date.

b. To ensure uninterrupted permit coverage for industrial stormwater discharges, an owner or operator of a facility covered under the 1200-COLS permit that expired on September 30, 2016, must have submitted a DEQ-approved renewal application form to DEQ or agent, by August 1, 2016, unless DEQ or agent approved a later date.
c. DEQ will notify registrants in writing if coverage is approved or denied. Renewed facilities must submit updated SWPCP to DEQ or agent by December 29, 2017, unless DEQ or agent approved a later date.
d. For Tier II corrective action requirements triggered during the second year of coverage from the 1200-COLS permit that expired on September 30, 2016 or during the second year of coverage under the 1200-Z permit that expired on June 30, 2017, permit registrants must comply with the implementation deadline in the previous permit.
e. Permit registrants for which the Tier II corrective action implementation deadline was after June 30, 2017, under the 1200-COLS permit that expired on September 30, 2016 or under the 1200-Z permit that expired on June 30, 2017, are exempt from Schedule A.11 for the parameter(s) and discharge point(s) that triggered Tier II.

4. Existing Facilities Covered Under the 1200-ZN or 1200-COLSB

a. Permit registrants for which DEQ or agent has received a renewal application, facilities will automatically be re-assigned coverage under this permit in accordance to condition 3.c.

5. Name Change or Transfer of Permit Coverage

a. For a name change or transfer of permit coverage between legal entities, the new owner or operator must submit to DEQ no later than 30 calendar days after the name change or planned transfer. A complete application must include the following:
   i. One paper copy of a DEQ-approved Name Change and/or Permit Transfer form;
   ii. One paper copy and one electronic pdf copy of an updated SWPCP; and
   iii. Applicable fee.
b. DEQ will notify the applicant in writing if the name change or transfer is approved or denied. Transfer of permit will be effective upon DEQ approval.
c. For a name change or transfer of permit coverage between legal entities where there will also be a change in an industrial process at the site to a new primary industrial sector, the owner or operator must submit a new application for coverage under this permit as required in condition 2.a.iv above.

6. "No Exposure" Conditional Exclusion from Permit Coverage

a. An owner or operator that applies for a "no exposure" conditional exclusion under 40 CFR §122.26(g) from coverage under this permit must:
   i. Protect industrial materials and activities from exposure to rain, snow, snowmelt, and runoff by using a storm resistant shelter, except as provided in the Environmental Protection Agency (EPA) Guidance Manual for Conditional Exclusion from Stormwater Permitting Based on "No Exposure" of Industrial Activities to Stormwater (EPA 833-B-00-001, June 2000) and EPA's Fact Sheet on Conditional No Exposure Exclusion for Industrial Activity (EPA 833-F-00-015, revised December 2005). Storm resistant shelters with unsealed zinc or copper roofing materials are not eligible for the "no exposure" conditional exclusion;

ii. Ensure that known significant materials from previous operations are controlled, removed or otherwise not exposed to stormwater.
iii. Complete and sign a DEQ-approved certification, that there is no stormwater exposure to industrial materials and activities from the entire facility.
iv. Submit the signed certification to DEQ or agent once every five years, beginning five years after the date of first submittal. If DEQ or agent does not comment on the "no exposure" certification within 60 calendar days, the "no exposure" conditional exclusion is deemed approved. DEQ or agent may notify the applicant in writing or by email of its approval. The owner or operator must keep a copy of the approved certification on-site.
v. Allow DEQ or agent to inspect the facility to determine compliance with the "no exposure" conditions; and
vi. If facility discharges through a municipal separate storm sewer system (MS4) submit a copy of the "no exposure" certification to the MS4 operator (for example, local municipality or district), upon their request, and allow inspection and public reporting by the MS4 operator.

b. Limitations for obtaining or maintaining the exclusion:
i. This exclusion is available on a facility-wide basis only, not for individual discharge points.
ii. If any industrial materials or activities become exposed to rain, snow, snowmelt, or runoff, the conditions for this exclusion no longer apply. In such cases, the discharge becomes subject to enforcement. Any conditionally exempt discharger who anticipates changes in circumstances must apply for and obtain permit coverage before the change of circumstances.
iii. DEQ or agent retains the authority to make a determination that the "no exposure" conditional exclusion no longer applies and require the owner or operator to obtain permit coverage.

7. Electronic Submissions

a. The applicant for coverage must submit the application and related documents in an electronic format to the initial recipient as specified below or as directed otherwise by DEQ as the National Pollutant Discharge Elimination System (NPDES) regulatory authority in Oregon according to 40 CFR 127.
b. Beginning after December 21, 2020, or when directed by DEQ, the permit registrant must submit application and related documents on DEQ-approved web-based forms including pre-approved attachments.
i. Submit any documents, including the SWPCP, not entered on the NeT format as a separate attachment in the NeT electronic tool. DEQ must pre-approve the attachment forms as an integral part of the DEQ-approved application.
ii. The permit registrant must sign and certify all electronic submissions in accordance with the requirements of Section D8 within Schedule F of this permit.
c. In accordance with 40 CFR 122.41(l)(9), DEQ will identify the initial recipient that is the designated entity for receiving electronic NPDES data. Until further notice from DEQ, EPA is the initial recipient to receive electronic submissions, and the permit registrant will use EPA's NeT for electronic reporting. DEQ will notify the permit registrant in advance of changes to the initial recipient status and use of another electronic reporting system other than NeT.

8. Authorized Non-Stormwater Discharges

a. Subject to the terms and conditions of the permit and Oregon law, the following non-stormwater discharges are authorized:
   i. Discharges from emergency or unplanned fire-fighting activities;
   ii. Fire hydrant flushing and maintenance;
   iii. Potable water, including water line flushing;
   iv. Uncontaminated condensate from air conditioners, coolers, chillers and other compressors, and from outside storage of refrigerated gases and liquids;
   v. Landscape watering and irrigation drainage;
   vi. Exterior vehicle wash water that does not use hot water or detergent; restricted to less than 8 per week;
   vii. Pavement wash water that does not use hot water, detergent or other cleaning products, no spills or leaks of toxic or hazardous materials have occurred (unless all spilled material has been removed), and surfaces are swept before washing;
   viii. Routine external building wash down that does not use hot water, detergent or other cleaning products;
   ix. Uncontaminated ground water or spring water;
   x. Foundation or footing drains where flows are not contaminated with process materials; and
   xi. Incidental windblown mist from cooling towers that collects on rooftops or adjacent portions of the facility, but not intentional discharges from the cooling tower (e.g., "piped" cooling tower blowdown or drains).

b. Separate any piping of interior floor drains and process wastewater discharge points from the storm drainage system to prevent unpermitted discharge of pollutants to waters of the state. Discharge from floor drains to the stormwater drainage system is a violation of this permit.

c. Any other wastewater discharge or disposal, including stormwater mixed with wastewater, must be permitted in a separate permit, unless the wastewater is reused or recycled without discharge or disposal, or is discharged to the sanitary sewer with approval from the sanitary sewer system operator.

9. Limitations on Coverage

a. Pursuant to OAR 340-045-0033(10), DEQ may deny permit coverage to an applicant or revoke a permit registrant's coverage under this permit and require the owner or operator to apply for and obtain an individual permit.

b. Coverage under this permit is not available under the following circumstances:
   i. If all stormwater discharges are regulated by another NPDES permit, except a MS4 permit.
   ii. If stormwater discharges were included in a permit that has been or is in the process of denial, termination or revoked unless the source is otherwise eligible for coverage under this permit and DEQ approves the source's application to register under it and simultaneously revokes coverage under the other permit.
   iii. For a new discharger to waters designated as Outstanding Resource Waters for antidegradation purposes under 40 CFR 131.12(a)(3) and OAR 340-041-0004.

c. Any operator not seeking coverage under this general permit must apply for an individual NPDES permit in accordance with the procedures in OAR 340-045-0030.

SCHEDULE A

TECHNOLOGY BASED EFFLUENT LIMITATIONS

1. Narrative Technology-Based Effluent Limits

The permit registrant must meet the following narrative technology based effluent limits and additional sector-specific limits in Schedule E of this permit, if applicable.

a. Minimize exposure - Minimize exposure of manufacturing, processing, material storage areas, including loading and unloading, disposal, cleaning, maintenance and fixed fueling areas to rain, snow, snowmelt and runoff. To the extent technologically available and economically practicable and achievable in light of best industry practice, the permit registrant must do the following:

i. Locate materials and activities indoors or protect them with storm resistant covers if stormwater from affected areas may discharge to surface waters. Acceptable covers include, permanent structures such as roofs or buildings and temporary covers such as tarps;

ii. Use grading, berming, or curbing to divert stormwater away from these areas and prevent stormwater contamination;

iii. Store all hazardous substances (see Schedule D.3, Definitions), petroleum/oil liquids, and other chemical solid or chemical liquid materials that have potential to contaminate stormwater within berms or other secondary containment devices to prevent leaks and spills. If the use of berms or secondary containment devices is not practicable, then store such substances in areas that do not drain off-site or into the storm sewer system;

iv. Locate materials, equipment and activities in containment and diversion systems, including the storage of leaking or leak-prone vehicles and equipment awaiting maintenance, to prevent leaks and spills from contaminating stormwater;

v. Use drip pans or absorbents under or around leaking or leak-prone vehicles/equipment or store indoors. Drain fluids from equipment and vehicles prior to on-site storage or disposal;

vi. Perform all cleaning operations indoors, under cover or in bermed areas that prevent runoff and run-on and also captures overspray;

vii. Clean up spills or leaks promptly using absorbents or other effective methods to prevent discharge of pollutants and use spill/overflow protection equipment;

viii. Ensure that all wash water is managed indoors or in bermed areas, disposed into sanitary sewer or drain to a proper collection system such as a closed-loop system or vegetated area and does not discharge into the stormwater drainage system unless allowed under condition 8, authorized non-stormwater discharge.

b. Oil and Grease - Employ oil/water separators, booms, skimmers or other methods to eliminate or minimize oil and grease contamination in stormwater discharges.

c. Waste Chemicals and Material Disposal - Recycle or properly dispose of wastes to eliminate or minimize exposure of pollutants to stormwater. Cover all waste contained in bins or dumpsters where there is a potential for drainage of stormwater through the waste to prevent exposure of stormwater to these pollutants. Acceptable covers include, storage of bins or dumpsters under roofed areas or use of lids or temporary covers such as tarps.

d. Erosion and Sediment Control - Stabilize exposed areas, including areas where industrial activity has taken place in the past and significant materials remain, and contain runoff using structural and nonstructural controls to minimize erosion of soil at the site and sedimentation. Employ

erosion control methods, such as vegetating exposed areas, graveling or paving to minimize erosion of soil at the site. Employ sediment control methods, such as detention facilities, vegetated filter strips, bioswales, flow velocity dissipation devices or other permanent erosion or sediment controls to minimize sediment loads in stormwater discharges. For activities that involve land disturbance, the permit registrant must contact the local municipality to determine if there are other applicable requirements related to stormwater control.

e. Debris Control - Employ screens, booms, settling ponds, or other methods to eliminate or minimize waste, garbage and floatable debris in stormwater discharges and ensure that this debris is not discharged to receiving waters.
f. Dust Generation and Vehicle Tracking of Industrial Materials - Minimize generation of dust, off-site tracking and discharge of soil, particulates and raw, final or waste materials.
g. Housekeeping - Routinely clean all exposed areas that may contribute pollutants to stormwater with measures such as sweeping at regular intervals, litter pick-up, keeping materials orderly and labeled, prompt clean-up of spills and leaks, proper maintenance of vehicles and stowing materials in appropriate containers.
h. Spill Prevention and Response Procedure - Minimize the potential for leaks, spills and other releases that may be exposed to stormwater and develop plans that include methods for spill prevention and clean-up and notification procedures. At a minimum, the permit registrant must use spill prevention and response measures including the following:
    i. Procedures for plainly labeling containers that could be susceptible to spillage or leakage to encourage proper handling and facilitate rapid response if spills or leaks occur as required by local, state and federal rules;
    ii. Preventative measures, such as barriers between material storage and traffic areas, secondary containment provisions, and procedures for material storage and handling;
    iii. Procedures for expeditiously stopping, containing, and cleaning up leaks, spills and other releases. Make the methods and procedures available to appropriate personnel. Employees who may cause, detect, or respond to a spill or leak must be trained in these procedures. Have the necessary clean-up material on-site and readily available; and
    iv. Procedures for notification of appropriate facility personnel, DEQ or agent, and the Oregon Emergency Response System (1-800-452-0311), when a spill may endanger health or the environment. Contact information must be in locations that are readily accessible and available.
i. Preventative Maintenance - Regularly inspect, clean, maintain, and repair all industrial equipment and systems and materials handling and storage areas that are exposed to stormwater to avoid situations that may result in leaks, spills, and other releases of pollutants discharged to receiving waters. Clean, maintain and repair all control measures, including stormwater structures, catch basins, and treatment facilities to ensure effective operation as designed and in a manner that prevents the discharge of pollution.
j. Employee Education - Develop and maintain an employee orientation and education program to inform personnel on the pertinent components and goals of this permit and the SWPCP.
    i. Training must cover:
        (1) Specific control measures used to achieve the narrative technology based effluent limits, such as spill response procedures and good housekeeping practices, and
        (2) Monitoring, inspection, reporting and documentation requirements.

ii. Permit registrant must ensure that the following personnel are trained and understand the facility's specific requirements and their responsibilities:
   (1) Personnel who are responsible for the design, installation, maintenance, or repair of controls including, pollution prevention and treatment measures;
   (2) Personnel responsible for the storage and handling of chemicals and materials that could contribute pollutants to stormwater;
   (3) Personnel who are responsible for conducting or documenting monitoring or inspections as required in Schedule B; and
   (4) Personnel who are responsible for conducting and documenting corrective actions.

iii. Education and training must be documented and must occur:
   (1) No later than 30 calendar days of hiring an employee who works in areas where stormwater is exposed to industrial activities or conducts duties related to the implementation of the SWPCP;
   (2) No later than 30 calendar days of change in duties for key personnel in Schedule A.1.j.ii; and
   (3) Annually thereafter.

iv. Education and training must be documented and include which specific employees received training. A log of training dates must kept on-site and submitted to DEQ or agent upon request.

k. Non-Stormwater Discharges - Eliminate any non-stormwater discharges not authorized by a NPDES permit (see condition 8; Permit Coverage and Exclusion from Coverage section of this permit for a list of authorized non-stormwater discharges).

2. Numeric Technology-Based Effluent Limits based on Stormwater Specific Effluent Limitations Guidelines - The permit registrant with the following industrial activities must meet the effluent limits referenced in the Table 3 below. An exceedance of the effluent limitation is a permit violation. See Schedule B.9 for corrective action requirements.

Table 3: Numeric Effluent Limit Guidelines

Regulated Activity	40 CFR Part/Subpart	Effluent Limit
Runoff from asphalt emulsion facilities (co-located SIC code only, 2951 covered under the 1200-A)	Part 443, Subpart A	See Schedule E.D.2
Runoff from material storage piles at cement manufacturing facilities	Part 411, Subpart C	See Schedule E.E.5
Runoff from hazardous waste landfills	Part 445, Subpart A	See Schedule E.K.3
Runoff from non-hazardous waste landfills	Part 445, Subpart B	See Schedule E.L.7
Runoff from coal storage piles at steam electric generating facilities	Part 423, Subpart E	See Schedule E.O.5

Regulated Activity	40 CFR Part/Subpart	Effluent Limit
Runoff containing urea from airfield pavement deicing at existing and new primary airports with 1,000 or more annual non-propeller aircraft departures	Part 449, Subpart S	See Schedule E.S.7

3. Control Measures for Technology Based Effluent Limits

a. The permit registrant must select, design, install, implement and maintain control measures, including all best management practices, (BMPs), to meet the narrative technology-based and numeric effluent limits in Schedule A.1, A.2 and Schedule E of this permit and describe these measures, maintenance schedules and frequency of housekeeping measures in the SWPCP.

b. For technology-based effluent limits that require permit registrants to minimize pollutants in the discharge, permit registrants must reduce or eliminate pollutants to the extent achievable using control measures that are technologically available and economically practicable and achievable in light of best industry practice.

c. The term "minimize" means reduce or eliminate, or both, to the extent achievable using control measures (including best management practices) that are technologically available and economically practicable and achievable in light of best industry practice. The term "feasible" means technologically possible and economically practicable and achievable in light of best industry practice. In selecting the appropriate control measures to meet these limits, permit registrant may consider the age of the equipment and facilities involved, the processes employed, the engineering aspects of the application of various types of control techniques, the pollutant reductions likely to be achieved, any adverse environmental or energy effects of potential measures, and the costs of achieving pollutant reductions.

d. The permit registrant must install, implement and maintain the control measures in accordance with good engineering practices and manufacturers' specifications. Justify any deviation from the manufacturer's specifications in the SWPCP.

e. DEQ or agent may require the permit registrant to take corrective actions to meet the narrative technology-based and numeric effluent limits in Schedule A.1, A.2 and Schedule E of this permit.

   i. If the permit registrant is failing to implement the control measures in the SWPCP, they must take corrective actions and implement the measures before the next storm event if practicable, unless otherwise approved by DEQ or agent.

f. If modifications to the control measures are necessary to meet the technology-based effluent limits in this permit, the permit registrant must revise the SWPCP no later than 30 calendar days from completion of the modifications, unless otherwise approved by DEQ or agent. Permit registrant must implement the corrective actions before the next storm event if practicable or no later than 60 calendar days from discovering the violation, unless DEQ or agent approved a later date.

WATER QUALITY BASED EFFLUENT LIMITATIONS

4. Water Quality Standards

a. The permit registrant must not cause or contribute to a violation of instream water quality standards as established in OAR 340-041.

b. If at any time the permit registrant becomes aware, or DEQ or agent determines, that the discharge causes or contributes to an excursion of water quality standards permit registrant must take the following corrective actions:

i. No later than 24-hours of discovering the violation:

(1) Investigate the conditions that triggered the violation; and

(2) Review the SWPCP and the selection, design, installation and implementation of control measures to ensure compliance with this permit.

ii. No later than 30 calendar days after receiving the monitoring results, submit a Water Quality Standards Corrective Action report to DEQ or agent that documents the following:

(1) The results of the investigation, including the date the violation was discovered and a brief description of the conditions that triggered the violation;

(2) Corrective actions taken or to be taken, including the date the corrective action was completed or is expected to be completed; and

(3) Document whether SWPCP revisions are necessary. If permit registrant determines that SWPCP revisions are necessary based on the corrective action review, submit a revised SWPCP to DEQ or agent with the report.

iii. Permit registrant must implement the corrective action before the next storm event, if possible, or no later than 30 calendar days after discovering the violation, whichever comes first, unless DEQ or agent approved a later date.

c. DEQ or agent may impose additional monitoring, site controls or compliance schedules on a site-specific basis, or require the permit registrant to obtain coverage under an individual permit, if information in the application, required reports, or from other sources indicates that the discharge is causing or contributing to a violation of water quality standards, either in the receiving waterbody or a downstream waterbody. If DEQ or agent determines that additional site specific requirements are necessary, DEQ or agent will require the permit registrant to revise the SWPCP. DEQ will hold a 30 calendar day public review period on the revised SWPCP.

5. Discharges to Impaired Waters

a. Existing Discharger to an Impaired Water without a TMDL for Pollutant(s) - Permit registrant that discharges to an impaired water without a TMDL, based on the EPA-approved 303(d) list (Category 5) that is in effect on May 1, 2017, for the pollutant(s) must meet Schedule A.4 and B.1.b of this permit.

b. Existing Discharger to an Impaired Water with a TMDL for Pollutant(s) - Must comply with all applicable requirements of the EPA-approved TMDL(s). If a TMDL establishes wasteload allocation(s) for industrial stormwater discharges, DEQ will list the permit registrant's requirements to comply with this condition in the permit assignment letter. If DEQ determines that additional monitoring, site controls or compliance schedules are necessary to comply with applicable TMDL wasteload allocations for industrial stormwater discharges, DEQ will include such requirements in the permit assignment letter and require a SWPCP revision. DEQ will hold a

30 calendar day public review period on the revised SWPCP. Permit registrant must meet Schedule A.4 and B.1.b of this permit.

c. New Discharger to an Impaired Water - New discharges to impaired waters authorized to discharge under this permit must implement and maintain any control measures or conditions on the site that enabled the permit registrant to become eligible for permit coverage and modify such measures or conditions as necessary pursuant to corrective action requirements in this permit. Permit registrant must meet Schedule A.4 and B.1.b of this permit.
d. For the purposes of this permit, impaired waters and approved TMDLs will be based on those in effect as of May 1, 2017.

STORMWATER POLLUTION CONTROL PLAN

6. Preparation and Implementation of SWPCP

a. The SWPCP must be prepared by a person knowledgeable in stormwater management and familiar with the facility.
b. The SWPCP must be signed and certified in accordance with 40 CFR §122.22.
c. The SWPCP must include each narrative technology-based effluent limit to eliminate or reduce the potential to contaminate stormwater and prevent any violation of instream water quality standards.
d. Permit registrants must implement the SWPCP and any revisions to the plan. Failure to implement any of the control measures or practices described in the SWPCP is a violation of this permit.
e. The SWPCP must be kept current and revised as necessary to reflect applicable changes to the site.
f. Revisions must be made in accordance with Schedule A.8.

7. Required Elements

The SWPCP, at a minimum, must include the components below and describe how the permit registrants intends to comply with the narrative technology-based effluent limit to eliminate or reduce the potential to contaminate stormwater and prevent any violation of instream water quality standards.

a. Title Page - The title page of the SWPCP must contain the following information:
   i. Plan date.
   ii. Name of the site.
   iii. Name of the site operator or owner.
   iv. The name of the person(s) preparing the SWPCP.
   v. File number and EPA permit number as indicated in permit coverage documents.
   vi. Primary SIC code and any co-located SIC codes.
   vii. Contact person(s) name, telephone number and email.
   viii. Physical address, including county, and mailing address if different.
b. Site Description - The SWPCP must contain the following information, including any applicable information required in Schedule E of the permit:
   i. Site map(s) including the following:
      (1) general location of the site in relation to surrounding properties, transportation routes, surface waters and other relevant features;

(2) drainage patterns;
(3) conveyance and discharge structures, such as piping or ditches;
(4) all discharge points assigned a unique three-digit identifying number starting with 001, 002 used for electronic reporting;
(5) outline of the drainage area for each discharge point;
(6) paved areas and buildings within each drainage area;
(7) areas used for outdoor manufacturing, treatment, storage, or disposal of significant materials;
(8) existing structural control measures for minimizing pollutants in stormwater runoff;
(9) structural features that reduce flow or minimize impervious areas;
(10) material handling and access areas;
(11) hazardous waste treatment, storage and disposal facilities;
(12) location of wells including waste injection wells, seepage pits, drywells;
(13) location of springs, wetlands and other surface waterbodies both on-site and adjacent to the site;
(14) location of groundwater wells;
(15) location and description of authorized non-stormwater discharges;
(16) exact location of monitoring points, indicating if any discharge points are "substantially similar" and not being monitored;
(17) location and description of spill prevention and cleanup materials; and
(18) locations of the following materials and activities if they are exposed to stormwater and applicable:
(A) fueling stations;
(B) vehicle and equipment maintenance cleaning areas;
(C) loading/unloading areas;
(D) locations used for the treatment, storage, or disposal of wastes;
(E) liquid storage tanks;
(F) processing and storage areas;
(G) immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility;
(H) transfer areas for substances in bulk;
(I) machinery; and
(J) locations and sources of run-on to your site from adjacent property.

ii. A description of industrial activities conducted at the site and significant materials stored, used, treated or disposed of in a manner which exposes those activities or materials to stormwater. Include in the description the methods of storage, usage, treatment or disposal.
iii. Location and description, with any available characterization data, of areas of known or discovered significant materials from previous operations.
iv. Regular business hours of operation.
v. For each area of the site where a reasonable potential exists for contributing pollutants to stormwater runoff, a description of the potential pollutant sources that could be present in stormwater discharges and if associated with a co-located SIC code.
vi. A description of control measures installed and implemented to meet the technology and water quality based requirements in Schedule A.1 –A.5 and any applicable sector-specific

requirements in Schedule E of this permit. Include a description of how the stormwater control measures address potential pollutant sources from industrial activities and significant materials on-site, spills and leaks and authorized non-stormwater discharges.

vii. A description of treatment controls or source control, including low impact development, in response to corrective action requirements and operation and maintenance procedures.

viii. An estimate of the amount of impervious surface area (including paved areas and building roofs) and the total area drained by each stormwater discharge point to be reported in area units.

ix. The name(s) of the receiving water(s) for stormwater drainage. If drainage is to a municipal storm sewer system, the name(s) of the ultimate receiving waters and the name of the municipality; and

x. The identification of each discharge point and the location(s) where stormwater monitoring will occur as required by Schedule B.2. The monitoring location must also be labeled in the SWPCP as "monitoring location." Existing discharge points excluded from monitoring must include a description of the discharge point(s) and data or analysis supporting that the discharge point(s) are substantially similar as described in Schedule B.2.c.ii of this permit.

c. Procedures and Schedules -The SWPCP must contain the following information to meet the narrative technology-based effluent limits in Schedule A.1 of this permit:

i. Spill Prevention and Response - Procedures for preventing and responding to spills and clean-up and notification procedures. Indicate who is responsible for on-site management of significant materials and include their contact information. Spills prevention plans required by other regulations may be substituted for this provision if the spill prevention plan addresses stormwater management concerns and the plan is included with the SWPCP.

(1) Indicate how spill response will be coordinated between the permit registrant and otherwise unpermitted tenants. The permit registrant is ultimately responsible for spills of tenant and appropriate response.

ii. Preventative maintenance - Procedures for conducting inspections, maintenance and repairs to prevent leaks, spills, and other releases from drums, tanks and containers exposed to stormwater and the scheduled regular pickup and disposal of waste materials. Include the schedule or frequency for maintaining all control measures and waste collection.

iii. Operation and Maintenance Plans - Include an operation and maintenance plan for active treatment systems, such as electro-coagulation, chemical flocculation, or ion-exchange. The O&M plan must include, as appropriate to the type of treatment system, items such as system schematic, manufacturer's maintenance/operation specifications, chemical use, treatment volumes and a monitoring or inspection plan and frequency. For passive treatment and low impact development control measures, include routine maintenance standards.

iv. Employee Education - The elements of the training program must include the requirements in Schedule A.1.j. Include a description of the training content and the required frequency.

8. SWPCP Revisions

a. Permit registrants must prepare SWPCP revisions in compliance with Schedule A.6; and

b. SWPCP revisions must be submitted if they are made for any of the following reasons:

i. Change in site contact(s);

ii. In response to a corrective action or inspection;

iii. Changes to the site, operations or control measures that may significantly change the nature of pollutants present in stormwater discharge; or significantly increase the pollutant(s) levels, discharge frequency, discharge volume or flow rate; and
iv. Changes to the monitoring locations or discharge points.

c. If submission of SWPCP revisions is required, permit registrant must submit the revised pages of the SWPCP and site map if applicable, to DEQ or agent no later than 30 calendar days after the completion of modification.
d. Review of the revisions by DEQ or agent prior to implementation is not required, except revision to location of monitoring locations. The proposed revisions are deemed accepted after 30 calendar days of receipt unless the permit registrant receives a response from DEQ or agent.
e. DEQ or agent may require the permit registrant to revise the SWPCP at any time. The permit registrant must submit the revisions no later than 30 calendar days from the request date, unless DEQ or agent approved a later date.
f. SWPCP revisions are not subject to public notice and comment unless revisions are in response to water quality based effluent limit requirements in Schedule A.4 and A.5 of this permit.
g. For Tier II SWPCP submittal requirements, refer to Schedule A.11.

STORMWATER DISCHARGE BENCHMARKS

9. Benchmarks

Benchmarks and reference concentrations for impairment pollutants are guideline concentrations, not numeric effluent limits. A benchmark or reference concentration exceedance, therefore, is not a permit violation. Benchmark monitoring assist the permit registrant in determining whether site controls are effectively reducing pollutant concentrations in stormwater discharged from the site.

Permit registrants must monitor for the following applicable benchmarks at all discharge points. See Schedule E of this permit for sector-specific benchmarks that apply to certain industrial sectors and co-located industrial activities.

Table 4: Statewide Benchmarks

Parameter	Units	Columbia River	Columbia Slough	Portland Harbor	Regional
Total Copper	mg/L	0.020	0.020	0.020	0.020
Total Lead	mg/L	0.040	0.060	0.040	0.015
Total Zinc	mg/L	0.12	0.24	0.12	0.12
pH	SU	5.5 – 9.0	5.5 – 8.5	5.5 – 9.0	5.5 – 9.0
TSS	mg/L	100	30	30	100
Total Oil & Grease	mg/L	10	10	10	10
E. coli	counts/100 ml	406*	406	406*	406*
BOD5	mg/L	N/A	33	N/A	N/A
Total Phosphorus	mg/L	N/A	0.16	N/A	N/A

*The benchmark for E. coli applies only to active landfills and sewage treatment plants.
N/A: Not Applicable (no benchmark or required sampling for this parameter)

CORRECTIVE ACTIONS FOR IMPAIRMENT POLLUTANT AND BENCHMARK EXCEEDANCES

10. Tier I Corrective Action Response to Exceedances of Impairment Pollutants and Benchmarks:

a. If stormwater monitoring results exceed any of the applicable statewide benchmarks in Schedule A.9 of this permit, sector-specific benchmarks in Schedule E of this permit, or reference concentrations for impairment pollutants identified in the permit assignment letter, the permit registrant must, no later than 30 calendar days after receiving the monitoring results or visual observations show signs of pollution:

i. Investigate the cause of the elevated pollutant levels, including conducting, commencing or planning for any needed pollutant source tracing activities. Develop a plan to ensure that known or discovered significant materials from previous operations are controlled, removed or otherwise not exposed.

ii. Review the SWPCP and the selection, design, installation and implementation of control measures to ensure compliance with this permit and manufacturers' specifications. Evaluate whether any previous removal or pollutant source isolation actions are complete and whether additional removal or modifications to pollutant source isolation are necessary. Evaluate any treatment measures, including if they were properly installed, maintained and implemented and whether maintenance, corrections, or modifications to treatment measures are necessary.

iii. If permit registrant determines that additional control measures or other changes are necessary based on corrective action review, revise the SWPCP and submit the revised pages of the SWPCP to DEQ or agent, including a schedule for implementing the control measures.

iv. Tier I report - Summarize the following information in a Tier I report:

(1) The results of the investigation referred to in condition 10.a.i, above.

(2) Corrective actions taken or to be taken, including date corrective action completed or expected to be completed. Where the permit registrant determines that corrective action is not necessary, provide the basis for this determination.

(3) Document whether SWPCP revisions are necessary.

v. The Tier I report must be kept on site, and a copy provided to DEQ or agent upon request. In the event of an exceedance of a reference concentration for any impairment pollutant identified in the permit assignment letter, the Tier I report must be submitted to DEQ or agent no later than 60 calendar days after receiving monitoring results.

b. Implement corrective actions before the next storm event, if possible, or no later than 30 calendar days after receiving the monitoring results, whichever comes first. If permit registrant fails to complete the corrective action within this time frame, the reasoning should be documented in the Tier 1 Report, and corrective actions must be completed as soon as practicable.

c. Permit registrants are exempt from the Tier I investigation and reporting requirements for exceedances of benchmark parameter(s) addressed by proposed Tier II corrective action requirements in Schedule A.11. The exemption applies from the end of second monitoring year through the Tier II implementation deadline only. Tier I investigation and reporting must resume once Tier II is implemented.

11. Tier II Corrective Action Response based on second year Geometric Mean Benchmark Evaluation:

a. Permit registrants must evaluate the sampling results collected during the second monitoring year of permit coverage and determine if the geometric mean of the qualifying samples collected at each monitored discharge point exceeds any applicable statewide benchmarks in Schedule A.9 of this permit. DEQ or agent will identify in the permit assignment letter the registrant's Tier II evaluation year. The permit registrant must report the geometric mean of qualifying samples in the 4th quarter Discharge Monitoring Report due on August 15 of the second monitoring year of permit coverage. Permit registrants are not required to conduct this evaluation for the benchmark parameter(s) for which DEQ or agent has granted a monitoring waiver in accordance with Schedule B.4 of this permit.

b. For the pH benchmark, Tier II corrective action requirements are triggered if 50 percent or more of qualifying samples during the first two monitoring years of permit coverage are outside of the pH benchmark range.

c. For permit registrants that received new coverage under a previous industrial stormwater general permit (that is, the 1200-COLS, 1200-COLSB or 1200-Z) on or after July 1, 2016, time spent covered under the previous permit is included in determining the second year of permit coverage and other Tier II deadlines.

d. The permit registrant must use all qualifying samples to calculate the geometric mean.

e. If fewer than four qualifying samples were collected during the second monitoring year of permit coverage, qualifying sample results from the previous monitoring year may be used to obtain four consecutive values for the Tier II calculation.

f. If the geometric mean of the qualifying sampling results for any monitored discharge point exceeds any applicable statewide benchmark in Schedule A.9 of this permit (or if 50 percent or more of any pH sampling results for any monitored discharge point are outside of the pH benchmark range), permit registrant must submit a Tier II report, a Tier II mass reduction waiver request, or a Tier II natural background waiver request, along with associated revisions of the SWPCP, to DEQ or agent no later than December 31 of the third year of permit coverage, unless a later date is approved in writing by DEQ or agent. DEQ or agent will notify permit registrant within 60 calendar days of receipt if the Tier II corrective action response is accepted or denied.

g. Tier II corrective action(s) or mass reduction action(s) must be installed and implemented no later than June 30 of the fourth monitoring year, unless DEQ or agent approved a later date in writing. If the permit registrant changes the specifics of the corrective actions before implementation, revisions must be submitted and accepted by DEQ or agent before implementation. Corrective action revisions do not change the implementation deadline.

h. No later than 30 calendar days from implementing all Tier II corrective actions or mass reduction measures, the permit registrant must submit written confirmation to DEQ or agent with the date Tier II corrective action response was implemented in accordance with the revised approved SWPCP.

i. Properly apply and size approved Tier II corrective action responses and mass reduction measures to all substantially similar discharge points.

j. <u>Tier II Report</u>

   i. The Tier II report must include a proposal for active or passive treatment. This may include a combination of source removal, control and treatment measures, with the goal of achieving

the benchmark(s) in Schedule A.9 of this permit. The report must include the rationale for the selection of the control and treatment measures, the projected reduction of pollutant concentration(s) and the schedule for implementing these measures.

ii. An Oregon registered professional engineer (PE) must design and stamp the portion of the SWPCP that addresses these control measures.

iii. At discharge points where Tier II has been implemented:
   (1) Permit registrants must take Tier I corrective actions in accordance with A.10.
   (2) Monitoring must resume at substantially similar discharge points.
   (3) Permit registrants may request a monitoring waiver if the geometric mean of four consecutive qualifying samples is equal to or below the benchmark.

k. Tier II Mass Reduction Waiver

i. A permit registrant may request a mass reduction waiver from the requirements in Schedule A.11.j above if the permit registrant implements or has implemented volume reduction measures, such as low impact development practices, that will or has resulted in reductions of the mass load of pollutants in the discharge below the mass equivalent of the applicable statewide benchmarks in Schedule A.9 of this permit.

ii. The mass reduction waiver request and the revised SWPCP must include data and analysis to support the rationale for the mass load reduction selection. Include in the waiver request a description of the measure(s), and a mass load analysis, and expected implementation date(s).

iii. An Oregon Professional Engineer (PE) or Oregon certified engineering geologist (CEG) must design and stamp the portion of the SWPCP that addresses the mass reduction measures.

iv. At discharge points at which a Tier II mass reduction waiver has been implemented:
   (1) Permit registrants must take Tier I corrective actions in accordance with A.10.
   (2) Monitoring must resume at substantially similar discharge points.
   (3) Permit registrants may request a monitoring waiver if the geometric mean of four consecutive qualifying samples is equal to or below the benchmark.

l. Tier II Natural Background Waiver

i. A permit registrant may request a natural background waiver from the requirements in Schedule A.11.j above if the benchmark exceedance(s) is attributed solely to the presence of the pollutant(s) in natural background and is not associated with industrial activities at the site (see Schedule D.3, Definitions). The Tier II natural background waiver request must include the investigation and analysis used to demonstrate that the exceedances are due only to natural background conditions and data collected by the permit registrant or others (including peer-reviewed literature studies) that describe the levels of natural background pollutants in the discharge.

12. Permit Compliance

a. Any noncompliance with any of the requirements of this permit constitutes a violation of the Clean Water Act.

b. Any corrective actions and time periods specified for remedying noncompliance with the permit do not absolve permit registrants of the initial underlying violations.

c. Where corrective action is triggered by an event that does not itself constitute a violation, such as a benchmark exceedance, there is no permit violation associated with the trigger event provided that the permit registrant takes the corrective action within the deadlines identified in this permit.

d. A new permit registrant with a new facility (that begins operation after August 1, 2017) or an existing facility (that was in operation before August 1, 2017, without a stormwater discharge permit) must implement stormwater control measures to meet new technology and water quality based requirements in Schedule A.1 – A.5, including applicable sector-specific requirements in Schedule E of this permit, no later than 90 calendar days after receiving permit coverage. Control measures that require capital improvements must be completed no later than two years after receiving permit coverage, unless DEQ or agent approved a later date.

13. Corrective Action Triggers

The permit contains many types of corrective action triggers: statewide benchmarks, sector-specific benchmarks, numeric effluent limits and impairment reference concentrations. The numeric value of the corrective action trigger for a particular pollutant is often different for different types of triggers. For a particular facility, multiple corrective action triggers may apply for a particular pollutant. When exceeding multiple applicable corrective action triggers, the permit registrant must follow the corrective actions for each trigger.

SCHEDULE B

MONITORING REQUIREMENTS

1. Pollutant Parameters

a. Benchmarks - Permit registrants must monitor for the applicable statewide benchmark pollutants identified in Schedule A.9 of this permit. Permit registrants must also monitor for benchmarks specified for applicable industrial sector(s) identified in Schedule E, for both primary industrial activity and any co-located industrial activities.

b. Impairment Pollutants

i. Permit registrants that discharge to impaired waterbodies, based on the EPA-approved 303(d) list (Category 5) that is in effect as of May 1, 2017, (see Schedule D.3, Definitions) for pollutant(s), must monitor for impairment pollutant(s) identified in the permit assignment letter for which a standard analytical method exists (see 40 CFR Part 136).

ii. Before granting coverage under this permit, DEQ or agent will identify in the permit assignment letter the impairment pollutants that the permit registrant is required to monitor and reference concentrations for these pollutants. Reference concentrations reflect the approved acute aquatic life criterion for the pollutant when applicable. If there is not an acute criterion for the pollutant, DEQ or agent will use an applicable chronic criterion. If there is not a chronic criterion for the pollutant, DEQ or agent will use an applicable human health criterion.

(1) If the pollutant for which the waterbody is impaired is suspended solids, turbidity or sediment/sedimentation, permit registrants must monitor for Total Suspended Solids (TSS).

(2) If the pollutant for which the waterbody is impaired is expressed in the form of an indicator or surrogate pollutant, permit registrants must monitor for that indicator or surrogate pollutant.

(3) No monitoring is required when a waterbody's impairment is due to one of the following:

(A) Biological communities and no pollutant, including indicator or surrogate pollutants, is specified as causing the impairment; or
(B) Temperature, hydrologic modifications, or impaired hydrology.

iii. Permit registrants must meet Schedule B.1.b.i. unless the permit registrant:
(1) Prevents all pollutants for which the waterbody is impaired from being exposed to stormwater, and documents in the SWPCP those procedures it has taken to prevent exposure on site; or
(2) Provides monitoring data demonstrating that the pollutant(s) for which the waterbody is impaired are not present in the discharge.

c. Numeric Effluent limits pursuant to Federal Effluent Limit Guidelines - Permit registrants subject to effluent limit guidelines must monitor for the parameters in Schedule A.2 of this permit at each discharge point containing the discharges from industrial activities identified in the guidelines and report the monitoring results in the Discharge Monitoring Report required by Schedule B.8.

d. Multiple Requirements - When more than one type of monitoring for the same pollutant at the same discharge point applies, the permit registrant may use a single sample to satisfy both monitoring requirements. Permit registrant must complete corrective action and reporting requirement for each parameter.

2. Sampling Procedures

a. Grab Sampling
i. For each discharge point monitored, collect a single grab sample of stormwater discharge or a series of composite samples.
ii. Composite samples may be used as an alternative to grab sampling, except when monitoring for pH, oil and grease and E. coli. Composited samples must be collected from same storm event. Registrants may not switch between grab sampling to composite sampling during a monitoring year without DEQ or agent approval.
iii. Permit registrants may use a single grab sample or composite to satisfy multiple pollutant parameter monitoring requirements (for example, required to monitor for zinc as benchmark and impairment pollutant).

b. Representative Sample
i. Samples must be representative of the discharge.
ii. Monitoring locations must be identified in the SWPCP.
iii. Stormwater discharges regulated by this permit include stormwater run-on that commingles with stormwater discharges associated with industrial activity.
iv. If discharges authorized by this permit commingle with discharges authorized under a separate NPDES permit, any required sampling of the authorized discharges must be performed at a point before they mix with other waste streams, to the extent practicable. When combined flows are unavoidable, sampling must include all permitted parameters.
v. Authorized non-stormwater discharges under condition 8 of this permit must be sampled when commingled with stormwater discharges associated with industrial activity.
vi. Stormwater flows may combine into a common on-site treatment facility.
vii. The permit registrant shall, to the extent practicable, sample stormwater associated with industrial activity as it flows off-site before it combines with stormwater, wastewater or other waste streams from another facility or mixes with any surface water.

c. Multiple Discharges - Each discharge point must be monitored unless:

i. Discharge point serves an area without exposure of stormwater to industrial activities; or
ii. Discharge point has effluent that is substantially similar to the effluent(s) of a monitored discharge point and the same BMPs are implemented and maintained at the substantially similar discharge points or drainage areas that lead to the discharge points. Substantially similar effluent(s) are discharges from drainage areas serving comparable activities where the discharges are expected to be similar in composition. The determination of substantial similarity of effluent(s) must be based on past monitoring data or an analysis supporting that the discharge points are substantially similar. The supporting data or analysis must be included in the SWPCP. This provision does not apply to discharge point(s) covered by a numeric effluent limit.

d. Timing - Monitor the discharge during the first 12 hours of the discharge event, which is a storm event or snowmelt resulting in an actual discharge from a site. If it is not practicable to collect the sample within this period, collect the sample as soon as practicable and provide documentation with the Discharge Monitoring Report why it was not practicable to take samples within the period. Permit registrant is not required to sample outside of regular business hours of operation or during unsafe conditions.
e. Sampling for pH - Approved methods for pH sampling require either measuring the pH directly in the flow, or analyzing the sample within 15 minutes of sample collection.
   i. Obtain accurate pH readings with a properly calibrated pH meter.
   ii. Permit registrant must follow manufacturers' specifications and keep meter in good working order.
   iii. pH paper may not be used for determining the precise parameters established in this permit.
f. Monitoring Frequency - Permit registrants must monitor their stormwater discharge according to the frequency described in Table 5 below unless DEQ or agent grant a monitoring waiver in writing or approve a monitoring variance.
   i. Stormwater samples must be collected at least 14 calendar days apart.
   ii. Permit registrant may collect more samples than the minimum frequency described below, but must report this additional data in the Discharge Monitoring Report. All qualifying samples must be included to establish a monitoring waiver in Schedule B.4 or to conduct the geometric mean evaluation in Schedule A.11 of this permit.
   iii. Exceedance of Numeric Effluent Limit in Schedule A.2 of this permit – Permit registrants must conduct follow-up monitoring of any pollutant that exceeds the numeric effluent limit(s) no later than 30 calendar days (or during the next storm event should none occur within 30 calendar days) of receiving the monitoring results. If the follow-up monitoring exceeds the numeric effluent limit, the permit registrant must monitor the discharge four times per year until compliance with the numeric effluent limit is achieved. Once monitoring achieves the effluent limit value, semi-annual frequency may resume.

Table 5: Monitoring Frequency

Pollutant Category	Minimum Frequency
All applicable statewide benchmarks in Schedule A.9, any applicable sector-specific benchmarks in Schedule E and any applicable impairment pollutants	Four times per year, two samples between January 1 and June 30, and two samples between July 1 and December 31
Any applicable numeric effluent limitations based upon Effluent Limitation Guidelines (see Schedule A.2. and Schedule E)	Two times per year, One sample between January 1 and June 30, and one sample between July 1 and December 31

3. Monitoring Variance

a. Permit registrants may request a monitoring variance for missed samples due to no storm events of sufficient magnitude to produce run-off during regular business hours of operation and safe conditions. For each missed sample, variance requests are due on February 15 and August 15. Report no discharge in the Discharge Monitoring Report and include supporting data and analysis demonstrating why the monitoring did not occur at the time of DMR submission. If DEQ or agent has evidence contradicting the permit registrant's no discharge claim, failure to complete the required monitoring may be a permit violation. Supporting data may include:
   i. State or federal authorities declared the year a drought year.
   ii. Demonstration that rainfall in the area where the permit registrant's facility is located was 20 percent or more below the three-year average rainfall for that area.
   iii. Photo documentation, rain gauge data, detention basin storage volumes, storm infiltration rate or retention capacity.

4. Monitoring Waiver for Benchmark and Impairment Pollutant Monitoring

a. A monitoring waiver may be requested from DEQ or agent in the following circumstances:
   i. When the benchmark or impairment reference concentration has been achieved, as demonstrated by:
      (1) The geometric mean of four consecutive qualifying samples is equal to or below the impairment reference concentration, applicable statewide or sector-specific benchmarks.
      (2) pH results are within the range for four consecutive qualifying readings.
      (3) For Tier II parameters and discharge points once the corrective action has been implemented, and the geometric mean of four consecutive qualifying samples is equal to or below the applicable statewide benchmark, or pH results are within the range for four consecutive readings.
   ii. If the exceedance(s) is attributed solely to the presence of the pollutant(s) in natural background and is not associated with industrial activities at the site. Permit registrant may submit a natural background waiver report to DEQ or agent that describes the investigation and analysis to demonstrate that the exceedances are due to natural background conditions and includes any data collected by the permit registrant or others (including peer-review literature studies) that describe the levels of natural background pollutants in the discharge.

iii. If a facility is inactive and unstaffed and no industrial materials or activities are exposed to stormwater, the permit registrant is not required to conduct monitoring for the remainder of the permit term.
(1) Permit registrant must provide documentation with the Discharge Monitoring Report indicating that the site is inactive and unstaffed, and that there are no industrial materials or activities exposed to stormwater, in accordance with the substantive requirements in 40 CFR 122.26(g)(4)(iii).
(2) Sign and certify the statement in accordance with D8 in Schedule F of this permit.

b. The permit registrant's request must include documentation to support the request. Monitoring waivers may be allowed for individual parameters and separate discharge points.
c. If the facility has triggered Tier II during this permit term, permit registrants are ineligible for monitoring waivers at all discharge points and parameters that exceeded the geometric mean in Schedule A.11. The ineligibility applies to the end of second monitoring year through Tier II implementation date.
d. DEQ or agent will notify the permit registrant in writing if a monitoring waiver is approved or denied. Until written approval of the monitoring waiver is received, the permit registrant must continue monitoring.
e. Monitoring waivers are valid for the remainder of the permit term. Upon renewal into a subsequent permit, permit registrants must reinstate all monitoring, and re-establish the basis for all monitoring waivers.
f. There is no reduction in monitoring allowed for:
i. Visual observations, unless the site is inactive or unstaffed and there are no industrial materials or activities exposed to stormwater and permit registrant meets requirements in Schedule B.4.a.iii of this permit.
ii. Monitoring for federal numeric effluent limit guidelines.
g. Reinstatement of Monitoring
i. It is the responsibility of the permit registrant to reinstate discharge monitoring under the following circumstances or if notified by DEQ or agent:
(1) Prior monitoring used to establish the monitoring waiver was improper or sampling results were incorrect;
(2) Changes to site conditions are likely to affect stormwater discharge characteristics, such as change in SIC code, process change or increased pollutants sources exposed to stormwater;
(3) Additional monitoring occurs and the sampling results exceed benchmark(s) or impairment reference concentration(s); or
(4) For inactive or unstaffed sites, the facility becomes active or staffed, or industrial materials or activities become exposed to stormwater.
h. Revocation of Monitoring Waiver
DEQ or agent may revoke the monitoring waiver based on any of the above conditions or in response to an inspection or corrective action. In this event, DEQ or agent will notify the permit registrant in writing that the monitoring waiver is revoked.

5. Additional Monitoring- DEQ may notify permit registrants in writing of additional discharge monitoring requirements. Any such notice will state the reasons for the monitoring, locations and

pollutants to be monitored, frequency and period of monitoring, sample types and reporting requirements.

6. **For new permit registrants discharging to Clackamas River, McKenzie River above Hayden Bridge (River Mile 15), North Santiam River or North Fork Smith River subbasin** under OAR 340-041-0350 (For potential or existing dischargers that did not have a permit prior to January 28, 1994, and existing dischargers that have a NPDES stormwater discharge permit but request an increased load limitation.)
   a. No later than 180 calendar days after obtaining permit coverage, permit registrant must submit to DEQ a monitoring and water quality evaluation program. This program must be effective in evaluating the in-stream impacts of the discharge as required by OAR 340-041-0350.
   b. No later than 30 calendar days from DEQ approval, the permit registrant must implement the monitoring and water quality evaluation program.

INSPECTIONS

7. **Permit registrant must meet the following monthly inspection requirements:**
   a. Inspect areas where industrial materials or activities are exposed to stormwater and areas where stormwater control measures, structures, catch basins, and treatment facilities are located. Inspections must include all discharge points and the following areas:
      i. Industrial materials, residue, or trash that may have or could come into contact with stormwater;
      ii. Leaks or spills from industrial equipment, drums, tanks, and other containers;
      iii. Offsite and internal tracking of industrial or waste materials, or sediment where vehicles enter or exit the site;
      iv. Tracking or blowing of raw, final, or waste materials that results in exposure of stormwater falling on the site;
      v. Evidence of, or the potential for, pollutants entering the drainage system;
      vi. Evidence of pollutants discharging to receiving waters at all discharge point(s);
      vii. Visual observation for the presence of floating, suspended or settleable solids, color, odor, foam, visible oil sheen, or other obvious indicators of pollution in the stormwater discharge at all discharge point(s), including discharge points that have been authorized to be substantially similar in accordance with Schedule B.2.c.ii; and
      viii. Stormwater control measures, including treatment, to ensure they are functioning properly.
   b. Conduct all inspections by personnel that have completed employee training and are familiar with aspects of the SWPCP.
   c. Conduct and document visual inspections at the site on a monthly basis when the facility is in operation. Visual observations above must be conducted during a discharge event if one occurs during the month, regardless whether the monthly site inspection has already occurred.
   d. For exceptionally large facilities where monthly inspections of all areas or visual observation at all substantially similar discharge points are infeasible, DEQ or agent may approve in writing a modified inspection frequency.
   e. Conduct visual observations during regular business hours of operation and safe conditions.

f. Document the following in an inspection report that is retained on-site and submitted to DEQ or agent upon request:
   i. The inspection date and time;
   ii. The name(s) of inspector(s);
   iii. Control measures and treatment facilities needing cleaning, replacement, maintenance, reconditioning or repair;
   iv. The condition of the drainage and conveyance system and need for maintenance;
   v. Previously unidentified sources of pollutants;
   vi. Stormwater discharge visual observations, a Tier I report is required if visual observation shows evidence of stormwater pollution as indicated condition Schedule B.7.a.vii.;
   vii. Nature of the discharge; whether snow or rain; and
   viii. Any corrective action, source control or maintenance taken or scheduled to remedy problems found.

REPORTING AND RECORDKEEPING REQUIREMENTS

8. Reporting Monitoring Data

a. Paper Submissions
   i. Permit registrant must submit all monitoring results required in this permit via DEQ-approved Discharge Monitoring Report (DMR) forms until directed by DEQ to do otherwise.
      (1) DMRs are due quarterly as outlined in Table 6 for samples taken during the preceding calendar quarter.
      (2) Reports must include laboratory results from the testing laboratory, including minimum detection level, Quality Assurance/Quality Control and analytical methods for the parameters analyzed.
      (3) Submit pH field notes and chain of custody.
      (4) Report non-detections as directed by DEQ. In calculating the geometric mean, use one-half of the detection level for non-detections.
      (5) Report all sample results from discharge points.
      (6) The permit registrant must sign and certify submittals of Discharge Monitoring Reports, any additional reports, and other information in accordance with the requirements of Section D8 within Schedule F of this permit.
   ii. Until directed by DEQ to begin electronic submission, paper DMR forms must be received by the due dates in Table 6, regardless of whether semi-annual monitoring has been satisfied in the 1st or 3rd quarter.
   iii. All monitoring results received between July 1, 2018, and December 31, 2018, must be reported in the 2nd quarter DMR, February 2019.
   iv. Permit registrant must report Tier II geometric mean benchmark evaluation on the 4th quarter DMR after the second monitoring year of permit coverage.

Table 6: DMR Submission Deadlines

Reporting Quarters	Months	DMR Due Dates
1st	July-September	November 15
2nd	October-December	February 15*
3rd	January-March	May 15
4th	April-June	August 15*

*Variance request may be submitted semi-annually as applicable

b. Electronic Submission
   i. Permit registrant must submit the sampling and analysis results and other required information of Schedule B in an electronic format to the initial recipient as specified below or as directed otherwise by DEQ as the NPDES regulatory authority in Oregon according to 40 CFR 127.
   ii. When directed by DEQ, the permit registrant must submit monitoring results and other information required by this permit on DEQ-approved web-based Discharge Monitoring Report forms including pre-approved attachments.
   iii. The permit registrant must report monitoring requirements listed in Schedule B of this permit via NetDMR when directed by DEQ. Submit laboratory results from the testing laboratory and other required reporting not entered on the NetDMR form via NetDMR as a separate attachment.
      (1) The permit registrant must submit a Discharge Monitoring Report to DEQ or agent as outlined in Table 6. Report the sampling results for the previous monitoring year and include the laboratory results from the testing laboratory, including minimum detection level, QA/QC and analytical methods for the parameters analyzed.
      (2) Submit pH field notes and chain of custody.
      (3) Report non-detections as directed by DEQ. In calculating the geometric mean, use one-half of the detection level for non-detections.
      (4) Report all sample results from discharge points.
      (5) The permit registrant must sign and certify submittals of Discharge Monitoring Reports, any additional reports, and other information in accordance with the requirements of Section D8 within Schedule F of this permit.
   iv. In accordance with 40 CFR 122.41(l)(9), DEQ will identify the initial recipient that is the designated entity for receiving electronic NPDES data. Until further notice from DEQ, EPA is the initial recipient to receive electronic submissions, and the permit registrant will use EPA's NetDMR for electronic reporting of Discharge Monitoring Report information. DEQ will notify the permit registrant in advance of changes to the initial recipient status and use of another electronic reporting system other than NetDMR.

9. Exceedance Report for Numeric Effluent Limits - If follow-up monitoring pursuant to Schedule B.2.f.iii of this permit exceeds a numeric effluent limit, permit registrant must submit an Exceedance

Report to DEQ or agent no later than 30 calendar days after receiving the monitoring results. The report must include the monitoring data from this monitoring event and the preceding monitoring event(s), an explanation of the situation, and what the permit registrant has done to correct the violation or intends to do if the corrective actions are not complete.

10. **Record Keeping Procedures -**Permit registrant must record and maintain at the facility the following information. All records must be retained by the permit registrant for at least three years and made available to DEQ, agent or local municipality upon request.
    a. A copy of the SWPCP and any revisions, including revised stamped SWPCP from Tier II corrective action;
    b. A copy of this permit;
    c. Permit assignment letter and coverage documents from DEQ for the current permit term;
    d. Documentation of maintenance and repairs of control measures and treatment systems;
    e. Tier I reports;
    f. All inspection reports;
    g. Documentation of any benchmark exceedance and corrective action taken;
    h. All copies of any reports or corrective action submitted to DEQ or agent;
    i. Spills or leaks of significant materials (See Schedule D.3, Definitions) that impacted or had the potential to impact stormwater or surface waters. Include the corrective actions to clean up the spill or leak as well as measures to prevent future problems of the same nature;
    j. Documentation to support your claim that your facility has changed its status from active to inactive and unstaffed with respect to the requirements to conduct routine facility inspections;
    k. Discharge Monitoring Reports, laboratory reports and field sampling notes; and
    l. Employee education materials and records of training.

11. Summary of Reporting Requirements and Submittal Date.

Table 7: Reporting

Permit Condition	Permit Schedule	Report Required	Due Date
Must not cause or contribute to a violation of instream water quality standard	Schedule A.4	Water Quality Standards Corrective Action Report	No later than 30 calendar days after receiving monitoring results
SWPCP submission	Schedule A.8	SWPCP revision	No later than 30 calendar days after the completion of modification
Sample results exceed applicable statewide or sector-specific benchmarks	Schedule A.10	Tier I Report*	No later than 30 calendar days after receiving monitoring results; Retain on-site and submit upon request
Sample results exceed applicable impairment reference concentrations	Schedule A.10.a.v	Tier I report	No later than 60 calendar days after receiving monitoring results
Second year geometric mean exceeds benchmarks	Schedule A.11	Tier II Report Tier II Mass Reduction Waiver Tier II Natural Background Waiver	No later than December 31 of third monitoring year of coverage
Written confirmation of Tier II implementation	Schedule A.11	Email or letter confirming Tier II proposal installation	No later than 30 calendar days of implementation
Sample results continue to exceed benchmark for Tier II parameters post implementation	Schedule A.11.j.iii	Tier I Report*	No later than 30 calendar days after receiving monitoring results; Retain on-site and submit upon request
Sample results exceed numeric effluent limits	Schedule B.9	Exceedance Report	No later than 30 calendar days after receiving monitoring results
Submission of monitoring results after the preceding calendar quarter	Schedule B.8	Discharge Monitoring Report	No later than February 15, May 15, August 15, and November 15

***Do not submit Tier I report for exceedance of statewide or sector-specific benchmarks unless requested by DEQ or agent**

SCHEDULE D

SPECIAL CONDITIONS

1. **Releases in Excess of Reportable Quantities.** This permit does not relieve the permit registrant of the reporting requirements of 40 CFR §117 Determination of Reportable Quantities for Hazardous Substances and 40 CFR §302 Designation, Reportable Quantities, and Notification.

2. **Availability of SWPCP and Monitoring Data.** The Stormwater Pollution Control Plan and stormwater monitoring data must be made available to government agencies responsible for stormwater management in the permit registrant's area.

3. **Definitions**
   For the purpose of this permit:
   a. Arid areas means portion of the state where annual precipitation averages range from 0 to 10 inches.
   b. Capital Improvements means the following improvements that require capital expenditures:
      i. Removal or permanent isolation from exposure to stormwater of significant materials left from previous activities on the site.
      ii. Treatment best management practices including to settling basins, oil/water separation equipment, grassy swales, detention/retention basins, and media filtration devices.
      iii. Manufacturing modifications that incur capital expenditures, including process changes for reduction of pollutants or wastes at the source.
      iv. Concrete pads, dikes and conveyance or pumping systems utilized for collection and transfer of stormwater to treatment systems.
      v. Roofs and appropriate covers for manufacturing areas.
      vi. Volume reduction measures, including low impact development control measures.
   c. Best management practices ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of "waters of the United States." BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. See 40 CFR 122.2.
   d. Co-located Industrial Activities means any industrial activities, excluding the primary industrial activity(ies), located on-site that are defined by the stormwater regulations at 122.26(b)(14)(i - ix, xi) and identified in Table 1: Sources Covered of the permit. An activity at a facility is not considered co-located if the activity, when considered separately, does not meet the description of a category of industrial activity covered by the stormwater regulations or identified in Table 1.
   e. Columbia Slough means the waterway in northern Multnomah County flowing roughly parallel to the Columbia River between Fairview Lake and the Willamette River. *Confirm discharges to Columbia Slough by contacting the cities of Portland or Gresham.*
   f. Control Measure means any Best Management Practice or other method used to prevent or reduce the discharge of pollutants to waters of the state.

g. Discharge Point means the location where collected and concentrated stormwater flows discharge from the facility such that the first receiving waterbody into which the discharge flows, either directly or through a separate storm sewer system, is a waters of the state.
h. Existing Discharger means an operator applying for coverage under this permit for discharges authorized previously under an NPDES general or individual permit.
i. Feasible means technologically possible and economically practicable and achievable in light of best industry practices.
j. Hazardous Substances is defined in 40 CFR §302 Designation, Reportable Quantities, and Notification.
k. High Quality Waters means those waters that meet or exceed levels that are necessary to support the propagation of fish, shellfish, and wildlife; recreation in and on the water; and other designated beneficial. Waters identified on the 303(d) (Category 5) list as not meeting applicable state water quality standards for a given pollutant are not high quality waters.
l. Impaired Waters means those waters identified by a State or EPA pursuant to Section 303(d) (Category 5) of the Clean Water Act as not meeting applicable State water quality standards for one or more pollutants. This may include both waters with approved TMDLs (Category 4), and those for which a TMDL has not yet been approved.
m. Industrial Activity means the categories of industrial activities included in the definition of "stormwater discharges associated with industrial activity" as defined in 40 CFR 122.26(b)(14)(i)-(ix) and (xi) or activities identified by DEQ as a significant contributor of pollutants, such as Table 2.
n. Industrial Stormwater means stormwater discharge associated with industrial activity (40 CFR 122.26(b)(14)).
o. Material Handling Activities include the storage, loading and unloading, transportation or conveyance of raw material, intermediate product, finished product, by-product or waste product.
p. Minimize means reduce or eliminate, or both, to the extent achievable using control measures (including best management practices) that are technologically available and economically practicable and achievable in light of best industry practice.
q. Monitoring year is from July 1 of one year to June 30 of the following year (for example, the 2017/2018 monitoring year is from July 1, 2017, through June 30, 2018).
r. Natural background pollutants include substances that are naturally occurring in soils or groundwater. Natural background pollutants do not include legacy pollutants from earlier activity on the site, or pollutants in run-on from neighboring sources that are not naturally occurring.
s. New Discharger means a facility from which there is or may be a discharge, that did not commence the discharge of pollutants at a particular site prior to August 13, 1979, which is not a new source, and which has never received a finally effective NPDES permit for discharges at that site. See 40 CFR 122.2.
t. New Source means any building, structure, facility, or installation from which there is or may be a "discharge of pollutants," the construction of which commenced: after promulgation of standards of performance under section 306 of the CWA which are applicable to such source, or after proposal of standards of performance in accordance with section 306 of the CWA which are applicable to such source, but only if the standards are promulgated in accordance with section 306 within 120 days of their proposal. See 40 CFR 122.2.

u. No Exposure means all industrial materials or activities are protected by a storm-resistant shelter to prevent exposure to rain, snow, snowmelt, and/or runoff. See 40 CFR 122.26(g).
v. Operator means any entity with a stormwater discharge associated with industrial activity that meets either of the following two criteria:
    i. The entity has operational control over industrial activities, including the ability to modify those activities; or
    ii. The entity has day-to-day operational control of activities at a facility necessary to ensure compliance with this permit (e.g., the entity is authorized to direct workers at a facility to carry out activities required by this permit).
w. Outstanding Resource Waters means those waters designated by the Environmental Quality Commission where existing high quality waters constitute an outstanding state or national resource based on their extraordinary water quality or ecological values or where special water quality protection is needed to maintain critical habitat areas.
x. Permit Assignment Letter means a document sent by DEQ when coverage is granted or renewed that establishes registrant's monitoring year, sampling requirements, pollutant concentrations and monitoring frequency based on applicants' site information. Monitoring parameters include applicable statewide benchmarks, sector-specific benchmarks (primary and co-located), impairment reference concentrations and numeric effluent limits. This document may contain additional site-specific requirements.
y. Portland Harbor means the study area of EPA's Portland Harbor Superfund site located in the Lower Willamette River from approximately river mile 1.9 to 11.8.
z. Primary industrial activity means any activities performed on-site that are (1) identified by the facility's primary SIC code; or (2) included in the narrative descriptions of 122.26(b)(14)(i), (iv), (v), or (vii), and (ix). Narrative descriptions in 40 CFR 122.26(b)(14) identified above include: (i) activities subject to stormwater effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards; (iv) hazardous waste treatment storage, or disposal facilities including those that are operating under interim status or a permit under subtitle C of the Resource Conservation and Recovery Act (RCRA); (v) landfills, land application-sites and open dumps that receive or have received industrial wastes; (vii) steam electric power generating facilities; and (ix) sewage treatment works with a design flow of 1.0 mgd or more.
aa. Qualifying samples are samples that are collected at least 14 calendar days apart, are analyzed using approved methods (see Schedule F), and satisfy the Quality Assurance/Quality Control requirements of the method.
bb. Regular business hours of operation means those time frames when the facility is engaged in its primary production process, with personnel that have completed the required SWPCP training.
cc. Run-on sources of stormwater means stormwater that drains from land located upslope or upstream from the regulated facility.
dd. Semi-arid areas means where annual rainfall averages range from 10 to 20 inches.
ee. Significant Materials includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical that a facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ash, slag, and sludge that have the potential to be released with stormwater discharges.

ff. Stormwater means stormwater runoff, snow melt runoff and surface runoff drainage. See 40 CFR 122.26(b)(13).

gg. Stormwater associated with industrial activity (40 CFR 122.26(b)(14)), means the discharge from any conveyance that is used for collecting and conveying stormwater and that is directly related to:

i. Industrial plant yards;
ii. Immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility;
iii. Material handling sites (Material handling activities include the storage, loading and unloading, transportation or conveyance of raw material, intermediate product, finished product, by-product or waste product.);
iv. Refuse sites;
v. Sites used for the application or disposal of process waste waters (as defined in 40 CFR part401);
vi. Sites used for storage or maintenance of material handling equipment;
vii. Sites used for residual treatment, storage, or disposal; shipping and receiving areas;
viii. Manufacturing buildings;
ix. Storage areas (including tank farms) for raw materials, and intermediate and finished products;
x. Areas where industrial activity has taken place in the past and significant materials remain and are exposed to stormwater. Significant materials include, but are not limited to: raw materials storage; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical that a facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ash, slag, and sludge that have the potential to be released with stormwater discharges; or
xi. Stormwater run-on that commingles with stormwater discharges associated with industrial activity at the facility.
xii. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with stormwater drained from the above described areas.

hh. Stormwater Conveyance means a sewer, ditch, or swale that is designed to carry stormwater; a stormwater conveyance may also be referred to as a storm drain or storm sewer.

ii. Total Maximum Daily Load (TMDL) is the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint sources and background. See OAR 340-041-0002(65) and OAR 340-042-0030(15).

jj. Treatment Measures mean Best Management Practices that are intended to remove pollutants from stormwater. These measures include: settling basins, oil/water separation equipment, detention/retention basins, media filtration devices, electrocoagulation, constructed wetlands and bioswales.

kk. Wasteload Allocation (WLA) means the portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation. See OAR 340-041-0002(67).

4. Local Public Agencies Acting as DEQ's Agent

DEQ has authorized certain local governments and special districts to act as its agent in implementing portions of this permit. The agent conducts the following activities, including: application and SWPCP review, inspections, monitoring data review, stormwater and wastewater monitoring, and verification and approval of no-exposure certifications. Where DEQ has entered into such an agreement, DEQ or agent will notify the permit registrant of where to submit no-exposure certifications, and other notifications or correspondence associated with this permit.

5. Terminating Permit Coverage

a. Registrants must meet one or more of the following conditions:
   i. Cease all industrial operations and stormwater discharge associated with industrial activity as defined in 40 CFR 122.26(b)(14);
   ii. Obtain NPDES coverage under an individual permit;
   iii. A new owner or operator legally acquires responsibility of property or industrial activity;
   iv. Conditions for termination under sector G and H have been met.

b. To terminate permit coverage, registrants must:
   i. Complete and submit a Notice of Termination to DEQ or agent for approval.
   ii. Resolve all outstanding compliance issues.

c. Until termination has been approved by DEQ, permit registrants must comply with all permit conditions.

SCHEDULE E

SECTOR-SPECIFIC REQUIREMENTS

1. Permit registrants must meet the sector-specific requirements in Schedule E associated with their primary industrial activity and any co-located industrial activities, as defined in Schedule D of this permit. The sector-specific requirements apply to the areas of the facility where the sector-specific activities occur.
2. These sector-specific requirements in Schedule E are in addition to the requirements in Schedule A and B of this permit.
3. Samples may qualify for one or more monitoring requirement; however, corrective action is based on each exceedance.
4. Table E-1 below identifies SIC codes and activities descriptions that are required to meet the sector-specific requirements in Schedule E of the permit.

Table E-1. Sectors of Industrial Activity with Description

SIC Code or Activity Code	Activity Represented
SECTOR A: TIMBER PRODUCTS	
2421	General Sawmills and Planing Mills
2411	Logging
2426	Hardwood Dimension and Flooring Mills
2429	Special Product Sawmills, Not Elsewhere Classified
2431-2439 (except 2434, see Sector W)	Millwork, Veneer, Plywood, and Structural Wood
2448	Wood Pallets and Skids
2449	Wood Containers, Not Elsewhere Classified
2451, 2452	Wood Buildings and Mobile Homes
2491	Wood Preserving
2493	Reconstituted Wood Products
2499	Wood Products, Not Elsewhere Classified
2441	Nailed and Lock Corner Wood Boxes and Shook
SECTOR B: PAPER AND ALLIED PRODUCTS	
2631	Paperboard Mills
2611	Pulp Mills
2621	Paper Mills
2652-2657	Paperboard Containers and Boxes
2671-2679	Converted Paper and Paperboard Products, Except Containers and Boxes

Table E-1. Sectors of Industrial Activity with Description

SIC Code or Activity Code	Activity Represented
SECTOR C: CHEMICALS AND ALLIED PRODUCTS MANUFACTURING AND REFINING	
2873-2879 (excluding 2874)	Agricultural Chemicals
2812-2819	Industrial Inorganic Chemicals
2841-2844	Soaps, Detergents, and Cleaning Preparations; Perfumes, Cosmetics, and Other Toilet Preparations
2821-2824	Plastics Materials and Synthetic Resins, Synthetic Rubber, Cellulosic and Other Manmade Fibers Except Glass
2833-2836	Medicinal Chemicals and Botanical Products; Pharmaceutical Preparations; in vitro and in vivo Diagnostic Substances; and Biological Products, Except Diagnostic Substances
2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products
2861-2869	Industrial Organic Chemicals
2891-2899	Miscellaneous Chemical Products
3952 (limited to list of inks and paints)	Inks and Paints, Including China Painting Enamels, India Ink, Drawing Ink, Platinum Paints for Burnt Wood or Leather Work, Paints for China Painting, Artist's Paints and Artist's Watercolors
2911	Petroleum Refining
SECTOR D: PETROLEUM REFINING AND RELATED INDUSTRIES **Asphalt Paving Mixtures and Blocks, Primary SIC code 2951, Covered by 1200-A General Permit**	
2951 (co-located SIC code only), 2952	Asphalt Paving and Roofing Materials
2992, 2999	Miscellaneous Products of Petroleum and Coal
SECTOR E: GLASS, CLAY, CEMENT, CONCRETE, AND GYPSUM PRODUCTS **Ready-Mixed Concrete, Primary SIC code 3273, Covered by 1200-A General Permit**	
3251-3259	Structural Clay Products
3261-3269	Pottery and Related Products
3271-3275 (3273 co-located SIC code only)	Concrete, Gypsum and Plaster Products
3211	Flat Glass
3221, 3229	Glass and Glassware, Pressed or Blown
3231	Glass Products Made of Purchased Glass
3241	Hydraulic Cement
3281	Cut Stone and Stone Products
3291-3299	Abrasive, Asbestos, and Miscellaneous Nonmetallic Mineral Products
SECTOR F: PRIMARY METALS	
3312-3317	Steel Works, Blast Furnaces, and Rolling and Finishing Mills
3321-3325	Iron and Steel Foundries

Table E-1. Sectors of Industrial Activity with Description

SIC Code or Activity Code	Activity Represented
3351-3357	Rolling, Drawing, and Extruding of Nonferrous Metals
3363-3369	Nonferrous Foundries (Castings)
3331-3339	Primary Smelting and Refining of Nonferrous Metals
3341	Secondary Smelting and Refining of Nonferrous Metals
3398, 3399	Miscellaneous Primary Metal Products
SECTOR G: METAL MINING (ORE MINING AND DRESSING)	
1021	Copper Ore and Mining Dressing Facilities
1011	Iron Ores
1021	Copper Ores
1031	Lead and Zinc Ores
1041, 1044	Gold and Silver Ores
1061	Ferroalloy Ores, Except Vanadium
1081	Metal Mining Services
1094, 1099	Miscellaneous Metal Ores
SECTOR H: COAL MINES AND COAL MINING-RELATED FACILITIES	
1221-1241	Coal Mines and Coal Mining-Related Facilities
SECTOR I: OIL AND GAS EXTRACTION AND REFINING	
1311	Crude Petroleum and Natural Gas
1321	Natural Gas Liquids
1381-1389	Oil and Gas Field Services
SECTOR J: MINERAL MINING AND DRESSING- Discharges Covered by 1200-A General Permit	
SECTOR K: HAZARDOUS WASTE TREATMENT, STORAGE, OR DISPOSAL FACILITIES	
HZ	Hazardous Waste Treatment, Storage, or Disposal Facilities: • Hazardous waste storage • Hazardous waste disposal • Hazardous waste facilities operating under interim status • Hazardous waste facilities operating under a permit under Subtitle C of RCRA HZ is the Activity Code for this Sector. It potentially applies to any facility regardless of SIC, in addition to these specifically related to hazardous waste: • SIC 4953 Refuse Systems (hazardous waste treatment and disposal)
SECTOR L: LANDFILLS, LAND APPLICATION SITES, AND OPEN DUMPS	

Table E-1. Sectors of Industrial Activity with Description

SIC Code or Activity Code	Activity Represented
LF	All Landfill, Land Application Sites and Open Dumps
LF	All Landfill, Land Application Sites and Open Dumps, except Municipal Solid Waste Landfill (MSWLF) Areas Closed in Accordance with 40 CFR 258.60
SECTOR M: MOTOR VEHICLE PARTS, USED	
5015	Automobile Salvage Yards
SECTOR N: SCRAP AND WASTE MATERIALS	
5093	Scrap Recycling and Waste Recycling Facilities except Source-Separated Recycling
5093	Source-separated Recycling Facility
SECTOR O: STEAM ELECTRIC GENERATING FACILITIES	
SE	Steam Electric Generating Facilities, including coal handling sites: • steam electric power generation using coal, including coal handling areas • steam electric power generation using natural gas • steam electric power generation using oil • steam electric power generation using nuclear energy • steam electric power generation using any other fuel to produce a steam source • coal pile runoff (includes effluent limitations established by 40 CFR 423) • dual fuel co-generation (i.e., steam generation using fossil fuel to augment a heat-capture generation system) SE is the Activity Code for this Sector. It may apply to any facility SIC Code, in addition to these specifically related to steam electric generation: • SIC 4911 Electric Services (fossil fuel power generation, nuclear electric power generation & other electric power generation)
SECTOR P: LAND TRANSPORTATION AND WAREHOUSING	
4011, 4013	Railroad Transportation
4111-4173	Local and Highway Passenger Transportation
4212-4215	Trucking and Courier Services, Except Air
4226, 4231	Special Warehousing and Storage, Not Otherwise Classified, Terminal and Joint Terminal Maintenance Facilities for Motor Freight Transportation
4311	United States Postal Service
5171	Petroleum Bulk Stations and Terminals

Table E-1. Sectors of Industrial Activity with Description

SIC Code or Activity Code	Activity Represented
SECTOR Q: WATER TRANSPORTATION	
4412-4499	Water Transportation Facilities
SECTOR R: SHIP AND BOAT BUILDING AND REPAIRING YARDS	
3731, 3732	Ship and Boat Building or Repairing Yards
SECTOR S: AIR TRANSPORTATION FACILITIES	
4512-4581	Air Transportation Facilities
SECTOR T: TREATMENT WORKS	
TW	Treatment Works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR Part 403.
SECTOR U: FOOD AND KINDRED PRODUCTS	
2041-2048	Grain Mill Products
2074-2079	Fats and Oils Products
2011-2015	Meat Products
2021-2026	Dairy Products
2032-2038	Canned, Frozen, and Preserved Fruits, Vegetables, and Food Specialties
2051-2053	Bakery Products
2061-2068	Sugar and Confectionery Products
2082-2087	Beverages
2091-2099	Miscellaneous Food Preparations and Kindred Products
2111-2141	Tobacco Products
SECTOR V: TEXTILE MILLS, APPAREL, AND OTHER FABRIC PRODUCT MANUFACTURING; LEATHER AND LEATHER PRODUCTS	
2211-2299	Textile Mill Products
2311-2399	Apparel and Other Finished Products Made from Fabrics and Similar Materials
3131-3199	Leather and Leather Products (note: see Sector Z1 for Leather Tanning and Finishing)
SECTOR W: FURNITURE AND FIXTURES	

Table E-1. Sectors of Industrial Activity with Description

SIC Code or Activity Code	Activity Represented
2434	Wood Kitchen Cabinet and countertop Manufacturing
2511-2519	Household Furniture
2521, 2522	Office Furniture
2531	Public Building and Related Furniture
2541, 2542	Partitions, Shelving, Lockers, and Office and Store Fixtures
2591, 2599	Miscellaneous Furniture and Fixtures
SECTOR X: PRINTING AND PUBLISHING	
2711-2796	Printing, Publishing, and Allied Industries
SECTOR Y: RUBBER, MISCELLANEOUS PLASTIC PRODUCTS, AND MISCELLANEOUS MANUFACTURING INDUSTRIES	
3011	Tires and Inner Tubes
3021	Rubber and Plastics Footwear
3052, 3053	Gaskets, Packing and Sealing Devices, and Rubber and Plastic Hoses and Belting
3061, 3069	Fabricated Rubber Products, Not Elsewhere Classified
3081-3089	Miscellaneous Plastics Products
3931	Musical Instruments
3942-3949	Dolls, Toys, Games, and Sporting and Athletic Goods
3951-3955 (except 3952 – see Sector C)	Pens, Pencils, and Other Artists' Materials
3961, 3965	Costume Jewelry, Costume Novelties, Buttons, and Miscellaneous Notions, Except Precious Metal
3991-3999	Miscellaneous Manufacturing Industries
SECTOR Z: LEATHER TANNING AND FINISHING	
3111	Leather Tanning and Finishing
SECTOR AA: FABRICATED METAL PRODUCTS	
3411-3499 (except 3479)	Fabricated Metal Products, Except Machinery and Transportation Equipment, and Coating, Engraving, and Allied Services.
3911-3915	Jewelry, Silverware, and Plated Ware
3479	Fabricated Metal Coating and Engraving
SECTOR AB: TRANSPORTATION EQUIPMENT, INDUSTRIAL OR COMMERCIAL MACHINERY	
3511-3537	Engines and Turbines, Farm and Garden Machinery and Equipment, Construction, Mining and Materials Handling Machinery and Equipment
3541-3549	Metalworking Machinery and Equipment

Table E-1. Sectors of Industrial Activity with Description

SIC Code or Activity Code	Activity Represented
3552-3559	Special Industry Machinery, Except Metalworking Machinery
3561-3569	General Industrial Machinery and Equipment
3581-3599	Refrigeration and Service Industry Machinery, Miscellaneous Industrial and Commercial Machinery and Equipment
3711-3716	Motor Vehicles and Motor Vehicle Equipment
3721-3751	Aircraft and Parts, Ship and Boat Building and Repairing, Railroad Equipment, Motorcycles, Bicycles and Parts
3761-3799	Guided Missiles and Space Vehicles and Parts, Miscellaneous Transportation Equipment
SECTOR AC: ELECTRONIC, ELECTRICAL, PHOTOGRAPHIC AND OPTICAL GOODS ***No Sector-specific requirements***	
3571-3579	Computer and Office Equipment
3612-3699	Electronic and Other Electrical Equipment and Components, Except Computer Equipment
3812-3829	Measuring, Analyzing, Optical and Controlling Instruments
3841-3861	Photographic, Medical and Optical Goods
3873	Watches and Clocks

Sector A – Timber Products.
Additional Technology-Based Effluent Limits

E.A.1 *Good Housekeeping*. In areas where storage, loading and unloading, and material handling occur, perform good housekeeping to limit the discharge of wood debris, minimize the leachate generated from decaying wood materials, and minimize the generation of dust.

E.A.2 Additional SWPCP Requirements

E.A.2.1 *Drainage Area Site Map*. Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: processing areas, treatment chemical storage areas, treated wood and residue storage areas, wet decking areas, dry decking areas, untreated wood and residue storage areas, and treatment equipment storage areas.

E.A.2.2 *Inventory of Exposed Materials*. Where such information exists, if your facility has used chlorophenolic, creosote, or chromium-copper-arsenic formulations for wood surface protection or preserving, document in your SWPCP the following: areas where contaminated soils, treatment equipment, and stored materials still remain and the management practices employed to minimize the contact of these materials with stormwater runoff.

E.A.2.3 *Description of Stormwater Management Controls*. Document measures implemented to address the following activities and sources: log, lumber, and wood product storage areas; residue storage areas; loading and unloading areas; material handling areas; chemical storage areas; and equipment and vehicle maintenance, storage, and repair areas. If your facility performs wood surface protection and preservation activities, address the specific control measures, including any BMPs, for these activities.

E.A.3 Additional Inspection Requirements.

E.A.3.1. If your facility is a wood preserving facility under SIC 2491, inspect processing areas, transport areas, and treated wood storage areas monthly to assess the usefulness of practices to minimize the deposit of treatment chemicals on unprotected soils and in areas that will come in contact with stormwater discharges.

E.A.4 Sector-Specific Benchmarks

Table E.A-1 identifies benchmarks that apply to the specific subsectors of Sector A. These benchmarks apply to both your primary industrial activity and any co-located industrial activities, which describe your site activities.

Table E.A-1

Subsector (You may be subject to requirements for more than one sector/subsector)	**Parameter**	**Benchmark Monitoring Concentration**
General Sawmills and Planing Mills (SIC 2421)	Chemical Oxygen Demand (COD)	120.0 mg/L
Hardwood Dimension and Flooring Mills; Special Products Sawmills, not elsewhere classified; Millwork, Veneer, Plywood, and Structural Wood; Wood Pallets and Skids; Wood Containers, not elsewhere classified; Wood Buildings and Mobile Homes; Reconstituted Wood Products; and Wood Products Facilities not elsewhere classified (SIC 2426, 2429, 2431-2439 (except 2434), 2441, 2448, 2449, 2451, 2452, 2493, and 2499)	Chemical Oxygen Demand (COD)	120.0 mg/L
Wood Preserving (SIC 2491)	Total Arsenic	0.15 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector B – Paper and Allied Products

E.B.1 Sector-Specific Benchmarks

Table E.B-1 identifies benchmarks that apply to the specific subsectors of Sector B. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.B-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	**Parameter**	**Benchmark Monitoring Concentration**
Paperboard Mills (SIC Code 2631)	Chemical Oxygen Demand (COD)	120 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector C – Chemical and Allied Products Manufacturing, and Refining

E.C.1 Sector-Specific Benchmarks

Table E.C-1 identifies benchmarks that apply to the specific subsectors of Sector C. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.C-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Agricultural Chemicals (SIC 2873-2879, excluding 2874)	Nitrate plus Nitrite Nitrogen	0.68 mg/L
	Total Iron	1.0 mg/L
	Phosphorus	2.0 mg/L
Industrial Inorganic Chemicals (SIC 2812-2819)	Total Aluminum	0.75 mg/ L
	Total Iron	1.0 mg/L
	Nitrate plus Nitrite Nitrogen	0.68 mg/L
Soaps, Detergents, Cosmetics, and Perfumes (SIC 2841-2844)	Nitrate plus Nitrite Nitrogen	0.68 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector D – Petroleum Refining and Related Industries

E.D.1 Limitation of Coverage

Asphalt Paving Mixtures and Blocks, Primary SIC code 2951, must apply for coverage under the 1200-A General Permit.

E.D.2 Effluent Limitations Based on Effluent Limitations Guidelines

Table E.D-1 identifies effluent limits that apply to the industrial activities described below. Compliance with these effluent limits is to be determined based on discharges from these industrial activities independent of commingling with any other wastestreams that may be covered under this permit.

Table E.D-1[1]

Industrial Activity	Parameter	Effluent Limit
Discharges from asphalt emulsion facilities. **Co-located SIC code only.**	Total Suspended Solids (TSS)	23.0 mg/L, daily maximum
		15.0 mg/L, 30-day avg.
	pH	6.0 - 9.0 s.u.
	Oil and Grease	15.0 mg/L, daily maximum
		10 mg/L, 30-day avg.

[1]Monitor semi-annually.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector E – Glass, Clay, Cement, Concrete, and Gypsum Products

E.E.1 Limitations of coverage

Ready-Mixed Concrete, primary SIC code 3273, must apply for coverage under the 1200-A General Permit.

E.E.2 Additional Technology-Based Effluent Limits

E.E.2.1 *Good Housekeeping Measures*. With good housekeeping, prevent or minimize the discharge of spilled cement, aggregate (including sand or gravel), kiln dust, fly ash, settled dust, or other significant material in stormwater from paved portions of the site that are exposed to stormwater. Consider sweeping regularly or using other equivalent measures to minimize the presence of these materials. Indicate in your SWPCP the frequency of sweeping or equivalent measures. Determine the frequency based on the amount of industrial activity occurring in the area and the frequency of precipitation, but it must be performed at least once a week if cement, aggregate, kiln dust, fly ash, or settled dust are being handled or processed. You must also prevent the exposure of fine granular solids (cement, fly ash, kiln dust, etc.) to stormwater, where practicable, by storing these materials in enclosed silos, hoppers, or buildings, or under other covering.

E.E.3 Additional SWPCP Requirements

E.E.3.1 *Drainage Area Site Map*. Document in the SWPCP the locations of the following, as applicable: bag house or other dust control device; recycle/sedimentation pond, clarifier, or other device used for the treatment of process wastewater; and the areas that drain to the treatment device.

E.E.3.1 *Discharge Testing*. For facilities producing ready-mix concrete, concrete block, brick, or similar products, include in the non-stormwater discharge testing a description of measures that ensure that process wastewaters resulting from washing trucks, mixers, transport buckets, forms, or other equipment are discharged in accordance with NPDES wastewater permit requirements or are recycled.

E.E.4 Sector-Specific Benchmarks

Table E.E-1 identifies benchmarks that apply to the specific subsectors of Sector E. These benchmarks apply to both your primary industrial activity and any co-located industrial activities, which describe your site activities.

Table E.E-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	**Parameter**	**Benchmark Monitoring Concentration**
Clay Product Manufacturers (SIC 3251-3259, 3261-3269)	Total Aluminum	0.75 mg/L
Concrete and Gypsum Manufacturers (SIC 3271-3275) **3273: co-located SIC code only.**	Total Iron	1.0 mg/L

E.E.5 Effluent Limitations Based on Effluent Limitations Guidelines

Table E.E-2 identifies effluent limits that apply to the industrial activities described below. Compliance with these limits is to be determined based on discharges from these industrial activities independent of commingling with any other wastestreams that may be covered under this permit.

Table E.E-2[1]

Industrial Activity	Parameter	Effluent Limit
Discharges from material storage piles at cement manufacturing facilities(3241)	Total Suspended Solids (TSS)	50 mg/L, daily maximum
	pH	6.0 - 9.0 s.u.
[1]Monitor semi-annually.		

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector F – Primary Metal

E.F.1 Additional Technology-Based Effluent Limits

E.F.1.1 *Good Housekeeping Measures*. As part of your good housekeeping program, include a cleaning and maintenance program for all impervious areas of the facility where particulate matter, dust, or debris may accumulate, especially areas where material loading and unloading, storage, handling, and processing occur; and, where practicable, the paving of areas where vehicle traffic or material storage occur but where vegetative or other stabilization methods are not practicable (institute a sweeping program in these areas too). For unstabilized areas where sweeping is not practicable, consider using stormwater management devices such as sediment traps, vegetative buffer strips, filter fabric fence, sediment filtering boom, gravel outlet protection, or other equivalent measures that effectively trap or remove sediment.

E.F.2 Additional SWPCP Requirements

E.F.2.1 *Drainage Area Site Map*. Identify in the SWPCP where any of the following activities may be exposed to precipitation or surface runoff: storage or disposal of wastes such as spent solvents and baths, sand, slag and dross; liquid storage tanks and drums; processing areas including pollution control equipment (e.g., baghouses); and storage areas of raw material such as coal, coke, scrap, sand, fluxes, refractories, or metal in any form. In addition, indicate where an accumulation of significant amounts of particulate matter could occur from such sources as furnace or oven emissions, losses from coal and coke handling operations, etc., and could result in a discharge of pollutants to waters of the United States.

E.F.2.2 *Inventory of Exposed Material*. Include in the inventory of materials handled at the site that potentially may be exposed to precipitation or runoff, areas where deposition of particulate matter from process air emissions or losses during material-handling activities are possible.

E.F.3 Additional Inspection Requirements

As part of conducting your monthly inspections address all potential sources of pollutants, including (if applicable) air pollution control equipment (e.g., baghouses, electrostatic precipitators, scrubbers, and cyclones), for any signs of degradation (e.g., leaks, corrosion, or improper operation) that could limit their efficiency and lead to excessive emissions. Consider monitoring air flow at inlets and outlets (or use equivalent measures) to check for leaks (e.g., particulate deposition) or blockage in ducts. Also inspect all process and material handling equipment (e.g., conveyors, cranes, and vehicles) for leaks, drips, or the potential loss of material; and material storage areas (e.g., piles, bins, or hoppers for storing coke, coal, scrap, or slag, as well as chemicals stored in tanks and drums) for signs of material losses due to wind or stormwater runoff.

E.F.4 Sector-Specific Benchmarks

Table E.F-1 identifies benchmarks that apply to the specific subsectors of Sector F. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.F-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Cutoff Concentration
Steel Works, Blast Furnaces, and Rolling and Finishing Mills (SIC 3312-3317)	Total Aluminum	0.75 mg/L
Iron and Steel Foundries (SIC 3321-3325)	Total Aluminum	0.75 mg/L
	Total Iron	1.0 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector G – Metal Mining

E.G.1 Covered Stormwater Discharges

The requirements in Sector G apply to stormwater discharges associated with industrial activity from Metal Mining facilities, including mines abandoned on Federal lands, as identified by the SIC Codes specified under types of industrial sources required to obtain coverage, Table 1. Coverage is required for metal mining facilities that discharge stormwater contaminated by contact with, or that has come into contact with, any overburden, raw material, intermediate product, finished product, byproduct, or waste product located on the site of the operation.

E.G.1.1 *Covered Discharges from Inactive Facilities.* All stormwater discharges.

E.G.1.2 *Covered Discharges from Active and Temporarily Inactive Facilities*. Only the stormwater discharges from the following areas are covered:

- Waste rock and overburden piles if composed entirely of stormwater and not combined with mine drainage;
- Topsoil piles;
- Offsite haul and access roads;
- Onsite haul and access roads constructed of waste rock, overburden or spent ore if composed entirely of stormwater and not combining with mine drainage;
- Onsite haul and access roads not constructed of waste rock, overburden or spent ore except if mine drainage is used for dust control;
- Runoff from tailings dams or dikes when not constructed of waste rock or tailings and no process fluids are present;
- Runoff from tailings dams or dikes when constructed of waste rock or tailings and no process fluids are present, if composed entirely of stormwater and not combining with mine drainage;
- Concentration building if no contact with material piles;
- Mill site if no contact with material piles;
- Office or administrative building and housing if mixed with stormwater from industrial area;
- Chemical storage area;
- Docking facility if no excessive contact with waste product that would otherwise constitute mine drainage;
- Explosive storage;
- Fuel storage;
- Vehicle and equipment maintenance area and building;
- Parking areas (if necessary);
- Power plant;
- Truck wash areas if no excessive contact with waste product that would otherwise constitute mine drainage;
- Unreclaimed, disturbed areas outside of active mining area;
- Reclaimed areas released from reclamation requirements prior to December 17, 1990;
- Partially or inadequately reclaimed areas or areas not released from reclamation requirements.

E.G.1.3 *Covered Discharges from Earth-Disturbing Activities Conducted Prior to Active Mining Activities*. All stormwater discharges.

E.G.1.4 *Covered Discharges from Facilities Undergoing Reclamation*. All stormwater discharges.

E.G.2 Limitations on Coverage

E.G.2.1 *Prohibition of Stormwater Discharges.* Stormwater discharges not authorized by this permit: discharges from active metal mining facilities that are subject to effluent limitation guidelines for the Ore Mining and Dressing Point Source Category (40 CFR Part 440).
Note: Stormwater runoff from these sources are subject to 40 CFR Part 440 if they are mixed with other discharges subject to Part 440. In this case, they are not eligible for coverage under this permit. Discharges from overburden/waste rock and overburden/waste rock-related areas are not subject to 40 CFR Part 440 unless they: (1) drain naturally (or are intentionally diverted) to a point source; and (2) combine with "mine drainage" that is otherwise regulated under the Part 440 regulations. For such sources, coverage under this permit would be available if the discharge composed entirely of stormwater does not combine with other sources of mine drainage that are not subject to 40 CFR Part 440. Operators bear the initial responsibility for determining if they are eligible for coverage under this permit, or must seek coverage under another NPDES permit.

E.G.2.2 *Prohibition of Non-Stormwater Discharges*. Not authorized by this permit: adit drainage, and contaminated springs or seeps discharging from waste rock dumps that do not directly result from precipitation events.

E.G.3 Definitions

The following definitions are not intended to supersede the definitions of active and inactive mining facilities established by 40 CFR 122.26(b)(14)(iii).

E.G.3.1 *Mining operation* – For this permit, mining operations are grouped into two distinct categories, with distinct technology based effluent limits and requirements applicable to each: a) earth-disturbing activities conducted prior to active mining activities); and b) active mining activities, which includes reclamation. "Mining operations" can occur at both inactive mining facilities and temporarily inactive mining facilities.

E.G.3.2 *Earth-disturbing activities conducted prior to active mining activities* – Consists of two classes of earth-disturbing (i.e., clearing, grading and excavation) activities:
a. activities performed for purposes of mine site preparation, including: cutting new rights of way (except when related to access road construction); providing access to a mine site for vehicles and equipment (except when related to access road construction); other earth disturbances associated with site preparation activities on any areas where active mining activities have not yet commenced (e.g., for heap leach pads, waste rock facilities, tailings impoundments, wastewater treatment plants); and
b. construction of staging areas to prepare for erecting structures such as to house project personnel and equipment, mill buildings, etc., and construction of access roads. Earth-disturbing activities associated with the construction of staging areas and the construction of access roads conducted prior to active mining are considered to be "construction" and have additional technology based effluent limits in E.G.4.2.

E.G.3.3 *Active mining activities* – Activities related to the extraction, removal or recovery, and benefication of metal ore from the earth; removal of overburden and waste rock to expose mineable minerals; and site reclamation and closure activities. All such activities occur within

the "active mining area." Reclamation involves activities undertaken, in compliance with applicable mined land reclamation requirements, to return the land to an appropriate post-mining contour and land use in order to meet applicable federal and state reclamation requirements. In addition, once earth-disturbing activities conducted prior to active mining activities have ceased and all related requirements in E.G.4 have been met, and a well-delineated "active mining area" has been established, all activities (including any clearing, grading, and excavation) that occur within the active mining area are "active mining activities."

E.G.3.4 *Active mining area* – A place where work or other activity related to the extraction, removal or recovery of metal ore is being conducted, except, with respect to surface mines, any area of land on or in which grading has been completed to return the earth to desired contour and reclamation work has begun.
Note: Earth-disturbing activities described in the definition in E.G.3.2 that occur on areas outside the active mining area (e.g., for expansion of the mine into undeveloped territory) are considered "earth-disturbing conducted prior to active mining activities", and must comply with the requirements in E.G.4

E.G.3.5 *Inactive metal mining facility* – A site or portion of a site where metal mining and/or milling occurred in the past but there are no active mining activities occurring as defined above, and where the inactive portion is not covered by an active mining permit issued by the applicable state or federal agency. An inactive metal mining facility has an identifiable owner / operator. Sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation, or processing of mined materials and sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim are not considered either active or inactive mining facilities and do not require an NPDES industrial stormwater permit.

E.G.3.6 *Temporarily inactive metal mining facility* – A site or portion of a site where metal mining and/or milling occurred in the past but currently are not being actively undertaken, and the facility is covered by an active mining permit issued by the applicable State or Federal agency.

E.G.4 Requirements Applicable to Earth-Disturbing Activities Conducted Prior to Active Mining Activities

Stormwater discharges from earth-disturbing activities conducted prior to active mining activities (defined in E.G.3.3) are covered under this permit. For such earth-disturbing activities, permit registrants do not need to comply the technology-based effluent limits or Schedule B, monitoring or inspection frequency in Schedule B or E.G.5, E.G.7 or E.G.8.

Authorized discharges from areas where earth-disturbing activities have ceased and stabilization as specified in E.G.4.1.9 or E.G.4.2.11, where appropriate, has been completed (stabilization is not required for areas where active mining activities will occur), are no longer subject to E.G.4 requirements. At such time, authorized discharges become subject to all other applicable requirements in the permit, including not need to comply the technology-based effluent limits or Schedule B, monitoring or inspection frequency in Schedule B and Sector E.G.5, E.G.7 and E.G.8.

E.G.4.1 *Technology-Based Effluent Limits Applicable to All Earth-Disturbing Activities Conducted Prior to Active Mining Activities*. The following technology-based effluent limits apply to authorized discharges from all earth-disturbing activities conducted prior to active mining activities defined in E.G.3. These limits supersede the technology-based limits listed in Schedule A.

E.G.4.1.1 *Erosion and sediment control installation requirements*.

- By the time construction activities commence, install and make operational downgradient sediment controls, unless this timeframe is infeasible. If infeasible

you must install and make such controls operational as soon as practicable or as soon as site conditions permit.

- All other stormwater controls described in the SWPCP must be installed and made operational as soon as conditions on each portion of the site allows.

E.G.4.1.2 *Erosion and sediment control maintenance requirements*. You must:

- Ensure that all erosion and sediment controls remain in effective operating condition.
- Wherever you determine that a stormwater control needs maintenance to continue operating effectively, initiate efforts to fix the problem immediately after its discovery, and complete such work by the end of the next work day.
- When a stormwater control must be replaced or significantly repaired, complete the work within 7 days, unless infeasible. If 7 days is infeasible, you must complete the installation or repair as soon practicable.

E.G.4.1.3 *Perimeter controls*. You must:

- Install sediment controls along those perimeter areas of your disturbed area that will receive stormwater, except where site conditions prevent the use of such controls (in which case, maximize their installation to the extent practicable).
- Remove sediment before it accumulates to one-half of the above-ground height of any perimeter control.

E.G.4.1.4 *Sediment track-out*. For construction vehicles and equipment exiting the site directly onto paved roads, you must:

- Install sediment controls along those perimeter areas of your disturbed area that will receive stormwater, except where site conditions prevent the use of such controls (in which case, maximize their installation to the extent practicable).
- Remove sediment before it accumulates to one-half of the above-ground height of any perimeter control.
- Note: DEQ recognizes that some fine grains may remain visible on the surfaces of off-site streets, other paved areas, and sidewalks even after you have implemented sediment removal practices. Such "staining" is not a violation of E.G.4.1.4.

E.G.4.1.5 *Soil or sediment stockpiles*. You must:

- Minimize erosion of stockpiles from stormwater and wind via temporary cover, if feasible.
- Prevent up-slope stormwater flows from causing erosion of stockpiles (e.g., by diverting flows around the stockpile).
- Minimize sediment from stormwater that runs off of stockpiles, using sediment controls (e.g., a sediment barrier or downslope sediment control).

E.G.4.1.6 *Sediment basins*. If you intend to install a sediment basin to treat stormwater from your earth-disturbing activities, you must:

- Provide storage for either (1) the 2-year, 24-hour storm, or (2) 3,600 cubic feet per acre drained.
- Prevent erosion of (1) basin embankments using stabilization controls (e.g., erosion control blankets), and (2) the inlet and outlet points of the basin using erosion controls and velocity dissipation devices.

E.G.4.1.7 *Minimize dust*. You must minimize the generation of dust through the appropriate application of water or other dust suppression techniques that minimize pollutants being discharged into surface waters.

E.G.4.1.8 *Restrictions on use of treatment chemicals*. If you intend to use sediment treatment chemicals at your site, you are subject to the following minimum requirements:

- Use conventional erosion and sediment controls prior to and after application of chemicals;
- Select chemicals suited to soil type, and expected turbidity, pH, flow rate;
- Minimize the discharge risk from stored chemicals;
- Comply with state/local requirements;
- Use chemicals in accordance with good engineering practices and specifications of chemical supplier;
- Ensure proper training;
- Provide proper SWPCP documentation.

If you plan to use cationic treatment chemicals, you are ineligible for coverage under this permit, unless you notify your applicable DEQ regional office or agent in advance and receive authorization under this permit after you have included appropriate controls and implementation procedures designed to ensure that your use of cationic treatment chemicals will not lead to a violation of water quality standards.

E.G.4.1.9 *Site stabilization requirements for earth-disturbing activities performed for purposes of mine site preparation as defined in E.G.3.2(a) (i.e., not applicable to construction of staging areas for structures and access roads as defined in E.G.3.2(b)).* You must comply with the following stabilization requirements except where the intended function of the site accounts for such disturbed earth (e.g., the earth disturbances will become actively mined, or the controls implemented at the active mining area effectively control the disturbance) (although you are encouraged to do so within the active mining area, where appropriate):

- *Temporary stabilization of disturbed areas*. Stabilization measures must be initiated immediately in portions of the site where earth-disturbing activities performed for purposes of mine site preparation (as defined in E.G.3.2(a)) have temporarily ceased, but in no case more than 14 days after such activities have temporarily ceased. In arid, semi-arid, and drought-stricken areas, or in areas subject to snow or freezing conditions, where initiating perennial vegetative stabilization measures is not possible within 14 days after earth-disturbing activities performed for purposes of mine site preparation has temporarily ceased, temporary vegetative stabilization measures must be initiated as soon as practicable. Until temporary vegetative stabilization is achieved, interim measures such as erosion control blankets with an appropriate seed base and tackifiers must be employed. In areas of the site where earth-disturbing activities performed for purposes of mine site preparation have permanently ceased prior to active mining, temporary stabilization measures must be implemented to minimize mobilization of sediment or other pollutants until active mining activities commence.
- *Final stabilization of disturbed areas*. Stabilization measures must be initiated immediately where earth-disturbing activities performed for purposes of mine site preparation (as defined in E.G.3.2(a)) have permanently ceased, but in no case more than 14 days after the earth-disturbing activities have permanently ceased. In arid, semi-arid, and drought-stricken areas, or in areas subject to snow or freezing conditions, where initiating perennial vegetative stabilization measures is not possible within 14 days after earth-disturbing activities have permanently ceased, final vegetative stabilization measures must be initiated as soon as possible. Until

final stabilization is achieved, temporary stabilization measures, such as erosion control blankets with an appropriate seed base and tackifiers, must be used.

E.G.4.2 *Additional Technology-Based Effluent Limits Applicable Only to the Construction of Staging Areas for Structures and Access Roads*. The following technology-based effluent limits apply to authorized discharges from earth-disturbing activities associated with the construction of staging areas and the construction of access roads, as defined in E.G.3.2(b). These limits supersede the technology-based limits listed in Schedule B and E.G.5 of this sector. These limits do not apply to earth-disturbing activities performed for purposes of mine site preparation (as defined in E.G.3.2(a)).

E.G.4.2.1 *Area of disturbance*. You must minimize the amount of soil exposed during construction activities.

E.G.4.2.2 *Erosion and sediment control design requirements*. You must:

- Design, install and maintain effective erosion and sediment controls to minimize the discharge of pollutants from earth-disturbing activities. Account for the following factors in designing your erosion and sediment controls:
  - The expected amount, frequency, intensity and duration of precipitation;
  - The nature of stormwater runoff and run-on at the site, including factors such as impervious surfaces, slopes and site drainage features;
  - The range of soil particle sizes expected to be present on the site.
- Direct discharges from your stormwater controls to vegetated areas of your site to increase sediment removal and maximize stormwater infiltration, including any natural buffers, unless infeasible. Use velocity dissipation devices if necessary to prevent erosion when directing stormwater to vegetated areas.
- If any stormwater flow becomes or will be channelized at your site, you must design erosion and sediment controls to control both peak flowrates and total stormwater volume to minimize channel and streambank erosion and scour in the immediate vicinity of discharge points.
- If you install stormwater conveyance channels, they must be designed to avoid unstabilized areas on the site and to reduce erosion, unless infeasible. In addition, you must minimize erosion of channels and their embankments, outlets, adjacent streambanks, slopes, and downstream waters during discharge conditions through the use of erosion controls and velocity dissipation devices within and along the length of any constructed stormwater conveyance channel, and at any outlet to provide a non-erosive flow velocity.

E.G.4.2.3 *Natural Buffers*. For any stormwater discharges from earth-disturbing activities within 50 feet of a water of the U.S., you must comply with one of the following compliance alternatives:

1. Maintain a 50-foot undisturbed natural buffer between earth-disturbing activities and the water of the U.S.; or
2. Provide an undisturbed natural buffer that is less than 50 feet, permit registrant must implement one or more of the BMPs listed below to control and treat sediment and turbidity:
   - Compost berms, compost blankets, or compost socks;
   - Erosion control mats;
   - Takifiers used in combination with perimeter sediment controls;

- Approved water treatment by electro-coagulation, flocculation, or filtration; and/or
- Other substantially equivalent sediment or turbidity control measures approved by DEQ or agent.

3. Ensure all discharges are treated by control measures prior to entering the natural buffer.
4. Delineate and clearly mark off all natural buffers.

There are exceptions when buffer requirements do not apply:

- The natural buffer has already been eliminated by preexisting development disturbances;
- The disturbance is for a water-dependent structure or earth-disturbing approved under a CWA section 404 permit.

E.G.4.2.4 *Soil or sediment stockpiles*. In addition to the requirements in E.G.4.1.5, you must locate any piles outside of any natural buffers established under E.G.4.2.3.

E.G.4.2.5 *Sediment basins*. In addition to the requirements in E.G.4.1.6, you must locate sediment basins outside of any surface waters and any natural buffers established under E.G.4.2.3, and you must utilize outlet structures that withdraw water from the surface, unless infeasible.

E.G.4.2.6 *Native topsoil preservation*. You must preserve native topsoil removed during clearing, grading, or excavation, unless infeasible. Store topsoil in a manner that will maximize its use in reclamation or final vegetative stabilization (e.g., by keeping the topsoil stabilized with seed or similar measures). This requirement does not apply if the intended function of the disturbed area dictates that topsoil be disturbed or removed.

E.G.4.2.7 *Steep slopes*. You must minimize the disturbance of steep slopes. The permit does not prevent or prohibit disturbance on steep slopes.

Depending on site conditions and needs, disturbance on steep slopes may be necessary (e.g., a road cut in mountainous terrain; for grading steep slopes prior to erecting the mine office). Where steep slope disturbances are necessary, you can minimize the disturbances to steep slopes through the implementation of a number of standard erosion and sediment control practices, such as by phasing disturbances in these areas and using stabilization practices specifically for steep grades.

E.G.4.2.8 *Soil compaction*. Where final vegetative stabilization will occur or where infiltration practices will be installed, you must either restrict vehicle/ equipment use in these areas to avoid soil compaction or use soil conditioning techniques to support vegetative growth. Minimizing soil compaction is not required where compacted soil is integral to the functionality of the site.

E.G.4.2.9 *Dewatering Practices*. You are prohibited from discharging ground water or accumulated stormwater that is removed from excavations, trenches, foundations, vaults or other similar points of accumulation, unless such waters are first effectively managed by appropriate controls (e.g., sediment basins or sediment traps, sediment socks, dewatering tanks, tube settlers, weir tanks, or filtration systems).

Uncontaminated, non-turbid dewatering water can be discharged without being routed to a control.

You must also meet the following requirements for dewatering activities:

- Discharge requirements:
  - No discharging visible floating solids or foam;

- Remove oil, grease and other pollutants from dewatering water via an oil-water separator or suitable filtration device (such as a cartridge filter);
- Utilize vegetated upland areas of the site, to the extent feasible, to infiltrate dewatering water before discharge. In no case shall waters of the U.S. be considered part of the treatment area;
- Implement velocity dissipation devices at all points where dewatering water is discharged;
- Haul backwash water away for disposal or return it to the beginning of the treatment process; and
- Clean or replace the filter media used in dewatering devices when the pressure differential equals or exceeds the manufacturers' specifications.

- Treatment chemical restrictions: If you use polymers, flocculants or other chemicals to treat dewatering water, you must comply with the requirements in E.G.4.1.8.

E.G.4.2.10 *Pollution prevention requirements*.

- Prohibited discharges:
  - Wastewater from washout of concrete;
  - Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds, and other materials;
  - Fuels, oils, or other pollutants used for operation and maintenance of vehicles or equipment;
  - Soaps, solvents, or detergents used in vehicle or equipment washing;
  - Toxic or hazardous substances from a spill or other release.
  - Design and location requirements: Minimize the discharge of pollutants from pollutant sources by:
- *Minimizing exposure*;
  - Using secondary containment, spill kits, or other equivalent measures;
  - Locating pollution sources away from surface waters, storm sewer inlets, and drainageways;
  - Cleaning up spills immediately (do not clean by hosing area down).
- *Pollution prevention requirements for wash waters*: Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters. Wash waters must be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge;
- *Pollution prevention requirements for the storage, handling, and disposal of construction products, materials, and wastes*: Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on the site to stormwater. Minimization of exposure is not required in cases where the exposure to stormwater will not result in a discharge of pollutants, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use).

E.G.4.2.11 *Site Stabilization requirements for the construction of staging areas for structures and access roads as defined in E.G.3.2(b) (i.e., not applicable to earth-disturbing activities performed for purposes of mine site preparation as defined in E.G.3.2(a)).* You must comply with the following stabilization requirements, except where the intended function of the site accounts for such disturbed earth (e.g., the area of

construction will become actively mined, or the controls implemented at the active mining area effectively control the disturbance):

- By no later than the end of the next work day after construction work in an area has stopped permanently or temporarily ("temporarily" means the land will be idle for a period of 14 days or more but earth-disturbing activities will resume in the future), immediately initiate stabilization measures;
- If using vegetative measures, by no later than 14 days after initiating stabilization:
  - Seed or plant the area, and provide temporary cover to protect the planted area;
  - Once established, vegetation must be uniform (evenly distributed without large bare areas) perennial vegetation, which provides 70 percent or more coverage based on density of native vegetation.
- If using non-vegetative stabilization, by no later than 14 days after initiating stabilization:
  - Install or apply all non-vegetative measures;
  - Cover all areas of exposed soil.

  Note: For the purposes of this permit, DEQ will consider any of the following types of activities to constitute the initiation of stabilization: 1. Prepping the soil for vegetative or non-vegetative stabilization; 2. Applying mulch or other non-vegetative product to the exposed area; 3. Seeding or planting the exposed area; 4. Starting any of the activities in #1 – 3 on a portion of the area to be stabilized, but not on the entire area; and 5. Finalizing arrangements to have stabilization product fully installed in compliance with the applicable deadline for completing stabilization.

Exceptions:

- Arid, semi-arid or drought-stricken areas:
  - Within 14 days of stopping construction work in an area, install any necessary non-vegetative stabilization measures;
  - Initiate vegetative stabilization as soon as conditions on the site allow;
  - Document the schedule that will be followed for initiating and completing vegetative stabilization;
  - Cover planted or seeded area with bio or photo degradable erosion controls designed to prevent erosion without active maintenance.
- Sites affected by severe storm events or other unforeseen circumstances:
  - Initiate vegetative stabilization as soon conditions on the site allow;
  - Document the schedule that will be followed for initiating and completing vegetative stabilization;
  - Add a suitable interim measures (such as mulch or bark) are in place if 70 percent coverage of vegetation is expected to expand.

E.G.4.3 *Water Quality-Based Requirements Applicable to Earth-Disturbing Activities Conducted Prior to Active Mining Activities.* The following water quality-based limits apply to earth-disturbing activities conducted prior to active mining activities defined in E.G.3.2(a) and E.G.3.2(b), in addition to the water quality-based limits in Schedule A.4 and Schedule A.5.

Stricter requirements apply if your site will discharge to an impaired waters that are listed for turbidity or sedimentation or have an EPA-approved TMDL for sedimentation or turbidity:

- More rapid stabilization of exposed areas: Complete initial stabilization activities within 7 days of stopping earth-disturbing work.

- More frequent site inspections: Once every 7 days and within 24 hours of a storm event of 0.25 inches or greater.

E.G.4.4 *Inspection Requirements Applicable to Earth-Disturbing Activities Conducted Prior to Active Mining Activities.* The following requirements supersede the inspection requirements in Schedule B and E.G.7 for earth-disturbing activities conducted prior to active mining activities defined in E.G.3.2(a) and E.G.3.2(b).

E.G.4.4.1 *Inspection frequency*

- At least once every 7 calendar days, or
- Once every 14 calendar days and within 24 hours of a storm event of 0.25 inches or greater.

Note:

- Inspections only required during working hours;
- Inspections not required during unsafe conditions; and
- If you choose to inspect once every 14 days, you must have a method for measuring rainfall amount on site (either rain gauge or representative weather station)

Note: To determine if a storm event of 0.25 inches or greater has occurred on your site, you must either keep a properly maintained rain gauge on your site, or obtain the storm event information from a weather station that is representative of your location. For any day of rainfall during normal business hours that measures 0.25 inches or greater, you must record the total rainfall measured for that day.

Note: You are required to specify in your SWPCP which schedule you will be following.

Note: "Within 24 hours of the occurrence of a storm event" means that you are required to conduct an inspection within 24 hours once a storm event has produced 0.25 inches, even if the storm event is still continuing. Thus, if you have elected to inspect bi-weekly and there is a storm event at your site that continues for multiple days, and each day of the storm produces 0.25 inches or more of rain, you are required to conduct an inspection within 24 hours of the first day of the storm and within 24 hours after the end of the storm.

E.G.4.4.2 *Reductions in inspection frequency*.

- Stabilized areas: You may reduce the frequency of inspections to once per month in any area of your site where stabilization has occurred pursuant to E.G.4.1.9 or E.G.4.2.11.
- Arid, semi-arid, and drought stricken areas: If earth-disturbing activities are occurring during the seasonally dry period or during a period in which drought is predicted to occur, you may reduce inspections to once per month and within 24 hours of a 0.25 inch storm event.
- Frozen conditions: You may temporarily suspend or reduce inspections to once per month until thawing conditions occur if frozen conditions are continuous and disturbed areas have been stabilized. For extreme conditions in remote areas, e.g., where transit to the site is perilous/restricted or temperatures are routinely below freezing, you may suspend inspections until the conditions are conducive to safe access, and more frequent inspections can resume.

E.G.4.4.3 *Areas to be inspected*. You must at a minimum inspect the all of the following areas:

- Disturbed areas;
- Stormwater controls and pollution prevention measures;

- Locations where stabilization measures have been implemented;
- Material, waste, borrow, or equipment storage and maintenance areas;
- Areas where stormwater flows;
- Points of discharge.

E.G.4.4.4 *What to check for during inspections*. At a minimum you must check:

- Whether all stormwater controls are installed, operational and working as intended;
- Whether any new or modified stormwater controls are needed;
- For conditions that could lead to a spill or leak;
- For visual signs of erosion/sedimentation at points of discharge.
- If a discharge is occurring, check:
- The quality and characteristics of the discharge;
- Whether controls are operating effectively.

E.G.4.4.5 *Inspection report*. Within 24 hours of an inspection, complete a report that includes:

- Inspection date;
- Name and title of inspector(s);
- Summary of inspection findings;
- Rainfall amount that triggered the inspection (if applicable);
- If it was unsafe to inspect a portion of the site, include documentation of the reason and the location(s);
- Each inspection report must be signed;
- Keep a current copy of all reports at the site or at an easily accessible location.

E.G.5 Technology-Based Effluent Limits for Active Mining Activities

Note: These requirements do not apply for any discharges from earth-disturbing activities conducted prior to active mining as defined in E.G.3.2(a) or E.G.3.2(b).

E.G.5.1 *Employee training*. (See also Schedule A.1.j) Conduct employee training at least annually at active and temporarily inactive facilities.

E.G.5.2 *Stormwater controls.* Apart from the control measures you implement to meet Schedule A technology-based effluent limits, where necessary to minimize pollutant discharges in stormwater, implement the following control measures at your site. The potential pollutants identified in E.G.6.3 shall determine the priority and appropriateness of the control measures selected. For mines subject to dust control requirements under DEQ or county air quality permits, provided the requirements are equivalent, compliance with such air permit dust requirements shall constitute compliance with the dust control effluent limit in Schedule A.1.f.

Stormwater diversions: Divert stormwater away from potential pollutant sources through implementation of control measures such as the following, where determined to be feasible including: interceptor or diversion controls (e.g., dikes, swales, curbs, berms); pipe slope drains; subsurface drains; conveyance systems (e.g., channels or gutters, open-top box culverts, and waterbars; rolling dips and road sloping; roadway surface water deflector and culverts); or their equivalents.

Capping: When capping is necessary to minimize pollutant discharges in stormwater, identify the source being capped and the material used to construct the cap.

Treatment: If treatment of stormwater (e.g., chemical or physical systems, oil - water separators, artificial wetlands) is necessary to protect water quality, describe the type and location of treatment used. Passive and/or active treatment of stormwater runoff is encouraged, where feasible. Treated runoff may be discharged as a stormwater source regulated under this permit

provided the discharge is not combined with discharges subject to effluent limitation guidelines for the Ore Mining and Dressing Point Source Category (40 CFR Part 440).

E.G.5.3 *Discharge testing.* Test or evaluate all off-site discharge points covered under this permit for the presence of specific mining-related but unauthorized non-stormwater discharges such as seeps or adit discharges, or discharges subject to effluent limitations guidelines (40 CFR Part 440), mine drainage or process water. Alternatively (if applicable), you may keep a certification with your SWPCP consistent with E.G.6.6.

E.G.6 Additional SWPCP Requirements for Mining Operations

Note: The requirements in E.G.6 are not applicable to inactive metal mining facilities. Some requirements may be already a requirement under Schedule A.7.

E.G.6.1 *Nature of industrial activities.* Briefly document in your SWPCP the mining and associated activities that can potentially affect the stormwater discharges covered by this permit, including a general description of the location of the site relative to major transportation routes and communities.

E.G.6.2 *Site map.* Document in your SWPCP the locations of the following (as appropriate): mining or milling site boundaries; access and haul roads; outline of the drainage areas of each stormwater outfall within the facility with indications of the types of discharges from the drainage areas; location(s) of all permitted discharges covered under an individual NPDES permit; outdoor equipment storage, fueling, and maintenance areas; materials handling areas; outdoor manufacturing, outdoor storage, and material disposal areas; outdoor chemicals and explosives storage areas; overburden, materials, soils, or waste storage areas; location of mine drainage (where water leaves mine) or other process water; tailings piles and ponds (including proposed ones); heap leach pads; off-site points of discharge for mine drainage and process water; surface waters; boundary of tributary areas that are subject to effluent limitations guidelines; and location(s) of reclaimed areas.

E.G.6.3 *Potential pollutant sources*. For each area of the mine or mill site where stormwater discharges associated with industrial activities occur, identify the types of pollutants (e.g., heavy metals, sediment) likely to be present in significant amounts. Consider these factors: the mineralogy of the ore and waste rock (e.g., acid forming); toxicity and quantity of chemicals used, produced, or discharged; the likelihood of contact with stormwater; vegetation of site (if any); and history of significant leaks or spills of toxic or hazardous pollutants. Also include a summary of any existing ore or waste rock or overburden characterization data and test results for potential generation of acid rock. If any new data is acquired due to changes in ore type being mined, update your SWPCP with this information.

E.G.6.4 *Documentation of control measures.* Document all control measures that you implement consistent with E.G.5.2. If control measures are implemented or planned but are not listed in E.G.5.2 (e.g., substituting a less toxic chemical for a more toxic one), include descriptions of them in your SWPCP. If you are in compliance with dust control requirements under state or county air quality permits, you must include (or summarize, as necessary) what the state or county air quality permit dust control requirements are and how you've achieved compliance with them.

E.G.6.5 *Employee training.* All employee training(s) must be documented in the SWPCP.

E.G.6.6 *Certification of permit coverage for commingled non-stormwater discharges*. If you are able, consistent with E.G.5.3 above, to certify that a particular discharge composed of commingled stormwater and non-stormwater is covered under a separate NPDES permit, and that permit subjects the non-stormwater portion to effluent limitations prior to any commingling, retain such certification with your SWPCP. This certification must identify the non-stormwater

discharges, the applicable NPDES permit(s), the effluent limitations placed on the non-stormwater discharge by the permit(s), and the points at which the limitations are applied.

E.G.7 Additional Inspection Requirements

Except for earth-disturbing activities conducted prior to active mining activities as defined in E.G.3.2(a) and E.G.3.2(b), which are subject to E.G.4.4, inspect sites at least monthly unless adverse weather conditions make the site inaccessible. See E.G.8.4 for inspection requirements for inactive and unstaffed sites.

E.G.8 Monitoring and Reporting Requirements. (See also Schedule B)

Note: There are no monitoring and reporting or impaired waters monitoring requirements for inactive and unstaffed sites.

E.G.8.1 Benchmark Monitoring for Active Copper Ore Mining and Dressing Facilities. Table E.G-1 identifies benchmarks that apply to active copper ore mining and dressing facilities. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.G-1

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Active Copper Ore Mining and Dressing Facilities (SIC 1021)	Nitrate plus Nitrite Nitrogen	0.68 mg/L
	Chemical Oxygen Demand (COD)	120 mg/L

E.G.8.2 *Benchmark Monitoring Requirements for Discharges From Waste Rock and Overburden Piles at Active Metal Mining Facilities*. For discharges from waste rock and overburden piles, perform benchmark monitoring once in the first year for the parameters listed in Table E.G-2, and twice annually in all subsequent years of coverage under this permit for any parameters for which the benchmark has been exceeded. You are also required to conduct analytic monitoring for the parameters listed in Table E.G-3 in accordance with the requirements in E.G.8.3. DEQ may also notify you that you must perform additional monitoring to accurately characterize the quality and quantity of pollutants discharged from your waste rock and overburden piles.

Table E.G-2

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Iron Ores; Copper Ores; Lead and Zinc Ores; Gold and Silver Ores; Ferroalloy Ores, Except Vanadium; and Miscellaneous Metal Ores (SIC Codes 1011, 1021, 1031, 1041, 1044, 1061, 1081, 1094, 1099)	Turbidity	50 NTU
	pH	6.0-9.0 s.u.
	Total Antimony	0.64 mg/L
	Total Arsenic	0.15 mg/L
	Total Beryllium	0.13 mg/L
	Total Iron	1.0 mg/L
	Total Mercury	0.0014 mg/L
	Total Nickel	0.5 mg/L
	Total Selenium	0.005 mg/L
	Total Silver	0.0005 mg/L

E.G.8.3 *Additional Analytic Monitoring Requirements for Discharges From Waste Rock and Overburden Piles at Active Metal Mining Facilities*. In addition to the monitoring required in E.G.8.2 for discharges from waste rock and overburden piles, you must also conduct monitoring for additional parameters based on the type of ore you mine at your site. Where a parameter in Table E.G-3 is the same as a pollutant you are required to monitor for in Table E.G-2 (i.e., for all of the metals), you must use the corresponding benchmark in Table E.G-2 and you may use any monitoring results conducted for E.G.8.2 to satisfy the monitoring requirement for that parameter for E.G.8.3. For radium and uranium, which do not have corresponding benchmarks in Table E.G-2, there are no applicable benchmarks. The frequency and schedule for monitoring for these additional parameters is the same as that specified in Table 5.

Table E.G-3. Additional Monitoring Requirements for Discharges from Waste Rock and Overburden Piles

Supplemental Requirements			
Type of Ore Mined	**Pollutants of Concern**		
	Total Suspended Solids (TSS)	**pH**	**Metals, Total**
Tungsten Ore	X	X	Arsenic, Cadmium (H), Copper (H), Lead (H), Zinc (H)
Nickel Ore	X	X	Arsenic, Cadmium (H), Copper (H), Lead (H), Zinc (H)
Aluminum Ore	X	X	Iron
Mercury Ore	X	X	Nickel (H)
Iron Ore	X	X	Iron (Dissolved)
Platinum Ore			Cadmium (H), Copper (H), Mercury, Lead (H), Zinc (H)
Titanium Ore	X	X	Iron, Nickel (H), Zinc (H)
Vanadium Ore	X	X	Arsenic, Cadmium (H), Copper (H), Lead (H), Zinc (H)
Molybdenum	X	X	Arsenic, Cadmium (H), Copper (H), Lead (H), Mercury, Zinc (H)
Uranium, Radium, and Vanadium Ore	X	X	Chemical Oxygen Demand, Arsenic, Radium (Dissolved and Total), Uranium, Zinc (H)

Note: An "X" indicated for TSS and/or pH means that you are required to monitor for those parameters. (H) indicates that hardness must also be measured when this pollutant is measured.

E.G.8.4 *Inactive and Unstaffed Sites – Conditional Exemption from No Exposure Requirements for Monthly Visual Assessments and Routine Facility Inspections*. As a Sector G facility, if you are seeking to exercise a monitoring or inspection waiver, you are conditionally exempt from the requirement to certify that "there are no industrial materials or activities exposed to stormwater" in Schedule B.4.iii of the permit. This exemption is conditioned on the following:

- If circumstances change and your facility becomes active and/or staffed, this exception no longer applies and you must immediately begin complying with the monitoring and inspection requirements; and
- DEQ retains the authority to revoke this exemption and/or the monitoring waiver where it is determined that the discharge causes, has a reasonable potential to cause, or contributes to an instream excursion above an applicable water quality standard, including designated uses.

Table E.G-4. Applicability of the Permit to Stormwater Runoff From Active Mining and Dressing Sites, Temporarily Inactive Sites, and Sites Undergoing Reclamation

Discharge/Source of Discharge	Note/Comment
Piles	
Waste rock/overburden	If composed entirely of stormwater and not combining with mine drainage. See note below.
Topsoil	--
Roads constructed of waste rock or spent ore	
Onsite haul roads	If composed entirely of stormwater and not combining with mine drainage. See note below.
Offsite haul and access roads	--
Roads not constructed of waste rock or spent ore	
Onsite haul roads	Except if mine drainage is used for dust control
Offsite haul and access roads	--
Milling/concentrating	
Runoff from tailings dams and dikes when constructed of waste rock/tailings	Except if process fluids are present and only if composed entirely of stormwater and not combining with mine drainage. See Note below.
Runoff from tailings dams/dikes when not constructed of waste rock and tailings	Except if process fluids are present
Concentration building	If stormwater only and no contact with piles
Mill site	If stormwater only and no contact with piles
Ancillary areas	
Office and administrative building and housing	If mixed with stormwater from the industrial area
Chemical storage area	--
Docking facility	Except if excessive contact with waste product that would otherwise constitute mine drainage
Explosive storage	--
Fuel storage (oil tanks/coal piles)	--
Vehicle and equipment maintenance area/building	--
Parking areas	But coverage unnecessary if only employee and visitor-type parking
Power plant	
Truck wash area	Except when excessive contact with waste product that would otherwise constitute mine drainage
Reclamation-related areas	
Any disturbed area (unreclaimed)	Only if not in active mining area
Reclaimed areas released from reclamation requirements prior to Dec. 17, 1990	--
Partially/inadequately reclaimed areas or areas not released from reclamation requirements	--

Note: Stormwater runoff from these sources are subject to the NPDES program for stormwater unless mixed with discharges subject to 40 CFR Part 440 that are regulated by another permit prior to mixing. Non-stormwater discharges from these sources are subject to NPDES permitting and may be subject to the effluent limitation guidelines under 40 CFR Part 440. Discharges from overburden/waste rock and overburden/waste rock-related areas are not subject to 40 CFR Part 440 unless: (1) it drains naturally (or is intentionally diverted) to a point source; and (2) combines with "mine drainage" that is otherwise regulated under the Part 440 regulations. For such sources, coverage under this permit would be available if the discharge composed entirely of stormwater does not combine with other sources of mine drainage that are not subject to 40 CFR Part 440, as well as meeting other eligibility criteria contained in Part 1.1 of the permit. Operators bear the initial responsibility for determining the applicable technology-based standard for such discharges.

E.G.9. Termination of Permit Coverage

E.G.9.1 *Termination of Permit Coverage for Sites Reclaimed After December 17, 1990.* A site or a portion of a site that has been released from applicable state or federal reclamation requirements after December 17, 1990, is no longer required to maintain coverage under this permit. If the site or portion of a site reclaimed after December 17, 1990, was not subject to reclamation requirements, the site or portion of the site is no longer required to maintain coverage under this permit if the site or portion of the site has been reclaimed as defined in E.G.3.3.

E.G.9.2 *Termination of Permit Coverage for Sites Reclaimed Before December 17, 1990.* A site or portion of a site that was released from applicable state or federal reclamation requirements before December 17, 1990, or that was otherwise reclaimed before December 17, 1990, is no longer required to maintain coverage under this permit if the site or portion of the site has been reclaimed. A site or portion of a site is considered to have been reclaimed if: (1) stormwater runoff that comes into contact with raw materials, intermediate byproducts, finished products, and waste products does not have the potential to cause or contribute to violations of state water quality standards, (2) soil disturbing activities related to mining at the sites or portion of the site have been completed, (3) the site or portion of the site has been stabilized to minimize soil erosion, and (4) as appropriate depending on location, size, and the potential to contribute pollutants to stormwater discharges, the site or portion of the site has been revegetated, will be amenable to natural revegetation, or will be left in a condition consistent with the post-mining land use.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector H – Coal Mines and Coal Mining-Related Facilities

E.H.1 Definitions

The following definitions are not intended to supersede the definitions of active and inactive mining facilities established by 40 CFR 122.26(b)(14)(iii).

E.H.1.1 *Mining operations* - For this permit, mining operations are grouped into two distinct categories, with distinct effluent limits and requirements applicable to each: a) earth-disturbing activities conducted prior to active mining activities); and b) active mining activities, which includes reclamation. "Mining operations" can occur at both inactive mining facilities and temporarily inactive mining facilities.

E.H.1.2 *Earth-disturbing activities conducted prior to active mining activities* – Consists of two classes of earth-disturbing (i.e., clearing, grading and excavation) activities:

a. activities performed for purposes of mine site preparation, including: cutting new rights of way (except when related to access road construction); providing access to a mine site for vehicles and equipment (except when related to access road construction); other earth disturbances associated with site preparation activities on any areas where active mining activities have not yet commenced (e.g., for heap leach pads, waste rock facilities, tailings impoundments, wastewater treatment plants); and

b. construction of staging areas to prepare for erecting structures such as to house project personnel and equipment, mill buildings, etc., and construction of access roads. Earth-disturbing activities associated with the construction of staging areas and the construction of access roads conducted prior to active mining are considered to be "construction" and have additional technology based effluent limits in E.H.2.2.

E.H.1.3 *Active mining activities* – Activities related to the extraction, removal or recovery, and preparation of coal; removal of overburden and waste rock to expose mineable minerals; and site reclamation and closure activities. All such activities occur within the "active mining area." Reclamation involves activities undertaken, in compliance with applicable mined land reclamation requirements, to return the land to an appropriate post-mining contour and land use in order to meet applicable federal and state reclamation requirements. In addition, once earth-disturbing activities conducted prior to active mining activities have ceased and all related requirements in E.H.2 have been met, and a well-delineated "active mining area" has been established, all activities (including any clearing, grading, and excavation) that occur within the active mining area are "active mining activities."

E.H.1.4 *Active mining area* – A place where work or other activity related to the extraction, removal or recovery of coal is being conducted, except, with respect to surface mines, any area of land on or in which grading has been completed to return the earth to desired contour and reclamation work has begun.

Note: Earth-disturbing activities described in the definition in E.H.1.2 that occur on areas outside the active mining area (e.g., for expansion of the mine into undeveloped territory) are considered "earth-disturbing conducted prior to active mining activities", and must comply with the requirements in E.H.2.

E.H.1.5 *Inactive coal mining facility* – A site or portion of a site where coal mining and/or milling occurred in the past but there are no active mining operations occurring as defined above, and where the inactive portion is not covered by an active mining permit issued by the applicable state or federal agency. An inactive coal mining facility has an identifiable owner / operator. Sites where mining claims are being maintained prior to disturbances associated with the

extraction, beneficiation, or processing of mined materials and sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim are not considered either active or inactive mining facilities and do not require an NPDES industrial stormwater permit.

E.H.1.6 *Temporarily inactive coal mining facility* – A site or portion of a site where coal mining and/or milling occurred in the past but currently are not being actively undertaken, and the facility is covered by an active mining permit issued by the applicable state or federal agency.

E.H.2 Requirements Applicable to Earth-Disturbing Activities Conducted Prior to Active Mining Activities

Stormwater discharges from earth-disturbing activities conducted prior to active mining activities (defined in E.H.1.2) are covered under this permit. For such earth-disturbing activities, you must comply with all applicable requirements in technology-based effluent limits in E.H.3 and Schedule A, the inspection and monitoring requirements in Schedule B and in E.H.5 and E.H.6

Authorized discharges from areas where earth-disturbing activities have ceased and stabilization as specified in E.H.2.1.9 or E.H.2.2.11, where appropriate, has been completed (stabilization is not required for areas where active mining activities will occur), are no longer subject to the E.H.2 requirements. At such time, authorized discharges become subject to all other applicable requirements in the permit, including the technology based effluent limits in limits in E.H.3 and Schedule A, the inspection and monitoring requirements in Schedule B and in E.H.5 and E.H.6.

E.H.2.1 *Technology-Based Effluent Limits Applicable to All Earth-Disturbing Activities Conducted Prior to Active Mining Activities*. The following technology-based effluent limits apply to authorized discharges from all earth-disturbing activities conducted prior to active mining activities defined in E.H.1.2(a) and E.H.1.2(b). These limits supersede the technology-based effluent limits listed in Schedule A.

E.H.2.1.1 *Erosion and sediment control installation requirements*.

- By the time construction activities commence, install and make operational downgradient sediment controls, unless this timeframe is infeasible. If infeasible you must install and make such controls operational as soon as practicable or as soon as site conditions permit.
- All other stormwater controls described in the SWPCP must be installed and made operational as soon as conditions on each portion of the site allows.

E.H.2.1.2 *Erosion and sediment control maintenance requirements*. You must:

- Ensure that all erosion and sediment controls remain in effective operating condition.
- Wherever you determine that a stormwater control needs maintenance to continue operating effectively, initiate efforts to fix the problem immediately after its discovery, and complete such work by the end of the next work day.
- When a stormwater control must be replaced or significantly repaired, complete the work within 7 days, unless infeasible. If 7 days is infeasible, you must complete the installation or repair as soon practicable.

E.H.2.1.3 *Perimeter controls*. You must:

- Install sediment controls along those perimeter areas of your disturbed area that will receive stormwater, except where site conditions prevent the use of such controls (in which case, maximize their installation to the extent practicable).
- Remove sediment before it accumulates to one-half of the above-ground height of any perimeter control.

E.H.2.1.4 *Sediment track-out*. For construction vehicles and equipment exiting the site directly onto paved roads, you must:

- Use appropriate stabilization techniques to minimize sediment track-out from vehicles and equipment prior to exit;
- Use additional controls to remove sediment from vehicle and equipment tires prior to exit, where necessary;
- Remove sediment that is tracked out onto paved roads by end of the work day.

Note: DEQ recognizes that some fine grains may remain visible on the surfaces of off-site streets, other paved areas, and sidewalks even after you have implemented sediment removal practices. Such "staining" is not a violation of E.H.2.1.4.

E.H.2.1.5 *Soil or sediment stockpiles*. You must:

- Minimize erosion of stockpiles from stormwater and wind via temporary cover, if feasible.
- Prevent up-slope stormwater flows from causing erosion of stockpiles (e.g., by diverting flows around the stockpile).
- Minimize sediment from stormwater that runs off of stockpiles, using sediment controls (e.g., a sediment barrier or downslope sediment control).

E.H.2.1.6 *Sediment basins*. If you intend to install a sediment basin to treat stormwater from your earth-disturbing activities, you must:

- Provide storage for either (1) the 2-year, 24-hour storm, or (2) 3,600 cubic feet per acre drained.
- Prevent erosion of (1) basin embankments using stabilization controls (e.g., erosion control blankets), and (2) the inlet and outlet points of the basin using erosion controls and velocity dissipation devices.

E.H.2.1.7 *Minimize dust*. You must minimize the generation of dust through the appropriate application of water or other dust suppression techniques that minimize pollutants being discharged into surface waters.

E.H.2.1.8 *Restrictions on use of treatment chemicals*. If you intend to use sediment treatment chemicals at your site, you are subject to the following minimum requirements:

- Use conventional erosion and sediment controls prior to and after application of chemicals;
- Select chemicals suited to soil type, and expected turbidity, pH, flow rate;
- Minimize the discharge risk from stored chemicals;
- Comply with state/local requirements;
- Use chemicals in accordance with good engineering practices and specifications of chemical supplier;
- Ensure proper training;
- Provide proper SWPCP documentation.

If you plan to use cationic treatment chemicals (as defined in Appendix A), you are ineligible for coverage under this permit, unless you notify your applicable DEQ regional office or agent in advance and the DEQ regional office or agent authorizes coverage under this permit after you have included appropriate controls and implementation procedures designed to ensure that your use of cationic treatment chemicals will not lead to a violation of water quality standards.

E.H.2.1.9 *Site stabilization requirements for earth-disturbing activities performed for purposes of mine site preparation as defined in E.H.1.2(a) (i.e., not applicable to construction*

of staging areas for structures and access roads as defined in E.H.1.2(b)). You must comply with the following stabilization requirements except where the intended function of the site accounts for such disturbed earth (e.g., the earth disturbances will become actively mined, or the controls implemented at the active mining area effectively control the disturbance):

- *Temporary stabilization of disturbed areas*. Stabilization measures must be initiated immediately in portions of the site where earth-disturbing activities performed for purposes of mine site preparation (as defined in E.H.1.2(a)) have temporarily ceased, but in no case more than 14 days after such activities have temporarily ceased. In arid, semi-arid, and drought-stricken areas, or in areas subject to snow or freezing conditions, where initiating perennial vegetative stabilization measures is not possible within 14 days after earth-disturbing activities performed for purposes of mine site preparation has temporarily ceased, temporary vegetative stabilization measures must be initiated as soon as practicable. Until temporary vegetative stabilization is achieved, interim measures such as erosion control blankets with an appropriate seed base and tackifiers must be employed. In areas of the site where earth-disturbing activities performed for purposes of mine site preparation have permanently ceased prior to active mining, temporary stabilization measures must be implemented to minimize mobilization of sediment or other pollutants until active mining activities commence.

- *Final stabilization of disturbed areas.* Stabilization measures must be initiated immediately where earth-disturbing activities performed for purposes of mine site preparation (as defined in E.H.1.2(a)) have permanently ceased, but in no case more than 14 days after the earth-disturbing activities have permanently ceased. In arid, semi-arid, and drought-stricken areas, or in areas subject to snow or freezing conditions, where initiating perennial vegetative stabilization measures is not possible within 14 days after earth-disturbing activities have permanently ceased, final vegetative stabilization measures must be initiated as soon as possible. Until final stabilization is achieved, temporary stabilization measures, such as erosion control blankets with an appropriate seed base and tackifiers, must be used.

E.H.2.2 *Additional Technology-Based Effluent Limits Applicable Only to the Construction of Staging Areas for Structures and Access Roads*. The following technology-based effluent limits apply to authorized discharges from earth-disturbing activities associated with the construction of staging areas and the construction of access roads, as defined in E.H.1.2(b). These limits supersede the technology-based limits listed in Schedule A and E.H.3. These limits do not apply to earth-disturbing activities performed for purposes of mine site preparation (as defined in E.H.1.2(a)).

E.H.2.2.1 *Area of disturbance*. You must minimize the amount of soil exposed during construction activities.

E.H.2.2.2 *Erosion and sediment control design requirements*. You must:

- Design, install and maintain effective erosion and sediment controls to minimize the discharge of pollutants from construction activities. Account for the following factors in designing your erosion and sediment controls:
  - The expected amount, frequency, intensity and duration of precipitation;

- The nature of stormwater runoff and run-on at the site, including factors such as impervious surfaces, slopes and site drainage features;
- The range of soil particle sizes expected to be present on the site.

- Direct discharges from your stormwater controls to vegetated areas of your site to increase sediment removal and maximize stormwater infiltration, including any natural buffers, unless infeasible. Use velocity dissipation devices if necessary to prevent erosion when directing stormwater to vegetated areas.
- If any stormwater flow becomes or will be channelized at your site, you must design erosion and sediment controls to control both peak flowrates and total stormwater volume to minimize channel and streambank erosion and scour in the immediate vicinity of discharge points.
- If you install stormwater conveyance channels, they must be designed to avoid unstabilized areas on the site and to reduce erosion, unless infeasible. In addition, you must minimize erosion of channels and their embankments, outlets, adjacent streambanks, slopes, and downstream waters during discharge conditions through the use of erosion controls and velocity dissipation devices within and along the length of any constructed stormwater conveyance channel, and at any outlet to provide a non-erosive flow velocity.

E.H.2.2.3 *Natural Buffers*. For any stormwater discharges from earth-disturbing activities within 50 feet of a water of the U.S., you must comply with one of the following compliance alternatives:

1. Maintain a 50-foot undisturbed natural buffer between earth-disturbing activities and the water of the U.S.; or
2. Provide an undisturbed natural buffer that is less than 50 feet, permit registrant must implement one or more of the BMPs listed below to control and treat sediment and turbidity:
   - Compost berms, compost blankets, or compost socks;
   - Erosion control mats;
   - Takifiers used in combination with perimeter sediment controls;
   - Approved water treatment by electro-coagulation, flocculation, or filtration; and/or
   - Other substantially equivalent sediment or turbidity control measures approved by DEQ or agent.
3. Ensure all discharges are treated by control measures prior to entering the natural buffer.
4. Delineate and clearly mark off all natural buffers.

There are exceptions when buffer requirements do not apply:

- The natural buffer has already been eliminated by preexisting development disturbances;
- The disturbance is for a water-dependent structure or earth-disturbing approved under a CWA section 404 permit.

E.H.2.2.4 *Soil or sediment stockpiles*. In addition to the requirements in E.H.2.1.5, you must locate any piles outside of any natural buffers established under E.H.2.2.3.

E.H.2.2.5 *Sediment basins*. In addition to the requirements in E.H.2.1.6, you must locate sediment basins outside of any surface waters and any natural buffers established

under E.H.2.2.3, and you must utilize outlet structures that withdraw water from the surface, unless infeasible.

E.H.2.2.6 *Native topsoil preservation*. You must preserve native topsoil removed during clearing, grading, or excavation, unless infeasible. Store topsoil in a manner that will maximize its use in reclamation or final vegetative stabilization (e.g., by keeping the topsoil stabilized with seed or similar measures). This requirement does not apply if the intended function of the disturbed area dictates that topsoil be disturbed or removed.

E.H.2.2.7 *Steep slopes*. You must minimize the disturbance of steep slopes. The permit does not prevent or prohibit disturbance on steep slopes.

Depending on site conditions and needs, disturbance on steep slopes may be necessary (e.g., a road cut in mountainous terrain; for grading steep slopes prior to erecting the mine office). Where steep slope disturbances are necessary, you can minimize the disturbances to steep slopes through the implementation of a number of standard erosion and sediment control practices, such as by phasing disturbances in these areas and using stabilization practices specifically for steep grades.

E.H.2.2.8 *Soil compaction*. Where final vegetative stabilization will occur or where infiltration practices will be installed, you must either restrict vehicle/ equipment use in these areas to avoid soil compaction or use soil conditioning techniques to support vegetative growth. Minimizing soil compaction is not required where compacted soil is integral to the functionality of the site.

E.H.2.2.9 *Dewatering Practices*. You are prohibited from discharging ground water or accumulated stormwater that is removed from excavations, trenches, foundations, vaults or other similar points of accumulation, unless such waters are first effectively managed by appropriate controls (e.g., sediment basins or sediment traps, sediment socks, dewatering tanks, tube settlers, weir tanks, or filtration systems). Uncontaminated, non-turbid dewatering water can be discharged without being routed to a control.

You must also meet the following requirements for dewatering activities:

- Discharge requirements:
  - No discharging visible floating solids or foam;
  - Remove oil, grease and other pollutants from dewatering water via an oil-water separator or suitable filtration device (such as a cartridge filter);
  - Utilize vegetated upland areas of the site, to the extent feasible, to infiltrate dewatering water before discharge. In no case shall waters of the U.S. be considered part of the treatment area;
  - Implement velocity dissipation devices at all points where dewatering water is discharged;
  - Haul backwash water away for disposal or return it to the beginning of the treatment process; and
  - Clean or replace the filter media used in dewatering devices when the pressure differential equals or exceeds the manufacturers' specifications.
- Treatment chemical restrictions: If you use polymers, flocculants or other chemicals to treat dewatering water, you must comply with the requirements in E.H.2.1.8.

E.H.2.2.10 *Pollution prevention requirements*.

- Prohibited discharges:
  - Wastewater from washout of concrete;
  - Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds, and other materials;
  - Fuels, oils, or other pollutants used for operation and maintenance of vehicles or equipment;
  - Soaps, solvents, or detergents used in vehicle or equipment washing;
  - Toxic or hazardous substances from a spill or other release.
- Design and location requirements: Minimize the discharge of pollutants from pollutant sources by:
  - Minimizing exposure;
  - Using secondary containment, spill kits, or other equivalent measures;
  - Locating pollution sources away from surface waters, storm sewer inlets, and drainageways;
  - Cleaning up spills immediately (do not clean by hosing area down).
- Pollution prevention requirements for wash waters: Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters. Wash waters must be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge;
- Pollution prevention requirements for the storage, handling, and disposal of construction products, materials, and wastes: Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on the site to stormwater. Minimization of exposure is not required in cases where the exposure to stormwater will not result in a discharge of pollutants, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use).

E.H.2.2.11 *Site Stabilization requirements for the construction of staging areas for structures and access roads as defined in E.H.1.2(b) (i.e., not applicable to earth-disturbing activities performed for purposes of mine site preparation as defined in E.H.1.2(a)).* You must comply with the following stabilization requirements, except where the intended function of the site accounts for such disturbed earth (e.g., the area of construction will become actively mined, or the controls implemented at the active mining area effectively control the disturbance):

- By no later than the end of the next work day after construction work in an area has stopped permanently or temporarily ("temporarily" means the land will be idle for a period of 14 days or more but earth-disturbing activities will resume in the future), immediately initiate stabilization measures;
- If using vegetative measures, by no later than 14 days after initiating stabilization:
  - Seed or plant the area, and provide temporary cover to protect the planted area;
  - Once established, vegetation must be uniform (evenly distributed without large bare areas) perennial vegetation, which provides 70 percent or more coverage based on density of native vegetation.

- If using non-vegetative stabilization, by no later than 14 days after initiating stabilization:
  - Install or apply all non-vegetative measures;
  - Cover all areas of exposed soil.

Note: For the purposes of this permit, DEQ will consider any of the following types of activities to constitute the initiation of stabilization: 1. Prepping the soil for vegetative or non-vegetative stabilization; 2. Applying mulch or other non-vegetative product to the exposed area; 3. Seeding or planting the exposed area; 4. Starting any of the activities in #1 – 3 on a portion of the area to be stabilized, but not on the entire area; and 5. Finalizing arrangements to have stabilization product fully installed in compliance with the applicable deadline for completing stabilization.

Exceptions:

- Arid, semi-arid or drought-stricken areas:
  - Within 14 days of stopping construction work in an area, install any necessary non-vegetative stabilization measures;
  - Initiate vegetative stabilization as soon as conditions on the site allow;
  - Document the schedule that will be followed for initiating and completing vegetative stabilization;
  - Cover planted or seeded area with bio or photo degradable erosion controls designed to prevent erosion without active maintenance.
- Sites affected by severe storm events or other unforeseen circumstances:
  - Initiate vegetative stabilization as soon conditions on the site allow;
  - Document the schedule that will be followed for initiating and completing vegetative stabilization;
  - Add a suitable interim measures (such as mulch or bark) are in place if 70 percent coverage of vegetation is expected to expand.

E.H.2.3 *Water Quality-Based Requirements Applicable to Earth-Disturbing Activities Conducted Prior to Active Mining Activities.*

The following water quality-based limits apply to earth-disturbing activities conducted prior to active mining activities defined in E.H.1.2(a) and E.H.1.2(b), in addition to the water quality-based limits Schedule A.4 and A.5.

Stricter requirements apply if your site will discharge to an impaired waters that are listed for turbidity or sedimentation or have an EPA-approved TMDL for sedimentation or turbidity:

- More rapid stabilization of exposed areas: Complete initial stabilization activities within 7 days of stopping earth-disturbing work.
- More frequent site inspections: Once every 7 days and within 24 hours of a storm event of 0.25 inches or greater.

E.H.2.4 *Inspection Requirements Applicable to Earth-Disturbing Activities Conducted Prior to Active Mining Activities.*

The following requirements supersede the inspections requirements in Schedule B and E.H.7 of the permit for earth-disturbing activities conducted prior to active mining activities defined in E.H.1.2(a) and E.H.1.2(b).

E.H.2.4.1 *Inspection Frequency*

- At least once every 7 calendar days, or

- Once every 14 calendar days and within 24 hours of a storm event of 0.25 inches or greater.

Note:

- Inspections only required during working hours;
- Inspections not required during unsafe conditions; and
- If you choose to inspect once every 14 days, you must have a method for measuring rainfall amount on site (either rain gauge or representative weather station)

Note: To determine if a storm event of 0.25 inches or greater has occurred on your site, you must either keep a properly maintained rain gauge on your site, or obtain the storm event information from a weather station that is representative of your location. For any day of rainfall during normal business hours that measures 0.25 inches or greater, you must record the total rainfall measured for that.

Note: You are required to specify in your SWPCP which schedule you will be following.

Note: "Within 24 hours of the occurrence of a storm event" means that you are required to conduct an inspection within 24 hours once a storm event has produced 0.25 inches, even if the storm event is still continuing. Thus, if you have elected to inspect bi-weekly in and there is a storm event at your site that continues for multiple days, and each day of the storm produces 0.25 inches or more of rain, you are required to conduct an inspection within 24 hours of the first day of the storm and within 24 hours after the end of the storm.

E.H.2.4.2 *Reductions in Inspection Frequency*

- Stabilized areas: You may reduce the frequency of inspections to once per month in any area of your site where stabilization has occurred pursuant to E.H.2.1.9 or E.H.2.2.11.
- Arid, semi-arid, and drought stricken areas: If earth-disturbing activities are occurring during the seasonally dry period or during a period in which drought is predicted to occur, you may reduce inspections to once per month and within 24 hours of a 0.25 inch storm event.
- Frozen conditions: You may temporarily suspend or reduce inspections to once per month until thawing conditions occur if frozen conditions are continuous and disturbed areas have been stabilized. For extreme conditions in remote areas, e.g., where transit to the site is perilous/restricted or temperatures are routinely below freezing, you may suspend inspections until the conditions are conducive to safe access, and more frequent inspections can resume.

E.H.2.4.3 *Areas to be Inspected*. You must at a minimum inspect the following areas:

- Disturbed areas;
- Stormwater controls and pollution prevention measures;
- Locations where stabilization measures have been implemented;
- Material, waste, borrow, or equipment storage and maintenance areas;
- Areas where stormwater flows;
- Points of discharge.

E.H.2.4.4 *What to Check for During Inspections*. At a minimum you must check:

- Whether all stormwater controls are installed, operational, and working as intended;
- Whether any new or modified stormwater controls are needed;

- For conditions that could lead to a spill or leak;
- For visual signs of erosion/sedimentation at points of discharge.

If a discharge is occurring:

- The quality and characteristics of the discharge;
- Whether controls are operating effectively.

E.H.2.4.5 *Inspection Report*. Within 24 hours of an inspection, complete a report that includes:

- Inspection date;
- Name and title of inspector(s);
- Summary of inspection findings;
- Rainfall amount that triggered the inspection (if applicable);
- If it was unsafe to inspect a portion of the site, include documentation of the reason and the location(s);
- Each inspection report must be signed;
- Keep a current copy of all reports at the site or at an easily accessible location.

E.H.2.5 *Cessation of Requirements Applicable to Earth-Disturbing Activities Conducted Prior to Active Mining Activities.* The requirements in E.H.2 no longer apply for any earth-disturbing activities conducted prior to active mining activities as defined in E.H.1.2(a) or E.H.1.2(b) where:

1. Earth-disturbing activities have ceased; and
2. Stabilization has been met consistent with E.H.2.1.9 or E.H.2.2.11 (not required for areas where active mining activities will occur).

E.H.3 Technology-Based Effluent Limits for Active Mining Activities

Note: These requirements do not apply for any discharges from earth-disturbing activities conducted prior to active mining as defined in E.H.1.2(a) or E.H.1.2(b).

E.H.3.1 *Good Housekeeping Measures.* As part of your good housekeeping program, in order to minimize discharges of pollutants in stormwater, implement control measures such as the following, where determined to be feasible including: using sweepers and covered storage; watering haul roads to minimize dust generation; and conserving vegetation to minimize erosion. For mines subject to dust control requirements under state or county air quality permits, provided the requirements are equivalent, compliance with such air permit dust requirements shall constitute compliance with the dust control effluent limit in Schedule A.1.f.

E.H.3.2 *Preventive Maintenance.* Perform inspections or other equivalent measures of storage tanks and pressure lines of fuels, lubricants, hydraulic fluid, and slurry to prevent leaks due to deterioration or faulty connections.

E.H.4 Additional SWPCP Requirements for Mining Operations

Note: The requirements in E.H.6 are not applicable to inactive coal mining facilities. Some requirements may be already a requirement under Schedule A.7.

E.H.4.1 *Other Applicable Regulations.* Most active coal mining-related areas (SIC Codes 1221-1241) are subject to sediment and erosion control regulations of the U.S. Office of Surface Mining (OSM) that enforces the Surface Mining Control and Reclamation Act (SMCRA). OSM has granted authority to most coal-producing states to implement SMCRA through State SMCRA regulations. All SMCRA requirements regarding control of stormwater-related pollutant discharges must be addressed and then documented with the SWPCP (directly or by reference).

E.H.4.2 *Site Map.* Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: haul and access roads; railroad spurs, sliding, and internal hauling lines; conveyor belts, chutes, and aerial tramways; equipment storage and maintenance yards; coal handling buildings and structures; inactive mines and related areas; acidic spoil, refuse, or unreclaimed disturbed areas; and liquid storage tanks containing pollutants such as caustics, hydraulic fluids, and lubricants.

E.H.4.3 *Potential Pollutant Sources.* Document in your SWPCP the following sources and activities that have potential pollutants associated with them: truck traffic on haul roads and resulting generation of sediment subject to runoff and dust generation; fuel or other liquid storage; pressure lines containing slurry, hydraulic fluid, or other potential harmful liquids; and loading or temporary storage of acidic refuse or spoil.

E.H.4.4 If you are in compliance with dust control requirements under state or county air quality permits, you must include (or summarize, as necessary) what the state or county air quality permit dust control requirements are and how you've achieved compliance with them.

E.H.5 Additional Inspection Requirements

E.H.5.1 *Inspections of Active Mining-Related Areas.* Except for earth-disturbing activities conducted prior to active mining activities as defined in E.H.1.2(a) and E.H.1.2(b), which are subject to E.H.2.4, perform routine inspections of active mining areas covered by this permit, corresponding with the inspections as performed by SMCRA inspectors, of all mining-related areas required by SMCRA. Also maintain the records of the SMCRA authority representative. See E.H.8.1 for inspection requirements for inactive and unstaffed sties.

E.H.5.2 *Sediment and Erosion Control.* As indicated in E.H.4.1, SMCRA requirements regarding sediment and erosion control measures must be complied with for those areas subject to SMCRA authority, including inspection requirements.

E.H.5.3 *Routine Site Inspections.* Your inspection program must include inspections for pollutants entering the drainage system from activities located on or near coal mining-related areas. Among the areas to be inspected are haul and access roads; railroad spurs, sliding, and internal hauling lines; conveyor belts, chutes, and aerial tramways; equipment storage and maintenance yards; coal handling buildings and structures; and inactive mines and related areas.

E.H.6 Sector-Specific Benchmarks

Table E.H-1 identifies benchmarks that apply to the specific subsectors of Sector H. These benchmarks apply to both your primary industrial activity and any co-located industrial activities. Note: There are no monitoring and reporting or impaired waters monitoring requirements for inactive and unstaffed sites.

Table E.H-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Coal Mines and Related Areas (SIC 1221-1241)	Total Aluminum	0.75 mg/L
	Total Iron	1.0 mg/L

E.H.6.1 *Inactive and Unstaffed Sites – Conditional Exemption from No Exposure Requirements for Monthly Visual Assessments and Routine Facility Inspections*. As a Sector H facility, if you are seeking to exercise a monitoring or inspection waiver, you are conditionally exempt from the

requirement to certify that "there are no industrial materials or activities exposed to stormwater" in Schedule B.4.iii of the permit. This exemption is conditioned on the following:

- If circumstances change and your facility becomes active and/or staffed, this exception no longer applies and you must immediately begin complying with the monitoring and inspection requirements; and
- DEQ retains the authority to revoke this exemption and/or the monitoring waiver where it is determined that the discharge causes, has a reasonable potential to cause, or contributes to an instream excursion above an applicable water quality standard, including designated uses.

Subject to the two conditions above, if your facility is inactive and unstaffed, you are waived from the requirement to conduct routine facility inspections, monthly visual assessments, and benchmark and impaired waters monitoring. You are encouraged to inspect your site more frequently where you have reason to believe that severe weather or natural disasters may have damaged control measures or increased discharges.

E.H.7 Termination of Permit Coverage

E.H.7.1 *Termination of Permit Coverage for Sites Reclaimed After December 17, 1990.* A site or a portion of a site that has been released from applicable state or federal reclamation requirements after December 17, 1990, is no longer required to maintain coverage under this permit. If the site or portion of a site reclaimed after December 17, 1990, was not subject to reclamation requirements, the site or portion of the site is no longer required to maintain coverage under this permit if the site or portion of the site has been reclaimed.

E.H.7.2 *Termination of Permit Coverage for Sites Reclaimed Before December 17, 1990.* A site or portion of a site that was released from applicable state or federal reclamation requirements before December 17, 1990, or that was otherwise reclaimed before December 17, 1990, is no longer required to maintain coverage under this permit if the site or portion of the site has been reclaimed. A site or portion of a site is considered to have been reclaimed if: (1) stormwater runoff that comes into contact with raw materials, intermediate byproducts, finished products, and waste products does not have the potential to cause or contribute to violations of state water quality standards, (2) soil disturbing activities related to mining at the sites or portion of the site have been completed, (3) the site or portion of the site has been stabilized to minimize soil erosion, and (4) as appropriate depending on location, size, and the potential to contribute pollutants to stormwater discharges, the site or portion of the site has been revegetated, will be amenable to natural revegetation, or will be left in a condition consistent with the post-mining land use.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector I – Oil and Gas Extraction

E.I.1 Additional Technology-Based Effluent Limits

E.I.1.1 *Vegetative Controls.* Implement vegetative practices designed to preserve existing vegetation, where attainable, and revegetate open areas as soon as practicable after grade drilling. Consider the following (or equivalent measures): temporary or permanent seeding, mulching, sod stabilization, vegetative buffer strips, and tree protection practices. Begin implementing appropriate vegetative practices on all disturbed areas within 14 days following the last activity in that area.

E.I.2 Additional SWPCP Requirement

E.I.2.1 *Drainage Area Site Map.* Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: Reportable Quantity (RQ) releases; locations used for the treatment, storage, or disposal of wastes; processing areas and storage areas; chemical mixing areas; construction and drilling areas; all areas subject to the effluent guidelines requirements for "No Discharge" in accordance with 40 CFR 435.32; and the structural controls to achieve compliance with the "No Discharge" requirements.

E.I.2.2 *Potential Pollutant Sources.* Also document in your SWPCP the following sources and activities that have potential pollutants associated with them: chemical, cement, mud, or gel mixing activities; drilling or mining activities; and equipment cleaning and rehabilitation activities. In addition, include information about the reportable quantity (RQ) release that triggered the permit application requirements: the nature of the release (e.g., spill of oil from a drum storage area), amount of oil or hazardous substance released, amount of substance recovered, date of the release, cause of the release (e.g., poor handling techniques and lack of containment in the area), areas affected by the release (i.e., land and water), procedure to clean up release, actions or procedures implemented to prevent or improve response to a release, and remaining potential contamination of stormwater from release (taking into account human health risks, the control of drinking water intakes, and the designated uses of the receiving water).

E.I.2.3 *Erosion and Sedimentation Control.* Unless covered by the NPDES Construction Stormwater 1200-C General Permit, the additional documentation requirements for sediment and erosion controls for well drillings and sand/shale mining areas include the following:

E.I.2.3.1 *Site Description.* Also include a description in your SWPCP of the nature of the exploration activity, estimates of the total area of site and area disturbed due to exploration activity, an estimate of runoff coefficient of the site, a site drainage map, including approximate slopes, and the names of all receiving waters.

E.I.2.3.2 *Vegetative Controls.* Document vegetative practices used in the SWPCP.

E.I.3 Additional Inspection Requirements.

All erosion and sediment controls must be inspected either: 1) every 7 days; or 2) once every 14 calendar days and within 24 hours of a storm event of 0.25 inches or greater.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector K – Hazardous Waste Treatment, Storage, or Disposal Facilities

E.K.1 Definitions

K.1.1 *Contaminated stormwater* - stormwater that comes into direct contact with landfill wastes, the waste handling and treatment areas, or landfill wastewater as defined in E.K.1.4. Some specific areas of a landfill that may produce contaminated stormwater include (but are not limited to) the open face of an active landfill with exposed waste (no cover added); the areas around wastewater treatment operations; trucks, equipment, or machinery that has been in direct contact with the waste; and waste dumping areas.

K.1.2 *Drained free liquids* - aqueous wastes drained from waste containers (e.g., drums) prior to landfilling.

K.1.3 *Landfill* - an area of land or an excavation in which wastes are placed for permanent disposal, but that is not a land application or land treatment unit, surface impoundment, underground injection well, waste pile, salt dome formation, salt bed formation, underground mine, or cave as these terms are defined in 40 CFR 257.2, 258.2, and 260.10.

K1.4 *Landfill wastewater* - as defined in 40 CFR Part 445 (Landfills Point Source Category), all wastewater associated with, or produced by, landfilling activities except for sanitary wastewater, non-contaminated stormwater, contaminated groundwater, and wastewater from recovery pumping wells. Landfill wastewater includes, but is not limited to, leachate, gas collection condensate, drained free liquids, laboratory derived wastewater, contaminated stormwater, and contact wash water from washing truck, equipment, and railcar exteriors and surface areas that have come in direct contact with solid waste at the landfill facility.

K.1.5 *Leachate* - liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.

K.1.6 *Non-contaminated stormwater* - stormwater that does not come into direct contact with landfill wastes, the waste handling and treatment areas, or landfill wastewater as defined in E.K.1.4. Non-contaminated stormwater includes stormwater that flows off the cap, cover, intermediate cover, daily cover, and/or final cover of the landfill.

E.K.2 Sector-Specific Benchmarks

Table E.K-1 identifies benchmarks that apply to the specific subsectors of Sector K. These benchmarks apply to both your primary industrial activity and any co-located industrial activities, which describe your site activities.

Table E.K-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
ALL - Industrial Activity Code "HZ". Benchmarks only applicable to discharges not subject to effluent limitations in 40 CFR Part 445 Subpart A.	Ammonia	2.14 mg/L
	Total Magnesium	0.064 mg/L
	Chemical Oxygen Demand (COD)	120 mg/L
	Total Arsenic	0.15 mg/L
	Total Cadmium	0.001 mg/L
	Total Cyanide	0.022 mg/ L
	Total Mercury	0.0014 mg/ L
	Total Selenium	0.005 mg/L
	Total Silver	0.0005 mg/L

E.K.3 Effluent Limitations Based on Effluent Limitations Guidelines

Table E.K-2 identifies effluent limits that apply to the industrial activities described below. Compliance with these effluent limits is to be determined based on discharges from these industrial activities independent of commingling with any other wastestreams that may be covered under this permit.

Table E.K-2[1]

Industrial Activity	Parameter	Effluent Limit
Discharges from hazardous waste landfills subject to effluent limitations in 40 CFR Part 445 Subpart A.	Biochemical Oxygen Demand (BOD_5)	220 mg/L, daily maximum
		56 mg/L, monthly avg. maximum
	Total Suspended Solids (TSS)	88 mg/L, daily maximum
		27 mg/L, monthly avg. maximum
	Ammonia	10 mg/L, daily maximum
		4.9 mg/L, monthly avg. maximum
	Alpha Terpineol	0.042 mg/L, daily maximum
		0.019 mg/L, monthly avg. maximum
	Aniline	0.024 mg/L, daily maximum
		0.015 mg/L, monthly avg. maximum
	Benzoic Acid	0.119 mg/L, daily maximum
		0.073 mg/L, monthly avg. maximum
	Naphthalene	0.059 mg/L, daily maximum
		0.022 mg/L, monthly avg. maximum
	p-Cresol	0.024 mg/L, daily maximum
		0.015 mg/L, monthly avg. maximum
	Phenol	0.048 mg/L, daily maximum
		0.029 mg/L, monthly avg. maximum
	Pyridine	0.072 mg/L, daily maximum
		0.025 mg/L, monthly avg. maximum
	Total Arsenic	1.1 mg/L, daily maximum
		0.54 mg/L, monthly avg. maximum

Table E.K-2[1]		
Industrial Activity	**Parameter**	**Effluent Limit**
	Total Chromium	1.1 mg/L, daily maximum
		0.46 mg/L, monthly avg. maximum
	Total Zinc	0.535 mg/L, daily maximum
		0.296 mg/L, monthly avg. maximum
	pH	Within the range of 6-9 standard pH units (s.u.)

[1] Monitor semi-annually. As set forth at 40 CFR Part 445 Subpart A, these numeric limitations apply to contaminated stormwater discharges from hazardous waste landfills subject to the provisions of RCRA Subtitle C at 40 CFR Parts 264 (Subpart N) and 265 (Subpart N) except for any of the following facilities:

(a) landfills operated in conjunction with other industrial or commercial operations when the landfill receives only wastes generated by the industrial or commercial operation directly associated with the landfill;

(b) landfills operated in conjunction with other industrial or commercial operations when the landfill receives wastes generated by the industrial or commercial operation directly associated with the landfill and also receives other wastes, provided that the other wastes received for disposal are generated by a facility that is subject to the same provisions in 40 CFR Subchapter N as the industrial or commercial operation or that the other wastes received are of similar nature to the wastes generated by the industrial or commercial operation;

(c) landfills operated in conjunction with Centralized Waste Treatment (CWT) facilities subject to 40 CFR Part 437, so long as the CWT facility commingles the landfill wastewater with other non-landfill wastewater for discharge. A landfill directly associated with a CWT facility is subject to this part if the CWT facility discharges landfill wastewater separately from other CWT wastewater or commingles the wastewater from its landfill only with wastewater from other landfills; or

(d) landfills operated in conjunction with other industrial or commercial operations when the landfill receives wastes from public service activities, so long as the company owning the landfill does not receive a fee or other remuneration for the disposal service.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector L – Landfills, Land Application Sites, and Open Dumps

E.L.1 Definitions

E.L.1.1 *Contaminated stormwater* - stormwater that comes into direct contact with landfill wastes, the waste handling and treatment areas, or landfill wastewater. Some areas of a landfill that may produce contaminated stormwater include (but are not limited to) the open face of an active landfill with exposed waste (no cover added); the areas around wastewater treatment operations; trucks, equipment, or machinery that has been in direct contact with the waste; and waste dumping areas.

E.L.1.2 *Drained free liquids* - aqueous wastes drained from waste containers (e.g., drums) prior to landfilling.

E.L.1.3 *Landfill wastewater* - as defined in 40 CFR Part 445 (Landfills Point Source Category) all wastewater associated with, or produced by, landfilling activities except for sanitary wastewater, non-contaminated stormwater, contaminated groundwater, and wastewater from recovery pumping wells. Landfill process wastewater includes, but is not limited to, leachate; gas collection condensate; drained free liquids; laboratory-derived wastewater; contaminated stormwater; and contact washwater from washing truck, equipment, and railcar exteriors and surface areas that have come in direct contact with solid waste at the landfill facility.

E.L.1.4 *Leachate* - liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.

E.L.1.5 *Non-contaminated stormwater* - stormwater that does not come into direct contact with landfill wastes, the waste handling and treatment areas, or landfill wastewater. Non-contaminated stormwater includes stormwater that flows off the cap, cover, intermediate cover, daily cover, and/or final cover of the landfill.

E.L.2 Additional Technology-Based Effluent Limits

E.L.2.1 *Preventive Maintenance Program.* As part of your preventive maintenance program, maintain the following: all elements of leachate collection and treatment systems, to prevent commingling of leachate with stormwater; the integrity and effectiveness of any intermediate or final cover (including repairing the cover as necessary), to minimize the effects of settlement, sinking, and erosion.

E.L.2.2 *Erosion and Sedimentation Control*. Provide temporary stabilization (e.g., temporary seeding, mulching, and placing geotextiles on the inactive portions of stockpiles) for the following: materials stockpiled for daily, intermediate, and final cover; inactive areas of the landfill or open dump; landfills or open dump areas that have gotten final covers but where vegetation has yet to establish itself; and land application sites where waste application has been completed but final vegetation has not yet been established.

E.L.2.3 *Unauthorized Discharge Test Certification*. The discharge test and certification must also be conducted for the presence of leachate and vehicle washwater.

E.L.3 Additional SWPCP Requirements

E.L.3.1 *Drainage Area Site Map.* Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: active and closed landfill cells or trenches, active and closed land application areas, locations where open dumping is occurring or has occurred,

locations of any known leachate springs or other areas where uncontrolled leachate may commingle with runoff, and leachate collection and handling systems.

E.L.3.2 *Summary of Potential Pollutant Sources.* Document in your SWPCP the following sources and activities that have potential pollutants associated with them: fertilizer, herbicide, and pesticide application; earth and soil moving; waste hauling and loading or unloading; outdoor storage of significant materials, including daily, interim, and final cover material stockpiles as well as temporary waste storage areas; exposure of active and inactive landfill and land application areas; uncontrolled leachate flows; and failure or leaks from leachate collection and treatment systems.

E.L.4 Additional Inspection Requirements

E.L.4.1 *Inspections of Active Sites.* Except in arid and semi-arid climates, inspect operating landfills, open dumps, and land application sites at least once every 7 days. Focus on areas of landfills that have not yet been finally stabilized; active land application areas, areas used for storage of material and wastes that are exposed to precipitation, stabilization, and structural control measures; leachate collection and treatment systems; and locations where equipment and waste trucks enter and exit the site. Ensure that sediment and erosion control measures are operating properly. For stabilized sites and areas where land application has been completed, or where the climate is arid or semi-arid, conduct inspections at least once every month.

E.L.4.2 *Inspections of Inactive Sites.* Inspect inactive landfills, open dumps, and land application sites at least monthly. Qualified personnel must inspect landfill (or open dump) stabilization and structural erosion control measures, leachate collection and treatment systems, and all closed land application areas.

E.L.5 Additional Post-Authorization Documentation Requirements

E.L.5.1 *Recordkeeping and Internal Reporting*. Keep records with your SWPCP of the types of wastes disposed of in each cell or trench of a landfill or open dump. For land application sites, track the types and quantities of wastes applied in specific areas.

E.L.6 Sector-Specific Benchmarks

Table E.L-1 identifies benchmarks that apply to the specific subsectors of Sector L. These benchmarks apply to both your primary industrial activity and any co-located industrial activities, which describe your site activities.

Table E.L-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	**Parameter**	**Benchmark Monitoring Concentration[1]**
All Landfill, Land Application Sites and Open Dumps, except Municipal Solid Waste Landfill (MSWLF) Areas Closed in Accordance with 40 CFR 258.60 (Industrial Activity Code "LF")	Total Iron	1.0 mg/L
[1]Benchmark monitoring required only for discharges not subject to effluent limitations in 40 CFR Part 445 Subpart B (see Table L-2 below).		

E.L.7. Effluent Limitations Based on Effluent Limitations Guidelines

Table E.L-2 identifies effluent limits that apply to the industrial activities described below. Compliance with these effluent limits is to be determined based on discharges from these industrial activities independent of commingling with any other wastestreams that may be covered under this permit.

Table E.L-2[1]

Industrial Activity	Parameter	Effluent Limit
Discharges from non-hazardous waste landfills subject to effluent limitations in 40 CFR Part 445 Subpart B.	Biochemical Oxygen Demand (BOD_5)	140 mg/L, daily maximum
		37 mg/L, monthly avg. maximum
	Total Suspended Solids (TSS)	88 mg/L, daily maximum
		27 mg/L, monthly avg. maximum
	Ammonia	10 mg/L, daily maximum
		4.9 mg/L, monthly avg. maximum
	Alpha Terpineol	0.033 mg/L, daily maximum
		0.016 mg/L monthly avg. maximum
	Benzoic Acid	0.12 mg/L, daily maximum
		0.071 mg/L, monthly avg. maximum
	p-Cresol	0.025 mg/L, daily maximum
		0.014 mg/L, monthly avg. maximum
	Phenol	0.026 mg/L, daily maximum
		0.015 mg/L, monthly avg. maximum
	Total Zinc	0.20 mg/L, daily maximum
		0.11 mg/L, monthly avg. maximum
	pH	Within the range of 6-9 standard pH units (s.u.)

[1] Monitor semi-annually. As set forth at 40 CFR Part 445 Subpart B, these numeric limitations apply to contaminated stormwater discharges from MSWLFs that have not been closed in accordance with 40 CFR 258.60, and to contaminated stormwater discharges from those landfills that are subject to the provisions of 40 CFR Part 257 except for discharges from any of the following facilities:

(a) landfills operated in conjunction with other industrial or commercial operations, when the landfill receives only wastes generated by the industrial or commercial operation directly associated with the landfill;

(b) landfills operated in conjunction with other industrial or commercial operations, when the landfill receives wastes generated by the industrial or commercial operation directly associated with the landfill and also receives other wastes, provided that the other wastes received for disposal are generated by a facility that is subject to the same provisions in 40 CFR Subchapter N as the industrial or commercial operation, or that the other wastes received are of similar nature to the wastes generated by the industrial or commercial operation;

(c) landfills operated in conjunction with CWT facilities subject to 40 CFR Part 437, so long as the CWT facility commingles the landfill wastewater with other non-landfill wastewater for discharge. A landfill directly associated with a CWT facility is subject to this part if the CWT facility discharges landfill wastewater separately from other CWT wastewater or commingles the wastewater from its landfill only with wastewater from other landfills; or

(d) landfills operated in conjunction with other industrial or commercial operations when the landfill receives wastes from public service activities, so long as the company owning the landfill does not receive a fee or other remuneration for the disposal service.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector M – Automobile Salvage Yards

E.M.1 Additional Technology-Based Effluent Limits

E.M.1.1 *Spill and Leak Prevention Procedures.* Drain vehicles intended to be dismantled of all fluids upon arrival at the site (or as soon thereafter as feasible), or employ some other equivalent means to prevent spills and leaks.

E.M.1.2 *Employee Training.* If applicable to your facility, address the following areas (at a minimum) in your employee training program: proper handling (collection, storage, and disposal) of oil, used mineral spirits, anti-freeze, mercury switches, and solvents.

E.M.1.3 *Management of Runoff.* Consider the following management practices: berms or drainage ditches on the property line (to help prevent run-on from neighboring properties); berms for uncovered outdoor storage of oily parts, engine blocks, and above-ground liquid storage; installation of detention ponds; and installation of filtering devices and oil and water separators.

E.M.2 Additional SWPCP Requirements

E.M.2.1 *Drainage Area Site Map.* Identify locations used for dismantling, storage, and maintenance of used motor vehicle parts. Also identify where any of the following may be exposed to precipitation or surface runoff: dismantling areas, parts (e.g., engine blocks, tires, hub caps, batteries, hoods, mufflers) storage areas, and liquid storage tanks and drums for fuel and other fluids.

E.M.2.2 *Potential Pollutant Sources.* Assess the potential for the following to contribute pollutants to stormwater discharges: vehicle storage areas, dismantling areas, parts storage areas (e.g., engine blocks, tires, hub caps, batteries, hoods, mufflers), and fueling stations.

E.M.3 Additional Inspection Requirements

Immediately (or as soon thereafter as feasible) inspect vehicles arriving at the site for leaks. Inspect monthly for signs of leakage all equipment containing oily parts, hydraulic fluids, any other types of fluids, or mercury switches. Also, inspect monthly for signs of leakage all vessels and areas where hazardous materials and general automotive fluids are stored, including, but not limited to, mercury switches, brake fluid, transmission fluid, radiator water, and antifreeze.

E.M.4 Sector-Specific Benchmarks

Table E.M-1 identifies benchmarks that apply to the specific subsectors of Sector M. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.M-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Automobile Salvage Yards (SIC 5015)	Total Aluminum	0.75 mg/L
	Total Iron	1.0 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector N – Scrap and Waste Materials

E.N.1 Additional Technology-Based Effluent Limits

E.N.1.1 *Scrap and Waste Recycling Facilities (Non-Source Separated, Nonliquid Recyclable Materials).* Requirements for facilities that receive, process, and do wholesale distribution of nonliquid recyclable wastes (e.g., ferrous and nonferrous metals, plastics, glass, cardboard, and paper). These facilities may receive both nonrecyclable and recyclable materials. This section is not intended for those facilities that accept recyclables only from primarily non-industrial and residential sources.

E.N.1.1.1 *Inbound Recyclable and Waste Material Control Program.* Minimize the chance of accepting materials that could be significant sources of pollutants by conducting inspections of inbound recyclables and waste materials. Following are some control measure options: (a) provide information and education to suppliers of scrap and recyclable waste materials on draining and properly disposing of residual fluids (e.g., from vehicles and equipment engines, radiators and transmissions, oil filled transformers, and individual containers or drums) and removal of mercury switches from vehicles before delivery to your facility; (b) establish procedures to minimize the potential of any residual fluids from coming into contact with precipitation or runoff; (c) establish procedures for accepting scrap lead-acid batteries (additional requirements for the handling, storage, and disposal or recycling of batteries are contained in the scrap lead-acid battery program provisions in E.N.3.1.6); (d) provide training targeted for those personnel engaged in the inspection and acceptance of inbound recyclable materials; and (e) establish procedures to ensure that liquid wastes, including used oil, are stored in materially compatible and non-leaking containers and are disposed of or recycled in accordance with the Resource Conservation and Recovery Act (RCRA).

E.N.1.1.2 *Scrap and Waste Material Stockpiles and Storage (Outdoor).* Minimize contact of stormwater runoff with stockpiled materials, processed materials, and nonrecyclable wastes. Following are some control measure options: (a) permanent or semi-permanent covers; (b) sediment traps, vegetated swales and strips, catch basin filters, and sand filters to facilitate settling or filtering of pollutants; (c) dikes, berms, containment trenches, culverts, and surface grading to divert runoff from storage areas; (d) silt fencing; and (e) oil and water separators, sumps, and dry absorbents for areas where potential sources of residual fluids are stockpiled (e.g., automobile engine storage areas).

E.N.1.1.3 *Stockpiling of Turnings Exposed to Cutting Fluids (Outdoor Storage).* Minimize contact of surface runoff with residual cutting fluids by: (a) storing all turnings exposed to cutting fluids under some form of permanent or semi-permanent cover, or (b) establishing dedicated containment areas for all turnings that have been exposed to cutting fluids. Any containment areas must be constructed of concrete, asphalt, or other equivalent types of impermeable material and include a barrier (e.g., berms, curbing, elevated pads) to prevent contact with stormwater run-on. Stormwater runoff from these areas can be discharged, provided that any runoff is first collected and treated by an oil and water separator or its equivalent. You must regularly maintain the oil and water separator (or its equivalent) and properly dispose of or recycle collected residual fluids.

E.N.1.1.4 *Scrap and Waste Material Stockpiles and Storage (Covered or Indoor Storage).* Minimize contact of residual liquids and particulate matter from materials stored indoors or under cover with surface runoff. Following are some control measure options: (a) good housekeeping measures, including the use of dry absorbents or wet vacuuming to contain, dispose of, or recycle residual liquids originating from recyclable containers, or mercury spill kits for spills from storage of mercury switches; (b) not allowing washwater from tipping floors or other processing areas to discharge to the storm sewer system; and (c) disconnecting or sealing off all floor drains connected to the storm sewer system.

E.N.1.1.5 *Scrap and Recyclable Waste Processing Areas.* Minimize surface runoff from coming in contact with scrap processing equipment. Pay attention to operations that generate visible amounts of particulate residue (e.g., shredding) to minimize the contact of accumulated particulate matter and residual fluids with runoff (i.e., through good housekeeping, preventive maintenance, etc.). Following are some control measure options: (a) regularly inspect equipment for spills or leaks and malfunctioning, worn, or corroded parts or equipment; (b) establish a preventive maintenance program for processing equipment; (c) use dry-absorbents or other cleanup practices to collect and dispose of or recycle spilled or leaking fluids or use mercury spill kits for spills from storage of mercury switches; (d) on unattended hydraulic reservoirs over 150 gallons in capacity, install protection devices such as low-level alarms or equivalent devices, or secondary containment that can hold the entire volume of the reservoir; (e) containment or diversion structures such as dikes, berms, culverts, trenches, elevated concrete pads, and grading to minimize contact of stormwater runoff with outdoor processing equipment or stored materials; (f) oil and water separators or sumps; (g) permanent or semi-permanent covers in processing areas where there are residual fluids and grease; (h) retention or detention ponds or basins; sediment traps, and vegetated swales or strips (for pollutant settling and filtration); (i) catch basin filters or sand filters.

E.N.1.1.6 *Scrap Lead-Acid Battery Program.* Properly handle, store, and dispose of scrap lead-acid batteries. Following are some control measure options (a) segregate scrap lead-acid batteries from other scrap materials; (b) properly handle, store, and dispose of cracked or broken batteries; (c) collect and dispose of leaking lead-acid battery fluid; (d) minimize or eliminate (if possible) exposure of scrap lead-acid batteries to precipitation or runoff; and (e) provide employee training for the management of scrap batteries.

E.N.1.1.7 *Spill Prevention and Response Procedures*. (See also Schedule A.1.h) Install alarms and/or pump shutoff systems on outdoor equipment with hydraulic reservoirs exceeding 150 gallons in the event of a line break. Alternatively, a secondary containment system capable of holding the entire contents of the reservoir plus room for precipitation can be used. Use a mercury spill kit for any release of mercury from switches, anti-lock brake systems, and switch storage areas.

E.N.1.1.8 *Supplier Notification Program.* As appropriate, notify major suppliers which scrap materials will not be accepted at the facility or will be accepted only under certain conditions.

E.N.1.2 *Waste Recycling Facilities* (Liquid Recyclable Materials).

E.N.1.2.1 *Waste Material Storage (Indoor).* Minimize or eliminate contact between residual liquids from waste materials stored indoors and from surface runoff. The plan may refer to applicable portions of other existing plans, such as Spill Prevention, Control,

and Countermeasure (SPCC) plans required under 40 CFR Part 112. Following are some control measure options (a) procedures for material handling (including labeling and marking); (b) clean up spills and leaks with dry absorbent materials, a wet vacuum system; (c) appropriate containment structures (trenching, curbing, gutters, etc.); and (d) a drainage system, including appurtenances (e.g., pumps or ejectors, manually operated valves), to handle discharges from diked or bermed areas. Drainage should be discharged to an appropriate treatment facility or sanitary sewer system, or otherwise disposed of properly. These discharges may require coverage under a separate NPDES wastewater permit or industrial user permit under the pretreatment program.

E.N.1.2.2 *Waste Material Storage (Outdoor).* Minimize contact between stored residual liquids and precipitation or runoff. The plan may refer to applicable portions of other existing plans, such as SPCC plans required under 40 CFR Part 112. Discharges of precipitation from containment areas containing used oil must also be in accordance with applicable sections of 40 CFR Part 112. Following are some control measure options (a) appropriate containment structures (e.g., dikes, berms, curbing, pits) to store the volume of the largest tank, with sufficient extra capacity for precipitation; (b) drainage control and other diversionary structures; (c) corrosion protection and/or leak detection systems for storage tanks; and (d) dry-absorbent materials or a wet vacuum system to collect spills.

E.N.1.2.3 *Trucks and Rail Car Waste Transfer Areas.* Minimize pollutants in discharges from truck and rail car loading and unloading areas. Include measures to clean up minor spills and leaks resulting from the transfer of liquid wastes. Following are two control measure options: (a) containment and diversionary structures to minimize contact with precipitation or runoff, and (b) dry clean-up methods, wet vacuuming, roof coverings, or runoff controls.

E.N.1.3 *Recycling Facilities (Source-Separated Materials).* The following identifies considerations for facilities that receive only source-separated recyclables, primarily from non-industrial and residential sources.

E.N.1.3.1 *Inbound Recyclable Material Control.* Minimize the chance of accepting nonrecyclables (e.g., hazardous materials) that could be a significant source of pollutants by conducting inspections of inbound materials. Following are some control measure options: (a) providing information and education measures to inform suppliers of recyclables about acceptable and non-acceptable materials, (b) training drivers responsible for pickup of recycled material, (c) clearly marking public drop-off containers regarding which materials can be accepted, (d) rejecting nonrecyclable wastes or household hazardous wastes at the source, and (e) establishing procedures for handling and disposal of nonrecyclable material.

E.N.1.3.2 *Outdoor Storage.* Minimize exposure of recyclables to precipitation and runoff. Use good housekeeping measures to prevent accumulation of particulate matter and fluids, particularly in high traffic areas. Following are some control measure options (a) provide totally enclosed drop-off containers for the public; (b) install a sump and pump with each container pit and treat or discharge collected fluids to a sanitary sewer system; (c) provide dikes and curbs for secondary containment (e.g., around bales of recyclable waste paper); (d) divert surface water runoff away from outside material storage areas; (e) provide covers over containment bins, dumpsters, and roll-off boxes; and (f) store the equivalent of one day’s volume of recyclable material indoors.

E.N.1.3.3 *Indoor Storage and Material Processing.* Minimize the release of pollutants from indoor storage and processing areas. Following are some control measure options (a) schedule routine good housekeeping measures for all storage and processing areas, (b) prohibit tipping floor washwater from draining to the storm sewer system, and (c) provide employee training on pollution prevention practices.

E.N.1.3.4 *Vehicle and Equipment Maintenance.* Following are some control measure options for areas where vehicle and equipment maintenance occur outdoors (a) prohibit vehicle and equipment washwater from discharging to the storm sewer system, (b) minimize or eliminate outdoor maintenance areas whenever possible, (c) establish spill prevention and clean-up procedures in fueling areas, (d) avoid topping off fuel tanks, (e) divert runoff from fueling areas, (f) store lubricants and hydraulic fluids indoors, and (g) provide employee training on proper handling and storage of hydraulic fluids and lubricants.

E.N.2 Additional SWPCP Requirements

E.N.2.1 *Drainage Area Site Map.* Document in your SWPCP the locations of any of the following activities or sources that may be exposed to precipitation or surface runoff: scrap and waste material storage, outdoor scrap and waste processing equipment; and containment areas for turnings exposed to cutting fluids.

E.N.2.2 *Maintenance Schedules/Procedures for Collection, Handling, and Disposal or Recycling of Residual Fluids at Scrap and Waste Recycling Facilities.* If you are subject to E.N.1.1.3, your SWPCP must identify any applicable maintenance schedule and the procedures to collect, handle, and dispose of or recycle residual fluids.

E.N.3 Sector-Specific Benchmarks

Table E.N-1 identifies benchmarks that apply to the specific subsectors of Sector N. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.N-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Scrap Recycling and Waste Recycling Facilities except Source-Separated Recycling (SIC 5093)	Chemical Oxygen Demand (COD)	120 mg/L
	Total Recoverable Aluminum	0.75 mg/L
	Total Recoverable Iron	1.0 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector O – Steam Electric Generating Facilities.

E.O.1 Additional Technology-Based Effluent Limits.

The following good housekeeping measures are required in addition to Schedule A.1 of permit:

E.O.1.1 *Fugitive Dust Emissions.* Minimize fugitive dust emissions from coal handling areas. To minimize the tracking of coal dust offsite, consider procedures such as installing specially designed tires or washing vehicles in a designated area before they leave the site and controlling the wash water.

E.O.1.2 *Delivery Vehicles.* Minimize contamination of stormwater runoff from delivery vehicles arriving at the plant site. Consider procedures to inspect delivery vehicles arriving at the plant site and ensure overall integrity of the body or container and procedures to deal with leakage or spillage from vehicles or containers.

E.O.1.3 *Fuel Oil Unloading Areas.* Minimize contamination of precipitation or surface runoff from fuel oil unloading areas. Consider using containment curbs in unloading areas, having personnel familiar with spill prevention and response procedures present during deliveries to ensure that any leaks or spills are immediately contained and cleaned up, and using spill and overflow protection devices (e.g., drip pans, drip diapers, or other containment devices placed beneath fuel oil connectors to contain potential spillage during deliveries or from leaks at the connectors).

E.O.1.4 *Chemical Loading and Unloading.* Minimize contamination of precipitation or surface runoff from chemical loading and unloading areas. Consider using containment curbs at chemical loading and unloading areas to contain spills, having personnel familiar with spill prevention and response procedures present during deliveries to ensure that any leaks or spills are immediately contained and cleaned up, and loading and unloading in covered areas and storing chemicals indoors.

E.O.1.5 *Miscellaneous Loading and Unloading Areas.* Minimize contamination of precipitation or surface runoff from loading and unloading areas. Consider covering the loading area; grading, berming, or curbing around the loading area to divert run-on; locating the loading and unloading equipment and vehicles so that leaks are contained in existing containment and flow diversion systems; or equivalent procedures.

E.O.1.6 *Liquid Storage Tanks*. Minimize contamination of surface runoff from above-ground liquid storage tanks. Consider protective guards around tanks, containment curbs, spill and overflow protection, dry cleanup methods, or equivalent measures.

E.O.1.7 *Large Bulk Fuel Storage Tanks.* Minimize contamination of surface runoff from large bulk fuel storage tanks. Consider containment berms (or their equivalent). You must also comply with applicable State and Federal laws, including Spill Prevention, Control and Countermeasure (SPCC) Plan requirements.

E.O.1.8 *Spill Reduction Measures.* Minimize the potential for an oil or chemical spill, or reference the appropriate part of your SPCC plan. Visually inspect as part of your routine facility inspection the structural integrity of all above-ground tanks, pipelines, pumps, and related equipment that may be exposed to stormwater, and make any necessary repairs immediately.

E.O.1.9 *Oil-Bearing Equipment in Switchyards.* Minimize contamination of surface runoff from oil-bearing equipment in switchyard areas. Consider using level grades and gravel surfaces to retard flows and limit the spread of spills, or collecting runoff in perimeter ditches.

E.O.1.10 *Residue-Hauling Vehicles.* Inspect all residue-hauling vehicles for proper covering over the load, adequate gate sealing, and overall integrity of the container body. Repair vehicles without load covering or adequate gate sealing, or with leaking containers or beds.

E.O.1.11 *Ash Loading Areas.* Reduce or control the tracking of ash and residue from ash loading areas. Clear the ash building floor and immediately adjacent roadways of spillage, debris, and excess water before departure of each loaded vehicle.

E.O.1.12 *Areas Adjacent to Disposal Ponds or Landfills.* Minimize contamination of surface runoff from areas adjacent to disposal ponds or landfills. Reduce ash residue that may be tracked on to access roads traveled by residue handling vehicles, and reduce ash residue on exit roads leading into and out of residue handling areas.

E.O.1.13 *Landfills, Scrap yards, Surface Impoundments, Open Dumps, General Refuse Sites.* Minimize the potential for contamination of runoff from these areas.

E.O.2 Additional SWPCP Requirements

E.O.2.1 *Drainage Area Site Map.* Document in your SWPCP the locations of any of the following activities or sources that may be exposed to precipitation or surface runoff: storage tanks, scrap yards, and general refuse areas; short- and long-term storage of general materials (including but not limited to supplies, construction materials, paint equipment, oils, fuels, used and unused solvents, cleaning materials, paint, water treatment chemicals, fertilizer, and pesticides); landfills and construction sites; and stock pile areas (e.g., coal or limestone piles).

E.O.3 Additional Inspection Requirements

E.O.3.1 *Inspection.* Inspect the following areas monthly: coal handling areas, loading or unloading areas, switchyards, fueling areas, bulk storage areas, ash handling areas, areas adjacent to disposal ponds and landfills, maintenance areas, liquid storage tanks, and long term and short term material storage areas.

E.O.4 Sector-Specific Benchmarks

Table E.O-1 identifies benchmarks that apply to the specific subsectors of Sector O. These benchmarks apply to both your primary industrial activity and any co-located industrial activities, which describe your site activities.

Table E.O-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Steam Electric Generating Facilities (Industrial Activity Code "SE")	Total Iron	1.0 mg/L

E.O.5 Effluent Limitations Based on Effluent Limitations Guidelines

Table E.O-2 identifies effluent limits that apply to the industrial activities described below. Compliance with these effluent limits is to be determined based on discharges from these industrial activities independent of commingling with any other wastestreams that may be covered under this permit.

Table E.O-2[1]

Industrial Activity	Parameter	Effluent Limit
Discharges from coal storage piles at Steam Electric Generating Facilities	TSS	50 mg/l[2]
	pH	6.0 min - 9.0 max

[1] Monitor semi-annually.
[2] If your facility is designed, constructed, and operated to treat the volume of coal pile runoff that is associated with a 10-year, 24-hour rainfall event, any untreated overflow of coal pile runoff from the treatment unit is not subject to the 50 mg/L limitation for total suspended solids.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector P – Land Transportation and Warehousing.

E.P.1 Additional Technology-Based Effluent Limits

E.P.1.1 *Good Housekeeping Measures.* In addition to the Good Housekeeping requirements in Schedule A.1 of the permit, you must do the following:

E.P.1.1.1 *Vehicle and Equipment Storage Areas.* Minimize the potential for stormwater exposure to leaky or leak-prone vehicles/equipment awaiting maintenance. Consider the following (or other equivalent measures): use of drip pans under vehicles/equipment, indoor storage of vehicles and equipment, installation of berms or dikes, use of absorbents, roofing or covering storage areas, and cleaning pavement surfaces to remove oil and grease.

E.P.1.1.2 *Fueling Areas.* Minimize contamination of stormwater runoff from fueling areas. Consider the following (or other equivalent measures): Covering the fueling area; using spill/overflow protection and cleanup equipment; minimizing stormwater run-on/runoff to the fueling area; using dry cleanup methods; and treating and/or recycling collected stormwater runoff.

E.P.1.1.3 *Material Storage Areas.* Maintain all material storage vessels (e.g., for used oil/oil filters, spent solvents, paint wastes, hydraulic fluids) to prevent contamination of stormwater and plainly label them (e.g., "Used Oil," "Spent Solvents," etc.). Consider the following (or other equivalent measures): storing the materials indoors; installing berms/dikes around the areas; minimizing runoff of stormwater to the areas; using dry cleanup methods; and treating and/or recycling collected stormwater runoff.

E.P.1.1.4 *Vehicle and Equipment Cleaning Areas.* Minimize contamination of stormwater runoff from all areas used for vehicle/equipment cleaning. Consider the following (or other equivalent measures): performing all cleaning operations indoors; covering the cleaning operation, ensuring that all washwater drains to a proper collection system (i.e., not the stormwater drainage system); treating and/or recycling collected washwater, or other equivalent measures.

E.P.1.1.5 *Vehicle and Equipment Maintenance Areas.* Minimize contamination of stormwater runoff from all areas used for vehicle/equipment maintenance. Consider the following (or other equivalent measures): performing maintenance activities indoors; using drip pans; keeping an organized inventory of materials used in the shop; draining all parts of fluid prior to disposal; prohibiting wet clean up practices if these practices would result in the discharge of pollutants to stormwater drainage systems; using dry cleanup methods; treating and/or recycling collected stormwater runoff, minimizing run on/runoff of stormwater to maintenance areas.

E.P.1.1.6 *Locomotive Sanding (Loading Sand for Traction) Areas.* Consider the following (or other equivalent measures): covering sanding areas; minimizing stormwater run on/runoff; or appropriate sediment removal practices to minimize the offsite transport of sanding material by stormwater.

E.P.1.2 *Employee Training.* Address the following activities, as applicable: used oil and spent solvent management; fueling procedures; general good housekeeping practices; proper painting procedures; and used battery management.

E.P.2 Additional SWPCP Requirements

E.P.2.1 *Drainage Area Site Map.* Identify in the SWPCP the following areas of the facility and indicate whether activities occurring there may be exposed to precipitation/surface runoff: Fueling stations; vehicle/equipment maintenance or cleaning areas; storage areas for vehicle/equipment with actual or potential fluid leaks; loading/unloading areas; areas where treatment, storage or disposal of wastes occur; liquid storage tanks; processing areas; and storage areas.

E.P.2.2 *Potential Pollutant Sources.* Assess the potential for the following activities and facility areas to contribute pollutants to stormwater discharges: Onsite waste storage or disposal; dirt/gravel parking areas for vehicles awaiting maintenance; illicit plumbing connections between shop floor drains and the stormwater conveyance system(s); and fueling areas. Describe these activities in the SWPCP.

E.P.2.3 *Description of Good Housekeeping Measures.* You must document in your SWPCP the good housekeeping measures you implement consistent with E.P.1.

E.P.2.4 *Vehicle and Equipment Wash Water Requirements.* If wash water is handled in a manner that does not involve separate NPDES permitting (e.g., hauled offsite), describe the disposal method and include all pertinent information (e.g., frequency, volume, destination, etc.) in your SWPCP. Discharges of vehicle and equipment wash water, including tank cleaning operations, are not authorized by this permit for this sector.

E.P.3 Additional Inspection Requirements Inspect all the following areas/activities: storage areas for vehicles/equipment awaiting maintenance, fueling areas, indoor and outdoor vehicle/equipment maintenance areas, material storage areas, vehicle/equipment cleaning areas and loading/unloading areas.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector Q – Water Transportation

E.Q.1 Additional Technology-Based Effluent Limits

E.Q.1.1 *Good Housekeeping Measures.* You must implement the following good housekeeping measures in addition to requirements in Schedule A.1 of the permit:

E.Q.1.1.1 *Pressure Washing Area.* If pressure washing is used to remove marine growth from vessels, the discharge water must be permitted by a separate NPDES permit. Collect or contain the discharges from the pressure washing area so that they are not commingled with stormwater discharges authorized by this permit.

E.Q.1.1.2 *Blasting and Painting Area.* Minimize the potential for spent abrasives, paint chips, and overspray to discharge into receiving waters or the storm sewer systems. Consider containing all blasting and painting activities or use other measures to minimize the discharge of contaminants (e.g., hanging plastic barriers or tarpaulins during blasting or painting operations to contain debris). When necessary, regularly clean stormwater conveyances of deposits of abrasive blasting debris and paint chips.

E.Q.1.1.3 *Material Storage Areas.* Store and plainly label all containerized materials (e.g., fuels, paints, solvents, waste oil, antifreeze, batteries) in a protected, secure location away from drains. Minimize the contamination of precipitation or surface runoff from the storage areas. Specify which materials are stored indoors, and consider containment or enclosure for those stored outdoors. If abrasive blasting is performed, discuss the storage and disposal of spent abrasive materials generated at the facility. Consider implementing an inventory control plan to limit the presence of potentially hazardous materials onsite.

E.Q.1.1.4 *Engine Maintenance and Repair Areas.* Minimize the contamination of precipitation or surface runoff from all areas used for engine maintenance and repair. Consider the following (or their equivalents): performing all maintenance activities indoors, maintaining an organized inventory of materials used in the shop, draining all parts of fluid prior to disposal, prohibiting the practice of hosing down the shop floor, using dry cleanup methods, and treating and/or recycling stormwater runoff collected from the maintenance area.

E.Q.1.1.5 *Material Handling Area.* Minimize the contamination of precipitation or surface runoff from material handling operations and areas (e.g., fueling, paint and solvent mixing, disposal of process wastewater streams from vessels). Consider the following (or their equivalents): covering fueling areas, using spill and overflow protection, mixing paints and solvents in a designated area (preferably indoors or under a shed), and minimizing runoff of stormwater to material handling areas.

E.Q.1.1.6 *Drydock Activities.* Routinely maintain and clean the drydock to minimize pollutants in stormwater runoff. Address the cleaning of accessible areas of the drydock prior to flooding, and final cleanup following removal of the vessel and raising the dock. Include procedures for cleaning up oil, grease, and fuel spills occurring on the drydock. Consider the following (or their equivalents): sweeping rather than hosing off debris and spent blasting material from accessible areas of the drydock prior to flooding and making absorbent materials and oil containment booms readily available to clean up or contain any spills.

E.Q.1.2 *Employee Training.* At a minimum, address the following activities (as applicable): used oil management, spent solvent management, disposal of spent abrasives, disposal of vessel

wastewaters, spill prevention and control, fueling procedures, general good housekeeping practices, painting and blasting procedures, and used battery management.

E.Q.1.3 *Preventive Maintenance.* As part of your preventive maintenance program, perform timely inspection and maintenance of stormwater management devices (e.g., cleaning oil and water separators and sediment traps to ensure that spent abrasives, paint chips, and solids will be intercepted and retained prior to entering the storm drainage system), as well as inspecting and testing facility equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters.

E.Q.2 Additional SWPCP Requirements

E.Q.2.1 *Drainage Area Site Map.* Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: fueling; engine maintenance and repair; vessel maintenance and repair; pressure washing; painting; sanding; blasting; welding; metal fabrication; loading and unloading areas; locations used for the treatment, storage, or disposal of wastes; liquid storage tanks; liquid storage areas (e.g., paint, solvents, resins); and material storage areas (e.g., blasting media, aluminum, steel, scrap iron).

E.Q.2.2 *Summary of Potential Pollutant Sources.* Document in the SWPCP the following additional sources and activities that have potential pollutants associated with them: outdoor manufacturing or processing activities (e.g., welding, metal fabricating) and significant dust or particulate generating processes (e.g., abrasive blasting, sanding, and painting.)

E.Q.3 Additional Inspection Requirements

Inspect pressure washing area; blasting, sanding, and painting areas; material storage areas; engine maintenance and repair areas; material handling areas; drydock area; and general yard area.

E.Q.4 Sector-Specific Benchmarks

Table E.Q-1 identifies benchmarks that apply to the specific subsectors of Sector Q. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.Q-1.

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Water Transportation Facilities (SIC 4412-4499)	Total Aluminum	0.75 mg/L
	Total Iron	1.0 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector R – Ship and Boat Building and Repair Yards

E.R.1 Additional Technology-Based Effluent Limits

E.R.1.1 *Good Housekeeping Measures.*

E.R.1.1.1 *Pressure Washing Area.* If pressure washing is used to remove marine growth from vessels, the discharged water must be permitted as a process wastewater by a separate NPDES permit.

E.R.1.1.2 *Blasting and Painting Area.* Minimize the potential for spent abrasives, paint chips, and overspray to discharging into the receiving water or the storm sewer systems. Consider containing all blasting and painting activities, or use other measures to prevent the discharge of the contaminants (e.g., hanging plastic barriers or tarpaulins during blasting or painting operations to contain debris). When necessary, regularly clean stormwater conveyances of deposits of abrasive blasting debris and paint chips.

E.R.1.1.3 *Material Storage Areas.* Store and plainly label all containerized materials (e.g., fuels, paints, solvents, waste oil, antifreeze, batteries) in a protected, secure location away from drains. Minimize the contamination of precipitation or surface runoff from the storage areas. If abrasive blasting is performed, discuss the storage and disposal of spent abrasive materials generated at the facility. Consider implementing an inventory control plan to limit the presence of potentially hazardous materials onsite.

E.R.1.1.4 *Engine Maintenance and Repair Areas.* Minimize the contamination of precipitation or surface runoff from all areas used for engine maintenance and repair. Consider the following (or their equivalents): performing all maintenance activities indoors, maintaining an organized inventory of materials used in the shop, draining all parts of fluid prior to disposal, prohibiting the practice of hosing down the shop floor, using dry cleanup methods, and treating and/or recycling stormwater runoff collected from the maintenance area.

E.R.1.1.5 *Material Handling Area.* Minimize the contamination of precipitation or surface runoff from material handling operations and areas (e.g., fueling, paint and solvent mixing, disposal of process wastewater streams from vessels). Consider the following (or their equivalents): covering fueling areas, using spill and overflow protection, mixing paints and solvents in a designated area (preferably indoors or under a shed), and minimizing stormwater run-on to material handling areas.

E.R.1.1.6 *Drydock Activities.* Routinely maintain and clean the drydock to minimize pollutants in stormwater runoff. Clean accessible areas of the drydock prior to flooding and final cleanup following removal of the vessel and raising the dock. Include procedures for cleaning up oil, grease, or fuel spills occurring on the drydock. Consider the following (or their equivalents): sweeping rather than hosing off debris and spent blasting material from accessible areas of the drydock prior to flooding, and having absorbent materials and oil containment booms readily available to clean up and contain any spills.

E.R.1.2 *Employee Training.* As part of your employee training program, address, at a minimum, the following activities (as applicable): used oil management, spent solvent management, disposal of spent abrasives, disposal of vessel wastewaters, spill prevention and control, fueling procedures, general good housekeeping practices, painting and blasting procedures, and used battery management.

E.R.1.3 *Preventive Maintenance.* As part of your preventive maintenance program, perform timely inspection and maintenance of stormwater management devices (e.g., cleaning oil and water separators and sediment traps to ensure that spent abrasives, paint chips, and solids will be intercepted and retained prior to entering the storm drainage system), as well as inspecting and testing facility equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters.

E.R.2 Additional SWPCP Requirements

E.R.2.1 *Drainage Area Site Map.* Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: fueling; engine maintenance or repair; vessel maintenance or repair; pressure washing; painting; sanding; blasting; welding; metal fabrication; loading and unloading areas; treatment, storage, and waste disposal areas; liquid storage tanks; liquid storage areas (e.g., paint, solvents, resins); and material storage areas (e.g., blasting media, aluminum, steel, scrap iron).

E.R.2.2 *Potential Pollutant Sources.* Document in your SWPCP the following additional sources and activities that have potential pollutants associated with them (if applicable): outdoor manufacturing or processing activities (e.g., welding, metal fabricating) and significant dust or particulate generating processes (e.g., abrasive blasting, sanding, and painting).

E.R.2.3 *Documentation of Good Housekeeping Measures.* Document in your SWPCP any good housekeeping measures implemented to meet the effluent limits in E.R.1.1.

E.R.2.3.1 *Blasting and Painting Areas.* Document in the SWPCP any standard operating practices relating to blasting and painting (e.g., prohibiting uncontained blasting and painting over open water or prohibiting blasting and painting during windy conditions, which can render containment ineffective).

E.R.2.3.2 *Storage Areas.* Specify in your SWPCP which materials are stored indoors, and consider containment or enclosure for those stored outdoors.

E.R.3 Additional Inspection Requirements

Include the following in all monthly inspections: pressure washing area; blasting, sanding, and painting areas; material storage areas; engine maintenance and repair areas; material handling areas; drydock area; and general yard area.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector S – Air Transportation

E.S.1 Limitation on Coverage

E.S.1.1 *Limitations on Coverage.* This permit authorizes stormwater discharges from only those portions of the air transportation facility that are involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling and lubrication), equipment cleaning operations or deicing operations.

Note: the term "deicing" in this permit will generally be used to mean both deicing (removing frost, snow or ice) and anti-icing (preventing accumulation of frost, snow or ice) activities, unless specific mention is made otherwise.

E.S.2 Multiple Operators at Air Transportation Facilities

Air transportation facilities often have more than one operator who could discharge stormwater associated with industrial activity. Operators include the airport authority and airport tenants, including air passenger or cargo companies, fixed based operators, and other parties who routinely perform industrial activities on airport property.

The airport authority and tenants of the airport are encouraged to work in partnership in the development of the SWPCP. Tenants of the airport facility include air passenger or cargo companies, fixed based operators and other parties who have contracts with the airport authority to conduct business operations on airport property and whose operations result in stormwater discharges associated with industrial activity. An airport tenant may obtain authorization under this permit and develop a SWPCP for discharges from his/her own areas of the airport.

E.S.3 Additional Technology-Based Effluent Limits

E.S.3.1 *Good Housekeeping Measures.*

E.S.3.1.1 *Aircraft, Ground Vehicle and Equipment Maintenance Areas*. Minimize the contamination of stormwater runoff from all areas used for aircraft, ground vehicle and equipment maintenance (including the maintenance conducted on the terminal apron and in dedicated hangers). Consider the following practices (or their equivalents): performing maintenance activities indoors; maintaining an organized inventory of material used in the maintenance areas; draining all parts of fluids prior to disposal; prohibiting the practice of hosing down the apron or hanger floor; using dry cleanup methods; and collecting the stormwater runoff from the maintenance area and providing treatment or recycling.

E.S.3.1.2 *Aircraft, Ground Vehicle and Equipment Cleaning Areas*. Clearly demarcate these areas on the ground using signage or other appropriate means. Minimize the contamination of stormwater runoff from cleaning areas.

E.S.3.1.3 *Aircraft, Ground Vehicle and Equipment Storage Areas*. Store all aircraft, ground vehicles and equipment awaiting maintenance in designated areas only and minimize the contamination of stormwater runoff from these storage areas. Consider the following control measures, including any BMPs (or their equivalents): storing aircraft and ground vehicles indoors; using drip pans for the collection of fluid leaks; and perimeter drains, dikes or berms surrounding the storage areas.

E.S.3.1.4 *Material Storage Areas*. Maintain the vessels of stored materials (e.g., used oils, hydraulic fluids, spent solvents, and waste aircraft fuel) in good condition, to prevent or minimize contamination of stormwater. Also plainly label the vessels (e.g., "used oil," "Contaminated Jet A," etc.). Minimize contamination of precipitation/runoff from these areas. Consider the following control measures (or their equivalents): storing materials indoors; storing waste materials in a centralized location; and installing berms/dikes around storage areas.

E.S.3.1.5 *Airport Fuel System and Fueling Areas*. Minimize the discharge of fuel to the storm sewer/surface waters resulting from fuel servicing activities or other operations conducted in support of the airport fuel system. Consider the following control measures (or their equivalents): implementing spill and overflow practices (e.g., placing absorptive materials beneath aircraft during fueling operations); using only dry cleanup methods; and collecting stormwater runoff.

E.S.3.1.6 *Source Reduction*. Minimize, and where feasible eliminate, the use of urea and glycol-based deicing chemicals, in order to reduce the aggregate amount of deicing chemicals used and/or lessen the environmental impact. Chemical options to replace ethylene glycol, propylene glycol and urea include: potassium acetate; magnesium acetate; calcium acetate; and anhydrous sodium acetate.

E.S.3.1.6.1 *Runway Deicing Operation*: To minimize the discharge of pollutants in stormwater from runway deicing operations, implement source reduction control measures such as the following, where determined to be feasible and that accommodate considerations of safety, space, operational constraints, and flight considerations (list not exclusive): metered application of chemicals; pre-wetting dry chemical constituents prior to application; installing a runway ice detection system; implementing anti-icing operations as a preventive measure against ice buildup; heating sand; and product substitution.

E.S.3.1.6.2 *Aircraft Deicing Operations*. Minimize the discharge of pollutants in stormwater from aircraft deicing operations. Determine whether excessive application of deicing chemicals occurs and adjust as necessary, consistent with considerations of flight safety. Determine whether alternatives to glycol and whether containment measures for applied chemicals are feasible. Implement control measures for reducing deicing fluid such as the following, where determined to be feasible and that accommodate considerations of safety, space, operational constraints, and flight considerations (list not exclusive): forced-air deicing systems, computer-controlled fixed-gantry systems, infrared technology, hot water, varying glycol content to air temperature, enclosed-basket deicing trucks, mechanical methods, solar radiation, hangar storage, aircraft covers, and thermal blankets for MD-80s and DC-9s. Consider using ice-detection systems and airport traffic flow strategies and departure slot allocation systems where feasible and that accommodate considerations of safety, space, operational constraints, and flight considerations. The evaluations and determinations required by this Part should be carried out by the personnel most familiar with the particular aircraft and flight operations and related systems in question (versus an outside entity such as the airport authority.

E.S.3.1.7 *Management of Runoff*. Minimize the discharge of pollutants in stormwater from deicing chemicals in runoff. To minimize discharges of pollutants in stormwater from aircraft deicing, implement runoff management control measures such as the following, where determined to be feasible and that accommodate considerations of safety, space, operational constraints, and flight considerations (list not exclusive): installing a centralized deicing pad to recover deicing fluid following application; plug-and-pump (PnP); using vacuum/collection trucks (glycol recovery vehicles); storing contaminated stormwater/deicing fluids in tanks; recycling collected deicing fluid where feasible; releasing controlled amounts to a publicly owned treatment works; separation of contaminated snow; conveying contaminated runoff into a stormwater impoundment for biochemical decomposition (be aware of attracting wildlife that may prove hazardous to flight operations); and directing runoff into vegetative swales or other infiltration measures. To minimize discharges of pollutants in stormwater from runway deicing, implement runoff management control measures such as the following, where determined to be feasible and that accommodate considerations of safety, space, operational constraints, and flight considerations (list not exclusive): mechanical systems (snow plows, brushes); conveying contaminated runoff into swales and/or a stormwater impoundment; and pollution prevention practices such as ice detection systems, and airfield prewetting.
When applying deicing fluids during non-precipitation events (also referred to as "clear ice deicing"), implement control measures to prevent unauthorized discharge of pollutants (dry-weather discharges of pollutants would need coverage under an NPDES wastewater permit), or to minimize the discharge of pollutants from deicing fluids in later stormwater discharges, implement control measures such as the following, where determined to be feasible and that accommodate considerations safety, space, operational constraints, and flight considerations (list not exclusive): recovering deicing fluids; preventing the fluids from entering storm sewers or other stormwater discharge conveyances (e.g., covering storm sewer inlets, using booms, installing absorptive interceptors in the drains); releasing controlled amounts to a publicly owned treatment works Used deicing fluid should be recycled whenever practicable.

E.S.3.2 *Deicing Season.* You must determine the seasonal timeframe (e.g., December- February, October - March, etc.) during which deicing activities typically occur at the facility. Implementation of control measures, including any BMPs, facility inspections and monitoring must be conducted with particular emphasis throughout the defined deicing season. If you meet the deicing chemical usage thresholds of 100,000 gallons glycol and/or 100 tons of urea, the deicing season you identified is the timeframe during which you must obtain the four required benchmark monitoring event results for deicing-related parameters, i.e., BOD, COD, ammonia and pH.

E.S.4 Additional SWPCP Requirements

E.S.4.1 *Drainage Area Site Map*. Document in the SWPCP the following areas of the facility and indicate whether activities occurring there may be exposed to precipitation/surface runoff: aircraft and runway deicing operations; fueling stations; aircraft, ground vehicle and equipment maintenance/cleaning areas; storage areas for aircraft, ground vehicles and equipment awaiting maintenance.

E.S.4.2 *Potential Pollutant Sources.* In your inventory of exposed materials, describe in your SWPCP the potential for the following activities and facility areas to contribute pollutants to stormwater discharges: aircraft, runway, ground vehicle and equipment maintenance and cleaning; aircraft and runway deicing operations (including apron and centralized aircraft deicing stations, runways, taxiways and ramps). If you use deicing chemicals, you must maintain a record of the types (including the Safety Data Sheets [SDS]) used and the monthly quantities, either as measured or, in the absence of metering, as estimated to the best of your knowledge. This includes all deicing chemicals, not just glycols and urea (e.g., potassium acetate), because large quantities of these other chemicals can still have an adverse impact on receiving waters. Tenants or other fixed-based operations that conduct deicing operations must provide the above information to the airport authority for inclusion with any comprehensive airport SWPCPs.

E.S.4.3 *Vehicle and Equipment Washwater Requirements.* Attach to or reference in your SWPCP, a copy of the NPDES permit issued for vehicle/equipment washwater, if applicable. If an industrial user permit is issued under a local pretreatment program, include a copy in your SWPCP. If washwater is handled in another manner (e.g., hauled offsite, retained onsite), describe the disposal method and attach all pertinent documentation/information (e.g., frequency, volume, destination, etc.) in your SWPCP.

E.S.4.4 *Documentation of Control Measures Used for Management of Runoff:* Document in your SWPCP the control measures used for collecting or containing contaminated melt water from collection areas used for disposal of contaminated snow.

E.S.5 Sector-Specific Benchmarks

At a minimum conduct facility inspections at least monthly during the deicing season (e.g., October through April for most mid-latitude airports). If your facility needs to deice before or after this period, expand the monthly inspections to include all months during which deicing chemicals may be used. DEQ may specifically require you to increase inspection frequencies.

E.S.6 Sector-Specific Benchmarks

Table E.S-1 identifies benchmarks that apply to the specific subsectors of Sector S. These benchmarks apply to both your primary industrial activity and any co-located industrial activities, unless a facility has an Individual NPDES Permit for de-icing activities.

Table E.S-1

Subsector (You may be subject to requirements for more than one sector/subsector)	Parameter	Benchmark Monitoring Concentration
Where a single permittee, or a combination of permitted facilities, use more than 100,000 gallons of glycol-based deicing chemicals and/or 100 tons or more of urea on an average annual basis, monitor these parameters in outfalls that collect runoff from areas where deicing activities occur (SIC 4512-4581) and when deicing activities are occurring.	Biochemical Oxygen Demand (BOD_5)	30 mg/L
	Chemical Oxygen Demand (COD)	120 mg/L
	Ammonia	2.14 mg/L
	pH	5.5 - 9.0 s.u.

E.S.7 Effluent Limitations Based on Effluent Limitations Guidelines and New Source Performance Standards

E.S.7.1 *Airfield Pavement Deicing.* For both existing and new "primary airports" (as defined at 40 CFR 449.2) with 1,000 or more annual non-propeller aircraft departures that discharge stormwater from airfield pavement deicing activities, there shall be no discharge of airfield pavement deicers containing urea. To comply with this limitation, such airports must do one of the following: (1) certify annually on the annual report that you do not use pavement deicers containing urea, or (2) meet the effluent limitation in Table E.S-2.

E.S.7.2 *Aircraft Deicing.* Airports that are both "primary airports" (as defined at 40 CFR 449.2) and new sources ("new airports") with 1,000 or more annual non-propeller aircraft departures must meet the applicable requirements for aircraft deicing at 40 CFR 449.11(a). Discharges of the collected aircraft deicing fluid directly to waters of the U.S. are not eligible for coverage under this permit.

E.S.7.3 Monitoring, Reporting and Recordkeeping. For new and existing airports subject to the effluent limitations in E.S.7.1 or E.S.7.2 of this permit, you must comply with the applicable monitoring, reporting and recordkeeping requirements outlined in 40 CFR 449.20.

Table E.S-2[1]

Subsector (You may be subject to requirements for more than one sector/subsector)	**Parameter**	**Effluent Limitation**
Runoff containing urea from airfield pavement deicing at existing and new primary airports with 1,000 or more annual non-propeller aircraft departures	Ammonia as Nitrogen	14.7 mg/L. daily maximum

[1]Monitor semi-annually.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector T – Treatment Works

E.T.1 Additional Technology-Based Effluent Limits

E.T.1.1 *Control Measures.* In addition to the other control measures, consider the following: routing stormwater to the treatment works; or covering exposed materials (i.e., from the following areas: grit, screenings, and other solids handling, storage, or disposal areas; sludge drying beds; dried sludge piles; compost piles; and septage or hauled waste receiving station).

E.T.1.2 *Employee Training.* At a minimum, training must address the following areas when applicable to a facility: petroleum product management; process chemical management; spill prevention and controls; fueling procedures; general good housekeeping practices; and proper procedures for using fertilizer, herbicides, and pesticides.

E.T.2 Additional SWPCP Requirements

E.T.2.1 *Site Map*. Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: grit, screenings, and other solids handling, storage, or disposal areas; sludge drying beds; dried sludge piles; compost piles; septage or hauled waste receiving station; and storage areas for process chemicals, petroleum products, solvents, fertilizers, herbicides, and pesticides.

E.T.2.2 *Potential Pollutant Sources*. Document in your SWPCP the following additional sources and activities that have potential pollutants associated with them, as applicable: grit, screenings, and other solids handling, storage, or disposal areas; sludge drying beds; dried sludge piles; compost piles; septage or hauled waste receiving station; and access roads and rail lines.

E.T.2.3 *Wastewater and Washwater Requirements.* If wastewater and/or vehicle and equipment wash-water is not covered by another NPDES permit but is handled in another manner (e.g., hauled offsite, retained onsite), the disposal method must be described and all pertinent information (e.g., frequency, volume, destination) must be included in your SWPCP. Discharges of vehicle and equipment washwater, including tank cleaning operations, are not authorized by this permit for this sector.

E.T.3 Additional Inspection Requirements

Include the following areas in all inspections: access roads and rail lines; grit, screenings, and other solids handling, storage, or disposal areas; sludge drying beds; dried sludge piles; compost piles; and septage or hauled waste receiving station.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector U – Food and Kindred Products

E.U.1 Additional Technology-Based Limitations

E.U.1.1 *Employee Training.* Address pest control in your employee training program.

E.U.2 Additional SWPCP Requirements

E.U.2.1 *Drainage Area Site Map.* Document in your SWPCP the locations of the following activities if they are exposed to precipitation or runoff: vents and stacks from cooking, drying, and similar operations; dry product vacuum transfer lines; animal holding pens; spoiled product; and broken product container storage areas.

E.U.2.2 *Potential Pollutant Sources.* Document in your SWPCP, in addition to food and kindred products processing-related industrial activities, application and storage of pest control chemicals (e.g., rodenticides, insecticides, fungicides) used on plant grounds.

E.U.3 Additional Inspection Requirements

Inspect on a monthly basis, at a minimum, the following areas where the potential for exposure to stormwater exists: loading and unloading areas for all significant materials; storage areas, including associated containment areas; waste management units; vents and stacks emanating from industrial activities; spoiled product and broken product container holding areas; animal holding pens; staging areas; and air pollution control equipment.

E.U.4 Sector-Specific Benchmarks

Table E.U-1 identifies benchmarks that apply to the specific subsectors of Sector U. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.U-1.

Subsector (You may be subject to requirements for more than one Sector / Subsector)	Parameter	Benchmark Monitoring Concentration
Fats and Oils Products (SIC 2074-2079)	Biochemical Oxygen Demand (BOD_5)	30 mg/L
	Chemical Oxygen Demand (COD)	120 mg/L
	Nitrate plus Nitrite Nitrogen	0.68 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector V – Textile Mills, Apparel, and Other Fabric Products

E.V.1 Additional Technology-Based Limitations

E.V.1.1 *Good Housekeeping Measures.*

E.V.1.1.1 *Material Storage Areas.* Plainly label and store all containerized materials (e.g., fuels, petroleum products, solvents, and dyes) in a protected area, away from drains. Minimize contamination of the stormwater runoff from such storage areas. Also consider an inventory control plan to prevent excessive purchasing of potentially hazardous substances. For storing empty chemical drums or containers, ensure that the drums and containers are clean (consider triple-rinsing) and that there is no contact of residuals with precipitation or runoff. Collect and dispose of washwater from these cleanings properly.

E.V.1.1.2 *Material Handling Areas.* Minimize contamination of stormwater runoff from material handling operations and areas. Consider the following (or their equivalents): use of spill and overflow protection; covering fueling areas; and covering or enclosing areas where the transfer of material may occur. When applicable, address the replacement or repair of leaking connections, valves, transfer lines, and pipes that may carry chemicals, dyes, or wastewater.

E.V.1.1.3 *Fueling Areas.* Minimize contamination of stormwater runoff from fueling areas. Consider the following (or their equivalents): covering the fueling area, using spill and overflow protection, minimizing run-on of stormwater to the fueling areas, using dry cleanup methods, and treating and/or recycling stormwater runoff collected from the fueling area.

E.V.1.1.4 *Above-Ground Storage Tank Area.* Minimize contamination of the stormwater runoff from above-ground storage tank areas, including the associated piping and valves. Consider the following (or their equivalents): regular cleanup of these areas; including measures for tanks, piping and valves explicitly in your SPCC program; minimizing runoff of stormwater from adjacent areas; restricting access to the area; inserting filters in adjacent catch basins; providing absorbent booms in unbermed fueling areas; using dry cleanup methods; and permanently sealing drains within critical areas that may discharge to a storm drain.

E.V.1.2 *Employee Training.* As part of your employee training program, address, at a minimum, the following activities (as applicable): use of reused and recycled waters, solvents management, proper disposal of dyes, proper disposal of petroleum products and spent lubricants, spill prevention and control, fueling procedures, and general good housekeeping practices.

E.V.2 Additional SWPCP Requirements

E.V.2.1 *Potential Pollutant Sources. Document in your SWPCP the following additional sources* and activities that have potential pollutants associated with them: industry-specific significant materials and industrial activities (e.g., backwinding, beaming, bleaching, backing bonding, carbonizing, carding, cut and sew operations, desizing, drawing, dyeing locking, fulling, knitting, mercerizing, opening, packing, plying, scouring, slashing, spinning, synthetic-felt processing, textile waste processing, tufting, turning, weaving, web forming, winging, yarn spinning, and yarn texturing).

E.V.2.2 *Description of Good Housekeeping Measures for Material Storage Areas.* Document in the SWPCP your containment area or enclosure for materials stored outdoors.

E.V.3 Additional Inspection Requirements

Inspect, at least monthly, the following activities and areas (at a minimum): transfer and transmission lines, spill prevention, good housekeeping practices, management of process waste products, and all structural and nonstructural management practices.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector W – Furniture and Fixtures

E.W.1 Additional Technology-Based Limitations

E.W.1.1 *Drainage Area Site Map.* Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: material storage (including tanks or other vessels used for liquid or waste storage) areas; outdoor material processing areas; areas where wastes are treated, stored, or disposed of; access roads; and rail spurs.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector X – Printing and Publishing

E.X.1 Additional Technology-Based Effluent Limits

E.X.1.1 *Good Housekeeping Measures*.

E.X.1.1.1 *Material Storage Areas.* Plainly label and store all containerized materials (e.g., skids, pallets, solvents, bulk inks, hazardous waste, empty drums, portable and mobile containers of plant debris, wood crates, steel racks, and fuel oil) in a protected area, away from drains. Minimize contamination of the stormwater runoff from such storage areas. Also consider an inventory control plan to prevent excessive purchasing of potentially hazardous substances.

E.X.1.1.2 *Material Handling Area.* Minimize contamination of stormwater runoff from material handling operations and areas (e.g., blanket wash, mixing solvents, loading and unloading materials). Consider the following (or their equivalents): using spill and overflow protection, covering fueling areas, and covering or enclosing areas where the transfer of materials may occur. When applicable, address the replacement or repair of leaking connections, valves, transfer lines, and pipes that may carry chemicals or wastewater.

E.X.1.1.3 *Fueling Areas.* Minimize contamination of stormwater runoff from fueling areas. Consider the following (or their equivalents): covering the fueling area, using spill and overflow protection, minimizing runoff of stormwater to the fueling areas, using dry cleanup methods, and treating and/or recycling stormwater runoff collected from the fueling area.

E.X.1.1.4 *Above Ground Storage Tank Area.* Minimize contamination of the stormwater runoff from above-ground storage tank areas, including the associated piping and valves. Consider the following (or their equivalents): regularly cleaning these areas, explicitly addressing tanks, piping and valves in the SPCC program, minimizing stormwater runoff from adjacent areas, restricting access to the area, inserting filters in adjacent catch basins, providing absorbent booms in unbermed fueling areas, using dry cleanup methods, and permanently sealing drains within critical areas that may discharge to a storm drain.

E.X.1.2 *Employee Training.* As part of your employee training program, address, at a minimum, the following activities (as applicable): spent solvent management, spill prevention and control, used oil management, fueling procedures, and general good housekeeping practices.

E.X.2 Additional SWPCP Requirements

E.X.2.1 *Description of Good Housekeeping Measures for Material Storage Areas.* In connection with E.X.1.1.1, describe in the SWPCP the containment area or enclosure for materials stored outdoors.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector Y – Rubber, Miscellaneous Plastic Products, and Miscellaneous Manufacturing Industries

E.Y.1 Additional Technology-Based Effluent Limits

E.Y.1.1 *Controls for Rubber Manufacturers.* Minimize the discharge of zinc in your stormwater discharges. Following are some general control measure options to consider: using chemicals purchased in pre-weighed, sealed polyethylene bags; storing in-use materials in sealable containers, ensuring an airspace between the container and the cover to minimize "puffing" losses when the container is opened, and using automatic dispensing and weighing equipment.

E.Y.1.1.1 *Zinc Bags.* Ensure proper handling and storage of zinc bags at your facility. Following are some control measure options: employee training on the handling and storage of zinc bags, indoor storage of zinc bags, cleanup of zinc spills without washing the zinc into the storm drain, and the use of 2,500-pound sacks of zinc rather than 50- to 100-pound sacks.

E.Y.1.1.2 *Dumpsters.* Minimize discharges of zinc from dumpsters through implementation of control measures such as the following, where determined to be feasible (list not exclusive): covering the dumpster; moving the dumpster indoors; and providing a lining for the dumpster.

E.Y.1.1.3 *Dust Collectors and Baghouses.* Minimize contributions of zinc to stormwater from dust collectors and baghouses. Replace or repair, as appropriate, improperly operating dust collectors and baghouses.

E.Y.1.1.4 *Grinding Operations.* Minimize contamination of stormwater as a result of dust generation from rubber grinding operations. Where determined to be feasible, install a dust collection system.

E.Y.1.1.5 *Zinc Stearate Coating Operations.* Minimize the potential for stormwater contamination from drips and spills of zinc stearate slurry that may be released to the storm drain. Where determined to be feasible, use alternative compounds to zinc stearate.

E.Y.1.2 *Controls for Plastic Products Manufacturers.* Minimize the discharge of plastic resin pellets in your stormwater discharges through implementation of control measures such as the following, where determined to be feasible (list not exclusive): minimizing spills; cleaning up of spills promptly and thoroughly; sweeping thoroughly; pellet capturing; employee education; and disposal precautions.

E.Y.2 Additional SWPCP Requirements

E.Y.2.1 *Potential Pollutant Sources for Rubber Manufacturers.* Document in your SWPCP the use of zinc at your facility and the possible pathways through which zinc may be discharged in stormwater runoff.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector Z – Leather Tanning and Finishing

E.Z.1 Additional Technology-Based Effluent Limits

E.Z.1.1 *Good Housekeeping Measures.*

E.Z.1.1.1 *Storage Areas for Raw, Semiprocessed, or Finished Tannery By-products.* Minimize contamination of stormwater runoff from pallets and bales of raw, semiprocessed, or finished tannery by-products (e.g., splits, trimmings, shavings). Store or protect indoors with polyethylene wrapping, tarpaulins, roofed storage, etc. where practicable. Place materials on an impermeable surface and enclose or put berms (or equivalent measures) around the area to prevent stormwater run-on and runoff where practicable.

E.Z.1.1.2 *Material Storage Areas.* Label storage containers of all materials (e.g., specific chemicals, hazardous materials, spent solvents, waste materials) minimize contact of such materials with stormwater.

E.Z.1.1.3 *Buffing and Shaving Areas.* Minimize contamination of stormwater runoff with leather dust from buffing and shaving areas through implementation of control measures such as the following, where determined to be feasible (list not exclusive): implementing dust collection enclosures; implementing preventive inspection and maintenance programs; or other appropriate preventive measures.

E.Z.1.1.4 *Receiving, Unloading, and Storage Areas.* Minimize contamination of stormwater runoff from receiving, unloading, and storage areas. If these areas are exposed, implement control measures such as the following, where determined to be feasible (list not exclusive): covering all hides and chemical supplies; diverting drainage to the process sewer; or grade berming or curbing the area to prevent stormwater runoff.

E.Z.1.1.5 *Outdoor Storage of Contaminated Equipment*. Minimize contact of stormwater with contaminated equipment through implementation of control measures such as the following, where determined to be feasible (list not exclusive): covering equipment, diverting drainage to the process sewer, and cleaning thoroughly prior to storage.

E.Z.1.1.6 *Waste Management.* Minimize contamination of stormwater runoff from waste storage areas through implementation of control measures such as the following, where determined to be feasible (list not exclusive): covering dumpsters; moving waste management activities indoors; covering waste piles with temporary covering material such as tarpaulins or polyethylene; and minimizing stormwater runoff by enclosing the area or building berms around the area.

E.Z.2 Additional SWPCP Requirements

E.Z.2.1 *Drainage Area Site Map.* Identify in your SWPCP where any of the following may be exposed to precipitation or surface runoff: processing and storage areas of the beamhouse, tanyard, and re-tan wet finishing and dry finishing operations.

E.Z.2.2 *Potential Pollutant Sources.* Document in your SWPCP the following sources and activities that have potential pollutants associated with them (as appropriate): temporary or permanent storage of fresh and brine-cured hides; extraneous hide substances and hair; leather dust, scraps, trimmings, and shavings.

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector AA – Fabricated Metal Products

E.AA.1 Additional Technology-Based Effluent Limits

E.AA.1.1 *Good Housekeeping Measures.*

E.AA.1.1.1 *Raw Steel Handling Storage.* Minimize the generation of and/or recover and properly manage scrap metals, fines, and iron dust. Include measures for containing materials within storage handling areas.

E.AA.1.1.2 *Paints and Painting Equipment.* Minimize exposure of paint and painting equipment to stormwater.

E.AA.1.2 *Spill Prevention and Response Procedures.* Ensure that the necessary equipment to implement a cleanup is available to personnel. The following areas should be addressed

E.AA.1.2.1 *Metal Fabricating Areas.* Maintain clean, dry, orderly conditions in these areas. Consider using dry clean-up techniques.

E.AA.1.2.2 *Storage Areas for Raw Metal.* Keep these areas free of conditions that could cause, or impede appropriate and timely response to, spills or leakage of materials through implementation of control measures such as the following, where determined to be feasible (list not exclusive): maintaining storage areas so that there is easy access in the event of a spill, and labeling stored materials to aid in identifying spill contents.

E.AA.2.2.3 *Metal Working Fluid Storage Areas.* Minimize the potential for stormwater contamination from storage areas for metal working fluids.

E.AA.1.2.4 *Cleaners and Rinse Water.* Control and clean up spills of solvents and other liquid cleaners, control sand buildup and disbursement from sand-blasting operations, and prevent exposure of recyclable wastes. Substitute environmentally benign cleaners when possible.

E.AA.1.2.5 *Lubricating Oil and Hydraulic Fluid Operations.* Minimize the potential for stormwater contamination from lubricating oil and hydraulic fluid operations. Use monitoring equipment or other devices to detect and control leaks and overflows where feasible. Install perimeter controls such as dikes, curbs, grass filter strips, or equivalent measures where feasible.

E.AA.1.2.6 *Chemical Storage Areas*. Minimize stormwater contamination and accidental spillage in chemical storage areas. Include a program to inspect containers and identify proper disposal methods.

E.AA.1.3 *Spills and Leaks.* In your spill prevention and response procedures, pay attention to the following materials (at a minimum): chromium, toluene, pickle liquor, sulfuric acid, zinc and other water priority chemicals, and hazardous chemicals and wastes.

E.AA.2 Additional SWPCP Requirements

E.AA.2.1 *Drainage Area Site Map.* Document in your SWPCP where any of the following may be exposed to precipitation or surface runoff: raw metal storage areas; finished metal storage areas; scrap disposal collection sites; equipment storage areas; retention and detention basins; temporary and permanent diversion dikes or berms; right-of-way or perimeter diversion devices; sediment traps and barriers; processing areas, including outside painting areas; wood preparation; recycling; and raw material storage.

E.AA.2.2 *Potential Pollutant Sources.* Document in your SWPCP the following additional sources and activities that have potential pollutants associated with them: loading and unloading operations for paints, chemicals, and raw materials; outdoor storage activities for raw materials, paints,

empty containers, corn cobs, chemicals, and scrap metals; outdoor manufacturing or processing activities such as grinding, cutting, degreasing, buffing, and brazing; onsite waste disposal practices for spent solvents, sludge, pickling baths, shavings, ingot pieces, and refuse and waste piles.

E.AA.3 Additional Inspection Requirements

E.AA.3.1 *Inspections.* At a minimum, include the following areas in all inspections: raw metal storage areas, finished product storage areas, material and chemical storage areas, recycling areas, loading and unloading areas, equipment storage areas, paint areas, and vehicle fueling and maintenance areas. Also inspect areas associated with the storage of raw metals, spent solvents and chemicals storage areas, outdoor paint areas, and drainage from roof. Potential pollutants include chromium, zinc, lubricating oil, solvents, aluminum, oil and grease, methyl ethyl ketone, steel, and related materials.

E.AA.4 Sector-Specific Benchmarks

Table E.AA-1 identifies benchmarks that apply to the specific subsectors of Sector AA. These benchmarks apply to both your primary industrial activity and any co-located industrial activities.

Table E.AA-1

Subsector (You may be subject to requirements for more than one sector/subsector)	**Parameter**	**Benchmark Monitoring Concentration**
Fabricated Metal Products, except Coating (SIC 3411-3499; 3911-3915)	Total Aluminum	0.75 mg/L
	Total Iron	1.0 mg/L
	Nitrate plus Nitrite Nitrogen	0.68 mg/L
Fabricated Metal coating and Engraving (SIC 3479)	Nitrate plus Nitrite Nitrogen	0.68 mg/L

Schedule E – Sector-Specific Requirements for Industrial Activity
Sector AB – Transportation Equipment, Industrial or Commercial Machinery

E.AB.1 Additional SWPCP Requirements

E.AB.1.1 *Drainage Area Site Map.* Identify in your SWPCP where any of the following may be exposed to precipitation or surface runoff: vents and stacks from metal processing and similar operations.

SCHEDULE F
NPDES GENERAL CONDITIONS

SECTION A. STANDARD CONDITIONS

A1. Duty to Comply with Permit

The permittee must comply with all conditions of this permit. Failure to comply with any permit condition is a violation of Oregon Revised Statutes (ORS) 468B.025 and the federal Clean Water Act and is grounds for an enforcement action. Failure to comply is also grounds for DEQ to terminate, modify and reissue, revoke, or deny renewal of a permit.

A2. Penalties for Water Pollution and Permit Condition Violations

The permit is enforceable by DEQ or EPA, and in some circumstances also by third-parties under the citizen suit provisions of 33 USC § 1365. DEQ enforcement is generally based on provisions of state statutes and Environmental Quality Commission (EQC) rules, and EPA enforcement is generally based on provisions of federal statutes and EPA regulations.

ORS 468.140 allows DEQ to impose civil penalties up to $25,000 per day for violation of a term, condition, or requirement of a permit.

Under ORS 468.943, unlawful water pollution in the second degree, is a Class A misdemeanor and is punishable by a fine of up to $25,000, imprisonment for not more than one year, or both. Each day on which a violation occurs or continues is a separately punishable offense.

Under ORS 468.946, unlawful water pollution in the first degree is a Class B felony and is punishable by a fine of up to $250,000, imprisonment for not more than 10 years, or both.

The Clean Water Act provides that any person who violates permit condition, or any requirement imposed in a pretreatment program approved under sections 402(a)(3) or 402(b)(8) of the Act, is subject to a civil penalty not to exceed $25,000 per day for each violation.

The Clean Water Act provides that any person who *negligently* violates any condition, or any requirement imposed in a pretreatment program approved under section 402(a)(3) or 402(b)(8) of the Act, is subject to criminal penalties of $2,500 to $25,000 per day of violation, or imprisonment of not more than 1 year, or both.

In the case of a second or subsequent conviction for a *negligent* violation, a person shall be subject to criminal penalties of not more than $50,000 per day of violation, or by imprisonment of not more than 2 years, or both.

Any person who *knowingly* violates such sections, or such conditions or limitations is subject to criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment for not more than 3 years, or both.

In the case of a second or subsequent conviction for a *knowing* violation, a person shall be subject to criminal penalties of not more than $100,000 per day of violation, or imprisonment of not more than 6 years, or both.

Any person who *knowingly* violates section any permit condition, and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine of not more than $250,000 or imprisonment of not more than 15 years, or both.

In the case of a second or subsequent conviction for a *knowing* endangerment violation, a person shall be subject to a fine of not more than $500,000 or by imprisonment of not more than 30 years, or both.

An organization, as defined in section 309(c)(3)(B)(iii) of the CWA, shall, upon conviction of violating the imminent danger provision, be subject to a fine of not more than $1,000,000 and can be fined up to $2,000,000 for second or subsequent convictions.

Any person may be assessed an administrative penalty by the Administrator for violating any permit condition or limitation implementing any of such sections in a permit issued under section 402 of this Act.

Administrative penalties for Class I violations are not to exceed $10,000 per violation, with the maximum amount of any Class I penalty assessed not to exceed $25,000.

Penalties for Class II violations are not to exceed $10,000 per day for each day during which the violation continues, with the maximum amount of any Class II penalty not to exceed $125,000.

A3. Duty to Mitigate

The permittee must take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit. In addition, upon request of DEQ, the permittee must correct any adverse impact on the environment or human health resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

A4. Duty to Reapply

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and have the permit renewed. The application must be submitted at least 180 days before the expiration date of this permit.

DEQ may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date.

A5. Permit Actions

This permit may be modified, revoked and reissued, or terminated for cause including, but not limited to, the following:

a. Violation of any term, condition, or requirement of this permit, a rule, or a statute.
b. Obtaining this permit by misrepresentation or failure to disclose fully all material facts.
c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

d. The permittee is identified as a Designated Management Agency or allocated a wasteload under a total maximum daily load (TMDL).

e. New information or regulations.
f. Modification of compliance schedules.
g. Requirements of permit reopener conditions
h. Correction of technical mistakes made in determining permit conditions.
i. Determination that the permitted activity endangers human health or the environment.
j. Other causes as specified in 40 CFR §§ 122.62, 122.64, and 124.5.
k. For communities with combined sewer overflows (CSOs):
   (1) To comply with any state or federal law regulation for CSOs that is adopted or promulgated subsequent to the effective date of this permit.
   (2) If new information that was not available at the time of permit issuance indicates that CSO controls imposed under this permit have failed to ensure attainment of water quality standards, including protection of designated uses.
   (3) Resulting from implementation of the permittee's long-term control plan and/or permit conditions related to CSOs.

The filing of a request by the permittee for a permit modification, revocation or reissuance, termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

A6. Toxic Pollutants
The permittee must comply with any applicable effluent standards or prohibitions established under Oregon Administrative Rule (OAR) 340-041-0033 and section 307(a) of the federal Clean Water Act for toxic pollutants, and with standards for sewage sludge use or disposal established under section 405(d) of the federal Clean Water Act, within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

A7. Property Rights and Other Legal Requirements
The issuance of this permit does not convey any property rights of any sort, or any exclusive privilege, or authorize any injury to persons or property or invasion of any other private rights, or any infringement of federal, tribal, state, or local laws or regulations.

A8. Permit References
Except for effluent standards or prohibitions established under section 307(a) of the federal Clean Water Act and OAR 340-041-0033 for toxic pollutants, and standards for sewage sludge use or disposal established under section 405(d) of the federal Clean Water Act, all rules and statutes referred to in this permit are those in effect on the date this permit is issued.

A9. Permit Fees
The permittee must pay the fees required by OAR.

SECTION B. OPERATION AND MAINTENANCE OF POLLUTION CONTROLS

B1. Proper Operation and Maintenance
The permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve

compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires

the operation of back-up or auxiliary facilities or similar systems that are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

B2. Need to Halt or Reduce Activity Not a Defense

For industrial or commercial facilities, upon reduction, loss, or failure of the treatment facility, the permittee must, to the extent necessary to maintain compliance with its permit, control production or all discharges or both until the facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced or lost. It is not a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

B3. Bypass of Treatment Facilities

a. Definitions
   (1) "Bypass" means intentional diversion of waste streams from any portion of the treatment facility. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, provided the diversion is to allow essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs b and c of this section.
   (2) "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Prohibition of bypass.
   (1) Bypass is prohibited and DEQ may take enforcement action against a permittee for bypass unless:
      i. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
      ii. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that occurred during normal periods of equipment downtime or preventative maintenance; and
      iii. The permittee submitted notices and requests as required under General Condition B3.c.
   (2) DEQ may approve an anticipated bypass, after considering its adverse effects and any alternatives to bypassing, if DEQ determines that it will meet the three conditions listed above in General Condition B3.b.(1).

c. Notice and request for bypass.
   (1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, a written notice must be submitted to DEQ at least ten days before the date of the bypass.

(2) Unanticipated bypass. The permittee must submit notice of an unanticipated bypass as required in General Condition D5.

B4. Upset

a. Definition. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operation error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

b. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of General Condition B4.c are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

c. Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
   (1) An upset occurred and that the permittee can identify the causes(s) of the upset;
   (2) The permitted facility was at the time being properly operated;
   (3) The permittee submitted notice of the upset as required in General Condition D5, hereof (24-hour notice); and
   (4) The permittee complied with any remedial measures required under General Condition A3 hereof.

d. Burden of proof. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

B5. Treatment of Single Operational Upset

For purposes of this permit, a single operational upset that leads to simultaneous violations of more than one pollutant parameter will be treated as a single violation. A single operational upset is an exceptional incident that causes simultaneous, unintentional, unknowing (not the result of a knowing act or omission), temporary noncompliance with more than one federal Clean Water Act effluent discharge pollutant parameter. A single operational upset does not include federal Clean Water Act violations involving discharge without a NPDES permit or noncompliance to the extent caused by improperly designed or inadequate treatment facilities. Each day of a single operational upset is a violation.

B6. Overflows from Wastewater Conveyance Systems and Associated Pump Stations

a. Definition. "Overflow" means any spill, release or diversion of sewage including:
   (1) An overflow that results in a discharge to waters of the United States; and
   (2) An overflow of wastewater, including a wastewater backup into a building (other than a backup caused solely by a blockage or other malfunction in a privately owned sewer or building lateral), even if that overflow does not reach waters of the United States.

b. Reporting required. All overflows must be reported orally to DEQ within 24 hours from the time the permittee becomes aware of the overflow. Reporting procedures are described in more detail in General Condition D5.

B7. Public Notification of Effluent Violation or Overflow

If effluent limitations specified in this permit are exceeded or an overflow occurs that threatens public health, the permittee must take such steps as are necessary to alert the public, health agencies and other affected entities (for example, public water systems) about the extent and nature of the discharge in accordance with the notification procedures developed under General Condition B8.

Such steps may include, but are not limited to, posting of the river at access points and other places, news releases, and paid announcements on radio and television.

B8. Emergency Response and Public Notification Plan

The permittee must develop and implement an emergency response and public notification plan that identifies measures to protect public health from overflows, bypasses, or upsets that may endanger public health. At a minimum the plan must include mechanisms to:

a. Ensure that the permittee is aware (to the greatest extent possible) of such events;
b. Ensure notification of appropriate personnel and ensure that they are immediately dispatched for investigation and response;
c. Ensure immediate notification to the public, health agencies, and other affected public entities (including public water systems). The overflow response plan must identify the public health and other officials who will receive immediate notification;
d. Ensure that appropriate personnel are aware of and follow the plan and are appropriately trained;
e. Provide emergency operations; and
f. Ensure that DEQ is notified of the public notification steps taken.

B9. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters must be disposed of in such a manner as to prevent any pollutant from such materials from entering waters of the state, causing nuisance conditions, or creating a public health hazard.

SECTION C. MONITORING AND RECORDS

C1. Representative Sampling

Sampling and measurements taken as required herein must be representative of the volume and nature of the monitored discharge. All samples must be taken at the monitoring points specified in this permit, and must be taken, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points must not be changed without notification to and the approval of DEQ. Samples must be collected in accordance with requirements in 40 CFR part 122.21 and 40 CFR part 403 Appendix E.

C2. Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices must be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices must be installed, calibrated and maintained to insure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected must be capable of measuring flows with a maximum deviation of less than ± 10 percent from true discharge rates throughout the range of expected discharge volumes.

C3. Monitoring Procedures

Monitoring must be conducted according to test procedures approved under 40 CFR part 136 or, in the case of sludge (biosolids) use and disposal, approved under 40 CFR part 503 unless other test procedures have been specified in this permit.

For monitoring of recycled water with no discharge to waters of the state, monitoring must be conducted according to test procedures approved under 40 CFR part 136 or as specified in the most recent edition of Standard Methods for the Examination of Water and Wastewater unless other test procedures have been specified in this permit or approved in writing by DEQ.

C4. Penalties for Tampering

The federal Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit may, upon conviction, be punished by a fine of not more than $10,000 per violation, imprisonment for not more than two years, or both. If a conviction of a person is for a violation committed after a first conviction of such person, punishment is a fine not more than $20,000 per day of violation, or by imprisonment of not more than four years, or both.

C5. Reporting of Monitoring Results

Monitoring results must be summarized each month on a Discharge Monitoring Report form approved by DEQ. The reports must be submitted monthly and are to be mailed, delivered or otherwise transmitted by the 15th day of the following month unless specifically approved otherwise in Schedule B of this permit.

C6. Additional Monitoring by the Permittee

If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR part 136 or, in the case of sludge (biosolids) use and disposal, approved under 40 CFR part 503, or as specified in this permit, the results of this monitoring must be included in the calculation and reporting of the data submitted in the Discharge Monitoring Report. Such increased frequency must also be indicated. For a pollutant parameter that may be sampled more than once per day (for example, total residual chlorine), only the average daily value must be recorded unless otherwise specified in this permit.

C7. Averaging of Measurements

Calculations for all limitations that require averaging of measurements must utilize an arithmetic mean, except for bacteria which must be averaged as specified in this permit.

C8. Retention of Records

Records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities must be retained for a period of at least 5 years (or longer as required by 40 CFR part 503). Records of all monitoring information including all calibration and maintenance records, all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit and records of all data used to complete the application for this permit must be retained for a period of at least 3 years from the date of the sample, measurement, report, or application. This period may be extended by request of DEQ at any time.

C9. Records Contents

Records of monitoring information must include:

a. The date, exact place, time, and methods of sampling or measurements;
b. The individual(s) who performed the sampling or measurements;
c. The date(s) analyses were performed;
d. The individual(s) who performed the analyses;
e. The analytical techniques or methods used; and
f. The results of such analyses.

C10. Inspection and Entry

The permittee must allow DEQ or EPA upon the presentation of credentials to:

a. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
d. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by state law, any substances or parameters at any location.

C11. Confidentiality of Information

Any information relating to this permit that is submitted to or obtained by DEQ is available to the public unless classified as confidential by the Director of DEQ under ORS 468.095. The permittee may request that information be classified as confidential if it is a trade secret as defined by that statute. The name and address of the permittee, permit applications, permits, effluent data, and information required by NPDES application forms under 40 CFR § 122.21 are not classified as confidential [40 CFR § 122.7(b)].

SECTION D. REPORTING REQUIREMENTS

D1. Planned Changes

The permittee must comply with OAR 340-052, "Review of Plans and Specifications" and 40 CFR § 122.41(l)(1). Except where exempted under OAR 340-052, no construction, installation, or modification involving disposal systems, treatment works, sewerage systems, or common sewers may be commenced until the plans and specifications are submitted to and approved by DEQ. The permittee must give notice to DEQ as soon as possible of any planned physical alternations or additions to the permitted facility.

D2. Anticipated Noncompliance

The permittee must give advance notice to DEQ of any planned changes in the permitted facility or activity that may result in noncompliance with permit requirements.

D3. Transfers

This permit may be transferred to a new permittee provided the transferee acquires a property interest in the permitted activity and agrees in writing to fully comply with all the terms and conditions of the permit and EQC rules. No permit may be transferred to a third party without prior written approval from DEQ. DEQ may require modification, revocation, and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary

under 40 CFR § 122.61. The permittee must notify DEQ when a transfer of property interest takes place.

D4. Compliance Schedule

Reports of compliance or noncompliance with, or any progress reports on interim and final requirements contained in any compliance schedule of this permit must be submitted no later than 14 days following each schedule date. Any reports of noncompliance must include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirements.

D5. Twenty-Four Hour Reporting

The permittee must report any noncompliance that may endanger health or the environment. Any information must be provided orally (by telephone) to the DEQ regional office or Oregon Emergency Response System (1-800-452-0311) as specified below within 24 hours from the time the permittee becomes aware of the circumstances.

a. Overflows.
   (1) Oral Reporting within 24 hours.
      i. For overflows other than basement backups, the following information must be reported to the Oregon Emergency Response System (OERS) at 1-800-452-0311. For basement backups, this information should be reported directly to the DEQ regional office.
         (a) The location of the overflow;
         (b) The receiving water (if there is one);
         (c) An estimate of the volume of the overflow;
         (d) A description of the sewer system component from which the release occurred (for example, manhole, constructed overflow pipe, crack in pipe); and
         (e) The estimated date and time when the overflow began and stopped or will be stopped.
      ii. The following information must be reported to the DEQ regional office within 24 hours, or during normal business hours, whichever is earlier:
         (a) The OERS incident number (if applicable); and
         (b) A brief description of the event.
   (2) Written reporting postmarked within 5 days.
      i. The following information must be provided in writing to the DEQ regional office within 5 days of the time the permittee becomes aware of the overflow:
         (a) The OERS incident number (if applicable);
         (b) The cause or suspected cause of the overflow;
         (c) Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the overflow and a schedule of major milestones for those steps;
         (d) Steps taken or planned to mitigate the impact(s) of the overflow and a schedule of major milestones for those steps; and
         (e) For storm-related overflows, the rainfall intensity (inches/hour) and duration of the storm associated with the overflow.

      DEQ may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.
b. Other instances of noncompliance.
   (1) The following instances of noncompliance must be reported:

i. Any unanticipated bypass that exceeds any effluent limitation in this permit;
ii. Any upset that exceeds any effluent limitation in this permit;
iii. Violation of maximum daily discharge limitation for any of the pollutants listed by DEQ in this permit; and
iv. Any noncompliance that may endanger human health or the environment.

(2) During normal business hours, the DEQ regional office must be called. Outside of normal business hours, DEQ must be contacted at 1-800-452-0311 (Oregon Emergency Response System).

(3) A written submission must be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission must contain:
i. A description of the noncompliance and its cause;

ii. The period of noncompliance, including exact dates and times;
iii. The estimated time noncompliance is expected to continue if it has not been corrected;
iv. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance; and
v. Public notification steps taken, pursuant to General Condition B**7.**

(4) DEQ may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

D6. Other Noncompliance
The permittee must report all instances of noncompliance not reported under General Condition D4 or D5 at the time monitoring reports are submitted. The reports must contain:
a. A description of the noncompliance and its cause;
b. The period of noncompliance, including exact dates and times;
c. The estimated time noncompliance is expected to continue if it has not been corrected; and
d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

D7. Duty to Provide Information
The permittee must furnish to DEQ within a reasonable time any information that DEQ may request to determine compliance with the permit or to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit. The permittee must also furnish to DEQ, upon request, copies of records required to be kept by this permit.

Other Information: When the permittee becomes aware that it has failed to submit any relevant facts or has submitted incorrect information in a permit application or any report to DEQ, it must promptly submit such facts or information.

D8. Signatory Requirements
All applications, reports or information submitted to DEQ must be signed and certified in accordance with 40 CFR § 122.22.

D9. Falsification of Information
Under ORS 468.953, any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, is subject to a Class C felony punishable by a fine not to exceed $125,000 per violation and up to 5 years in prison per ORS chapter 161. Additionally, according to 40 CFR § 122.41(k)(2), any person who knowingly

makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit including monitoring reports or reports of compliance or non-compliance will, upon conviction, be punished by a federal civil penalty not to exceed $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

D10. Changes to Indirect Dischargers

The permittee must provide adequate notice to DEQ of the following:

a. Any new introduction of pollutants into the POTW from an indirect discharger which would be subject to section 301 or 306 of the federal Clean Water Act if it were directly discharging those pollutants and;

b. Any substantial change in the volume or character of pollutants being introduced into the POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.

c. For the purposes of this paragraph, adequate notice must include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

SECTION E. DEFINITIONS

E1. *BOD* or BOD_5 means five-day biochemical oxygen demand.
E2. *CBOD* or $CBOD_5$ means five-day carbonaceous biochemical oxygen demand.
E3. *TSS* means total suspended solids.
E4. *Bacteria* means but is not limited to fecal coliform bacteria, total coliform bacteria, *Escherichia coli* (*E. coli*) bacteria, and *Enterococcus* bacteria.
E5. *FC* means fecal coliform bacteria.
E6. *Total residual chlorine* means combined chlorine forms plus free residual chlorine
E7. *Technology based permit effluent limitations* means technology-based treatment requirements as defined in 40 CFR § 125.3, and concentration and mass load effluent limitations that are based on minimum design criteria specified in OAR 340-041.
E8. *mg/l* means milligrams per liter.
E9. *µg/l* means microgram per liter.
E10. *kg* means kilograms.
E11. m^3/d means cubic meters per day.
E12. *MGD* means million gallons per day.
E13. *Average monthly effluent limitation* as defined at 40 CFR § 122.2 means the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.
E14. *Average weekly effluent limitation* as defined at 40 CFR § 122.2 means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.
E15. *Daily discharge* as defined at 40 CFR § 122.2 means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the daily discharge must be calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the daily discharge must be calculated as the average measurement of the pollutant over the day.
E16. *24-hour composite sample* means a sample formed by collecting and mixing discrete samples taken periodically and based on time or flow.

E17. *Grab sample* means an individual discrete sample collected over a period of time not to exceed 15 minutes.
E18. *Quarter* means January through March, April through June, July through September, or October through December.
E19. *Month* means calendar month.
E20. *Week* means a calendar week of Sunday through Saturday.
E21. *POTW* means a publicly-owned treatment works.

APPENDIX B

ODEQ Stormwater Pollution Control Plan Check List

Appendix II

DEQ Industrial Stormwater Permit Stormwater Pollution Control Plan (SWPCP) Check List

Instructions: Complete this form and submit with SWPCP. Fill in the appropriate page number(s) indicating the location of information in the SWPCP. New requirements are italicized. At a minimum, the SWPCP must include the components below and describe how the permit registrants intends to comply with the narrative technology-based effluent limit to eliminate or reduce the potential to contaminate stormwater and prevent any violation of instream water quality standards.

Site Name:	Grassy Mountain Mine	**File No.:**	

Permit Schedule		**Requirement**	**Page #**	**Comments (For official use only)**
New Discharger	Permit Cover and Exclusion	A new discharger to an impaired water without a TMDL must meet one of the conditions in this section of the permit to obtain coverage	2	
Tier II Status	A.3	*Facility triggered Tier II under previous permit term* ☐ *Yes* *Facility triggered Tier II under current permit term* ☐ *Yes* *Provide a description of treatment controls or source control or mass load reduction waivier, including low impact development, in response to corrective action requirements and operation and maintenance procedures.*	NA	
Signature	A.6.b	Signed and certified in accordance with 40 CFR 122.22	Client	
Title Page	A.7.a	*Plan date*	ii	
		Name of the site	1	
		Name of the site operator or owner	1	
		The name of the person(s) preparing the SWPCP	1	
		File No. and *EPA permit No.*	TBD	
		Primary SIC code and any co-located SIC codes	1	
		Contact person(s) name, telephone number and *email*	2	
		Physical address, including county	2	
		Mailing address if different	Title Pg	
Site Description*	A.7.b.ii	A description of industrial activities conducted at the site and significant materials stored, used, treated or disposed of in a manner which exposes those activities or materials to storm-water. Include in the description the methods of storage, usage, treatment or disposal	6-8	
	A.7.b. iii	*Location and description, with any available characterization data, of areas of known or discovered significant materials from previous operations*	3	
	A.7.b.iv	*Regular business hours of operation*	2	
General Location Map	A.7.b.i	General location of the site in relation to surrounding properties, transportation routes, surface waters and other relevant features	Fig 1	
Site Map* (please identify clearly)	A.7.b.i	2. Drainage patterns	Fig 1	
		3. Conveyance and discharge structures, such as piping or ditches	Figs 1,2	
		4. All discharge points assigned a unique three-digit identifying number starting with 001, 002 used for electronic reporting	Figs 1,2	
		5. Outline of the drainage area for each discharge point	Fig 1	

Permit Schedule		Requirement	Page #	Comments (For official use only)
Site Map* (please identify clearly)	A.7.b.i	6. Paved areas and buildings within each drainage area	Fig 2	
		7. Areas used for outdoor manufacturing, treatment, storage, or disposal of significant materials	Fig 2	
		8. Existing structural control measures for minimizing pollutants in stormwater runoff	NA	
		9. Structural features that reduce flow or minimize impervious areas	Fig 2	
		10. Material handling and access areas	Fig 2	
		11. Hazardous waste treatment, storage and disposal facilities	ND Area	
		12. Location of wells including waste injection wells, seepage pits, drywells	NA	
		13. Location of springs, wetlands and other surface waterbodies both on-site and adjacent to the site	NA	
		14. Location of groundwater wells	Fig 1	
		15. Location and description of authorized non-stormwater discharges	Fig 1,2 F	
		16. Exact location of monitoring points, indicating if any discharge points are "substantially similar" and not being monitored	Fig 2	
		17. Location and description of spill prevention and cleanup materials	ND Area	
		18. Locations of the following materials and activities if they are exposed to stormwater and applicable:		
		A. *Fueling stations*	ND Area	
		B. *Vehicle and equipment maintenance cleaning areas*	ND Area	
		C. *Loading/unloading areas*	ND Area	
		D. *Locations used for the treatment, storage, or disposal of wastes*	ND Area	
		E. *Liquid storage tanks*	ND Area	
		F. *Processing and storage areas*	ND Area	
		G. *Immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility;*	Figs 1,2	
		H. *Transfer areas for substances in bulk*	Fig 2	
		I. *Machinery*	ND Area	
		J. *Locations and sources of run-on to your site from adjacent property*	Fig 1	
Potential Pollutants	A.7.b.v	For each area of the site where a reasonable potential exists for contributing pollutants to stormwater runoff, a description of the potential pollutant sources that could be present in stormwater discharges *and if associated with a co-located SIC code*	7	
Impervious Area	A.7.b.viii	An estimate of the amount of impervious surface area (including paved areas and building roofs) and the total area drained by each stormwater discharge point to be reported in area units	NA	
Receiving Waters	A.7.b.ix	The name(s) of the receiving water(s) for stormwater drainage. If drainage is to a municipal storm sewer system, the name(s) of the ultimate receiving waters and the name of the municipality	2	
Monitoring Locations*	A.7.b.x	The identification of each discharge point and the location(s) where stormwater monitoring will occur as required by Schedule B.2. The monitoring location must also be labeled in the SWPCP as "monitoring location"	18	
		Existing discharge points excluded from monitoring must in-clude a description of the discharge point(s) and data or analysis	18	

Permit Schedule		Requirement	Page #	Comments (For official use only)
		supporting that the discharge point(s) are substantially similar as described in Schedule B.2.c.ii of this permit SWPCP as "monitoring location"		
Site Controls*	A.7.b.vi	A description of the control measures installed and implemented to meet the technology and water quality based requirements below and any applicable sector specific requirements (Sch.E)		
		a. Minimize Exposure	8	
		b. Oil and Grease		
		c. Waste chemicals and material disposal	9	
		d. Erosion and sediment control	9	
		e. Debris control	9	
		f. Dust generation and vehicle tracking	9	
		g. Housekeeping	10	
		h. Spill prevention and response	0	
		i. Preventative maintenance	10	
		j. Employee education	10	
		k. Non-stormwater discharges	11	
Procedures and Schedules	A.7.c.i	**Spill Prevention and Response Procedures.** Procedures for preventing and responding to spills and cleanup and notification procedures. *Indicate who is responsible for on-site management of significant materials and include their contact information.* Spills prevention plans required by other regulations may be substituted for this provision if the spill prevention plan addresses stormwater management concerns and the plan is included with the SWPCP	10	
		Indicate how spill response will be coordinated between the permit registrant and otherwise unpermitted tenants. The permit registrant is ultimately responsible for spills of the tenant and appropriate response	10	
	A.7.c.ii	**Preventative Maintenance Procedures.** Procedures for conducting inspections, maintenance and repairs to prevent leaks, spills, and other releases from drums, tanks and containers exposed to stormwater and the scheduled regular pickup and disposal of waste materials. Include the schedule or frequency for maintaining all control measures and waste collection	10	
	A.7.c.iii	**Operations and Maintenance Plan.** *Include an operation and maintenance plan for active treatment systems, such as electrocoagulation, chemical flocculation, or ion-exchange. The O&M plan must include, as appropriate to the type of treatment system, items such as system schematic, manufacturer's maintenance/operation specifications, chemical use, treatment volumes and a monitoring or inspection plan and frequency. For passive treatment and low impact development control measures, include routine maintenance standards*	NA	
	A.7.c.iv	**Employee Education Schedule.** Orientation no later than 30 calendar days of hire or change in duties, education annually. *Include a description of the training content* and the required frequency	10	

* Some facilities must meet sector specific requirements (Schedule E) and include additional information in SWPCP, including the site map. If applicable, ensure that the SWPCP includes the sector specific information.

For Official Use Only			
New applicant:	☐ Yes ☐ No		
New discharger:	☐ Yes ☐ No	New discharger to impaired waters condition met:	☐ Yes ☐ No
Existing facilities:	☐ Yes ☐ No	SWPCP update per renewal:	☐ Yes ☐ No
		SWPCP update per Schedule A.8:	☐ Yes ☐ No
		Facility triggered Tier II under previous permit term:	☐ Yes ☐ No
		Facility triggered Tier II under current permit term:	☐ Yes ☐ No
Sector E Requirements:	☐ Yes ☐ No	Sch. E additional information in SWPCP and site plan	☐ Yes ☐ No
Date received:		Plan Accepted:	☐ Yes ☐ No

Reviewed by:

1._____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

golder.com

Appendix Z: Petroleum Contaminated Soil Management Plan

CALICO RESOURCES USA CORP.

GRASSY MOUNTAIN MINE PROJECT
MALHEUR COUNTY, OREGON

PETROLEUM-CONTAMINATED SOILS MANAGEMENT PLAN

October 2019

Submitted to

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation & Reclamation
229 Broadalbin Street SW
Albany, Oregon 97321-2246

Prepared for

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
PETROLEUM-CONTAMINATED SOILS MANAGEMENT PLAN

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CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
PETROLEUM-CONTAMINATED SOILS MANAGEMENT PLAN

1 INTRODUCTION

This Petroleum-Contaminated Soils Management Plan (PCS Plan) has been prepared in support of the Grassy Mountain Mine Project (Project) located in Malheur County, Oregon, and has been included as part of the Consolidated Permit Application.

The Project would not treat or dispose of PCS on site; therefore, this PCS Plan has been prepared to only describe the storage activities of any PCS prior to the removal and transport to an off-site facility for appropriate management.

1.1 Resource Study Area

The Project is located approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 2). The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or re-routing, and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be approximately 30 feet wide, which includes a 20-foot wide road travel width (ten feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

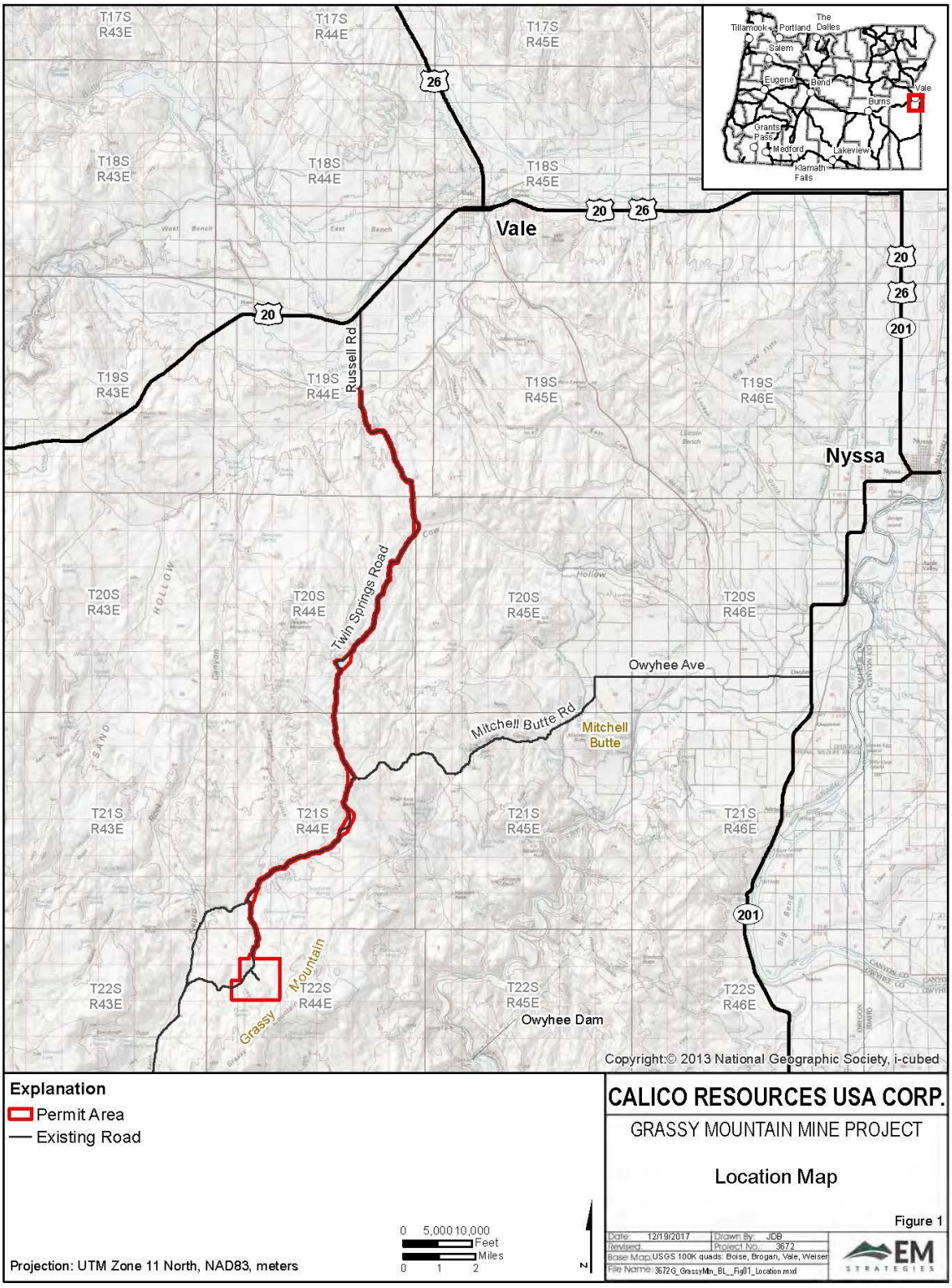

Figure 1. Location Map

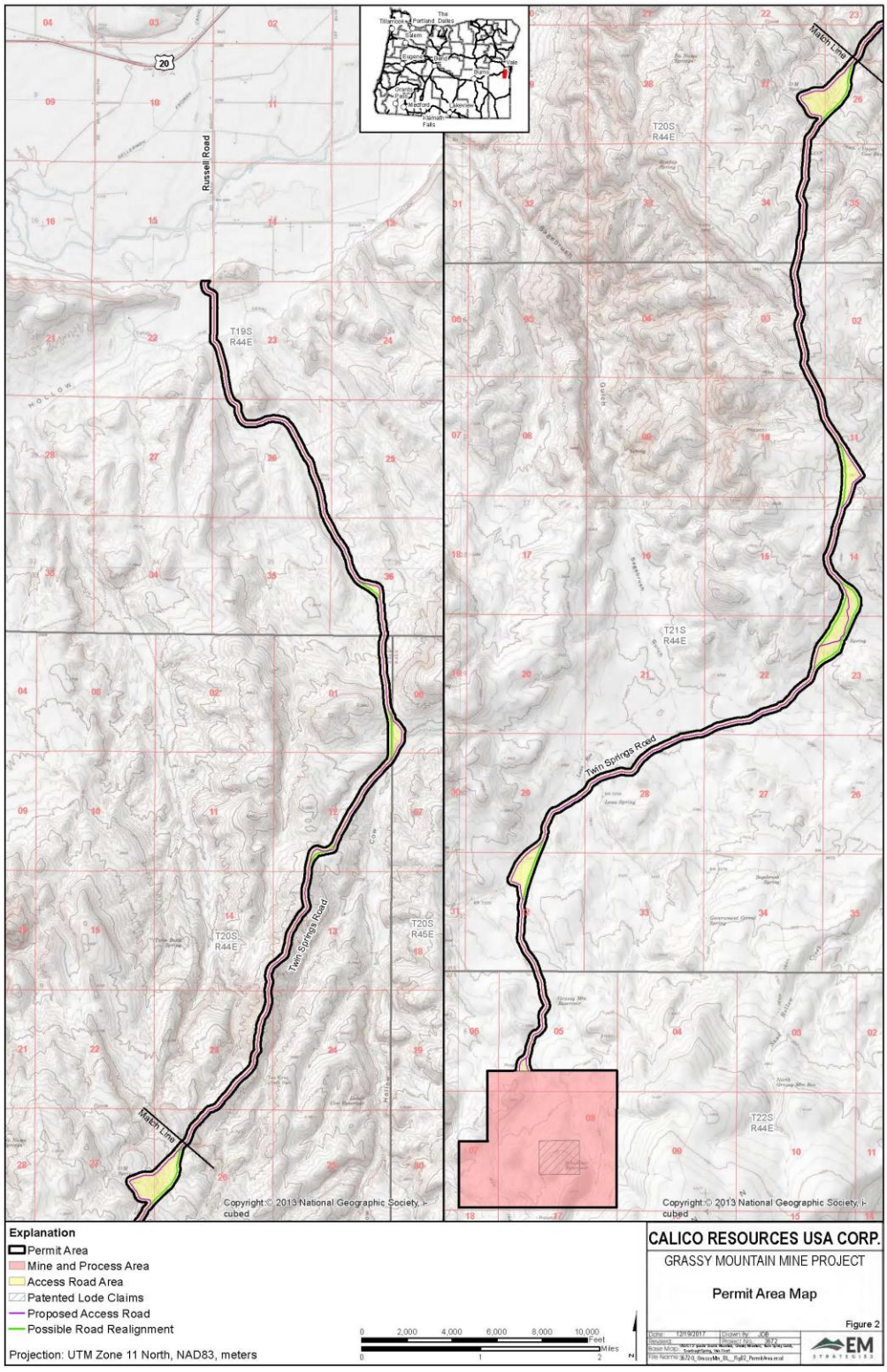

Figure 2. Permit Area Map

2 PROJECT DESCRIPTION

Calico Resources USA Corp. (Calico) plans to construct, operate, reclaim, and close an underground mining and precious metal milling operation. In general, the proposed mining and precious metal processing operations will consist of an underground mine and ore processing facilities, including a conventional mill and tailings storage facility (TSF) and a waste rock storage area (WRSA), as well as other support facilities. The Project will include the following major components:

- One underground mine;
- One WRSA;
- One carbon-in-leach (CIL) processing plant;
- One borrow pit area;
- One TSF;
- Run-of-mine ore stockpile;
- One reclaim pond;
- A water supply well field and pipeline, associated water delivery pipelines, and power;
- A power substation and distribution system;
- One ventilation shaft;
- Access and haul roads;
- Ancillary facilities that include the following: haul, secondary, and exploration roads; truck workshop; warehouse; stormwater diversions; sediment control basins; reagent and fuel storage; storage and laydown yards; explosive magazines; fresh water storage; monitoring wells; meteorological station; an administration/security building; borrow areas; growth media stockpiles; a landfill; and solid and hazardous waste management facilities to manage wastes; and
- Reclamation and closure, including the potential development of an evaporation cell for the TSF.

3 POTENTIAL PCS SOURCES

The following are identified as potential sources of PCS at the Project:

- Maintenance area which includes an equipment maintenance area and wash bay;
- Fuel storage depot; and
- Accidental spills from stationary and mobile equipment.

The primary source of PCS at the Project is anticipated to result from accidental spills. The principal sources of hydrocarbon spills that will be managed under this PCS Plan include diesel fuel spills, motor/lube oil spills, and hydraulic fluid spills. Motor/lube oil and hydraulic fluid spills are associated with equipment failures, such as line ruptures, and thus are relatively infrequent.

Calico will transport, store, and use a variety of fuels and other petroleum products. A summary of these materials expected to be present at the site is provided in Table 1.

Table 1. Anticipated Petroleum Products

Product	On-site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Diesel – Truck Shop	30,000 gallons	Up to 30,000 gallons	6,000 gpd	1
Ammonium Nitrate/Fuel Oil	60-ton silo	Up to 60 tons	8 tons/day	1
Gasoline	10,000 gallons	Up to 10,000 gallons	250 gpd	1
30WT Motor Oil	4,000 gallons	Up to 4,000 gallons	15-20 gpd	1
Used Motor Oil	4,000 gallons	Up to 4,000 gallons	15-20 gpd	1
Antifreeze	2,000 gallons	Up to 2,000 gallons	1 G15 gpd	1
Hydraulic Fluid	2,000 gallons	Up to 2,000 gallons	10-15 gpd	1
90WT Gear Lube	2,000 gallons	Up to 2,000 gallons	10-15 gpd	1
Waste Antifreeze	2,000 gallons	Up to 2,000 gallons	10-15 gpd	1
Grease bins	4 x 120-gallon totes, 4 x 30-gallon drums	Up to 4 totes, up to 4 drums	5-10 gpd	1

gpd – gallons per day

An Emergency Response Plan has been prepared for the Project, which includes measures to take in case of an accidental spill. Safety Data Sheets for each chemical will be maintained at appropriate locations at the Project site.

3.1 Gasoline PCS

Soil contaminated with gasoline will be managed separately from other PCS sources and as a hazardous waste until the analytical results confirm whether or not the material is characterized as hazardous.

In the event of a spill, liquid gasoline will be recovered by safe and practical means prior to excavating the contaminated soil. Gasoline PCS, including the sorbent material, will be placed in a roll-off bin labeled to identify the contents and sampled and analyzed according to this PCS Plan. If the analytical results indicate the material is not hazardous, the bin contents will be shipped to the licensed off-site disposal site for appropriate management. If the results show the material to be hazardous, the material will be treated as a hazardous waste and shipped off site to a licensed facility in accordance with federal, state, and local regulations.

3.2 Hazardous Waste Determination

PCS may be determined to be a characteristic hazardous waste when it exhibits any of the following characteristics as defined in 40 Code of Federal Regulations Section 261: ignitability; corrosivity; reactivity; or toxicity. Calico will determine whether a shipment of PCS meets any of the hazardous waste characteristics during pre-shipping sampling and route the load to the appropriate final disposal site based on the determination.

4 INTERIM PCS MANAGEMENT

4.1 Interim PCS Management Strategy

Calico will collect PCS from the identified facilities and accidental spill sites and place the material into a roll-off bin provided by a licensed contractor. The material will be sampled in accordance with federal, state, and local regulations, and contractor requirements to characterize the material prior to shipping off site.

4.2 PCS Storage Area

The PCS storage area will consist of a concrete pad with six-inch walls to contain the roll-off bin and allow for removal of filled roll-off bins and placement of empty roll-off bins. The PCS storage area is topographically constrained from naturally draining into nearby surface water bodies or drainages.

The licensed contractor will provide a 20-cubic yard roll-off bin with either a lid or a tarp that seals down to store the PCS on site. The roll-off bin will be placed on a concrete pad with applicable warning signs to prevent unauthorized placement of materials other than PCS in the bin. The roll-off bin will be picked up by a licensed contractor and transported off site for management at an appropriate facility. The roll-off bin will be covered appropriately by the transportation contractor.

4.3 Estimated Volume

Calico estimates that up to 20 cubic yards of PCS will be generated annually.

4.4 Best Management Practices

Protection from groundwater infiltration is provided by placing the roll-off bin on a concrete pad. Protection of surface water is provided by situating the PCS storage area away from storm water drainage ditches. Warning and informative signage will deter unauthorized placement of non-PCS materials.

Good housekeeping best management practices include routine cleanup of PCS accidentally spilled onto the concrete pad containment, as well as cleanup of vehicle track-out, both of which will be placed back into the PCS storage area.

4.5 Sample Collection and Analytical Protocols

The environmental staff at the Project will conduct the sampling in accordance with established protocols by taking a composite sample comprised of multiple sub-samples of PCS in the roll-off bin. No less than one composite sample will be collected for each 20 cubic yards of PCS. The samples will be placed in a laboratory-prepared container suitable for the collection of soil samples. The containers will be filled to minimize head space and be sealed with an airtight lid. Sampling tools will be decontaminated between each composite interval. The samples will ship under a chain-of-custody to an outside laboratory for analysis.

4.6 Record Keeping

Calico will maintain a record of the hazardous waste determination(s) as applicable. The volume of PCS added to the roll-off bins, the volume transported off site, and shipping manifests will be recorded quarterly and kept for a minimum of seven years.

5 CONTINGENCY PLAN

PCS will not be disposed of on site; therefore, there is no contingency plan for the storage of the PCS or the off-site transport. A licensed contractor will transport the PCS roll-off bin to an approved disposal facility.

6 CLOSURE AND RECLAMATION

Calico's management strategy is to send PCS for off-site disposal using a licensed contractor. As such, no PCS will remain on site that will require special closure plans. The concrete pad will be closed in a manner similar to the other concrete pads and foundations that will be constructed at the Project. The concrete pad will be broken using a track-hoe mounted hydraulic hammer or similar methods and buried in place under approximately three feet of material in such a manner to prevent ponding and to allow vegetation growth. After demolition and salvage operations are complete, the disturbed area will be covered with approximately 12 inches of growth media and revegetated.

7 REFERENCES

Calico Resources USA Corp. (Calico). 2019. *Grassy Mountain Mine Project, Malheur County, Oregon, Emergency Response Plan*.

Appendix AA: Quality Assurance Plan

Golder Associates Inc.
Construction Quality Assurance Plan
Tailings Storage Facility and Waste Rock Dump

Construction Quality Assurance Plan
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon

Submitted to:

Calico Resources USA Corp.
665 Anderson St.
Winnemucca, NV 98445

Submitted by:

Golder Associates Inc.
595 Double Eagle Court, Suite 1000
Reno, Nevada, USA 89521

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1663241-055-R-REV0

November 6, 2019

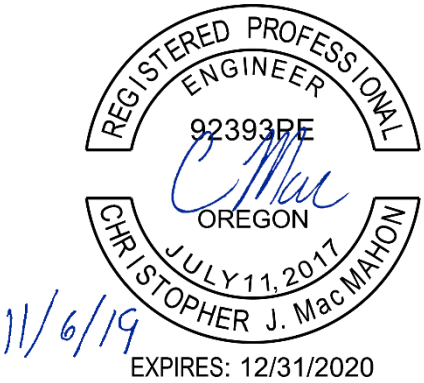
Construction Quality Assurance Plan
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon

The following Construction Quality Assurance Plan has been prepared by the staff of Golder Associates Inc. under the professional supervision of the engineers whose signatures appear herein.

This Plan is presented to Calico Resources USA Corp. and has been prepared in accordance with generally accepted profession engineering principles and practices.

Golder Associates Inc.



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APPENDIX

Appendix A Example of CQA Daily Field Report

1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan has been prepared by Golder Associates Inc. (Golder) on behalf of Calico Resources USA Corp. (Calico). This CQA Plan describes the program used to verify and document that earthwork construction, geomembrane installation, gravity pipe installation, and structural concrete installation for the Grassy Mountain Tailings Storage Facility (TSF) and Waste Rock Dump (WRD) are conducted in accordance with the Technical Specifications and the Drawings included in the Contract Documents for the Project.

This Plan is intended as summary of the Technical Specifications prepared as part of the Grassy Mountain TSF and WRD construction-level design presented as Appendix C in the Grassy Mountain Mine consolidated Permit Application.

Quality Control (QC) is a planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the requirements of the Technical Specifications and the Owner's needs. The objective of QC is to provide a work product that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification to meet the Owner's needs, production to meet the full intent of the Technical Specifications, inspection to determine whether the resulting material, product, service, etc. is in accordance with the Technical Specifications. In practice, QC refers to those procedures, criteria, and tests employed by the Quality Control Team to confirm the Work meets industry standards of practice and complies with the approved Design Drawings, Technical Specifications, and the CQA Plan. This plan does not address quality control procedures, criteria and/or tests employed by the Contractor.

Quality Assurance (QA) is a planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves evaluating the adequacy and effectiveness of the overall Quality Control program and implementing corrective measures where necessary. For a specific material, product, service, etc., this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment. In practice, QA refers to those procedures, criteria, and tests required by the Owner or Engineer to confirm the Work performed by the Contractor is in compliance with the approved Design Drawings and Technical Specifications and any additional requirements of this Plan.

The inspection and testing activities addressed under this CQA Plan include the following:

- Excavation
  - Embankment Fill Borrow Areas
  - Reclaim Pond
  - Waste Rock Dump
  - Stormwater Diversion Channels
  - Geotechnical Explorations
- Fill Materials
  - Subgrade

  - Embankment Fill
  - Grading Fill
  - Prepared Subgrade
  - Drainage Layer
  - Filter Fill
  - Anchor Trench Backfill
  - Drain Gravel
  - Leak Detection Fill
  - Pipe Bedding Fill
  - Cable Bedding Fill
  - Riprap
  - Safety Berm Material
- Geosynthetic Materials
  - Geomembrane
  - Geotextile
  - Geosynthetic Clay Liner
  - Geonet
- Monitoring Systems
  - Vibrating Wire Piezometers
  - Underdrain Flow Rate Monitoring and Flumes
  - Survey Monuments
  - Inclinometers
  - Leak Detection
- Cast-in-place Concrete
- Gravity Piping and Valves

2.0 ORGANIZATION

This section of the CQA Plan describes the parties involved during construction.

Owner: The Owner is the individual, corporation, entity, public body, or authority with whom the Contractor has entered into the Agreement and for whom the Work is performed. For this Project, the Owner is Calico Resources USA Corp. (Calico).

Engineer of Record (EOR): Engineer, or EOR, is the representative appointed and authorized by the Owner. The Engineer is responsible for preparation of the Design Drawings and Technical Specifications and this CQA Plan for the Project. The Engineer is also responsible for the interpretation of those documents and for resolution of technical matters that arise during construction. For this Project, the Engineer is Golder Associates Inc. (Golder). The Engineer-of-Record for this project is Christopher J. MacMahon, PE from Golder's Reno, Nevada Office.

Resident Engineer (RE): The RE is the on-site representative of the Engineer and oversees the Quality Assurance Team. The RE is responsible for overseeing the completion of the Work in accordance with the Drawings, Technical Specifications, and this CQA Plan. Other responsibilities include documenting daily construction activities, review of material submittals, review of the Quality Control program, and acceptance of completed Work. The RE will work directly with the Engineer and oversee the Quality Assurance Team. For this project, the RE will be a senior field technician provided by Golder.

Earthworks Contractor: Party, independent of the Owner, whose primary responsibility is to ensure the TSF is constructed in accordance with the Drawings, Technical Specifications, and this CQA Plan developed by the Engineer and approved by the permitting agency. Other responsibilities include the performance of all construction activities (including Subcontractors) at the site including site facilities, administration, material purchasing (other than materials procured by the Owner and Geomembrane Contractor), material handling and storage, safety, supervision, construction Quality Control program, installation, and subcontracting. The Contractor is also responsible for informing the Owner, Engineer, and Quality Assurance Team of the scheduling and occurrence of all construction activities and shall be fully responsible for scheduling and coordinating the work of the Quality Control Team and Subcontractor(s). The Contractor is responsible for the protection of completed work until it is accepted by the Owner.

Geosynthetics Contractor: Party, independent of the Owner, contracted through the Owner or Earthworks Contractor, responsible for field handling, sorting, placing, seaming, ballasting (against wind), and other aspects of the geosynthetics installation, including geomembranes, geotextiles, geonet, and Geosynthetic clay liners. The Geosynthetics Contractor is also responsible for transportation of these materials to the site, unless otherwise directed by the Owner. In addition, the Geosynthetics Contractor is responsible for the protection of the materials once they arrive on site, until the Work is accepted by the Owner.

Quality Control Team (QCT): Party, independent from the Owner, contracted through the Owner or Earthworks Contractor, responsible for performing the earthwork and geomembrane Quality Control field and laboratory testing, observations, and inspections required by the Technical Specifications. The QCT shall be approved by the Owner and Engineer. The QCT shall have experience in testing earth fills, aggregates, concrete, and geosynthetics and be familiar with the test methods and standards as required in the Technical Specifications.

At a minimum, the QCT shall consist of the following personnel:

- QC Manager – Registered Professional Engineer licensed in the State of Oregon responsible for all QC material testing, observation, and reporting of all QC activities required by the Technical Specifications

- QC Field Technician(s) – Qualified field technicians responsible for performing all earthwork, geomembrane and concrete field sampling, testing, and observations required by the Technical Specifications
- QC Earthwork Testing Laboratory – Qualified geotechnical testing laboratory responsible for performing all geotechnical laboratory testing required by the Technical Specifications
- QC Geomembrane Testing Laboratory – Qualified geomembrane testing laboratory responsible for performing all geomembrane laboratory testing during manufacturing required by the Technical Specifications

At a minimum, the QCT shall be responsible for the following:

- Performing all QC geotechnical testing required by the Technical Specifications
- Performing all QC geomembrane testing as required by the Technical Specifications
- Performing all QC concrete testing as required by the Technical Specifications
- Procuring all material data sheets and certifications of manufactured materials used to complete the Work and submitting to the Engineer for approval as required by the Technical Specifications
- Formally submitting test results, observations, manufacturer certifications, and QC daily field reports to the Engineer as required by the Technical Specification
- Preparation of the Quality Control Report and shall be approved and sealed by the QC Manager

At a minimum, the QC Manager shall have the following responsibilities:

- Oversee the QC Technicians and review of testing and analytical procedures employed to perform the QC testing, observation, and reporting of all QC activities as required by the Technical Specifications
- Review of all QC test results, observations, and QC daily field reports for all QC activities as required by the Technical Specifications
- Reporting of all QC tests and daily field reports to the Engineer as required by the Technical Specifications
- Report identified deficiencies and proposed corrective action to the QAT

Quality Assurance Team (QAT): Party, independent from the Contractor and QCT, responsible for QA field and laboratory testing, observations, documenting activities required by the Technical Specifications. The QAT shall be contracted through the Owner and perform assigned duties at the direction of the RE and Engineer. The QCT shall have experience in testing earth fills, aggregates, concrete, and geosynthetics and be familiar with the test methods and standards as required in the Technical Specifications.

At a minimum the QAT shall consist of the following personnel:

- RE – On-site representative of the Engineer overseeing the QAT

- QA Field Technician(s) – Qualified field technicians responsible for performing all geotechnical and geomembrane QA sampling, testing, and observations required by the Technical Specifications and at the direction of the Engineer
- QA Geotechnical Laboratory - Qualified geotechnical testing laboratory responsible for performing geotechnical laboratory at the direction of the Engineer
- QA Geomembrane Laboratory – Qualified geomembrane testing laboratory responsible for performing all geomembrane laboratory conformance testing during manufacturing required by the Technical Specifications

At a minimum, the QAT shall be responsible for the following:

- Review and approval of manufacturer QC certificates and test results as required by the Technical Specifications
- Review and approval of QC test results, observations, and QC daily field reports
- Review and approval of compaction procedures for materials placed and compacted as required by the Technical Specifications
- Sampling and performing geomembrane conformance tests as required by the Technical Specifications
- Initiation of design changes or clarifications required by the Engineer or Contractor
- Verify that the Work is constructed in accordance with industry standards of practice, Technical Specifications, and the Owner's needs
- Prepare the Record of Construction Report and shall be approved and sealed by the Engineer

Geosynthetic Manufacturer (Manufacturer): The party responsible for manufacturing the geomembrane, geosynthetic clay liner, geotextile, and appurtenances.

Subcontractor: The Subcontractor is an entity or individual who has a direct contract with the Contractor for the performance of a part of the Work. The Subcontractor shall communicate with the Owner or Engineer through the Contractor. The Subcontractor shall adhere to the requirements of the Drawings, Technical Specifications, and this CQA Plan as it relates to the Subcontractor's part of the Work.

3.0 MEETINGS

3.1 General Preconstruction Activities

Prior to the start of construction, a preconstruction meeting shall be held among the Owner, the Engineer, RE, QCT, QAT, and the Contractor(s) responsible for completing the Work. If necessary, a separate preconstruction meeting shall be held upon mobilization of the Geosynthetics Contractor if they cannot attend the first preconstruction meeting. The topics covered at this meeting shall include, but not be limited to:

- Providing each party with all relevant Construction Documents and supporting information
- Familiarizing each Party with this site-specific CQA Plan, its role relative to accomplishing the intent of the design, as well as review of the Design Drawings and Technical Specifications

- Reviewing the responsibilities of each Party
- Reviewing lines of authority and communication for each Party
- Discussing the established procedures or protocols for construction, deficiencies, repairs, and retesting
- Reviewing methods of documenting and reporting inspection data
- Reviewing work area security and safety protocols
- Discussing procedures for the location and protection of construction materials, and for the prevention of damage of the materials from inclement weather or other adverse events
- Conducting a site walk to review site conditions as well as material staging and storage locations
- Discussing the construction plan, schedule, and procedures
- Clarifying installation, testing, and acceptance criteria and procedures

3.2 Progress Meetings

Progress meetings will be held throughout progress of the Work at least once per week unless more frequent meetings are required. The RE and/or the Contractor will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record the minutes, and distribute copies of the minutes within three days to the participants and those affected by decisions made. At a minimum, progress meetings shall be attended by the RE, the Contractor, and major Subcontractors. The purpose of a progress meeting is to address the following items:

- Review minutes of previous meetings
- Review Work progress and schedule
- Field observations, problems, and decisions
- Identify problems that impede planned progress
- Review submittals schedule and status of submittals
- Review material availability and quality
- Plan Work activities and progress during succeeding work period
- Coordinate projected progress
- Discuss construction quality and work standards
- Discuss other issues relating to the work

3.3 Problem or Work Deficiency Meeting

A special meeting shall be held when, and if, a problem or deficiency is present or is anticipated. At a minimum, the meeting shall be attended by the RE and the Contractor. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- Define and discuss the problem or deficiency

- Review alternative solutions
- Implement an action plan to resolve the problem or deficiency

The meeting shall be documented by the RE. Copies of the meeting minutes shall be distributed within three days to participants and those affected by decisions made.

4.0 CONSTRUCTION QUALITY ASSURANCE REQUIREMENTS

4.1 General

This section of the CQA Plan describes the observations and testing activities that will be performed during construction. The scope of this section addresses the construction method, including material installation and the manufacture/fabrication as specified in the following Technical Specification sections:

- Section 01041 – Project Coordination
- Section 01050 – Field Engineering
- Section 01051 – Geotechnical Exploration
- Section 01400 – Quality Control and Assurance
- Section 02110 – Site Clearing and Stripping
- Section 02205 – Fill Materials
- Section 02211 – Rough Grading
- Section 02222 – Excavating
- Section 02223 – Filling
- Section 02272 - Geotextile
- Section 02272 – Geonet
- Section 02350 – Geosynthetic Clay Liner
- Section 02710 – Gravity Piping
- Section 02775 – Geomembranes
- Section 03110 – Concrete Formwork
- Section 03220 – Reinforcing Steel
- Section 03300 – Cast-in-Place Concrete
- Section 11207 – Parshall Flumes
- Section 17150 – Meters and Instrumentation

Acceptance criteria for construction work shall be as identified in the Technical Specifications. The RE will be on-site at all times while construction is ongoing, observing and documenting all relevant activities. QA shall consist of observing the work as construction proceeds and review of laboratory and field testing

performed by the QCT to ensure that the materials conform to the Specifications and construction performance specifications are achieved. The RE will also review the required Contractor/Subcontractor submittals as specified in the Technical Specifications.

The Engineer shall visit the site periodically as construction progress warrants. Such visits will be frequent enough to allow the Engineer to be fully knowledgeable of the construction methods and performance. The Engineer may then determine if QC/QA observation and testing activities are adequate to meet the requirements of this CQA Plan.

4.2 List of Applicable Methods

List of applicable methods (references) are provided in the Technical Specifications.

4.3 Sampling and Testing Requirements

The QC\QA sampling and testing requirements for the construction activities are summarized in the tables in Section 6.0.

5.0 GENERAL QUALITY CONTROL/ASSURANCE PROCEDURES

5.1 General Description

The QCT shall be responsible for implementing a QC program that satisfies the requirements of the Technical Specifications and this CQA Plan. The QAT shall be responsible for reviewing all QC field and laboratory test results, observations, and QC daily field reports and document that the project construction has been completed in conformance with the Technical Specifications, Design Drawings, and the CQA Plan.

For this Project, QA testing performed by the QAT will satisfy the QC testing requirements of the Project. If selected by the Contractor and approved by the Owner, the Contractor may elect to not perform field QC testing in solely rely on the QAT to document contractor QC. This does not eliminate the requirements of the Contractor from performing assigned Work in accordance with the Technical Specifications and Design Drawings.

5.2 Visual Observations

5.2.1 Quality Control Team

Visual observations shall be performed by the QCT that include, but not be limited to, the following:

- Compaction method for materials placed (placement, moisture conditioning, equipment type, number of passes) as required by the Technical Specifications
    - Adherence to the procedures established during the test fills (if any)
- Consistency of materials during processing and/or placement
- Deleterious material that may hinder proper construction
- Attention to areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred
- Safe working procedures and construction methods

5.2.2 Quality Assurance Team

Visual observations shall be performed by the QAT that include, but no be limited to, the following:

- Compaction method for materials placed (placement, moisture conditioning, equipment type, number of passes)
  - Adherence to the procedures established during the test fills (if any)
- Proper material usage
- Reviewing QCT procedures for sampling, testing, observations, and documentation
- Approval of areas where Work has been completed
- Safe working procedures and construction methods

5.3 Defects and Repairs

5.3.1 Identification

If a defect is identified, the QCT shall determine the extent and the nature of the defect and notify the QAT immediately. If the defect is indicated by an unsatisfactory test result, the QAT shall determine the extent of the deficient area by additional QC tests, observations, review of records, or other means that the QAT deems appropriate.

5.3.2 Notification

After determining the extent and nature of the defect, the QAT shall promptly notify the Contractor. The QAT shall review the QCT's determination regarding the extent of the defect. If the QAT agrees with the QCT's determination, the Contractor shall be notified of the defect. If in the opinion of the QAT, disagrees with the QCT's determination, additional observations and testing may be required prior to notifying the Contractor.

5.3.3 Repairs and Retesting

Upon notification from the QAT, the Contractor shall correct all deficiencies to meet the Contract Documents. The QAT and QCT shall schedule appropriate retests when the Work deficiencies have been corrected. All retests by the QCT or QAT must verify that the deficiencies have been corrected before additional Work may be performed by the Contractor in the deficient area. The QAT shall observe any repair and report any noncompliance with the above requirements in writing to the Engineer.

5.4 Documentation

5.4.1 General

Proper documentation shall be maintained throughout the duration of the construction activities. The QCT will be responsible for ensuring that applicable forms and written records are completed daily. Originals of applicable forms and written documentation will be stored on-site and shall be made available for the QAT's review upon request. Copies of written documentation will be made each week and shall be sent to the QAT. Further details of typical documentation are presented below.

5.4.2 Daily Records

5.4.2.1 Quality Control Daily Reports

The QCT shall issue a typed daily report of activities. QC daily reports shall include the following:

- Date and shift
- List of organizations and their responsibilities
- List of equipment used for construction of Work
- Health and safety issues
- Summary of QC activities
  - Materials used for construction
  - Summary of samples taken, sample locations and elevations as appropriate, and test results
  - Test equipment calibrations
  - List of materials received
- Issues and problems encountered, and resolutions reached
- Summary of meetings and discussions (if any)
- QCT personnel hours, gear, and vehicles
- Photographs taken with a description

A template for daily reports is provided in Appendix A.

5.4.2.2 Quality Assurance Daily Reports

The QAT shall issue a typed daily report of activities. QA daily reports shall include the following:

- Date and shift
- Weather conditions
- List of organizations and their responsibilities
- List of equipment operating on-site
- Health and safety issues
- Summary of QC documentation review
- Summary of QC activities
- Issues and problems encountered, and resolutions reached
- Summary of meetings and discussions
- QAT personnel hours, personal protective equipment used, and vehicles
- Photographs taken with a description

A template for daily reports is provided in Appendix A.

5.4.3 Construction Reporting

5.4.3.1 Construction Quality Control Report

Following completion of construction, the QCT shall provide a Construction Quality Control Report by that will include the following:

- Description of Quality Control activities
- Summary of test results
- Copies of QC daily reports
- As-Built Survey documentation
- Color photographs of major project features

The Construction Quality Control Report shall be submitted to the Engineer within 14 days upon acceptance of the completed Work. The Construction Quality Control Report shall be sealed by a registered Professional Engineer, licensed in the State of Oregon certifying that the activities performed by the QCT have been performed in accordance with the Contract Documents.

5.4.3.2 As-built Survey Documentation

Following completion of construction, the Contractor shall provide As-built Survey Documentation of all Work performed by the Contractor that will include the following:

- Survey of all areas disturbed by the Contractor that pertain to the completion of the Work
- Survey of all structures, pipes, utilities, and other facilities that pertain to the completion of the Work

The As-built Survey Documentation shall be submitted to the Engineer within 14 days upon acceptance of the completed Work. The As-built Survey Documentation shall be sealed by a registered Professional Land Surveyor, licensed in the State of Oregon certifying that the surveys are in accordance with the Contract Documents.

5.4.3.3 Record of Construction Report

Following completion of Construction and receipt of the Construction Quality Control Report and As-built Survey Documentation, the Engineer shall prepare the Record of Construction report documenting the following:

- Description of construction activities
- Summary of test results
- Copies of QCT and Resident Engineer Daily Reports
- As-built Survey documentation
- As-built Drawings
- Critical correspondence pertaining to the Work including changes and clarifications to the Drawings

- Description of deviations from the Technical Specifications and justification for such changes
- Color photographs of major project features

The Record of Construction Report will be sealed by the Engineer, certifying that the facility has been constructed in accordance with the Contract Documents.

6.0 QUALITY CONTROL REQUIREMENTS

Table 1: Subgrade

Type	Parameter	Standard	Test Method	Frequency (units per test)	Comments
Subgrade Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	N/A	
	Sieve Analysis	N/A	ASTM D 6913	200,000 sq.ft of prepared surface	
	Atterberg Limits	N/A	ASTM D 4318	200,000 sq.ft of prepared surface	
	Moisture-Density Relationship	Modified Proctor	ASTM D 1557	500,000 sq.ft of prepared surface	
Subgrade Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Scarification Depth	6 inches below	N/A	Continuous Monitoring	
	Field Density	90% of Max Dry Density as determined by ASTM D 1557	ASTM D 6938	50,000 sq.ft of prepared surface	
	Field Moisture Content	N/A	ASTM D 6938	50,000 sq.ft of prepared surface	May be collected during field density test
	Sand Cone Referee Density	N/A	ASTM D 1556	1 test per 10 field density tests	As required by the Engineer
	Laboratory Moisture Content	N/A	ASTM D 4643	1 test per 10 field moisture tests	As required by the Engineer

Table 2: Embankment Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Embankment Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	N/A		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	- A maximum of any 1 sieve is allowed to be out of spec for an individual test - Maximum particle size shall be less than 2/3 loose lift thickness
		16 inch	100			
		12 inch	50 – 100			
		8 inch	30 – 100			
		¾ inch	0 – 80			
		No. 4	0 – 40			
		No. 200	0 – 15			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	20,000 cu.yds	Per material type
Embankment Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	12, 18, and 24-inch test fill		USACOE	Continuous Monitoring	Per test fill procedures described in Section 02223
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	2,000 cu.yds	
	Field Moisture Content	N/A		ASTM D 6938	Continuous Visual Monitoring	
	Sand Cone Referee Density	N/A		ASTM D 1556	N/A	
	Laboratory Moisture Content	N/A		ASTM D 2216 or D 4643	N/A	

Table 3: Grading Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Grading Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 15		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	
		6 inch	100			
		¾ inch	20 – 100			
		No. 4	10 – 70			
		No. 40	0 – 40			
		No. 200	0 – 30			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	20,000 cu.yds	Per material type
Grading Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	Soil Fill: Maximum 12-inch thick loose lift Rock Fill: 12, 18, and 24-inch test fill		USACOE	Continuous Monitoring	Per test fill procedures described in Section 02223
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	1,000 cu.yds	
	Field Moisture Content	N/A		ASTM D 6938	Continuous Visual Monitoring	
	Sand Cone Referee Density	N/A		ASTM D 1556	N/A	
	Laboratory Moisture Content	N/A		ASTM D 2216 or D 4643	N/A	

Table 4: Prepared Subgrade

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Prepared Subgrade Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 20		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	
		3 inch	100			
		¾ inch	70 – 100			
		No. 4	20 – 100			
		No. 40	0 – 60			
		No. 200	0 – 50			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	15,000 cu.yds	Per material type
Prepared Subgrade Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	Maximum 12-inch thick loose lift On slopes steeper than 20% maximum 18-inch lifts measured perpendicular to slope		N/A	Continuous Monitoring	May be placed in a single 6-inch lift if the underlying Embankment Fill is free of coarse material. Lift thickness shall be approved by Engineer.
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	1,000 cu.yds	
	Field Moisture Content	N/A		ASTM D 6938	Continuous Visual Monitoring	
	Sand Cone Referee Density	N/A		ASTM D 1556	N/A	
	Laboratory Moisture Content	N/A		ASTM D 2216 or D 4643	N/A	

Table 5: Drainage Layer

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Drainage Layer Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 10		ASTM D 4318	5,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	5,000 cu.yds	
		3 inch	100			
		¾ inch	50 – 100			
		No. 4	20 – 50			
		No. 40	0 – 25			
		No. 200	0 – 15			
	Moisture-Density Relationship	N/A		N/A	N/A	
	Hydraulic Conductivity	5 x 10^{-3} cm/sec or faster		ASTM D 5856	2 per material type	
Drainage Layer Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only Low Ground Pressure (LGP) tracks allowed for material spreading
	Lift Thickness	Single 18-inch thick loose layer		N/A	Continuous Monitoring	Not Compacted
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 6: Filter Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Filter Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 10		ASTM D 4318	3,000 cu.yds	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	3,000 cu.yds	
		8 inch	100			
		3 inch	70 – 100			
		¾ inch	30 – 90			
		No. 40	0 – 25			
		No. 200	0 – 15			
	Moisture-Density Relationship	N/A		N/A	N/A	
	Hydraulic Conductivity	5×10^{-4} cm/sec or faster		ASTM D 5856	2 per material type	
Filter Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only Low Ground Pressure (LGP) tracks allowed for material spreading.
	Lift Thickness	Single 6-inch thick loose lift		N/A	Continuous Monitoring	Not Compacted
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 7: Anchor Trench Fill

Type	Parameter	Standard	Test Method	Frequency (units per test)	Comments
Anchor Trench Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Atterberg Limits	N/A	ASTM D 4318	N/A	
	Sieve Analysis	N/A	ASTM D 6913	500 cu.yds	
	Moisture-Density Relationship	N/A	N/A	N/A	
Anchor Trench Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Lift Thickness	Maximum 12-inch-thick loose lifts	N/A	Continuous Monitoring	
	Field Density	N/A	N/A	Continuous Monitoring	Hand guided or bucket compacted
	Field Moisture Content	N/A	N/A	Continuous Monitoring	
	Sand Cone Referee Density	N/A	N/A	N/A	
	Laboratory Moisture Content	N/A	N/A	N/A	

Table 8: Drain Gravel

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Drain Gravel Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 10		ASTM D 4318	200 cu.yds or 3 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	200 cu.yds or 3 per material type	
		2 inch	100			
		¾ inch	50 – 80			
		No. 4	15 – 50			
		No. 200	0 – 5			
	Moisture-Density Relationship	N/A		N/A	N/A	
Drain Gravel Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only LGP track-mounted equipment allowed on Drain Gravel
	Lift Thickness	6-inch above and laterally around perforated pipe		N/A	Continuous Monitoring	Not Compacted
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 9: Leak Detection Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Leak Detection Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Native borrow material or process Waste Overburden
	Atterberg Limits	PI ≤ 15		ASTM D 4318	2 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	2 per material type	
		1 inch	100			
		¾ inch	75 – 100			
		⅜ inch	20 – 55			
		No. 200	0 – 10			
	Moisture-Density Relationship	N/A		N/A	N/A	
Leak Detection Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Only track-mounted equipment allowed on Leak Detection Fill
	Lift Thickness	8 inch above and laterally around perforated pipe		N/A	Continuous Monitoring	Hand placed below spring line of pipe
	Field Density	N/A		N/A	N/A	
	Field Moisture Content	N/A		N/A	N/A	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 10: Pipe Bedding Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Pipe Bedding Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 20		ASTM D 4318	200 lineal feet or 2 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	200 lineal feet or 2 per material type	
		2 inch	100			
		¾ inch	70 – 100			
		No. 4	20 – 70			
		No. 40	0 – 35			
		No. 200	0 – 25			
	Moisture-Density Relationship	Modified Proctor		ASTM D 1557	200 lineal feet or 3 per material type	Per material type
Pipe Bedding Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	Maximum 6-inch thick loose lift		N/A	Continuous Monitoring	
	Field Density	92% of Max Dry Density as determined by ASTM D 1557		ASTM D 6938	100 lineal feet	Only hand-guided, mechanical tampers, or hand-guided vibratory rollers shall be used around pipes
	Field Moisture Content	N/A		N/A	Continuous Monitoring	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 11: Cable Bedding Fill

Type	Parameter	Standard		Test Method	Frequency (units per test)	Comments
Cable Bedding Fill Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Atterberg Limits	N/A		ASTM D 4318	2 per material type	
	Sieve Analysis	Sieve Size	% Passing	ASTM D 6913	2 per material type	Screened Drainage Layer or Native Alluvium
		⅜ inch	100			
	Moisture-Density Relationship	smooth and non-yielding		ASTM D 1557	N/A	
Cable Bedding Fill Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials		N/A	Continuous Monitoring	
	Lift Thickness	6-inch loose lift below cables 12-inch loose lift above cables		N/A	Continuous Monitoring	Hand guided-compaction equipment only
	Field Density	Visually documentation of a smooth and non-yielding surface		N/A	Continuous Monitoring	
	Field Moisture Content	N/A		N/A	Continuous Monitoring	
	Sand Cone Referee Density	N/A		N/A	N/A	
	Laboratory Moisture Content	N/A		N/A	N/A	

Table 12: Riprap

Type	Parameter	Standard					Test Method	Frequency (units per test)	Comments
Riprap Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials					N/A	Continuous Monitoring	
	Atterberg Limits	PI ≤ 20					N/A	N/A	
	Sieve Analysis	**Riprap D50**	**8”**	**12”**	**16”**	**28”**	ASTM D 5519	2 per material type	
			Rock Size (in.)						
		D_{100}	12	18	24	42			
		D_{85}	10	14	20	36			
		D_{50}	8	12	16	28			
		D_{15}	3	4	6	12			
	Moisture-Density Relationship	N/A					N/A	N/A	
Riprap Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials					N/A	Continuous Monitoring	Shall be placed in horizontal lifts
	Lift Thickness	1.5 x D_{50}					N/A	Continuous Monitoring	
	Field Density	N/A					N/A	Continuous Monitoring	Track-walked or bucket compacted
	Field Moisture Content	N/A					N/A	N/A	
	Sand Cone Referee Density	N/A					N/A	N/A	
	Laboratory Moisture Content	N/A					N/A	N/A	

Table 13: Safety Berm Material

Type	Parameter	Standard	Test Method	Frequency (units per test)	Comments
Safety Berm Material Physical Properties	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Atterberg Limits	N/A	N/A	N/A	
	Sieve Analysis	N/A	N/A	N/A	
	Moisture-Density Relationship	N/A	N/A	N/A	
Safety Berm Material Compaction	Visual Inspection	Free of sod, brush, roots or other perishable and unsuitable materials	N/A	Continuous Monitoring	
	Lift Thickness	N/A	N/A	N/A	Shall be placed by loader, dozer or grader
	Field Density	N/A	N/A	N/A	Uncompacted
	Field Moisture Content	N/A	N/A	N/A	
	Sand Cone Referee Density	N/A	N/A	N/A	
	Laboratory Moisture Content	N/A	N/A	N/A	

Table 14: Textured Geomembrane Required Minimum Properties (Per GRI-GM13)

Parameter	Test Value		Test Method (ASTM)	Manufacturer Quality Control Frequency (units per test)
	60 mil	80 mil		
Thickness mils (min avg.)	57 mil	76 mil	D 5994	Per roll
Thickness (Minimum 8 of 10)	-10% (54 mil)	-10% (72mil)		
Lowest individual for any of the 10 values	-15% (51 mil)	-15% (68 mil)		
Asperity Height	16 mil	18 mil	D 7466	Every 2nd roll*
Density (g/cc) min.	0.940	0.940	D 1505/D 792	200,000 lb
Tensile Properties (min. avg.)*				
Yield Strength (lb/in)	126	168	D 6693 Type IV	20,000 lb
Break strength (lb/in)	90	120		
Yield Elongation (%)	12	12		
Break Elongation (%)	100	710		
Tear Resistance (lbs) (min. ave)	42	56	D 1004	45,000 lb
Puncture Resistance (lbs) (min. ave)	90	120	D 4833	45,000 lb
Stress Crack Resistance (hr)*	500 hr	500 hr	D 5397	Per GRI GM-10
Carbon Black Content (%)	2.0-3.0	2.0-3.0	D 4218*	20,000 lb
Carbon Black Dispersion*	See Notes*	See Notes*	D 5596	45,000 lb
Oxidative Induction Time (OIT)				
Standard OIT (minutes), or	100	100	D 3895	200,000 lbs
High Pressure OIT (HP OIT) (minutes)	400	400	D 5885	
Oven Aging at 85°C (min. avg.)*)			D5721	Per each formulation
a. Std OIT (% retained after 90 days) min. avg. or;	55	55	D 3895	
b. HP OIT (% retained after 90 days) min avg.	80	80	D 5885	
UV Resistance (min ave)*			D5721	Per each formulation
a. Std. OIT (min. avg.), or	N.R.	N.R.	D 3895	
b. HP OIT (min. avg.) (% ret. after 1600 hrs)*	50%	50%	D 5885	

*Refer to Notes presented in Table 02775-1 of Section 02775 in the Technical Specifications

Table 15: HDPE Geomembrane Seam Properties Wedge and Extrusion Welds (per GRI GM-19a)

Parameter	Textured HDPE Test Values		Test Method (ASTM)	Testing Frequency (units per Test)	Comments
	60 mil	80 mil			
Seam Shear Strength (lbs/in) minimum*	120	160	D 6392	500 LF per machine	Peel and Shear seams must fail in the Film Tear Bond mode*
Lowest Individual Seam Shear Strength of 5 tests (lbs/in)*	96	128			
Shear elongation at break (%)	50	50			
Seam Peel Strength (lbs/in) minimum*	91 for hot wedge 78 for extrusion	121 for hot wedge 104 for extrusion			
Lowest Individual Seam Peel Strength of 5 tests (lbs/in)*	73 for hot wedge 62 for extrusion	97 for hot wedge 83 for extrusion			
Peel separation (%)	25	25			

*Refer to Notes presented in Table 02775-2 of Section 02775 in the Technical Specifications

Table 16: Geomembrane Conformance Testing

Property	Test Value	Test Method (ASTM)	Testing Frequency (units per Test)
Thickness (mils)	See Table 13	D 5199	2,000,000 sq. ft. per liner type, or per resin lot, whichever is greater (each test)
Compound Density (g/cc)	See Table 13	D 1505	
Tensile Strength (Both yield and ultimate strength and elongation, as specified)	See Table 13	D 6693	
Carbon Black Content (%)	See Table 13	D 4218	

Table 17: Minimum Average Roll Values For Reinforced Geofilm Related GCL Material (per GRI-GCL3)

Property	ASTM Test Method	Value	Comments
Cap Geosynthetic			Material Data Sheets shall be provided to the Engineer per Section 01300 of the Technical Specifications
Type	-	Non-woven	
Weight	ASTM D 5261	6.0 oz/sq.yd.	
Carrier Geosynthetic			
Type	-	Woven	
Weight	ASTM D 5261	3.0 oz/sq.yd.	
Geofilm			
Thickness	ASTM D 5199/ D 5994	4 mil	
Break Tensile Strength (MD & XMD)	ASTM D 882	12 lb/in	
Clay Properties			
Clay Type	-	80% or more montmorillonite	
Bentonite Mass at 0% Moisture*	ASTM D 5993	0.75 psf	
Maximum Allowable Moisture Content	ASTM D 5993	35%, by weight	
Swell Index	ASTM D 5890	24 ml/2g min	
Fluid Loss	ASTM D 5891	18 ml max	
GCL Composite Properties			
GCL Permeability*	ASTM D 6766	5×10^{-10} cm/sec max at 5.0 psi	
Tensile Strength in Machine Direction	ASTM D 6768	23 lb/in	
Peel Strength	ASTM D 6496	2.1 lb/in	
Geofilm Durability*	ASTM D 5721	80% strength	
Internal Shear Strength	ASTM D 6243	150 psf typical	

*Refer to Notes presented in Table 02350-2 of Section 02350 in the Technical Specifications

Table 18: Minimum Average Roll Values For Geotextile Material (per GRI-GT12a)

Parameter	ASTM Test Method	Value	Testing Frequency	Comments
Weight	D 5261	12 oz/sq.yd.	1 per material type, or as requested by the Engineer	Material Data Sheets shall be provided to the Engineer per Section 01300 of the Technical Specifications
Grab Tensile	D 4632	300 lb		
Grab Tensile Elongation	D 4632	50%		
Trapezoidal Tear Strength	D 4533	115 lb		
Puncture (CBR) Strength	D 6241	800 lb		
UV Resistance (at 500 hrs)	D 7238	70% strength retained		
Apparent Opening Size	D 4751	No. 100 Sieve (0.15 mm)		

*Refer to Notes presented in Table 02272-1 of Section 02272 in the Technical Specifications.

Table 19: Minimum Average Roll Values for Geonet Material (per GRI-GN4)

Parameter	ASTM Test Method	Value	Testing Frequency	Comments
Thickness* (min. ave.)	D 5199	200 mil	1 per material type, or as requested by the Engineer	Material Data Sheets shall be provided to the Engineer per Section 01300 of the Technical Specifications
Density* (min. ave.)	D 1505/D 792	0.950 g/cm*		
Carbon Black Content (%)	D 1603/D 4218	1.5-3.0%		
Tensile Strength* (MD)	D 7179	180 lb/in		
Compressive Strength* (min. ave.)	D 6364	120		
Transmissivity*	D 4716	5.0 gal/min-ft		

*Refer to Notes presented in Table 02273-1 of Section 02273 in the Technical Specifications.

Table 20: Cast-In-Place Concrete

Type	Parameter	Test Value	Test Method (ASTM)	Testing Frequency	Comments
Cast-In-Place Concrete (Reinforced)	Compressive strength	4,000 psi at 28 days	C 39	4 Standard 6-inch diameter by 12-inches long test cylinders for every 50 yards of concrete poured or for each pour, whichever is greater	One at 7 days, one at 14 days, and one at 28 days, one reserve
	Maximum aggregate size	3/4-inch	C 136		
	Slump	3 to 5 inches	C 143	Every 50 yards of concrete poured or for each pour, whichever is greater	
	Air Entrainment (%)	4 to 6%	C 233	Every 50 yards of concrete poured or for each pour, whichever is greater	
Lean Mix Concrete (unreinforced)	Compressive strength	2,000 psi at 28 days	C 39	4 Standard 6-inch diameter by 12-inches long test cylinders for every 50 yards of concrete poured or for each pour, whichever is greater	One at 7 days, one at 14 days, and one at 28 days, one reserve
	Maximum aggregate size	1.5-inch	C 136		
	Slump	3 to 5 inches	C 143	Every 50 yards of concrete poured or for each pour, whichever is greater	

APPENDIX A

Example of CQA Daily Field Report

DAILY FIELD REPORT

DATE: **PROJECT NO.**

REPORT NO.
FILE TO:

GRASSY MOUNTAIN TSF CONSTRUCTION

Table 1: Present at Site

Organization	Responsibility

Table 2: Equipment Present at Site

Qty	Type	Make/Model	Notes

Health and Safety

■

Construction Activity Summary

■

QA/QC Activity Summary

■

Issues and Resolution

■

Meetings and Discussions Summary

■

Signature
First and Last Name
Title

Total Hours On-site:
Field Equipment:
Vehicle:

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Description

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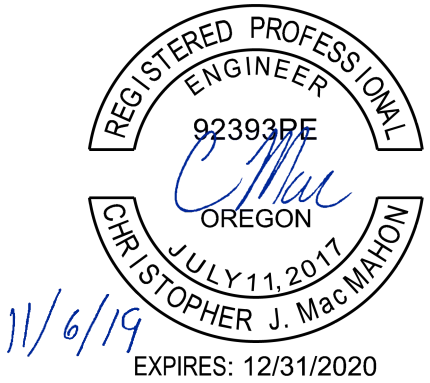
Golder Associates Inc.
Technical Specifications
Tailings Storage Facility and Waste Rock Dump

Technical Specifications
Tailings Storage Facility and Waste Rock Dump
Grassy Mountain Mine

Malheur County, Oregon



Submitted to:

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Submitted by:

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1662341-056-SP-Rev0

November 6, 2019

Table of Contents

Specification Number	Specification Title	Revision	Date
01010	Summary of Work	0	November 6, 2019
01041	Project Coordination	0	November 6, 2019
01042	Mobilization	0	November 6, 2019
01050	Field Engineering	0	November 6, 2019
01051	Geotechnical Exploration	0	November 6, 2019
01090	Reference Standards and Regulations	0	November 6, 2019
01300	Submittals	0	November 6, 2019
01400	Quality Control Assurance	0	November 6, 2019
01410	Testing Laboratory Services	0	November 6, 2019
01500	Construction Facilities and Temporary Controls	0	November 6, 2019
01600	Materials and Equipment	0	November 6, 2019
01700	Demobilization	0	November 6, 2019
02110	Site Clearing and Stripping	0	November 6, 2019
02205	Fill Materials	0	November 6, 2019
02211	Rough Grading	0	November 6, 2019
02222	Excavating	0	November 6, 2019
02223	Filling	0	November 6, 2019
02272	Geotextile	0	November 6, 2019
02273	Geonet	0	November 6, 2019
02350	Geosynthetic Clay Liner	0	November 6, 2019
02710	Gravity Piping	0	November 6, 2019
02775	Geomembranes	0	November 6, 2019
03110	Concrete Formwork	0	November 6, 2019
03220	Reinforcing Steel	0	November 6, 2019
03300	Cast-in-Place Concrete	0	November 6, 2019
11207	Parshall Flumes	0	November 6, 2019
17150	Meters and Instrumentation	0	November 6, 2019

SECTION 01010
SUMMARY OF WORK

1.0 GENERAL

1.1 Section Includes

A. Work Scope

B. Definitions

C. Contradictions

D. Contractor's Responsibilities

1.2 Work Scope

A. The scope of work for this project shall consist of construction of Tailings Storage Facility (TSF) and Waste Rock Dump (WRD) at the Grassy Mountain Mine as shown on the Drawings. The Work under this contract will include, but is not limited to:

1. Mobilization of all equipment and material required for the Work including: mobilization of temporary power facilities, sanitation facilities, and communication facilities.
1. Installation of temporary and permanent surface water control.
2. Furnishing and placement of construction water for both fill moisture control and dust control on roads and fills associated with construction of the Work in coordination with the Owner.
3. Backfilling and compaction of exploration test pits and boreholes, as required by the Owner, within the TSF and WRD footprints.
4. Clearing, grubbing, and stripping as required for the Work.
5. Construction of temporary access and haul roads.
6. Excavation, hauling, placement, of fill materials for the embankment, including Embankment Fill, Grading Fill, and Prepared Subgrade including moisture-conditioning and compaction.
7. Excavation, hauling, processing, and placement of fill materials Drainage Layer, Filter Fill, Anchor Trench Backfill, Drain Gravel, Leak Detection Fill, Pipe Bedding Fill, and Cable Bedding Fill including moisture-conditioning and compaction.
8. Subgrade preparation for geosynthetic clay liner (GCL) and high-density polyethylene (HDPE) geomembrane liner and embankment foundations.
9. Furnishing and installing 60 and 80 mil HDPE Geomembrane liner in the areas shown on the Drawings.
10. Furnishing and installing GCL.
11. Furnishing and installing Non-woven Geotextile in areas shown on the Drawings.
12. Furnishing and installing geonet in areas shown on the Drawings.
13. Furnishing, welding, and installing corrugated polyethylene (CPE) and HDPE piping and filling.
14. Demobilization, which includes: removal of temporary structures, shaping, contouring, and grading of final surfaces in preparation of reclamation seeding.

1.3 DEFINITIONS

B. The following definitions apply to these Technical Specifications:

1. "Owner" is defined as an authorized representative of Calico Resources USA Corp. (Calico).

2. “Engineer” is defined as a representative appointed and authorized by the Owner (Golder Associates, Inc.). The Engineer shall be a registered Professional Engineer in the State of Oregon, or a designated site representative under his supervision during construction.
3. “Resident Engineer” is defined as the Engineer’s on-site representative to oversee the completion of Quality Assurance of the Work.
4. “Quality Control Team” is defined as the individuals working under the direction of Engineer to perform on-site Quality Control tasks at the frequencies listed in these Specifications. The Quality Control Team shall be approved by the Owner. All field and laboratory testing shall be supervised by a registered Professional Engineer licensed in the State of Oregon.
5. “Quality Assurance Team” is defined as the individuals working under the direction of Engineer to perform on-site quality assurance tasks for the Owner during earthwork placement, pipe installation, and geomembrane installation.
6. “Contractor” is defined as the party which has executed a contract agreement for the specified work with the Owner.
7. “Geomembrane Installation Contractor: is defined as the Subcontractor retained by the Contractor or the Owner to install the geomembrane, geotextile, geonet and related appurtenances.
8. “Vendor” is defined as the supply or manufacturer of fabricated materials retained by the Contractor or Owner required to complete the Work.
9. “Subcontractor” is defined as a party retained by the Contractor to provide services or materials required to complete the Work. The Subcontractor shall be under direct supervision and report directly to the Contractor.
10. “Quality Control” is defined as inspection and testing performed prior to manufactured material being placed as well as inspection and testing performed on earthwork materials placed during construction of the Work. Performed by the Contractor, Manufacturer, or facility retained by the Contractor or Manufacturer.
11. “Quality Assurance” is defined as inspection and testing performed by the Quality Assurance Team and third-party laboratories retained by the owner.
12. “Specifications” are defined as this document of Technical Specifications prepared by Golder Associates Inc. (Golder) for the Owner.
13. “Report” is defined as the Construction-level Design Report presented as Appendix C in the Grassy Mountain Consolidated Permit Application and titled *Detailed Design, Tailings Storage Facility and Waste Rock Dump, Grassy Mountain Mine, Malheur County, Oregon,* Revision 0, dated November 6, 2019 prepared by Golder in conjunction with these Specifications and Drawings.
14. “Drawings” are defined as the construction-level design drawings prepared by Golder in conjunction with these Specifications titled *Grassy Mountain Mine, Tailings Storage Facility and Waste Rock Dump,* Revision 0, dated November 6, 2019.
15. “Modifications” are defined as changes made to the Specifications or the Drawings that are approved by the Owner and Engineer in writing after the Specifications or the Drawings have been finalized.
16. “On-Site Material” is defined as borrow soils obtained from within required facility excavations.
17. “Off-Site Materials” is defined as material obtained from sources other than on-site.
18. “Record Documents” are defined as the documents prepared by the contractor documenting the progress, location, type and quantity of materials placed to complete the Work.
19. “Products” are defined as new material, machines, components, equipment, fixtures, and systems forming the Work. This does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing material or components required for reuse.

20. “Work is defined as the entire complete construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.
21. “Contract Documents” are defined as the Agreement, Addenda (which pertain to the Contract Documents), Contractor’s Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Bonds, the General Conditions, the Supplementary Conditions, the Specifications, the Drawings, the CQA Plan, together with all Modifications issued after the execution of the Agreement.
22. All slopes are described in terms of horizontal distance to vertical distance (H:V).

1.4 CONTRADICTIONS

A. Should any contradiction, either implied or real, exist between the Specifications and the Drawings, the Contractor shall:

1. Notify the Owner and Engineer.
2. Stop all work that concerns the contradiction until the contradiction is remedied or clarified by the Engineer.

B. The decision of the Engineer is final.

1.5 CONTRACTOR’S RESPONSIBILITIES

A. The Contractor Shall:

1. Maintain Oregon Workman’s Compensation Insurance and provide evidence of such to the Owner.
2. Familiarize himself/herself with the relevant regional and site-specific conditions which may have an impact upon the work.
3. Be responsible for making his own measurements and installing his work to fit the conditions encountered.
4. Before proceeding with the Work, examine all Drawings, Specifications, CQA Plan, and Reports and notify the Engineer and Owner in writing of any apparent discrepancies or interferences. The Engineer, in consultation with the Owner, shall make minor alterations to the Drawings as needed. All alterations shall be issued under a covering work order signed by the Owner prior to the start of alteration, if the alteration will affect the terms of Contract.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01041
PROJECT COORDINATION

1.0 GENERAL

1.1 Section Includes

A. Contractor's Responsibilities

B. Submittals

1.2 Related Sections

A. Section 01010 – Summary of Work

B. Section 01300 – Submittals

C. Section 01500 – Reference Standards

1.3 Contractor's Responsibilities

A. Cooperate with the Owner in allocation of mobilization areas, areas for field offices, access, traffic, and parking facilities.

B. During construction, coordinate use of site and facilities through the Owner.

C. Comply with Owner's and Engineer's procedures for intra-project communications

D. Comply with instructions from the Owner for use of temporary utilities and construction facilities.

E. Submit request for interpretation of the Contract Documents to the Owner, and obtain instructions through the Owner.

F. All Contractor's personnel may be required to take site specific hazard training session, conducted by the Owner, and must have updated MSHA training in order to work at the site.

1.4 Submittals

A. Submit Contractor's MSHA number to Owner.

B. Submit MSHA health and safety certification of each employee that will work on site to the Owner prior to working at the site.

C. Submit preliminary deployment drawings, show drawings, product data, and samples in accordance with Section 01300 for review and compliance with Contract Documents. Revise and resubmit as required.

D. Maintain a record of man-hours worked on site and lost time accident hours. Submit the record weekly to the Owner.

E. Submit copies of air quality permits, if such permits are required to construct the Work.

F. Submit Material Safety Data Sheets (MSDS) to Owner for all chemicals or hazardous materials used on site, or stored on site, in support of performance of the Work. Submit weekly quantity use of TRI chemicals to the Owner, as requested by the Owner.

G. Submit a disposal plan for all waste r contaminated materials developed on site during performance of the Work. Submit plan prior to mobilization.

H. Submit statement at the end of the project stating that all waste and contaminated materials were disposed of in accordance with the approved plan.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01042
MOBILIZATION

1.0 GENERAL

1.1 Section Includes

A. General

1.2 Work Scope

A. Section 01010 – Summary of Work

B. Section 01500 – Construction Facilities and Temporary Controls

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 General

A. Upon receipt of notice to proceed, the Contractor shall furnish, mobilize and install such temporary works, materials, equipment, and construction plants as necessary for the successful completion of the Work. The Contractor shall also operate and maintain such temporary works, equipment and construction plants throughout the period of construction. All applicable temporary works, such as sanitation facilities, shall fully comply with the rules and regulations of the government agency having jurisdiction. Portable screening or crushing facilities used on-site shall have applicable air emissions permits. Clearing, grading, earthwork and construction of access roads necessary for the temporary works, if any, shall be included as mobilization.

B. The Contractor shall obtain any permits necessary to complete the Work at Contractor's expense.

*****END OF SECTION*****

SECTION 01050
FIELD ENGINEERING

1.0 GENERAL

1.1 Section Includes

A. Project Record Documents

B. Examination

C. Survey

D. Alterations to Drawings and Specifications

1.2 Related Sections

A. Section 01010 – Summary of Work

B. Section 01090 – Reference Standards

C. Section 01300 – Submittals

1.3 Project Record Documents

A. The Contractor shall:

1. Maintain a complete and accurate log of survey control and survey work.
2. Make the log available for review to the Owner and Engineer without limitation.

B. After project completion, submit record documents per Section 01300 – Submittals: As-built Documentation.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 General

A. The Contractor shall notify the Owner and Engineer of any discrepancies discovered in the surveying or Drawings.

3.2 Survey

A. The Owner shall provide a minimum of three (3) survey control points to layout and control the Work.

B. The Contractor shall:

1. Retain the services of a surveyor licensed in the State of Oregon.
2. Use the survey control points provided by the Owner to lay out the Work.
3. Triangulate between the three control-points to verify accuracy prior to using the points for control work.
4. Perform a survey of the site in its original form on a minimum 100-foot grid. The survey will be submitted to the Engineer for review prior to initiation of growth media stripping. The survey will be used as a basis for quantity verification for site grading. If earthworks are performed prior to survey verification, Contract shall remedy at Contractor's expense.
5. Survey the grid after completion of the following tasks and submit the topographic survey to the Owner and Engineer.
    a. Growth Media Stripping.

b. Excavation and placement of Embankment Fill.

c. Placement of Liner Bedding Fill (survey will be used to determine finish geomembrane liner limits and elevations).

d. Placement of Drainage Layer.

e. Placement of Filter Layer.

f. All permanent cut slopes or water diversion/control areas affected during construction.

6. Submit each survey to the Engineer within two (2) weeks of completion of each task.

7. Provide additional surveying necessary to accurately maintain slopes and grades for control of the Work.

8. The Contractor shall make every effort to preserve Owner-provided control and points. If, in the opinion of the Owner, any survey control points have been carelessly or willfully disturbed or destroyed by the Contractor or his employees, the cost of replacement shall be incurred by the Contractor.

3.3 Alterations To Drawings and Specifications

A. Alterations made by the Contractor to either the Specifications or Drawings shall be subject to the Owner's and Engineer's approval and, where applicable, to the approval of regulatory agencies. All alterations shall be issued under a covering work order signed by the Owner prior to the start of alteration.

*****END OF SECTION*****

SECTION 01051
GEOTECHNICAL EXPLORATION

1.0 GENERAL

1.1 Section Includes

A. Summary

B. Verification

C. Warranty

1.2 Summary

A. Geotechnical explorations in the Tailings Storage Facility and Waste Rock Dump footprints were conducted during the following:

1. December 2017 – 15 Borings, 44 Test Pits and six (6) field falling head permeability tests conducted in boreholes
2. March 2019 – Six geotechnical boreholes at previously completed Test Pits
3. July 2019 – 11 cone penetration test soundings at previously completed Borings and Test Pits

B. The design for the Grassy Mountain TSF and WRD, written by Golder in November 2019 titled D*etailed Design, Tailings Storage Facility and Waste Rock Dump, Grassy Mountain Mine, Malheur County, Oregon,* Revision 0, dated November 2019 references the geotechnical investigation findings.

C. Test Pit, Boring, and CPT exploration locations located within the TSF embankment, TSF basin, and WRD footprint will require over-excavation and backfill in accordance with Section 02222 and Section 02223.

1.3 Verification

A. Field verify the location of all exploration boreholes and test pits with the Engineer and Owner.

B. Contractor shall supply certification that all test pits have been filled in accordance with these Specifications. The Contractor will supply a list of the boreholes/pits backfilled with the certification, including the depth of each borehole/test pit.

1.4 Warranty

A. The conclusions and recommendations described in the Golder Report cited above were based on Golder's understandings of the project, as described in the Report, and the site conditions as documented during Golder's geotechnical investigation. Unanticipated soil and subsurface conditions are commonly encountered and cannot be fully determined by reviewing soil logs from the borings or test pits. The report prepared by Golder should not be construed as a warranty of actual subsurface conditions.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Verification

A. Bidders shall visit the site and familiarize themselves with all existing surface and subsurface conditions, whether covered in the reports or not, and shall understand all recommendations associated with the earthwork.

*****END OF SECTION*****

SECTION 01090
REFERENCE STANDARDS AND REGULATIONS

1.0 GENERAL

1.1 Section Includes

A. Codes and Regulations

B. Schedule of References

1.2 Related Sections

A. Section 01400 – Quality Control/Assurance

B. Section 01600 – Materials and Equipment

C. Section 02110 – Site Clearing and Stripping

D. Section 02205 – Fill Materials

E. Section 02211 – Rough Grading

F. Section 02223 – Filling

G. Section 02273 – Geonet

H. Section 02350 – Geosynthetic Clay Liner

I. Section 02710 – Gravity Piping

J. Section 02775 – Geomembrane

K. Section 03300 – Cast-in-Place Concrete

1.3 Codes and Regulations

A. The work shall conform to applicable federal, state, county, and local regulations.

B. The following publications current at the date of Contract Documents, unless specified otherwise, are a part of this specification, except where modified or replaced by local codes or ordinances having jurisdiction, in which case such local codes or ordinances shall govern:

1. Occupational Safety and Health Administration, General Industry and Health Standards – OSHA 2206.
2. Mine Safety and Health Administration - Code of Federal Regulations - Title 30 (Mineral Resources)
3. Oregon Department of Transportation.
4. U.S. Department of Transportation.
5. Clean Water Act – Oregon Department Environmental Quality.
6. Environmental Impact Statement and the Plan of Operations at the site, if applicable.
7. Water Resources Department (WRD), Dam Safety Regulations, OAR 690, Division 20.
8. Department of Geology and Minerals Industries (DOGAMI), Chemical Process Mine Regulations, OAR 632, Division 37.
9. Department of Fish and Wildlife (ODFW), Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420.

10. Department of Environmental Quality (DEQ), Chemical Mining, OAR Chapter 340, Division 43.

1.4 Schedule of References

A. For products of workmanship specified by association, trade, or Federal Standards, all shall comply with the requirements of the standard, except when more rigid requirements are specified or are required by applicable codes. Conform to reference standard that is current at the date of Contract Documents. As a minimum the following reference standards shall be used for this project:

1. AASHTO — American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W.
Washington, DC 20001

2. ACI — American Concrete Institute
Box 19150
Redford Station
Detroit, MI 48219

3. ANSI — American National Standards Institute
1430 Broadway
New York, NY 10018

4. ASTM — American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

5. AWWA — American Water Work Association
6666 West Quincy Avenue
Denver, CO 80235

6. CRSI — Concrete Reinforcing Steel Institute
933 Plum Grove Road
Schaumburg, IL 60195

7. NSF — National Sanitation Foundation
Box 1468
Ann Arbor, MI 48106

8. GRI — Geosynthetics Research Institute
Drexel University
West Wing – Rush Building, #10
Philadelphia, PA 19104

9. NSF — National Sanitation Foundation
Box 1468
Ann Arbor, MI 48106

10. PPI — Plastic Pipe Institute
105 Decker Court, Suite 825
Irvine, TX 75062

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01300
SUBMITTALS

1.0 GENERAL

1.1 Section Includes

A. Technical Data

B. Progress Schedules

C. As-Built Documentation

1.2 Related Sections

A. Section 01400 – Quality Control/Assurance

B. Section 01600 – Materials and Equipment

C. Section 02205 – Fill Materials

D. Section 02223 – Filling

E. Section 02273 – Geonet

F. Section 02350 – Geosynthetic Clay Liner

G. Section 02710 – Gravity Piping

H. Section 02775 – Geomembrane

I. Section 03220 – Reinforcing Steel

J. Section 03300 – Cast in Place Concrete

1.3 Technical Data

A. Engineering data covering all equipment and fabricated materials to be furnished under this contract shall be submitted to the Engineer for review. This data shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and operation of component material and devices: the external connections, anchorages, and supports required: performance characteristics; and dimensions needed for installations and correlation with other materials and equipment. Data submitted shall include drawings showing essential details of any changes proposed by Contractor.

B. No work shall be performed in connection with the fabrication or manufacture of materiaI and equipment, nor shall any accessory or appurtenance be purchased until the drawings and data have been reviewed and approved by the Engineer, except at the Contractor's own risk and responsibility.

C. Three (3) copies of each submittal, drawing, and necessary data shall be submitted to the Engineer. Each drawing or data sheet shall be clearly marked with the name of the project, the Contractor's name, references to applicable Specification paragraphs, and Drawing sheets. When catalog pages are submitted, the applicable items shall be identified. The Engineer shall return one (1) copy of the submittal to the Contractor with comments.

D. When the drawings and data are returned marked REVISE AND RESUBMIT the corrections shall be made as noted thereon and as instructed the Engineer and not less than three (3) corrected copies resubmitted.

E. When the drawings and data are returned marked REJECTED, the Contractor shall take necessary corrective actions to comply with contract documents. All items marked REJECTED will not be accepted and a substitute must be submitted for approval from the Engineer.

F. Unless otherwise directed by the Engineer, when drawings and data are returned marked APPROVED AS NOTED, the changes shall be made as noted thereon and not less than three (3) corrected copies shall be furnished to the Engineer.

G. When the drawings and data are returned marked APPROVED, one (1) copy, shall be returned to the Contractor, one (1) copy shall be retained for the Owner, and one (1) copy shall be retained by the Engineer.

H. The Engineer's review of drawings and data submitted by the Contractor shall cover only general conformity to the Drawings and Specifications, external connections, and dimensions which affect the layout. The Engineer's review of drawings and data returned marked APPROVED or APPROVED AS NOTED does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, devices, or items shown, and does not relieve the Contractor from any responsibility for errors or deviations from the contract requirements.

I. All drawings and data, after the final processing by the Engineer, shall become a part of the Contract Documents and the Work shown or described thereby shall be performed in conformity therewith unless authorized by the Owner or the Engineer.

1.4 Progress Schedules

A. Procedure

1. Submit a preliminary progress schedule to the Owner.
2. After Owner's review, revise and resubmit schedule to comply with Owners review.
3. Submit revised progress schedule every two weeks or according to a scheduled agreed upon by the Owner.

B. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

C. Provide subcontractors activity schedules.

D. Provide separate schedule of submittal dates for shop drawings, product data, and samples, including Owner furnished products, and dates that reviewed submittals shall be required from the Owner and Engineer. Indicate delivery data for products.

E. Schedules shall be in a form that is acceptable to the Owner.

F. Distribute copies of reviewed schedules to the project file, Subcontractors, suppliers, and the Engineer.

G. Instruct recipients to promptly report in writing problems anticipated by projections indicated in schedules.

1.5 Quality Control Test Results and Daily Field Reports

A. The Contractor shall be responsible for material property testing of soil, rock, and aggregate material in accordance with the testing frequencies in Section 02223.

B. Quality Control testing shall be performed by qualified personnel under direct supervision of a Professional Engineer licensed in the State of Oregon.

C. Complete Quality Control Test results shall be submitted to the Owner and Engineer within twenty-four (24) hours of collecting sample for testing, or upon request, for review and approval.

D. All Quality Control test results shall be stored in hard copy in the Contractor's or Quality Control's on-site facility and shall be available for review from the Owner and Engineer at all times.

E. The Quality Control Team shall be responsible for accurately testing and reporting results of all Quality Control test results and observations in a timely manner to the Owner and Contractor throughout the project in the form of a Daily Field Report.

1. Daily Field Reports shall be typed and submitted to the Engineer and/or Owner within one (1) working day.
2. Minimum information required, and example Daily Field Report are presented in the CQA Plan

1.6 As-Built Documentation

A. As-built Survey Documentation

1. The Contractor shall be responsible for accurately surveying the locations and elevations and, where applicable, the type, thickness and geometry of any and all pipes and fittings, ditches, geosynthetic materials, breaks in fill or cut slopes, general grading, change in fill or synthetic material type and any other aspect of the work required by the Engineer.
2. The Contractor shall submit as-built documentation surveys as described in Section 01050.
3. Submittal: Completed as-built documentation will be submitted within two (2) weeks of project acceptance in the following manner:
    a. Submit one (1) digital reproducible copy each to the Owner and Engineer.
    b. Submit one (1) paper copy each to the Owner and Engineer.
        i. As-built documentation survey shall be sealed by a registered Professional Land Surveyor licensed in the State of Oregon.

B. Quality Control Documentation

1. Submittal: Within two (2) weeks of project acceptance, the Quality Control Team shall submit a Quality Control Summary Report sealed by a Professional Engineer licensed in the State of Oregon documenting all manufacturer, field, and laboratory quality control test result and data sheets that include the following:
    a. One (1) digital reproducible copy and one (1) paper copy of each of the following Quality Control Report(s):
        i. Earthwork Quality Control Documentation in accordance with Section 02223.
        ii. Geonet Quality Control Documentation in accordance with Section 02273.
        iii. Geosynthetic Clay Liner Quality Control Documentation in accordance with Section 02350.
        iv. Piping Quality Control Documentation in accordance with Section 02710
        v. Geomembrane Quality Control Documentation in accordance with Section 02275.
        vi. Reinforcing Steel Quality Control Documentation in accordance with Section 03220.
        vii. Cast in Place Concrete Quality Control Documentation in accordance with Section 03300.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01400
QUALITY CONTROL AND ASSURANCE

1.0 GENERAL

1.1 Section Includes

A. References

B. General Quality Control Requirements

C. Manufacturer's Quality Control Inspection, Sampling, and Testing

D. Quality Control Sampling and Testing Frequency

E. Quality Assurance and Referee Inspection and Testing

1.2 Related Sections

A. Section 01090 – Reference Standards

B. Section 01300 – Submittals

C. Section 01410 – Testing Laboratory Services

D. Section 01600 – Materials and Equipment

E. Section 02205 – Fill Materials

F. Section 02211 – Rough Grading

G. Section 02223 – Filling

H. Section 02273 – Geonet

I. Section 02350 – Geosynthetic Clay Liner

J. Section 02710 – Gravity Piping

K. Section 02775 – Geomembrane

L. Section 03300 – Cast-in-Place Concrete

1.3 References

A. Conform to reference standard by date of issue current on date of Contract Documents unless specified otherwise in the specific section.

B. Should specified reference standards conflict with Contract Documents, the Contractor shall request clarification from Engineer before proceeding.

C. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.4 General Quality Control Requirements

A. The Quality Control Team as defined in Section 01010 shall perform the Quality Control testing and inspection required by these Specifications for all earthworks, geosynthetics, and piping installation.

B. The Quality Control Team shall be under the direct supervision of a Professional Engineer licensed in the State of Oregon. All Quality Control test results shall be used as the record tests documented in the Quality Control As-built Report in accordance with Section 01300.

C. Results of Quality test results are subject to verification by the Engineer. Should a discrepancy between results of the Quality Control Team and the Engineer, the Engineer's, results and conclusions shall prevail.

D. Quality Control test results are not a basis of acceptance of Work. Results of inspection and testing on in-place material approved the Engineer or performed by the Quality Assurance Team shall prevail.

E. The Contractor shall be responsible to monitor Quality Control over Vendors, Manufacturers, products, services, site conditions and workmanship to produce Work of specified quality.

F. Comply fully with Manufacturers' instructions. Should Manufacturers' instructions conflict with the Contract Documents, the Contractor shall request clarification from the Engineer prior to proceeding.

G. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes or specified requirements indicate higher standard or more precise workmanship.

H. The Quality Control Team's inspections will not relieve the Contractor of responsibility for the acceptance of the finished Work or portions thereof.

I. Work performed by the Quality Control Team personnel shall be qualified to perform specified testing in accordance with specified test methods and procedures as required by these Specifications.

J. A summary report of the Quality Control Work performed shall be submitted to the Engineer in accordance with Section 01300 and be sealed by a Professional Engineer licensed in the State of Oregon.

K. Re-testing required due to the Contractor's non-conformance to specified requirements of these Specifications shall be performed by the same Quality Control Team, Quality Assurance Team, or independent third party, as instructed by the Engineer. The cost of re-resting shall be borne by the Contractor if re-testing requires the testing agency to work extra hours or overtime.

1.5 Manufacturer's Quality Control Inspection, Sampling, and Testing

A. The Manufacturer shall sample and perform Quality Control testing at the frequencies specified in these Specifications. Test results shall be submitted by the Contractor and/or the Manufacturer to the Engineer in accordance with Section 01300.

B. The Manufacturer and/or Contractor will cooperate with the Quality Control Team; furnish samples of materials, design mixes, equipment, tools, storage, and assistance as required and:

1. Notify the Engineer and Quality Control Team twenty-four (24) hours prior to expected time for operations requiring services.
2. Make arrangements with Quality Control Team and pay for additional samples and tests required for Contractor's use.

C. The Quality Control Team will submit to the Engineer one (1) copy of reports indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents in accordance with Section 01300.

1. If observations, inspections, or Manufacture Quality Control test results identify any materials or methods used to complete the Work that do not meet these Specifications, the Engineer shall be notified immediately.

2. In the event that a test failed to meet these Specifications and a retest is performed, the Engineer shall be notified regardless of the retest results.
3. Removal of materials, repairs, or retests shall be determined by the Engineer. Costs associated with the Contractor's actions to remediate deficiencies shall be borne by the Contractor.

1.6 Quality Control Sampling and Testing Frequency

A. The frequency of Contractor and Manufacturer Quality Control testing of materials is specified in the following sections:

Table 01400-1: Testing Frequency Reference Sections

MATERIAL	REFERENCE SECTION
Fill Materials	02205
Rough Grading	02211
Filling	02223
Geonet	02273
Geosynthetic Clay Liner	02350
Gravity Piping	02710
Geomembrane	02775
Cast-in-Place Concrete	03300

1.7 Quality Assurance and Referee Inspection and Testing

A. The Quality Assurance Team as defined in Section 01010 shall perform the Quality Assurance testing and inspection required by these Specifications.

B. At any time during the project Work, the Engineer may collect a sample split from the Quality Control sample and perform a referee test for Quality Assurance.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Quality Control

A. Maintain access at all times for the Engineer and/or Quality Assurance Team to perform inspection, sampling, and testing. At no time deny the Quality Assurance Team personnel, Engineer, or Owner access to any Work area, fabrication area, staging area, or any other area associated with the Work.

B. Make allowance for the Quality Assurance or referee sampling and testing to be performed and divert equipment elsewhere during the required sampling and testing.

C. Quality Control test results shall be provided to the Owner and/or Engineer within 24 hours of collecting sample for testing, or upon request, for review and approval in accordance with Section 01300.

D. Daily Field Reports shall be completed and submitted to the Engineer and/or Owner within one (1) working day in accordance with Section 01300. The minimum information required for each Daily Field Report as well as an example is provided in the CQA Plan.

E. There is no provision for claims of delays due to Quality Assurance inspection, testing, or sampling. Should Contractor feel that delays are being incurred due to Quality Assurance inspection, testing, sampling, or other activities, notify Owner and Engineer in writing documenting in detail the date, time, and quality assurance activity of each occurrence. Should Owner and/or Engineer determine that excessive time is being spent at quality assurance activities causing delay to Work, corrective action will be taken.

F. If any Work should be covered up without prior approval or consent of the Engineer, it must, if required by the Engineer, be uncovered for examination. After the uncovered Work has been observed and authorization given by the Engineer, the Work shall be recovered in accordance with the Specifications. The cost of uncovering and recovering the Work and any consequential costs shall be the responsibility of the Contractor regardless of the condition of the Work uncovered. If the Work is found to be deficient, the Contractor shall expose all Work that was covered prior to approval, correct any Work that is deficient, and proceed according to the Specifications. The cost of uncovering deficient Work, correcting deficient Work and any consequential costs shall be borne entirely by the Contractor.

G. All Work performed by the Contractor shall meet the approval of the Engineer. The method and manner of doing the Work will be under the control of the Contractor. The Engineer may review the Contractor's work practices and make adjustments as necessary to minimize the risk of damage to critical components of the Work.

3.2 Submittals

A. The Contractor shall submit all Quality Control test results to the Engineer for review and approval on a regular basis, or at the request of the Engineer.

B. Fill materials proposed by the Contractor for use to complete the Work shall be tested by the Quality Control Team prior to placement to verify that the materials meets these Specifications.

C. Initial Quality Control test results of proposed materials shall be submitted to the Engineer for the approval at least 24 hours prior to material placement.

D. At the completion of the Work, a sealed Quality Control Report shall be submitted to the Owner and Engineer in accordance with Section 01300 and include at a minimum:

1. Cover letter summarizing the quantities of materials placed, required testing frequency, and actual testing frequency achieved. The Quality Control Report shall be sealed by a Professional Engineer licensed in the State of Oregon.
2. Typed field documentation including daily field reports, field and laboratory test results summary tables and individuals test results forms for all tests performed for each construction material for tests specified in the Specifications.
3. Summary tables shall be suitable for report presentation and regulatory agency review. One (1) digital reproducible copy of the summary tables shall be provided to the Engineer.

*****END OF SECTION*****

SECTION 01410
TESTING LABORATORY SERVICES

1.0 GENERAL

1.1 Section Includes

A. Selection and Payment

B. Laboratory Reports

C. Limits on Testing Laboratory Authority

D. Contractor Responsibilities

1.2 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Control/Assurance

C. Section 01600 – Materials and Equipment

D. Section 02205 – Fill Materials

E. Section 02211 – Rough Grading

F. Section 02223 – Filling

G. Section 02273 – Geonet

H. Section 02350 – Geosynthetic Clay Liner

I. Section 02775 – Geomembrane

J. Section 03300 – Cast-in-Place Concrete

1.3 Selection and Payment

A. The Contractor shall perform, or will employ and pay for services of an independent testing laboratory to perform specified inspection and testing.

B. All laboratory testing shall be performed under the direct supervision of a registered Professional Engineer licensed in the State of Oregon.

C. Employment of testing laboratory shall in no way relieve the Contractor of obligation to perform work in accordance with requirements of Contract Documents.

1.4 Laboratory Reports

A. After each inspection and test, promptly submit a copy of laboratory report to the Engineer, and a copy to the Owner.

B. Include in Report:

1. Date issued
2. Project title and number
3. Name of inspector
4. Date and time of sampling or inspection
5. Identification of product and Specifications Section

6. Location in the Project
7. Type of inspection or test
8. Date of test
9. Results of test
10. Conformance with Contract Documents
11. When requested by Engineer, provide interpretation of test results

1.5 Limits On Testing Laboratory Authority

A. Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Laboratory may not approve or accept any portion of the Work.

C. Laboratory many assume any duties of Contractor.

D. Laboratory has no authority to stop Work.

1.6 Contractor Responsibilities

A. The Contractor shall notify the laboratory and Engineer at least five (5) working days in advance of intended use of materials that require laboratory testing to allow sufficient time for laboratory to retrieve samples and perform testing.

B. Provide proposed mix designs at least five (5) working days in advance of intended use.

C. Cooperate with laboratory personnel, and provide access to the Work.

D. Provide incidental labor and facilities to provide access to Work to be tested, to obtain and handle samples at the site or at source of products to be tested, to facilitate tests and inspections, storage and curing of test samples.

E. When requested by the Engineer prior to sampling, the Contractor shall provide Engineer a split sample for Quality Assurance testing. The sample shall be split in accordance with ASTM C702-*Standard Practice for Reducing Samples of Aggregate to Testing Size,* and shall be of sufficient quantity to meet minimum testing requirements.

F. Notify the laboratory and Engineer 24 hours prior to expected time for operations requiring field inspection and field testing services.

G. Arrange with the laboratory and pay for additional testing and inspection services required by Contractor beyond specified requirements.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

1.0 GENERAL

1.1 Section Includes

A. Access

B. Power

C. Construction Water

D. Fugitive Dust Control

E. Surface Water Control

F. Work Limits

G. Traffic Control/Road Use

1.2 Related Sections

A. Section 01010 – Summary of Work

1.3 Access

A. Access to the site shall be provided by the Owner.

B. The Contractor shall not construct any staging areas, temporary facilities, haul roads, or access roads without the approval of the Owner.

1.4 Power

A. Contractor shall provide his own temporary power needs, unless provided by the Owner.

1.5 Construction Water

A. Water for dust control on haul roads, moisture conditioning of borrow material to be placed as fill, and for maintaining in place fill soils shall be obtained by the Contractor. The Contractor shall supply all the pumps and tanks necessary to provide an adequate supply of water fulfill the conditions of the contract. Water will be available in a pond and/or truck standpipe at a location designated by the Owner.

1.6 Fugitive Dust Control

A. During the performance of the Work defined by these Specifications or any operations appurtenant thereto, whether on right-of-way provided by the Owner or elsewhere, the Contractor shall:

1. Furnish all labor, equipment, materials, and means required to perform proper and efficient measures to reduce the dust nuisance.
2. Prevent dust which has originated from the Work from damaging land, vegetation, and dwellings or causing a nuisance to persons.
3. Control dust to a degree acceptable to the appropriate State and Federal Agencies, and to the Owner.
4. Notify Owner in writing, and obtain Owner's approval, to use chemical additives to control fugitive dust. Provide Material Safety Data Sheets (MSDA) for such chemicals to Owner.

1.7 Surface Water Control

A. Install permanent ditches and/or channels shown on the drawings and construct facilities to control surface water resulting from precipitation.

B. Provide temporary erosion protection for prepared surfaces and all potential erosion areas associated with the Work, or as directed by the Engineer, until all such portions of the Work have been accepted by the Owner. Erosion control shall consist of silt fences, fiber rolls, and sediment traps in accordance with best management practices.

C. If precipitation or runoff damage occurs to the Work prior to acceptance of the Owner, repair the damaged Work in accordance to these Specifications at the Contractor's expense.

D. All temporary and final design storm water diversion ditches, sedimentation basins, and/or channels shall be installed prior to site grading.

1.8 Work Limits

A. Confine apparatus, equipment, the storage of Materials, and the operation of workmen to the limits indicated by law, ordinances, permits, or as directed by the Owner.

B. Avoid unreasonable encumbering the premises with materials or equipment.

C. Do not block plant or other access roads or traveled ways.

D. Avoid interfering with the Owners operations.

E. Do not present a hazard to the Owner's personnel and equipment or to the public.

F. Use existing roads whenever possible.

G. Minimize construction of new roads.

H. Keep the site neat, tidy and free of waste materials or rubbish.

I. Store and dispense fuel, lubricating oils, and chemicals in such a manner as to prevent or contain spills and prevent said materials from reaching local streams or groundwater according to regulatory requirements.

J. Dispose of waste in accordance with state and local regulations.

K. Keep MSDS on file at the site and provide copies of such sheets to the Owner for all hazardous materials.

L. Avoid damage to monitoring wells, piezometers, survey monuments, or any other instrumentation used at the site.

M. Notify Owner if monitoring wells, piezometers, or instrumentation is in conflict with the Work prior to construction.

1.9 Traffic Control/Road Use

A. Owner's mine haulage traffic has the right-of-way at all times. The Contractor shall conduct his haul operations in a safe manner yielding to Owner's haulage equipment and providing flagmen, if necessary, to stop Contractor's equipment at haul road crossings, public road crossings, or other

traffic areas. Flag persons will not be required at haul road crossings during water truck hauling. A stop sign will be installed at crossings to give the Owner's haulage equipment right-of-way.

B. Any Public or private roads that become damaged as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

C. Contractor's personnel will park personal vehicles in areas designated by the Owner. The quantity and routes of normal construction or supervisory vehicles through the mine site will agreed on by the Owner and Contractor.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01600
MATERIALS AND EQUIPMENT

1.0 GENERAL

1.1 Section Includes

A. Transportation and Handling

B. Storage and Protection

C. Product Options

D. Substitutions

1.2 Related Sections

A. Section 01400 – Quality Assurance/Control

1.3 Transportation and Handling

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.4 Storage and Protection

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

B. For exterior storage or fabricated products, place on sloped supports, above ground.

C. Cover products subject to deterioration from ultraviolet light or weather with impervious sheet covering.

D. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surface in a well-drained area.

F. Prohibit mixing with foreign matter.

G. Arrange storage of products to permit access for inspection.

H. Contractor shall inspect products to assure products are undamaged and maintained under specified conditions.

I. At the end of construction, catalog all remaining unused permanent materials and provide catalog list to Owner, including description, quantity, and location. Store unused permanent materials in the location directed by the Owner. Except for soil and rock products, all permanent materials shall be stored on pallets or other methods to prevent ground contact. Containers holding permanent materials shall be protected against deterioration from rain and water.

1.5 Product Options

A. Products Specified by Reference Standard or by Description Only: Any product meeting those standards or descriptions.

B. Products Specified by Naming One or More Manufacturers. Products of manufacturers named and meeting Specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.6 Substitutions

A. Engineer will consider request for Substitutions only within 15 days after date established in Notice to Proceed.

B. Substitutions may be considered when a products becomes unavailable through no fault of the Contractor.

C. Substitution Submittal Procedure:

1. Submit three (3) copies of Request for Substitution for Consideration. Limit each request to one proposed substitution.
2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
3. The Engineer shall notify the Contractor, in writing, of decision to accept or reject request.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

NOT USED

*****END OF SECTION*****

SECTION 01700
DEMBOLIZATION

1.0 GENERAL

1.1 Section Includes

A. General

B. Warranty

C. Summary

1.2 Related Sections

A. Section 01010 – Summary of Work

B. Section 01600 – Materials and Equipment

1.3 General

A. The demobilization work consists of repairing all slopes disturbed during construction, the removal of all construction debris, and returning the site to a suitable condition for permanent stabilization and reclamation of disturbed surfaces as required by the Owner.

1.4 Warranty

A. All materials and workmanship furnished by the Contractor under this specification shall be guaranteed by the Contractor against failure due to defective materials or improper installation for a period of one year from the date of final acceptance, or as noted otherwise in these Specifications. Upon receipt of written notice of failure of guaranteed workmanship or materials during the guarantee period, the Contractor shall promptly furnish and install new materials and/or furnish the labor necessary to correct the failure at the expense of the Contractor.

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Summary

A. Permanent cut slopes outside of the Work area that have been affected by the Work shall not have a slope steeper than 2.5H:1V unless otherwise shown in the Drawings or otherwise approved by the Owner and Engineer.

B. The Contractor shall remove all trash, debris, hazardous and dangerous chemicals or waste, and waste material from the site that was brought on site by the contractor and properly dispose of all said materials. The Owner will have the right to determine what is waste or rubbish and the manner and place of disposal. All materials furnished for the execution of the Work and thereby purchased by the Owner shall remain the property of the Owner.

C. The Contractor shall clean out all installations and tear down and remove all temporary structures built by the Contractor. Any existing structures or installations that were in place prior to construction shall be left in a condition at least as good as the condition prior to construction. All trash and remnants of the Contractor's work shall be removed by the Contractor prior to final inspection and acceptance by the Owner.

D. Unused permanent materials shall be cataloged and stored in accordance with specification Section 01600.

E. The final condition of the site is subject to approval by the Owner.

*****END OF SECTION*****

SECTION 02110
SITE CLEARING AND STRIPPING

1.0 GENERAL

1.1 Section Includes

A. Clearing

B. Stripping

1.2 Related Sections

A. Section 02205 – Fill Materials

B. Section 02211 – Rough Grading

C. Section 02222 – Excavating

D. Section 02223 – Filling

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Summary

A. Clearing area required for access to site and execution of Work as shown on the Drawings.

B. Remove shrubs and other vegetative growth within the required areas. Remove stumps and roots great than ½ inch in diameter to a minimum depth of 6 inches.

C. Remove man-made structures, debris, or waste material as directed by the Owner/Engineer.

D. All clearing shall be completed prior to the start of any grading operations.

E. Clearing shall extend laterally beyond excavation, liner systems, and fill slopes a minimum of 10 feet but shall not extend past the Plan of Operations Boundary as designated by the Owner.

F. Clearing shall not be performed until all exploration test pits and boreholes within the limits of the proposed site grading have been excavated and re-compacted in accordance with Sections 02222 and 02223 as approved by the Owner. The location of the test pits and boreholes are shown on the Drawings.

3.2 Stripping

A. Growth media (the surficial soils often referred to as Topsoil) shall be stripped from cleared areas to a depth approved by the Engineer. In undisturbed areas, the typical stripping depth is anticipated to be 6-inches. The actual depth will be determined in the field by the Engineer during the stripping operation.

B. Growth media shall be stockpiled in areas designated by the Owner. Construct stockpiles with maximum 3H:1V slopes and in a manner that the soil receive the maximum amount of compactive effort from the haulage equipment.

C. Growth media stripping shall include removal of all organic sod, grass, topsoil and roots greater than ½ inch in diameter.

D. Stripping shall be performed in the footprint of the TSF embankments and basin, reclaim pond, waste rock dump facility, containment channels, temporary and permanent access roads, haul roads, construction and staging areas, on-site borrow areas, and temporary and permanent diversion facilities.

E. Stripping shall extend laterally beyond excavations, liner systems, and fill slopes a minimum of 10 feet but shall not extend past the Plan of Operations Boundary as designated by the Owner.

F. Stripping shall not be performed until all exploration test pits and boreholes within the limits of the proposed site grading have been excavated and re-compacted in accordance with Sections 02222 and 02223 as approved by the Owner. The location of the test pits and boreholes are shown on the Drawings.

G. All stripping shall be completed prior to the start of any grading.

H. Excess stripping without the prior approval of the Owner will be at the expense of the Contractor.

*****END OF SECTION*****

SECTION 02205
FILL MATERIALS

1.0 GENERAL

1.1 Section Includes

A. Definitions
B. References
C. General
D. Embankment Fill
E. Grading Fill
F. Prepared Subgrade
G. Drainage Layer
H. Filter Fill
I. Anchor Trench Backfill
J. Drain Gravel
K. Leak Detection Fill
L. Pipe Bedding Fill
M. Cable Bedding Fill
N. Riprap
O. Safety Berm Material

1.2 Related Sections

A. Section 01051 –Geotechnical Exploration
B. Section 01400 – Quality Control/Assurance
C. Section 02110 – Site Clearing and Stripping
D. Section 02211 – Rough Grading
E. Section 02222 – Excavating
F. Section 02223 – Filling

1.3 Definitions

A. Embankment Fill: Fill material that is non-gold-bearing blasted run-of-mine rock or native alluvial overburden soils borrowed from on-site grading and quarry operations. Embankment Fill will be placed and compacted in controlled lifts and used as the primary fill material for TSF embankment construction in accordance with Section 02223.

B. Grading Fill: Native alluvial soils excavated to be placed and compacted in controlled lifts below the geomembrane liner within the TSF basin and WRD pad.

C. Drainage Layer: Crushed rock or screened native alluvium material placed above the geomembrane liner within the TSF basin to promote drainage into the perforated underdrain collection pipes.

D. Filter Fill: Alluvial fill material placed above the Drainage Layer within the TSF basin to act as a filter between the Drainage Layer and the tailings and promote drainage into the perforated underdrain collection pipes.

E. Anchor Trench Backfill: Soil or rock material placed and compacted in the geomembrane anchor trenches and placed as ballast on the above ground process conveyance pipes.

F. Drain Gravel: Crushed rock material installed around the primary perforated CPE and HDPE underdrain collection pipes and in the reclaim pond leak detection sump.

G. Leak Detection Fill: Crushed rock material placed around the PVC leak detection pipes below the TSF geomembrane liner to promote drainage into the perforated leak detection pipes.

H. Riprap: Crushed and screened rock material placed in permanent diversion channels and outlet aprons for erosion protection.

I. Safety Berm Material: native or processed material placed along travel to protect proposed structures from vehicle traffic.

1.4 References

A. American Society for Testing and Materials (ASTM)

B. ASTM C 702 – Standard Practice for Reducing Samples of Aggregate to Testing Size

C. ASTM D 422 – Stand Test Method for Particle-Size Analysis of Soils

D. ASTM D 1140 – Standard Test Method for Amount of Materials in Soils Finer than the No.200 (75 Micrometers)

E. ASTM D 1556 – Test Method for Density of Soils in Place by the Sand-Cone Method

F. ASTM D 1557 – Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer ad 18-in. (457-mm) Drop

G. ASTM D 2216 – Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

H. ASTM D 4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

I. ASTM D 4643 – Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

JJ. ASTM D 5519 - Standard Test Methods for Particle Size Analysis of Natural and Man-made Riprap Materials

J. ASTM D 5856 – Standard Test Method for Measurement of Hydraulic Conductivity of Porous Material Using a Rigid-wall, Compaction-mold Permeameter.

K. ASTM D 6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-aggregate by Nuclear Methods (Shallow Depth)

2.0 PRODUCTS

2.1 General

A. All fill materials shall be obtained from required excavations, designated borrow areas, and stockpiles as directed by the Owner. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the Engineer.

B. Fill materials shall contain no sod, brush, roots or other perishable, unsuitable materials, debris, and the type of materials used as earth fill shall be as described in the Specifications and Drawings. The suitability of all fill materials intended for use in the Work shall be subject to approval by the Engineer.

2.2 Embankment Fill

A. Embankment Fill shall be material that is non-gold-bearing blasted run-of-mine rock from on-going mining operations or the basalt borrow.

B. If Embankment Fill contains greater than 30% of particles in excess of three-quarter inch (3/4") nominal grain size it shall be considered a rock fill and placed accordingly as described in Specification 02223.

C. Embankment Fill shall meet the following gradational and plasticity requirement and shall be placed and compacted in accordance with Section 02223:

Table 1: 02205-1 Embankment Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
16 inch*	100
12 inch*	50-100
8 inch*	30-100
¾ inch	0-80
No. 4	0-40
No. 200	0-20

Plastic Limit: N/A

D. A maximum of any one (1) sieve size is allowed to be out of the specified range list above for any individual test.

E. * Maximum particle size shall be limited to 2/3 the allowable loose lift height based on the Embankment Fill being classified as a Soil or Rock Fill material. Allowable loose lift thickness shall determined in accordance with Section 02223.

2.3 Grading Fill

A. Native alluvial materials excavated during on-site grading operation within the TSF basin and WRD pad or imported native alluvial materials.

B. Native foundation clay materials, as defined by the Engineer, shall not be used as Grading Fill.

C. If Grading Fill contains greater than 30% of particles in excess of three-quarter inch (3/4") nominal grain size it shall be considered a rock fill and placed accordingly as described in Specification 02223.

Table 2: 02205-2 Grading Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
6 inch	100
¾ inch	20-100
No. 4	10-70
No. 40	0-40
No. 200	0-30

Plastic Limit: Less than or equal to 15

2.4 Prepared Subgrade

A. Native material generated from on-site grading operations or developed from on-site borrow area to be place immediately below the geosynthetic clay liner within the TSF basin, WRD Pad, on the TSF upstream embankment slopes, and below the reclaim pond.

B. Prepared Subgrade shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

2. Table 3: 02205-3 Prepared Subgrade Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
3 inch	100
¾ inch	70-100
No. 4	20-100
No. 40	0-60
No. 200	0-50

Plastic Limit: Less than or equal to 20

2.5 Drainage Layer

A. Crushed rock material or processed native alluvium placed above the geomembrane liner within the TSF basin and WRD Pad to promote drainage into the perforated underdrain collection pipes.

B. Drainage Layer shall have a maximum hydraulic conductivity of 5×10^{-3} cm/sec (ASTM D5856).

C. The Drainage Layer shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 4: 02205-4 Drainage Layer Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
3 inch	100
¾ inch	50-100
No. 4	20-50
No. 40	0-25
No. 200	0-15

Plastic Limit: Less than or equal to 10

2.6 Filter Fill

A. Crushed rock material, processed or native alluvium placed above the Drainage Layer within the TSF basin to act as a filter between the Drainage Layer and the tailings and promote drainage into the perforated underdrain collection pipes.

B. Filter Fill shall have a maximum hydraulic conductivity of 5×10^{-4} cm/sec (ASTM D5856).

C. Filter Fill shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 5: 02205-5 Filter Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
1.5 inch	100
¾ inch	30-90
No. 4	55-85
No. 40	25-50
No. 200	10-30

Plastic Limit: Less than or equal to 10

2.7 Anchor Trench Backfill

A. Anchor Trench Backfill shall be on-site native alluvium placed in geomembrane anchor trenches and placed as ballast on the Tailings Distribution and Decant Return pipes in accordance with the Drawings.

B. Anchor Trench Backfill shall be placed in accordance with Section 02223.

C. Anchor Trench Backfill has no gradational or plasticity requirements.

2.8 Drain Gravel

A. Drain Gravel shall be a manufactured, crushed rock installed around the primary underdrain collection pipes, within the underdrain outlet channel, and the reclaim pond leak detection sump.

B. Drain Gravel shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 6: 02205-6 Drain Gravel Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
2 inch	100
¾ inch	50-80
No. 4	15-50
No. 200	0-5

Plastic Limit: Less than or equal to 10

2.9 Leak Detection Fill

A. Crushed rock material installed around the leak detection pipes in accordance with the drawings to promoted drainage into the perforated leak detection pipes.

B. The Leak Detection Fill shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 7: 02205-7 Leak Detection Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
1 inch	100
¾ inch	75-100
⅜ inch	20-55
No. 200	0-10

Plastic Limit: Less than or equal to 5

2.10 Pipe Bedding Fill

A. Pipe Bedding Fill shall be on-site native alluvium placed as backfill around culverts and buried HDPE Piping in locations as shown on the Drawings.

B. Pipe Bedding Fill shall be placed in accordance with Section 02223 and shall meet the following gradational and plasticity requirements:

Table 8: 02205-8 Drainage Layer Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight
2 inch	100
¾ inch	70-100
No. 4	20-70
No. 40	0-35
No. 200	0-25

Plastic Limit: Less than or equal to 20

2.11 Cable Bedding Fill

A. Cable Bedding Sand shall be placed as backfill around instrumentation signal cables in locations as shown on the Drawings.

B. Cable Bedding Fill shall the finer fraction of on-site native alluvium or Drainage Layer processed over the ⅜-inch screen and placed in accordance with Section 02223.

2.12 Riprap

A. Riprap shall be a process rock material placed as erosion protection as the finish surface layer on the side slope and toe diversion channel as shown on the Drawings.

B. Riprap shall consist of a competent rock material with a specific gravity greater than 2.65 and a rock strength of R4 or greater in accordance with ISRM and from an on-site borrow area or raveling from exposed rock cut slopes near the Work area.

C. Riprap shall meet the following gradational and plasticity requirements and be placed in accordance with Section 02223.

Table 9: 02205-8 Drainage Layer Gradation

Rip Rap D_{50}	Rock Gradation	Rock Size (in.)
8”	D_{100}	12
	D_{85}	10
	D_{50}	8
	D_{15}	3
12”	D_{100}	18
	D_{85}	14
	D_{50}	12
	D_{15}	4
16”	D_{100}	24
	D_{85}	20
	D_{50}	16
	D_{15}	6
28”	D_{100}	42
	D_{85}	36
	D_{50}	28
	D_{15}	12

2.13 Safety Berm Material

A. Safety Berm Material shall be on-site native alluvium placed along the edges of access and haul roads as needed for vehicle and structure protection.

B. Safety Berm Material has no gradational or plasticity requirements.

2.14 Source Quality Control

A. Quality Control inspection and testing will be performed under provisions of Sections 01010, 01400, and 01410 under the supervision of a professional engineer licensed in the State of Oregon.

B. Frequency of testing will be in accordance with Section 02223.

C. Quality Control tests and analysis of soil materials will be in accordance with ASTM D 422, ASTM D 1557, ASTM D 4318 and ASTM D 2167, and D 6938.

D. If tests indicate materials do not meet specified requirements, changes in material or placement conditions, retests shall be performed by the Quality Control Team at no cost to Owner.

3.0 EXECUTION

3.1 Stockpiling

A. If stockpiling is performed, materials shall be stockpiled at locations designated by the Owner. Stockpile sufficient material to meet project schedule and requirements. Separate different materials to prevent mixing. Direct Surface water away from stockpile to prevent erosion or deterioration of material.

B. Leave unused stockpile material in a neat, compact stockpile.

C. Prevent mixing of native subgrade soils with stockpile material.

D. Refer to Section 02223 for fill placement requirements.

3.2 Borrow Area Cleanup

E. Leave area in a clean and neat condition. Grade site surface to prevent free standing surface water. Grade slopes to a maximum 2.5H:1V slope.

*****END OF SECTION*****

SECTION 02211
ROUGH GRADING

1.0 GENERAL

1.1 Section Includes

A. References

B. Lines and Grades

C. Subgrade Preparation

D. Site Grading

E. Field Quality Assurance

1.2 Related Sections

A. Section 01051 – Geotechnical Exploration

B. Section 01400 – Quality Control/Assurance

C. Section 01410 – Testing Laboratory Services

D. Section 02110 – Site Clearing and Stripping

E. Section 02205 – Fill Materials

F. Section 02222 – Excavating

G. Section 02223 – Filling

1.3 References

A. American Society for Testing and Materials (ASTM)

1. ASTM D 422 – Stand Test Method for Particle-Size Analysis of Soils
2. ASTM D 1556 – Test Method for Density of Soils in Place by the Sand-Cone Method
3. ASTM D 1557 – Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer ad 18-in. (457-mm) Drop
4. ASTM D 2216 – Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
5. ASTM D 4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
6. ASTM D 4643 – Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
7. ASTM D 6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Lines and Grades

A. Locate control points and verify that the vertical and horizontal positioning are as indicated on the Drawings.

B. Stake required lines, levels, contours, and datum.

C. Protect Owner-supplied control points from excavation equipment and vehicular traffic.

D. Replacement of destroyed or lost Owner-supplied control points shall be at the expense of the Contractor.

E. As required in Section 01050, prior to commencement of grading within Work area, and after completion of site stripping activities, the Contractor shall provide a detailed survey of the stripped ground surface of the Owner. The survey shall have an accuracy of plus or minus 0.2 feet with a 2 foot contour interval. The survey will be used by the Owner and Engineer to confirm that the general grading requirement provided in these Specifications are met and to detail areas where additional site grading may be required.

3.2 Subgrade Preparation

A. Remove all stockpiles, roadway fills, and any other undocumented fills prior to subgrade preparation.

B. *Under Embankment Foundation and Grading Fill:* Proof-roll subgrade under the footprint of the dam embankment with a loaded scrapper, a loaded water truck, or a loaded haul truck to identify soft spots in the presence of the Engineer. Remove soft or yielding subgrade soils identified by the proof-roll to the depth determined by the Engineer. Fill these areas in accordance with Section 02223. Prior to placement of the Embankment Fill material, scarify the subgrade to a minimum depth of 12 inches, moisture condition to near optimum moisture content, and compact the subgrade to a minimum of 90 percent of the soils maximum dry density as determined by ASTM D 1557, or as approved by the Engineer. Roughen the final surface with at least two (2) passes of sheepsfoot compactor, wedge foot compactor, or other equipment approved by the Engineer.

C. *In Areas within the TSF Basin to Receive Geomembrane where Grading Fill is Required:* Proof-roll subgrade under the Grading Fill with a loaded scrapper, a loaded water truck, or a loaded haul truck to identify soft spots in the presence of the Engineer. Remove soft or yielding subgrade soils identified by the proof-roll to the depth determined by the Engineer. Fill these areas in accordance with Section 02223. Prior to placement of the Grading Fill material, scarify the subgrade to a minimum depth of 12 inches, moisture condition to near optimum moisture content, and compact the subgrade to a minimum of 90 percent of the soils maximum dry density as determined by ASTM D 1557, or as approved by the Engineer. Roughen the final surface with at least two (2) passes of sheepsfoot compactor, wedge foot compactor, or other equipment approved by the Engineer.

D. *In Areas within the TSF Basin to Receive Geomembrane on Native or Excavated Ground:* Following compaction, the upper surface of Prepared Subgrade shall be graded and oversized rock greater than 1-inch diameter, and projections shall be removed from the exposed surface. Prior to geosynthetics placement, the final surface of the Prepared Subgrade shall be proof-rolled with a minimum of 4 passes with vibratory smooth drum roller with a 10-ton static and 25 ton dynamic drum weight. The final surface shall be free draining, compact, free of protrusions, and suitable for geosynthetics placement

E. If prior placed or prepared, tested, and accepted Prepared Subgrade or fills become loosened, softened, or disturbed by construction equipment traffic, during dry or wet weather, these materials shall be moisture-conditioned or dried, and recompacted. If weather or soil conditions prevent soils

from being properly compacted, the unsuitable soils shall be removed and replaced with properly compacted fill at no expense to the Owner.

3.3 Site Grading

A. Grading Fill may be required to fill depressions or other areas identified by the Engineer. This material shall be placed according to Specifications 02223.

B. Where fill is required in areas that are inaccessible using conventional compaction equipment, these area shall be compacted using hand-held equipment or backfilled using Lean Mix Concrete with the approval of the Engineer.

3.4 Field Quality Control

A. Field Quality Control inspections and testing shall be performed in accordance with Sections 01010, 01400 and 01410. The Quality Control Team shall be under the supervision of a Professional Engineer licensed in the State of Oregon.

B. In place density testing shall be performed in accordance with ASTM D 1556 or D 6938.

C. Laboratory compaction testing to determine the soils maximum dry density shall be performed in accordance with ASTM D 1557.

D. Frequency of tests: Field and laboratory testing of the Prepared Subgrade shall be performed in accordance with Section 02223.

*****END OF SECTION*****

SECTION 02222
EXCAVATING

1.0 GENERAL

1.1 Section Includes

A. Lines and Grades

B. Excavation

C. Tolerances

D. Quality Assurance

1.2 Related Sections

A. Section 01051 – Geotechnical Explorations

B. Section 01400 – Quality Control/Assurance

C. Section 01500 – Construction Facilities and Temporary Controls

D. Section 02110 – Site Clearing and Stripping

E. Section 02211 – Rough Grading

F. Section 02205 – Fill Materials

G. Section 02223 – Filling

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

3.1 Lines and Grades

A. Locate control points and verify that the vertical and horizontal positioning are as indicated on the Drawings.

B. Stake required lines, levels, contours, and datum.

C. Protect Owner-supplied control points from excavation equipment and vehicular traffic.

D. Replacement of destroyed or lost Owner-supplied control points shall be at the expense of the Contractor.

E. As required in Section 01050, prior to commencement of grading within Work area, and after completion of site stripping activities, the Contractor shall provide a detailed survey of the stripped ground surface of the Owner. The survey shall have an accuracy of plus or minus 0.2 feet with a 2-foot contour interval. The survey will be used by the Owner and Engineer to confirm that the general grading requirement provided in these Specifications are met and to detail areas where additional site grading may be required.

3.2 Excavation

A. Contractor shall excavate all loose and disturbed soil from exploration borings and test pits within the TSF, WRD, and reclaim pond footprints, as shown on the Drawings and presented in Section 01051 and backfill in accordance with Section 02223. Excavation and backfill borings and test pits shall be performed prior to site clearing and stripping.

B. Excavate soils and rock to the lines and slopes shown on the Drawings.

C. On-site materials encountered in excavations are anticipated to be alluvial soils, residual soils, and waste material.

D. Grade the top perimeter of excavations to prevent surface water from draining into the excavation.

E. Alluvial soils excavated on-site may be used for fill in the dam, subject to the specifications described in Section 02205 and Section 02223.

F. All final cut surfaces will be moisture-conditioned and compacted in accordance with Section 02211 prior to subsequent fill placement.

G. Remove loose, soft, and yielding material from the bottom and sides of excavations at the direction of the Engineer.

H. During excavating operations, underlying foundation clays materials may be exposed. Contractor shall protect excavations from surface water run-on. In the event that foundation clay materials become saturated, or deemed unacceptable by the engineer, the Contractor shall overexcavate unsuitable materials and backfill the excavation with General Fill in accordance with Section 02223.

I. Excavation extending beyond the lines, grades, and dimensions shown on the Drawings shall be backfilled with Grading Fill in accordance with Section 02223 at no expense to the Owner.

J. Excavations shall be graded and properly maintained to provide adequate drainage at all times. Ponding shall not be allowed to develop. In excavation that cannot be properly graded to drain, such as ponds, the Contractor will provide equipment and labor to keep the excavation free of standing water.

K. Excavation shall be suspended when the site is wet, muddy or in any other condition where the area cannot be properly maintained.

L. Correct areas over-excavated in accordance with Section 02223.

M. Stockpiles excess excavated material as directed by the Owner.

N. The Contractor shall lay out diversion ditches and channels, so channels are excavated in original site soils and not fill. Ditches shall be laid out to provide minimum grades of 1 percent, unless shown flatter on the Drawings. Channel grade breaks shall not exceed 2 percent, unless otherwise shown on the Drawings.

3.3 Tolerances

A. Local slopes shall be within 5 percent of those shown on the Drawings. Overall slopes will be within 0.1 percent of those shown on the Drawings.

B. Finished grades shown on the Drawings are given in feet and tenths or hundredths of feet and shall slope uniformly between given spot and contour elevations. All grades shall provide for natural runoff of water without low spots or pockets.

C. All excavations shall not exceed 0.3 feet in variation from dimensions and elevations shown on the Drawings, unless authorized by the Engineer.

D. Minimum grades and slopes shown on the Drawings to provide drainage control shall be maintained.

E. Correction of over-excavated and backfilling past the tolerances identified above shall be to the Contractor's account, at no expense to the Owner.

3.4 Quality Control

A. Field Quality Control inspection and testing will be performed in accordance with Sections 01400 and 01410.

B. Visual inspection of the excavated surface will be made to verify that all loose material has been removed or compacted and that there are no soft and yielding areas.

C. In place density testing will be performed in accordance with Sections 02211 and 02223.

*****END OF SECTION*****

SECTION 02223
FILLING

1.0 GENERAL

1.1 Section Includes

JJ. Related Sections
KK. References
LL. Fill Materials
MM. Verification
NN. Subgrade Preparation
OO. Fill Placement
PP. Tolerances
QQ. Protection of Finished Work
RR. Quality Control
SS. Submittals
TT. Quality Assurance

1.2 Related Sections

A. Section 01051 – Geotechnical Explorations
B. Section 01300 – Submittals
C. Section 01400 – Quality Control/Assurance
D. Section 01500 – Construction Facilities and Temporary Controls
E. Section 02205 – Fill Materials
F. Section 02222 – Excavating
G. Section 02273 – Geonet
H. Section 02350 – Geosynthetic Clay Liner
I. Section 02775 – Geomembranes
J. Section 02710 – Gravity Piping
K. Section 03300 – Cast-in-Place Concrete

1.3 References

A. ASTM D 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate.
B. ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils
C. ASTM D 1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method
D. ASTM D 1557 - Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
E. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
F. ASTM D 2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
G. ASTM D 4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

H. ASTM D 4643 – Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

I. ASTM D 5519 – Standard Test Methods for Particle Size Analysis of Natural and Man-made Riprap Materials

J. ASTM D 5856 – Standard Test Method for Measurement of Hydraulic Conductivity of Porous Material Using a Rigid-Wall, Compaction-Mold Permeameter

K. ASTM D 6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.0 PRODUCTS

A. Embankment Fill

B. Grading Fill

C. Drainage Layer

D. Filter Fill

E. Anchor Trench Backfill

F. Drain Gravel

G. Leak Detection Fill

H. Riprap

I. Safety Berm Material

3.0 EXECUTION

3.1 VERIFICATION

A. Verify that lines and grades of fill limits and slopes have been established as required.

B. Field verify location of all exploration boreholes and test pits with Engineer and Owner prior to site clearing and stripping.

C. Contractor shall supply certification that all boreholes and test pits have been filled in accordance with these Specifications. The Contractor will supply a list of the boreholes/pits backfilled with the certification, including the depth of each borehole/pit.

3.2 SUBGRADE PREPARATION

A. Prepare subgrade according to Section 02211 and Section 02222.

B. Do not place fill until subgrade has been tested and approved by the Engineer.

3.3 FILL PLACEMENT

A. Do not place frozen material as fill.

B. Do not place fill on frozen ground. EXCEPTION: Fill may be placed on frozen subgrade provided that the depth of freezing is no more than 2 inches AND the subgrade has been previously tested and proof-rolled and approved by the Engineer. Engineer shall be consulted prior to fill placement when freezing depths are greater than 2 inches. Fill placement on frozen subgrade shall only be performed with the approval of the Engineer.

C. Prior to topsoil stripping, boreholes and test pits within the TSF, WRD, and reclaim pond footprints shall be re-excavated to their original depths in accordance with Section 02222. All loose soils and debris shall be removed. The re-excavated explorations shall be backfilled with General Fill, placed in 12-inch maximum loose lifts, moisture-conditioned, compacted with tampers, vibratory compactors, hoe-packs, or other suitable approved compaction methods, to achieve a stable, non-yielding surface. Open boreholes shall be backfilled with bentonite seal in accordance with regulatory requirements.

D. Fill materials shall be obtained from designated borrow areas or areas designated by the Engineer and Owner. For fill materials that are proposed to be imported by the Contractor from areas other than those designated by the Engineer, the Contractor shall give the Owner at least five (5) working days' notice prior to using the imported material to enable the Owner's representative to sample and test the material. Imported material must be tested for compliance with the Specifications and the results approved by the Engineer prior to the material being delivered to the site.

E. Placement of fill shall be made only in areas approved by the Engineer for fill placement. Fill shall be placed to the lines and grades shown on the Drawings and according with these Specifications.

F. Fill placement shall be temporarily stopped due to inclement weather conditions at the direction of the Engineer. Under marginal weather conditions, the Contractor may place fill, provided the fill, when tested, meets these Specifications.

G. The distribution of materials shall be such that the fill is free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. The combined borrow excavation and fill placement operation shall be such that the materials, when compacted in the fill, will be blended sufficiently to provide the best practicable distribution of the material, subject to the approval of the Engineer.

H. If, in the opinion of the Engineer, the surface of the subgrade or the surface of any layer of the fill is too dry or too smooth to bond properly with the layer of material to be placed thereon, it shall be scarified to a depth of 6 inches, or as directed by the Engineer, then moisture-conditioned to provide a satisfactory bonding surface before the next layer of fill material is placed.

I. If, in the opinion of the Engineer, the surface of the subgrade or the rolled surface of any layer of the fill in place is too wet for proper compaction of the layer of fill material to be placed thereon, it shall be removed and allowed to dry or shall be worked with discs, scarifier, or other equipment to reduce the moisture content to the required amount, and then compacted before the next layer of fill material is placed.

J. The Contractor shall place fill only after the subgrade below fills has been adequately compacted and approved by the Engineer. Should any of the work be covered before it has been approved, the Contractor shall uncover all such work at no cost to the Owner. After the work has been examined, tested and approved by the Engineer, the Contractor shall make all repairs and replacements necessary to restore the work to the contract specifications at no additional cost to the Owner.

K. All fill materials shall be moisture-conditioned prior to applying compactive effort. Moisture-conditioning may be performed to fill material either in the borrow area or at the fill site or in both areas as directed by the Engineer. The Owner may also require additional moisture conditioning in the cut or fill to limit fugitive dust.

L. During compaction operations, the borrow and reworked in-place materials requiring moisture conditioning shall be maintained within the range of moisture content required in these Specifications to achieve, with the equipment being used, adequate compaction to the specified density. The moisture content of the fill material prior to and during compaction shall be uniform throughout the material.

M. When material is too dry for proper compaction and/or is below the minimum moisture content specified, the Contractor shall spray water on the fill and work the moisture into the fill by discing or scarifying, or other means approved by the Engineer, until a uniform distribution of moisture is obtained.

N. Material that is too wet for proper compaction and/or is above the maximum moisture content specified, shall be removed from the fill or the material may be spread and permitted to dry, assisted by discing or scarifying until the moisture content is reduced to an amount suitable for obtaining the specified degree of compaction. The Contractor shall not mix underlying fill materials with fill materials being moisture conditioned.

O. The upper 1-foot of final travel way surfaces shall not contain oversize materials greater than 3 inches.

P. For purposes of these Specifications, soil fills are defined as a material where greater than 70% (by weight) passes the ¾-inch screen and rock fills are defined as materials where greater than 30% (by weight) is retained on the ¾-inch screen.

Q. The relative compaction of fill materials shall be tested in-place to check compliance with the Specifications. Rock fills shall be compacted using compactive efforts and performance-based specifications as herein specified, or by an Engineer's approved method based on test fills with specific roller equipment. For the purposes of these specifications, relative compaction of soil fill is the ratio of the in-place dry density of the constructed fill to the maximum laboratory dry density determined by ASTM D 1557 (Modified Proctor).

R. The Engineer shall continuously evaluate the Contractor's equipment and methods. If such equipment or methods are found unsatisfactory for the intended use, the Engineer will require the Contractor to replace the unsatisfactory equipment with other types or adjust methods until proper compaction is achieved.

S. The Contractor shall maintain and protect fills in a condition satisfactory to the Engineer at all times until the final completion and acceptance of the work. Any approved fill material which becomes unsuitable for any reason whatsoever, after being placed in the fill and before final acceptance of the Work, shall be removed and replaced by the Contractor in a manner satisfactory to the Engineer.

T. The Contractor shall route equipment and take all actions necessary to prevent material of one type from being deposited inadvertently, either by dumping or through travel of equipment, in or on material of another type. Such improperly deposited material shall be removed from the fill areas, as directed by the Engineer. If in-place material becomes contaminated, it shall also be removed. All removed material shall be wasted in locations designated by the Engineer. Removal of all such material shall be at no cost to the Owner.

U. At no time shall the native foundation clay be used as General Fill or Embankment Fill. Any foundation clay that becomes exposed during rough grading operations, it shall be over excavated and backfilled, or capped with a minimum 12 inches of General Fill to the lines and grades shown on the Drawings at the direction of the owner.

V. If prior placed, tested and accepted in-place fills become loosened, softened, or disturbed by construction equipment traffic, during dry or wet weather, these materials shall be moisture-conditioned or dried as previously described and recompacted. If weather or soil conditions prevent soils from being properly compacted, the unsuitable soils shall be removed and replaced with properly compacted fill. Such replacement and/or re-compaction shall be at no expense to the Owner.

W. Berms and fills placed for diversion ditches shall be placed, compacted, and tested in accordance with these Specifications. When backfilling staged diversion ditches, fill shall be placed, compacted, and tested in accordance with these Specifications.

X. Embankment Fill:

1. Areas to receive Embankment Fill shall include, but are not limited to: embankment, diversion ditches, access and perimeter roads, and diversion berms.
2. Condition to a moisture content which allows compaction to the required density without an excessive amount of effort and that results in a stable non-yielding surface.
3. Prior to subsequent staged Embankment Fill placement, the dam crest shall be scarified to a depth of 6 inches, or as directed by the Engineer, then moisture-conditioned prior to placement of the first lift of new Embankment Fill. The first lift placed over the scarified dam crest shall be placed to a maximum loose lift thickness of 12 inches to 18 inches, or less as required by these Specifications.
4. Embankment Fill with less than 30 percent rock materials above 3/4-inch size and 8-inch maximum rock size (Embankment Soil Fill) shall be placed in 12-inch maximum loose lifts and compacted to 92 percent of maximum dry density (ASTM D1557).
5. Embankment Fill containing more than 30 percent rock materials above 3/4-inch size (Compacted Rockfill) shall be placed as a rock fill and compacted according to the following method. However, in all cases vibratory drum compactors, if used as the primary means of compaction, must have a minimum 10-ton static and 25-ton dynamic drum weight.

6. For Rock Fills, a test fill shall be conducted to determine the maximum lift thickness and compactive effort for the material. The test fill may be located so that it is incorporated within the limits of the compacted fill area. The test fill shall be constructed and monitored as per U.S. Army Corps of Engineers' guidelines for test fill construction. The Contractor shall outline his proposed procedures for moisture conditioning and fill placement of Compacted Rock Fill and submit them to the Engineer for review and approval prior to placing the test fill.
7. Loose lift thicknesses of 12, 18, and 24 inches or as determined by the Engineer shall be used for the Test Fill; (three test fills to determine optimum lift thickness)
8. The data to be collected during construction of the test fill shall include:
    a. Amount of settlement after every two passes of the proposed compaction equipment to a maximum of ten (10) passes;
    b. Gradation and moisture content of in-place material; and
    c. In-place fill density at completion of the test by bulk density or Nuclear Gauge methods.
    d. A curve showing change in settlement versus number of passes shall be produced from the data. This curve will be used to determine the number of passes for acceptable compaction. In general, the minimum number of passes will be that number required to achieve 80 percent of the total settlement obtained after ten complete passes of the compaction equipment. Final determination by the Engineer of the lift thickness and minimum required passes will be based on a review of the test data.
    e. Maximum rock size for rock fills shall be two-thirds of the compacted lift thickness, unless otherwise approved by the Engineer. Provisions shall be made by the Contractor for removal of oversize materials from fills for use as riprap or exterior slope protection. No additional payment will be made to remove oversize materials.

Y. Grading Fill

1. Areas to receive General Fill shall include, but are not limited to: TSF basin, perimeter access roads, reclaim pond, underdrain channel, WRD pad, and permanent diversion channels.
2. It is the intent of the design to use excavated materials within the TSF basin footprint as much as possible for General Fill.
3. Condition the fill to a moisture content which allows compaction to the required density without an excessive amount of effort and that results in a stable non-yielding surface.
4. Soil General Fill:
    a. General Fill with less than 30 percent rock materials above 3/4-inch in size and 8-inch maximum rock size shall be placed in 12-inch maximum loose lifts and compacted to 92 percent of maximum dry density (ASTM D 1557).
5. Rock General Fill:
    a. General Fill containing more than 30 percent rock materials above 3/4-inch size (Compacted Rockfill) shall be placed as a rockfill based on the results of a Test Fill as described in the Embankment Fill Section below. The type of compaction equipment, number of passes, lift thickness, and maximum rock size shall be approved by the Engineer in writing based on the acceptable Test Fill performance.
    b. Maximum rock size for rock fills shall be two-thirds of the compacted lift thickness, unless otherwise approved by the Engineer. Provisions shall be made by the Contractor for removal of oversize materials from fills for use as riprap or exterior slope protection. No additional payment will be made to remove oversize materials.
6. The Contractor shall adopt methods to remove all oversize rock from the fill. Oversize rock will be stockpiled in a location designated by the Owner. No additional payment shall be made to the Contractor for oversize rock removal.

7. Where bedrock is encountered within 12 inches of the bottom of Prepared Subgrade, the Contractor shall place a 12-inch thick lift of soil General Fill as a “Rock Cap”.

Z. Prepared Subgrade

1. Condition Prepared Subgrade to a moisture content which allows compaction to the required density without an excessive amount of effort and that results in a stable non-yielding surface.
2. Prepared Subgrade shall be placed in 12-inch maximum loose lifts and compacted to 92 percent of maximum dry density (ASTM D1557).
3. Following compaction, the upper surface of the Prepared Subgrade shall be treated as described in Section 02211 of these Specifications in preparation of geomembrane liner placement.
4. On slopes steeper than 20 percent, Prepared Subgrade shall be placed in 18-inch lifts be as measured perpendicular to the slope. Prepared Subgrade may be placed in a single 6-inch lift if the underlying Embankment Fill material is free from excessive coarse material, cobbles, and boulders. Reduction of the total lift thickness shall be approved by the Engineer.

AA. Drainage Layer

1. Drainage Layer shall not be placed until final inspection and approval of the geosynthetics has been made by the Engineer
2. Drainage Layer shall be placed over the geomembrane liner in one lift to result in a minimum eighteen (18)-inch-thick layer after construction is complete.
3. Drainage Layer shall not be compacted.
4. Drainage Later shall have an in-place hydraulic conductivity of 5×10^{-3} cm/sec when tested in accordance with ASTM D 5856.
5. Drainage Layer shall be placed by dumping with trucks or loaders at the edge of geomembrane cover and spreading over the geomembrane with a dozer equipped with Low Ground Pressure (LGP) tracks that exert a pressure of seven (7.0) psi or less, or similar equipment, as approved by the Engineer, that will prevent heavy loads on the liner. Equipment shall not be allowed to come in direct contact with the plastic liner. Rubber-tire equipment shall not be allowed to cross over collection and distribution pipe at any time unless it can be proved by a field test that the subject equipment will not crush the pipe. It may be necessary to place a thicker lift of Drainage Fill over piping if an alternate method of placement is used. Alternative methods of placement proposed by the Contractor will be considered. However, such methods shall be proposed to and approved by the Engineer prior to mobilization of equipment to the site. The Engineer reserves the right to accept or reject any such alternative placement proposal.
6. Thickness of the Drainage Layer will be monitored by the Contractor with twenty-four (24)-inch-high highway cones, or an alternative method proposed by the Contractor and approved by the Engineer.
7. Hauling equipment shall operate on a minimum thickness of Drainage Layer Material above any geosynthetic layer as determined by the Engineer. Prior to commencing Work, Contractor shall provide a list of proposed equipment to operate on the Drainage Layer for approval and minimum roadway thickness determination.
8. In locations with the TSF basin and WRD pad where heat seaming has been used to join geomembrane sections, the protective cover material shall be spread in the same direction as the seam overlap to avoid placing additional stress on the seam.
9. The finished surface of the Drainage Layer shall be bladed with the LGP dozer to provide a surface free of ridges, mounds, and ponding areas.
10. The Contractor shall protect underlying geosynthetics from mechanical damage at all times during placement of Drainage Layer.

11. The geomembrane Installation Contractor shall take steps to minimize wrinkle generation in underlying geosynthetic materials during placement of the Drainage Layer. The measures may include placing protective layer material in the early morning hours when the geosynthetic materials are cool and monitoring and walking out wrinkles in the geosynthetic materials that appear at the edge of the placement area.
12. Placement of Drainage Layer shall not be performed when the ambient air temperature exceeds 100°F or if excessive wrinkles developed in the geomembrane as determined by the Engineer.

BB. The Contractor shall survey to control overall protective cover and drainage layer thickness as specified in Section 01050. Results shall be provided to the Engineer.

CC. Filter Fill

1. Filter Fill shall be placed in a single 6-inch loose lift above the Drainage Layer and under riprap in the permanent diversion channels.
2. Filter Fill shall not be compacted above the drainage layer.
3. Filter Fill shall be compacted to a smooth and non-yielding surface where used as bedding below riprap.
4. Filter Fill shall be placed by dumping with trucks or loaders and spreading over the Drainage Layer with a dozer equipped with Low Ground Pressure (LGP) tracks that exert a pressure of seven (7.0) psi or less, or similar equipment, as approved by the Engineer, that will prevent heavy loads on the liner. Rubber-tire equipment shall not be allowed to cross over collection and distribution pipe at any time unless it can be proved by a field test that the subject equipment will not crush the pipe. Alternative methods of placement proposed by the Contractor will be considered. However, such methods shall be proposed to and approved by the Engineer prior to mobilization of equipment to the site. The Engineer reserves the right to accept or reject any such alternative placement proposal.
5. Thickness of the Filter Fill will be monitored by the Contractor with twenty-four (24)-inch-high highway cones, or an alternative method proposed by the Contractor and approved by the Engineer.
6. Hauling equipment shall operate on a minimum thickness of Drainage Layer Material above any geosynthetic layer as determined by the Engineer. Prior to commencing Work, Contractor shall provide a list of proposed equipment to operate on the Drainage Layer for approval and minimum roadway thickness determination.
7. The finished surface of the Filter Fill shall be bladed with the LGP dozer to provide a surface free of ridges, mounds, and ponding areas.

DD. The Contractor shall survey to control overall protective cover and Filter Fill thickness as specified in Section 01050. Results shall be provided to the Engineer

EE. Anchor Trench Backfill

1. Anchor Trench Backfill shall be placed in geomembrane anchor trenches.
2. Fill placed in geomembrane anchor trenches shall be placed in maximum 12-inch thick compacted horizontal lifts and compacted by tamping with a minimum of two passes with a mechanical “whacker” type tamper or bucket compacted.
3. Anchor Trench Backfill may be used as pipe ballast as directed by the Owner.

FF. Drain Gravel

1. Drain Gravel shall be placed around the primary perforated CPE and HDPE underdrain collection pipes.
2. Drain Gravel shall be placed around the pipe with a minimum clearance of 6-inches on all sides then wrapped with a non-woven geotextile.

3. No equipment other than track-mounted vehicle shall be allowed on the Drain Gravel.

GG. Leak Detection Fill

1. Leak Detection Fill shall be placed around the perforated PVC leak detection pipes.
2. Leak Detection Fill shall be around the pipe with a minimum clearance of 8-inches above and on the sides of the pipe.
3. Leak Detection Fill and leak detection pipe shall be placed directly above the GCL within the leak detection channel as shown on the Drawings.
4. No equipment other than track-mounted vehicle shall be allowed on the Leak Detection Fill.

HH. Pipe Bedding Fill

1. Pipe bedding fill shall be placed around leak detection risers, culverts and buried HDPE piping as shown on the Drawings.
2. Pipe Bedding Fill shall be brought up in horizontal lifts to prevent unbalanced pressure on structures or pipes.
3. Pipe Bedding Fill shall be placed a minimum of 6 inches below the pipe and shall be compacted and approved by the Engineer prior to pipe placement.
4. Pipe Bedding Fill shall be worked under pipe haunches by hand to provide uniform support of the pipe.
5. Pipe Bedding Fill shall be placed in maximum 6-inch loose lift, moisture-conditioned, and compacted to 92 percent of maximum dry density (ASTM D1557).
6. Only hand-guided mechanical tampers or hand-guided vibratory rollers shall be used for compaction around, over, near, or adjacent to pipes.

II. Cable Bedding Fill

1. Cable Bedding Fill shall be placed below and around instrumentation signal cables as shown on the Drawings.
2. Cable Bedding Fill shall be placed in a minimum 6 inches compacted lift below the signal cables and compacted to a smooth and non-yielding surface using hand-guided compaction equipment.
3. Cable Bedding Fill shall be placed in a single 12-inch loose above the signal cables and compacted with hand-guided compaction equipment to achieve a smooth and non-yielding surface.
4. Cable Bedding Fill shall extend a minimum of 12 inches on either side of the maximum extents of the signal cable layout.

JJ. Riprap

1. Riprap shall be placed above Filter Fill in permanent diversion channel and outlet aprons to the lines and grades shown on the Drawings.
2. Riprap shall be placed in a single lift equivalent to 1.5 times D_{50}.
3. Riprap shall be track walked or bucket compacted.

KK. Safety Berm Material

1. Safety Berm Material shall be placed along light vehicle and haul roads.
2. Safety Berm Material shall be uncompacted and placed by either front end loader, dozer, or motor grader.
3. Safety Berm Material shall be placed to such a height as to be equal to the middle of the axel of the largest vehicle assigned to the Work Area.

3.4 TOLERANCES

A. Local slopes shall be within 5 percent of those shown on the Drawings, and overall slopes shall be within 0.1 percent of those shown on the Drawings.

B. Finished grades shown on the Drawings are given in feet and tenths or hundredths of feet, and shall slope uniformly between given spot and contour elevations. All grades shall provide for natural runoff of water without low spots or pockets.

C. Fill and backfill shall be placed within a tolerance of plus or minus 0.2 feet, unless otherwise approved by the Engineer. Where the thickness of fill or backfill is specified as a minimum thickness on the Drawings and/or in the Specifications, place fill to the minimum thickness shown. Layer thicknesses shown on the drawings are compacted thicknesses.

D. Minimum grades and slopes shown on the Drawings provide drainage control and shall be maintained.

E. Correction of over-excavation and backfilling beyond the tolerances identified above shall be to the Contractor's account, at no expense to the Owner.

3.5 PROTECTION OF FINISHED WORK

A. Protect finished Work and Work in progress in accordance with of Section 01500.

3.6 QUALITY CONTROL

A. Quality Control inspection and testing will be performed under provisions of Sections 01010, 01300, 01400, and 01410 under the supervision of a Professional Engineer licensed in the State of Oregon.

B. In place density testing shall be performed in accordance with ASTM D 1556 or D 6938.

C. Laboratory compaction testing to determine the soils maximum dry density shall be performed in accordance with ASTM D 1557.

D. Laboratory permeability testing to determine hydraulic conductivity of the Drainage Layer shall be performed in accordance with ASTM D 5856.

E. Field particle size analyses of riprap materials shall be performed in accordance with ASTM D 5519.

F. If Quality Control test results indicate Work does not meet specified requirements, perform remedial action as described below.

1. Immediately notify the Engineer.
2. Compaction below specified minimum density:
    a. Apply additional effort, or scarify, moisture condition, recompact, and retest.
3. Moisture content outside of specified limits during compaction:
    a. Moisture content below specified minimum: Scarify the depth of the lift, moisture condition, mix to achieve uniform moisture content, recompact, and retest.
    b. Moisture content above specified maximum: Scarify the depth of the lift, allow to air dry, mix to achieve uniform moisture content, recompact, and retest or remove the wet material. Mixing of dry material to lower the moisture content will not be allowed without the prior approval of the Engineer and on a case by case basis.
4. Moisture content outside of specified limits after compaction and approved prior to covering: Determine depth of material outside of specified limits and correct as specified above.
5. Material not in accordance with material specification requirements of Section 02205: Remove material in its entirety as determined by the Engineer.

G. Frequency of tests:

The following table shows the minimum frequency of Quality Control testing of soil, rock, and aggregate materials placed, unless otherwise approved by the Engineer:

Table 1: 02233-1 QUALITY CONTROL - MINIMUM TESTING FREQUENCIES

Materia Type		**Number of Units Per Test**					
	Test	Field Density and Moisture	Field Particle Size Analysis	Laboratory Sieve Analysis	Laboratory Atterberg Limits	Laboratory Moisture Density Relationship	Laboratory Permeability
	ASTM	**D 6938**	**D 5519**	**D 422**	**D 4318**	**D 1557**	**D 5856**
Subgrade	sq.ft	50,000	N/A	200,000	200,000	500,000	
Embankment Fill	cu.yds	2,000	N/A	5,000	5,000	20,000 per material type	
Grading Fill	cu.yds	1,000	N/A	5,000	5,000	20,000	
Prepared Subgrade	cu.yds	1,000	N/A	5,000	5,000	15,000	
Drainage Layer	cu.yds	N/A	N/A	5,000	5,000	N/A	2 per material type
Filter Fill	cu.yds	N/A	N/A	3,000	3,000	N/A	2 per material type
Anchor Trench Backfill	cu.yds	N/A	N/A	500	N/A	N/A	
Drain Gravel	cu.yds	N/A	N/A	200 (or 3 per material type)	200 (or 3 per material type)	N/A	
Leak Detection Fill	Each	N/A	N/A	2 per material type	2 per material type	N/A	
Pipe Bedding Fill	LF	100	N/A	100 (2 per material type)	100 (2 per material type)	200 (1 per material type)	
Cable Bedding Fill	cu.yds	N/A	N/A	2 per material type	2 per material type	N/A	
Riprap	cy.yds	N/A	2 per material type	N/A	N/A	N/A	
Safety Berm Material	cu.yds	N/A	N/A	N/A	N/A	N/A	

6. Tests may be conducted more or less frequently at the direction of the Engineer. More frequent testing shall be performed, where indicated by the following guidelines:
    a. Areas where special compaction equipment or methods are used.
    b. Areas where the height of fill rises quickly versus the quantity of fill placed.
    c. Areas where doubtful construction procedures are being used.
    d. Areas where the required compaction may not have been achieved based upon visual observations.
    e. Areas where unacceptable material may have been placed.
7. If additional Quality Control testing is required by the Engineer, costs for additional testing shall be borne by the Contractor.

H. Quality Control test results shall be made available to the Owner and Engineer within twenty-four (24) hours after completion of test.

I. Quality Control test results shall be stored in hard copy in the Quality Control Team's on-site facility for from the Owner or Engineer at all times. If no hard copies are stored on-site, the Quality Control Team shall provide the electronic test results to the Engineer within twenty-four (24) hours after completion of the test.

3.7 Submittals

A. The Quality Control test results shall be submitted to the Engineer for review and approval on a regular basis, or at the request of the Engineer.

B. The Quality Control Team shall be responsible for accurately testing and reporting results of all Quality Control test results and observations in a timely manner to the Owner and Contractor throughout the project in the form of a Daily Field Report.

1. Daily Field Reports shall be typed and submitted to the Engineer and/or Owner within one (1) working day.

C. Fill materials proposed by the Contractor for use to complete the Work shall be tested by the Quality Control Team prior to placement to verify that the material meets these Specifications.

D. Initial Quality Control test results of proposed materials shall be submitted to the Engineer for approval at least twenty-four (24) hours prior to material placement.

E. At the completion of the Work, a sealed Quality Control Report shall be submitted to the Owner and Engineer in accordance with Section 01300 and include at a minimum:

1. Cover letter summarizing the quantities of materials placed, required testing frequency, and actual testing frequency achieved. The Quality Control Report shall be sealed by a professional engineer licensed in the State of Oregon.
2. Typed field documentation including daily field reports, field and laboratory test results summary tables and individual test results forms for all tests performed for each construction material for the tests specified in these Specifications.
3. Summary tables shall be suitable for report presentation and regulatory agency review. One (1) digital reproducible copy of the summary tables shall be provided to the Engineer.

3.8 Quality Assurance

A. The Quality Assurance Team shall perform Quality Assurance or Referee testing at the direction of the Engineer.

B. The Engineer has the final decision regarding the use of a proposed material for completion of the Work.

C. At any time, the Engineer or Quality Assurance Team may collect a sample split from the Quality Control Team's sample and perform a referee test for Quality Assurance.

1. Quantity of tests and frequencies shall be at the discretion of the Engineer. Costs for Quality Assurance testing where test results do not meet these Specifications shall borne by the Contractor.

*****END OF SECTION*****

SECTION 02272
GEOTEXTILE

1.0 GENERAL

1.1 Section Includes

A. References
B. Performance Requirements
C. Submittals
D. Delivery, Storage, and Handling
E. Material
F. Deployment
G. Seaming
H. Quality Control
I. Quality Assurance

1.2 Related Sections

A. Section 01300 – Submittals
B. Section 01400 – Quality Control/Assurance
C. Section 01410 – Testing Laboratory Services
D. Section 02205 – Fill Materials
E. Section 02223 – Filling

1.3 References

A. American Society for Testing and Materials (ASTM)
   1. ASTM D 4354 – Practice for Sampling of Geosynthetics for Testing
   2. ASTM D 4355 – Test Method for Deterioration of Geotextile from Exposure to Ultraviolet Light and Water
   3. ASTM D 4533 -Test Method for Trapezoidal Tearing Strength of Geotextiles
   4. ASTM D 4632 – Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
   5. ASTM D 4751 – Test Method for Determining Apparent Opening Size of a Geotextile
   6. ASTM D 4759 – Practice for Determining the Specification Conformance of Geosynthetics
   7. ASTM D 4873 – Guide for Identification, Storage and Handling of Geotextiles
   8. ASTM D 5035 – Test Method for Break Strength and Elongation of Textile Fabrics (2” Strip Method)
   9. ASTM D 5261 – Test Method for Determining Mass Per Unit Area
   10. ASTM D 6241 – Test Method for Static Puncture Strength of Geotextiles and Geotextile Related Products Using a 50-mm Probe
   11. ASTM D 7238 – Test Method for Effect of Exposure of Unreinforced Polyfin Geomembrane Using Fluorescent Condensation Apparatus
B. Geosynthetic Research Institute (GRI)
   1. GT12a – Test Method and Properties for Nonwoven Geotextile Used as Protection (or cushioning) Materials

1.4 Performance Requirements

A. Contractor shall furnish and install the geotextile and all materials incidental to the installation in accordance with these Specifications.

B. Alignment, lengths, and areas for geotextile placement are shown on the Drawings. Exact locations and lengths may be varied to suit conditions encountered in the field only as approved by the Engineer.

A. Contractor shall furnish sufficient material to provide the finished geotextile shown on the Drawings; including material for all seams and laps. Contractor shall balance the actual project geotextile requirements, as determined by their quantity take-offs, against those shown on the Drawings.

1.5 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Product Data: Provide manufacturer's data regarding filtration, permeability, and mechanical properties.

2. Sample: Submit one (5 feet by 5 feet) sample with the machine direction marked.

C. During Installation:

1. Manufacturer Quality Control certificates

1.6 Delivery, Storage, and Handling

D. Transportation: The geotextile shall be packaged and shipped in such a manner that the material is not damaged or exposed to damaging substances. Transportation shall be the responsibility of the Geomembrane Installation Contractor unless agreed to by the Manufacturer and the Owner, in writing, prior to the initiation of shipment of geotextile to the site.

E. Off-Loading: Off-loading of the geotextile is the responsibility of the Geomembrane Installation Contractor. No off-loading of geotextile shall be performed unless the Owner's representative is present. Any damage to the rolls during off-loading shall be documented by the Owner's representative and the Geomembrane Installation Contractor. All damaged rolls must be stored separate from the undamaged rolls until. The rolls shall be unrolled to determine the extent of the damage. The use of the roll or portions of the roll shall be only at the approval of the Engineer. The cost of evaluating, replacing or repairing rolls damaged during off-loading shall be the sole responsibility of the Installation Contractor.

F. Storage: The geotextile shall be stored according to manufacturer's recommendations, ASTM D 4873, and such that it is protected from puncture, dirt, grease, gasoline, diesel fuel, water, moisture, mud, mechanical abrasion, excessive heat and other causes of damage to the geotextile material.

A. Rolls without the proper documentation shall be stored separately until all the required documentation is received and approved by the Engineer.

2.0 PRODUCTS

2.1 Material

A. The geotextile as referenced in the Drawings and these Specifications shall be Non-woven Needle Punched Geotextile.

1. Composition: Geotextile shall be of polypropylene or polyethylene fibers.

2. Rolls shall be free of holes, contamination, and foreign matter.

B. The geotextile supplied to the project shall meet or exceed the minimum (unless noted otherwise) roll values shown in the table below:

Table 02272-1: Minimum Average Roll Values For Geotextile Material (per GRI-GT12a)

Property[1]	ASTM Test Method	Value
Weight	D 5261	12 oz/sq.yd.
Grab Tensile	D 4632	300 lb
Grab Tensile Elongation	D 4632	50%
Trapezoidal Tear Strength	D 4533	115 lb
Puncture (CBR) Strength	D 6241	800 lb
UV Resistance (at 500 hrs)	D 7238	70% strength retained
Apparent Opening Size	D 4751	No. 100 Sieve (0.15 mm)

Notes:
1. Evaluation to be on a 2.0 inch strip tensile specimens per ASTM D 5035 after 500 light hour exposure.

C. Rolls shall be manufactured a minimum of 15 feet wide and 300 feet long.

D. The geotextile will be warranted by the Manufacturer to be free from defects in materials and workmanship and to have a useful life of 5 years from the date of purchase under normal weathering and normal use.

3.0 EXECUTION AND DEPLOYMENT

3.1 Deployment

A. Procedure and methods shall not damage the geotextile. Manufacturer's recommended deployment techniques shall be followed by the Contractor to the greatest extent possible.

B. Do not deploy frozen geotextile.

C. Do not deploy geotextile over frozen ground.

D. Deploy only in areas approved by the Engineer.

E. Placement of drainage aggregate should proceed immediately following placement of the geotextile. If a perforated collection pipe is to be installed, a bedding layer of drainage aggregate should be placed below the pipe, with the remainder of the aggregate placed to the minimum required construction depth.

3.2 Seaming

A. Seams can be sewn or overlapped a minimum of 12 inches.

3.3 Quality Assurance

A. Quality Assurance shall consist of:

1. Review of required documentation.
2. Approval of geotextile rolls for deployment.
3. Observation of unrolled material for damage.
4. Observation of seaming procedure and completed seams.

B. Engineer has final authority in the Quality Assurance for the project.

C. Compliance Testing:

1. At the option of the Engineer, compliance testing may be performed at any time prior to, during, or after the installation.

2. The cost of the compliance testing shall be negotiated between the Owner and Contractor.
3. The tests performed for the compliance testing shall be directed by the Engineer.
4. Compliance testing shall not include any tests that are not listed in these Specifications as a basis for evaluating compliance of the geotextile to the Specifications.
5. Sampling for Compliance Testing:
    a. Samples shall be obtained by the Engineer.
    b. The sample shall be taken as close to the middle of the roll as practical but shall, at a minimum, be sampled no closer than three (3) feet from the end of a roll.
6. The sample shall be labeled by the Engineer, using a permanent marker, with the roll number, machine direction, date sampled, and name of individual that sampled the material.

D. Seams:

1. Will be observed for required overlap and seaming procedures.
2. Seams that do not have the required overlap will be marked for adjustment.

*****END OF SECTION*****

SECTION 02273
GEONET

1.0 GENERAL

1.1 Section Includes

A. Definitions
B. Performance Requirements
C. Submittals
D. Delivery, Storage, and Handling
E. Material
F. Deployment
G. Seaming
H. Quality Assurance

1.2 Related Sections

A. Section 02775 – Geomembrane

1.3 References

A. American Society for Testing and Materials (ASTM)

1. ASTM D 792 – Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2. ASTM D 1505 – Standard Test Method for Density of Plastic by the Density-Gradient Technique
3. ASTM D 1603 – Test Method for Carbon Black in Olefin Plastics
4. ASTM D 4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
5. ASTM D 4354 – Practice for Sampling of Geosynthetics and Rolled Erosion Control (RECPs)
6. ASTM D 4355 – Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
7. ASTM D 4491 – Test Methods for Water Permeability of Geotextiles by Permittivity D 4533 Test Method for Trapezoidal Tearing Strength of Geotextiles
8. ASTM D 4632 – Test Method for Grab Breaking Load and Elongation of Geotextiles
9. ASTM D 4716 – Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthectic using a Constant Head
10. ASTM D 4716 – Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
11. ASTM D 4751 – Test Method for Determining Apparent Opening Size of a Geotextile
12. ASTM D 4873 – Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples
13. ASTM D 5035 – Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
14. ASTM D 5199 – Standard Test Method for Measuring Nominal Thickness of Geotextile and Geomembranes
15. D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles

16. ASTM D 6241 – Standard Test Method for Static Puncture Strengths of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
17. ASTM D 6364 – Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics
18. ASTM D 7005 – Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposite
19. ASTM D7179 – Standard Test Method for Determining Geonet Breaking Force
20. ASTM D7238 – Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembranes Using Fluorescent UV Condensation Apparatus

B. Geosynthetic Research Institute (GRI)

1. GRI-GN2 and GC13 – Joining and Attaching Geonets and Drainage Composites
2. GRI-GN4 – Test Methods, Required Properties and Testing Frequencies for Biplaner Geonets and Biplaner Geonet Composites

1.4 Definitions

A. Installation Contractor: Subcontractor retained by the General Contractor to install the geonet or General Contractor, if General Contractor elects to install the geonet.

1.5 Performance Requirements

A. Installation Contractor shall furnish and install the geonet and all materials incidental to the installation in accordance with these Specifications.

B. Alignment, lengths, and areas for geonet placement are shown on the Drawings. Exact locations and lengths may be varied to suit conditions encountered in the field only as approved by the Engineer.

C. Installation Contractor shall furnish sufficient material to provide the finished geonet shown on the Drawings; including material for all seams and laps. Installation Contractor shall balance the actual project geonet requirements, as determined by his quantity take-offs, against those shown on the Drawings.

1.6 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Product Data: Provide manufacturer's data sheet.
2. Sample: Submit one (5 feet by 5 feet) sample with the machine direction marked.

1.7 Delivery, Storage, and Handling

A. Transportation: The geonet shall be packaged and shipped in such a manner that the material is not damaged or exposed to damaging substances. Transportation shall be the responsibility of the Geonet Installation Contractor unless agreed to by the Manufacturer and the Owner, in writing, prior to the initiation of shipment of geonet to the site.

B. Off-Loading: Off-loading of the geonet is the responsibility of the Geonet Installation Contractor. No off-loading of geonet shall be performed unless the Owner's representative is present. Any damage to the rolls during off-loading shall be documented by the Owner's representative and Geonet Installation Contractor. All damaged rolls must be stored separate from the undamaged rolls until. The rolls shall be unrolled to determine the extent of the damage. The use of the roll or portions of the roll shall be only at the approval of the Engineer. The cost of evaluating, replacing or repairing rolls damaged during off-loading shall be the sole responsibility of the Installation Contractor.

C. Storage: The geonet shall be stored according to manufacturer's recommendations and such that it is protected from puncture, dirt, grease, gasoline, diesel fuel, water, moisture, mud, mechanical abrasion, excessive head and other causes of damage to the geotextile material.

D. Rolls without the proper documentation shall be stored separately until all the required documentation is received and approved by the Engineer.

2.0 PRODUCTS

2.1 Material

Table 02273-1: Minimum Average Roll Values for Geonet Material (per GRI-GN4)

Property	ASTM Test Method	Minimum Average Roll Value
Thickness[1] (min. ave.)	D 5199	200 mil
Density[2] (min. ave.)	D 1505/D 792	0.950 g/cm^3
Carbon Black Content (%)	D 1603/D 4218	1.5-3.0%
Tensile Strength[3] (MD)	D 7179	180 lb/in
Compressive Strength[4] (min. ave.)	D 6364	120
Transmissivity[5]	D 4716	5.0 gal/min-ft

Notes:

1. The diameter of the presser foot shall be 2.22 in. and the pressure shall be 2.9 lb./in^2.
2. Density is of the formulated material; the base resin will be slightly lower.
3. This is the average peak value for five equally spaced machine direction tests across the roll width.
4. Test to be conducted using Section 6.3, the movable plate method.
5. Geonets shall be tested between rigid end platens at a hydraulic gradient of 1.0; a pressure of 10,000 lb/ft^2, and a seating dwell time of 15 min. Test values are for machine direction only.

3.0 EXECUTION AND DEPLOYMENT

3.1 Installation

A. Do not deploy frozen geonet.

B. Do not deploy geonet over frozen ground.

C. Deploy only in areas approved by the Engineer.

D. Deploy the geonet in a downhill manner, when applicable, with the long dimensions of the panel sloping downhill.

E. Install the overlying geomembrane liner without damaging the geonet layer or underlying geomembrane.

3.2 Seaming

A. Use plastic wire ties of a color contrasting to the color of the geonet.

B. Tie Spacing: According to manufacturer's recommendations but at a minimum of 5 feet on seam perpendicular to slopes, 2 feet on seams parallel to slopes, 5 feet on seams on grades of less than 5percent, and 6 inches on seams in anchor trenches.

C. Do not overlap.

3.3 Construction Quality Assurance

A. Construction Quality Assurance (CQA) shall consist of:

1. Observation of geonet prior to and during deployment for dirt and debris that may clog the leak detection system.
2. Observation of tie spacing.
3. Observation of procedures for damage to secondary liner.

*****END OF SECTION*****

SECTION 02350
GEOSYNTHETIC CLAY LINER

1.0 GENERAL

1.1 Section Includes

A. References
B. Performance Requirements
C. Submittals
D. Delivery, Storage, and Handling
E. Material
F. Deployment
G. Seaming
H. Quality Assurance

1.2 Related Sections

A. Section 01300 – Submittals
B. Section 01400 – Quality Control/Assurance
C. Section 02205 – Fill Materials
D. Section 02223 – Filling

1.3 References

A. American Society for Testing and Materials (ASTM)
   1. ASTM D 4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
   2. ASTM D 5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
   3. ASTM D 5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
   4. ASTM D 5887 – Standard Test Method for Measuring the Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
   5. ASTM D 5993 – Standard Test Method for Measuring Mass per Unit Area of Geosynthetic Clay Liners
   6. ASTM D 5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembranes
   7. ASTM D 6243 – Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punch Geosynthetic Clay Liners
   8. ASTM D 6496 – Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
   9. ASTM D 6768 – Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
B. Geosynthetic Research Institute (GRI)
   1. GCL3 – Geosynthetic Research Institute Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)

1.4 Performance Requirements

A. This Work shall include the furnishing of all labor, tools, equipment, and other items necessary for the installation of geosynthetic clay liner (GCL) as shown on the Drawings. All Work shall be performed in accordance with the lines, grades, sections, and dimensions shown on the Drawings, or as directed by the Engineer

1.5 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Product Data: Provide manufacturer's data regarding filtration, permeability, and mechanical properties.

2. Sample: Submit one (5 feet by 5 feet) sample with the machine direction marked.

C. During Installation:

1. Manufacturer Quality Control certificates

D. After Installation:

1. At the completion of the Work, the GCL Installation Contractor shall submit the Quality Control Documentation outlined in Section 01300 and shall include at a minimum:

   a. Typed summary tables of the field documentation including summaries of on-site field personnel, GCL panel deployment, heat-bonded test seams, samples and test results recorded during installation, if any.

   b. A GCL record drawing showing panels and heat-bonded test locations. The record drawing shall be drawn on a 22 –inch by 34-inch sheet.

   c. The summary tables and record drawings shall be suitable for report presentation and agency review. One (1) digital reproducible copy of the summary tables and record drawings shall be provided to the Engineer.

1.6 Delivery, Storage, and Handling

A. Rolls shall be stored following all Manufacturer's recommendations and the requirements of ASTM D 4873.

B. Rolls shall be stored on a flat dry surface. Store to protect the GCL from dust, dirt, and debris. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

C. Rolls shall be handled utilizing a solid steel bar inserted through the core bar and slings or chains attached to the ends of the bar. The core bar shall be suspended from a spreader bar so that the edges of the liner are not damaged by the suspending straps or chains.

2.0 PRODUCTS

2.1 Material

A. The GCL as referenced in the Drawings and these Specifications shall be reinforced geofilm-related GCL similar to ContainMAT manufactured by GSE Environmental of Houston, Texas, or similar which has a maximum allowable composite hydraulic conductivity of 5×10^{-10} cm/sec.

B. The GCL shall be formulated and manufactured from polypropylene geotextiles and high swelling, containment resistant sodium bentonite.

C. The GCL shall be manufactured reinforced by the mechanical bonding of the needle punch process to enhance the friction characteristics of the GCL and to maintain the integrity of the GCL under hydration. No glues or adhesives shall be used in lieu of the needle punch process so as to retain these characteristics.

D. Needle-punched GCL's are those which, by the process of a needling board (similar to that used in the manufacture of standard non-woven geotextiles) have fibers of a non-woven geotextile pushed through the bentonite clay core and integrated into a woven or non-woven geotextile without the use of any chemical binders or adhesives.

E. No disassociation of geotextile components from the bentonite core shall occur. A sample of the GCL placed in 70º F tap water for 1 hour shall not delaminate.

F. The GCL supplied to the project shall meet or exceed the minimum (unless noted otherwise) roll values shown in the table below:

Table 02350-1: Minimum Average Roll Values For Reinforced Geofilm Related GCL Material (per GRI-GCL3)

PROPERTY	ASTM TEST METHOD	VALUE
Geotextile/Geofilm Properties		
Cap Geosynthetic		
Type	-	Non-woven
Weight	ASTM D 5261	6.0 oz/sq.yd.
Carrier Geosynthetic		
Type	-	Woven
Weight	ASTM D 5261	3.0 oz/sq.yd.
Geofilm		
Thickness	ASTM D 5199/ D 5994	4 mil
Break Tensile Strength (MD & XMD)	ASTM D 882	12 lb/in
Clay Properties		
Clay Type	-	80% or more montmorillonite
Bentonite Mass at 0% Moisture[2]	ASTM D 5993	0.75 psf
Maximum Allowable Moisture Content	ASTM D 5993	35%, by weight
Swell Index	ASTM D 5890	24 ml/2g min
Fluid Loss	ASTM D 5891	18 ml max
GCL Composite Properties		
GCL Permeability[1]	ASTM D 5887	5 x 10^{-10} cm/sec max at 5.0 psi
Tensile Strength in Machine Direction	ASTM D 6768	23 lb/in
Peel Strength	ASTM D 6496	2.1 lb/in
Geofilm Durability[4]	ASTM D 5721	80% strength
Internal Shear Strength	ASTM D 6243	150 psf typical

Notes:
1. Maximum allowable permeability per Golder.
2. For both cap and carrier fabrics for non-woven reinforced GCLs; one, or the other, must contain a scrim component of mass > 2.9 oz/sq.yd. for dimensional stability. This only applies to GM/GCL composites which are exposed to the atmosphere for several months or longer so as to mitigate panel separation.
3. If the GCL is manufactured at a higher moisture content, it shall have a minimum of 1 psf of bentonite when adjusted to a 12% moisture level.
4. Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60° C for 50 days.

G. Rolls shall be manufactured a minimum of 15.5 feet wide and 150 feet long. A minimum 6-inch lap line and a 9-inch match line shall be printed on both edges of the woven geotextile of the GCL (the upper surface as installed) to assist in overlap quality control.

H. The GCL will be warranted by the Manufacturer to be free from defects in materials and workmanship and to have a useful life of 5 years from the date of purchase under normal weathering and normal use.

3.0 EXECUTION AND DEPLOYMENT

3.1 Deployment

A. Procedure and methods shall not damage the GCL. Manufacturer's recommended deployment techniques shall be followed by the Contractor to the greatest extent possible.

B. Prior to deployment of the GCL, the subgrade shall be final graded and rolled to provide a smooth surface free of any soft areas, rocks protruding greater than 1/2 inches above the subgrade, or ruts in accordance with Section 02223. Subgrade shall also be free from any chemicals which could damage the GCL. The subgrade shall be approved by the Engineer prior to GCL deployment.

C. Panels shall be placed with the non-woven side against the subgrade and the woven polypropylene coated side oriented upwards. The GCL shall be smoothed to be free of wrinkles and creases.

D. The Contractor shall only Work on an area that can be completed in one working day. Completion shall be defined as the full installation of the liner and placement of the geomembrane liner. The GCL shall be covered immediately to protect it from any precipitation that may occur during construction.

E. Whenever possible, direct contact to the GCL will be avoided. If access requires travel over the GCL, the Contractor shall use low ground pressure (LGP) that exerts 7.0 psi or less to the contact area of GCL. Equipment tracks shall be made of rubber. Care shall be taken to avoid sharp turns and any quick stops or starts so as to avoid pinching or moving the GCL. Any damage caused by direct contact to the GCL will be repaired at the Contractor's expense.

F. The Contractor shall keep the GCL dry during installation. Installation shall not take place during high humidity, rain, or other types of precipitation. Any GCL which becomes hydrated prior to covering with drainage layer material or protective soil shall be removed and replaced at the Contractor's expense.

3.2 Seaming

A. Seams shall be flat without wrinkles and shall be overlapped a minimum of 18-inches on all sides.

B. Granular bentonite shall be placed between the upper and lower panels for a minimum width of 12-inches at a rate of the-quarter (1/4) pound per lineal foot of seam.

C. All seams shall be continuously heat-bonded together. Heat bonding techniques shall be approved by the Engineer. Care shall be taken to not place granular bentonite where it may interfere with heat-bonding of the seam.

D. Repair Procedures:

1. Rips, tears, or holes in the GCL shall be repaired by completely exposing the affected area, removing all foreign objects or soil, and then placing a patch over the defect, with a minimum overlap of 18-inches on all edges.

2. All seams shall be continuously heat-bonded to the underlying GCL panel.

3. Granular bentonite shall be placed between the patch and the repaired material at a rate of one-quarter (1/4) pound per lineal foot of edge.

    a. Defective seams, tears, and holes, shall be repaired as described above.

    b. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.

3.3 Quality Assurance

A. Quality Assurance shall consist of:

1. Review of required documentation.
2. Approval of GCL rolls for deployment.
3. Observation of unrolled material for damage.
4. Observation of seaming procedure and completed seams.

B. Engineer has final authority in the Quality Assurance for the project.

C. Compliance Testing:

1. At the option of the Engineer, compliance testing may be performed at any time prior to, during, or after the installation.
2. The cost of the compliance testing shall be negotiated between the Owner and Contractor.
3. The tests performed for the compliance testing shall be directed by the Engineer.
4. Compliance testing shall not include any tests that are not listed in these Specifications as a basis for evaluating compliance of the GCL to the Specifications.
5. Sampling for Compliance Testing:
    a. Samples shall be obtained by the Engineer.
    b. The sample shall be taken as close to the middle of the roll as practical but shall, at a minimum, be sampled no closer than three (3) feet from the end of a roll.
6. The sample shall be labeled by the Engineer, using a permanent marker, with the roll number, machine direction, date sampled, and name of individual that sampled the material.

D. Seams:

1. Will be observed for required overlap and seaming procedures.
2. Seams that do not have the required overlap will be marked for adjustment.

*****END OF SECTION*****

SECTION 02710
GRAVITY PIPING

1.0 GENERAL

1.1 Section Includes

A. Related Sections
B. References
C. Submittals
D. Piping
E. High Density Polyethylene Pipe and Fittings
F. Fabrication
G. Handling and Storage
H. Installation
I. Pipe Connections
J. Bedding and Backfill

1.2 Related Sections

A. Section 02205 – Fill Materials
B. Section 02222 – Excavating
C. Section 02223 – Filling
D. Section 11207 – Parshall Flumes
E. Section 03300 – Cast-in-place Concrete

1.3 References

A. AASHTO M252 - Standard Specification for Corrugated Polyethylene Drainage Pipe
B. ASTM D1693 – Standard Test Method for Environmental Stress Cracking Ethylene Plastics
C. ASTM 2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity Flow Applications
D. ASTM D3350 – Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
E. ASTM D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

1.4 Submittals

A. Submit the following under provisions of Section 01300:
   1. The Contractor shall provide detailed information to the Owner and Engineer for: pipe, valves, fittings, and joining manufacturer's data, including type/class, method of joining, specifications, manufacturer's name, and manufacturer’s certificate of compliance.
   2. If an equivalent product is proposed, submit samples, technical data, test data, and specifications sufficient to allow evaluation by Engineer.

2.0 PRODUCTS

2.1 Pipe

A. Tailings Storage Facility Underdrain Collection Piping
   1. 6-inch diameter perforated Underdrain Outlet Pipe (HDPE DR17)
   2. 6-inch diameter solid wall Underdrain Outlet Pipe (HDPE DR17)

3. 6-inch diameter, 20-foot long with 3-inch wide water stop Underdrain Outlet Pipe (HDPE DR17)
4. 6-inch diameter perforated CPE Underdrain Collection Pipe
5. 4-inch diameter perforated CPE Underdrain Collection Pipe

B. Waste Rock Dump Underdrain Collection Piping

1. 6-inch by 10-inch diameter dual containment Underdrain Outlet Pipe (HDPE DR17)
2. 6-inch diameter perforated Underdrain Outlet Pipe (HDPE DR17)
3. 6-inch diameter perforated CPE Underdrain Collection Pipe
4. 4-inch diameter perforated CPE Underdrain Collection Pipe

C. Reclaim Pond

1. 10-inch diameter solid wall Leak Detection Riser Pipe (HDPE DR17)

2.2 High Density Polyethylene Pipe and Fittings

A. The polyethylene pipe and fittings shall meet or surpass the physical property values. Pipe and fittings shall be made of polyethylene compounds which meet or exceed the requirements of Type III, Category 4 or 5, Grade P33 or P24, Class C per ASTM D 1248. Pipe fittings shall be manufactured from the same resin and by the same pipe Manufacturer.

B. HDPE pipe material shall be PE4710. The PE4710 material shall conform to ASTM D 3350 with the cell classification of 445574C.

C. All pipe shall comply with ASTM F 714.

D. The polyethylene compound shall contain a minimum of 2 percent carbon black to withstand outdoor exposure without loss of properties. The polyethylene compound shall have a minimum resistance of 5,000 hours when tested for environmental stress crack in accordance with requirements of ASTM D 1693.

E. Minimum parallel plate pipe stiffness values at 5% deflection shall be 50 psi per test method ASTM D 2412.

F. Pipes and fittings shall be homogenous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.

G. Fittings at the ends of pipes shall consist of polyethylene unless indicated otherwise on the Drawings. Fittings supplied by manufacturers other than the supplier of the pipe shall not be permitted without the approval of the Engineer. HDPE fittings shall be in accordance with ASTM D 3261.

H. Segments of pipe having cuts or gouges in excess of 10% of the wall thickness of the pipe shall be cut out, removed, and replaced.

I. The standard dimension ratio (DR) for the piping shall be as shown on the Drawings.

J. Where polyethylene pipe is to be slotted, slots shall be completed at the manufacturing plant or by the Contractor prior to installation of the Work.

K. Polyethylene pipe shall be supplied in standard laying lengths not exceeding 50 feet.

L. Underdrain water stop segments shall be cast-in-place to the lines and grades shown on the Drawings for the underdrain outlet pipes at the upstream toe of the Stage 1 embankment. Underdrain Pipe water stops shall be constructed of 20-foot long pipe segments with continuous 3-inch wide by ½-inch thick rig factory-fabricated at the midpoint of the segment length.

2.3 Valves

A. Butterfly Valve:

1. 6-inch gear operated butterfly valve, Class 150 manufactured by a company whose products are approved by the Engineer. Valve bodies shall be cast iron, ductile iron, or other approved material mounted with approved non-corrosive metals. All wearing surfaces shall be bronze or other approved non-corrosive materials compatible with the sodium cyanide solution used for the Project. There shall be no moving, bearing, or contact surfaces of iron in contact with iron. Contact surfaces shall be machined and finished in the best workmanlike manner, and all wearing surfaces shall be easily renewable or replaceable.

B. The valves shall be standard pattern of the Manufacturer whose products are approved by the Engineer. The valves shall have the name or mark of the Manufacturer, year valve casting was made, size, and working pressure plainly cast in raised letters on the valve body.

2.4 Fabrication

A. Finished pipe lengths shall have beveled ends for field welding.

B. Pipe shall be fabricated in accordance with manufacturer's recommendations and ASTM F 2620.

C. Underdrain water stop segments shall be prefabricated in the manufacturing facility. Pipe segment shall be a minimum of 20 feet long and suitable for field butt fusion welding.

3.0 EXECUTION

3.1 Handling and Storage

A. Transportation of pipe, valves, and fittings shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the pipe, valves, and fittings incurred prior to and during transportation to the site.

B. Handling, storage and care of the pipe, valves, and fittings prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Engineer.

C. The Contractor shall be responsible for storage of pipe, valves, and fittings at the site. Pipe, valves, and fittings shall be stored on clean level ground, which is free of sharp objects which could damage these materials. Stacking shall be limited to a height that shall not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitable and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

3.2 Installation

A. There is no guarantee that existing utilities are properly located or that other utilities are not present. It shall be the Contractor's responsibility to request locates, confirm locates, expose, and protect all nearby utilities or other potential subsurface facilities that may interfere with the work.

3.3 Work Staging Area

A. Installation of piping, fittings, and valves shall be done to replace existing damaged or malfunctioning parts, as directed by the Engineer.

B. Install all piping, fittings, and valves according to manufacturer's recommendations.

3.4 Pipe Connections

A. All connections for the piping system shall be watertight under maximum anticipated pressure head.

B. The ends of all pipe shall be capped with a manufactured pipe cap unless otherwise noted on the Drawings.

C. TSF underdrain outlet pipe cast-in-place water stops shall be prefabricated.

D. HDPE pipe shall be butt-heat-fusion welded in accordance with the manufacturer's guidelines and ASTM D3261 unless otherwise noted on the Drawings.

E. Perforated to solid wall HDPE pipe connections at the upstream toe of the Stage 1 embankment within the basin shall be electrofusion couplings.

3.5 Bedding and Backfill

A. Pipe Bedding Fill shall be placed only in the locations shown on the Drawings.

A. Backfill and compact Pipe Bedding Fill in accordance with Section 02223.

B. Pipe Bedding Fill shall be hand-worked under the haunches of the pipe to uniformly bed and support the pipe.

3.6 Tolerances

A. Grade surface in a manner so that piping can be laid straight at a uniform grade, without sags or humps.

3.7 Quality Control

A. A short description of the Quality Control program shall be submitted by the Contractor with the bid to the Engineer and Owner. This description shall state the Quality Control standard to be used and as a minimum containing the following:

1. An organization chart with a brief job description of Quality Control function
2. A list of applicable procedures for implementation of the Quality Control program
3. A general description of how each Quality Control requirement is to be fulfilled during the design, procurement, manufacture, assembly and testing

B. During award phase, the Quality Control documentation shall be forwarded to the Engineer as specified in Section 01300. Pertinent Quality Control documentation including Quality Control manuals shall be approved by the Engineer prior to any production work commencing. A minimum of five working days shall be allowed for the Engineer's review.

C. Upon delivery of the pipe, the Contractor shall forward the following documentation:

1. All Vendor certificates and tests performed per these Specifications
2. All Vendor documents verifying that inspection, control, and tests performed are in accordance with these Specifications
3. Identification lists with cross references between documents and hardware/materials for traceability purposes

D. The Engineer or Owner shall have the right to carry out audits at the Contractor’s, Vendor’s, and their subcontractor’s facilities, to verify compliance with all aspects of the documentation included in the purchase order. For the purpose of evaluating and auditing, the Contractor, Vendor, and their subcontractors shall give free access to all facilities concerned and to all the Quality Control documents and records

E. Applicable records may be requested by the Engineer or Owner at any time during production, these shall be forwarded to the Engineer or Owner upon request within five working days. The Contractor or Vendor shall give a written response to the Engineer or Owner for any corrective action requests and if requested, take the necessary corrective action in a timely manner

3.8 Mechanical Properties Testing

A. All mechanical properties shall be tested and records submitted per applicable codes and Vendor standards.

3.9 Non-Destructive Examination Requirements

A. All non-destructive examinations and records shall be submitted per applicable code and Vendor standards

3.10 Hydrostatic Pressure Tests

A. All piping must be hydrostatically tested per ASME B31.11 and the pipe class sheets. Test records shall be submitted by the Contractor as part of the turnover package

B. The Contractor shall continuously monitor the hydrostatic pressure throughout the test, from the start of pressurization to the completion of depressurization. Suitable equipment shall be used to provide a continuous record of test pressure, time and the ambient temperature.

C. Hydrostatic test gauges shall be calibrated prior to the commencement of production and shall be recalibrated weekly. Certified dead weight testers shall be used for calibration. The Engineer shall witness the calibration of the gauges.

D. The hydrostatic pressure test shall show no variation in pressure which is not directly related to a change in recorded temperature. The test medium shall be clean, filtered non-saline potable water with added corrosion inhibitors. The inhibited water shall be free from sand, dirt and organic materiaI. The hydrostatic testing records and certificates shall be identified to the individual pipe section numbers.

E. No welding shall be allowed after hydrostatic testing has been completed.

3.11 Supplemental Requirements

A. The Contractor shall submit the Vendor’s schedule showing the complete plan for drawing submittal, manufacturing, testing and delivery to site. This schedule shall include hold points pertaining to the entire Work.

B. The Engineer reserves the right to enter the Contractor’s, Vendor's, or any Subcontractor's facility, at any time, with 48 hours prior written notice, for verification of Work. The Engineer shall have the right to reject any and all materials or order the rework of any and all parts and components not meeting these Specifications at no additional cost to the Owner.

C. The Contractor shall provide the Engineer with all Vendor inspection records, laboratory certificates and any other documentation deemed by the Engineer to be required for verification of materials used or work done. The Contractor shall keep Vendor’s records of chemical and physical mill certifications for all materials. These records shall be made available to the Engineer and Owner, upon request.

D. The Contractor or Vendor shall be responsible for the inspection, Quality Assurance and Quality Control of the all the Vendor’s work. The Engineer reserves the right to supplement and amend the Contractor’s or Vendor's Quality Control program if determined necessary at any time.

E. Certification of all levels of personnel is the responsibility of the Vendor. A Vendor who purchases outside services is responsible for assuring that training and examination services are in accordance with the Vendor’s written practices and these Specifications.

3.12 Repair of Defects

A. All defect repair procedures require written approval by the Engineer.

B. Defects are to be reported to Engineer as soon as they are identified.

C. HDPE pipe repairs and defects:

1. Items that contain defects shall be rejected or repaired. Such injurious defects include defects that reduce the mechanical properties, such as internal or external surface gouges, scars, scratches, blisters, or discontinuities that produce a notch effect or reduce the specified pipe wall thickness by 10% or more.

2. The Contractor shall mark all bonds that have been examined and accepted inspected per the pipe manufacturer’s recommended inspection method. All bonds requiring repair shall be marked as defective. When a repaired bond is subsequently accepted, it shall be marked over with green paint signifying its acceptance. The marking shall be done in such a manner so as to enable the Quality Assurance Team, Engineer, and Contractor to determine the status of the bonds on the pipeline.

3. All repairs made to defects shall be re-inspected using the same inspection methods recommended by the pipe manufacturer.

4. Butt-heat-fusion welds that do not meet the acceptance criteria as noted in these Specification, Manufacturer's recommendations, or any Code shall be completely removed. All butt-heat-fusion welds are subject to visual inspection.

*****END OF SECTION*****

SECTION 02775
GEOMEMBRANES

1.0 GENERAL

1.1 Summary

A. This Section describes requirements for the manufacture and installation of geomembrane liner materials for the tailings storage facility.

B. The Work includes furnishing all labor, tools, equipment, and supervision required to install the geomembrane in accordance with the Drawings and these Specifications.

1.2 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Control/Assurance

C. Section 01500 – Testing Laboratory Services

D. Section 02205 – Fill Materials

E. Section 02211 – Rough Grading

F. Section 02223 – Filling

G. Section 02273 – Geonet

H. Section 02350 – Geosynthetic Clay Liner

1.3 References

A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Society for Testing and Materials (ASTM)

a. ASTM D 792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

b. ASTM D 882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting

c. ASTM D 1004 – Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting

d. ASTM D 1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique

e. ASTM D 1603 – Standard Test Method for Carbon Black in Olefin Plastics

f. ASTM D 1790 – Standard Test Method for Brittleness Temperature of Plastic Sheeting by Impact

g. ASTM D 3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry

h. ASTM D 4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

i. ASTM D 4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

j. ASTM D 5199 – Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

k. ASTM D 5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

l. ASTM D 5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembrane Using Notched Constant Tension Load Test

m. ASTM D 5596 – Standard Test Method Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

n. ASTM D 5721 – Standard Practice for Air-Oven Aging of Polyolefin Geomembranes

o. ASTM D 5885 – Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Colorimetry

p. ASTM D 5994 – Standard Test Method for Measuring Core Thickness of Textured Geomembrane

q. ASTM D 6392 – Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

r. ASTM D 6693 – Standard Test Method Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

s. ASTM 7003 - Standard Test Method for Strip Tensile Properties of Reinforced Geomembranes

2. Geosynthetic Research Institute (GRI):

a. GM10 – Specification for Stress Crack Resistance of Geomembrane Sheet

b. GM13 – Test Properties, Testing Frequency, and Recommended Warranty for HDPE Smooth and Textured Geomembranes

c. GM19a – Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.4 Submittals Prior To Construction

A. The Geomembrane Installation Contractor shall provide the following information to the Owner prior to mobilization:

1. Manufacturer information including; company name, address, telephone number, the names of the company president and quality control manager, and narrative of the company history. Additional information required includes factory size and production capability.

2. Quality Control Manuals from the Manufacturer and Geomembrane Installation Contractor for the installation and testing of the geomembrane, including trial seams, seaming, nondestructive testing, destructive testing procedures, repair procedures and in-field quality control forms. Upon review of the Quality Control Manuals, the Owner may request additional testing during the manufacturing process at no additional cost to the Owner.

3. A list of at least five completed facilities from the Manufacturer totaling a minimum of 5,000,000 square feet of the type of geomembrane that is being installed for this project. Each entry in this list should specify the name and purpose of the facility, its location and date of installation, the name of the Owner, the project manager, designer, fabricator (if any), and Geomembrane Installation Contractor and the name and telephone number of the contact at the facility who can discuss the project. In addition, the geomembrane thickness and total square footage of the installation surface should be included.

4. A list of at least five completed facilities, totaling 5,000,000 square feet for which the Geomembrane Installation Contractor has installed the type of geomembrane that is being installed for this project. For each installation, the following information shall be provided:

a. Name and purpose of facility, its location, and date of installation

b. Name of Owner, design engineer, manufacturer, fabricator, if applicable, and name and telephone number of the contact at the facility who can discuss the project

c. Geomembrane type and surface area of the installed geomembrane

d. Type of seaming, patching, and tacking equipment

e. A copy of the Manufacturer’s and/or fabricator's approval letter(s) and/or license(s), if applicable

f. applicable

B. The Geomembrane Installation Contractor shall provide the following information 14 days prior to geomembrane arrival on-site and prior to commencement of the Work:

1. A copy of each of the Quality Control Certificates on each lot of resin issued by the resin Supplier for the specific material at this project including certification of the resin for extrusion welding.
2. The results of Quality Control testing conducted by the Manufacturer on the resin used in manufacturing the specific material for this project.
3. A listing that correlates the resin to the individual geomembrane rolls and welding rods.
4. A copy of the geomembrane roll Quality Control Certificates. These certificates shall be supplied at a minimum frequency of one per every 50,000 square feet of geomembrane material produced. These certificates shall be issued only for the individual geomembrane rolls sampled and tested by the Manufacturer or its representative. The certificates shall contain test results of properties outlined in Article 2.1 of this Section. The Engineer reserves the right to refuse use of any geomembrane supplied without the proper quality control documentation at no cost to the Owner.
5. A detailed list of performance criteria for the geomembrane material being produced for this project. (Note: Performance criteria are sometimes referred to as "minimum property values". Refer to Articles 2.1 of this Section for geomembrane properties and Test Methods).
6. Resumes from the Geomembrane Installation Contractor of the Installation Superintendent, Master Seamer, and Quality Control Inspector to be assigned to the work, including dates and duration of employment.
7. Certification from the Geomembrane Installation Contractor that Installation Supervisor, Quality Control Inspector, and Master Seamer have reviewed the Specifications, Construction Quality Assurance Plan, and the Drawings.
8. A panel layout drawing showing the proposed installation layout identifying field seams and including areas such as sumps, trenches and pipe penetrations as well as any variance or additional details that deviate from the Drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc. Any proposed variance or deviation from these documents shall be submitted to the Engineer in writing a minimum of seven working days prior to the scheduled start of geomembrane installation and shall be accepted/rejected by the Engineer prior to start of installation.
9. A list of personnel performing field seaming operations along with pertinent experience information.
10. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

C. The Geomembrane Installation Contractor shall provide the following information daily to the Engineer during the course of the work:

1. Summaries of geomembrane panel deployment, field test seams, fusion and extrusion seams, extrusion seam repairs, nondestructive seam tests, seam pressure tests, defects and repairs, and seam destructive samples and test results recorded during installation.
2. Daily reports detailing arrival and departure times, the personnel present on-site, the progress of the Work, the arrival of materials, and any problems encountered.
3. Geomembrane record drawings identifying the panels, seams, and test locations. The Quality Control Inspector’s geomembrane record drawing shall be made available for review by the Engineer at any time during the day.
4. Subgrade surface acceptance certificates for each area to be covered by the lining system, signed by the Geomembrane Installation Contractor.
5. It is the Quality Control Inspector’s responsibility to ensure that the documentation is checked for errors and conflicts prior to submitting the documentation to the Engineer. The daily field documentation and record drawings shall be completed in a neat and professional manner.

1.5 Submittals After Construction

A. At the completion of the Work, the Geomembrane Installation Contractor shall submit the Quality Control Documentation outlined in Section 01300 and shall include at a minimum:

1. Typed summary tables of the field documentation including summaries of on-site field personnel, geomembrane panel deployment, field test seams, fusion and extrusion seams, extrusion seam repairs, nondestructive seam tests, seam pressure tests, defects and repairs, and seam destructive samples and test results recorded during installation.
2. A geomembrane record drawing showing panels and destructive test locations. The record drawing shall be drawn on a 22-inch by 34-inch sheet and in AutoCAD .dwg electronic format.
3. The summary tables and record drawings shall be suitable for report presentation and agency review. One (1) digital reproducible copy of the summary tables and record drawings shall be provided to the Engineer.

1.6 Quality Control

A. The geomembrane Manufacturer shall have the following qualifications:

1. Experience in the manufacture of the type of geomembrane that is being installed for this project totaling at least five completed facilities totaling a minimum of 5,000,000 square feet.
2. Sufficient production and qualified personnel to meet the demands of the work and shall have an internal quality control program for its product.
3. Shall permit the Quality Assurance Team, Engineer, or their authorized representatives to visit the manufacturing plant.

B. The Geomembrane Installation Contractor shall have the following qualifications:

1. The Manufacturer or an approved Geomembrane Installation Contractor trained and certified to install the Manufacturer's geomembrane.
2. Installation shall be performed under the constant direction of a single Installation Superintendent who shall remain on-site and be responsible, throughout the geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs, and all other installation activities related to geomembrane installation.
3. The Installation Superintendent shall have installed or supervised, at a minimum three installation projects that entailed the installation of at least a total of 1,000,000 square feet of the type of geomembrane that is being installed for this project.
4. Actual seaming shall be performed under the direction of a Master Seamer who has seamed a minimum of 1,000,000 square feet of the type of geomembrane that is being installed for this project, using the same type of seaming equipment specified for the Work.
5. The Installation Superintendent and/or Master Seamer shall be present whenever seaming is performed.

C. All Work shall be constructed, monitored, and tested in compliance with the requirements of these Specifications. The Geomembrane Installation Contractor and Manufacturer shall participate in and comply with all items in these Specifications.

D. The Geomembrane Installation Contractor shall ensure that geomembrane material supplied to this project has an internal product quality control program that meets Specifications.

E. During manufacturing of the geomembrane, samples of geomembrane shall be removed for laboratory conformance testing to ensure compliance with these Specifications. Conformance sampling and testing shall be performed by the Quality Assurance Team in accordance with Article 3.11 of this Section.

F. The Contractor shall assure that the geomembrane is delivered to the site at least 14 calendar days prior to installation. The Contractor shall provide required Quality Control information to the Quality Assurance Team and the Engineer 14 calendar days prior to geosynthetics being delivered to this project and on delivery of geosynthetics to the project site.

G. Geomembrane rolls that do not meet the requirements of this Specification shall be rejected. The Contractor shall replace the rejected material with new material that conforms to the Specification requirements, at no additional cost to the Owner.

H. The Geomembrane Installation Contractor shall ensure that all personnel performing geomembrane seaming operations are qualified by experience or by successfully passing seaming tests in accordance with Article 3.7 of this Section. The Engineer reserves the right to reject any welding technician whose performance is unsatisfactory.

I. The Geomembrane Installation Contractor's Installation Superintendent and QC Inspector shall attend the pre-construction meeting.

J. The Geomembrane Installation Contractor shall perform Quality Control during geomembrane installation in accordance with the Quality Control Manual.

K. Field Samples

1. Geomembrane sampling and testing shall be conducted in accordance with the project Specifications for the following:
    a. Trial seam testing (Article 3.7 of this Section)
    b. Non-destructive seam testing (Article 3.8 of the Section)
    c. Destructive seam testing (Article 3.9 of this Section)
2. The Geomembrane Installation Contractor shall maintain on-site a minimum of one spare operable tensiometer and provide documentation indicating that all tensiometers used at the project were calibrated within 60 days prior to the tensiometer arriving on-site for testing field samples.

L. In order to prevent wind damaged geomembrane from being placed, the following Quality Control procedures shall be followed:

1. The Geomembrane Installation Contractor shall utilize sufficient ballast as necessary to prevent wind uplift of the geomembrane panels.
2. If wind damage should occur, the Engineer shall determine if the geomembrane shall be repaired or replaced. Wind damage to the geomembrane shall include wrinkles, creases, and tears, as determined by Engineer.
3. Repair or replacement of the wind-damaged geomembrane shall be completed by the Geomembrane Installation Contractor at no additional cost to the Owner.
4. As determined by the Engineer, the geomembrane panel may be rejected at no cost to the Owner.

M. In order to prevent thermal stress damage to installed geomembrane, the following Quality Control procedures shall be followed:

1. The Geomembrane Installation Contractor shall perform its Work and utilize sufficient slack as necessary for temperature compensation to prevent bridging or trampolining of the installed geomembrane.
2. If bridging or trampolining should occur, the Engineer shall determine if the geomembrane shall be repaired or replaced.
3. Repair or replacement of the bridging or trampolining geomembrane shall be completed by the Geomembrane Installation Contractor at no additional cost to the Owner.

1.7 Delivery, Storage, and Handling

A. Packing and Shipping

1. Labels on each roll delivered to site shall identify the following:
    a. Manufacturer’s Name
    b. Product Identification

c. Thickness

d. Roll number

e. Batch or resin lot number

f. Panel number (when applicable)

g. Roll dimensions

h. Roll weight

2. The Geomembrane Installation Contractor shall ensure that geomembrane rolls are properly loaded and secured to prevent damage during transit in accordance with the Manufacturer's recommendations.

3. The Geomembrane Installation Contractor shall protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions in accordance with Manufacturer's recommendations.

4. The Geomembrane Installation Contractor shall ensure personnel responsible for loading, transport, and unloading of geomembrane are fully aware of the consequences of damage to geomembrane and are familiar with handling and transport constraints in accordance with the Manufacturer's recommendations.

5. Geomembrane shall be supplied in rolls with straps for unloading.

B. Acceptance at Site

1. The Quality Assurance Team or Engineer shall perform inventory and surface inspection for defects and damage of all geomembrane rolls upon delivery.

2. The Geomembrane Installation Contractor shall unroll and inspect any geomembrane roll that may be damaged below the outer surface of the roll.

3. The Geomembrane Installation Contractor shall repair damage resulting from handling and transport of geomembrane at no additional cost to the Owner. If irreparable, in the opinion of the Quality Assurance Team or the Engineer, damaged materials shall be replaced at no additional cost to the Owner.

C. Storage and Protection

1. The Owner shall provide area for on-site storage of the geomembrane rolls from time of delivery until installation.

2. The storage and handling of the materials is the responsibility of the Geomembrane Installation Contractor from the time the materials are manufactured until the time the completed installation is accepted by the Engineer. The Geomembrane Installation Contractor is responsible for preparing the storage location and for the protection of the materials from the elements (e.g. ultraviolet light, moisture, temperature, etc.).

3. The rolls shall be stored on a prepared continuous surface free of large protrusions (e.g. not wooden pallets) and should not be stacked more than two rolls high. Proper blocking shall be used to prevent rolls from moving (e.g. tire chocks).

4. After the Geomembrane Installation Contractor has removed material from storage, the Geomembrane Installation Contractor shall protect geomembrane from puncture, dirt, grease, water, moisture, mud, mechanical abrasion, excessive heat and other sources of damage.

5. The Geomembrane Installation Contractor shall preserve integrity and readability of the geomembrane roll labels and store the rolls such that the Engineer has access to the package slips or roll labels for each roll to verify roll acceptance.

1.8 Site Conditions

A. Geomembrane Deployment

1. Do not proceed with deployment at an ambient temperature below 14ºF or above 100ºF unless otherwise authorized, in writing, by the Engineer.
2. Do not deploy during precipitation, in the presence of excessive moisture (e.g. fog, dew, frost, rain, snow, sleet, hail), in an area of ponded water, or in the presence of excessive winds.
3. Do not undertake deployment if weather conditions shall preclude material seaming on same day as deployment.

B. Seaming

1. Normal Weather Conditions. Normal seaming procedures may take place if the following weather conditions exist:

a. Ambient temperature between 35ºF and 100ºF

b. Dry conditions, i.e., no precipitation or other excessive moisture, such as fog, dew, rain, snow, sleet, or hail

c. No excessive winds

2. Adverse Weather Conditions

a. Do not seam if ambient temperature is below 14ºF or above 102ºF

b. Do not seam during precipitation, in the presence of excessive moisture (e.g. fog, dew, frost, rain, snow, sleet, hail), in an area of ponded water, in the presence of excessive winds

c. If the ambient air temperature is between 14ºF and 35ºF for the entire shift, the following Cold Weather Seaming provisions shall govern:

i. In accordance with these Specifications, trial seaming shall be conducted under the same ambient temperature and condition as the production seams. A minimum of four trial seams for each welding apparatus shall be required during the shift, at approximately the same time interval throughout the scheduled work day; additional trial seams may be required, at the discretion of the Quality Assurance Team or Engineer.

ii. If the subgrade is frozen, geomembrane rub-sheets will be placed between the liner and the subgrade during fusion welding of the seams.

iii. It may be necessary for the Geomembrane Installation Contractor to pre-heat the liner using a hand-held leister type device during field seaming. If this procedure is used, a trial seam for each welding apparatus shall be performed using the same technique.

iv. Destructive testing for peel adhesion shall be conducted at the beginning and end of each extrusion welded seam in excess of 25 feet. The coupon sample shall exhibit a film tear bond (FTB) type of failure and may be pulled by hand by the welding technician using vice grip pliers. The testing shall be witnessed by the Quality Assurance Team.

v. Destructive testing frequencies may be increased at the discretion of the Quality Assurance Team and/or the Engineer.

vi. Air testing/vacuum testing of the seams/patches shall be performed on the same day as the welding, to ensure any potential problems are identified as early as possible.

vii. All patches shall be completed by the end of shift.

2.0 PRODUCTS

2.1 Materials

A. The geomembrane shall be 60-mil smooth and 80-mil double sided textured high-density polyethylene (HDPE) as shown in the Drawings. The geomembranes shall be manufactured of new, first-quality resin produced in the United States and shall meet or exceed all manufacturing requirements and recommendations for HDPE geomembranes specified by the American Society for Testing and Material (ASTM) and the Geosynthetics Research Institute (GRI).

B. All geomembrane shall be manufactured by the same manufacturer using the same resin compound or mixture. Geomembrane from more than one manufacture for each phase of Work shall not be permitted unless approved by the Engineer. If geomembrane between phases is of different manufacturing origin, prior to installation, documentation shall be provided to the Engineer showing that welds between both manufacturers' geomembrane meet the minimum requirements of these Specifications for seaming.

C. The geomembrane sheet shall be comprised of a minimum 96 percent pure polyethylene. The remaining portion shall be made up of materials necessary for the performance of the liner (such as carbon black, anti-oxidants, etc.) The geomembrane rolls shall meet the following Specifications:

1. The surface of the geomembrane shall not have striations, roughness (except texture as specified), pinholes, or bubbles and shall be free of holes, blisters, undispersed raw materials, or any contamination by foreign matter. The Engineer may request additional testing in order to support such acceptance. All such testing shall be done at the sole expense of the Geomembrane Installation Contractor.

2. The geomembrane supplied for the project shall meet or exceed the minimum values and testing requirements:

Table 02775-1: Required Minimum Geomembrane Properties for Textured HDPE Geomembrane (per GRI-GM13)

Property	Test Value		Test Method	MQC Testing Frequency
	60 mil	**80 mil**		
Thickness mils (min avg.)	57 mil	76 mil	ASTM D 5994	Per Roll
Thickness (Minimum 8 of 10)	-10% (54 mil)	-10% (72mil)		
Lowest individual for any of the 10 values	-15% (51 mil)	-15% (68 mil)		
Asperity Height	16 mil	18 mil	ASTM D 7466	Every 2nd Roll(1)
Density (g/cc) min.	0.940	0.940	ASTM D 1505/ D 792	200,000 lb
Tensile Properties (min. avg.)(2)				
Yield Strength (lb/in)	126	168	D 6993 Type IV	20,000 lb
Break strength (lb/in)	90	120		
Yield Elongation (%)	12%	12%		
Break Elongation (%)	100%	710%		
Tear Resistance (lbs) (min. ave)	42	56	D 1004	45,000 lb
Puncture Resistance (lbs) (min. ave)	90	120	D 4833	45,000 lb
Stress Crack Resistance (3)	500 hr	500 hr	D 5397	Per GRI GM-10
Carbon Black Content (%)	2.0-3.0	2.0-3.0	D 4218	20,000 lb
Carbon Black Dispersion (5)	*Note 5*	*Note 5*	D 5596	45,000 lb
Oxidative Induction Time (OIT)				
a. Std OIT, or	100 min	100 min	D 3895	200,000 lb
b. High Pressure (HP) OIT	400 min	400 min	D 5885	
Oven Aging at 85°C (min. avg.)(6),(7)			D 5721	Per Each Formulation
a. Std OIT (% ret. after 90 days) min. avg. or;	55%	55%	D 3895	
b. HP OIT (% ret. after 90 days) min. avg.	80%	80%	D 5885	
UV Resistance (min avg.)(8)			D 7238	Per Each Formulation
a. Std. OIT (min. avg.), or	N.R.	N.R.	D 3895	
b. HP OIT (min. avg.) (% ret. after 1600 hrs) (9)	50%	50%	D 5885	

*MQC = Manufacturing Quality Control

Notes:

1. Alternate measurement side for double sided textured sheet.
2. Machine direction and cross machine direction average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gage length of 33 mm. Break elongation is calculated using a gage length of 50 mm.
3. The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the Manufacturers mean value via MQC testing.
4. Other methods such as D 1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
5. Carbon Black Dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
6. The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.
7. Evaluate samples at thirty (30) and sixty (60) days and compare with the ninety (90) day response.
8. The condition of the test shall be a twenty (20) hour UV cycle at 75 degrees C followed by a four (4) hour condensation cycle at 60 degrees C.
9. UV Resistance is based on percent retained values regardless of the original HP-OIT value.

D. Seam Properties: The finished seams shall meet or exceed the values specified in the following table.

Table 02775-2: HDPE Geomembrane Seam Properties Wedge and Extrusion Welds (per GRI-GM19a)

Property	Test Value for 60 mil HDPE	Test Value for 80 mil HDPE	Test Method	MQC Testing Frequency
Seam Shear Strength lb/in	120	160	ASTM D6392	500 LF
Shear elongation at break %	50	50		500 LF
Seam Peel Strength (lb/in)	91 for hot wedge 78 for extrusion	121 for hot wedge 104 for extrusion		500 LF
Peel separation %	25	25		500 LF

Notes:

1. Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area. Failures in Non-FTB mode are allowed if the failure is classified as “AD-BRK” and the strength at failure exceeds the listed value.
2. Where applicable, both tracks of a double hot wedge seam shall be tested for peel adhesion.
3. Value listed for shear and peel strengths are for 4 out of 5 test specimens, the 5th specimen can be as low as 80 percent of the listed value.

E. Stainless steel clamps shall be used to fasten pipe to the polyethylene pipe boot (if any) as shown on the Drawings. The stainless steel clamps shall be approved by the Engineer prior to their installation.

2.2 Seaming and Test Equipment

A. Seaming:

1. Approved field seaming processes are hot shoe double fusion welding and extrusion welding, when approved by the Engineer. Use double fusion welding as primary method of seaming adjacent field panels.
2. The Geomembrane Installation Contractor shall maintain on-site a minimum of two spare operable seaming apparatuses.
3. Seaming equipment shall not damage the geomembrane.
4. The Geomembrane Installation Contractor may use a hot air device ("Leister") to temporarily bond geomembrane panels that are to be extrusion welded.
5. The Geomembrane Installation Contractor shall use extrusion welding apparatus equipped with gauges giving temperature of preheat and extrudate at nozzle of apparatus.

6. Welding rods or beads used for extrusion welding shall have the same physical properties as that used for the resin used in the manufacture of the type of geomembrane that is being installed for this project.
7. The Geomembrane Installation Contractor shall use fusion welding apparatus which are self-propelled devices equipped with a gauge indicating temperature of heating element, and a gauge indicating the speed of the welding apparatus.

B. Vacuum Testing (for extrusion seam only)

1. The equipment shall consist of the following:

a. Vacuum box assembly consisting of a rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing or port hole and valve assembly, and vacuum gauge.

b. Pump assembly equipped with pressure controller and pipe connections.

c. Rubber pressure/vacuum hose with fittings and connections.

d. Bucket of soapy solution.

e. Wide paint brush, or other means of applying soapy solution.

C. Air Pressure Testing (for double fusion seam only)

a. The equipment shall consist of the following:

b. Air pump (manual or motor driven), equipped with a pressure gauge, capable of generating, sustaining, and measuring pressure between 25 and 30 pounds per square inch (psi) and mounted on a cushion to protect geomembrane.

c. Rubber hose with fittings and connections.

d. Sharp hollow needle, or other approved pressure feed device.

e. An air pressure monitoring device.

3.0 EXECUTION

3.1 Subgrade

A. The Geomembrane Installation Contractor, on a daily basis, shall certify in writing that the surface on which the geomembrane shall be installed is acceptable. It shall be the Geomembrane Installation Contractor's responsibility to maintain and protect the subgrade in the condition that was originally accepted, prior to geosynthetic deployment until accepted by the Owner and Engineer.

3.2 Acceptance

A. The Geomembrane Installation Contractor shall retain all Ownership and responsibility for the geomembrane until final acceptance.

B. The geomembrane shall be accepted by the Owner and Engineer when all of the following conditions are met:

1. Installation is finished.
2. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
3. Certification, including QC documentation is provided by the Geomembrane Installation Contractor to the Engineer.
4. Recommended acceptance by the Engineer.

3.3 Anchor Trench

A. The anchor trenches shall be excavated to the lines, grade, and width shown on the Drawings, prior to geosynthetic placement. The Engineer shall verify that the anchor trench has been constructed according to the Drawings.

B. Slightly rounded corners shall be provided in the trench where the geomembrane adjoins the trench so as to avoid sharp bends in the geomembrane.

C. The anchor trench shall be backfilled and compacted in accordance with Section 02223 and as approved by the Engineer. Anchor Trench Backfill material shall be placed in 12-inch thick loose lifts and compacted by wheel rolling with light, rubber-tired or other light compaction equipment, as approved by the Engineer.

D. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. At no time shall construction equipment come into direct contact with the geomembrane. If damage occurs, it shall be repaired by the Geomembrane Installation Contractor prior to the completion of backfilling, at no additional cost to the Owner.

E. Extend geomembrane into the anchor trench as shown in the Drawings. The geomembrane shall be seamed along its entire length within the anchor trench.

3.4 Protection

A. The Geomembrane Installation Contractor shall be responsible for the following:

1. Do not use equipment or tools which may damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.
2. Ensure prepared surface underlying geomembrane has not deteriorated since previous acceptance, and remains acceptable until acceptance by the Owner, as detailed in Article 3.2 of this Section.
3. Keep any geotextile elements immediately underlying the geomembrane clean and free of debris.
4. Personnel shall not be permitted to smoke or wear damaging shoes while working on geomembrane.
5. Unroll panels in a manner which prevents scratches or crimps in geomembrane and does not damage supporting soil.
6. Place panels in a manner that prevents wrinkles (especially differential wrinkles between adjacent panels).
7. Prevent wind uplift and damage to geomembrane subgrade by providing temporary and permanent loading and/or anchoring that shall not damage geomembrane.
8. Prevent bridging of installed geomembrane by providing adequate slack.
9. Minimize direct contact of equipment and personnel with geomembrane.
10. Protect geomembrane in areas where excessive traffic is expected with geotextile, extra geomembrane, or other materials acceptable to the Engineer.

3.5 Field Panel Development

A. The Geomembrane Installation Contractor shall install field panels at locations indicated on the Geomembrane Installation Contractor's layout plan, as approved by the Engineer.

B. The Geomembrane Installation Contractor shall replace damaged (i.e., torn, twisted, or crimped) field panels, or portions thereof, at no cost to the Owner. The Geomembrane Installation Contractor shall repair less serious damage according to Article 3.10 of this Section, at no cost to the Owner. The Engineer shall determine if material is to be repaired or replaced.

C. The Geomembrane Installation Contractor shall remove damaged panels, portions of damaged panels, and other geomembrane scrap.

D. Geomembrane Installation Contractor shall not deploy more geomembrane field panels in one day than can be seamed during the day of deployment.

E. Geomembrane deployment shall proceed between ambient temperatures of 14º F to 102º F. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew) or in the presence of excessive winds, as determined by the Engineer.

F. Following the installation of the geomembrane, an examination of the entire surface shall be conducted to detect potentially harmful objects. Any such objects shall be removed and the geomembrane repaired by the Geomembrane Installation Contractor, at no cost to the Owner.

3.6 Factory Seams

A. The Engineer may require the Geomembrane Installation Contractor to test up to as much as 20 percent of factory fusion welds (non-destructive air pressure test) in the field to verify factory test results. Additional testing at Geomembrane Installation Contractor's expense shall be required if failed tests are obtained in the field.

3.7 Field Seams

A. Seam Layout

1. Seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

2. No horizontal or base T-seam or tie-in seams shall be closer than 5 feet from the toe or crest of the slope. Seams shall be aligned to prevent wrinkles and "fish mouths". If a fish mouth or wrinkle is found, it shall be relieved and capped.

3. The previous phase geomembrane shall be cut adjacent to the existing anchor trench and double fusion welded to the new geomembrane in accordance with the Design Drawings.

4. Panels of geomembrane shall have sufficient overlap provided to allow peel tests to be performed on the seam.

B. Seaming Method

1. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

2. The Geomembrane Installation Contractor shall use double fusion welding as primary method of seaming adjacent field panels.

a. For cross seam tees associated with fusion welding, the Geomembrane Installation Contractor shall patch panel intersections consisting of three or more panels and extrusion weld to a minimum distance of 4 inches on each side of patch. The edge of the sheet shall be ground to a 45º angle prior to welding.

b. Place a protective layer, e.g., insulting plate or fabric, beneath hot welding apparatus after usage.

c. When subgrade conditions dictate, use a moveable protective layer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent debris from collecting around pressure rollers.

d. Remove seaming sheets and excess geomembrane trimmed to provide required overlap.

3. Use conventional extrusion welding as a secondary method for seaming between adjacent panels and as a primary method of welding for detail and repair work.

a. Purge heat-degraded extrudate from barrel of extruder under the following conditions:

i. Prior to beginning a seam.

ii. Whenever extruder has been inactive.

b. Place a smooth insulating plate or fabric beneath hot welding apparatus after usage

i. Use clean and dry welding rods or extrudate pellets.

ii. Complete grinding process without damaging geomembrane according to Manufacturer's instructions no more than one hour prior to seaming operations.

iii. Prevent exposed grinding marks adjacent to an extrusion weld. Do not extend exposed grinding marks more than 1/4 inch from seam area. The Engineer may request that any and all abraded areas be covered with extrudate.

iv. Extrusion weld all cross seam tees to a minimum distance of 4 inches on each side of the tee.

v. For extrusion welds, the edge of the top sheet shall be beveled by grinding the edge of the sheet to approximately a 45 degree angle. Extrusion welds cannot be placed on previous extrusion welds.

C. Seaming Procedures

1. General Seaming Procedures

a. Areas to be seamed shall be cleaned and free of moisture, debris, or any marking on the geomembrane.

b. Use a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support if required.

c. Cut fish mouths or wrinkles at the seam overlap along the ridge of the wrinkle in order to achieve a flat overlap. The cut fish mouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

d. Extend seaming to the outside edge of panels placed in the anchor trench.

e. Do not field seam without the Seaming Supervisor present.

D. Field Trial Seams

1. Trial seams shall be conducted at the beginning of each seaming period and within 30 minutes of commencement of seaming, at the Engineer's discretion, and immediately following any work stoppage (i.e., lunch, weather conditions, etc.) of 30 minutes or more for each seaming apparatus used that day. Each Seamer shall make at least one trial seam each day.

2. Testing shall include visual observation of a trial seam on the geomembrane material. The Geomembrane Installation Contractor shall mark the trial seam with date, ambient air temperature, welding machine number, welding technician identification, and machine temperature and speed. For extrusion welding, the Geomembrane Installation Contractor shall include the nozzle and extrusion settings and welding technician identification. The remainder of trial seam should be cut in two pieces; one to be retained in the Owner's archive; and one to be retained by the Geomembrane Installation Contractor.

3. All trial seams shall be made at a location selected by the Engineer in the area of the seaming and in contact with the subgrade. The trial seam samples shall be a minimum of 5 feet long for fusion seaming and a minimum of 5 feet long for extrusion seaming, with the seam centered lengthwise. Specimens one inch wide shall be cut from opposite ends of the test seam by the Geomembrane Installation Contractor. The Geomembrane Installation Contractor shall use a tensiometer to test these specimens for shear and peel. Both inside and outside tracks of fusion welds shall be tested for peel. For both fusion and extrusion welds, two coupons shall be tested for peel and one coupon for shear. The tensiometer shall have a grip separation of 4 inches plus the width of the seam. The seam is to be centered between the clamps. These tests shall not fail according to the criteria in Article 2.1 of this Section. A break through the weld or at the weld/sheet interface shall be considered a failure in both shear and peel strength tests unless the weld strength exceeds the minimum strength, as discussed in Article 3.9 of this Section. If a trial seam fails to meet field seam

Specifications, the seaming apparatus and/or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

4. The Geomembrane Installation Contractor shall mark the test weld with date, ambient temperature, welding machine number, welding technician identification, machine temperature and speed. For extrusion welding, the Geomembrane Installation Contractor shall record the nozzle and extrusion settings.
5. The Geomembrane Installation Contractor shall cut remainder of successful trial seams into two pieces, one to be retained in the Owner's archives and one to be retained by Geomembrane Installation Contractor

3.8 Non-Destructive Testing

A. The Geomembrane Installation Contractor shall non-destructively test all field seams over their full length. All test equipment shall be furnished by the Geomembrane Installation Contractor.

B. The following vacuum box procedures are applicable to extrusion seaming and shall be followed by the Geomembrane Installation Contractor:

1. Clean the vacuum box window, gasket surfaces and check for leaks.
2. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.
3. Wet a strip of geomembrane the approximate dimensions of the vacuum box with the soapy solution.
4. Place the box over the wetted area and compress.
5. Close the bleed valve and open the vacuum valve.
6. Ensure that a leak-tight seal is created.
7. For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
8. If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap and repeat the process.
9. All areas where soap bubbles appear shall be marked and repaired and then retested.
10. Test locations, documentation number, date and tester shall be indicated with an indelible marker on the geomembrane for each repair or seam section. The color code for indelible markers is to be determined at the pre-construction meetings, and strictly adhered to.

C. The following nondestructive test procedures are applicable to fusion seaming and shall be followed by the Geomembrane Installation Contractor:

1. Seal one end of the seam to be tested.
2. Insert needle or other approved pressure feed device through the sealed end of the channel created by the double wedge fusion weld.
3. Energize the air pump to verify the unobstructed passage of air through the channel.
4. Seal the other end of the channel.
5. Energize the air pump to the pressure of approximately 30 psi, close valve, and sustain pressure for approximately 5 minutes.
6. If loss of pressure exceeds 3 psi, or pressure does not stabilize, locate faulty area, repair and retest.
7. Remove needle or other approved pressure feed device.
8. Repair pressure test locations as described in Article 3.10 of this Section.

9. Beginning and ending pressures and times, test locations, documentation number, date and tester shall be indicated with an indelible marker on the liner at each test interval location.

D. The following procedures shall apply to locations where seams cannot be non-destructively tested, as determined by the Engineer:

1. If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.

2. If the seam cannot be tested prior to final installation, the seaming operations shall be observed by the Engineer for uniformity and completeness.

E. In the event that seam continuity cannot be demonstrated for a non-destructive test of a fusion seam as outlined above, the Geomembrane Installation Contractor shall perform the non-destructive testing over smaller areas as a means of defining the questionable area, and shall:

1. Extrusion weld the outside edge of the questionable seam area and vacuum box test the extrusion weld, or

2. Cap the questionable area and vacuum test the cap.

3.9 Destructive Testing

A. The Geomembrane Installation Contractor shall test a minimum of one destructive test sample per 500 feet of seam length per welding machine from a location specified by the Engineer. The Geomembrane Installation Contractor shall not be informed in advance of the sample location. The samples shall be taken centered over the seam and prioritized as follows:

1. All areas identified as suspect during seaming, non-destructive testing/monitoring, and in unusual working conditions.

2. A minimum of one sample for each geomembrane seamer.

3. A minimum of one sample every 500 feet of seaming.

B. Samples shall be cut by the Geomembrane Installation Contractor as the seaming progresses. Sampling locations shall be determined by the Engineer. The Engineer must witness the obtainment of all destructive test samples by the Geomembrane Installation Contractor. All samples shall be marked with their seam number, date, welding machine number, welding technician identification, extruder and nozzle/wedge temperature, and ambient air temperature. The Geomembrane Installation Contractor shall document the date, time, roll and seam number, ambient temperature, and pass or fail description. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired. All patches shall be vacuum tested.

C. The samples shall be a minimum 12 inches wide by 24 inches long with the seam centered lengthwise. The sample shall be cut into two equal length pieces, half to be given to the Owner for archiving and the other kept by the Geomembrane Installation Contractor for testing.

D. Geomembrane Installation Contractor shall cut and test ten (10) one-inch (1”) wide specimens from his sample. All testing shall be conducted at room temperature (60ºF to 80ºF). The Geomembrane Installation Contractor shall test five (5) specimens for seam shear strength and five (5) for peel strength. Both inside and outside tracks of fusion seams shall be tested for peel strength. To be acceptable, four (4) out of the five (5) specimens must pass according to criteria established in Article 2.1 of this Section. Any specimen that fails through the weld or at the weld/sheet interface shall be considered a failure, unless the weld strength exceeds the minimum strength specified in Table 02775-2, as discussed Article 2.1. The tensiometer shall have a grip separation of 4 inches plus the width of the seam. The seam is to be centered between the clamps.

E. The Engineer must witness the testing of all destructive samples. Destructive tests shall be performed within two (2) days of the samples being obtained.

F. Failing tests shall be subjected to additional testing until a passing area is found. A passing area is defined as a seam(s) bounded at each end by a passing destructive test. Seams shall be tracked in each direction until a passing destructive test is found or until a previous passing destructive test is

reached. Seams shall be tracked according to the welding apparatus and the machine operator. The following procedures shall apply whenever a sample fails the field destructive test:

1. The Geomembrane Installation Contractor can retrace the welding path to an intermediate location (at a minimum of 10 feet from the location of the failed test), at the Engineer's discretion, and take a small sample for an additional field test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, the process shall be repeated.
2. Over the length of seam failure, the Geomembrane Installation Contractor shall either cut out the old seam, reposition the panel and reseam, or add a cap strip, as required by the Engineer.
3. After reseaming or placement of the cap strip, additional destructive field test(s) shall be taken within the reseamed area. The reseamed sample shall be found acceptable if test results are approved by the Engineer. If test results are not acceptable, this process shall be repeated until the reseamed length is judged satisfactory by Engineer.
4. Samples taken as the result of failed tests do not count toward the total number of destructive tests required.

G. The Geomembrane Installation Contractor shall document all actions taken in conjunction with destructive test failures, with the Engineer providing Quality Assurance documentation.

H. Cap strips shall be non-destructively tested as described in Article 3.8 of this Section.

3.10 Defects and Repairs

A. All seams and non-seam areas of the geomembrane shall be observed by the Engineer for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of observation. The geomembrane surface shall be brushed, blown, or washed by the Geomembrane Installation Contractor if the amount of dust or mud inhibits inspection. The Engineer shall determine if cleaning of the geomembrane is needed to facilitate observation.

B. Each suspect location in seam and non-seam areas shall be non-destructively tested as determined appropriate by the Engineer, in the presence of the Engineer. Each location that fails the non-destructive testing shall be marked by the Geomembrane Installation Contractor, and repaired accordingly.

C. Repair Procedures

1. Defective seams shall be reconstructed as described in these Specifications.
2. Small holes shall be repaired by abrading the sheet surface and welding an extrusion bead. If the hole is larger than ¼-inch in diameter it shall be patched.
3. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded prior to patching.
4. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.
5. Surface of geomembrane that are to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. No more than 10 percent of the thickness shall be removed.

D. Patches shall be round or oval in shape, and extend a minimum of 6 inches beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled to an approximately 45º angle with an angle grinder prior to placement of the patch. Patches shall be applied using approved methods only.

E. The extrusion welding process shall restart by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least 2 inches. Reseaming over an existing seam without regrinding shall not be permitted.

F. Each repair shall be non-destructively tested, except when the Engineer requires a destructive seam sample obtained from a repaired seam. Repairs that pass the destructive test shall be taken as an

indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved.

G. Recording the Results: Daily documentation of all non-destructive and destructive testing shall be provided to the Engineer. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

3.11 Conformance Testing

A. During manufacturing of the geomembrane, the Engineer shall be present to observe manufacturing of geomembrane and shall ensure that samples are obtained and forwarded to the Geomembrane Quality Assurance Testing Laboratory for testing to ensure conformance with the Specifications.

B. Samples shall be taken across the entire width of the roll and shall not include the first 3 feet. Unless otherwise stated, samples shall be 3 feet long by the width of the roll. The Engineer shall mark the machine direction on the samples with an arrow. Unless otherwise stated, samples shall be taken at a frequency of no less than one per 2,000,000 square feet or one per lot, whichever is less. As a minimum, the following tests shall be performed to verify conformance to the design Specifications with minimum values specified in Article 2.1 of this Section:

Table 02775-3: Minimum Conformance Testing

PROPERTY	TEST METHOD	FREQUENCY
Thickness (mils)	ASTM D 5199	2,000,000 sq. ft or Minimum 1 test per resin lot, whichever is greater (each test)
Compound Density (g/cc)	ASTM D 1505	
Tensile Strength (Both yield and ultimate strength and elongation, as specified)	ASTM D 6693	
Carbon Black Content (%)	ASTM D 1603	

C. Manufacturer shall provide current certification for Oxidation Induction Time (OIT) for each formulation and shall meet the minimum test values presented in Article 2.1 of this Section.

3.12 Placement of Soil or Granular Materials

A. All soil materials located on top of a geomembrane shall be placed in such a manner as to ensure:

1. The geomembrane and any underlying geotextile is not damaged.
2. Minimal slippage of the geomembrane on underlying layers occurs.
3. Minimal movement and wrinkling or folding of the underlying geosynthetics layer(s) occurs.

No excess tensile stresses shall occur in the geomembrane, such as by earth moving equipment making sudden starts, stops, turns. The allowable ground pressure for equipment shall be prescribed by the Engineer for the material type and layer thickness.

3.13 Warranty

A. Without limiting the provisions of the Contract, the Geomembrane Installation Contractor shall warrant the Work to the Owner in accordance with the following:

B. The geomembrane supplied is suitable for the environmental conditions at the site and the service conditions as described in this Specification.

C. The geomembrane supplied meets or exceeds all published Specifications as referenced by the Specification.

D. The geomembrane is free of defects in materials and workmanship.

E. The Geomembrane Installation Contractor shall repair or replace all defects in the material detected on-site, including uncovering and recovering the work, in compliance with the Specifications.

F. The Geomembrane Installation Contractor shall repair any detected leaks in any seams (Manufactured or field joined), including uncovering and recovering the work, in compliance with the Specifications.

G. All workmanship furnished by the Geomembrane Installation Contractor under this Specification shall be guaranteed by the Geomembrane Installation Contractor against failure due to improper installation for a period of not less than two (2) years. All permanent materials furnished by the Geomembrane Installation Contractor under this Specification shall be guaranteed by the Geomembrane Installation Contractor and the geomembrane manufacturer for a period of not less than twenty (20) years.

H. Upon written notice that the material fails to meet the original intent of the design, or of failure of guaranteed materials or workmanship during the guarantee period, the Geomembrane Installation Contractor shall promptly furnish and install new materials and/or furnish the workmanship necessary to correct the failure at the expense of the Geomembrane Installation Contractor. The Geomembrane Installation Contractor shall bear all costs for labor and materials associated with repair of guaranteed work.

*****END OF SECTION*****

SECTION 03110
CONCRETE FORMWORK

1.0 GENERAL

1.1 Section Includes

A. Related Sections

B. Products

C. Execution

1.2 Related Sections

A. Section 03300 – Cast-in-place Concrete

1.3 Products

1.3.1 Materials

A. Forms shall be 5-ply, ¾-inch, waterproof, exterior type plywood, free of loose knots, splinters, or other defects. The face adjacent to concrete shall be Grade B or better. Forms may be fiberboard, Fed. Spec. LLL-B-810, Type II, tempered, waterproof, screenback, concrete form hardboard.

B. Form ties shall be of the removable end, permanently embedded body type. Cones shall be provided on the outer ends of each tie and the permanently embedded portion shall be at least one inch back from the concrete face. Form ties for water bearing walls, shall be provided with water seal washers located on the permanently embedded portions of the tie at the approximate center of the wall. The cone ends of the form ties shall have a diameter of 1 inch and shall be constructed so that they are easily removed or broken off without damage to the concrete. Form ties may be Burke BA Penta-Tie with a water seal washer, or an equivalent approved by the Engineer.

C. Form release or coating shall be nontoxic after 30 days and non-staining, such as Nox-Crete "Form Coating" or Protex "Pro-Cote", or Richmond "Rich-Cote".

2.0 EXECUTION

2.1 Installation

A. The Contractor shall be responsible for the location and placement of all sleeves, pipe fittings, anchors, ties, and inserts, and shall make certain that offsets, recesses, openings, and block-outs are in place in the forms before concrete is placed.

B. Form release agents shall be applied at no more than the manufacturer's recommended application rates.

C. Where forms are placed above geomembrane liner, no anchoring of the forms will be allowed that damage the geomembrane liner. Use of sandbags, earth forms, or other form of anchoring/bracing maybe employed and approved by the Engineer prior to construction of formwork.

D. Horizontal joints shall be level and continuous. Vertical joints shall be plumb.

E. Forms shall be sufficiently tight and rigid to prevent leakage of concrete.

F. Forms shall be properly tied, braced, shored, and supported to insure stability against pressure from any source and without deflection or failure of any component or part.

G. Forms shall be removed without damage to the concrete, chamfers, inserts, anchors, geomembrane liners, and piping.

H. Forms shall not be removed until concrete has sufficiently hardened. Unless otherwise approved by the Engineer, forms shall not be removed within five (5) days of placement.

*****END OF SECTION*****

SECTION 03220
REINFORCING STEEL

1.0 GENERAL

1.1 Section Includes

A. Related Sections
B. References
C. Submittals
D. Quality Control
E. Delivery, Storage, and Handling
F. Products
G. Execution

1.2 Related Sections

A. Section 03110 – Concrete Formwork
B. Section 03300 – Cast-in-place Concrete

1.3 References

A. ACI 301 - Specifications for Structural Concrete
B. ACI 315 - Details and Detailing of Concrete Reinforcement
C. ACI 318 – Building Code Requirements for Structural Concrete
D. ASTM A 82/A82M- Steel Wire, Plain, for Concrete Reinforcement
E. ASTM A 184/A 184M - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
F. ASTM A 416/A 416M - Steel Strand, Uncoated Seven-Wire for Pre-stressed Concrete
G. ASTM A 496/A 496M - Steel Wire, Deformed, for Concrete Reinforcement
H. ASTM A 497/A 497M - Steel Welded Wire Reinforcement, Deformed, for Concrete
I. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
J. ASTM A 704/A 704M-06 (R2011) - Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
K. ASTM A 775/A 775M-07B - Epoxy-Coated Reinforcing Steel Bars
L. ASTM A 1064/A 1064M-14 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
M. AWS D1.4 - Structural Welding Code - Reinforcing Steel
N. IBC 2018 - International Building Code 2018

1.4 Submittals

A. Detail reinforcement in accordance with ACI 301, ACI 315 and ACI 318.
B. Provide complete bar lists together with location and setting drawings with sufficient plans, elevations, sections and details to clearly show the positioning and number of bars. Identify bar lists with drawings. Identify by mark number of each bar. Show relationship of reinforcement with construction joints, control joints, expansion joints and embedded parts.
C. Ensure that embedded parts not shown on the Drawings, but required for the Work, are shown on the reinforcing setting drawings when submitted to the Owner or His Representative for review.

D. Do not prepare work until the bar lists and drawings covering that work have been reviewed and approved by the Owner or his Representative. Submit bar list well in advance of required fabrication to avoid construction delay.

E. Improperly prepared bar lists and drawings are subject to rejection on that basis alone without further review. Redraw and resubmit.

1.5 Quality Control

A. Personnel Qualifications

1. Contractor shall employ personnel skilled and experienced in the fabrication and installation of reinforcement.

B. Tolerances

1. Fabricate and install concrete reinforcement in accordance with ACI 301 except as required by the Drawings.

1.6 Delivery, Storage, and Handling

A. In addition to the requirements of ACI 301:

1. Store and handle reinforcing steel so as not to alter the shape and dimensions.
2. Prevent contamination of the reinforcing steel.
3. Do not dump materials when unloading or handling.

2.0 PRODUCTS

2.1 Materials

A. Reinforcing steel and rock dowels

1. In accordance with ASTM A615 GRADE 60.

B. Welded wire fabric:

1. In accordance with ASTM A1064.

C. Headed Studs:

1. Headed studs shall be mild streel studs from Nelson Stud Welding conforming to the requirement of ASTM A108.

D. Support of reinforcement

1. Supports, spacers and chairs:
   a. Precast concrete blocks, for bottom bars in ground supported slabs and foundations only.
   b. Plastic of approved design and manufacture.
   c. Steel of approved design and manufacture with rust-proof finish where any part extends to the surface of the concrete.

2.2 Fabrication

A. Reinforcing steel

1. Fabricate reinforcing steel in accordance with ACI 301 to the dimensions shown on the bar lists and shop drawings.
2. Do not bend or straighten reinforcing bars in a manner, which might damage the bars or reduce the cross-section. Do not use bars with kinks or sharp bends.
3. Identify each bar, with the same code used for it in the bar lists and shop drawings.
4. Verify foundation elevations at the Site before cutting and bending reinforcing steel.

3.0 EXECUTION

3.1 Examination

A. Prior to commencing installation, thoroughly examine other work upon which the Work of this Section is dependent. Report any deficiencies discovered and propose adjustments to the Owner or His Representative and obtain written authorization before proceeding.

B. Check that forms are in satisfactory condition for the Work of this Section to proceed.

3.2 Installation

A. Install reinforcement in accordance with ACI 301, ACI 315, ACI 318 and the following:

B. Secure crossing bars at every intersection (unless otherwise noted on the Drawing) by using black tie-wire of not less than No. 16 gage.

C. Ensure concrete cover, placing and maintaining position of reinforcement is in accordance with ACI 301, ACI 315, ACI 318 and as shown on the Drawings.

D. Install tension and compression splices for reinforcing steel in accordance with ACI 318 and as shown on the Drawings.

E. At running joints, place starter bars or dowels equivalent in size and spacing to the continuing reinforcing of the member.

F. At wall corners, provide embedment and splice all horizontal bars according to code requirements.

G. Welding of Reinforcing Steel:

1. Obtain approval of the Owner or His Representative before welding or tack welding reinforcement. Rebar may only be welded along the longitudinal axis only with the approval of the Owner or His Representative.
2. Perform welding in accordance with AWS D1.4.
3. Weld structural reinforcement in accordance with the requirements of ACI 301.
4. Do not weld reinforcing steel closer than 2 inches from the beginning of a bend and within a bend.

H. Openings in Concrete

1. Provide additional reinforcing bars around opening as shown on the Drawings.
2. Where opening of 18 inches diameter or square and larger occur and interrupt more than two reinforcing bars, add reinforcing bars equivalent to the interrupted reinforcing bars at each side of the opening.

*****END OF SECTION*****

SECTION 03300
CAST-IN-PLACE CONCRETE

1.0 GENERAL

1.1 Section Includes

A. Submittals
B. Materials
C. Mixes
D. Curing Compounds
E. Installation
F. Quality Control

1.2 Relation Sections

A. Section 01010 – Summary of Work
B. Section 01300 – Submittals
C. Section 02710 – Gravity Piping
D. Section 11207 – Parshall Flumes

1.3 References

A. American Concrete Institute (ACI)

1. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete
2. ACI 305R - Hot Weather Concreting
3. ACI 306R - Cold Weather Concreting
4. ACI 318 - Building Code Requirements for Structural Concrete

B. American Society of Testing and Materials (ASTM)

1. ASTM C 33 – Standard Specification for Concrete Aggregates
2. ASTM C 39 – Standard Specification for Compressive Strength of Cylindrical Concrete Specimens
3. ASTM C 94 – Standard Specification for Ready-Mix Concrete
4. ASTM C 143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
5. ASTM C 150 – Standard Specification for Portland Cement
6. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
7. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete
8. ASTM C 309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
9. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete
10. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete

C. International Building Code

1. IBC 2018 – International Building Code 2018

1.4 Submittals

A. Submit mix designs to the Engineer under provisions of Section 01300 and this section.

B. Product Data: Mix design for each tentative mix for Lean Mix Concrete:

1. Slump on which design is based
2. Total gallons of water per cubic yard
3. Brand, type, composition, and quantity of cement
4. Specific gravity and gradation of each aggregate
5. Ration of fine to total aggregates
6. Weight (surface dry) of each aggregate per cubic yard
7. Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture
8. Air content
9. Compressive strength based on 7 day and 28-day compression tests
10. Time of initial set

2.0 PRODUCTS

2.1 Materials

A. Portland cement, ASTM C 150, Type II.

B. Coarse aggregate, ASTM C 33, except that clay and shale particles shall not exceed on percent.

C. Fine aggregate, ASTM C 33, washed natural sand.

2.2 Mixes

A. Mix Designs

1. Concrete mix design shall be designed by an independent testing laboratory.

B. Cast-in-Place Concrete, reinforced

1. Cast-in-Place Concrete shall have a minimum 28-day compressive strength of 4,000 psi.
2. Maximum aggregate size of ¾-inch.
3. Placement slump of 4 inches, with tolerances of plus 1-inch or minus 1-inch.
4. Design mix shall assure 4 to 6 percent air entrainment.

C. Lean Mix Concrete, unreinforced

1. Lean Concrete shall have a minimum 28-day compressive strength of 2,000 psi.
2. Maximum aggregate size of 1-½ inches.
3. Placement slump of 4 inches, with tolerances of plus 1-inch or minus 1-inch.

2.3 Curing Compounds

A. Concrete curing compounds shall be a clear compound conforming to ASTM C 309, Type 1-D, Class A and B, such as “RES-X” by Burke, or an equivalent approved by the Engineer.

3.0 EXECUTION

3.1 Installation

A. Ready-mix concrete shall be batched, transported, and placed in accordance with ASTM C94. Each batch delivered to the site shall be accompanied by a certified weightmaster's delivery ticket.

B. All mixed concrete delivered to the site shall be placed within 90 minutes from the time of introduction of cement and water into the mix.

C. No water shall be added after leaving the batch plant without the approval of the Engineer.

D. Placement of concrete, once started, shall be performed as a continuous operation until the scheduled pour is completed.

E. Concrete placed under water will be placed using tremie methods. Concrete will not be allowed to free fall through water.

F. Concrete shall not be placed during freezing weather conditions.

3.2 Schedules

A. The Contractor shall notify the Engineer at least 48-hours before each concrete placement.

3.3 Quality Control

A. Concrete testing will be performed by the Quality Assurance Team. Such testing shall not relieve the Contractor from providing quality control to make sure concrete is in compliance with specification.

B. Four standard 6-inch diameter by 12-inches long test cylinders shall be prepared for every 50 cubic yards of concrete poured or for each pour, whichever is greater.

C. Standard compression tests shall be performed to determine the compressive strength: one at 7 days, one at 14 days, and one at 28 days. The fourth cylinder shall be kept in reserve for additional testing, if necessary.

D. Slump and air entrainment testing shall be performed at the time the cylinders are prepared.

*****END OF SECTION*****

SECTION 11207
PARSHALL FLUMES

1.0 GENERAL

1.1 Section Includes

A. References
B. Submittals
C. Parshall Flumes
D. Fabrication
E. Handling and Storage
F. Installation
G. Pipe Connections
H. Cast-in-place Concrete

1.2 Related Sections

A. Section 02205 – Fill Materials
B. Section 02222 – Excavating
C. Section 02223 – Filling
D. Section 03110 – Concrete Formwork
E. Section 03220 – Reinforcing Steel
F. Section 03300 – Cast-in-place Concrete

1.3 References

A. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
B. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials.
C. ASTM D 1941-91(2001) – Standard Test Method for Open Channel Flow Measurement of Water with Parshall Flume
D. ASTM D 2583 – Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol impressor.
E. ISO 982-92 – Measurement of Liquid Flow in Open Channel – Parshall and SANIIRI Flumes.
F. United States Department of the Interior, Bureau of Reclamation, Water Measurement Manual.

1.4 Submittals

A. Submit the following under provisions of Section 01300.
B. The Contractor shall provide detailed information to the Owner and Engineer for: flume, fittings, measurement attachments, and joining manufacturer's data, including type/class, method of joining, specifications, manufacturer's name, and manufacturer’s certificate of compliance.
C. Shop Drawings:
    1. Critical dimensions, jointing and connections, fasteners, and anchors.
    2. Materials of construction.
    3. Sizes, spacing, location of structural members, connections, attachments, openings, and fasteners.
D. Contractor to follow Manufacturer’s recommended installation instructions. Deviations from Manufacturer’s installation instructions shall be approved by the Engineer.

E. If an equivalent product is proposed, submit samples, technical data, test data, and specifications sufficient to allow evaluation by Engineer.

2.0 PRODUCTS

2.1 Parshall Flumes

A. Flumes shall be manufactured by TRACOM, Inc. of Alpharetta, Georgia, USA, or an equivalent approved by the Engineer.

B. Flumes shall be 2-inch Parshall type and shall be of one-piece construction

C. Materials:

1. Fiberglass reinforced plastic.
2. Gloss inside surfaces, free of irregularities.
3. Minimum 3/16-inch wall thickness.
4. Minimum 30% glass, by weight.
5. Isophthalic polyester resin.
6. Removable pultruded fiberglass bracing at top of flume with T-304 stainless steel hardware.
7. 2-inch (minimum) top and end stiffening flanges.
8. Molded-in stiffening ribs, maximum 12-inch center-to-center spacing.
9. 15 mil Isophthalic UV resistant gel coat on all surfaces, white interior, grey exterior.
10. Anchor clips, pre-drilled with ¾-inch hole, pultruded fiberglass construction
11. Tensile strength (ASTM D 638) – 14,000 psi.
12. Flexural strength (ASTM D 790) – 27,000 psi.
13. Flexural modulus (ASTM D 790) – 1.0 million psi.
14. Barcol hardness (ASTM D 2583) – 50.

2.2 Flume Attachments

A. Ultrasonic Mounting Bracket:

1. Fixed Position stainless steel.
2. Horizontally and vertically adjustable stainless steel.
3. 2-inch diameter NPT coupling for third-party mounting bracket, if required.

2.3 End Connections

A. Inlet and outlet end adaptors

1. 6-inch inlet and outlet pipe stubs shall be fitted with a bolt pattern to allow bolting to a 6-inch IPS flange adaptor and ANSI 150 lb. flat-faced flange.

3.0 EXECUTION

3.1 Handling and Storage

A. Transportation of Parshall Flumes and fittings shall be the responsibility of the Contractor. The Contractor shall be liable for all damage incurred prior to and during transportation to the site.

B. Handling, storage and care of the pipe, valves, and fittings prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Engineer.

C. The Contractor shall be responsible for storage of Parshall Flumes and fittings at the site. Pipe, valves, and fittings shall be stored on clean level ground, which is free of sharp objects which could damage these materials. Stacking shall be limited to a height that shall not cause excessive deformation of the bottom flumes under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitable and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

3.2 Installation

A. Parshall Flumes shall be installed above an 80-mil HDPE geomembrane rubsheet within the Underdrain Collection Channel in accordance with the Design Drawings.

B. Parshall Flumes shall be installed to the lines and grades shown on the Design Drawings.

C. Parshall Flumes shall be installed plumb and the upstream floor of the Flume is level.

D. Parshall Flumes shall be embedded in concrete. Pour concrete in maximum 6-inch lifts. Internally line and brace the flume as necessary to prevent bowing or distortion of the of the flume until concrete in cured. Concrete shall meet the specifications of Section 03300 – Cast-in-place Concrete.

3.3 Tolerances

A. Parshall Flumes shall be installed to the lines and grades in the Design Drawings.

B. Parshall Flumes shall be installed plump and the upstream floor level.

3.4 Quality Control

A. A short description of the Quality Control program shall be submitted by the Contractor with the bid to the Engineer and Owner. This description shall state the Quality Control standard to be used and as a minimum containing the following:

1. An organization chart with a brief job description of Quality Control function
2. A list of applicable procedures for implementation of the Quality Control program
3. A general description of how each Quality Control requirement is to be fulfilled during the design, procurement, manufacture, assembly and testing

B. During award phase, the Quality Control documentation shall be forwarded to the Engineer as specified in Section 01300. Pertinent Quality Control documentation including Quality Control manuals shall be approved by the Engineer prior to any production work commencing. A minimum of five working days shall be allowed for the Engineer's review.

C. Upon delivery of the pipe, the Contractor shall forward the following documentation:

1. All Vendor certificates and tests performed per these Specifications
2. All Vendor documents verifying that inspection, control, and tests performed are in accordance with these Specifications
3. Identification lists with cross references between documents and hardware/materials for traceability purposes

D. The Engineer or Owner shall have the right to carry out audits at the Contractor’s, Vendor’s, and their subcontractor’s facilities, to verify compliance with all aspects of the documentation included in the purchase order. For the purpose of evaluating and auditing, the Contractor, Vendor, and their subcontractors shall give free access to all facilities concerned and to all the Quality Control documents and records

E. Applicable records may be requested by the Engineer or Owner at any time during production, these shall be forwarded to the Engineer or Owner upon request within five working days. The Contractor or Vendor shall give a written response to the Engineer or Owner for any corrective action requests and if requested, take the necessary corrective action in a timely manner.

*****END OF SECTION*****

SECTION 17150
METERS AND INSTRUMENTATION

1.0 GENERAL

1.1 Section Includes

A. Prequalification
B. Performance Requirements
C. Design Requirements
D. Submittals
E. Delivery, Storage, and Handling
F. Products
G. Execution

1.2 Performance Requirements

A. This Work shall include the furnishing of all labor, tools, equipment, and other items necessary for the installation meters and instrumentation as shown on the Drawings. All Work shall be performed in accordance with the lines, grades, sections, and dimensions shown on the Drawings, or as directed by the Engineer.

1.3 Design Requirements

A. All instrumentation materials, installation methods and materials, and data collection prior to, during, and after installation shall meet the minimum requirements of Manufacturer's recommendation and the **Geotechnical Monitoring Plan for the Grassy Mountain TSF and WRD, Revision 0 prepared by Golder Associates Inc.**

B. All instrumentation installation shall be performed by, or at the direction of, the Engineer.

1.4 Submittals

A. Submittals detailed below shall be in accordance with Section 01300.

B. After the Contract Award:

1. Submit equipment models, operation, installation, and maintenance manuals for vibrating wire piezometers, settlement cells and gauges, readout equipment, and inclinometers. Obtain Engineer approval for all instrumentation prior to shipping to the site.
2. Submit shop drawings of prefabricated instruments and materials for approval by the Engineer.
3. Submit proof of qualification for installation of any instrumentation.

C. After Installation:

1. Submit installation details for all instrumentation, including boring logs, location and elevation of the piezometers, piezometer cables, riser pipes, readout stations, surface monuments, inclinometers, and underdrain flow meters.
2. Submit the installation-specific operation manual developed for the vibrating wire piezometers, inclinometers, underdrain flow meters, and readout stations including calibration data for conversion of gauge readings to pressure.

2.0 PRODUCTS

2.1 Product Handling

A. Shipping Precautions: After completion of shop assembly, factory test, and approval, instruments shall be packed and secured to provide complete protections from damage, dust and moisture.

A. Special Instructions: Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of instrument prior to packaging and shipment.

B. Tagging: Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment. Identification shall be prominently displayed on the outside of the package.

C. Storage: Instruments shall not be stored outdoors. Instruments shall be stored in dry permanent shelters and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor.

2.2 Manufacturer's Services

A. Contractor may need to furnish some or all of the manufacturer's services for the instrumentation listed in this specification:

1. Perform factory bench calibration
2. Oversee installation
3. Verify installation of installed instrument
4. Site verification of calibration

2.3 Material

A. Vibrating Wire (VW) Piezometers

1. Impoundment (PZ-TI and PZ-WI Series) and Underliner VW Piezometers (PZ-TU, PZ-WU Series)
   a. Impoundment and Underliner VW piezometers shall have a pressure range of 0 to 100 psi with a resolution of 0.03 psi at 100 psi (Model Number VW2100-XXXX).
   b. Signal output shall be a frequency output in the millivolt range or digits.
   c. The filter shall be Standard: 50 micron sintered stainless steel.
   d. VW piezometers shall be manufactured by RST Instruments, based in Maple Ridge, British Columbia, or other manufacturer approved by the Engineer.
2. Embankment Foundation VW Piezometers (PZ-TF Series)
   a. Embankment Foundation VW piezometers shall be of standard VW piezometers prefabricated in nested construction (Multi-point Piezometer Strings).
   b. Embankment Foundation VW piezometers shall have a pressure range of 0 to 150 psi with a resolution of 0.04 psi at 150 psi (Model Number VW2100MP).
   c. Nesting of the Embankment Foundation VW piezometers will be at the vertical intervals described in the Geotechnical Monitoring Plan, or at the direction of the Engineer.
   d. Signal output shall be a frequency output in the millivolt range or digits.
   e. The filter shall be Standard: 50 micron sintered stainless steel.
   f. VW piezometers shall be manufactured by RST Instruments, based in Maple Ridge, British Columbia, or other manufacturer approved by the Engineer

B. VW Piezometer Signal Cables

1. Impoundment VW Piezometer (PZ-TI, PZ-WI Series) and Underliner (PZ-TU, PZ-WU Series) Signal Cable
   a. Shall be standard vibrating wire signal cable (Model EL380004) manufactured by RST Instruments, based in Maple Ridge, British Columbia.

b. Shall be with 22-gauge tinned-copper conductors and polyurethane jacket.

c. Signal cable shall be prefabricated to the VW piezometer during manufacturing to the specific cable length required for each instrument as shown on the Drawings and Geotechnical Monitoring Plan.

d. Cable conduit shall be 2-inch diameter Schedule 80 PVC pipe with flush interior glue joints.

2. Embankment Foundation VW Piezometers (PZ-TF Series)

a. Shall be 12 conductor, Kevlar® wire with water-blocked polyurethane jacket signal cable (Model EL380012) manufactured by RST Instruments, based in Maple Ridge, British Columbia.

b. Shall be with 22-gauge tinned-copper conductors and polyurethane jacket.

c. Signal cable shall be prefabricated to the VW piezometer during manufacturing to the specific cable length required for each instrument as shown on the Drawings and Geotechnical Monitoring Plan.

3. Cable splicing shall be limited to areas where vertical overburden pressures are limited to less than 25 psi and as directed by the Engineer. Cable splicing kits shall be manufactured by RST Instruments, based in Maple Ridge, British Columbia and shall be compatible with the specific VW piezometer signal cables.

4. Impoundment (PZ-TI and PZ-WI Series) and Underliner VW Piezometers (PZ-TU, PZ-WU Series) shall be placed in canvas bags supplied by the manufacturer and surrounded by No. 30 concrete sand.

C. Readout Stations

1. Single Channel VW portable readout (model number VW2106), shall be used for all VW piezometers for instantaneous field measurements during and after installation. The readout will measure a frequency range of 400 Hz to 6000 Hz, a temperature readout range between -50 and 80 °C, with a frequency resolution of 0.01 µs and temperature resolution of 0.1 °C.

2. After initial installation, Data loggers and multiplexers shall be installed within each Readout Station to collect real-time measurements of all WV piezometers.

3. Data Loggers shall be the RST FlexDAQ system and include the following:

a. CR6 Data Logger manufactured by Campbell Scientific, Inc. of Logan, Utah

b. RST Flexi-Mux Multiplexer(s) manufactured by RST Instruments.

c. AC or DC (solar) power supply with battery backup module

d. Electrical grounding if DC-powered

e. Lightning protection

f. Communication module (if required by, and at the direction of, the Owner)

g. Weatherproof NEMA-rated enclosure

h. Mounting post and hardware

4. Each Readout Station shall be constructed such that it has the capability to read and record in real-time the following quantity of instruments:

a. RS-1 – Twenty-two (22) VW piezometer signal cables

b. RS-2 – Four (4) VW piezometer signal cables

c. RS-3 – Four (4) Ultrasonic transducer signal cables and dataloggers

d. RS-4 – Eight (8) VW piezometer signal cables

e. RS-5 – Six (6) VW piezometer signal cables

D. Inclinometers

1. Inclinometer casing shall be installed along the downstream dam crest of the Stages 1 through 3 main north embankments as shown on the Drawings and in accordance with the Geotechnical Monitoring Plan.
2. Inclinometer casings shall be 70-mm (2.75-inch) diameter Snap Seal type (Model ICS205 or ICS210) manufactured by RST Instruments, based in Maple Ridge, British Columbia.
3. Inclinometer casings shall be either 5-foot or 10-foot segments and constructed of non-recycled virgin ABS resin.
4. Associated attachments such as bottom cap, top cap, casing anchor, alignment tool, and grout cap shall be manufactured by RST Instrumentation and approved by the Engineer.
5. Inclinometers shall be measured during and after installation with an RST MEMS Digital Inclinometer System or other suitable device approved by the Engineer.
6. Inclinometer signal cable shall have a minimum length of 200 feet.

E. Dam Crest Survey Monuments

1. Survey monuments shall be imbedded into the embankment at least 18 inches and constructed 12-inch diameter corrugated CPE pipe backfilled with grout.
2. Grout shall have a minimum 2,000 psi compressive strength at 28 days.
3. The survey marker shall be 2½-inch diameter cast-in-place brass survey cap (Model M/M-BCS-2 1/2FS) as manufactured by Surv-Kap, or an equivalent approved by the Owner.

F. Underdrain Flow Meters

1. Underdrain Flow Meters shall be installed above the Underdrain Parshall Monitoring Flumes as shown on the Drawings.
2. Underdrain Flow Meters shall be of Open Channel Flow Meter type (Model Dynasonics iSonic 4000) as manufactured by Badger Meter, Inc., of Milwaukee, Wisconsin.
3. Ultrasonic transducer shall be the EchoPod DL-10 mafactured by Badger Meter.
4. Underdrain Flow Meters shall be capable of measuring flume water levels in standard Parshall Flumes with an accuracy 0.125 inches (3 mm).

3.0 EXECUTION

3.1 Vibrating Wire Piezometer Installation

A. Impoundment (PZ-TI and PZ-WI Series) and Underliner VW Piezometers (PZ-TU and PZ-WU Series)

1. Installation of the Impoundment and Underdrain VW piezometers shall be installed at the locations identified on the Drawings and Geotechnical Monitoring Plan.
2. Installation methods, materials, and data collection procedures shall be in accordance with manufacturer's recommendations and at the direction of the Engineer.
3. VW Piezometers shall be placed in canvas sand filter bags provided by the piezometer manufacturer. Bags will be filled with No. 30 concrete sand with the piezometer centered in the bag.

B. Embankment Foundation VW Piezometers (PZ-TF Series)

1. Installation of the Impoundment and Underdrain VW piezometers shall be installed at the locations identified on the Drawings and Geotechnical Monitoring Plan.
2. Installation methods, materials, and data collection procedures shall be in accordance with manufacturer's recommendations and at the direction of the Engineer.

3. Boreholes shall be advanced below the TSF embankment foundation to the depths required for down-hole installation of the nested multi-point VW piezometers.
    a. Boreholes shall be advanced to a minimum of 1 foot (12 inches) below the deepest VW piezometer.
4. Downhole VW piezometers shall be installed using the Fully Grouted Method per RST Instruments recommendations.
    a. A bentonite-Type I/II cement mix shall be used to backfill the boreholes after nested VW piezometer installation.
    b. Viscosity of bentonite-cement backfill mix may be adjusted by the cutting short or additional bentonite to allow mixture to remain flowable for downhole pumping.
    c. Care shall be taken to prevent air entrapment in the VW piezometer filter stone. The VW piezometers shall be installed upside down and secured to either the signal cable or PVC guide pipe.
    d. If a PVC guide pipe is used during installation, it shall remain in place and be backfilled with bentonite-cement backfill mix.
    e. The PVC guide pipe shall be terminated no shallower than 2 feet below the native ground surface.

C. Calibrate piezometers to site-specific factors.

D. All cable shall be placed to loosely meander in the trench and the riser casing to allow for settlement and avoid development of tension in cable. Minimum cable meander shall be between 12 inches and 18 inches of amplitude for every 36 inches of pitch.

E. All cables shall be surrounded with Cable Bedding Fill as shown in the Drawings. Cable Bedding Fill will be compacted using hand-guided compaction equipment to form a smooth and non-yielding surface. Where placed as backfill in cable risers, Cable Bedding Fill shall be placed in lifts of 4 inches and tamped to a dense condition using a wood pole or rod.

F. Survey the precise location and elevation of each of the piezometers to an accuracy of 0.1 feet in all directions. Survey the location of wiring and conduits leading to the piezometers to an accuracy of 0.5 feet. Provide the surveyed locations with the as-built documentation. Permanently label piezometers in the readout stations and protect the stations from damage due to traffic and construction operations.

3.2 Readout Station Installation

A. Instrumentation Readout Stations shall be installed at the general locations shown on the Drawings.

B. Installation Criteria and Validation: Field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on manufacturers' installation requirements.
2. Technical assistance from the Engineer is available to installation personnel at least by telephone.
3. Installation personnel have one copy of the approved Drawings, Geotechnical Monitoring Plan and pertinent data.
4. Power and signal wires shall be terminated with crimp type lugs, where the terminal block requires this.
5. Connectors shall be, as a minimum, water tight.
6. Wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
7. Wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected without splices unless specifically approved by the Engineer. Wiring shall be protected from sharp edges and corners.

8. Lightning protection shall be installed on the Readout Stations.

C. Verify the correctness of each installation, including polarity of electric power and signal connections, and make sure process connections are free of leaks.

3.3 Inclinometer Installation

A. Boreholes shall be advanced from the TSF embankment dam crest and into the clay foundation at the locations shown on the Drawings.

B. Boreholes shall be advanced to a minimum of 1 foot (12 inches) below the deepest VW piezometer.

C. Inclinometers shall be installed using the per RST Instruments recommendations.

D. The “A” axis of the inclinometer shall be installed perpendicular to the dam alignment. Proper alignment of the casing shall be maintained at all times during installation. Casing shall not be twisted or pushed from top during installation.

E. A bentonite-Type I/II cement mix shall be used to backfill the boreholes after nested VW piezometer installation.

A. Viscosity of bentonite-cement backfill mix may be adjusted by the cutting short or additional bentonite to allow mixture to remain flowable for downhole pumping.

3.4 Dam Crest Survey Monument Installation

A. Embankment Crest Survey Monuments shall be made an 18” diameter CPE pipe with smooth interior and backfilled with Lean Mix Concrete in accordance with Section 03300.

B. A minimum 6-inch wide base of concrete shall be pours around the outside of the vertical CPE pipe to for a minimum depth of 6 inches from the base of the pipe.

C. A 12-inch long ⅝ inch diameter “All Thread” rod with coarse thread shall be cast plumb into the concrete with a minimum 2½ inch extending above the top of the concrete.

D. 1-inch diameter weep holes shall be drilled through the CPE pipe immediately above the top of the concrete to provide drainage of surface water. A minimum of six weep holes shall be installed equally spaced around the circumference of the CPE pipe.

E. The annular space between the edges of the excavation and the CPE pipe shall be backfilled with Pipe Bedding Fill and placed in accordance with Section 02223.

F. The CPE pipe shall be capped with a removable lid to protect concrete and survey monument.

3.5 Underdrain Flow Meter Installation

G. Ultrasonic transducers shall be installed in accordance with the manufacturer’s recommendation.

H. Ultrasonic transducers shall be mounted to the Parshall Flumes using manufacturer-supplied mounting brackets.

I. Signal cables shall be routed to Readout Station RS-3 shown on the Drawings.

J. Signal cables shall be secured and protected from damage.

K. Transducer readouts shall be installed in a weatherproof NEMA enclosure adjacent to the reclaim pond as shown on the Drawings.

L. Weatherproof enclosure shall be mounted to fence post installed below grade and founded in Lean Mix Concrete meeting the requirements of Section 03300.

M. Power shall be supplied to the transducers in either AC (275V max, 50-60 Hz) or DC (9 to 36 V, max 9W).

3.6 Calibration

A. General: Devices provided shall be calibrated according to the manufacturer's recommended procedures to verify operation readiness and ability to meet the indicated functional and tolerance requirements.

B. Calibration Points: When possible each instrument shall be calibrated at 5, 50, and 90 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

C. Bench Calibration: Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment.

D. Field Calibration: Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument data sheets.

3.7 Performance Test

A. All instruments shall operate for 30 days without failure.

B. The Contractor shall furnish support staff as required to satisfy the repair or replacement requirements at no cost to the Owner.

C. If any component fails during the performance test, it shall be repaired or replaced at no Cost to the Owner.

3.8 Acceptance

A. The following conditions shall be fulfilled before the WORK is considered substantially complete:

1. Submittals have been completed and approved.
2. The instruments have been calibrated.
3. Any necessary training has been performed.
4. Spare parts and expendable supplies and test equipment have been delivered.
5. The performance test has been successfully completed.
6. Record drawings have been submitted.
7. Revisions to the Technical Manuals that may have resulted from the field tests have been made and reviewed.
8. Debris associated with installation of instrumentation has been removed.

*****END OF SECTION*****

Ausenco
Grassy Mountain Project
Project Quality Plan – Processing

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Revision Number C

Calico Resources USA Corp. Grassy Mountain Project

Project Quality Plan - Processing May 2019

14 May 2019

Revision Status

Revision	Date	Description	Author		Approver	
			FirstName LastName	Position Title	FirstName LastName	Position Title
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Appendix 1 – Continual Improvement Cycle

Appendix 2 – Quality Assurance Inspection Register

Appendix 3 – Quality Assurance Audits Schedule

Appendix 4 – QA Documentation Examples

Appendix 5 – Selected Final Inspection QA Checklists

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1 Introduction

The Project Quality Plan forms an integral part of the Project Execution Plan and is the principal document in the Quality Assurance and Quality Control document hierarchy. The plan is intended as a live document and is reviewed and updated as the project evolves. It will be reviewed as a minimum of every 6 months and at the following stages:

- Prior to award of each major contract package
- Commencement of site construction to cover Construction and Commissioning.

The Project refers to the Grassy Mountain underground gold mine located in Oregon, USA.

2 Purpose and Scope

The purpose of this plan is to define the Quality requirements for the Project. This includes Management of Design, Supply of Materials, Mechanical and Electrical Equipment, Fabricated items, Construction and Commissioning activities to be undertaken for the Grassy Mountain project.

The overall goal of this Quality Assurance Plan as related to Construction and Installation is to ensure that proper construction techniques and procedures are used, and equipment is installed in accordance with the design drawings and specifications. Quality Control for the works will be performed by the Contractor in conjunction with the EPCM Contractor Quality or Engineering representative.

3 Terms and Definitions

In the context of this plan, the following words, phrases or abbreviations shall be deemed to have the meaning assigned to them:

As-built drawings	Accurate and approved records of all deviations between works as designed and works as installed.
Certification Record	Documents summarising the predefined inspection, checks and testing that have been performed and signed off as acceptable. This includes Drawings, as-built calculations, traceability, and third party data reports.
Contractor	Consultant or Supplier providing goods and/or services under contractual Terms and Conditions to the EPCM Contractor or the Owner under EPCM Contractor management.
EPCM Contractor	Engineering Procurement Construction Management Contractor
Hold Point	A stage in the sequence of the manufacture/construction process beyond which work may not proceed without release being granted by the nominated party. A minimum of 5 working days notification is required.
Inspection	Activities such as measuring, examining, testing, gauging one or more characteristics of a product or service and comparing these with specified requirements to determine conformity.

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Inspection and Test Plan (ITP)	A formalised plan describing how, when and where the characteristics of products/works will be inspected, tested or measured to provide evidence that design, regulatory and contractually specified requirements have been met.
Inspection Register	A register that states the supplier location, inspection and criticality levels, pre-inspection meeting dates, estimated inspection visits and costs vs actual visits and costs, and any other criteria as required by the Project Management.
Manufacturer's Data Record (MDR)	A volume or number of volumes compiled by vendors and/or the EPCM Contractor, containing records, certification and objective evidence of compliance with requirements appertaining to material, equipment or installation work for the Project.
Material	Stock-in-trade items such as lengths of steel, piping, grating, handrails and bolts.
Material Test Certificate	Document issued and authenticated by the material manufacturer defining the chemical composition and mechanical properties of a material item.
Non-conformance Report (NCR)	A report raised in relation to a deficiency in characteristics, documentation or process implementation which renders an item or process indeterminate or outside that required by the relevant contract, technical specification, code, drawing and/or process requirement.
Non Destructive Examination (NDE)	Examination of welds by various techniques that have no damaging effect on the item being examined in order to confirm compliance with a specified code or standard.
Owner/Client	Calico Resources USA Corp.
Package	A definable portion of work performed by the EPCM Contractor or sub-contractor to a technical specification, code, drawing and/or process requirement.
Plant System	Part of the facility containing, or associated with, a particular product and/or medium.
Plant System Handover	The point in time at which responsibility for and control of a plant system is passed from one entity to another.
PQP	Project Quality Plan – this plan.
Project	Grassy Mountain
Project Execution Plan (PEP)	A plan to carry out the Project.
Punch list	A list of items in the Contractor work scope to be completed for practical completion, or in the case of minor items that do not prevent the Owner from utilising the equipment and can be completed after Plant System Handover.
Quality Assurance (QA) and Quality Control (QC)	Quality Assurance (QA) is focused on providing confidence that quality requirements will be met, whereas Quality Control (QC) is focussed on the actual fulfilment of those quality requirements.
Request for Information (RFI)	An RFI will be generated when additional information, or clarification, is required from the Contractor, Consultant, Owner, Sub-Contractor, Supplier or Vendor.
Sub-Contractor	Consultant or Supplier providing goods and/or services to a Project appointed Contractor where all parties are functioning under the Project's contractual Terms and Conditions.
Supplier	Any persons, firm or company, contracted to supply any material or equipment to the Project.
Technical Query (TQ)	Any query relating to a design interpretation which requires clarification or confirmation.
Test Pack	Documentation compiled progressively during site construction and commissioning that verifies compliance to the codes and specifications.

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Traceability	The ability to trace the history, application or location by means of recorded identification. That is, the systematic, planned and documented approach to produce records to provide trails back from a completed product to the sources of materials, details of batches or lots, the equipment used, the operators involved, dates, times, details of conditions and other pertinent information.
Vendor	Any persons, firm or company, contracted to supply any material or service relating to the Project. This terminology includes Suppliers, Sub-Suppliers, Contractors or Sub-Contractors.
Witness Point	A stage in the sequence of the manufacture/construction process where a nominated party is given the option of formally witnessing the actions of another party in carrying out inspection and test activities. A minimum of 5 workings days notification is required.

4 Quality Policy, Objectives, Continual Improvement

4.1 Policy

The EPCM contractor will operate under the Management System based on the requirements of International Quality, Environmental and Safety Standards:

- ISO9001 Quality Management Systems Requirements
- ISO 14001 Environmental Management
- OHSAS 18001 Health and Safety Management

4.2 Quality Objectives

It is the responsibility of the EPCM contractor Project team to ensure that the quality outcomes on the Project are in line with the objectives of Calico Resources USA Corp. These objectives may include:

- Provided services meet or exceed clients' expectations for quality, reliability, safety, value for money, productivity and timely execution.
- Products and services will comply with the agreed specifications and appropriate laws and regulations, as well as satisfying contractual and commercial conditions.
- Implementation and continually improvement of a formal quality management system that is consistent with the requirements of Standard ISO 9001:2008, and that fosters prevention rather than detection.
- The EPCM Contractor will provide a working environment that supports the philosophy of teamwork and encourages employee involvement in continuous improvement activities.
- All employees will receive relevant training and communications to enable their effective participation in the EPCM quality management program.
- The EPCM Contractor will seek to develop and nurture relationships with our suppliers that emphasise continuous improvement in product quality and cost.
- The EPCM Contractor will communicate and implement these quality objectives by example.

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Key performance indicators, for overall scope defined in the contract, are developed between the Owner and EPCM contractor at the onset of the Work and are monitored during all phases of the projects.

4.3 Continual Improvement

The EPCM Contractor Senior Management will engage the Project team in a culture of continual improvement and will create a working environment that encourages innovation and improvement.

The EPCM contractor will strive to improve performance through innovation and the streamlining of their work methods to assist in performing tasks in the most expedient and value adding manner without compromising Quality.

All team members are encouraged to participate in this process and offer any suggestions as to how this may be achieved best. All ideas for improving performance will be evaluated and credit will go to the party that made the suggestion. The implementation of the idea will be monitored and the resultant improvements will be brought to the attention of the team.

Continual improvement will be an agenda item at all Project team meetings and meetings conducted on site. Continual improvement will, as a minimum, be addressed in:

- engineering design
- project controls
- contract management
- procurement
- quality management
- commercial
- construction
- Health, Safety and Environmental Management

Refer to Appendix 1 – Continual Improvement Cycle.

5 Responsibilities and Authority

5.1 Responsibilities and Authority

Resources for this Project have been identified by the Project Manager will be detailed in the Project Organisation Chart which will be referenced to in the Project Execution Plan. The Organisation Chart shall be regularly reviewed to reflect any changes to the Project Team members or structure.

The responsibilities and authorities of the personnel are defined in job descriptions. The specific responsibilities of staff in relation to Quality are detailed below. A person can act in more than one role on a project however the following descriptions define the scope and responsibility of each of these roles.

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5.1.1 Project Manager

The Project Manager has the overall authority in the determination of all matters affecting the implementation and operation of Quality practices on the Project. The Project Manager is responsible for:

- identifying resources and equipment for Project Quality purposes
- ensuring training is provided to improve awareness of Quality issues
- incorporating Quality Management aspects in Project Planning
- ensuring Project Operations are performed in accordance with Project requirements
- reviewing the effectiveness of the Project related systems for continuous improvement and enforcing the implementation of systems updates in relation to continuous improvement
- ensuring that all Contractors fulfil their contractual obligations.

5.1.2 Engineering Manager

The Engineering Manager, in conjunction with the Project Manager, is responsible for ensuring that Engineering personnel are fully aware and understand the Quality requirements of the Project. The Engineering Manager is responsible for:

- overseeing preparation of Design Drawings and Technical Documents
- ensuring the Design is prepared in accordance with the Project Scope and Governing Code/Standards
- ensuring that applicable Code/Standards and Quality requirements are included in the technical documentation
- incorporating Quality Management aspects into engineering activities
- ensuring engineering targets and programmes are achieved
- ensuring capture of data in accordance with engineering procedures and checklists

5.1.3 Construction Manager

The Construction Manager, in conjunction with the Project Manager, is responsible for ensuring that Project construction personnel are fully aware and understand the Quality requirements of the Project. The Construction Manager is responsible for:

- ensuring that adequate resources and equipment are available for carrying out the work on site
- incorporating Quality Management aspects into construction activities
- reviewing the effectiveness of the Site Quality System for continuous improvement in conjunction with the Project Quality Manager, and assisting the implementation of updated systems in relation to continuous improvement
- ensuring construction targets and programmes are achieved
- ensuring capture of data in accordance with ITPs/checklists etc
- ensuring all procedures on the project are complied with and specific personnel have defined Quality Assurance duties specified within their duty statements/position descriptions.

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5.1.4 Project Engineers

Project Engineers shall report to the Project Manager and shall take ownership and accountability for the delivery of an allocated Project Scope.

- Scope of Works/Services/Materials/Products to be provided
- Technical requirements (Specification, Standards, Codes, Testing)
- Quality requirements for products, equipment and services
- Documentation requirements (e.g. as-builts, warranties, technical data etc.)
- Contractual obligation (terms and conditions, delivery milestones, vendor design approval, change management process)
- handling, storage, packaging and delivery requirements
- coordination with third parties (e.g. inspections, freight forwarder, customs agent)
- progress reporting requirements during the fabrication/manufacturing process.

5.1.5 Project Quality Manager

The Project Quality Manager (PQM) reports directly to the Project Manager. The PQM may allocate tasks to the Project Engineers, Quality Inspector (or 3rd party inspectors), and any other Project Quality personnel, but remains responsible for:

- ensuring that the Project Quality Plan is implemented to meet the requirements for the Project
- reviewing quality aspect of tenders submitted to Project from suppliers and contractors and being involved with Pre-Qualification of suppliers and contractors as directed by Package Engineers
- reviewing quality requirements of tender packages prior to issuing to Suppliers and Contractors
- conducting Criticality Assessments to establish appropriate Supplier and Contractor surveillance levels
- reviewing and approving Supplier's and Contractor's quality documentation prior to commencement of work, and at the completed MDR stage
- consulting with Project, Engineering, Procurement, Contracts, Construction and Commissioning Managers on Quality matters
- approving 3rd party inspection agencies and scheduling inspections
- ensuring that vendor inspections are carried out as planned, and recorded on appropriate inspection plans and assignments
- conducting both internal and external Quality System audits
- liaising with the Client to ensure satisfactory completion of Quality Conformance checks
- inspection of incoming material for compliance in accordance with Codes, Standards and Specifications
- ensuring the quarantine of non-complying product
- ensuring Non-Conformances are reported and corrective/preventative actions taken, and recorded in a Project NCR Register

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- reviewing inspection reports and ensuring any actions required are initiated and closed out or resolved
- ensuring that all contractors fulfil their contractual Quality Management obligations
- preparing and submitting Project Quality Reports
- attending meetings on Quality issues
- ensuring that products' traceability requirements are met
- on and off site inspection of fabricated items for the Project as directed by the Project Manager
- reviewing and approval of NDE requirements, welders' qualifications, welding procedures, weld maps and material traceability drawings; and provide welding information to Supervisors
- liaising with Engineering, Construction and Inspection personnel during the execution of the Project to ensure that all contractual and statutory records requirements are understood and reflected in Inspection and Test Plans and associated documentation
- ensuring progressive compilation of the MDRs, including setting up of filing requirements as defined in the MDR Index, and ensuring that all records of Inspection and Test are in compliance with the Project specified Codes, Standards and Specifications. With the assistance from engineering personnel and Document Controllers, consolidation of all records for inclusion and final handover to the client
- reviewing Supplier Performance at close out stage and reporting accordingly
- final review and handover of the MDRs to the Client.

5.1.6 QA Inspectors/Site Engineers

QA Inspectors/Site Engineers shall report directly to the Construction Manager and/or Project Quality Manager, and shall be responsible for the following:

- Overseeing completion of Work in accordance with project documentation
- tracking of ITPs, Quality forms and checklists
- performing Quality Inspections including visual inspection of fit up and/or installation works and verifying on checklists
- monitoring, with the Project Quality Manager, the implementation of Construction activities to ensure their adequacy and conformance to Codes, Standards and Specifications
- in conjunction with welding inspectors, ensuring that all required NDE and Test requirements are carried out and complete as specified to Codes, Standards and Specifications
- ensuring all "Hold, Witness and Verification" points are verified
- with the Project Quality Manager, witness inspection and testing
- in conjunction with Project Quality Manager, utilising the Non-Conformance process to identify defective workmanship and materials
- marking out and reporting on unsatisfactory/defective areas for rework or repair
- verifying that corrective and preventive action is taken when required for non-conforming work
- assisting the Project Quality Manager with compilation of the MDRs.

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5.2 Competence, Awareness and Training

Personnel performing specified assigned tasks are to be qualified on the basis of appropriate education, training and/or experience as required. Competency assessments, identification of training needs and the provision of training for personnel shall be identified by the Project Manager during the Project setup and execution, and revised, as applicable, throughout the life of the Project.

6 Specific Operational Controls

6.1 Design Control

Design Control is achieved through the documented Deliverables Verification process to ensure that:

- design input/output requirements are identified, documented and reviewed for adequacy
- design quality requirements are identified, specified and included in the project technical documentation
- the design and drawing activities are properly planned, and milestones at which design documents are to be produced and/or reviewed, are identified and approved by the Engineering Manager or the Lead/Nominated Engineer and, where relevant, the Client
- the milestones at which design verification will be performed are established and identified
- design documents are identified and controlled to record design and safety considerations, analysis, calculations, assumptions, development, feasibility studies and analysis, and decisions made from tender to detail design stage
- design output meets the design input requirements and safety requirements, as verified by means such as design reviews, qualification tests, alternative calculations, and comparison with proven design as applicable
- the design is reviewed prior to release to assure the project that it has been appropriately verified at all key points and that verification records are complete
- evidence of verification is indicated on documents by signature and date

Design changes, whether originated by the Contractor, the Client, or EPCM contractor, shall be processed according to Change Management Protocol approved for the project.

6.2 Codes and Standards

Project design will be developed based on the latest edition of applicable Codes, Standards, Laws and Regulations. The specific Codes and Standards used will be included in the Project Design Criteria, Project Specifications, Drawings and Datasheets.

Furthermore, Project Technical documentation specifies any additional inspection and testing requirements where not covered by relevant codes or standards.

Typical technical reference Codes are noted below, however engineering project documents provide detailed Quality requirements and serve as a basis for Quality inspection, testing and acceptance.

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Table 1 – Typical Technical Reference Codes/Standards

Code	Description
ASTM American Society for Testing and Materials	Various materials and testing standards
ASME American Society of Mechanical Engineers, BPVC Codes	Boiler &Pressure Vessels and Welding Codes
AWS - American Welding Society	D1.1 Structural Welding Steel; D1.4 Reinforcing steel; D 1.6 Stainless steel
ISO 12944	Painting systems and environment classifications
SSPC – Society for Protective Coatings	Steel surface preparation and surface coating inspection standards
ACI – American Concrete Institute	Concrete, reinforced concrete standards

6.3 Document/Records Control

The fundamental purpose of the document and data control procedure(s) is to ensure that all documents and data affecting product quality and final acceptance are reviewed for adequacy, and approved by authorised personnel, prior to release, and that applicable issues of relevant documents are available at all points of use.

Project Documents and Records will be numbered and revision controlled. Naming and Numbering of documents can also be adjusted to meet specific requirements of Client's filing system as needed.

The project will be using integrated Document Management system for electronic filing and management of documents, records and correspondence. Documentation will be filed in accordance with established Project Filing structure. Critical Email correspondence shall be filed along with other project documentation in the applicable folders of the document control system.

Issue and receipt of the documents externally is accomplished through Document Control function using computer generated and traceable Document Transmittal.

Where required on construction site, a hard copy filing system will also be established. The Document Controller in liaison with the Project Quality Manager shall establish a hard-copy filing index to ensure that records are indexed and filed in a manner to facilitate easy retrieval of information and shall align with the electronic filing index.

6.4 Archiving

Project documents are to be archived for the periods specified by The EPCM Contractor archiving procedure and contractual requirements.

7 Procurement and Contracts Management

7.1 Procurement and Contracts Control

Procurement and Contracts will be managed in accordance with the respective Strategy and Management Plans.

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Based on criticality to the successful completion of the Project, potential Suppliers/Contractors will be pre-qualified using either recommendation by the Client, previous successful experience with EPCM contractor projects, pre-qualification form; visit to the Supplier/ Contractor premises to perform a survey or combination of the above.

When a visit to the Supplier/Contractor premises is required, the Project Engineer, allocated Quality person and other relevant Project team members will make an assessment of the proposed premises and sites and their operations to establish or clarify their capacity and capability to meet Project requirements.

Once the Supplier/Contractor has been selected, and prior to any notification being made of award of the Purchase Order or Contract, the EPCM contractor ensures that the necessary approval level signatures are obtained and establishes whether Client approval is required.

Procurement Manager and Contracts Manager are responsible to ensure that the tender/procurement documents cover all relevant items including:

1. scope of works/services/materials/products to be provided
2. quality standard requirements
3. delivery/services schedule
4. materials/products specifications
5. documentation requirements
6. handling, storage, packaging and delivery requirements
7. coordination with 3rd parties (e.g. inspections, freight forwarder, customs agent)
8. progress reporting requirements during the fabrication/manufacturing process.

Standard Quality Requirements are included in the Contract “Provision of Materials, Equipment or Contract Services”. Additional details, specific to each Contract/Package are given in project technical documentation.

7.2 Quality Surveillance Level

The Project Quality Manager will assist the Project Manager (in liaison with the Project Engineering and Procurement Managers) with identification and ranking of equipment and service packages based on their criticality to the successful execution of the Project. Packages will be assessed using the Supplier Quality Surveillance Assessment Form (Appendix 5) and the resulting criticality ranking will determine the level of surveillance and verifying documentation required from each Vendor/Contractor.

8 Construction Quality Management

8.1 Construction Quality Control (QC) and Quality Assurance (QA)

Contractors and Vendors are responsible for conducting Quality Control of their work and Quality Assurance of their sub-contractors Quality. The Contractor/Vendors shall carry out quality tests in accordance with the requirements of the Scope of Work, Technical Specifications, Engineering Specifications and Drawings.

The EPCM Contractor is responsible for overall Quality Assurance of the project. Construction Quality Assurance will consist of:

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- monitoring Quality Control and Quality Assurance processes implemented by contractors/vendors;
- conducting independent Quality Assurance verification testing with frequency determined based on criticality rating for each contract;
- conducting periodic Quality Assurance audits to ensure approved protocols are in use.

The Contractor's Quality Control inspection/testing and EPCM Contractor Quality Assurance verification will form the basis for acceptance of the Work. In case of disagreement between QC and QA testing the discrepancy shall be resolved following protocol noted in Section 8.6.

8.2 Contractor/Vendor Quality Control Requirements

The Contractor/Vendor shall be responsible for all aspects of the quality of the Work, and shall put into place a suitable Quality Control Program to ensure that quality standards are met, and that the Work meets the requirements and intent of the Project Documents.

The Contractor/Vendor shall conduct, at its own cost, all necessary quality control testing and sub-contractors quality assurance verification that is required to demonstrate that Work conform to the Project Documents.

The Contractor/Vendor shall provide valid calibrated equipment and qualified personnel to perform all quality control field and laboratory testing necessary to determine and monitor the characteristics of the materials produced and incorporated into the Work.

The EPCM Contractor may carry out Quality Assurance testing and in order to provide assurance that Work is in accordance with the Contract and to verify the Contractor's quality control data. Testing and inspection by The EPCM Contractor will not relieve the Contractor/Vendor of its responsibility to perform quality control testing and inspection.

Kick-off meetings will be conducted by EPCM contractor personnel prior to commencement of each Package and Contract so that Quality Requirements can be reviewed and confirmed with Contractor/Vendor.

8.3 Contractor Submittals

The Contractor/Vendor shall submit a Quality Control Plan, Construction Procedures, Inspection and Testing Plan (ITP) and other documentation required by Contract in accordance with Vendor Drawings and Data Requirements (VDDR) as specified for each contract/package prior to commencement of Work for EPCM contractor review and approval.

The Contractor/Vendor Quality Control Plan shall include but not be limited to the following:

- The procedures that will be adopted by the Contractor to ensure conformance with the requirements of the Specifications and Drawings.
- Construction work plans for each phase of the work to be performed
- Qualification statements for all tradespersons.
- The name of QC independent inspection and testing agency, where applicable that will be used to monitor the quality of the Work.
- Welding procedures, qualifications and related requirements.
- Painting, Lining, and Protective Coating procedures.
- Document control procedures

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- Non-conformance tracking and remediation.
- Inspection and Testing Plans (ITPs) for the Contractor/Vendor and any Sub-Contractors – detailing frequency of tests, acceptance criteria, responsibilities for review and approval.
- Inspection and testing methods, including testing of materials, soil compaction, concrete strength, welds, protective coating, pipeline leakage, etc., and a description of what methods will be used if not specifically listed in the contract Documents.

ITP shall be provided for each critical construction/installation step noted in the Vendor/Contractor schedule and the following points shall be identified:

- acceptance criteria and records produced
- each stage of the process covered by the ITP
- stages subject to any QC independent examination
- inspections to be carried out by the subcontractor/supplier, or witnessed, by any third party or the contractor
- hold points beyond which work cannot proceed before completion of all verification and related activities.

Refer to Appendix 4 for an example of acceptable ITP format.

8.4 Contractor Quality Control Inspections and Testing

Minimum testing and inspection requirements shall be in accordance with the requirements of the Project Documentation and all applicable Laws, Regulations, Standards and Codes and approved contractor's ITP.

Upon completion of QC testing, the Contractor/Vendor shall submit copies of quality control test results to the EPCM Contractor within twenty-four (24) hours of them becoming available. The Contractor shall provide copies of inspection and test results to its subcontractors and suppliers where quality assurance tests were performed on materials, products, or work supplied or undertaken by them.

All Supplier and Contractor ITPs are to be reviewed and approved by the Project Quality Manager (or nominee) prior to commencement of the work applicable to the ITP. The Project Quality Manager (or nominee) shall ensure that QC Hold and Witness Points are included in the ITPs at the appropriate stages based on the determination of critical processes in construction/installation.

The EPCM Contractor will impose QA witness and hold points at the critical stages on the Contractor's ITP. The Contractor shall not proceed with the Work until a QA hold point has been released by an EPCM contractor representative. The Contractor shall notify the EPCM contractor representative when areas of work are completed and ready for inspection, testing and approval. The Contractor shall allow adequate time for the EPCM contractor representative's review to be performed.

The Contractor shall report, track, correct, and retest any deficient Work determined by the QC or QA inspection at no additional cost.

Where a section of the Work, or a product, is found to be in non-conformance by quality control (QC) or assurance (QA) testing, the Contractor shall increase the frequency of quality control testing on adjacent areas or similar products.

8.5 EPCM Contractor Quality Assurance

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The EPCM contractor representative shall be granted safe access to the Work at all reasonable times for the purposes of Quality Assurance inspections and/or tests.

EPCM contractor Quality Assurance (QA) will consist of the following:

- The EPCM Contractor will conduct periodic quality audits of Contractor's protocols and documentation to ensure Work is conducted according to approved work plans and procedures and that documentation is maintained in the manner prescribed by the contract. Refer to Appendix 3 for QA Audit schedule template.
- The EPCM Contractor representative will attend to all QA witness and hold points noted on Contractor approved ITPs and sign off QC check lists for all disciplines.
- The EPCM Contractor , directly or using third party agencies will carry out QA inspections, measurements, and testing of the Work in order to assure that the quality of the Work is in accordance with the requirements of the Contractor/Vendor's contract and to check and verify the quality control results and records of the Contractor/Vendor's Quality Control Program.
- The frequency of Quality Assurance verification testing and inspections will be determined for each contract/package and each Trade based on work criticality Refer to Supplier Quality Surveillance Assessment Form in Appendix 4.
- The frequency of QA verification testing and inspection will be adjusted based on the results of the QC and QA tests.

The EPCM contractor will give the Contractor timely notice of the intention to carry out any specific QA inspections and tests. The EPCM Contractor may, however, carry out routine inspections and tests on any part of the Work without notice. Once notice has been given by the EPCM Contractor, the Contractor shall not cover, or permit to be covered, Work that has been selected for specific tests.

All or any part of the Work, and any off-site locations where material or products for the Work are being prepared or stored, may be inspected by the EPCM Contractor when and as often as deemed expedient in order to meet the objectives of quality assurance. Refer to Appendix 2 for the QA inspections register template, which will be used to plan and document QA inspection for fabrication, construction and equipment installation.

Examples of Construction QA activities will include:

- Review the Contractor's QC Program and inspection test procedures.
- Review the Contractor's submittals
- Identify hold points on the Contractor's ITP's
- Review the Contractor's QC test results, reports and certificates
- Review and witness the construction of the Works
- Raise Non-Conformance for deficiencies they identify
- Review and comment on all Non-Conformances identified by the Contractor or the Inspectors
- Confirm acceptance or report Non-Conformances to the PM
- Conduct QA testings (concrete, welding NDE, coating, etc.)
- Identify and request third party material testing and inspections.

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- Review third party inspection and testing reports and take appropriate actions if deficiencies are identified.
- Issue Daily and Monthly Construction Reports summarizing QA activities.

8.6 QC and QA testing discrepancy resolution

The Contractor may challenge the results of any Quality Assurance tests indicating non-conformance and differ from the results of QC tests. The section of the Work in question shall be re-tested by an independent testing agency acceptable to both the Contractor and Client. Should the re-test confirm the results of the earlier test, the Contractor shall bear the costs of the additional tests. Should the re-test indicate conformance with the required quality standards, the Client shall cover the costs of the test.

8.7 Final Inspection

The purpose final inspection is to ensure that prior to offering items and/or completed services for acceptance by Client and/or Statutory Authority:

- all inspections and tests have been satisfactorily completed
- all necessary inspection records are available for verification.

Finished items and/or completed services are inspected for:

- compliance with drawings, specification and referenced standards
- functionality
- appearance
- quantity
- correct identification
- conformance with any other final inspection requirements specified on the ITP.

Refer to Appendix 5 for the construction and installation QA checklists which will be used for Final Inspections.

9 Products, Services and Material Traceability

9.1 Products, Services and Material Traceability

Each product or service will be appropriately identified and be traceable to the contract and/or technical documentation, at all stages from receipt through to dispatch or in the case of site work, commissioning. Material Traceability levels will be in accordance with the requirements of the design standards for the project.

When, and to the extent, required by a contract, Code or Statutory Authority, each product or service shall have its unique identification recorded on all relevant documents and records, so as to enable traceability from beginning to end.

Identification and traceability requirements in respect of design/drawings/specifications, etc. are set out in EPCM Contractor drawing office procedures.

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The Project Quality Manager will ensure that Suppliers and Contractors comply with the relevant traceability requirements applied to items or services in their Scope of Work.

The Traceability Level for off-site fabrication works shall be entered into the Technical and Procurement documentation. If the traceability level varies for different components of a fabricated item, this shall also be noted.

9.2 Control of Customer (the Client) Supplied Items

Where the Client has supplied material or individual loose items for incorporation in the Project, these are appropriately identified as the Client property to avoid possible loss or accidental use on other work. Client supplied products/materials which are not to be immediately incorporated into the works shall be stored.

Client supplied design documentation will be reviewed for adequacy and accuracy and any anomalies or clarifications required will be addressed and resolved at contract review or, where they come to light.

10 Control of Non-Conforming Products

10.1 Control of Non-Conforming Products

The EPCM Contractor will be responsible for managing Project Non-conformance log.

All non-conforming products will be identified and controlled to prevent misuse until such time as disposition requirements are identified and project approved is received.

Types of disposition include:

- rework or repair to bring back to a compliant state
- use as is
- scrap

The dispositions may be subject to concession control as defined below.

Any Project personnel (including Client personnel) identifying a potential non-conformance shall notify the EPCM Contractor Project Manager or Discipline Engineer, who shall investigate the issue and confirm a non-conformance (NCR). Where a non-conformance is confirmed, a Non-Conformance Report (refer to Appendix 4) shall be raised detailing the nature of the non-conformance in accordance with the EPCM Contractor NCR Procedure.

The NCR shall be forwarded to the Project Quality Manager or nominee for registering and issuing of a unique number and the electronic copy forwarded to the relevant Discipline Engineer, Supervisor Supplier and/or Contractor. The PQM is responsible for logging of the NCR, review, approval and/or rejection of the proposed remedial action and final close-out of the non-conformance with the assistance of the relevant Supervisor/Lead/Manager.

Corrective and Preventative actions shall be established to address appropriate actions to correct non-conforming product and to assess the reasons for “failure” with a view to prevent re-occurrence. All corrective and preventative actions will be appropriate to the degree and severity of the non-conformity.

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10.2 Concessions

The EPCM Contractor, in collaboration with suppliers/sub-contractors, may need to raise proposals for concessions for disposition of products that do not exactly meet specified requirements but, in the EPCM Contractor's opinion, are suitable for their intended use.

All proposals for a concession shall be subject to the approval of the design and quality representative, and if specified, the Client Representative(s).

This review/approval shall include specific details of the procedures to be followed to assure suitability.

The Contractor shall keep records of all changes as they occur (mark-ups of drawings and specifications), which will be compiled at the end of the project into Record Drawings.

11 Commissioning and Client Handover/Test Packs

Site equipment commissioning is supported by Test Packs developed during construction and completed by the addition of commissioning test records. The Test Pack is a compilation of construction and installation QC verification documents and is handed over to commissioning at the completion of pre-commissioning testing by the construction team.

The commissioning team will add commissioning checklists to the Test Packs as each level of testing is completed. The test packs are progressively combined into the integrated system documentation until the Performance Testing , Area Handover to the client and Commissioning Closeout are completed.

The Project Quality Manager will maintain an actively interface with the Commissioning team to ensure that issues with as-built compliance, completions and documentation are expeditiously identified and reconciled.

Commissioning activities will be audited for compliance to the Project Procedures by the Project Quality Manager or authorised delegate.

11.1 Manufacturer's Data Record (MDR)

The EPCM Contractor shall be responsible for providing a suite of documentation verifying that all necessary inspections, checks and testing requirements have been met prior to Plant System Handover for all work in the Project scope. The EPCM Contractor Quality Requirements noted in the Vendor/Contractor Contracts shall be used to create MDR Index.

Work shall not be considered as complete without the submission of Certification Records (e.g. inspection/completion reports) to the Client for approval and sign-off. These records shall be formulated and submitted progressively in parallel with construction activities.

Compilation of this documentation together with Manufacturer's records, if applicable, shall be made progressively throughout the Project and will constitute the Project Document and Data Deliverables handover to the client as a set of Manufacturer's Data Records (MDRs).

Certification Records shall be kept current throughout the execution of the Project. The Document Controller/Project Quality Manager shall ensure that the Certification Records are

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maintained and compiled in a professional manner and filed on documents and records control system.

Electronic and/or hardcopies formats of MDR shall be prepared as per agreement with the Client.

All documents included in the MDRs shall be written in English, be clear and legible. MDR first volume shall contain an index for the entire set. Every other volume shall include an index for the contents of that specific volume. Each volume shall be clearly labelled.

Completed MDR shall be delivered to the Client no later than 12 weeks after EPCM Project completion of works.

12 Performance Measurement and Monitoring

12.1 Audits

The Project Quality Manager (or delegate) will develop QA audit schedule and conduct Internal and External Project QA Audits to ensure that Project approved protocols are implemented and followed. Refer to Appendix 3 – QA Audit Schedule:

- Internal audits are conducted to ensure the management system is operating effectively.
- External audits carried out on suppliers/sub-contractors to ensure that products/services supplied comply with the specified requirements.

12.2 Lessons Learnt

The Project Quality Manager shall collect lessons learnt through the duration of the Project and analyse them to identify opportunities for improvement and to avoid the recurrence of the problems.

Lessons learnt resulting in Process Improvements (as agreed by the Project Manager and other applicable Project team members) will be incorporated into the Project Plan and Procedures and issued to Project Team members for implementation.

As a minimum Lessons Learnt will be recorded at:

- detailed design completion
- commencement of site construction
- project closeout.

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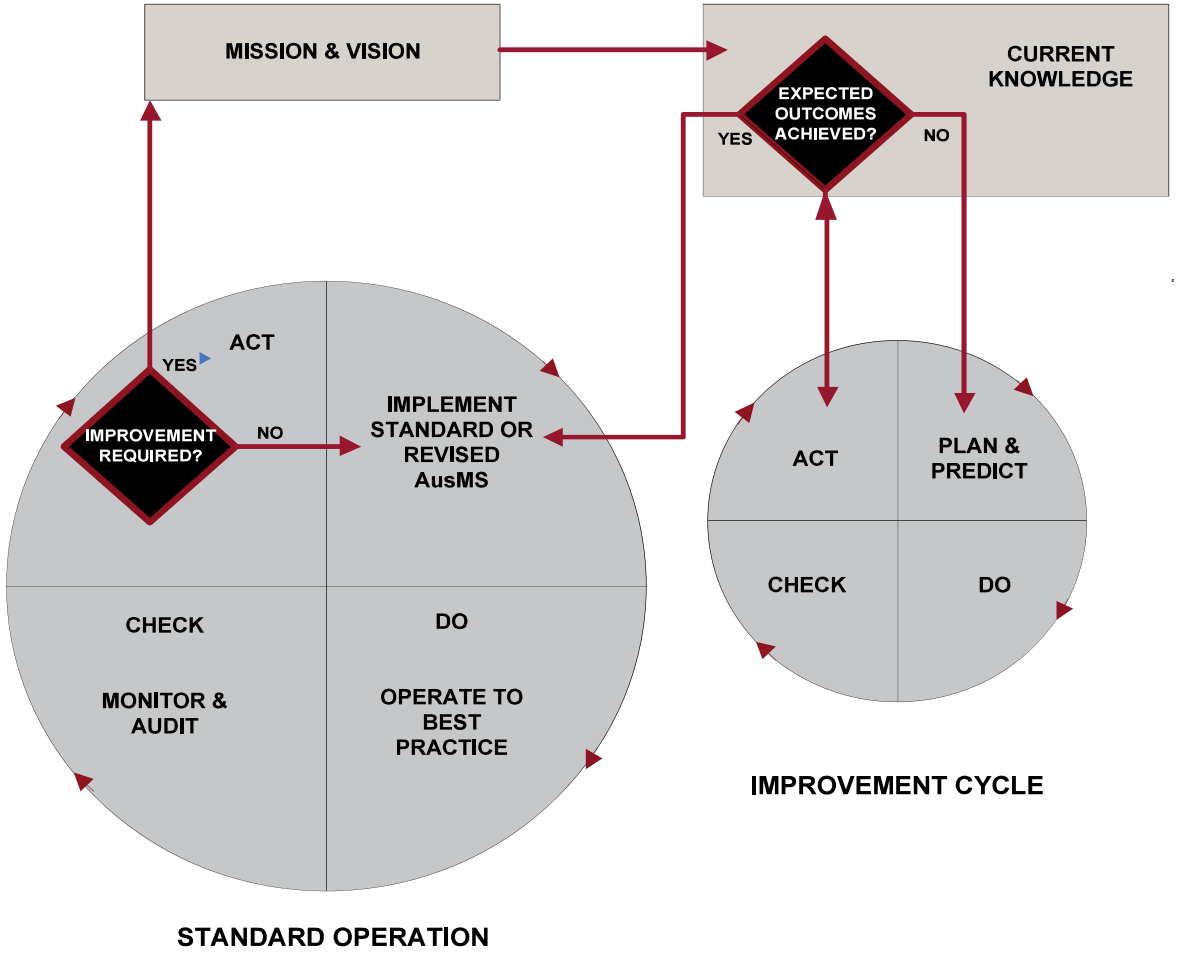
Appendix 1 – Continual Improvement Cycle



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CALICO RESOURCES

Appendix 2 – Quality Assurance Inspection Register

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QA Inspections Register

Activity ID/MR Number/PO Number	Description	- inspection date	Prime Supplier	Sub-Supplier	Inspection Scope	Acceptance documents	Surveillance Level	QA Inspection frequency	Contractor ITP# step#	QA Inspector Name

0 Total forecasted hours
0 Total hours used to date
0 Total hours remaining

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Appendix 3 – Quality Assurance Audits Schedule

QA Audit Program II Form

			Scheduled:	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug			
Audit area	Audit Type/Audit Category	Assigned Auditor (s)	Duration	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

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Appendix 4 –QA Documentation Examples

1. Suppliers Quality Surveillance Assessment Form
2. Vendor/Contractor ITP format example
3. Construction Daily report template
4. NCR Report template

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Supplier Quality Surveillance Assessment Form

|| Form

Part A – Supplier Details

Supplier Name:	
Address:	
Telephone No:	
Facsimile No:	
P.O/Contract No:	
Description:	
Scope of Supply:	

Part B – Supplier Quality Surveillance Criteria

The following matrices provide a method for the objective assessment of a surveillance rating based on scoring the Supplier on a set of four criteria.

Additional risk factors to be considered when rating Surveillance are the country of manufacture and the extent of subcontracting that will be used. (e.g. if manufacture is in a country or from a supplier where problems have been encountered previously, the rating score may need to be adjusted and the next level of surveillance applied).

A. Safety and/or Quality Significance of the products and services to be supplied.

Rating:
- ☐ Low criticality
- ☐ Medium criticality
- ☐ High criticality

B. Cost Value of products/services to be supplied.

Rating:
- ☐ Low cost value
- ☐ Medium cost value
- ☐ High cost value

C. Scope of products/services to the Project programme.

Rating:
- ☐ Low potential to impact Project programme
- ☐ Medium potential to impact Project programme (long lead items or availability)
- ☐ Critical path items

D. Complexity of the scope of products/services to be supplied.

Rating:
- ☐ Low complexity, standard or simple items of supply
- ☐ Medium complexity
- ☐ Highly complex scope of supply

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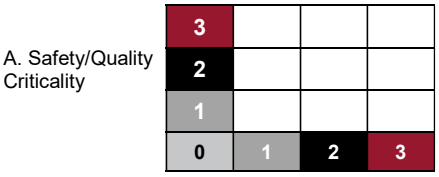
Part C – Supplier Quality Surveillance Scoring

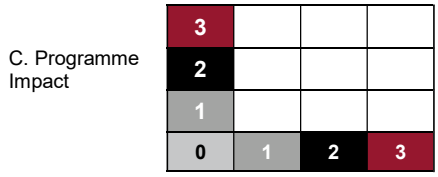
Rate surveillance on all criteria and position score on the matrix correspondingly (e.g. 2x3=6, 1x2=2)

Safety/Quality versus Cost Value
(A versus B)



Score: ☐

Programme Impact versus Complexity
(C versus D)



Score: ☐

Part D – Supplier Quality Assessment & Surveillance Level

Determine final rating based on the score achieved in either matrix in Section C (i.e. use the highest score achieved. If two and four are scored, then assume four).

Rating	Score	SQ Level	Quality Assessment Action
Non-critical	0	0	No inspection required
Low criticality	1	1	Final Inspection/release by appropriate third party. Usually indicates visits at end of the assignment, but may include an initial inspection.
Medium criticality	2	2	Witness & Hold Points, and Final Inspection/release by Ausenco appointed inspector. Visits include those indicated on ITP as Witness and Hold Points, and Final inspection/release.
Highly criticality	3-4	3	Includes the same as SQ Level 2, but includes frequent stipulated visits (e.g. fortnightly or weekly).
Extremely critical	6-9	4	Resident Ausenco appointed inspector. Audit and review against specific scope and consider scheduling a multi-discipline review/audit and release. Continuous inspection for the full allocated assignment period.

SQ Surveillance Assessment Completed By: _____

(Name & Position)

Date: _____

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Inspection and Test Plan Form || Form

Name of Author:	**Revision No.:**
Position Title:	**Issue Date:**
Document Number:	**Page 1 of 1**

Project Name:		**Contractor Number:**	
Project No.:		**Contractor Name:**	
Client:		**Equipment Name:**	

1. Activity #	2. Process Activity	3. Reference (Specifications, Drawings, Work Instructions)	4. Acceptance Criteria	Inspection Point (W=Witness, H=Hold, V=Verification, S=Surveillance, R=Review)			8. Comments/Records	9. Tests Completed OK (Initial)	10. Date Inspected
				5. Sub-supplier/ Sub-contractor	6. Supplier/ Contractor	7. Company Representative			

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Daily Construction Report || Form

Job no.: _____ Site: _____ Date: _____

(Design/Construction/Commissioning) Day: _____

Summary

Weather	☐	☐	Fine	☐	☐	Raining	☐	☐	Windy	Rainfall	_____ mm
	AM	PM		AM	PM		AM	PM			
Temperature	☐	☐	Warm	☐	☐	Cool					
	AM	PM		AM	PM						

Site Workforce

Accidents or Incidents: _____

Inductions		

Daily Record; QC/QA activities; NCRs

Item	Events and Details	Action

Raised by: _____

Distribution: Site file

Head office

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Job no.: _____ Site: _____ Date: _____

(Design/Construction/Commissioning) Day: _____

Item	Events and Details	Action

Raised by: _____

Distribution: Site file

Head office

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Non-Conformance Report || Form

Ausenco procedures require that anomalies are recorded with a corrective action. This report is a permanent record of corrective and preventive actions taken to address non-conformance(s).

Section One: General Information			
NCR #:		Date:	
Initiated by:		Project #:	
Client:		Project Title:	
Business Process:		Project Manager:	
Business Process Owner:		Advisory Date:	
Manager Assigned:		Advisory Date:	

Section Two: Description of Non-Conformance			
Initiator completes this section:			
Type (tick one): ☐ Non-Conformance ☐ Non-Conforming Product ☐ Client Complaint			
Description (include requirement reference and clause):			
Immediate Actions Taken to Correct:			
Assigned to:		Completion date:	

Section Three: Investigate Root Cause and Plan Action		
Assignee completes this section:		
Root Cause Investigation:		
Type (tick applicable):	☐ Corrective Action	☐ Preventive Action
Action Plan:		

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Name of Actionee:		Target Completion date:	
Name of Assignee:		Date:	
Section Four: Action Completed			
Actionee completes this section:			
Details of Action Completed:			
Name of Actionee:		Date:	
Approved by Assignee:		Date:	
Section Five: Verify Effectiveness and Close Out			
Quality completes this section:			
Proposed follow-up date:		Assigned to:	
Details of Verification:			
Signature:		Date:	

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Appendix 5 – Selected Final Inspection QA Checklists

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C0 – Pre-Commissioning:

Tank Installation	**Test Report** C0 – M – 015

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	Installation checked against Drawings	☐	☐	☐
2.	Materials of construction as per Specification and Drawings	☐	☐	☐
3.	All debris and waste material removed from Tank and Bund Area	☐	☐	☐
4.	Drain Valve Installed Correctly and gasket in place and all bolts tight	☐	☐	☐
5.	Inspection Door/Manhole Covers Gasket in place and bolts tight.	☐	☐	☐
6.	Sealant in place and not damaged between base of tank and ring bream	☐	☐	☐
7.	Foam material removed around base of concrete ring bream and sealant in place	☐	☐	☐
8.	Floor Plate, Handrails and Kick plates installed and secure.	☐	☐	☐
9.	All Timber flooring captured within stops welded to the steelwork	☐	☐	☐
10.	Tank Baffles welded or bolted in place	☐	☐	☐
11.	Downcomers Installed	☐	☐	☐
12.	Gaskets correct type, in place and all bolts tight on tank launders	☐	☐	☐
13.	Launder Slide Gates installed/ move freely up and down	☐	☐	☐
14.	Intertank Screen Support Frame in place and secure	☐	☐	☐
15.	If Removable Roof Installed, gasket and bolts all in place and tight	☐	☐	☐
16.	Hydrostatic testing of tank complete (refer to Check Sheet C0-M-05)	☐	☐	☐
17.	Vent Pipe installed and secure	☐	☐	☐
18.	Internal Paint spark tested and repairs completed	☐	☐	☐
19.	No Damaged External Paint work	☐	☐	☐
20.	Air Sparges installed/secured and all nozzles fitted and tight	☐	☐	☐
21.	Cooling Coils installed and secured	☐	☐	☐
22.	Bracing supports for Air Sparges and Cooling Coils secure	☐	☐	☐
23.	Carbon transfer Pump support frame installed and secure.	☐	☐	☐
24.	Tank Number visible on side of tank (painted/signage)	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
25.	All rubber lined tanks signage posted stating (No Welding or Cutting)	☐	☐	☐
26.	Seal Pot Installed and filled with water up to drain hole	☐	☐	☐
27.	Punch list completed	☐	☐	☐

Comments

	Completed by	Approved by	Accepted by
Company:			
Signature:			
Print Name:			
Position Title:			
Date:			

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C0 – Pre-Commissioning:

Welding	**Test Report** C0 – M – 109

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

In Process Inspection/Activity		**N/A**	**Inspected by Contractor**	**Inspected by Engineer**
This checklist is to be filled out at the completion of each work area.				
1.	Material complies with specified requirements.	☐	☐	☐
2.	Weld Procedures/welder qualifications. issued and approved.	☐	☐	☐
3.	Pre-fit up/cleanliness, root gap, landing-welding check.	☐	☐	☐
4.	Dimensional checks to drawing acceptable prior to weld out.	☐	☐	☐
5.	Consumable verification as per WPS.	☐	☐	☐
6.	Joint and flange alignment acceptable.	☐	☐	☐
7.	In process production weld checks.	☐	☐	☐
8.	Root run visual check/as per code requirement.	☐	☐	☐
9.	Hot pass visual check/as per code requirement.	☐	☐	☐
10.	Capping run visual check/as per code requirement.	☐	☐	☐
11.	Random WPS parameter check applicable as per code requirement.	☐	☐	☐
12.	100 % visual inspection/complies and acceptable.	☐	☐	☐
13.	Post welding checks.	☐	☐	☐
14.	PWHT acceptable/register/as per code requirement. After PWHT replace gaskets as required and retighten flange bolts.	☐	☐	☐
15.	In process NDT conducted/as per code requirement.	☐	☐	☐
16.	NDT completed and acceptable/register.	☐	☐	☐

Comments

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	Completed by	Approved by	Accepted by
Company:			
Signature:			
Print Name:			
Position Title:			
Date:			

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C0 – Pre-Commissioning:

Cathode Winder	**Test Report** C0 – M – 066

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Manufacturer's requirements complied with.	☐	☐	☐
2.	Design checked against Drawings.	☐	☐	☐
3.	All debris and waste material removed.	☐	☐	☐
4.	Bearings where grease nipples fitted (Shaft) have two full pumps with grease gun.	☐	☐	☐
5.	Frame wheels locking pins in place and clearance between wheel and frame sufficient to stop binding.	☐	☐	☐
6.	Rotating mechanism operates freely with no binding.	☐	☐	☐
7.	Cathode support frames installed and secure.	☐	☐	☐
8.	All safety signage installed.	☐	☐	☐
9.	Punch list completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Centrifugal Slurry Pump	**Test Report** C0 – M – 023

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Manufacturer's requirements complied with.	☐	☐	☐
2.	Pump Base Frame bolts in place/Grouting complete.	☐	☐	☐
3.	Installation checked against Drawings.	☐	☐	☐
4.	All debris and waste material removed.	☐	☐	☐
5.	Motor/Pump Shaft locking clamps removed.	☐	☐	☐
6.	Initial fill of lubricant to shaft housing bath complete/checked.	☐	☐	☐
7.	Bearings where grease nipples fitted (Motor/Shaft/Barrel) have two full pumps with grease gun.	☐	☐	☐
8.	Grease Packed Bearing Initial fill checked.	☐	☐	☐
9.	No visible oil leaks.	☐	☐	☐
10.	Ensure no load is transmitted to pump from discharge and suction piping.	☐	☐	☐
11.	V Belt Pulleys Alignment complete (Attach check sheet C0-M-013).	☐	☐	☐
12.	Gland seal Packing in place.	☐	☐	☐
13.	Gland Water piping and insolation valve installed and secure.	☐	☐	☐
14.	Manually rotate pump as per directional arrow with V belts removed. If no free movement adjustment of impeller will be required	☐	☐	☐
15.	Suction and Discharge Pipes installed correctly, right gaskets in place and all bolts tight.	☐	☐	☐
16.	Suction Scuttle plug seals tight.	☐	☐	☐
17.	Isolation Valve on suction line installed correctly, right gaskets in place and all bolts tight.	☐	☐	☐
18.	All Safety Guards Installed and checked for pinch points.	☐	☐	☐
19.	All safety signage installed.	☐	☐	☐
20.	Punch list Completed.	☐	☐	☐

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C0 – Checksheets:

Concrete Pour Record	Test Report C0 – C – 010

Project Title:		**Contract No:**	
Date:		**Weather:**	
Pour Commence Time:			
Concrete Docket Numbers			
Cylinders Take:	☐ **Yes** ☐ **No**		

Pour Location Details/Description:				
1.	Pour Reference			
2.	Drawing Reference			
3.	Mix/Code Reference			
			Actioned by	
4.	**A Drawing Quantity**	M^3	**Engineer ^^**	
5.	**B Site Measure Quantity**	M^3	**Engineer**	
6.	**C Delivered Quantity**	M^3	**Engineer/Foreman**	
7.	**D Placed Quantity**	M^3	**Engineer/Foreman**	
8.	**E Loss on Pour (A-D=E)**	M^3	**Engineer Calculation**	

^^ From Weekly Programme.
* If Placed quantity is less than delivered (i.e. does not match C) identify location of used below.

Record of Concrete used in other Locations:

Possible reason for any loss on Pour (E above)

Quality Assurance Report Details				
Pour Progress OK	☐ Yes ☐ No	**NCR?**	☐ Yes ☐ No	
NCR details (as required)				
Interval between Loads				
Pour Rate Restrictions				
Supervisor Responsible		**Prepared by**		

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C0 – Pre-Commissioning:

Concrete Work	**Test Report** C0 – C – 002

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

In Process Inspection/Activity		**N/A**	**Inspected by Contractor**	**Inspected by Engineer**
This checklist is to be filled out at the completion of each work area.				
Pre-Work				
1	Mix design approved by Engineer	☐	☐	☐
2	Work area established as per Scope of Work and confirmed by superintendent	☐	☐	☐
Foundation Preparation				
3	Surveyed and marked-out limit of area	☐	☐	☐
4	Excavation completed as per specification (correct batter slope or benching if required)	☐	☐	☐
5	Subbase material as per geotechnical specification	☐	☐	☐
6	Bearing tests completed, compaction tests completed, compaction levels accepted and within tolerance of specifications	☐	☐	☐
7	Water proofing membrane/blinding installed as per drawing and specification	☐	☐	☐
Reinforcement				
8	Reinforcement fabricated as per drawings	☐	☐	☐
9	Sufficient ties and chairs (non-metallic), rebar clearance	☐	☐	☐
10	Lap lengths and positions, spliced bars in contact and firmly tied together	☐	☐	☐
11	Tie-wire ends turned in to the concrete core	☐	☐	☐
12	Starters capped	☐	☐	☐
13	Surface condition of reinforcement (free of deep rust, scaling, paint or grease)	☐	☐	☐
Formwork Installation				
14	Set out/correctly positioned as per design	☐	☐	☐
15	Shutters fabricated/assembled as per design	☐	☐	☐
16	Forms checked so no potential for grout leaks	☐	☐	☐
17	Props and tubes inspected; free from splits, cracks, visible deformations, rusts and dents	☐	☐	☐

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In Process Inspection/Activity		N/A	Inspected by Contractor	Inspected by Engineer
This checklist is to be filled out at the completion of each work area.				
18	Propped and braced as per design, formwork signed off (greater than 2 m high)	☐	☐	☐
Embedment				
19	Block outs as per drawings	☐	☐	☐
20	Services installed as per drawings	☐	☐	☐
21	Hold down bolts - number, size and position as per drawing, exposed threads protected	☐	☐	☐
Concrete Pour				
22	Concrete finished as per specification and drawings (steel trowel, etc.)	☐	☐	☐
23	Concrete cured as per specification and drawings	☐	☐	☐
24	Concrete joined to existing structure as per specification and drawings (surfaces cleaned and scabbled, construction joints, water stops, bonding paints)	☐	☐	☐
25	Concrete finished to required level, shape, thickness, falls, etc - Confirmed by survey	☐	☐	☐
26	Concrete finished as per specification and drawings (steel trowel, etc.)	☐	☐	☐
Formwork Stripping				
27	Stripping of formwork completed to specification	☐	☐	☐
28	Retardants washed off concrete surface	☐	☐	☐
29	Inspection of concrete completed for spalling, significant blowholes, honeycombing, etc.	☐	☐	☐
30	Formwork ties cut off and grout applied to cut-out location	☐	☐	☐
Backfilling				
31	Backfill material inspected and approved for use as per Scope of Work and specification	☐	☐	☐
32	Backfill placed and compacted as per specifications and drawings	☐	☐	☐
Post-Work				
33	"As-Built" Drawings Completed	☐	☐	☐
34	All items completed as per Scope of Work	☐	☐	☐

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C0 – Pre-Commissioning:

Conveyor	**Test Report** C0 – M – 002

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	Installation checked against drawings	☐	☐	☐
2.	Location and overall dimensions correct	☐	☐	☐
3.	Materials of construction as per Specification and Drawings	☐	☐	☐
4.	All alignments and levels checked and adjusted, in particular:			
	• Stringers	☐	☐	☐
	• Pulleys and pulley bearings	☐	☐	☐
	• Troughing idlers	☐	☐	☐
	• Training idlers	☐	☐	☐
	• Transition idlers	☐	☐	☐
	• Impact idlers	☐	☐	☐
	• Belt	☐	☐	☐
	• Feed chutes	☐	☐	☐
	• Others	☐	☐	☐
5.	All bolted connections checked for tightness, in particular:			
	• Structure	☐	☐	☐
	• Idlers	☐	☐	☐
	• Pulley bearing holding down and alignment bolts	☐	☐	☐
6.	All other connections checked for firmness	☐	☐	☐
7.	Belt drive pulleys alignment sheet C0-M-13 complete	☐	☐	☐
8.	Mechanical Coupling Alignment Sheet C0-M-11 or C0-M-12 complete	☐	☐	☐
9.	Initial fill of lubricant to gear box complete/checked	☐	☐	☐
10.	Hydraulic Reservoir initial fill on fluidised coupling complete/checked	☐	☐	☐
11.	Bearings where grease nipples fitted have two full pumps with grease gun	☐	☐	☐
12.	No visible oil leaks	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
13.	Brake Tension adjustment completed/checked to hold when no power to drive/release when power onto drive.	☐	☐	☐
14.	All rotating components greased and checked for free running, in particular:			
	• Pulleys	☐	☐	☐
	• Idlers	☐	☐	☐
15.	All idlers correctly seated in frames	☐	☐	☐
16.	Freedom of take-up pulley movement checked	☐	☐	☐
17.	Take-up mass _____ kg	☐	☐	☐
18.	Screw take-up adjusted	☐	☐	☐
19.	Holdback on drive checked, in particular:			
	• Arrow on cam face in direction of rotation	☐	☐	☐
	• Torque arm correctly installed	☐	☐	☐
20.	Belt splice test report C0-M-04 complete	☐	☐	☐
21.	Belt weigher installation checked	☐	☐	☐
22.	Belt weigher calibration weights in place	☐	☐	☐
23.	All handrails, safety guards(checked for pinch points) and wind guards in place	☐	☐	☐
24.	All belt and personnel safety devices installed and checked	☐	☐	☐
25.	All grouting complete	☐	☐	☐
26.	All safety signs in place	☐	☐	☐
27.	All debris and waste material moved	☐	☐	☐
28.	All moving parts clear of stationary items	☐	☐	☐
29.	Punch list completed	☐	☐	☐

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C0 – Pre-Commissioning:

Cyclone	**Test Report** C0 – M – 079

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Manufacturer's requirements complied with.	☐	☐	☐
2.	Installation checked against Drawings.	☐	☐	☐
3.	Location and overall dimensions correct.	☐	☐	☐
4.	Materials of construction as per Specification and Drawings.	☐	☐	☐
5.	All alignments checked in accordance with appropriate test report.	☐	☐	☐
6.	All bolts tightened to specified torque.	☐	☐	☐
7.	All pipe work cleaned, treated and correctly installed.	☐	☐	☐
8.	All debris and waste material removed.	☐	☐	☐
9.	Handrails and kickplates in place and secure.	☐	☐	☐
10.	All Safety signs installed.	☐	☐	☐
11.	Signage posted on Cyclone stating (No Welding or Cutting).	☐	☐	☐
12.	Punch list Completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Earthworks Construction	**Test Report** C0 – C – 003

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	Clearing and grubbing completed, rubbish material relocated to waste dump	☐	☐	☐
2.	Excavations completed to required level	☐	☐	☐
3.	Subbase material inspected as per geotechnical specification	☐	☐	☐
4.	Subbase compaction tests completed, compaction levels accepted and within tolerance of specifications	☐	☐	☐
5.	Placement of geofabric sheets as per drawings and specifications	☐	☐	☐
6.	Backfill material inspected and approved for use as per Scope of Work and specification	☐	☐	☐
7.	Backfill compaction tests completed, compaction levels accepted and within tolerance of specifications	☐	☐	☐
8.	Road constructed as per Scope of Work, signage, guiderails and safety bunds installed, finished levels achieved	☐	☐	☐
9.	All areas free draining to sump or outlet, grating on sumps	☐	☐	☐
10.	Culverts and pipes installed as per drawings	☐	☐	☐
11.	Installation of sediment fences as per drawings	☐	☐	☐
12.	All fencing established as per drawings	☐	☐	☐
13.	All items in Scope of Work completed	☐	☐	☐

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C0 – Pre-Commissioning:

Electrowinning Cell	**Test Report** C0 – M – 064

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Equipment installed in accordance with Design requirements, Project specifications and Manufacturers instruction.	☐	☐	☐
2.	Installation checked against Drawings.	☐	☐	☐
3.	All debris and waste material removed.	☐	☐	☐
4.	Ensure Name Plate data is correct.	☐	☐	☐
5.	Adjustable weir installed and secure.	☐	☐	☐
6.	Check all Stainless Steel Anode plates installed.	☐	☐	☐
7.	Check all Cathode Plates installed.	☐	☐	☐
8.	Copper Bus Bar secure, all bolts in place and tigh.t	☐	☐	☐
9.	Inlet and Discharge Pipes installed correctly, right gaskets in place and all bolts tight.	☐	☐	☐
10.	Isolation Valves on inlet/outlet and cell drainage lines installed correctly, right gaskets in place and all bolts tight.	☐	☐	☐
11.	All safety signage installed.	☐	☐	☐
12.	Punch list completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Elution/Acidwash Column	**Test Report** C0 – M – 070

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Manufacturer's requirements complied with.	☐	☐	☐
2.	Installation checked against Drawings.	☐	☐	☐
3.	Verify that the nameplate data is correct.	☐	☐	☐
4.	Column opened/inspected/any waste material removed.	☐	☐	☐
5.	Inspection hatch gasket and all bolts in place/bolts tight.	☐	☐	☐
6.	Support beams bolts in place/Grouting complete.	☐	☐	☐
7.	Ensure that the earthing boss installed as per drawing standard.	☐	☐	☐
8.	Isolation Valves-Inlet/Outlet pipe lines installed, right Gaskets in place and all bolts tight.	☐	☐	☐
9.	Non-Return Valves Installed Correctly.	☐	☐	☐
10.	Busting disc inspected and no visible damage .	☐	☐	☐
11.	Ensure all flanges on Elution Column suitable Class 3 Pressurized Vessel.	☐	☐	☐
12.	Rubber lining inspected and no visible damage.	☐	☐	☐
13.	Pressure release valve installed and ungagged.	☐	☐	☐
14.	Internal Strainers installed correctly.	☐	☐	☐
15.	Manifold installed correctly, all gaskets and bolts correct type.	☐	☐	☐
16.	All thermal and acoustic insulation to Specification.	☐	☐	☐
17.	All debris and waste material removed.	☐	☐	☐
18.	All safety signage installed.	☐	☐	☐
19.	Punch list complete.	☐	☐	☐

Comments

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C0 – Pre-Commissioning:

Fire Water System	**Test Report** C0 – M – 041

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Manufacturer's requirements complied with.	☐	☐	☐
2.	Installation checked against Drawings.	☐	☐	☐
3.	All debris and waste material removed.	☐	☐	☐
4.	Pressure testing of piping complete (refer to Check Sheet C0-M-08).	☐	☐	☐
5.	Piping Installation check sheet complete (refer to Check Sheet C0-M-17).	☐	☐	☐
6.	All safety signage installed.	☐	☐	☐
7.	All Fire Hydrant Cabinets installed correctly and secure.	☐	☐	☐
8.	Water valve opens and closes freely and no pinch points.	☐	☐	☐
9.	Fire Hydrant cabinet contents in particular:	☐	☐	☐
	• Water hose correct type	☐	☐	☐
	• Hose Couplings secured to hose with clamp and tight	☐	☐	☐
	• Coupling gaskets in place	☐	☐	☐
	• Hose Nozzle correct type and gasket in place.	☐	☐	☐
10.	All Hose Reel racks installed correctly and secure.	☐	☐	☐
11.	Manually rotated hose reel cradle to check for binding.	☐	☐	☐
12.	Hose and Nozzle correct type/nozzle clamped to hose and tight.	☐	☐	☐
13.	Hose guide installed and roller moves freely.	☐	☐	☐
14.	Punch list completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Gravity Concentrator	**Test Report** C0 – M – 082

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Punch Lists completed.	☐	☐	☐
2.	Installation checked against Drawings.	☐	☐	☐
3.	Location and overall dimensions correct.	☐	☐	☐
4.	Check maintenance access.	☐	☐	☐
5.	Rotor spins freely.	☐	☐	☐
6.	Piping installed (Concentrate, Tailings, Feed, Water), Feed valve installed.	☐	☐	☐
7.	Check ease of lid removal.	☐	☐	☐
8.	Materials of construction as per Specification and Drawings.	☐	☐	☐
9.	Inspect equipment for signs of damage during installation.	☐	☐	☐
10.	All moving parts clear or stationary items.	☐	☐	☐
11.	All bolts tightened to specified torque.	☐	☐	☐
12.	All grouting complete.	☐	☐	☐
13.	All pipe work cleaned, treated and correctly installed.	☐	☐	☐
14.	All pressure tests complete as Test Report C0-M-008.	☐	☐	☐
15.	All handrails, pull wires, guards (checked for pinch points) and other safety devices installed.	☐	☐	☐
16.	All drains and sumps free of foreign matter.	☐	☐	☐
17.	All debris and waste material removed.	☐	☐	☐
18.	Initial oil fill and greasing complete.	☐	☐	☐
19.	All Safety Signs in place.	☐	☐	☐
20.	All rubber lined tanks/Piping/chutes signage posted stating “No Welding or Cutting).	☐	☐	☐
21.	All Manufacturer's requirements complied with.	☐	☐	☐

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C0 – Pre-Commissioning:

Heat Exchanger	**Test Report** C0 – M – 073

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	Ensure that all equipment is installed in accordance with Design requirements, Project specifications and Manufacturers instructions.	☐	☐	☐
2.	Check Name plate data is correct.	☐	☐	☐
3.	Verify all transport/storage items have been removed.	☐	☐	☐
4.	All debris and waste material removed.	☐	☐	☐
5.	All hold down bolts in place and tight/Grouting completed.	☐	☐	☐
6.	Verify that the heat exchanger position, orientation and level is correct to design requirements and project specification.	☐	☐	☐
7.	Check sliding end expansion bolts are set correctly.	☐	☐	☐
8.	Verify that the correct type/number of exchanger plates and gaskets have been installed correctly.	☐	☐	☐
9.	Inspect all exchanger nozzles and tubes are clear of debris.	☐	☐	☐
10.	Verify that isolation valves /flange gaskets are correct and bolts tight.	☐	☐	☐
11.	Verify shell and head bolts are torque to specification.	☐	☐	☐
12.	Verify inlet and discharge pipe work flanges aligned, gaskets in place and bolts tight.	☐	☐	☐
13.	All external fittings are correctly installed.	☐	☐	☐
14.	Check and verify correct relief valve installed and test certificate is available.	☐	☐	☐
15.	Check all thermal and acoustic insulation is correct to specification.	☐	☐	☐
16.	No visible lubricate/solution leaks.	☐	☐	☐
17.	All Safety Guards Installed and checked for pinch points.	☐	☐	☐
18.	No visible damage to heat exchanger unit.	☐	☐	☐
19.	All safety signage installed.	☐	☐	☐
20.	Punch list Completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Hydrostatic Pressure Test - Piping	**Test Report** C0 – M – 008

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

				N/A	**Inspected by Contractor**	**Inspected by Engineer**
1.	Line Nos. Included in Test:			☐	☐	☐
2.	Testing Data:			☐	☐	☐
	Test pressure:	Test medium:	Hold time:			
	Approx Vol:	Inhibitor:	Freq of data logging:			
	Temp.range:	Flushing time:	Flushing time:			
3.	Where required ,all instruments and sensitive equipment has been removed from test line			☐	☐	☐
4.	All openings in test line sealed with fittings adequate for the test pressure.			☐	☐	☐
5.	Vent points are at the highest point			☐	☐	☐
6.	Test Line is adequately supported			☐	☐	☐
7.	All Safety signs/tape in place			☐	☐	☐
8.	All valves in line open			☐	☐	☐
9.	System to be filled until fluid exits from high point vent			☐	☐	☐
10.	Pump system up to test pressure and locked in			☐	☐	☐
11.	When pressure stabilises test duration can commence and record pressures.			☐	☐	☐

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					N/A	Inspected by Contractor	Inspected by Engineer
12.	Record				☐	☐	☐
	Start time:	Start date:	Start temp:				
	End time:	End date:	End temp:				
	Gauge No:	Recorder No:	Calibration date:				
13.	**Date**	**Time**	**Pressure**	**Ambient Temp °C**	☐	☐	☐
14.	On Completion ensure:						
15.	• Pipework is drained and dried				☐	☐	☐
16.	• All instruments, equipment and valves re-installed				☐	☐	☐
17.	• All re-installed instruments, equipment and valve connections have gaskets and seals fitted and all flange bolts tight				☐	☐	☐
18.	Attach P&ID (Highlight pipe section in Question)				☐	☐	☐
19.	Safety Signs/tape removed				☐	☐	☐
20.	Punch List completed				☐	☐	☐

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C0 – Pre-Commissioning:

Hydrostatic Tank	**Test Report** C0 – M – 005

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	**Inspected by Contractor**	**Inspected by Engineer**
1.	Start Time: ..... Level:	☐	☐	☐
2.	Finish Time: ..... Level:	☐	☐	☐
3.	Duration: ..... Hours:	☐	☐	☐
4.	Loss in Level:: ..... mm	☐	☐	☐
5.	Other:	☐	☐	☐
6.	Results:	☐	☐	☐

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C0 – Pre-Commissioning:

Mill	**Test Report** C0 – M – 055

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	Ensure that all equipment is installed in accordance with design requirements, project specifications and manufacturer's instructions.	☐	☐	☐
2.	Verify that foundations and footings are correct and level.	☐	☐	☐
3.	Verify that the mill position, elevation, orientation and level are correct to drawing specification.	☐	☐	☐
4.	Verify that all structures and foundations are in accordance with design spec.	☐	☐	☐
5.	Verify that the type of grout, curing agent and setting time has been complied with and recorded.	☐	☐	☐
6.	All debris and waste material removed.	☐	☐	☐
7.	All moving parts clear of stationary objects.	☐	☐	☐
8.	Feed End Equipment correctly installed/check in particular:	☐	☐	☐
	• Feed spout fitted and aligned	☐	☐	☐
	• Feed end seal fitted	☐	☐	☐
	• Slurry slingers installed	☐	☐	☐
	• Pedestal support frame and clamps fitted	☐	☐	☐
	• Seal water lines in installed and secure.	☐	☐	☐
9.	Trunnion Bearings correctly installed/check in particular:	☐	☐	☐
	• Bearing Housing Aligned and bolts torque to manufacturers requirements	☐	☐	☐
	• Floating bearing positioning checked	☐	☐	☐
	• Seals and dust covers installed	☐	☐	☐
	• Hold down bolts torque to manufacturers requirements and grouting completed	☐	☐	☐
	• Adjustment shims spot welded to baseplate and covered with denso tape	☐	☐	☐
	• All piping and fittings installed correctly and secure.	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
10.	Girth Gear correctly installed/check in particular:	☐	☐	☐
	• All support bolts in place and torque to manufacturers requirements	☐	☐	☐
	• Gear lubrication system piping and fitting secure and unit ready for operation	☐	☐	☐
	• Jacking screws have been backed off	☐	☐	☐
	• Sufficient coating of lubricant on all gear teeth	☐	☐	☐
	• Girth gear guard secured	☐	☐	☐
	• Girth gear felt seals fitted and adjusted.	☐	☐	☐
11.	Pinion Bearing correctly installed/check in particular:	☐	☐	☐
	• Hold down bolts torque to manufacturers requirements and grouting completed	☐	☐	☐
	• Adjustment shims spot welded to baseplate and covered with denso tape	☐	☐	☐
	• Sufficient coating of lubricant on all pinion teeth	☐	☐	☐
	• End cover installed and secure.	☐	☐	☐
12.	Mill Motor installed correctly/Check in particular:	☐	☐	☐
	• Hold down bolts torque to manufacturers requirements and grouting completed	☐	☐	☐
	• Motor bearings which have grease nipples fitted (two full pumps with grease gun completed)	☐	☐	☐
	• Mechanical Coupling Alignment Sheet C0-M-011 or C0-M-012 complete	☐	☐	☐
	• Coupling safety guard in place and secure.	☐	☐	☐
13.	All bearing, temperature detectors and seals are installed correctly.	☐	☐	☐
14.	Verify rubber backing installed on internal of mill shell.	☐	☐	☐
15.	All Liners and lifters installed as per manufacturers drawings and bolts torque to spec.	☐	☐	☐
16.	Mill door fitted and secure.	☐	☐	☐
17.	Discharge trommel installed correctly/check in particular:	☐	☐	☐
	• Permatex or sikaflex type sealant inserted in any voids between trommel flange and Mill discharge end liner.	☐	☐	☐
	• All bolts torque to manufacturers requirements and exposed bolt heads cover with silaflex.	☐	☐	☐
	• No visible damage to rubber on trommel frame	☐	☐	☐
	• Screen fitted and secure	☐	☐	☐
	• Reverse spirals installed and secure	☐	☐	☐
	• Discharge grate installed and secure.	☐	☐	☐
18.	All safety fences, access platforms and safety signs are installed correctly.	☐	☐	☐
19.	Erecting cradle clear from Mill shell.	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
20.	Gearbox Installed Correctly/check in particular:	☐	☐	☐
	• Initial fill of lubricant to gear box complete/checked	☐	☐	☐
	• Hold down bolts torque to manufacturers requirements and grouting completed	☐	☐	☐
	• Mechanical Coupling Alignment Sheet C0-M-011 or C0-M-012 complete	☐	☐	☐
	• Coupling safety guard in place and secure	☐	☐	☐
	• Shaft Seals greased	☐	☐	☐
	• Breather line installed	☐	☐	☐
	• Cooling water system all piping and fittings secure	☐	☐	☐
	• Torque arm fitted and secure.	☐	☐	☐
21.	Punch list Completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Pipework-Final Inspection	**Test Report** C0 – M – 095

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	Materials Correct.	☐	☐	☐
2.	Supports, Anchors Correct.	☐	☐	☐
3.	Cold Spring/Expansion items Correct 'Where Applicable'.	☐	☐	☐
4.	Flange Connections Free of Stress.	☐	☐	☐
5.	Correct Studs/Gaskets Installed.	☐	☐	☐
6.	Bolts Correctly Tensioned and Identified (X).	☐	☐	☐
7.	Welding Completed.	☐	☐	☐
8.	Stress Relieving Complete.	☐	☐	☐
9.	Pressure Test Complete and Correct.	☐	☐	☐
10.	Flushing Complete and Correct.	☐	☐	☐
11.	Drying Out/Blowing Out Complete.	☐	☐	☐
12.	All Quality Requirements Met (NDT/Verification Records).	☐	☐	☐
13.	Check Valve Orientation/Flow Direction Correct.	☐	☐	☐
14.	Valve Ease of Operation Confirmed.	☐	☐	☐
15.	Orifice Plates Correctly Orientated.	☐	☐	☐
16.	Instrument Connections Correct and Secure.	☐	☐	☐
17.	Insulation Correct and Completed 'Where Applicable'.	☐	☐	☐
18.	Temporary Supporting Removed.	☐	☐	☐
19.	Painting Completed.	☐	☐	☐
20.	Services Banding and Flow Codes Applied.	☐	☐	☐

Comments

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C0 – Pre-Commissioning:

Primary Crusher	**Test Report** C0 – M – 037

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Manufacturer's requirements complied with.	☐	☐	☐
2.	Installation checked against Drawings.	☐	☐	☐
3.	All debris and waste material removed in particular the crusher jaw chamber and discharge chute.	☐	☐	☐
4.	All moving parts clear of Stationary items.	☐	☐	☐
5.	All Shipping Locks removed.	☐	☐	☐
6.	Grouting complete.	☐	☐	☐
7.	All bolted connections checked for tightness, in particular:	☐	☐	☐
	• Foundation bolts	☐	☐	☐
	• Bearing housing Studs	☐	☐	☐
	• Electric Motor	☐	☐	☐
	• Flywheel	☐	☐	☐
	• Tension Rods	☐	☐	☐
	• Jawface Retainer bolts	☐	☐	☐
	• Toggle Block.	☐	☐	☐
8.	Toggle block/adjusting cylinder hand pump valve fully open and toggle block is hard up against frame of shim.	☐	☐	☐
9.	.Jaw CSS setting checked (should be no less than 100mm).	☐	☐	☐
10.	Initial fill of lubricant to unit complete/checked.	☐	☐	☐
11.	Manual lubricant pump checked.	☐	☐	☐
12.	No damage to grease lines/grease is through to all points that are centrally lubricated (Jawholder and Main Bearings).	☐	☐	☐
13.	Electric Motor Bearings have two full pumps with grease gun completed.	☐	☐	☐
14.	No visible lubricate leaks.	☐	☐	☐
15.	V Belt Pulleys Alignment complete (Attach check sheet C0-M-13).	☐	☐	☐
16.	Floor grid mesh, Floor Plate in place and secured by welding or clamps, except grating panels nominated as removable.	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
17.	All Safety Guards Installed and checked for pinch points.	☐	☐	☐
18.	All safety signage installed.	☐	☐	☐
19.	Punch list Completed.	☐	☐	☐
20.	All Manufacturer's requirements complied with.	☐	☐	☐
21.	Installation checked against Drawings.	☐	☐	☐
22.	All debris and waste material removed in particular the crusher jaw chamber and discharge chute.	☐	☐	☐
23.	All moving parts clear of Stationary items.	☐	☐	☐
24.	All Shipping Locks removed.	☐	☐	☐

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C0 – Pre-Commissioning:

Pump Installation	Test Report C0 – M – 099

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

In Process Inspection/Activity		**N/A**	**Inspected by Contractor**	**Inspected by Engineer**
This checklist is to be filled out at the completion of each work area.				
1.	Foundations complete, level and accepted.	☐	☐	☐
2.	Pump and driver level base anchor bolts tight.	☐	☐	☐
3.	Grouting complete and accepted/coupling set and jacking screws tight.	☐	☐	☐
4.	Piping connections with no strain on connections/flanges.	☐	☐	☐
5.	Verify pressure test acceptance before final alignment/coupling checked and accepted.	☐	☐	☐
6.	Rotate driver and pump with the coupling open/coupling document number required (Mechanical Shaft Alignment Check Sheet).	☐	☐	☐
7.	Jacking Screws removed/mechanical seals or packing installed.	☐	☐	☐
8.	Shafts turn freely by hand/coupling lubricated and closed.	☐	☐	☐
9.	Accessories installed and ready for service i.e. gauges, guards, vents, drains, oil rings in and free.	☐	☐	☐
10.	Aux systems complete i.e. seal, flush, etc./temp suction screens in place.	☐	☐	☐
11.	Cleanliness checked/coupling guard secured.	☐	☐	☐
12.	Ground/earth strap installed.	☐	☐	☐
13.	Insulation completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Steel Frame Building Inspection	**Test Report** C0 – M – 116

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
Preliminaries				
1.	Equipment checked for suitability	☐	☐	☐
2.	Erection sequence established	☐	☐	☐
	Steel Erection			
3.	Steel erection checklists	☐	☐	☐
4.	Structure lever, aligned and plumbed	☐	☐	☐
5.	Bolts tightened (Bolting checklist completed)	☐	☐	☐
6.	Earthing completed	☐	☐	☐
7.	Grout correct (Grout mixing and placement checklist completed)	☐	☐	☐
8.	Ventilation installation complete	☐	☐	☐
Cladding				
9.	Correct purlins and girts (Bolting checklist completed)	☐	☐	☐
10.	Sheeting correct colour and placed	☐	☐	☐
11.	Fastening completed	☐	☐	☐
12.	Ventilation installation complete	☐	☐	☐
13.	Gutters and downpipes completed	☐	☐	☐
14.	Doors, fixtures and furnishings complete	☐	☐	☐
Associated Structures				
15.	Stairs and hand railing compete (Bolting checklist complete)	☐	☐	☐
16.	Crane rail alignment complete	☐	☐	☐
17.	Crane rail deflection test complete	☐	☐	☐
18.	Flooring correctly fixed and clipped	☐	☐	☐
19.	Overhead crane installed	☐	☐	☐
Records				
20.	Installation records complete	☐	☐	☐
21.	Fabrication records completed	☐	☐	☐

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C0 – Pre-Commissioning:

Strip Solution Heater	**Test Report** C0 – M – 072

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	Ensure that all equipment is installed in accordance with Design requirements, Project specifications and Manufacturer's instructions.	☐	☐	☐
2.	Check Name plate data is correct.	☐	☐	☐
3.	All debris and waste material removed.	☐	☐	☐
4.	All hold down bolts in place and tight/Grouting completed.	☐	☐	☐
5.	Ensure that all boiler tubes are complete and tested to specification.	☐	☐	☐
6.	Check all tube sheets.	☐	☐	☐
7.	Check fire tubes and heated tubes guides, supports and anchors are correct to specification.	☐	☐	☐
8.	Check Nozzle location, installation and orientation of burner is correct to specification.	☐	☐	☐
9.	Ensured burner pipe work is installed correctly and secure.	☐	☐	☐
10.	Ensure that the refractory lining are installed in accordance to design requirements, project specifications and manufacturer's instructions.	☐	☐	☐
11.	All piping connections aligned correctly to prevent pipe loads on equipment.	☐	☐	☐
12.	All gaskets fitted to flange joints are correct rating to specification.	☐	☐	☐
13.	Ensure that ductwork, flue, expansion joints and air seals installed correctly, secure and tight.	☐	☐	☐
14.	Check ductwork dampers installed and operate correctly.	☐	☐	☐
15.	Check all relief devices installed correctly and discharge to a safe area.	☐	☐	☐
16.	Check all thermal and acoustic insulation is correct to specification.	☐	☐	☐
17.	No visible lubricate leaks.	☐	☐	☐
18.	All Safety Guards Installed and checked for pinch points.	☐	☐	☐
19.	No visible damage to heater unit.	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
20.	All safety signage installed.	☐	☐	☐
21.	Punch list Completed.	☐	☐	☐

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C0 – Pre-Commissioning:

Structural Steel	**Test Report** C0 – M – 016

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Punch Lists completed.	☐	☐	☐
2.	Installation checked against Drawings.	☐	☐	☐
3.	Location and overall dimensions correct.	☐	☐	☐
4.	Materials of construction as per Specification and Drawings.	☐	☐	☐
5.	Handrails and kickplates in place and secure.	☐	☐	☐
6.	Floor grid mesh, Floor Plate in place and secured by welding or clamps, except grating panels nominated as removable	☐	☐	☐
7.	Stairway threads in place and secure.	☐	☐	☐
8.	Timber Flooring properly captured within stops welded to steel work	☐	☐	☐
9.	All bolts in place and correct length.	☐	☐	☐
10.	All Bolts welds nominated as per the drawings complete (not tack welded).	☐	☐	☐
11.	Any damaged bolts or fully tensioned bolts that have slackened replaced.	☐	☐	☐
12.	All bolts marked and tightened to specified torque	☐	☐	☐
13.	Bolts fully tensioned around Vibrating/Dynamic Equipment (Mill Platforms, Screen Platforms, etc.)	☐	☐	☐
14.	Random check of bolts with spanner.	☐	☐	☐
15.	Bolt ends projecting into trafficable walkways limited to a projection of one thread minimum, three threads maximum and curtailed where required.	☐	☐	☐
16.	Support columns and Steel Baseplates grouting complete.	☐	☐	☐
17.	Vertical ladders secure and Safety cage installed.	☐	☐	☐
18.	All Bracing Members in place and secure.	☐	☐	☐
19.	All Steel Members welded to cast in plates (in concrete) nominated as per the drawings.	☐	☐	☐
20.	Pipe Racks and Cable Trays secure.	☐	☐	☐
21.	Remedial work has all burrs, slag or weld spatter removed and undercut areas filled with weld metal and ground smooth.	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
22.	Steel Packers installed as per the drawings.	☐	☐	☐
23.	Chemical Anchors in place, including stair base slabs as per the Drawing.	☐	☐	☐
24.	Light Pole supports on tank top steelwork as per the drawings in place. (n.b. BIOX light pole supports off pipe rack top of tank).	☐	☐	☐
25.	No damaged Paint Work.	☐	☐	☐
26.	All Temporary false work and bracing used in construction removed.	☐	☐	☐
27.	Roof and Wall Cladding and Gutters in place.	☐	☐	☐
28.	All Safety Guards in place and checked for pinch points.	☐	☐	☐
29.	SWL Sign visible on Monorails.	☐	☐	☐
30.	All safety signs installed.	☐	☐	☐

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C0 – Pre-Commissioning:

Tank Agitator	**Test Report** C0 – M – 018

Project Title:		**Project No:**	
Equipment Description:			
Equipment No:			
Plant Area:			
TPK No:			

		N/A	Inspected by Contractor	Inspected by Engineer
1.	All Manufacturer's requirements complied with	☐	☐	☐
2.	Installation checked against Drawings	☐	☐	☐
3.	Shipping Stops Removed	☐	☐	☐
4.	Bolts torque to the correct setting as per vendors manual for blades to Shaft Hub (submit separate sheet with final torque settings)	☐	☐	☐
5.	Shaft Cap Screws torque to the correct setting as per vendors manual (submit separate sheet with final torque settings)	☐	☐	☐
6.	Bolts attaching blades to Shaft Hub covered with proxy	☐	☐	☐
7.	Agitator Alignment Sheet C0-M-009 Complete	☐	☐	☐
8.	Initial fill of lubricant to gear box complete/checked	☐	☐	☐
9.	Mechanical Seal Lubricated	☐	☐	☐
10.	Grease Packed Bearing Initial fill checked	☐	☐	☐
11.	Hoses and filters installed and tight on gearbox Lubricant system	☐	☐	☐
12.	Gear Box Electric Motor bearing where grease nipples fitted have two full pumps with grease gun completed	☐	☐	☐
13.	Agitator Gear Box checked for four point bolting pad contact to mounting structures	☐	☐	☐
14.	Bolts torque to the correct setting as per vendors manual for gear box to base frame. (submit separate sheet with final torque settings)	☐	☐	☐
15.	Electric Motor torque to the correct settings as per vendor's manual for instalment to Pedestal or mounting bracket	☐	☐	☐
16.	Electric Motor with Pedestal or Mounting bracket fitted installed correctly to gear drive housing and bolts torque to correct settings as per vendors manual	☐	☐	☐
17.	Mechanical Coupling Alignment Sheet C0-M-011or C0-M-012 Complete	☐	☐	☐
18.	Dipstick/Breather and Sight Gauges installed.	☐	☐	☐
19.	No visible damage to Agitator Unit	☐	☐	☐

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		N/A	Inspected by Contractor	Inspected by Engineer
20.	Manually rotate to check for any for binding, roughness or cyclic torque variations.	☐	☐	☐
21.	Agitator blades leading edge installed to run in direction of rotation	☐	☐	☐
22.	Lower shaft attachment to half coupling bolts torque to correct settings as per vendors manual (Submit separate sheet with final torque settings)	☐	☐	☐
23.	Base frames bolted to steel structure and torque to correct setting as per vendors manual.	☐	☐	☐
24.	No Visible lubricant leaks	☐	☐	☐
25.	Coupling safety guard in place and checked for pinch points.	☐	☐	☐
26.	Lubricant drain to grade	☐	☐	☐
27.	Punch list completed	☐	☐	☐

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Appendix AB: Hazardous Material Reporting

Grassy Mountain Mine Project
Hazardous Materials Storage Reporting Requirements

The storage of hazardous materials in Oregon is not regulated by permit. The storage of and quantities stored are reported to the Oregon Office of State Fire Marshal through the Community Right to Know (CR2K) program (Oregon Revised Statutes 453.307-367). The CR2K program operates the Oregon Community Right to Know Hazardous Substance Manager (CHS Manager) which is the reporting tool used to submit the hazardous substance report to the State Fire Marshal. The reports are due March 1 of each year which covers the hazardous substance inventories for the reporting period of the previous calendar year (January 1 through December 31). The reporting requirements (as listed in Oregon Administrative Rule [OAR] 837-085-0090 are attached.

Determination of hazardous substances is done using the United States Environmental Protection Agency (EPA) Consolidated List of Lists authorized under the *Emergency Planning and Community Right-to-Know Act,* also known as *Title III of the Superfund Amendments and Reauthorization Act of 1986*. The EPA List of Lists delineates what substances are reportable and at what quantities reporting may or may not be required.

Prior to commencement of activities, the proponent will register for the CHS Manager, obtain a Facility Identification number, and evaluate the updated list of chemicals to be stored on site against the EPA List of Lists to generate the first report for the CHS Manager.

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Department of State Police

Office of State Fire Marshal - Chapter 837

Division 85
COMMUNITY RIGHT-TO-KNOW SURVEY AND COMPLIANCE PROGRAMS

837-085-0090
Hazardous Substance Information — Reporting Requirements

(1) A covered employer, owner, and or operator must report hazardous substance information as required by these rules using methods provided and approved by the State Fire Marshal.

(2) A covered employer, owner, and or operator who possessed a reportable hazardous substance during the previous calendar year shall submit a Hazardous Substance Report by March 1 of the following year.

(3) Each substation must have identification posted at it that identifies the site by a company unique number or name and the Facility ID number issued by the State Fire Marshal.

(a) The identification must be readable from a distance of 50 feet.

(b) Substations that are completely underground and can only be accessed through a manhole or excavation are exempt from this posting requirement.

(4) A covered employer, owner, or operator required to report under these rules must provide the following information:

(a) The facility's reporting status, including:

(A) Whether hazardous substances were present at the site in reportable quantities;

(B) Whether Extremely Hazardous Substances were present that met or exceeded the threshold planning quantity of 40 CFR 355, Appendix A and B. If the facility has Extremely Hazardous Substances present that exceed the threshold planning quantity, provide the name, email address, phone number, and 24-hour phone number of the facility emergency coordinator as required under EPCRA section 303(d)(1);

(C) Whether the facility is subject to the reporting requirements of Section 112(r) of the Clean Air Act. If the facility is subject to the chemical accident prevention provisions codified in 40 CFR part 68, also known as the Risk Management Program (RMP), provide the RMP facility identification number assigned by EPA;

(D) If your facility is subject to the Toxic Release Inventory (TRI) program under section 313 of EPCRA, provide the identification number assigned by EPA;

(E) Whether the facility is subject to the Process Safety Management (PSM) requirements of the Occupational Safety and Health Administration (OSHA);

(b) Demographic information including:

(A) All applicable North American Industry Classification System codes for the facility;

(B) A description of the type of business conducted at the site;

(C) The Dun and Bradstreet Number, if applicable;

(D) The owner's or operator's full name and email address;

(E) The business name which the entity operates under;

(F) The department or division, if applicable;

(G) The physical site address including the street, city, county, and zip code; or a grid location acceptable to the responding fire department if no address exists;

(H) The latitude and longitude of the facility;

(I) The facility phone number for the site;

(J) The email address of the business or contact person, if available;

(K) The mailing address, if different from the site address;

(L) The potential maximum number of occupants including visitors at the site;

(M) The name, day and night phone number and email address of the person that can act as a referral if emergency responders need assistance in responding to a chemical accident at the facility;

(N) The name of the responding fire department by local jurisdiction;

(O) A brief summary of any procedures established by the covered employer, owner or operator for the control of hazardous substances in the event of an emergency;

(P) Whether the hazardous substance storage location for each reportable hazardous substance is placarded according to National Fire Protection Association (NFPA) Standard 704;

(Q) Whether the facility is occupied or unoccupied; and

(R) The Federal Employer Identification Number (FEIN), or for sole proprietors their Social Security number.

(c) The name and signature of the person completing the Hazardous Substance Report and the date it was completed.

(d) Information about each reportable hazardous substance meeting the reportable quantity thresholds including, but not limited to:

(A) The chemical, mixture, or product name;

(B) The chemical name of the hazardous ingredient present in the highest concentration;

(C) Whether the substance reported contains an extremely hazardous substance as listed in 40 CFR 355;

(D) Whether the substance meets the threshold planning quantity as defined by 40 CFR 355;

(E) If the chemical contains an Extremely Hazardous Substances, enter the name and CAS number of the Extremely Hazardous Substances in the mixture;

(F) Whether the substance reported contains a Clean Air Act, Section 112(r) listed chemical;

(G) Whether the substance reported contains a Process Safety Management listed chemical;

(H) Information regarding whether the substance is pure or a mixture;

(I) The physical state of the hazardous substance as it is released into the environment at Standard Temperature and Pressure (STP) relating whether it is a solid, liquid or a gas;

(J) The unit of measure used to report the quantity range of the hazardous substance, relating whether it is reported in pounds, gallons, cubic feet or millicuries;

(K) The average amount;

(L) The maximum amount;

(M) The maximum amount of each reported hazardous substance for each location reported;

(N) The total amount transported to the facility;

(O) The total amount transported from the facility;

(P) The total estimated number of days the hazardous substance was on-site;

(Q) The type of container the substance is stored in;

(R) The pressure and temperature at which the substance is stored;

(S) All applicable hazard classifications for each reportable hazardous substance;

(T) The Chemical Abstract Service (CAS) number, if known;

(U) The four-digit United Nations (UN) or North American (NA) number, if known;

(V) The EPA Pesticide Registration number if applicable; and

(W) The storage location.

(e) Upon request of the State Fire Marshal, a covered employer, owner, or operator must provide Safety Data Sheets (SDS);

(f) Other information that may be requested by the State Fire Marshal in order to meet the intent of The Community Right-to-Know and Protection Act.

[Publications: Publications referenced are available from the agency.]

Statutory/Other Authority: ORS 453.367
Statutes/Other Implemented: ORS 453.317(1) & 453.317(2)
History:
OSFM 1-2019, amend filed 01/02/2019, effective 01/02/2019
OSFM 1-2014, f. & cert. ef. 1-9-14
OSFM 1-2010, f. 1-27-10, cert. ef. 2-1-10
OSFM 5-2005, f. 3-31-05, cert. ef. 4-1-05
OSFM 9-2002, f. 11-14-02, cert. ef. 11-17-02
OSFM 1-1999, f. 2-2-99, cert. ef. 2-3-99
FM 4-1994, f. 12-14-94, cert. ef. 12-15-94
FM 1-1994, f. & cert. ef. 1-14-94

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v1.8.3

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Appendix AC: Road Design Report

Grassy Mountain Project
Access Road Design

Calico Resources

Vale OR and Vicinity

October 22, 2019

Contents

1.1 Project Description 1
1.2 Roadway Design 1
1.3 Drainage Analysis 1

Appendices

Appendix A. Photomaps

Appendix B. Design Criteria Matrix

Appendix C. Roadway and Drainage Plans

Appendix D. Drainage Analysis

1.1 Project Description

The Grassy Mountain Access Road Project consisted of reviewing and designing improvements to the existing access road for the Grassy Mountain Mine. The existing road begins at the intersection of Highway 20 and Russell Road and continues south along Cow Hollow Road and Twin Springs Road until reaching the mine. See Appendix A for Photomap sheets showing the proposed access road and improvements.

1.2 Roadway Design

HDR reviewed BLM and AASHTO design standards and developed a project specific design criteria matrix listing applicable standards (Appendix B). BLM *Gold Book* standards were used wherever available and supplemented with *AASHTO Guidelines for Geometric Design of Very Low Volume Local Roads (ADT<400).*

HDR reviewed the existing road to identify areas needing improvement to support equipment accessing the mine and to meet BLM standards. A field review was conducted to evaluate the existing road condition and document culvert sizes and locations. LIDAR survey data was provided by Calico and processed to create an existing ground model that could be reviewed to determine slopes and alignments. The existing road was then analyzed by laying out horizontal and vertical alignments to check that design standards were met. The cross section of the road was also checked during the field review and by cutting cross sections along the alignment to determine if the driving surface is wide enough and if ditches are adequate.

In locations where the existing road does not meet design standards, proposed alignments were developed and new road sections modeled to determine cut/fill limits. Improvements were focused on upgrading portions of the road that do not meet BLM design standards. The proposed design changes are shown in the Roadway and Drainage Plans (Appendix C).

1.3 Drainage Analysis

A drainage analysis was performed during the access road design to assess drainage patterns and identify locations requiring culverts. Existing culverts were examined for adequacy with new culverts and ditches specified where necessary. See Appendix D for Drainage Analysis Tech memo describing the methodology and recommendations. Proposed culverts are also identified on the roadway and drainage plans along with typical installation details and a culvert summary table.

Appendix A
Photomaps

Westfall
Vale
Harper
Fruitland
New Plymouth
Nyssa
Parma
Adrian
Notus
Wilder
Greenleaf
Homedale
Huston
Oregon
Idaho
Grassy Mountain Project
20
26
84
52
72
30
201
95
18
19
55

Seattle
WASHINGTON
MONTANA
Portland
OREGON
IDAHO
CALIFORNIA
Salt Lake City
UTAH

N

0 3.5 7
Miles

Legend

- Existing Road (Widening)
- Road Reconstruction Limits
- Cattle Guard, Existing
- Cross Drain Culvert
- Project Location
- Permit Corridor Line
- Proposed Mine Features
- Parcel
- Perennial Stream/Canal
- Intermittent Stream/Ditch
- Wetland
- Adjacent Sheet

Photomaps
Vicinity Map
Sheet 1 of 19

Calico - Grassy Mountain Project
34.5 kV Distribution Line
Access Road Improvements

Date: 10/21/2019
Document: Q:\CalicoResources\Power_Access\Work_in_Progress\map_docs\AR_ledland.mxd

2. STANDAGE ENTERPRISES LLC (19S44E1400500)

STANDAGE ENTERPRISES LLC (19S44E01100)

J-H Canal

KEZNO FUKIAGE BYPASS TRUST 47% (19S44E06200)

Sheet 6

Russell Rd

Bishop Rd

Sheet 7

WEGNER, DANIEL P TRUST ETAL (19S44E00901)

Sheet 8

Sheet 7

KEZNO FUKIAGE BYPASS TRUST 47% (19S44E00600)

Sand Hollow Rd

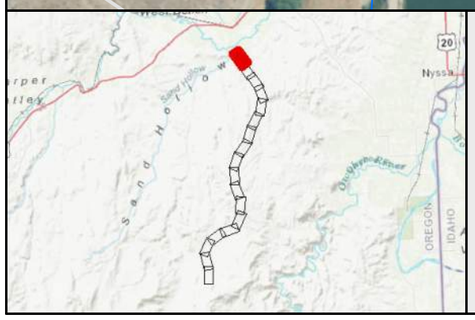
BLAKE, JONATHAN M & LACY A (19S44E00400)

CG

Cow Hollow Rd

1. BLAKE, JONATHAN M & LACY A (19S44E00400)

J-H Canal



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Legend

- Existing Road (Widening)
- Road Reconstruction Limits
- Cattle Guard, Existing
- Permit Corridor Line
- Parcel
- Perennial Stream/Canal
- Intermittent Stream/Ditch
- Adjacent Sheet

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Access Road Improvements

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Sheet 7

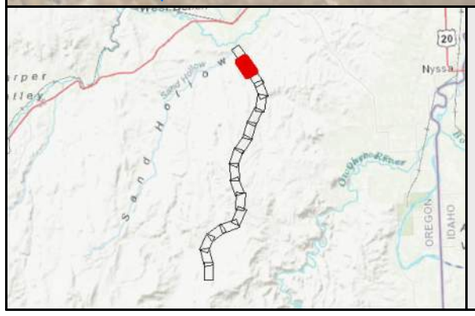
Cow Hollow Rd

Cow Hollow Rd

WEGNER, DANIEL
P TRUST ETAL
(19S44E00901)

Sheet 9

Sheet 8



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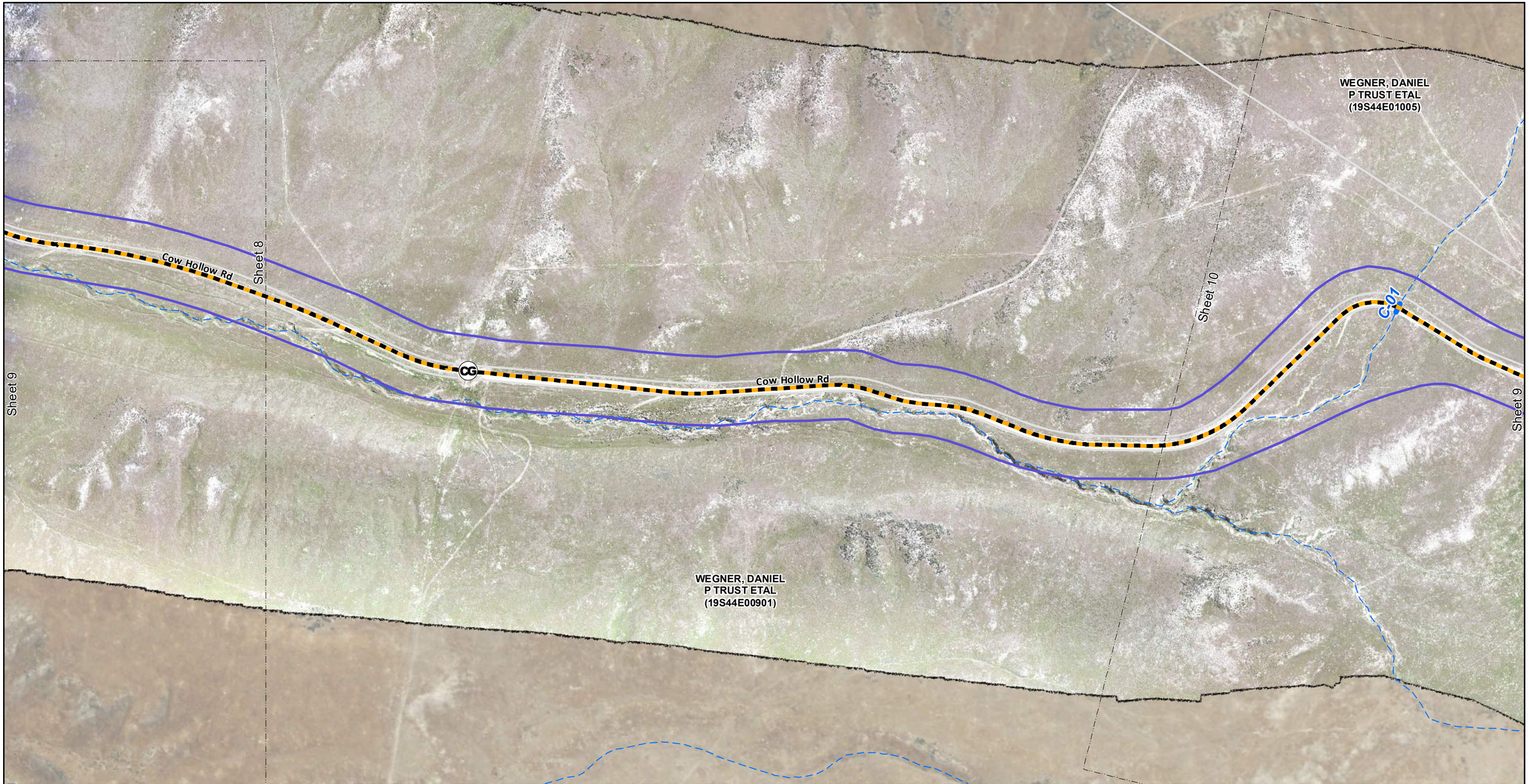

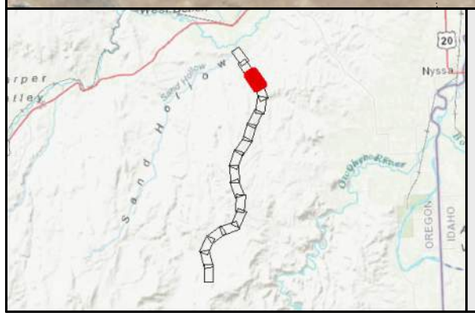

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Legend

- Existing Road (Widening)
- Cattle Guard, Existing
- Cross Drain Culvert
- Permit Corridor Line
- Parcel
- Intermittent Stream/Ditch
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Photomaps
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34.5 kV Distribution Line
Access Road Improvements

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P TRUST ETAL
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WEGNER, DANIEL
P TRUST ETAL
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WEGNER, DANIEL
P TRUST ETAL
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C-01

Cow Hollow Rd

Sheet 10

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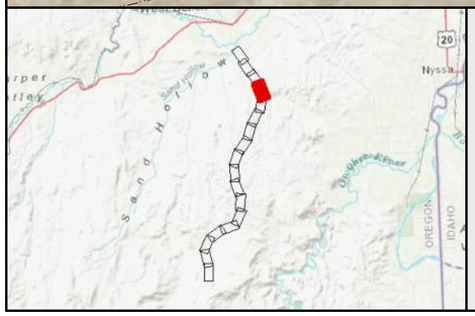

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WEGNER, DANIEL
P TRUST ETAL
(20S45E00200)

Cow Hollow Rd

Twin Springs Rd

Twin Springs Rd

U S A
(20S44E00300)

WEGNER, DANIEL
P TRUST ETAL
(20S44E00100)

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Sheet 12

Sheet 11

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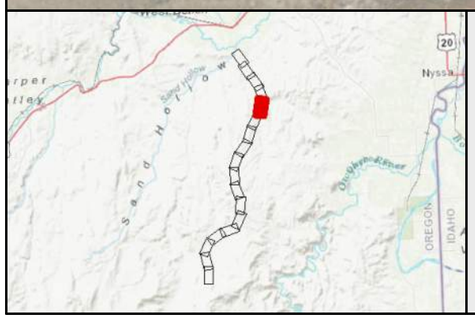

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Legend

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- Road Reconstruction Limits
- Cattle Guard, Existing
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- Parcel
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Twin Springs Rd

U S A
(20S44E00300)

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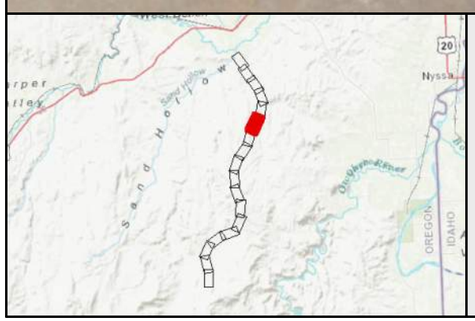

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- Road Reconstruction Limits
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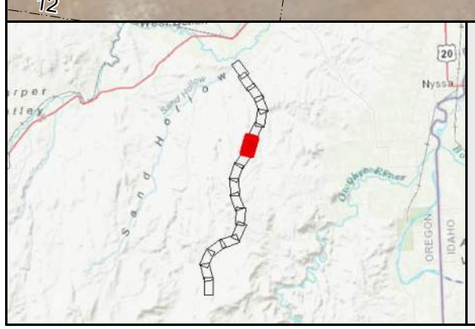

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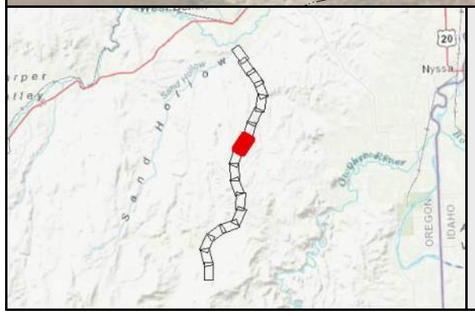

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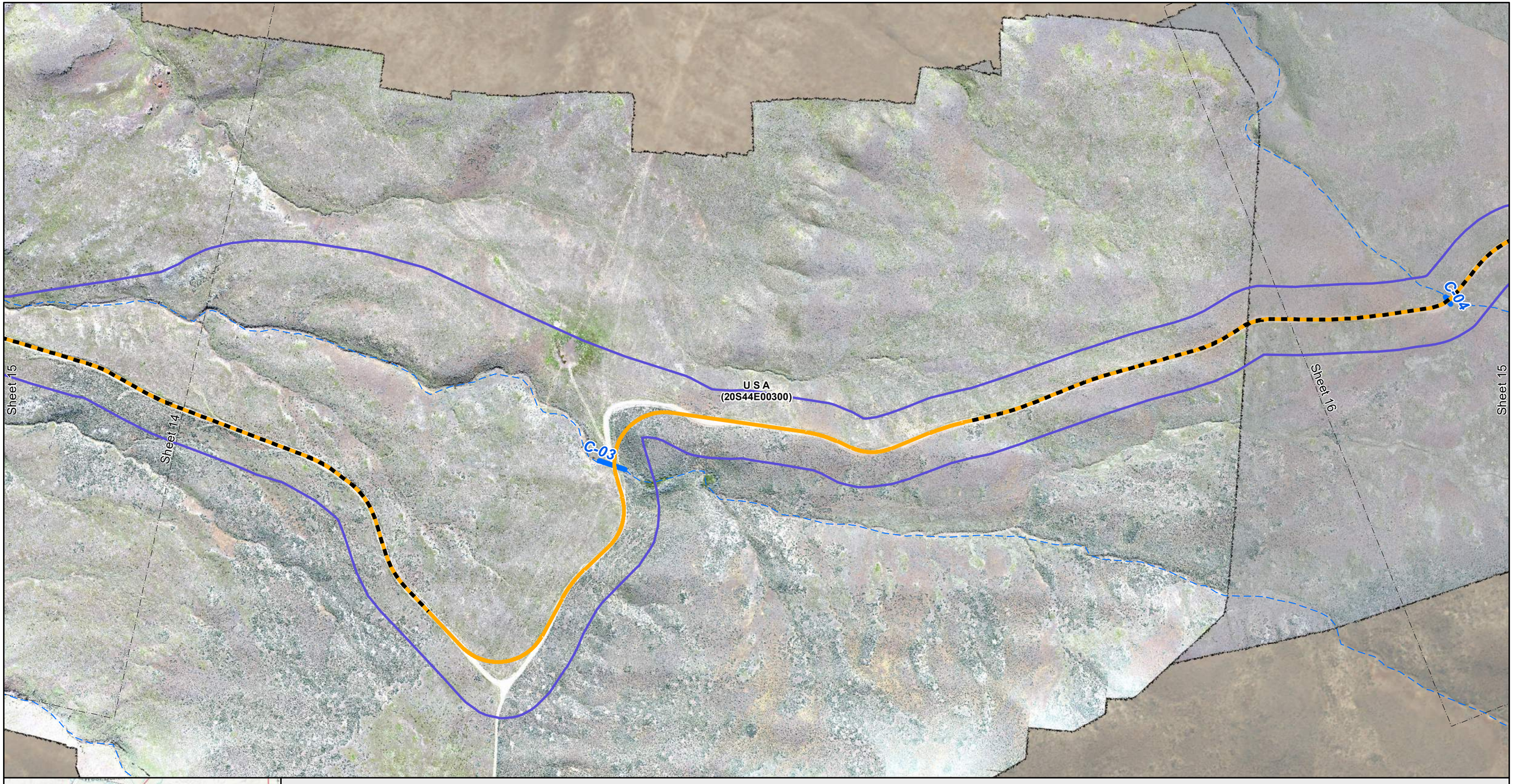

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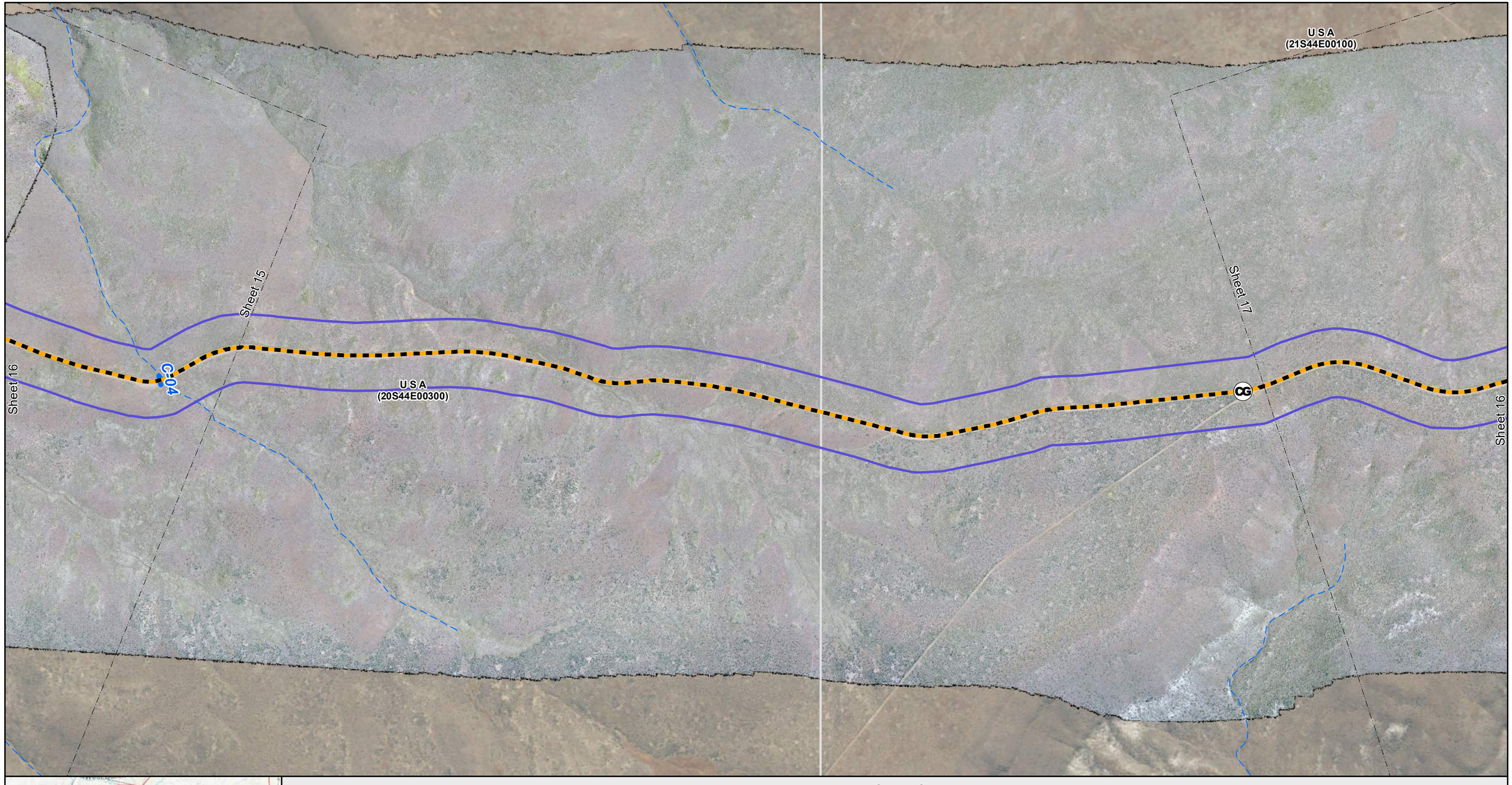

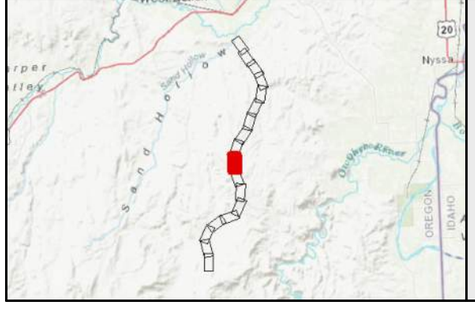

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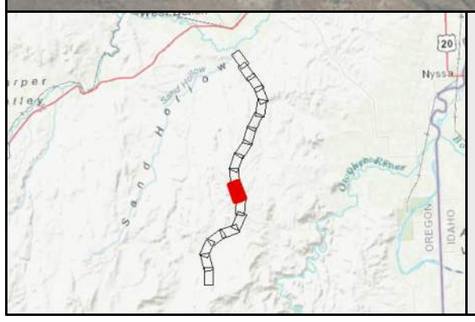

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Twin Springs Rd

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Twin Springs Rd

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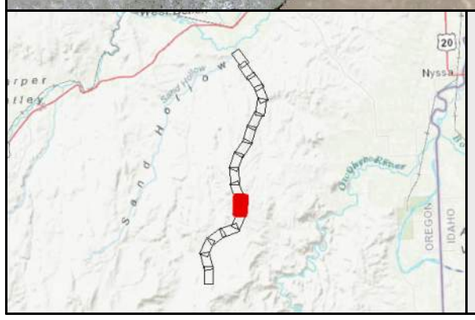

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Twin Springs Rd

Twin Springs Rd

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Twin Springs Rd

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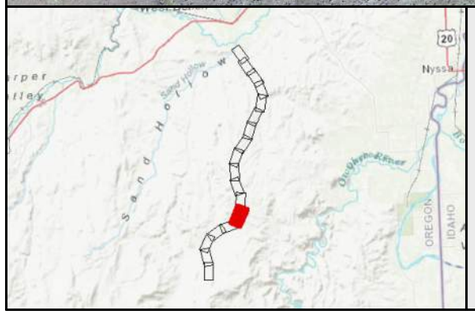

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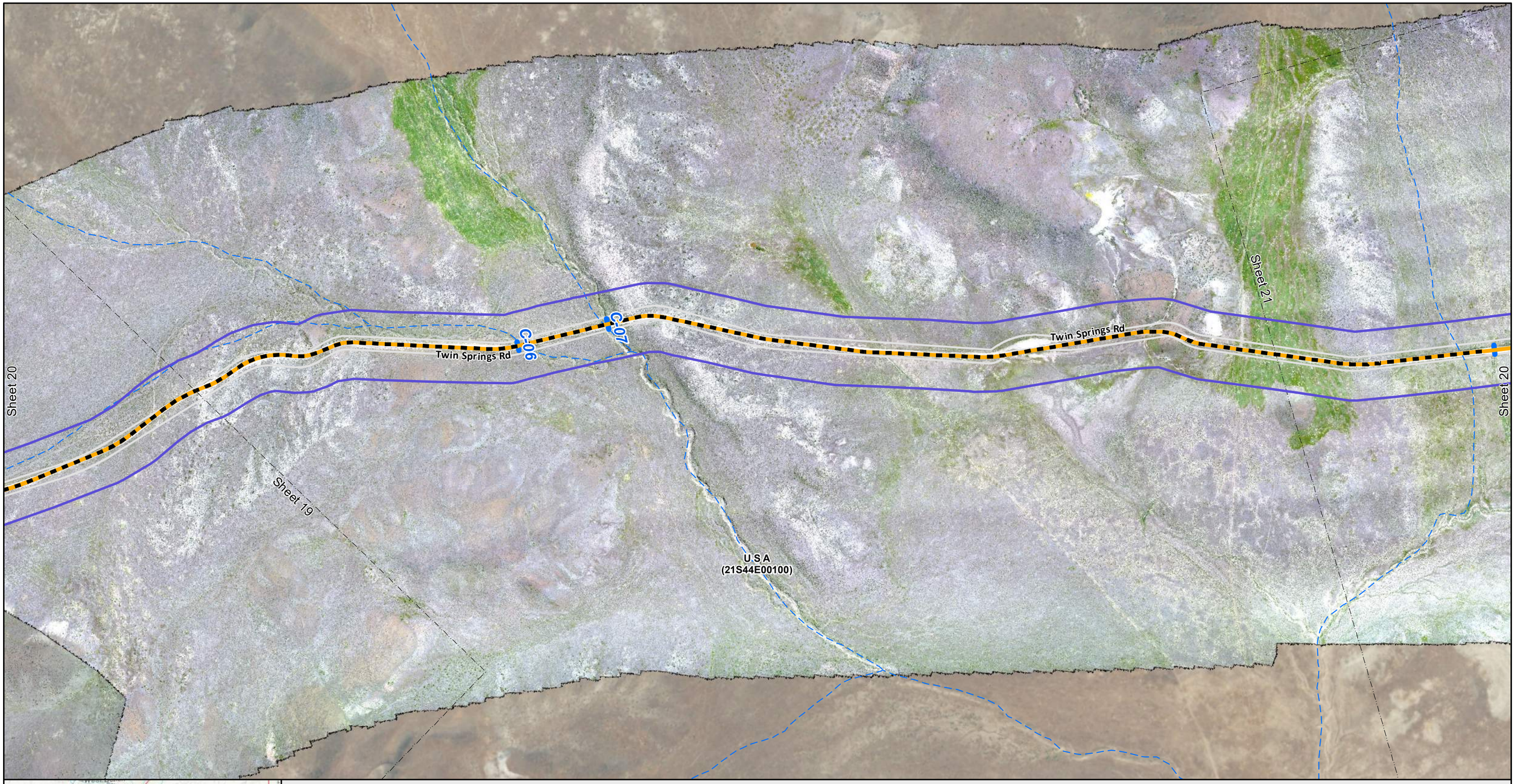

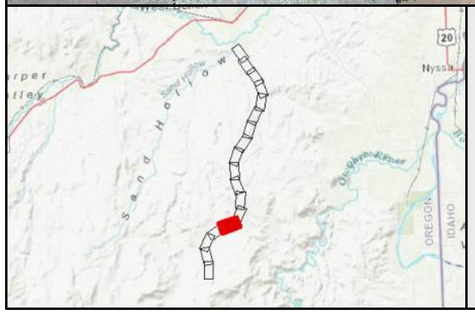

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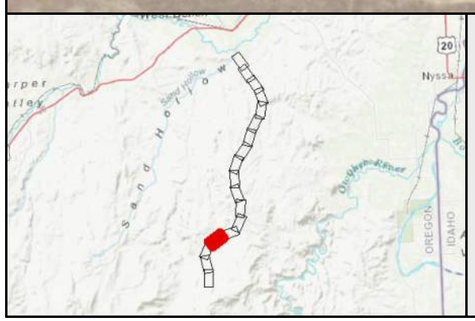
Access Road Improvements

Date: 10/21/2019
Document: Q:\CalicoResources\Power Access\Work in Progress\map docs\AR ledland mb400.mxd

Wetland 1
Wetland 2
C-08
C-09
Twin Springs Rd
Twin Springs Rd
CG
Sheet 21
Sheet 20
Sheet 22
Sheet 21
U S A
(21S44E00100)



0 400 800
Feet

Legend

- Existing Road (Widening)
- Road Reconstruction Limits
- Cattle Guard, Existing
- Cross Drain Culvert
- Permit Corridor Line
- Parcel
- Perennial Stream/Canal
- Intermittent Stream/Ditch
- Wetland
- Adjacent Sheet

Photomaps
Plan View
Sheet 16 of 19

Calico - Grassy Mountain Project
34.5 kV Distribution Line
Access Road Improvements

Date: 10/21/2019
Document: Q:\CalicoResources\Power Access\Work in Progress\map docs\AR ledland mb400.mxd

U S A
(21S44E00100)

Sheet 22

Sheet 21

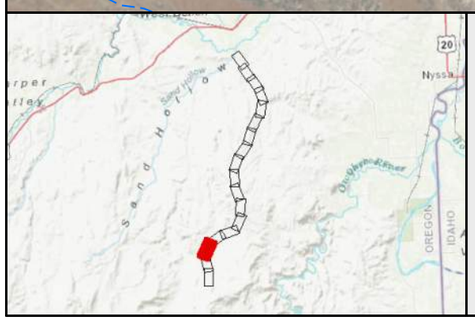
Sheet 23

Sheet 22

Twin Springs Rd

C-11

Twin Springs Rd



0 400 800
Feet

Legend

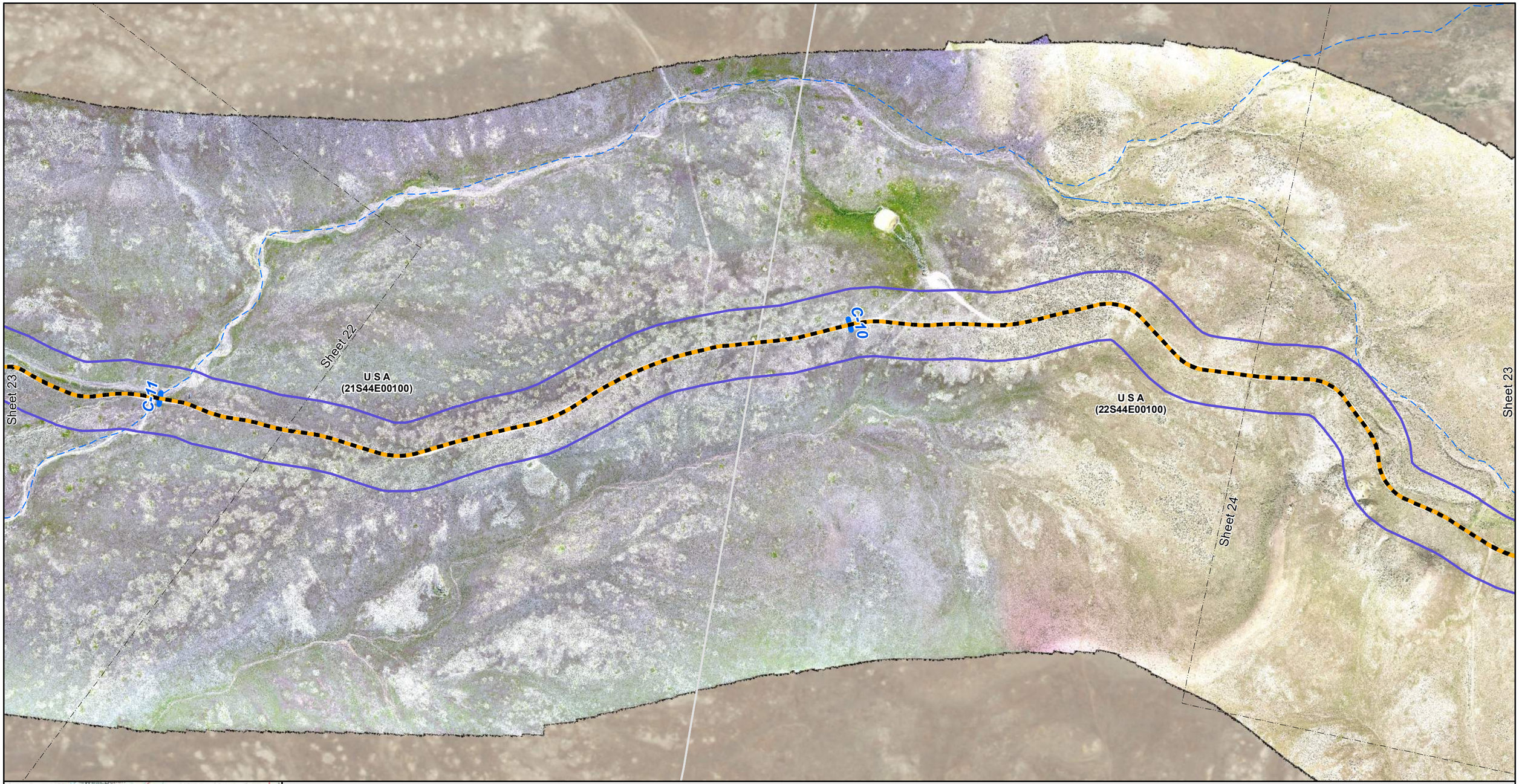
- Existing Road (Widening)
- Road Reconstruction Limits
- Cross Drain Culvert
- Permit Corridor Line
- Parcel
- Intermittent Stream/Ditch
- Adjacent Sheet

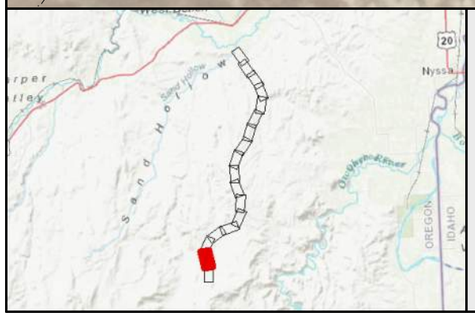
Photomaps
Plan View
Sheet 17 of 19

Calico - Grassy Mountain Project
34.5 kV Distribution Line
Access Road Improvements

Date: 10/21/2019

Document: Q:\CalicoResources\Power Access\Work in Progress\map docs\AR ledland mb400.mxd





0 400 800
Feet

Legend

- Existing Road (Widening)
- Cross Drain Culvert
- Permit Corridor Line
- Parcel
- Perennial Stream/Canal
- Intermittent Stream/Ditch
- Adjacent Sheet

Photomaps
Plan View
Sheet 18 of 19

Calico - Grassy Mountain Project
34.5 kV Distribution Line
Access Road Improvements

Date: 10/21/2019

Document: Q:\CalicoResources\Power_Access\Work_in_Progress\map_docs\AR_ledland_mb400.mxd

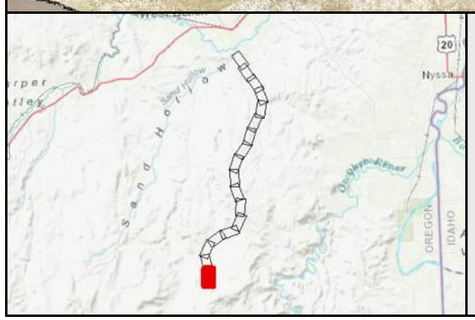
Sheet 24

Sheet 23

U S A
(22S44E00100)

Grassy Mountain
Project

Sheet 24



0 400 800
Feet

Legend

- Existing Road (Widening)
- Substation/Sub Tie-In
- Permit Corridor Line
- Proposed Mine Features
- Parcel
- Intermittent Stream/Ditch
- Adjacent Sheet

Photomaps
Plan View
Sheet 19 of 19

Calico - Grassy Mountain Project
34.5 kV Distribution Line
Access Road Improvements

Date: 10/21/2019
Document: Q:\CalicoResources\Power_Access\Work_in_Progress\map_docs\AR_ledland_mb400.mxd

Appendix B
Design Criteria Matrix

Design Criteria Matrix for Grassy Mountain Access Road Project

Project Number:	10162362	**Terrain Type:**	Vaires	**Date:**	3/22/2019
GIS Number:		**Highway Number:**		**Project Standards:**	BLM and Owner
Functional Classification:	BLM Collector	**MP to MP:**	Intersection of HWY-20 and Russel Rd to mine site.	**FHWA Project of Interest:**	NO
Construction Year:		**Design Year:**			

Project Description:

The purpose of the project is to review the existing road from Highway 20 to the mine site to identify areas needing improvements to support equipment accessing the mine. Improvements will focus on upgrading portions of the road that do not meet BLM standards, existing sections of road that meet standard will not be improved. The design will include roadway design and culvert sizing and placement.

Proposed Work Includes: Excavation, Drainage, Base, Subbase

Design Item	Criteria	Ref. Material
Design Elements		
Design Speed (mph)	35	BLM Gold Book - BLM Collector and FS Arterial Road, Page 27
Design Vehicle (max)	WB-67	Calico Requirement
Design Load	HS-20	Calico Requirement
Horizontal Alignment		
Minimum Curve Radius (ft.)	***460 feet unless shorter radii are approved*** Design without substantial truck recreational and vehicle volumes, acceptable operations can be obtained with smaller curve radii then shown in Exhibit 3 (p. 23). May reduce design speed 5 to 10 mph from tangents: 35 mph = 420' radii @ 4% max e 30 mph = 300' radii @ 4% max e 25 mph = 205' radii @ 4% max e	***BLM Gold Book - BLM Collector and FS Arterial Road, Page 27*** AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400) (2001), page 24
Minimum Curve Length (ft.)	500 feet for a 5 degree central angle. Where sight distance is limited, choose curves that appear to flow rather than curves that appear abrupt	BLM Handbook 9113-1 pg 5
Curve Widening Radius, width	Designed to suit local road characteristics. Varies depending on degree of curve, WB-67 wheel path and topography $Z = V / \sqrt{R}$ where: Z = extra width allowance, ft V = design speed of the highway, mph R = radius of curve or turning roadway (two-lane), ft	BLM Gold Book - BLM Collector and FS Arterial Road, Page 27 AASHTO - Green Book (2011) equation 3-33 page 3-90

Design Criteria Matrix for Grassy Mountain Access Road Project

Design Item	Criteria	Ref. Material
Vertical Alignment		
Maximum Grade (%)	Maximum grade is 8 percent (except pitch grades not exceeding 300 feet in length and 10 percent in grade).	BLM Gold Book - BLM Collector and FS Arterial Road, Page 27
Minimum Grade (%)	Avoid grades less than 0.5 percent due to difficulty in providing drainage of side ditches	BLM Handbook 9113-1 pg 6
Curve Location	When possible, avoid locating a vertical curve within a horizontal curve.	BLM Handbook 9113-1 pg 6
Minimum Curve Length (ft.)	3 X Design Speed 105	AASHTO - Geometric Design of Highways and Streets, page 3-153
Minimum Crest (K)	Based on Design Speed 14	BLM Gold Book - BLM Collector and FS Arterial Road, Page 27 AASHTO - Geometric Design of Very Low-Volume Local Roads Exhibit 12, page 39
Minimum Sag (K)	Based on Design Speed 14	BLM Gold Book - BLM Collector and FS Arterial Road, Page 27 AASHTO - Geometric Design of Very Low-Volume Local Roads Exhibit 12, page 39
Stopping Sight Distance (ft.)	170	AASHTO - Geometric Design of Very Low-Volume Local Roads Exhibit 12, page 39
Cross Section Elements		
Travelway (ft.)	20	Calico Recommendation
Shoulder Width	2 (each side)	Calico Recommendation
Subgrade Width	Select to the nearest 2' (applies to curve widening too)	BLM Handbook 9113-1 pg 7
Friction Factor	0.14	Calico Recommendation
Road Crown	Place shoulderline crowns with the downstream shoulder highest in order to prevent erosion of fills. Recommended slopes are as follows: ***Earth Surface .03-.05 ft./ft.*** ***Aggregate Surface .02-.04 ft./ft.*** ***Paved Surface .02-.03 ft./ft.***	BLM Handbook 9113-1 pg 7
Ditches	2:1 Cut Slope	BLM Handbook 9113-1 pg 7
Fill Widening	Fill widening must be a minimum of 2 feet where the slope is 2:1 or steeper	BLM Handbook 9113-1 pg 7

Design Criteria Matrix for Grassy Mountain Access Road Project

Design Item	Criteria	Ref. Material
Traffic		
ADT (Present/Future)	< 100	Calico Recommendation
DHV (Present/Future)	< 100	Calico Recommendation
Drainage		
Design Storm (peak flow)	25 Year	BLM Gold Book - BLM Collector and FS Arterial Road, Page 27
Minimum Culvert Diameter (in)	18	BLM Gold Book - BLM Collector and FS Arterial Road, Page 28
Minimum Culvert Cover (in)	12 inches or one-half the diameter, whichever is greater. Compliance with manufacturer's recommendations for cover over various culvert materials is necessary	BLM Handbook 9113-1 pg 11
Culvert Spacing	Culverts carrying runoff from one side of the road to the other between natural drainages are spaced as shown in Illustration 10 – Spacing for Drainage Laterals, unless local experience dictates otherwise.	BLM Handbook 9113-1 pg 23
Design Drawing and Templates		
Plan and Profile	To be plotted on standard plan and profle sheets to a scale of 1 inch = 100 feet horizontal and 1 inch = 20 feet vertical	BLM Gold Book - BLM Collector and FS Arterial Road, Page 27-29
Cross Sections	Standard templates of road cross-sections, drainage design, and culvert location and installation are required (Examples in Figures 3 through 6).	BLM Gold Book - BLM Collector and FS Arterial Road, Page 28
Materials	Mass diagrams and materials investigation and classifcation may be required.	BLM Gold Book - BLM Collector and FS Arterial Road, Page 28

Appendix C
Roadway and Drainage Plans

PARAMOUNT GOLD NEVADA CORPORATION

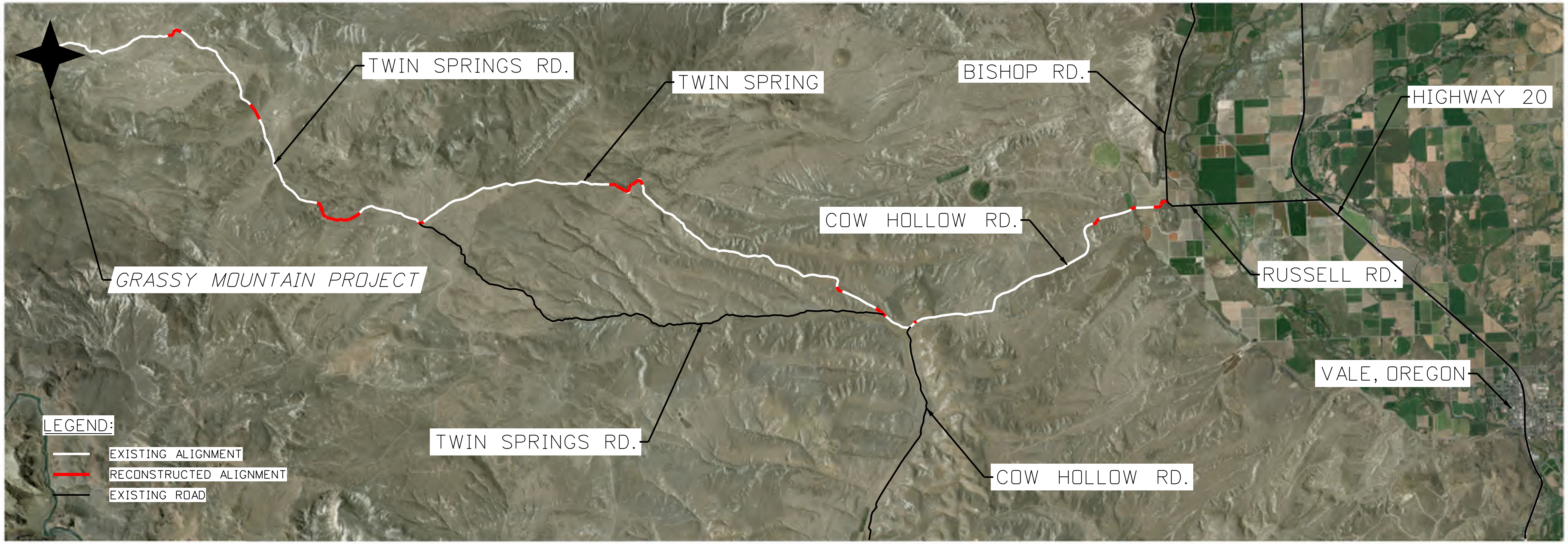
ROADWAY AND DRAINAGE PLANS

FOR

GRASSY MOUNTAIN PROJECT

MALHEUR COUNTY, OREGON

OCTOBER 2019



FEET

4250 0 8500

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBRODT
DWN BY: SGW
CKD BY: L. GREBE
PLOT SCALE:
PLOT DATE: 10\12\2019
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 10162...
SIZE: 11X17
FILE NAME: TITL_001.SHT

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS

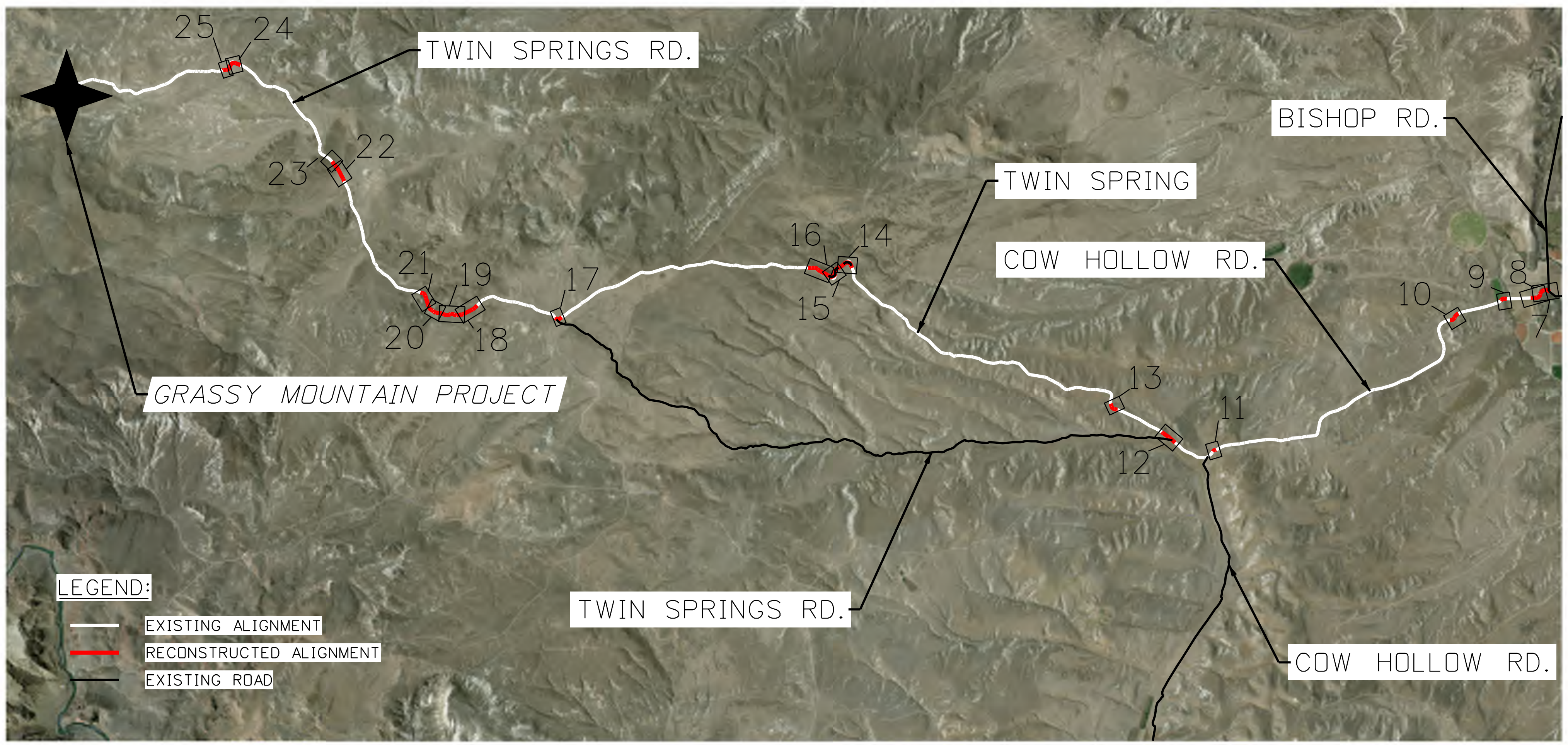
COVER AND VICINITY MAP

SHEET IDENTIFICATION

SHEET 1
OF 25

GENERAL NOTES:

1. TOPOGRAPHIC SURVEY WAS PERFORMED BY TCI CORP WITH A DRONE. THE COORDINATE SYSTEM USED FOR THIS PROJECT IS BASED ON THE OREGON STATE PLANE NAD 83 (2011) (EPOCH 2010), NAVD88 (GEOID12B) SOUTH ZONE (INTERNATIONAL FEET). THE CONTROL WAS DERIVED FROM THREE STATIONS USING STATIC DATA OBSERVATIONS PROCESSED THROUGH O.P.U.S. FROM THESE THREE STATIONS ADDITIONAL CONTROL FOR AERIAL TOPOGRAPHY WAS SET USING RTK METHODS FROM MAY 1 - MAY 5, 2017. AERIAL PHOTOGRAPHY WAS PERFORMED BY TCI CORP ON MAY 11, 2017.
2. ALL CONSTRUCTION MATERIAL AND WORKMANSHIP SHALL COMPLY WITH THE LATEST MALHEUR COUNTY, STATE OF OREGON, AND BUREAU OF LAND MANAGEMENT REQUIREMENTS. ALL CONSTRUCTION SHALL BE PERFORMED IN ACCORDANCE WITH THE MOST CURRENT STANDARDS FOR PUBLIC WORKS CONSTRUCTION AND THE OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY (D.E.Q) STANDARDS.
3. PRIOR TO ANY CONSTRUCTION OR EXCAVATION, CONTRACTOR IS REQUIRED TO SCHEDULE A PRE-CONSTRUCTION MEETING INVOLVING THE OWNER, ENGINEER, BUREAU OF LAND MANAGEMENT, COUNTY ROAD MASTER, AND THE UTILITY COMPANIES ASSOCIATED WITH THIS PROJECT.
4. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE AGENCIES GOVERNING THE CONSTRUCTION FOR THIS PROJECT PRIOR TO THE START OF CONSTRUCTION.
5. THE CONTRACTOR SHALL VERIFY ALL EXISTING UTILITY LOCATIONS AND COORDINATE WITH UTILITY COMPANIES FOR ANY PROTECTIVE MEASURES OR RELOCATIONS REQUIRED.
6. THE CONTRACTOR SHALL COORDINATE INSTALLATION OF UTILITIES TO AVOID CONFLICTS AND ASSURE PROPER DEPTHS ARE ACHIEVED AS WELL AS COORDINATE WITH THE REGULATORY AGENCY AS TO THE LOCATIONS AND TIE-IN/CONNECTIONS TO THEIR FACILITIES.
7. THE CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION AND MAINTENANCE OF ALL SIGNS FOR SAFETY AND TRAFFIC.
8. CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL DESIGN GRADES AND LOCATIONS PRIOR TO CONSTRUCTION, ANY DISCREPANCY SHOULD BE REPORTED TO THE ENGINEER IMMEDIATELY. NO CHANGES OR DEVIATION FROM DESIGN WILL BE MADE WITHOUT APPROVAL FROM ENGINEER.
9. CONTRACTOR SHALL RETAIN AND PROTECT ALL EXISTING ROAD ACCESS AND DRIVEWAYS. IF THE ROAD ACCESS IS DISTURBED DURING CONSTRUCTION. THE CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL AND REPLACEMENT OF ALL DAMAGED AREAS.



PLAN VIEW KEY MAP

FEET
4250 0 8500

INDEX OF SHEETS

SHEET NO.	DESCRIPTION
1	COVER AND VICINITY MAP
2	KEY MAP, NOTES AND DRAWING INDEX
3	TYPICAL SECTIONS AND QUANITIES
4	CULVERT SUMMARY
5	CULVERT DETAILS
6	TRENCH FOR CULVERT INSTALLATION
7	STA. 1127+00 TO STA. 1134+00
8	STA. 1134+00 TO STA. 1140+50
9	STA. 1154+10 TO STA. 1158+00
10	STA. 1183+50 TO STA. 1190+00
11	STA. 1363+00 TO STA. 1365+30
12	STA. 1391+00 TO STA. 1400+50
13	STA. 1429+50 TO STA. 1435+00
14	STA. 1618+00 TO STA. 1628+00
15	STA. 1628+00 TO STA. 1638+00
16	STA. 1638+00 TO STA. 1650+50
17	STA. 1804+00 TO STA. 1808+50
18	STA. 1857+70 TO STA. 1868+00
19	STA. 1868+00 TO STA. 1880+00
20	STA. 1880+00 TO STA. 1889+00
21	STA. 1889+00 TO STA. 1899+00
22	STA. 1983+00 TO STA. 1993+00
23	STA. 1993+00 TO STA. 1996+25
24	STA. 2078+50 TO STA. 2086+00
25	STA. 2086+00 TO STA. 2090+50

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

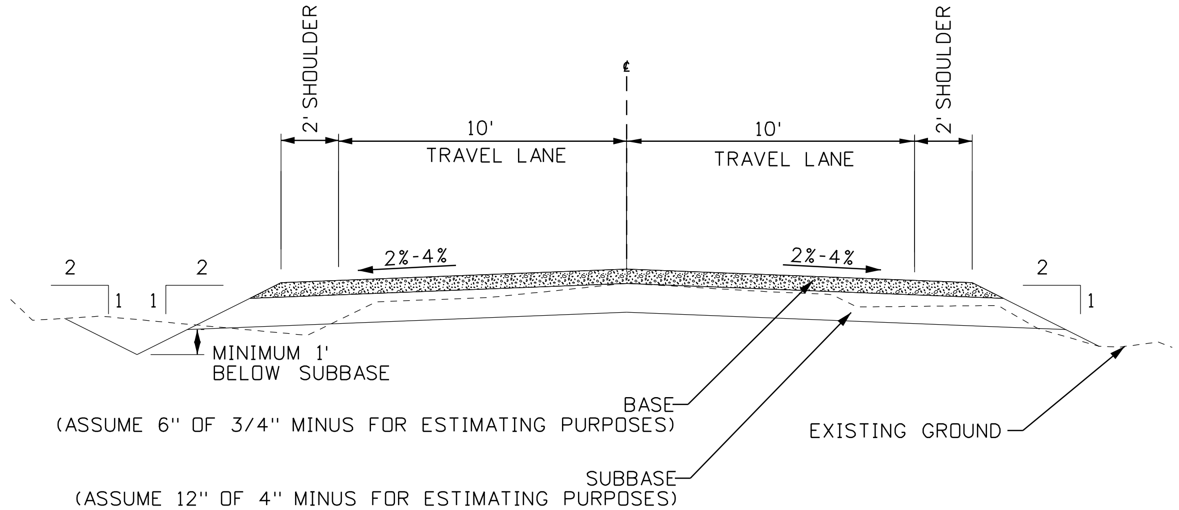
PRELIMINARY

DESIGNED BY: S. WARMBROOT
DATE: OCTOBER 2019
SIZE: 11X17
FILE NAME: TITL_002.SHT

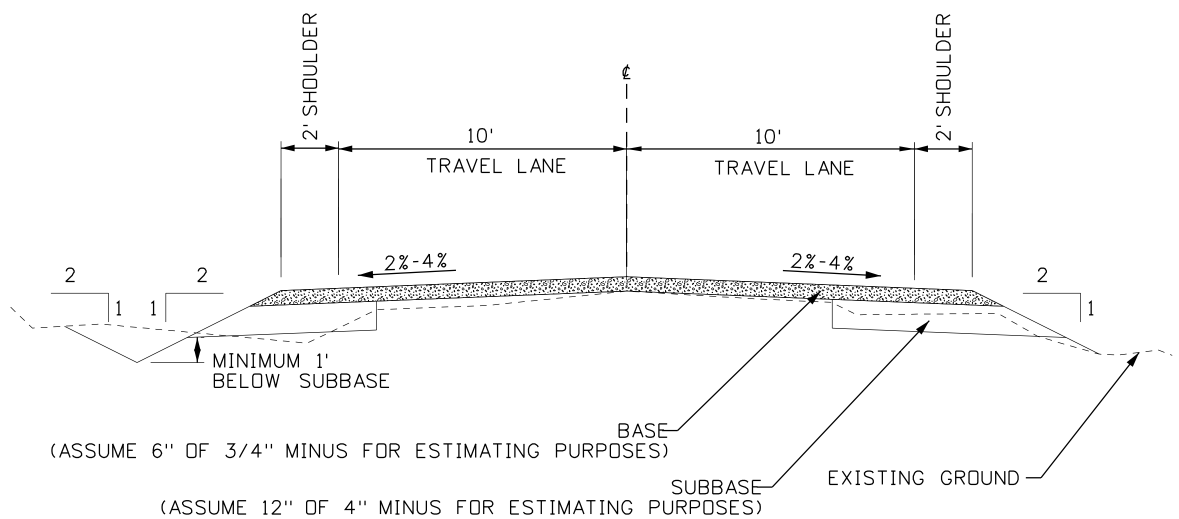
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
KEY MAP, NOTES AND DRAWING INDEX

SHEET IDENTIFICATION
SHEET 2
OF 25



TYPICAL SECTION
RECONSTRUCTION



TYPICAL SECTION
WIDENING

TYPICAL SECTION NOTES:

1. THE ROADWAY SOUTH OF BISHOP ROAD TO THE GRASSY MOUNTAIN MINE SITE SHALL BE GRADED AND WIDENED ACCORDINGLY. NEW SUBBASE MATERIAL SHALL BE ADDED BENEATH ROADWAY WIDENING.
2. ALL ROAD RECONSTRUCTION AND RE-ALIGNMENTS SHALL BE GRADED TO MATCH EXISTING AT THE STATIONS SHOWN ON THE PLANS.
3. ALL ORGANIC OR DISTURBED SOILS SHALL BE REMOVED TO A DEPTH OF 0.5 FOOT MINIMUM PRIOR TO ROAD CONSTRUCTION.
4. ALL ELEVATIONS ARE FINISH GRADE UNLESS OTHERWISE NOTED.

EARTHWORK QUANTITIES

STATIONING:	LENGTH (FEET)	EXCAVATION (CY)	BASE (CY)	SUBBASE (CY)
P: STA. 1127+00.00 TO STA. 1140+50.00	1,350	1,420	625	1,350
E: STA. 140+46.03 TO STA. 154+10.10	1,364	400	631	505
P: STA. 1154+10.00 TO STA. 1158+00.00	390	990	181	390
E: STA. 158+08.00 TO STA. 183+50.00	2,542	800	1,177	941
P: STA. 1183+50.00 TO STA. 1190+00.00	650	790	301	650
E: STA. 190+09.50 TO STA. 363+00.00	17,292	5,100	8,006	6,404
P: STA. 1363+00.00 TO STA. 1365+30.00	230	170	106	230
E: STA. 365+35.09 TO STA. 391+00.00	2,565	800	1,188	950
P: STA. 1391+00.00 TO STA. 1400+50.00	950	1,450	440	950
E: STA. 400+50.00 TO STA. 429+50.00	2,900	900	1,343	1,074
P: STA. 1429+50.00 TO STA. 1435+00.00	550	310	255	550
E: STA. 435+07.32 TO STA. 618+00.00	18,296	5,400	8,470	6,776
P: STA. 1618+00.00 TO STA. 1650+50.00	3,250	23,710	1,505	3,250
E: STA. 653+31.95 TO STA. 804+00.00	15,068	4,400	6,976	5,581
P: STA. 1804+00.00 TO STA. 1808+50.00	450	190	208	450
E: STA. 808+91.37 TO STA. 857+70.00	4,879	1,400	2,259	1,807
P: STA. 1857+70.00 TO STA. 1899+00.00	4,130	10,850	1,912	4,130
E: STA. 899+40.54 TO STA. 983+00.00	8,364	2,500	3,872	3,098
P: STA. 1983+00.00 TO STA. 1996+25.00	1,350	1,570	625	1,350
E: STA. 996+31.33 TO STA. 1078+50.00	8,218	2,400	3,805	3,044
P: STA. 2078+50.00 TO STA. 2090+50.00	1,200	290	556	1,200
E: STA. 1091+42.50 TO STA. 1176+57.88	8,515	2,500	3,942	3,154
TOTAL	104,500	68,340	48,380	47,830

* E: STATION ARE EXISTING NON-REALIGNMENT SECTIONS, AND P: STATION ARE PROPOSED REALIGNMENT SECTIONS.

** EMBANKMENT CONSTRUCTION IS INCIDENTAL TO EXCAVATION WORK AND QUANTITIES WILL BE BALANCED WITHIN EACH RECONSTRUCTION SEGMENT THROUGH SIDE-CASTING OF UNSUITABLE MATERIAL, OR ROADWAY WIDENING AND PROFILE ADJUSTMENTS WITH SUITABLE MATERIAL.

CURVE WIDENING TABLE

RADIUS	WIDEN INSIDE	LENGTH INSIDE
50	5	50
100	4	47
150	3	35
200	3	35
250	3	35
300	3	35
350	2	24
400	2	24
450	1	10
500	0	0

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

DATE: OCTOBER 2019
DESIGNED BY: S. WARMBROOT
DWN BY: SGW
CKD BY: L. GREBE
SIZE: 11X17
FILE NAME: TYPL_001.SHT

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
TYPICAL SECTIONS AND QUANTITIES

SHEET IDENTIFICATION
SHEET 3
OF 25

DITCH RELIEF CULVERT SUMMARY

BEGIN STA	END STA	REACH LENGTH (FT)	AVG. GRADE (%)	MIN CULVERT SPACING (FT)	NUMBER OF CULVERTS
119+25.65	129+64.34	1039	2	1225	1
129+64.34	132+58.74	294	9	270	2
132+58.74	136+15.09	356	-2	1225	1
136+15.09	137+95.69	181	-7	350	1
137+95.69	173+09.00	3513	-2	1225	3
173+09.00	177+00.00	391	2	1225	1
177+00.00	178+60.00	160	4	610	1
178+60.00	188+34.00	974	-3	815	2
188+34.00	190+55.00	221	4	610	1
190+55.00	191+96.00	141	-2	1225	1
191+96.00	210+48.00	1852	2	1225	2
210+48.00	283+77.00	7329	2	1225	6
283+77.00	304+73.00	2096	3	815	3
304+73.00	308+00.00	327	2	1225	1
308+00.00	311+00.00	300	7	350	1
311+00.00	315+84.00	484	2	1225	1
315+84.00	316+00.00	16	-8	305	1
316+00.00	324+32.00	832	5	490	2
324+32.00	331+00.00	668	-3	815	1
331+00.00	336+00.00	500	4	610	1
336+00.00	354+00.00	1800	8	305	6
354+00.00	371+00.00	1700	-2	1225	2
371+00.00	375+00.00	400	2	1225	1
375+00.00	394+00.00	1900	2	1225	2
394+00.00	402+00.00	800	8	305	3
402+00.00	468+00.00	6600	5	490	14
468+00.00	472+00.00	400	-4	610	1
472+00.00	506+00.00	3400	2	1225	3
506+00.00	535+00.00	2900	3	815	4
535+00.00	544+01.00	901	-7	350	3
544+01.00	563+00.00	1899	5	490	4
563+00.00	569+00.00	600	-2	1225	1
569+00.00	575+01.00	601	5	490	2
575+01.00	579+00.00	399	2	1225	1
579+00.00	624+00.00	4500	7	350	13
624+00.00	631+13.00	713	-2	1225	1
631+13.00	635+00.00	387	-11	220	2
635+00.00	650+00.00	1500	10	245	7
650+00.00	656+00.00	600	4	610	1
656+00.00	663+00.00	700	9	270	3
663+00.00	695+00.00	3200	2	1225	3
695+00.00	708+04.00	1304	6	410	4
708+04.00	737+00.00	2896	2	1225	3

DITCH RELIEF CULVERT SUMMARY CONT.

BEGIN STA	END STA	REACH LENGTH (FT)	AVG. GRADE (%)	MIN CULVERT SPACING (FT)	NUMBER OF CULVERTS
737+00.00	745+00.00	800	2	1225	1
745+00.00	751+00.00	600	-4	610	1
751+00.00	760+00.00	900	2	1225	1
760+00.00	801+00.00	4100	-4	610	7
801+00.00	807+00.00	600	2	1225	1
807+00.00	835+00.00	2800	3	815	4
835+00.00	848+16.00	1316	-3	815	2
848+16.00	861+00.00	1284	-6	410	4
861+00.00	880+00.00	1900	-8	305	7
880+00.00	908+00.00	2800	-6	410	7
908+00.00	956+00.00	4800	-4	610	8
956+00.00	992+77.00	3677	2	1225	4
992+77.00	1005+00.00	1223	4	610	3
1005+00.00	1033+00.00	2800	2	1225	3
1033+00.00	1074+00.00	4100	3	815	6
1074+00.00	1100+82.00	2682	2	1225	3
1100+82.00	1144+23.00	4341	3	815	6
1144+23.00	1146+39.00	216	-3	815	1
1146+39.00	1152+00.00	561	6	410	2
1152+00.00	1155+00.00	300	-7	350	1
1155+00.00	1176+84.00	2184	3	815	3
				TOTAL CULVERTS:	192

NOTES:
1. ALL DITCH RELIEF CULVERTS SHALL BE 18 INCHES IN DIAMETER

CROSS DRAIN CULVERT SUMMARY

CULVERT ID	EXISTING STATIONING	PEAK FLOWS (CFS)		PIPE MATERIAL	PIPE DIMENSIONS							NUMBER OF BARRELS	FILL HEIGHT (FEET)	RIPRAP D50 (FEET)
					SIZE (INCHES)									
		10-YR	5-YR		18	24	30	36	42	48	54			
					LENGTH (FEET)									
C-01	305+56.00	18	23	CMP		37.0						2	3.0	0.5
C-02	393+79.00	14	20	CMP		69.0						2	3.0	0.5
C-03	634+11.00	31	44	CMP			40.0					2	3.8	0.5
C-04	675+10.00	21	30	CMP		38.0						2	3.0	0.5
C-05	800+15.00	21	30	CMP		38.0						2	3.0	1.0
C-06	940+20.00	56	72	CMP				40.0				2	4.5	0.5
C-07	944+25.00	84	109	CMP					43.0			2	5.3	0.5
C-08	983+55.00	59	76	CMP						35.0		1	6.0	0.5
C-09	1021+30.00	75	97	CMP				35.0				3	4.5	0.5
C-10	1132+64.00	16	21	CMP		45.0						2	3.0	0.5
C-11	1101+19.00	130	169	CMP					48.0			3	5.3	0.5

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WAMBAUGH
DRAWN BY: SGW
PLOT SCALE: 1
DATE: OCTOBER 2019
CKD BY: L. GREBE
PLOT DATE: 10/29/2019
SIZE: 11X17
FILE NAME: DRAN_001.SHT

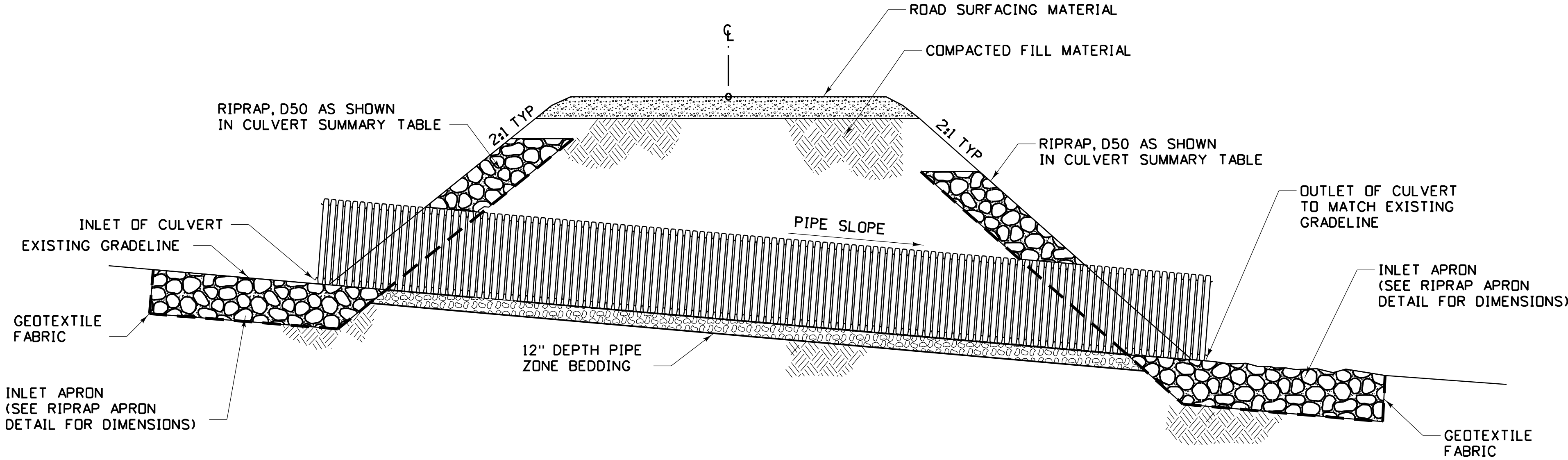
PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS

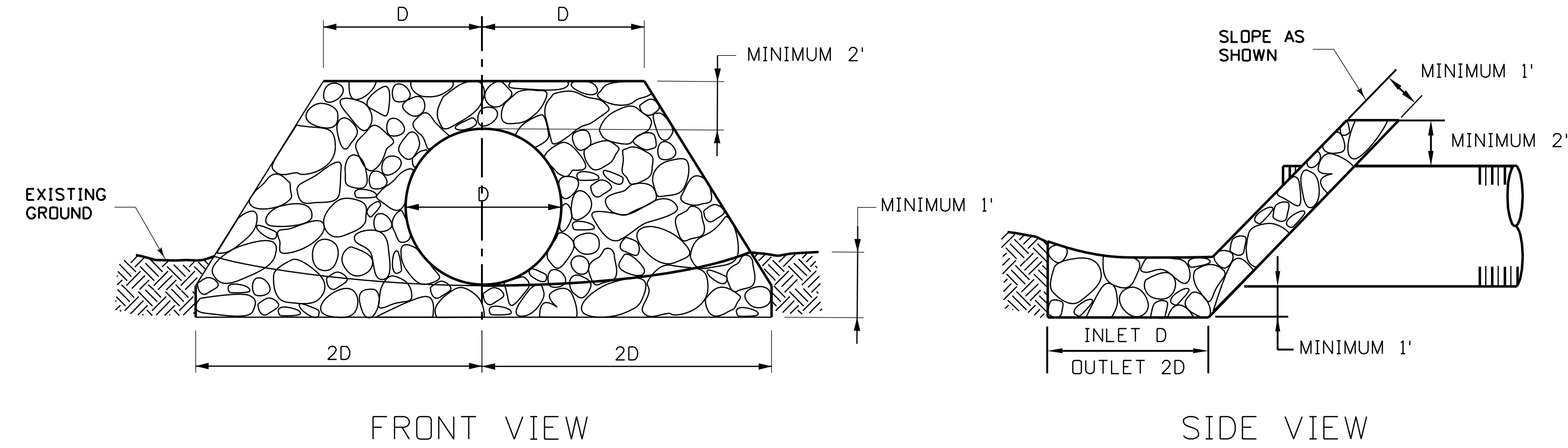
CULVERT SUMMARY

SHEET IDENTIFICATION
SHEET 4
OF 25



PROFILE VIEW - TYPICAL CULVERT INSTALLATION

NTS



RIPRAP APRON DETAIL

NTS

NOTES:

1. CULVERTS SHALL NOT BE INSTALLED AT SLOPES GREATER THAN 15%.
2. CONTRACTOR SHALL VERIFY ALL CULVERT LENGTHS BASED ON ACCESS ROAD DESIGN SIDE SLOPES AND EXISTING CONDITIONS FOUND IN THE FIELD.
3. CONTRACTOR TO VERIFY MINIMUM FILL HEIGHT BASED ON MANUFACTURERS SPECIFICATIONS.
4. SEE NOTES ON PLANS AND CULVERT SUMMARY TABLE FOR LOCATION AND SIZE OF CULVERT.
5. FOR CULVERT INSTALLATIONS AT ROADS WITH EXISTING ROADSIDE DITCHES, REGRADE THE DITCH TO PROVIDE THE MINIMUM REQUIRED CULVERT COVER AND POSITIVE DRAINAGE OF THE DITCH UPSTREAM AND DOWNSTREAM OF THE CULVERT. DITCH TRANSITION GRADING SHALL NOT EXCEED 15%.
6. ALL CULVERTS SHALL HAVE A MINIMUM SLOPE OF 0.50%.
7. APRON SURFACE MUST CONFORM TO SHAPE OF EXISTING GROUND AND BE LEFT ROUGH TO REDUCE WATER VELOCITY.

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: S. WARMBRODT		DATE: OCTOBER 2019
DWN BY: SGW	CKD BY: L. GREBE	HDR PROJECT [illegible]
PLOT SCALE:	PLOT DA[illegible]	
SIZE: 11X17	FILE NAME: DRAN_001.SHT	

PRELIMINARY

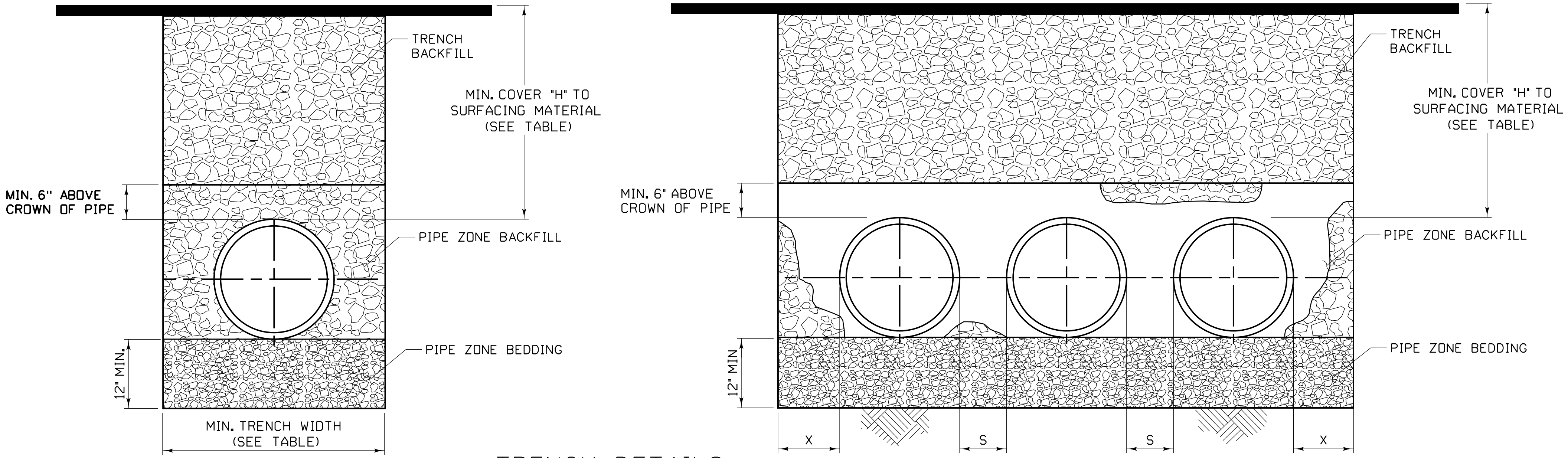
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS

CULVERT DETAILS

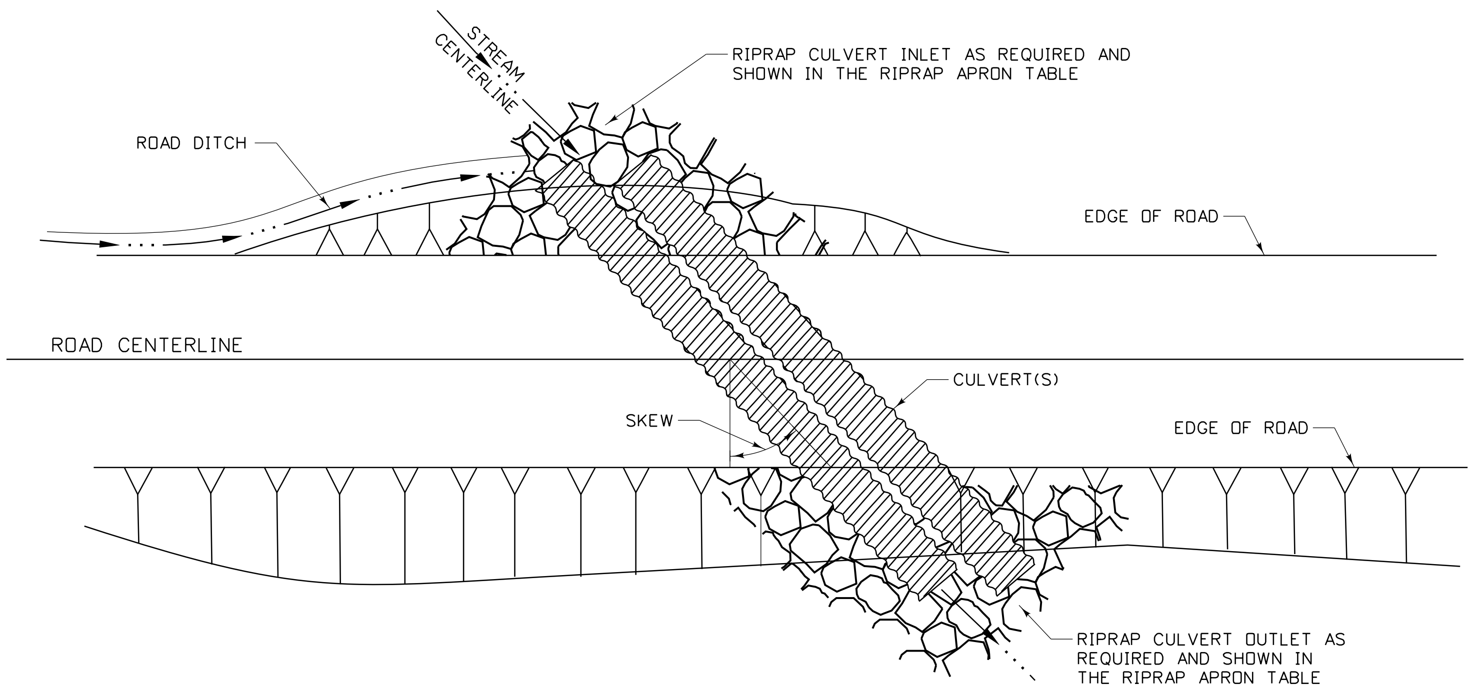
SHEET IDENTIFICATION

SHEET 5
OF 25



TRENCH DETAILS

NTS



SINGLE/DOUBLE CULVERT INSTALLATION W/ SKEW & STAGGER GUIDANCE PLAN VIEW

NTS

NOTES:

1. MEASURES SHOULD BE TAKEN TO PREVENT MIGRATION OF NATIVE FINES INTO BACKFILL MATERIAL.
2. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE, THE CONTRACTOR SHALL EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH SUITABLE MATERIAL AS SPECIFIED BY THE ENGINEER. AS AN ALTERNATIVE, AND AT THE DISCRETION OF THE ENGINEER, THE TRENCH BOTTOM MAY BE STABILIZED USING A GEOTEXTILE MATERIAL.
3. COLLAR SHALL BE 2' THICK AS NOTED IN THE CULVERT INSTALLATION TYPICAL DETAIL.
4. COLLAR SHALL BE EMBEDDED INTO NATIVE MATERIAL A MINIMUM OF 6", COLLAR SHALL BE COMPOSED OF IMPERVIOUS MATERIAL TO PREVENT PIPING.
5. IMPERVIOUS MATERIAL COULD INCLUDE: COMPACTED CLAY, CONTROLLED DENSITY FILL, OR READY MIX ON-SITE CONCRETE.
6. SKEW CULVERT 30-45° FROM PERPENDICULAR TO ROAD CENTERLINE. NO SKEW NECESSARY ON ROADS WITH GRADE LESS THAN 3% OR AT A LOW POINT IN THE ROAD PROFILE.

RECOMMENDED MINIMUM TRENCH WIDTHS AND COVER

PIPE DIAM.	MIN. TRENCH WIDTH	MIN "X"	MIN "S" *	MIN. COVER "H"
18"	36"	9"	12"	12"
24"	48"	10"	12"	12"
30"	56"	18"	15"	12"
36"	64"	18"	18"	12"
42"	72"	18"	21"	12"
48"	80"	18"	24"	12"
54"	88"	18"	27"	24"
60"	96"	18"	30"	24"

* MINIMUM SPACING ("S") MEASUED FROM OUTSIDE DIAMETER TO OUTSIDE DIAMETER. ADDITTIONAL PARALLEL PIPES SHALL BE SPACED "S" DISTANCE APART WITH "X" DISTANCE FROM TRENCH SIDE WALL.

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: S. WARMBRODT
DWN BY: SGW
CKD BY: L. GREBE
DATE: OCTOBER 2019
PLOT SCALE:
SIZE 11X17
FILE NAME: DRAN_002.SHT

PRELIMINARY

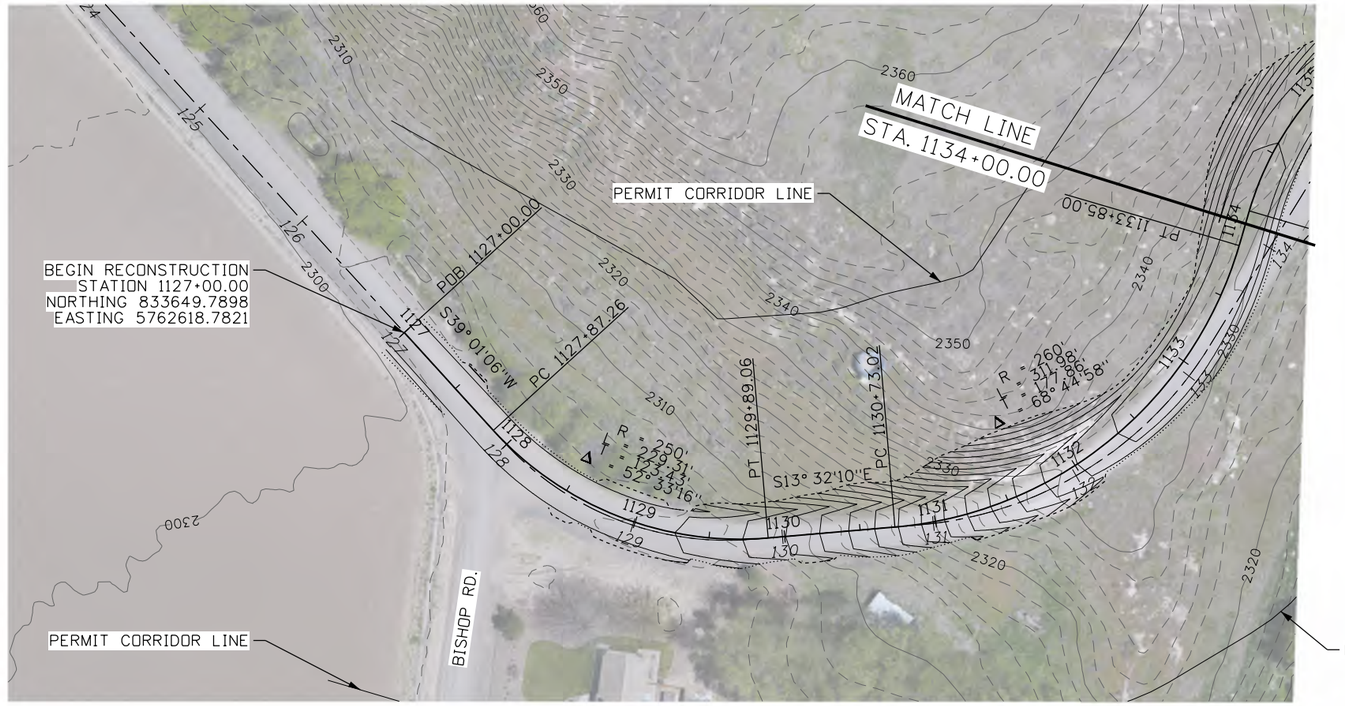
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
TRENCH DETAIL FOR CULVERT INSTALLATION

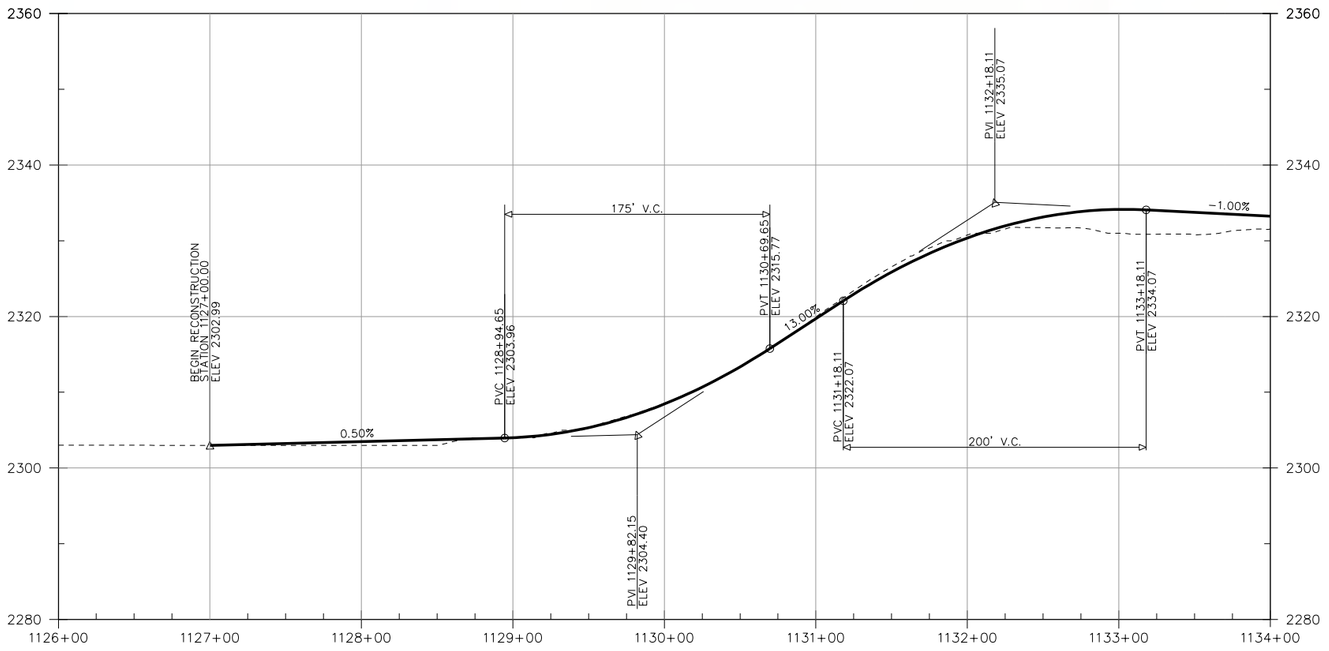
SHEET IDENTIFICATION
SHEET 6 OF 25

HORIZONTAL FEET

50 0 100



PLAN



PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
CHKD BY: L. GREBE
HDR PROJECT NO. 1141
PLOT DATE: 10/29/2019
SIZE: 11X17
FILE NAME: PLAN_PROF_001.SHT

PRELIMINARY

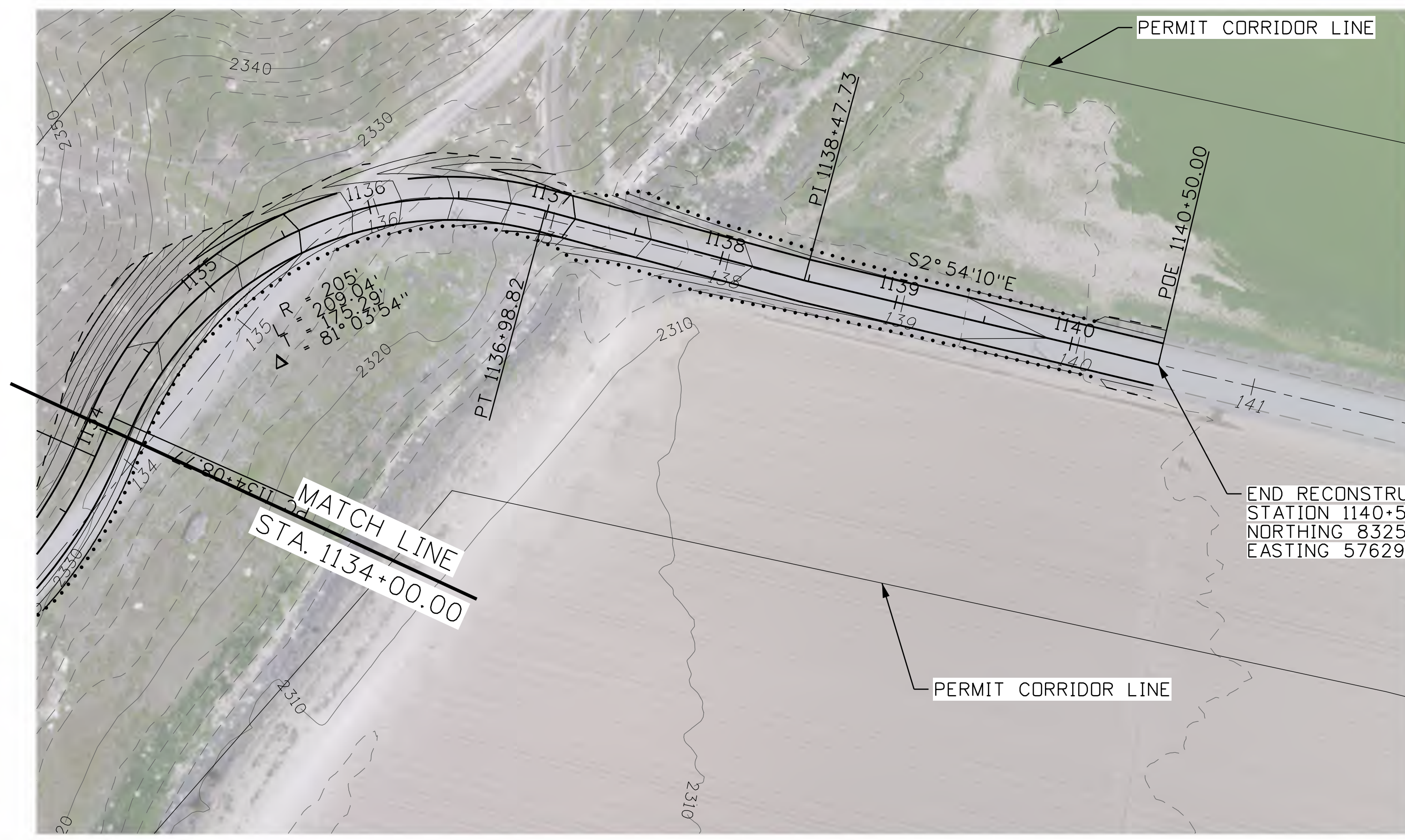
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1127+00 TO STA. 1134+00

SHEET IDENTIFICATION
SHEET 7
OF 25

HORIZONTAL FEET

50 0 100



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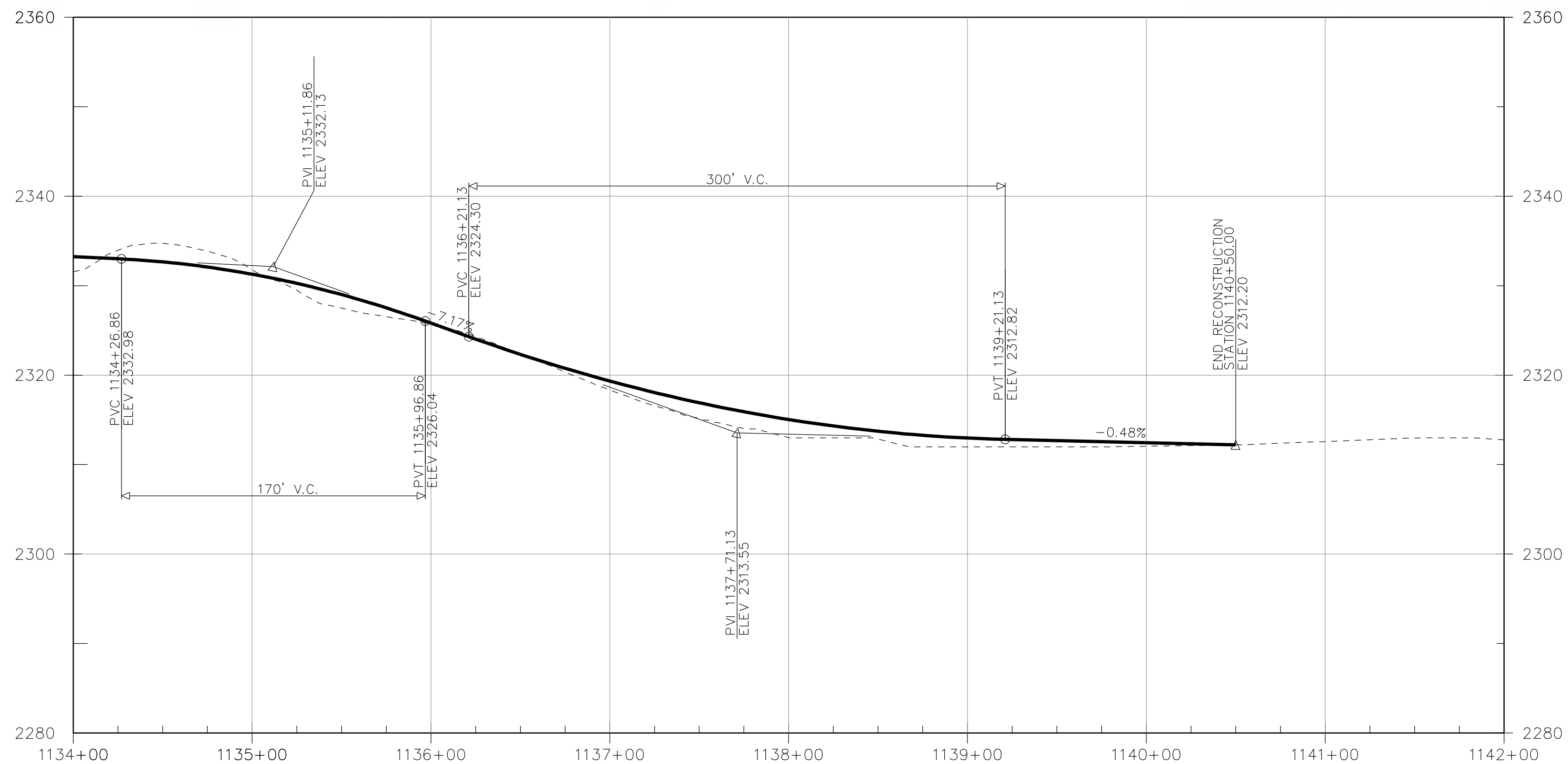


PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD Nevada

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: S. WARMBRODT
DWN BY: SGW
CKD BY: L. GREBE
PLOT SCALE: 1" = 100'
PLOT DATE:
DATE: OCTOBER 2019
HDR PROJECT NUMBER:
SIZE: 11X17
FILE NAME: PLAN_PROF_002.SHT

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

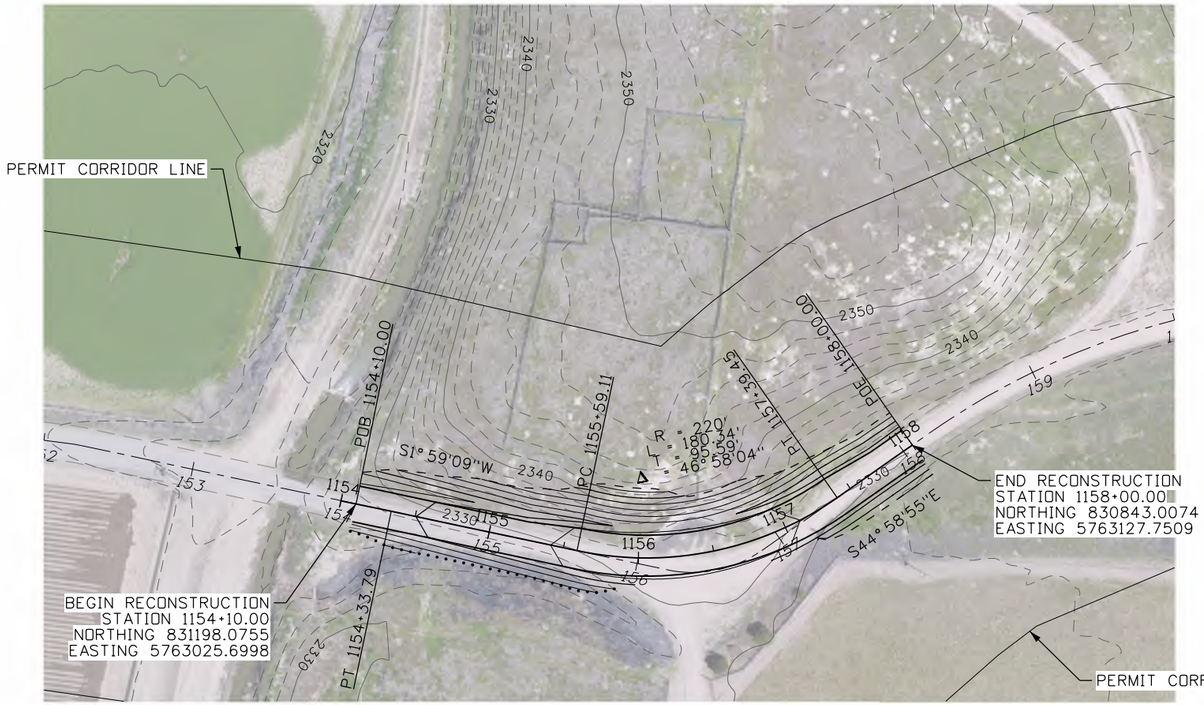
GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1134+00 TO STA. 1140+50

SHEET IDENTIFICATION

SHEET 8 OF 25

HORIZONTAL FEET

50 0 100



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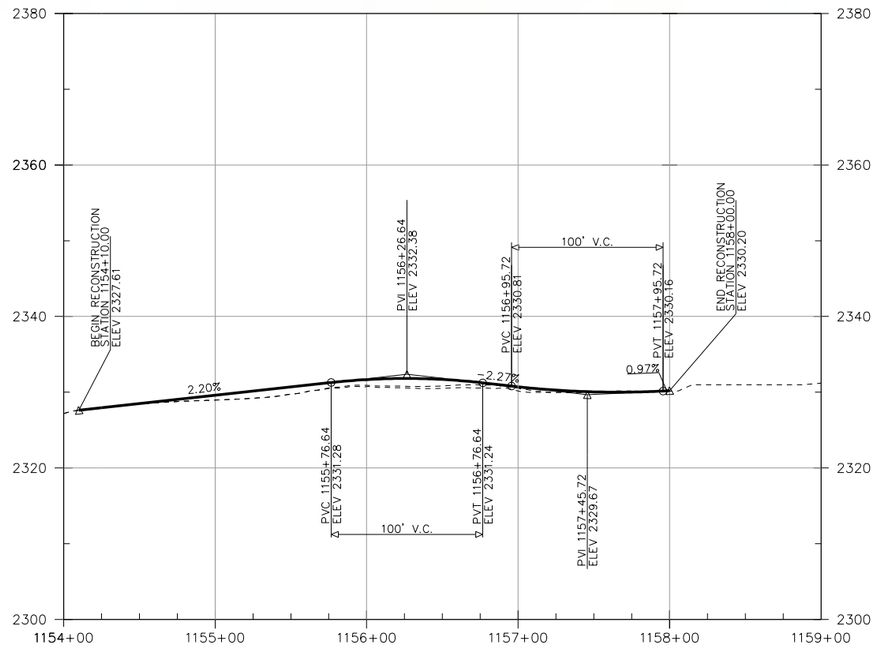


PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
CHKD BY: L. GREBE
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 1141
PLOT DATE: 10/25/2019
SIZE: 11X17
FILE NAME: PLAN_PROF_003.SHT

PRELIMINARY

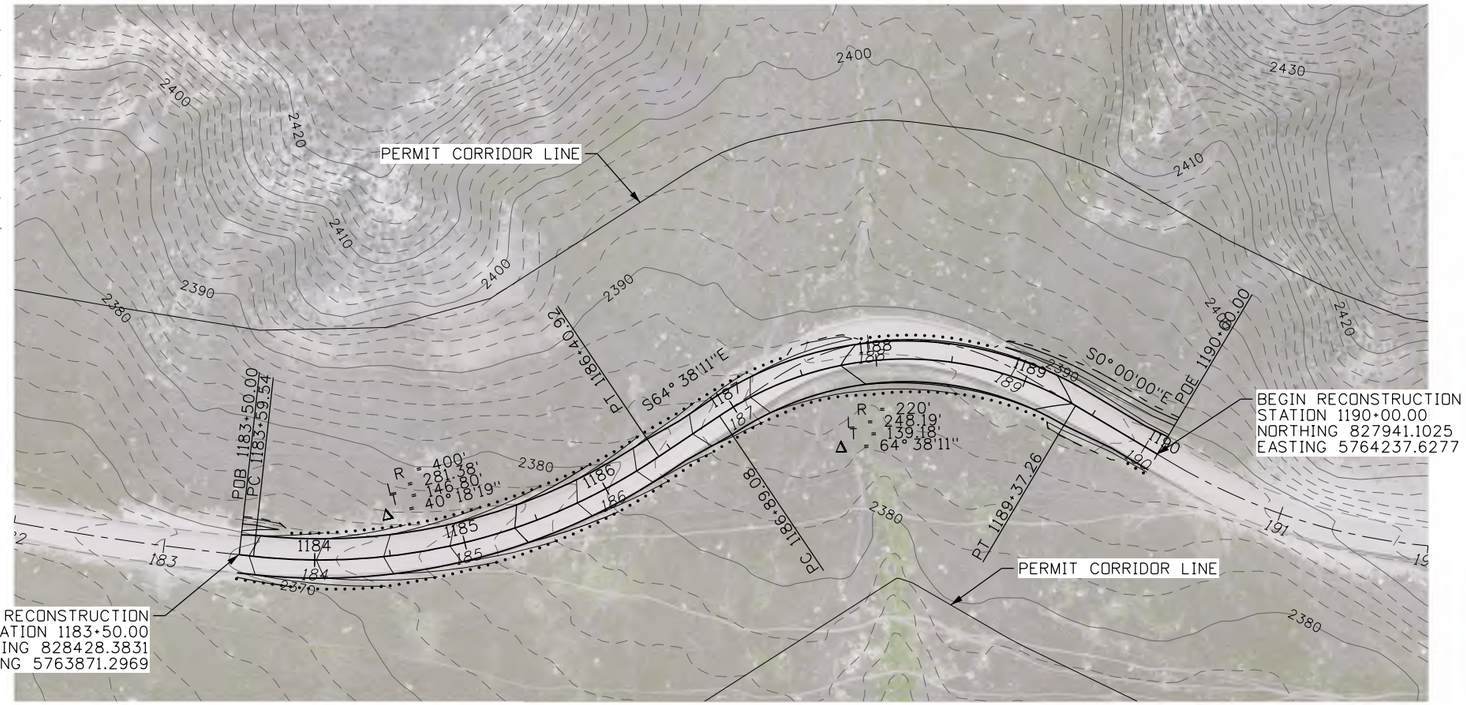
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1154+10 TO STA. 1158+00

SHEET IDENTIFICATION
SHEET 9
OF 25

HORIZONTAL FEET

50 0 100



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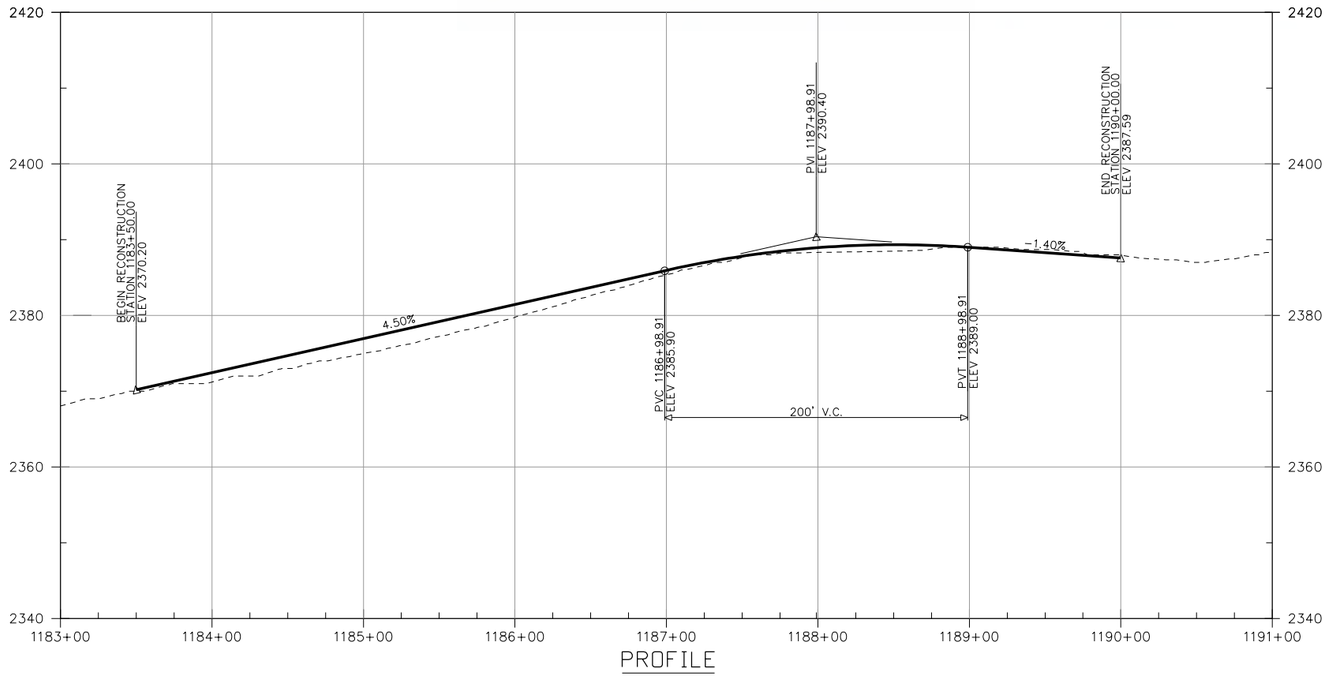


PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
PLOT SCALE: 1" = 100'
SIZE: 11X17
DATE: OCTOBER 2019
CKD BY: L. GREBE
HDR PROJECT NUMBER: 10142019
PLOT DATE: 10/24/2019
FILE NAME: PLAN_PROF_004.SHT

PRELIMINARY

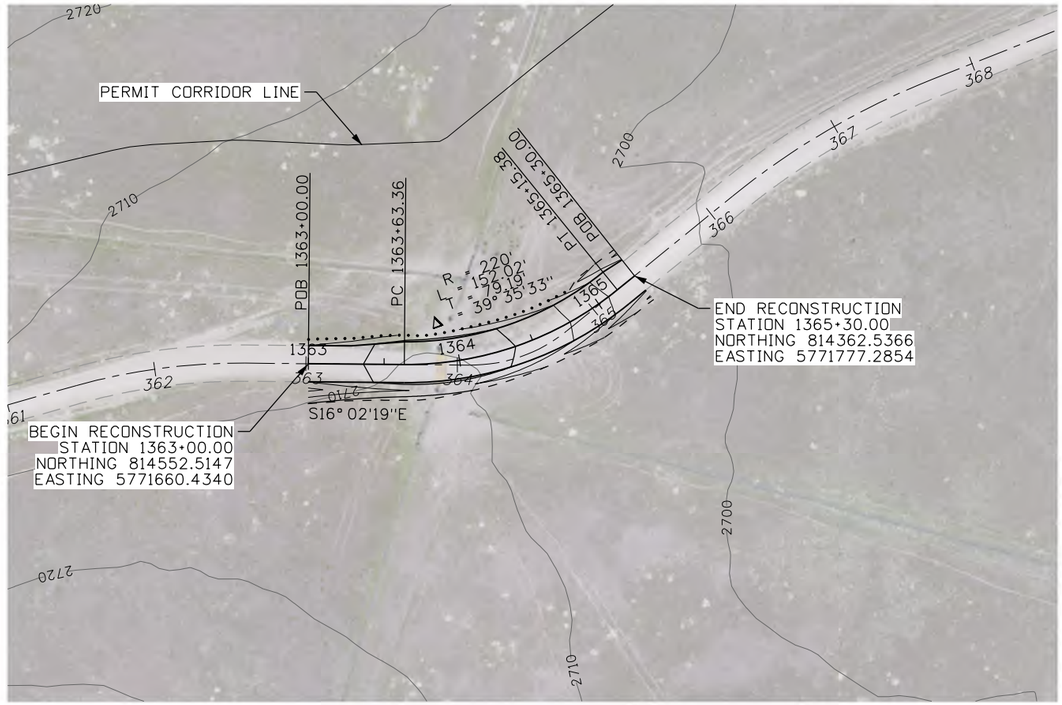
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1183+50 TO STA. 1190+00

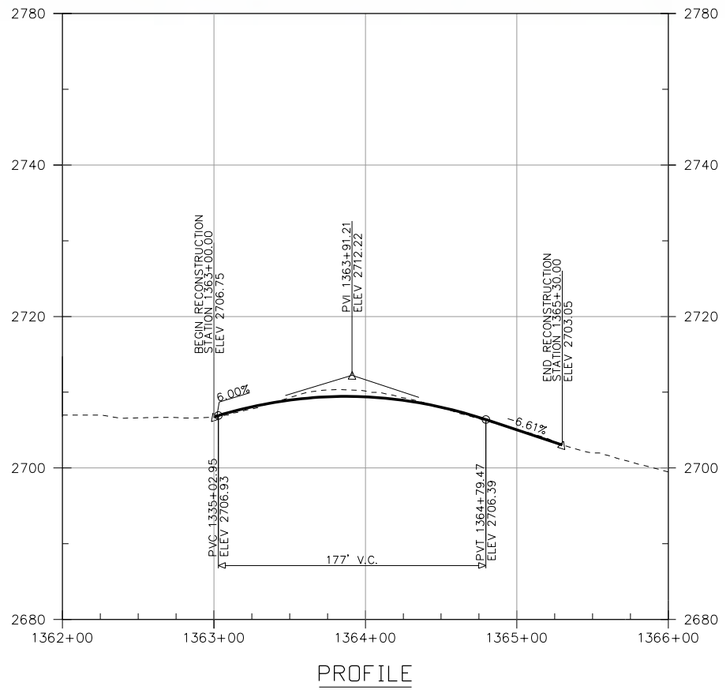
SHEET IDENTIFICATION
SHEET 10
OF 25

HORIZONTAL FEET

50 0 100



PLAN



PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WAMBROOT
DRAWN BY: SGW
CHKD BY: L. GREBE
PLOT DATE: 10/4/2019
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 10141844
SIZE: 11X17
FILE NAME: PLAN_PROF_005.SHT

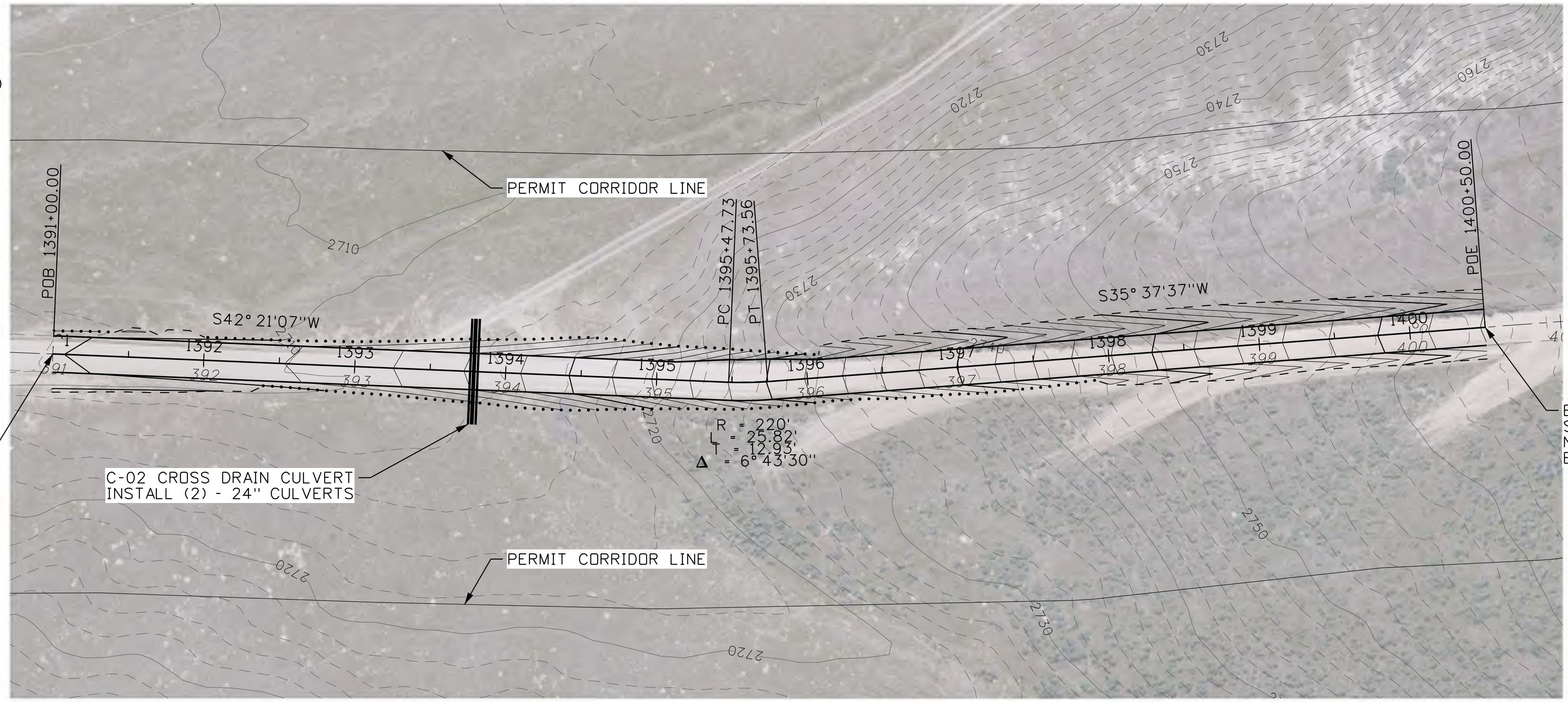
PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1363+00 TO STA. 1365+30

SHEET IDENTIFICATION
SHEET 11
OF 25

HORIZONTAL FEET
50 0 100

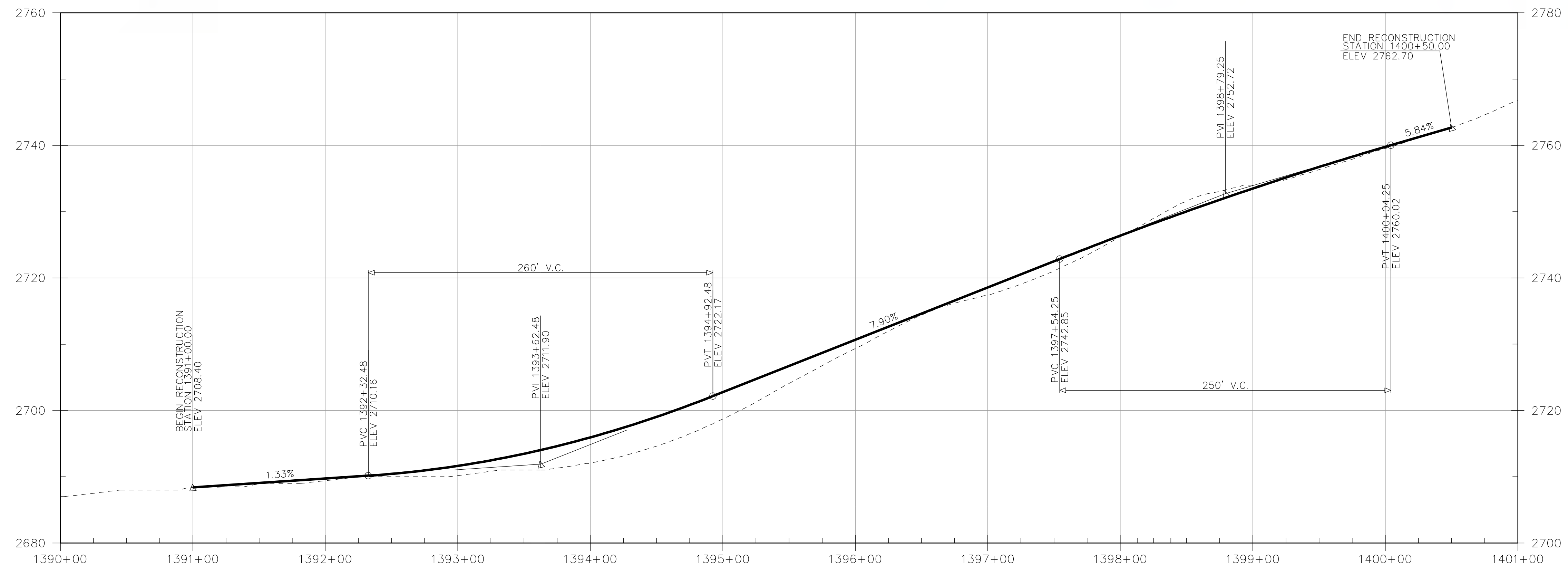


BEGIN RECONSTRUCTION
STATION 1391+00.00
NORTHING 812195.0769
EASTING 5771263.7828

C-02 CROSS DRAIN CULVERT
INSTALL (2) - 24" CULVERTS

BEGIN RECONSTRUCTION
STATION 1400+50.00
NORTHING 811456.8097
EASTING 5770668.3317

PLAN



PROFILE

VERTICAL FEET
10 0 20

PARAMOUNT GOLD Nevada
PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

PRELIMINARY

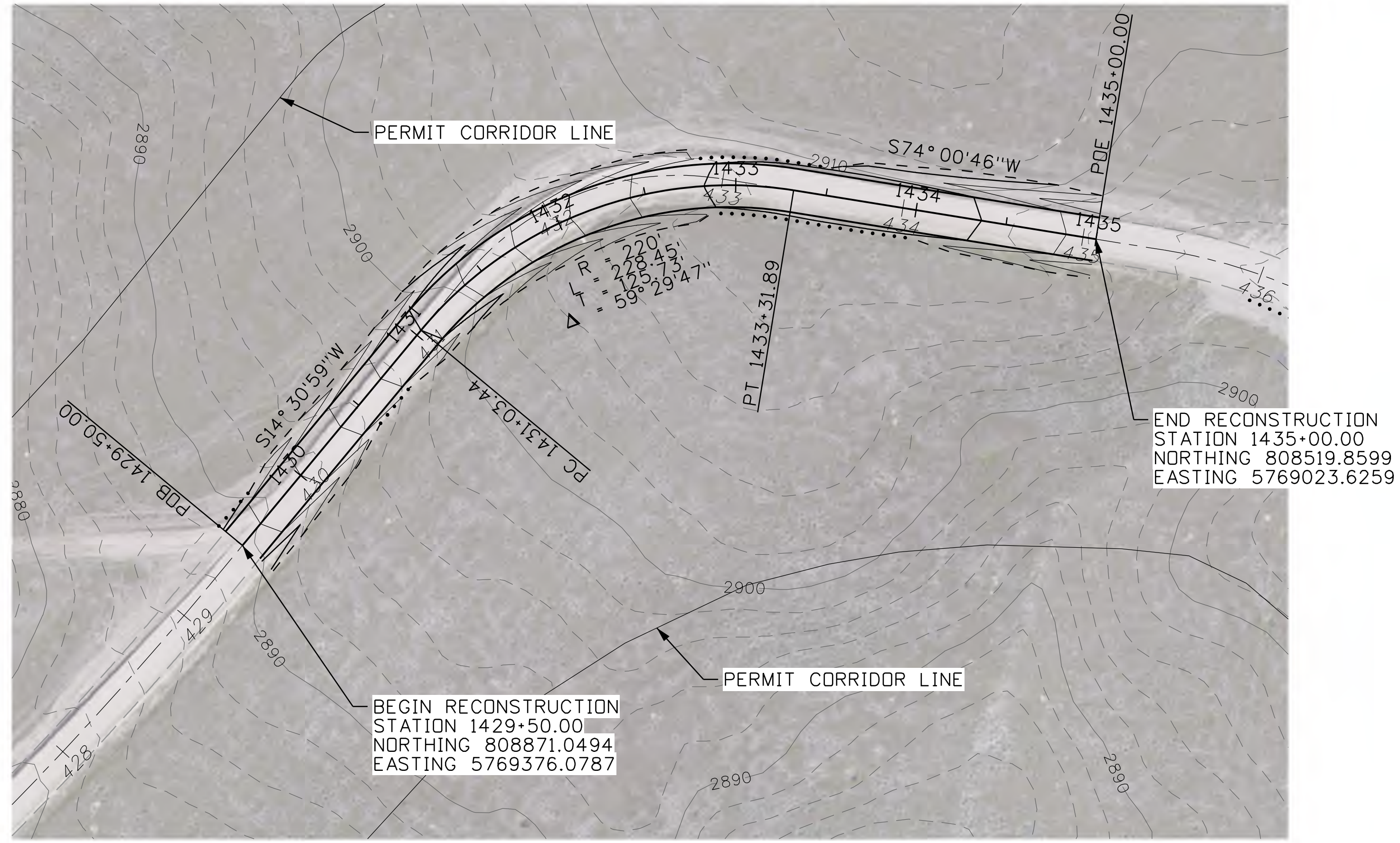
DESIGNED BY: S. WARMBRODT
DWN BY: SGW
CKD BY: L. GREBE
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER:
SIZE: 11X17
FILE NAME: PLAN_PROF_006.SHT

HDR
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

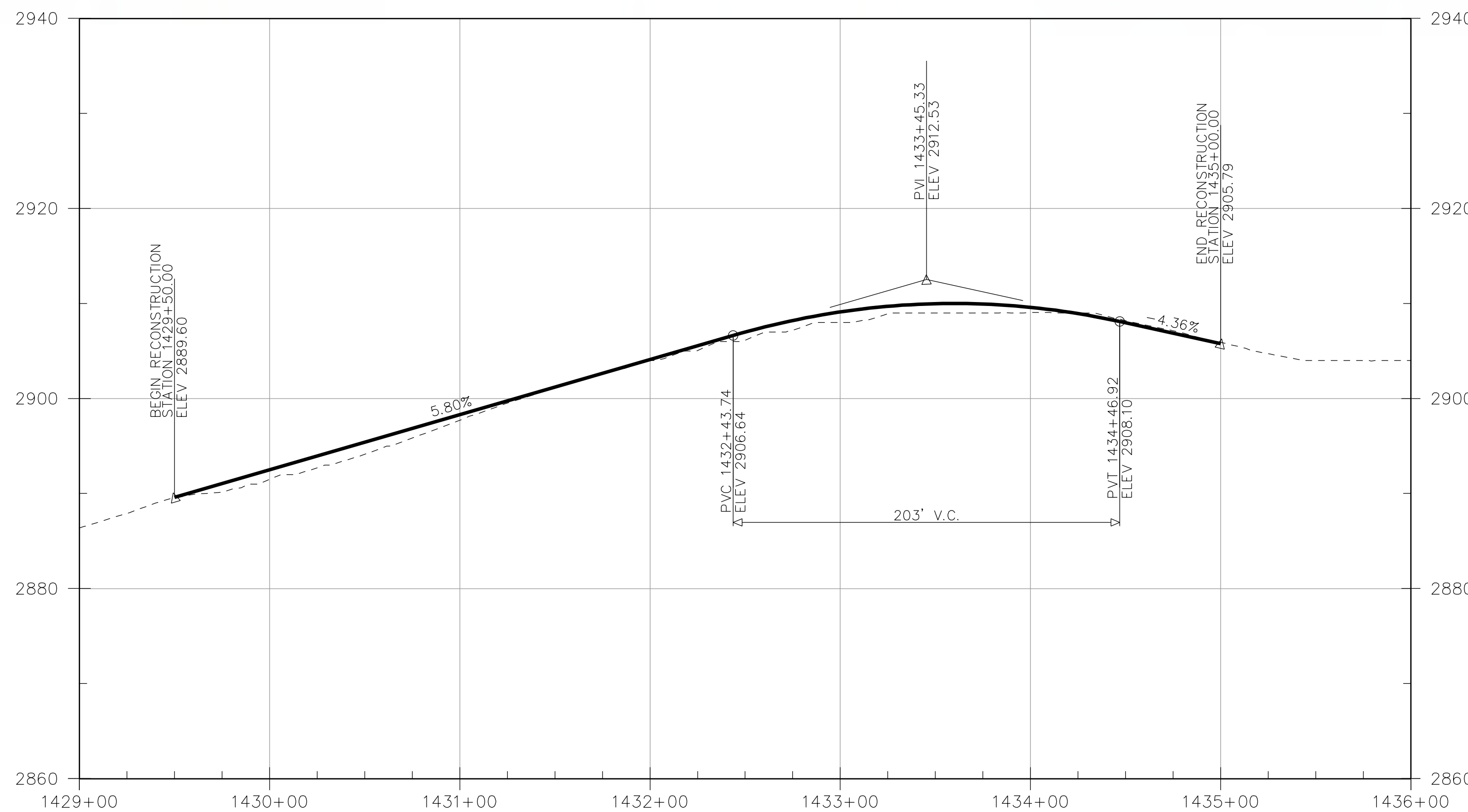
GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1391+00 TO STA. 1400+50

SHEET IDENTIFICATION
SHEET 12
OF 25

HORIZONTAL FEET
50 0 100



PLAN



PROFILE

VERTICAL FEET
10 0 20

PARAMOUNT GOLD Nevada

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: S. WARMBRODT
DWN BY: SGW
CKD BY: L. GREBE
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 10161...
PLOT DATE:
SIZE: 11X17
FILE NAME: PLAN_PROF_007.SHT

PRELIMINARY

HDR

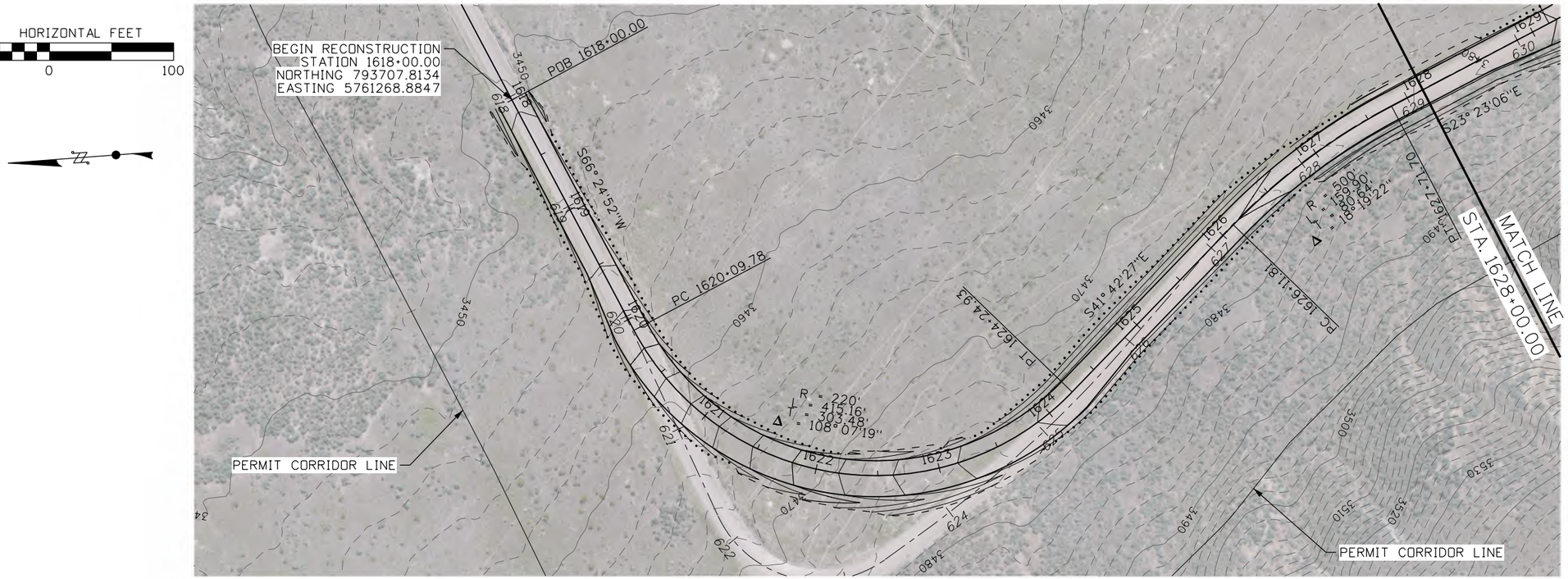
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1429+50 TO STA. 1435+00

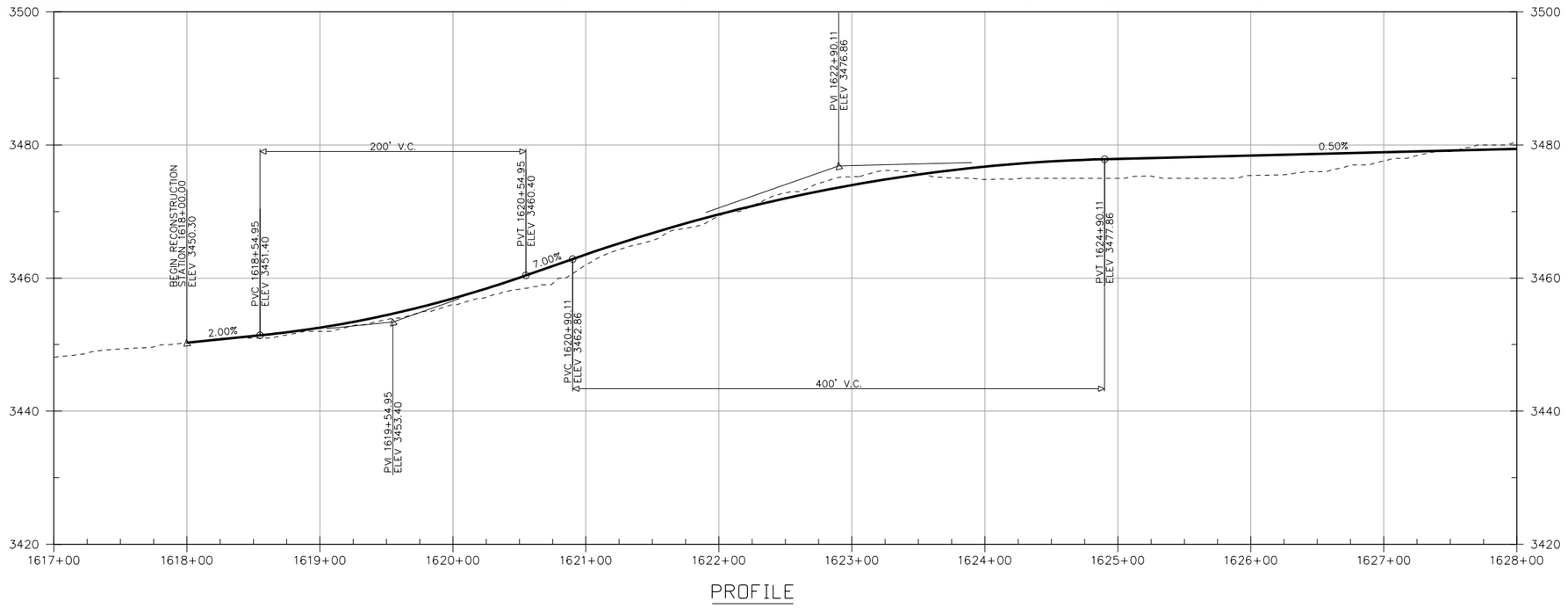
SHEET IDENTIFICATION
SHEET 13
OF 25

HORIZONTAL FEET

50 0 100



PLAN



PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
CHD BY: L. GREBE
HDR PROJECT NUMBER: 10147888
PLOT DATE: 10/25/2019
SIZE: 11X17
FILE NAME: PLAN_PROF_006.SHT

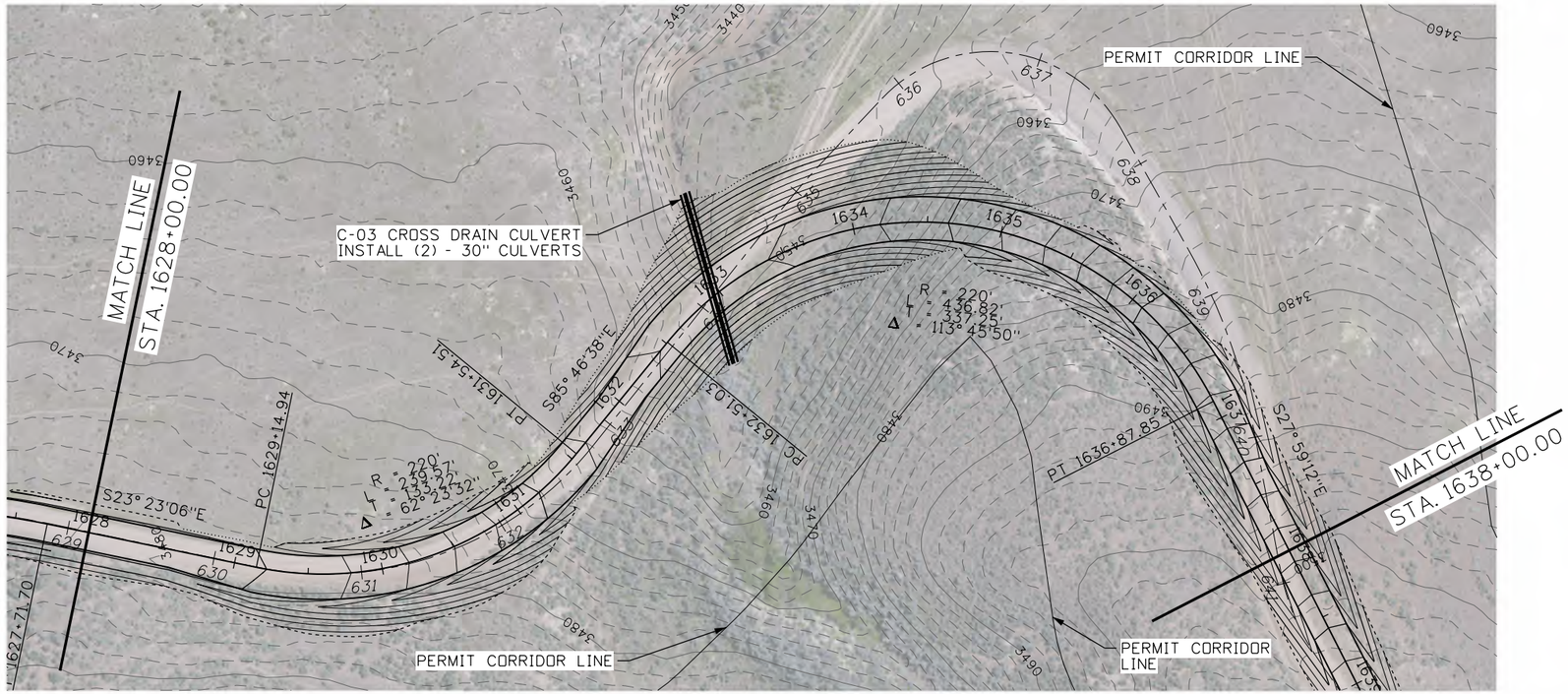
PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

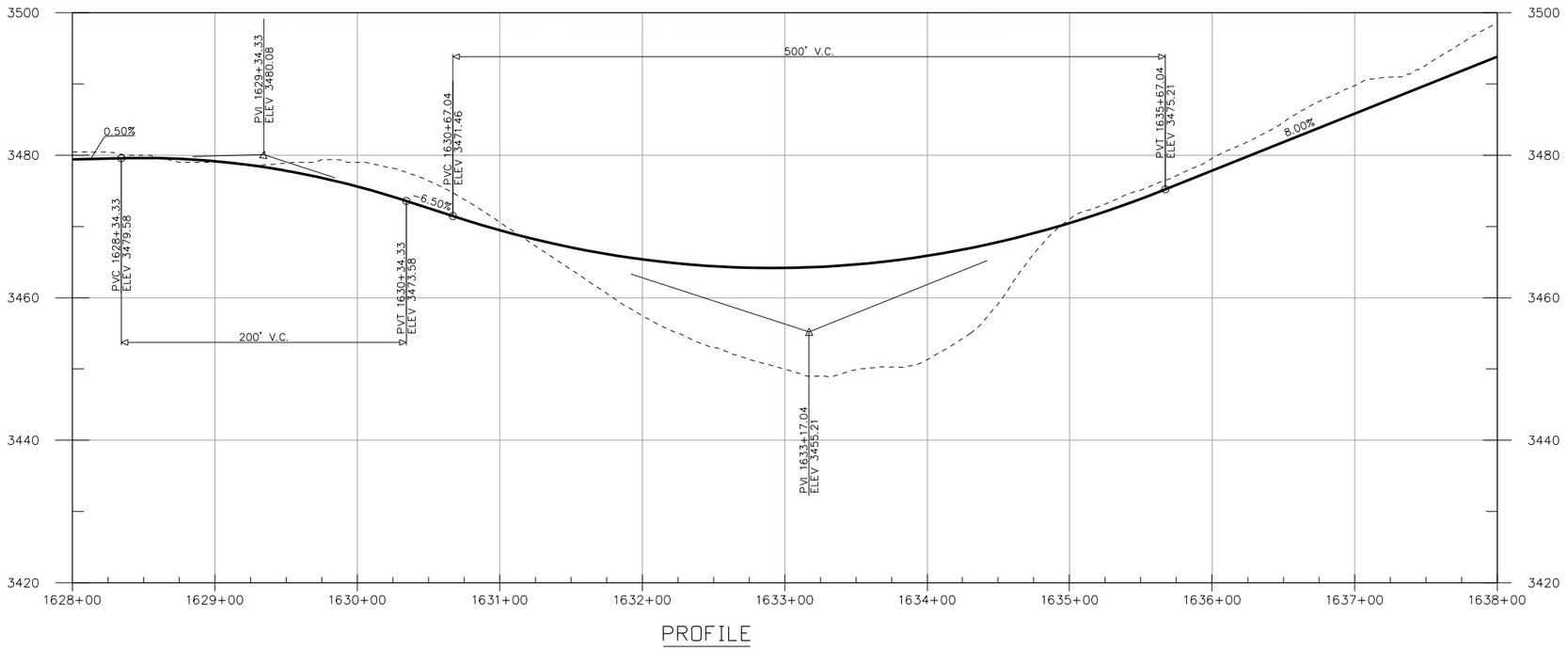
GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1618+00 TO STA. 1628+00

SHEET IDENTIFICATION
SHEET 14
OF 25

HORIZONTAL FEET
50 0 100



PLAN



PROFILE

VERTICAL FEET
10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

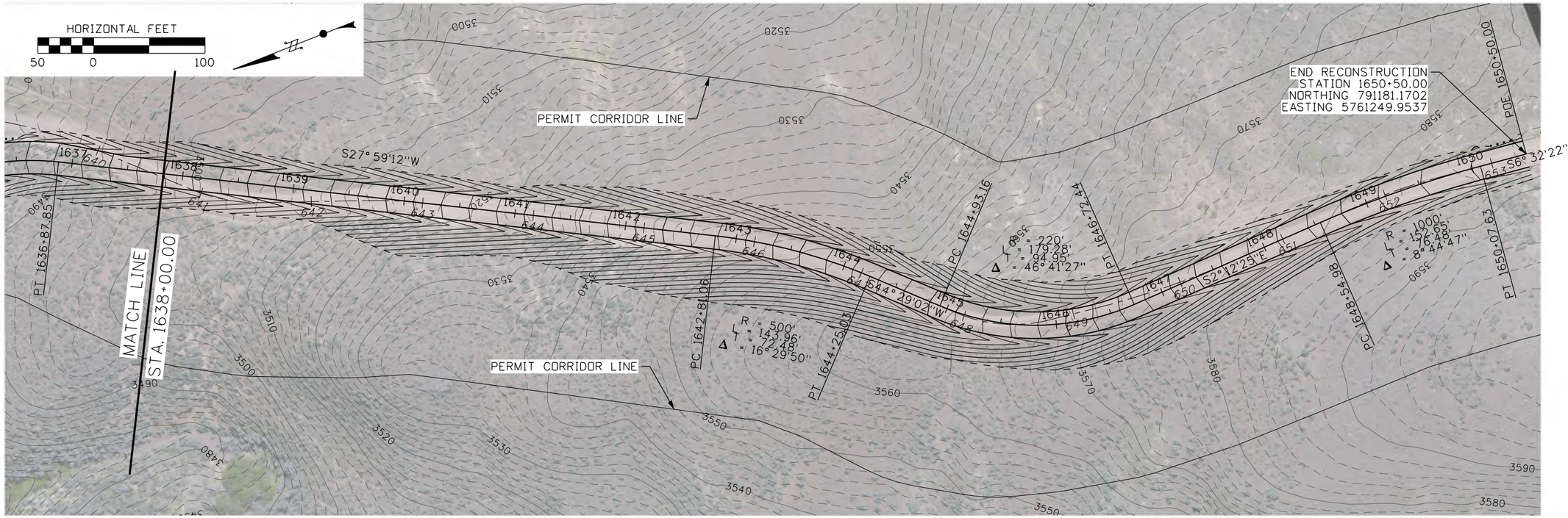
DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
CHKD BY: L. GREBE
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NO. 10147
PLOT DATE: 10/30/2019
SIZE: 11X17
FILE NAME: PLAN_PROF_005.SHT

PRELIMINARY

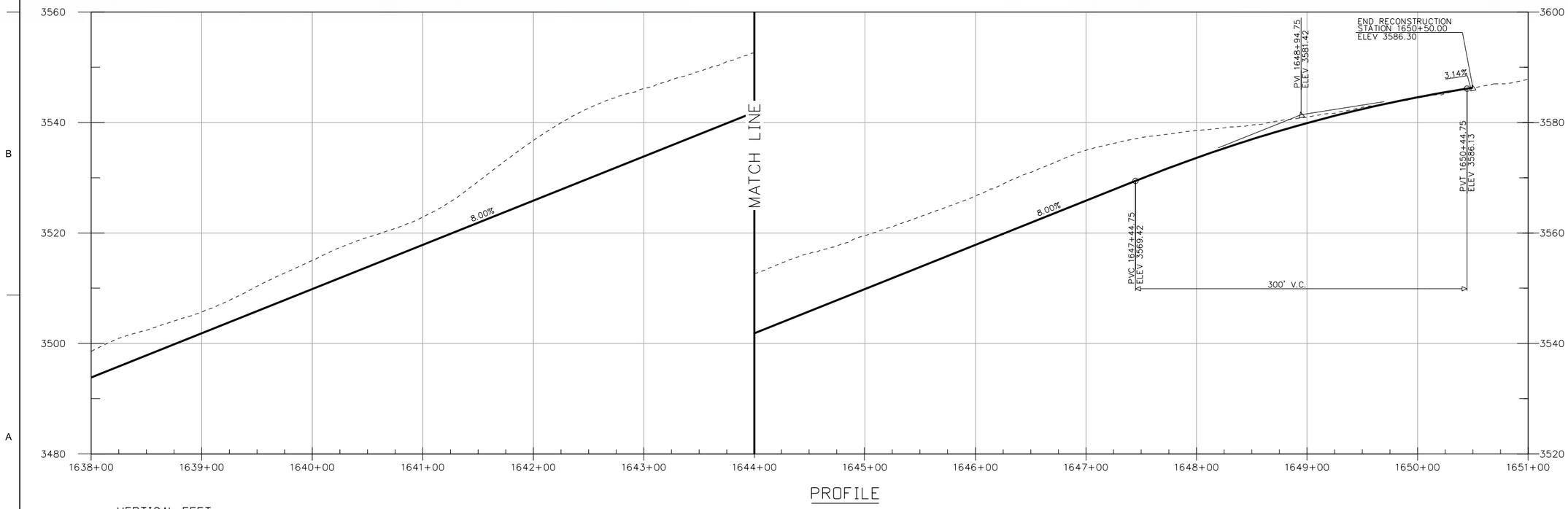
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1628+00 TO STA. 1638+00

SHEET IDENTIFICATION
SHEET 15
OF 25



PLAN



PROFILE

VERTICAL FEET
10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
CHKD BY: L. GREBE
PLOT DATE: 10/4/2019
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 1141
SIZE: 11X17
FILE NAME: PLAN_PROF_010.SHT

PRELIMINARY

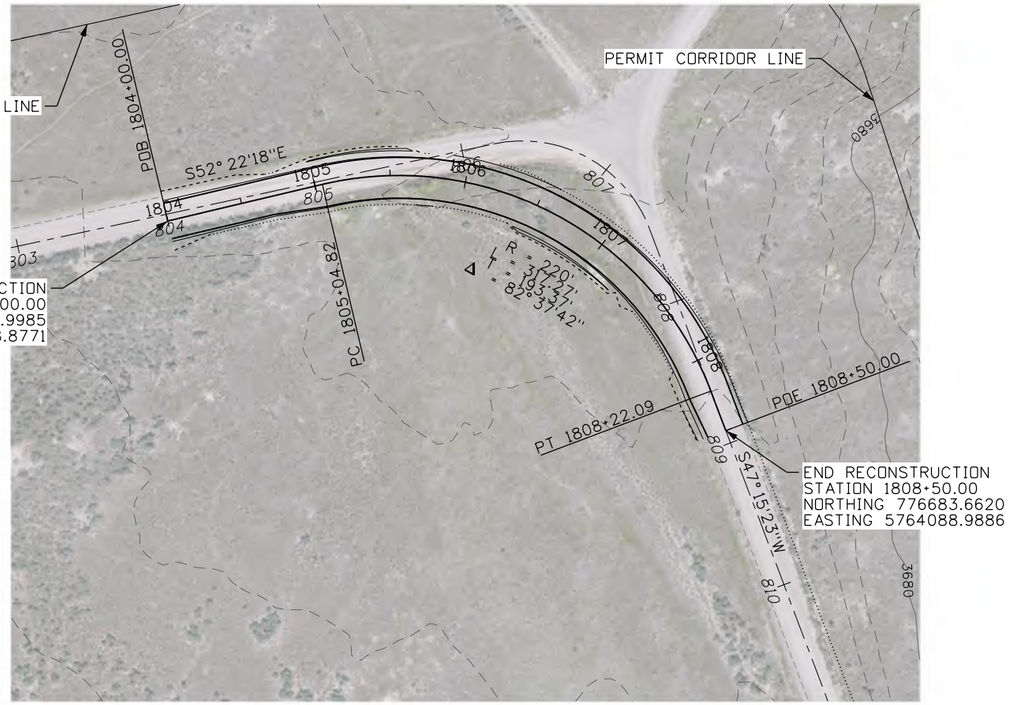
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1638+00 TO STA. 1650+50

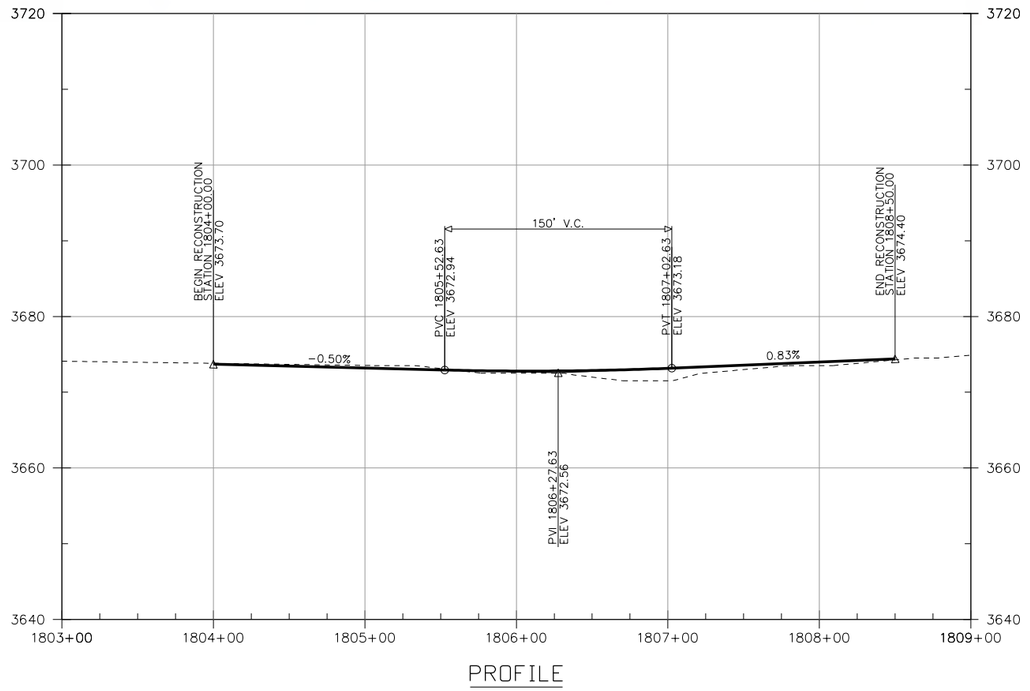
SHEET IDENTIFICATION
SHEET 16
OF 25

HORIZONTAL FEET

50 0 100



PLAN



PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
PLOT SCALE: 1" = 100'
SIZE: 11X17
DATE: OCTOBER 2019
CKD BY: L. GREBE
FILE NAME: PLAN_PROF_011.SHT
HDR PROJECT NUMBER: 10140554
PLOT DATE: 10/30/2019

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1804+00 TO STA. 1808+50

SHEET IDENTIFICATION
SHEET 17
OF 25

HORIZONTAL FEET

50 0 100

BEGIN RECONSTRUCTION
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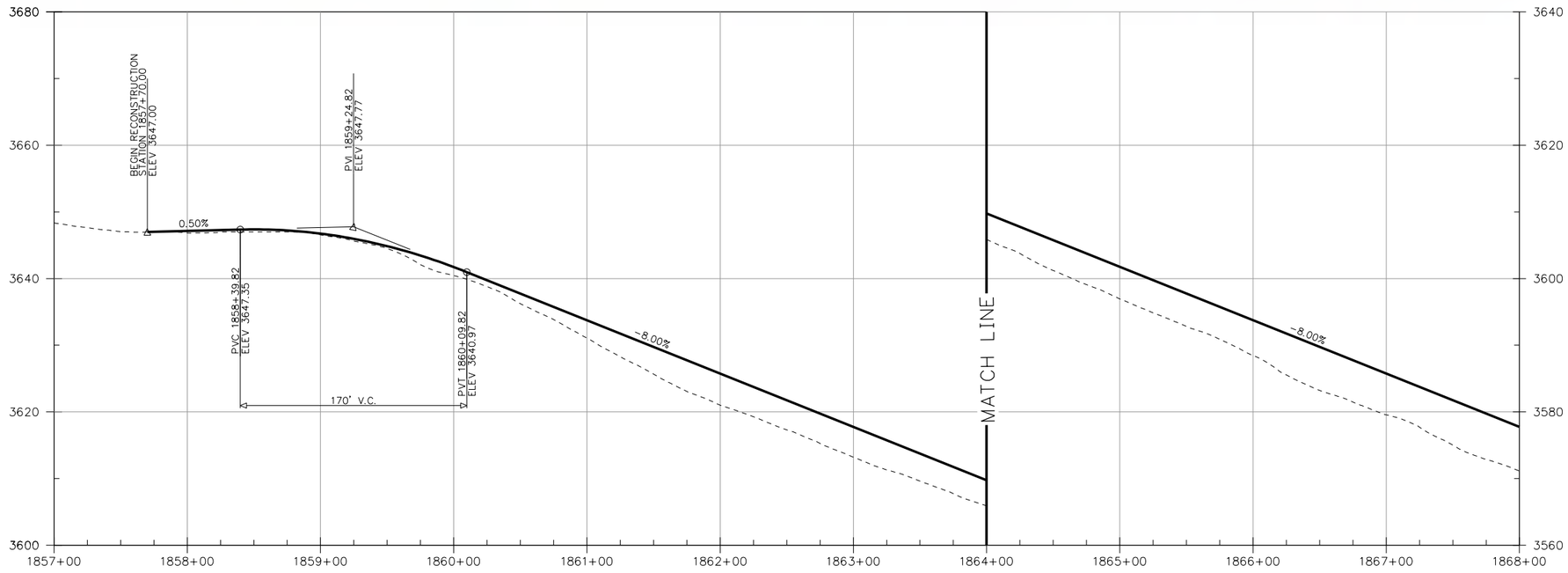
NORTHING 772235.4695
EASTING 5763400.6109

PLAN



PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

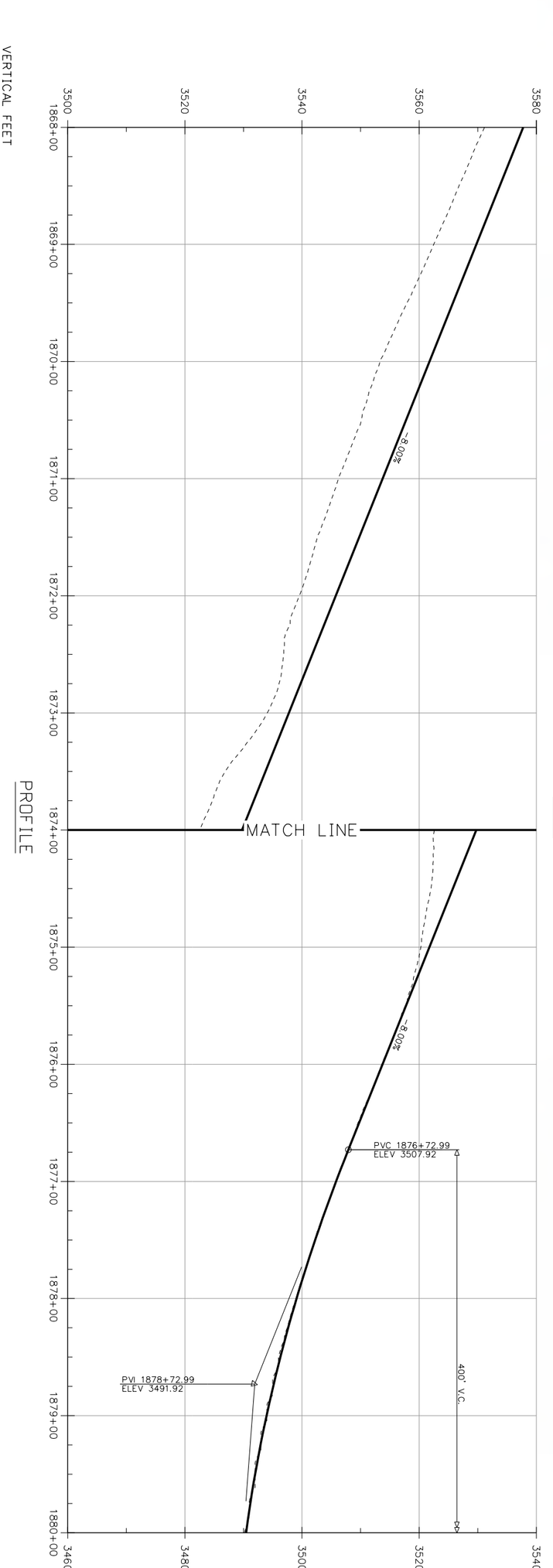
DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
CHKD BY: L. GREBE
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 10147844
PLOT DATE: 10/30/2019
SIZE: 11X17
FILE NAME: PLAN_PROF_012.SHT

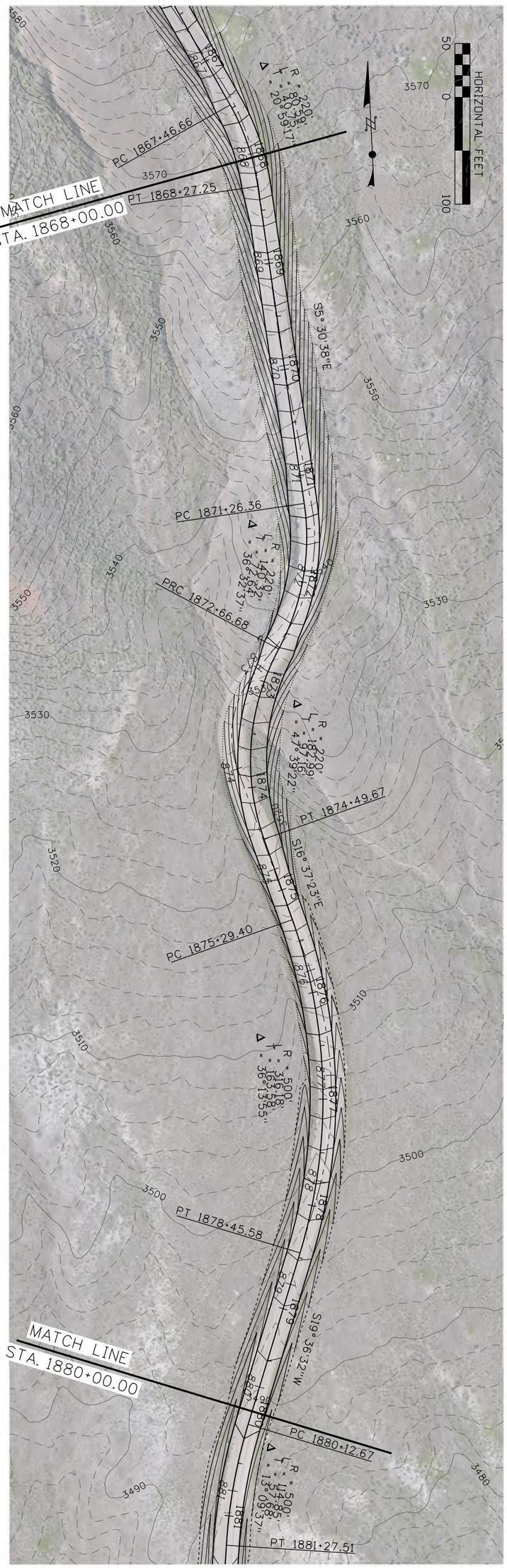
PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1857+70 TO STA. 1868+00

SHEET IDENTIFICATION
SHEET 18
OF 25





SHEET IDENTIFICATION
SHEET 19
OF 25

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1868+00 TO STA. 1880+00

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

DESIGNED BY: S. WARMBRODT		DATE: OCTOBER 2019
DWN BY: SGW	CKD BY: L. GREBE	HDR PROJECT NO. 10106
PLOT SCALE: 1" = 100'	PLOT DATE: 10/28/2019	
SIZE: 11X17	FILE NAME: PLAN_PROF_013.SHT	

PRELIMINARY

MARK	DESCRIPTION	DATE	APPR.

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

HORIZONTAL FEET

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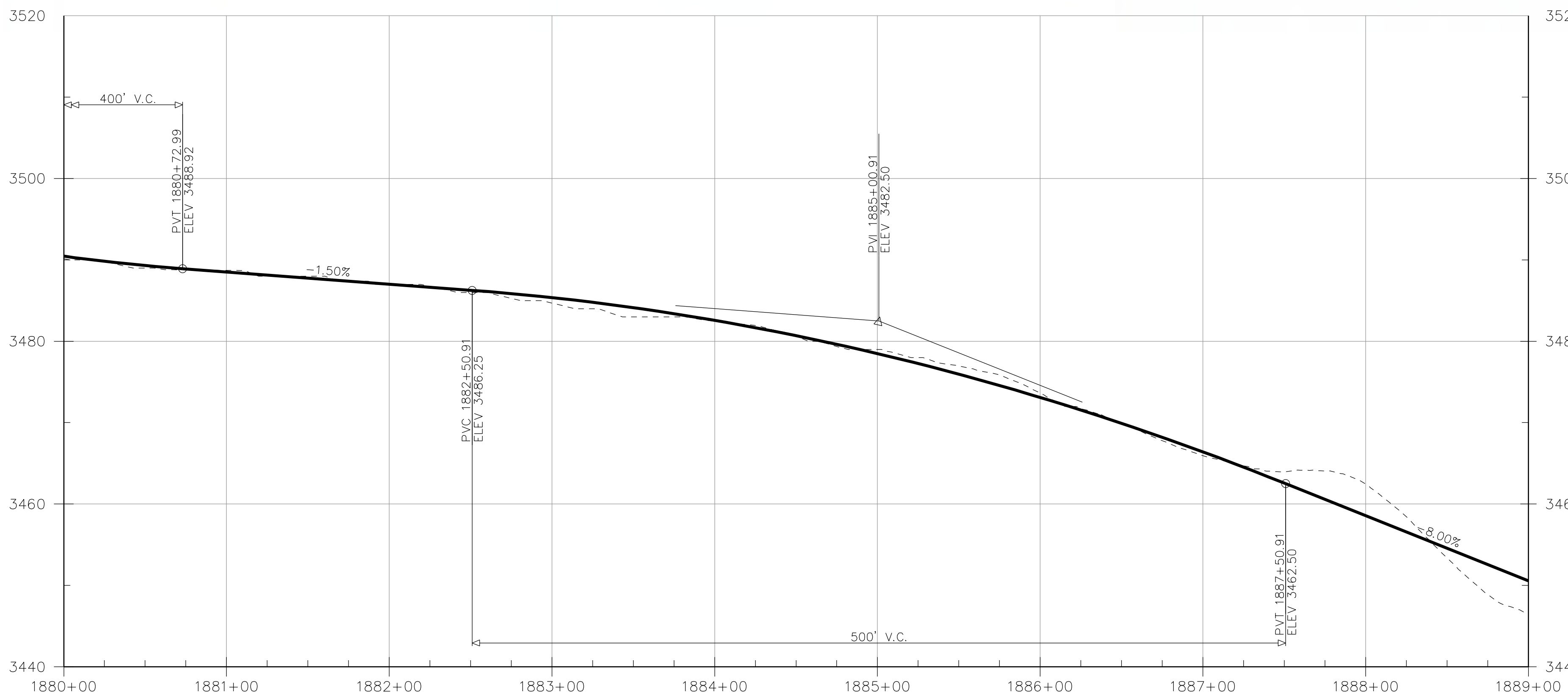
PLAN



PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: S. WARMBRODT
DWN BY: SGW
CKD BY: L. GREBE
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 10010931
SIZE: 11X17
FILE NAME: PLAN_PROF_014.SHT

PRELIMINARY

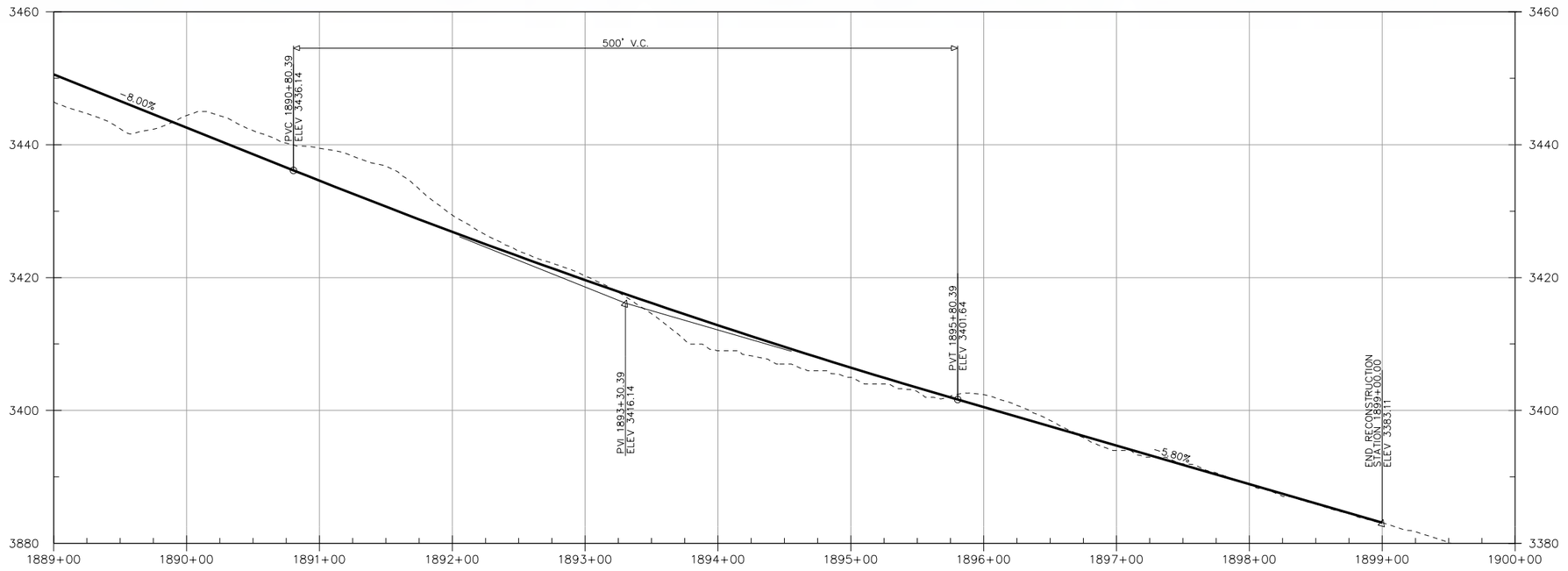
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1880+00 TO STA. 1889+00

SHEET IDENTIFICATION
SHEET 20
OF 25

HORIZONTAL FEET
50 0 100

PLAN



PROFILE

VERTICAL FEET
10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

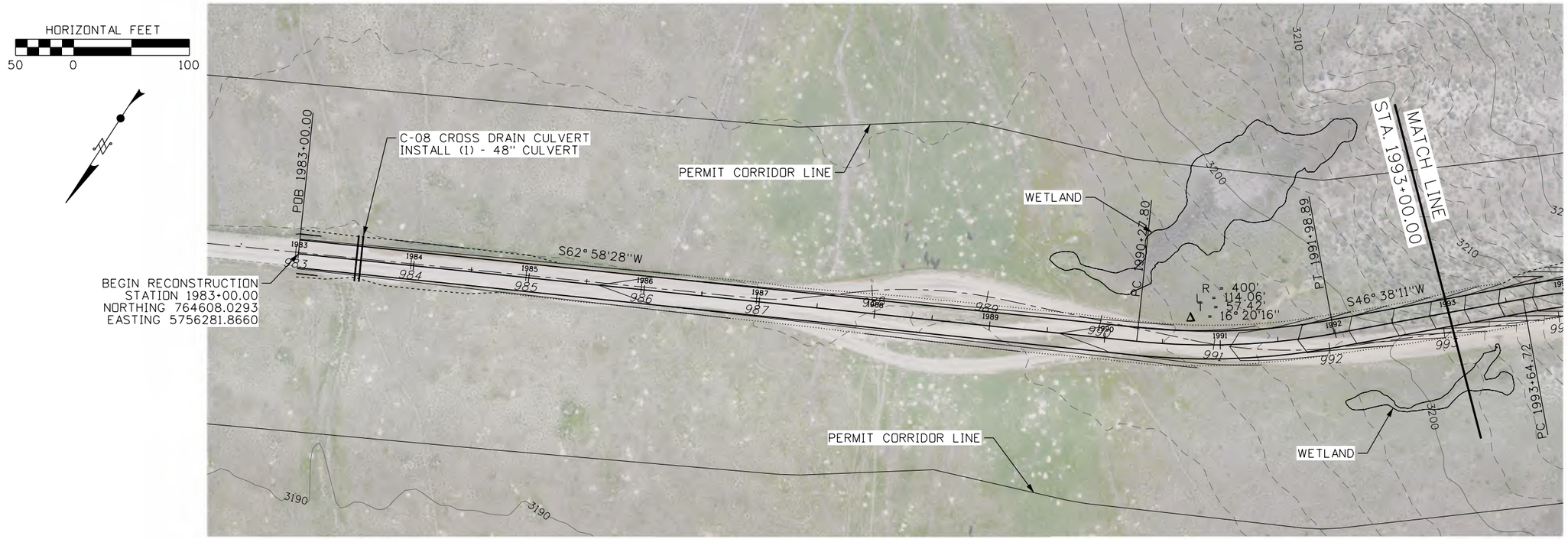
DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
CHKD BY: L. GREBE
PLOT DATE: 10/4/2019
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
HDR PROJECT NUMBER: 10147
SIZE: 11X17
FILE NAME: PLAN_PROF_015.SHT

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1889+00 TO STA. 1899+00

SHEET IDENTIFICATION
SHEET 21
OF 25



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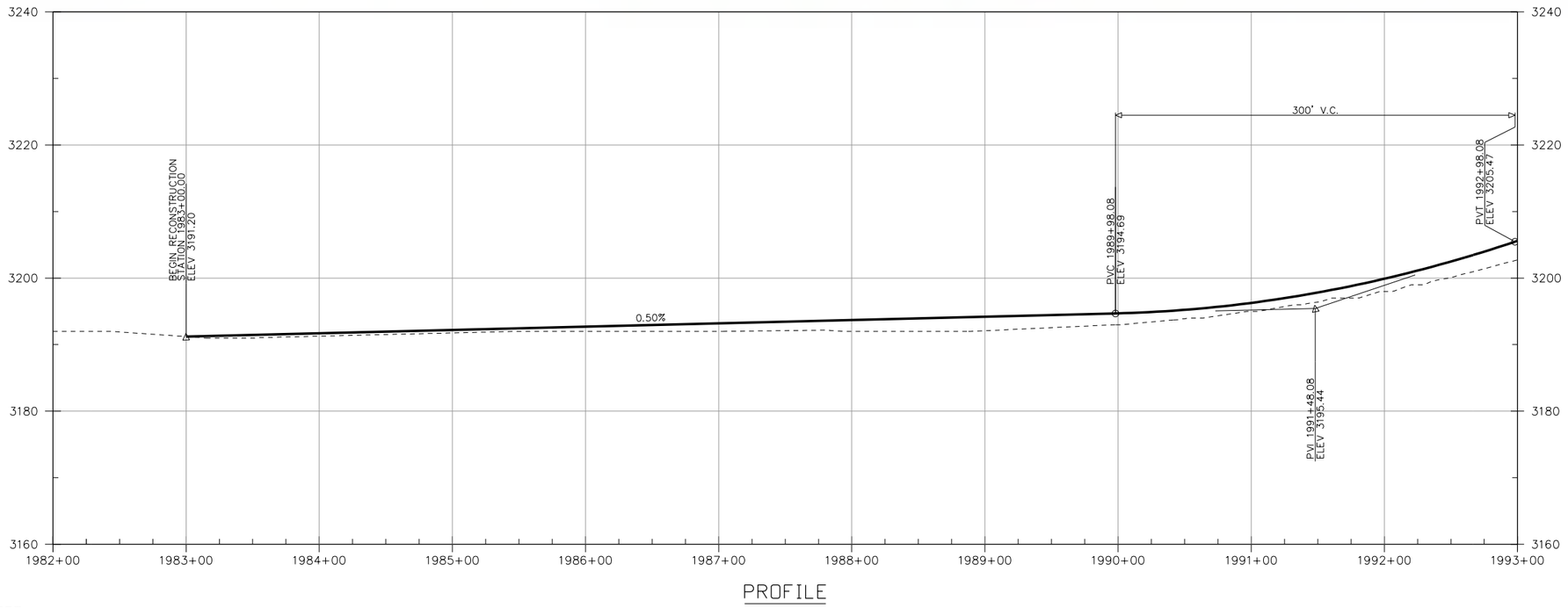


PROFILE

VERTICAL FEET
10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
CKD BY: L. GREBE
HDR PROJECT NUMBER: 1141
PLOT DATE: 10/30/2019
SIZE: 11X17
FILE NAME: PLAN_PROF_016.SHT

PRELIMINARY

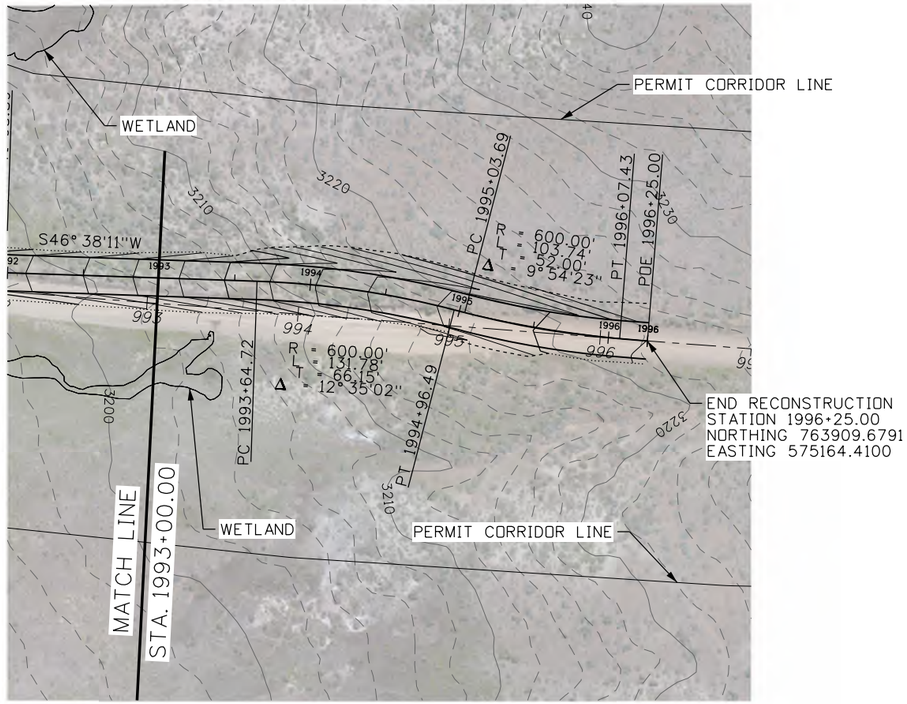
HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1983+00 TO STA. 1993+00

SHEET IDENTIFICATION
SHEET 22
OF 25

HORIZONTAL FEET

50 0 100



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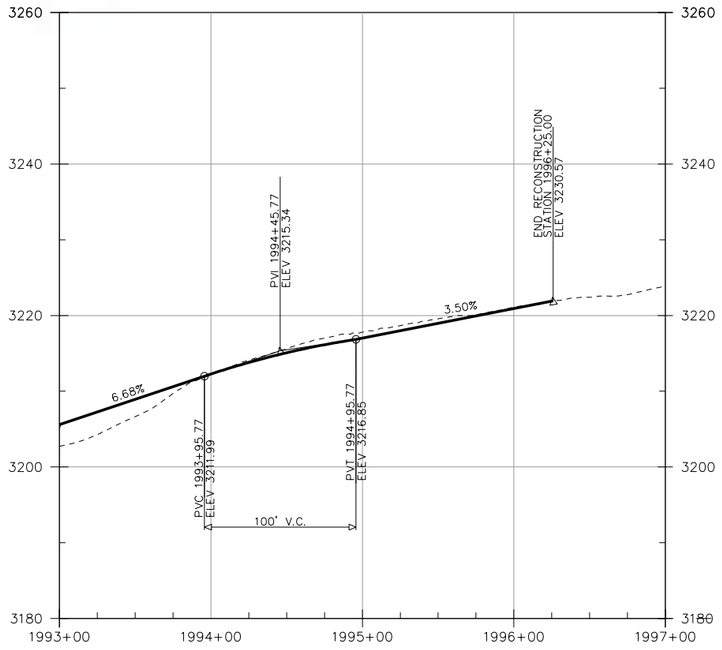


PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
PLOT SCALE: 1" = 100'
DATE: OCTOBER 2019
CKD BY: L. GREBE
HDR PROJECT NUMBER: 10140447
PLOT DATE: 10/30/2019
SIZE: 11X17
FILE NAME: PLAN_PROF_017.SHT

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 1993+00 TO STA. 1996+25

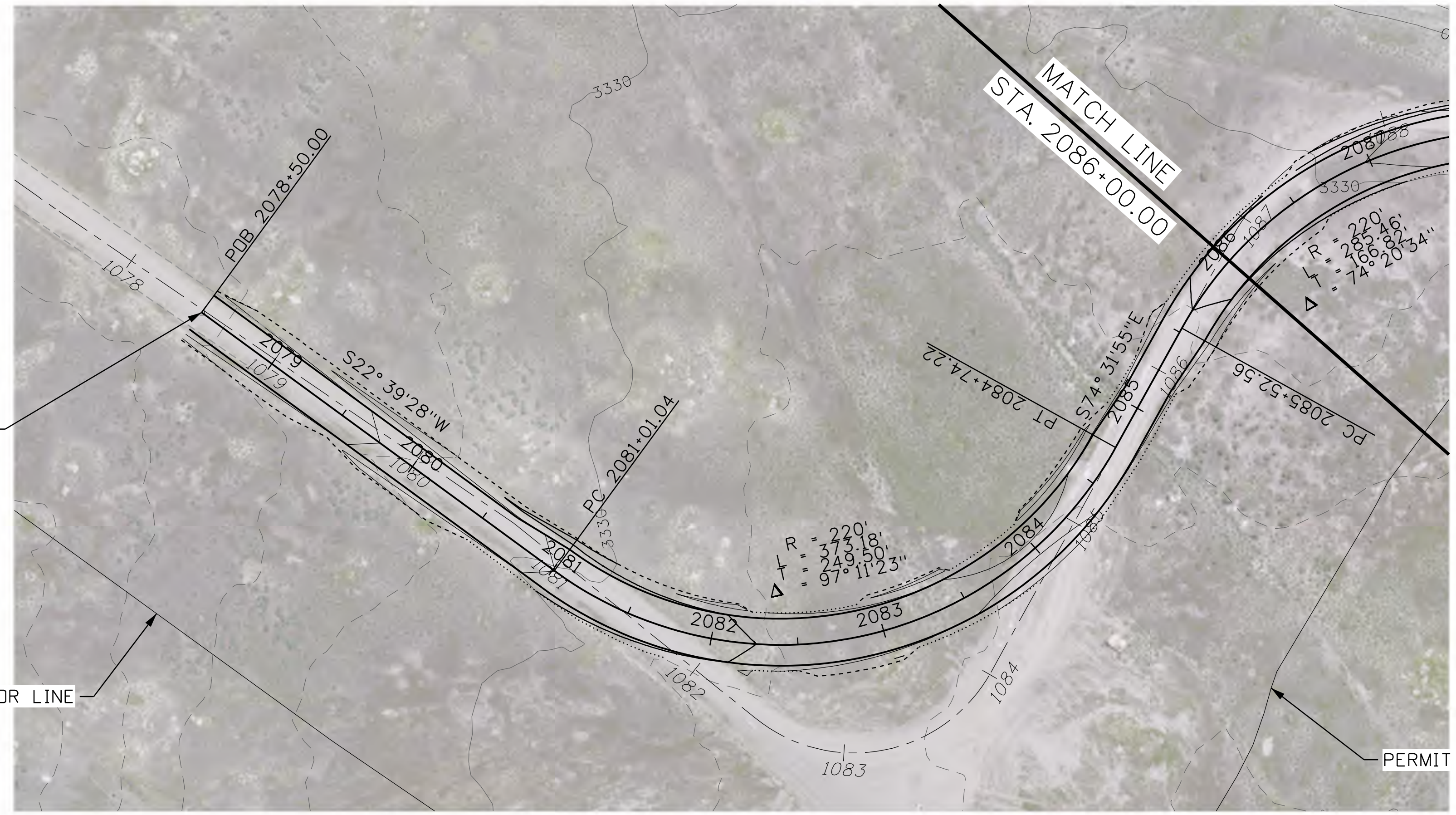
SHEET IDENTIFICATION
SHEET 23
OF 25

HORIZONTAL FEET

50 0 100

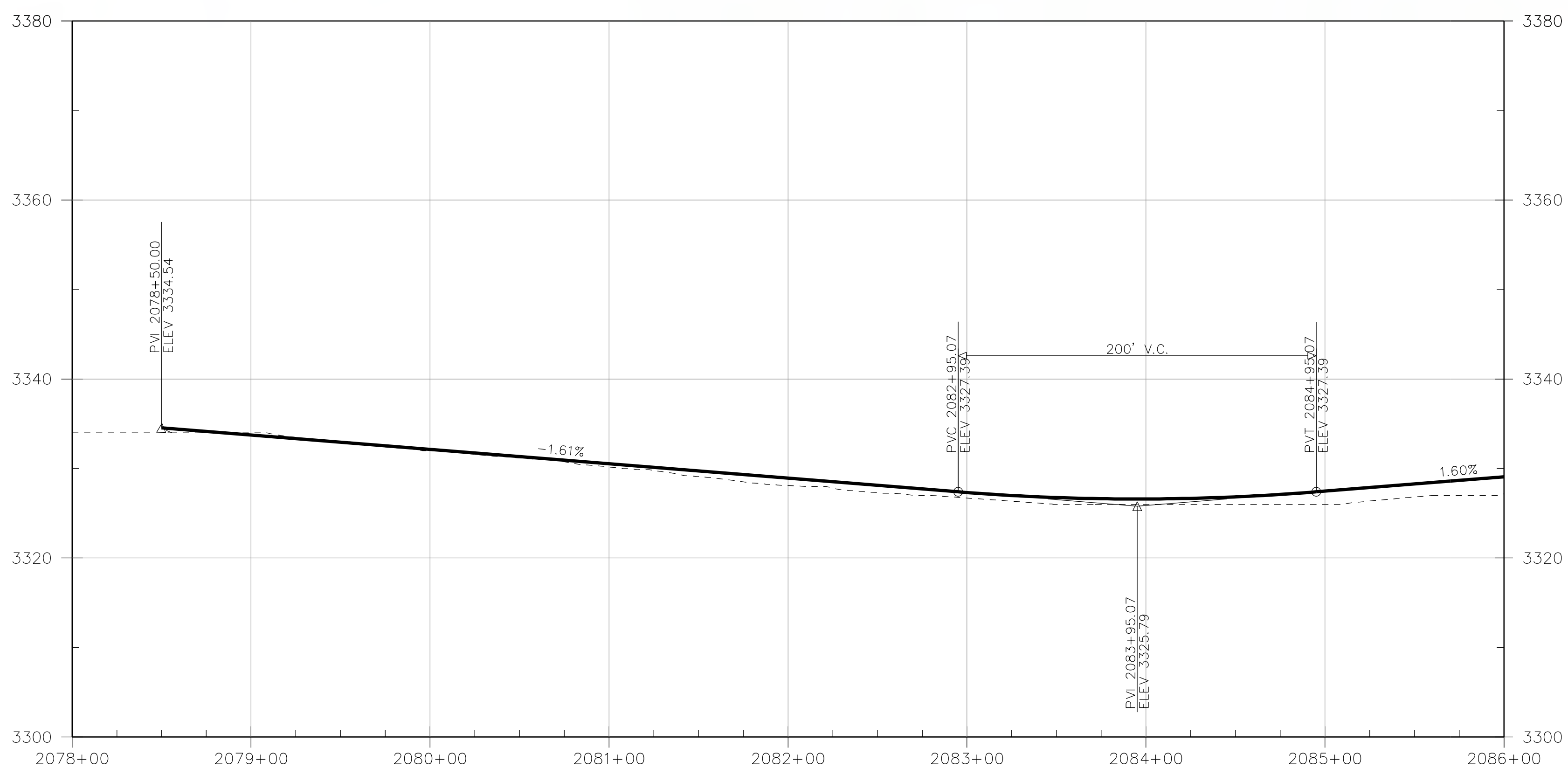
BEGIN RECONSTRUCTION
STATION 2078+50.00
NORTHING 758615.6407
EASTING 5749620.3244

PERMIT CORRIDOR LINE



PERMIT CORRIDOR LINE

PLAN



PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: S. WARMBROD
DWN BY: SGW
CKD BY: L. GREBE
DATE: OCTOBER 2019
PLOT SCALE: 1" = 100'
SIZE: 11X17
FILE NAME: PLAN_PROF_018.SHT

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

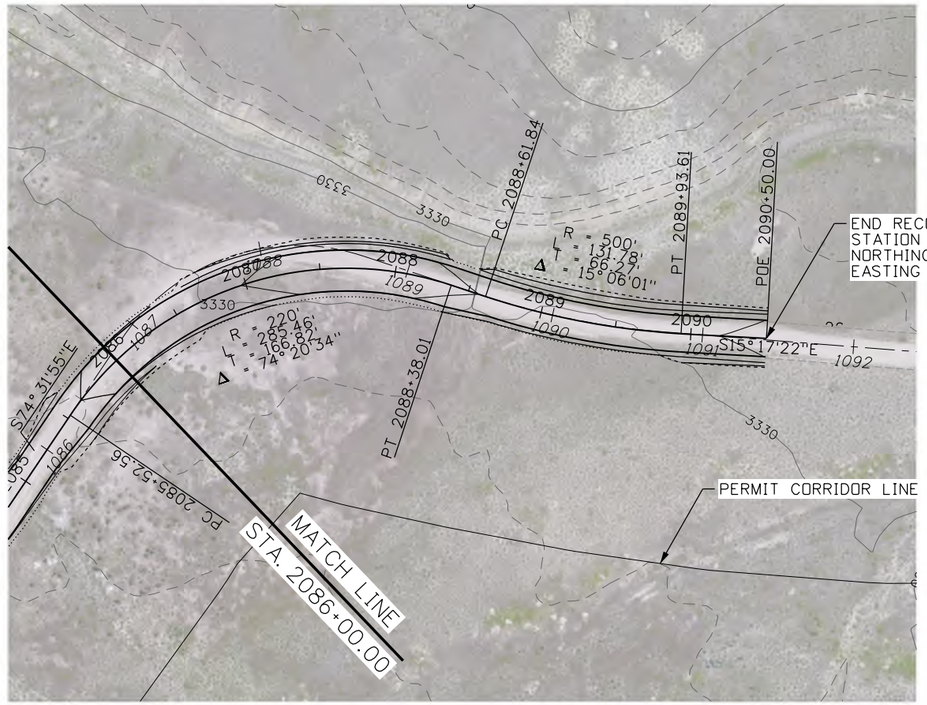
GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 2078+50 TO STA. 2086+00

SHEET IDENTIFICATION

SHEET 24
OF 25

HORIZONTAL FEET

50 0 100



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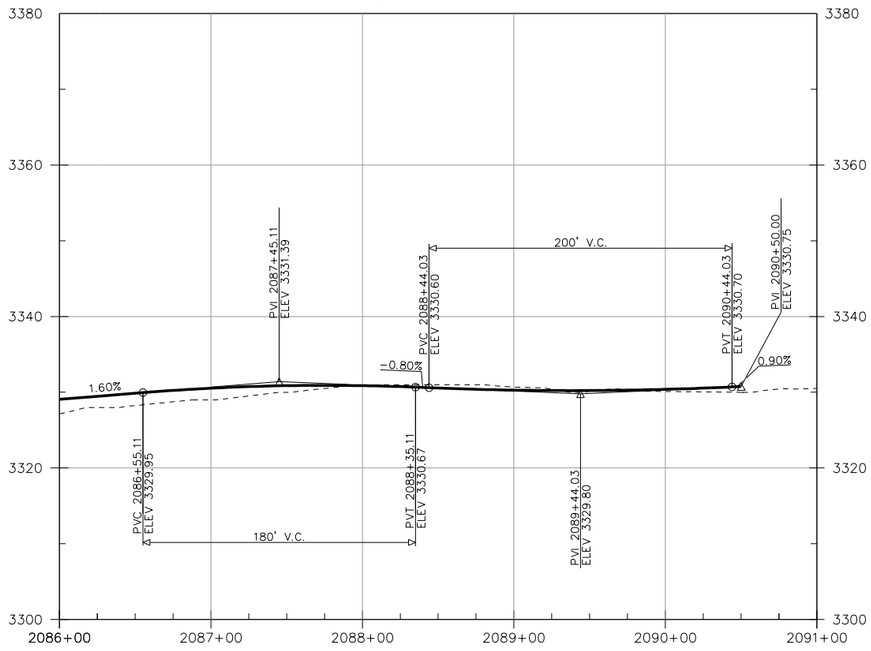


PROFILE

VERTICAL FEET

10 0 20

PARAMOUNT GOLD NEVADA CORP
665 ANDERSON ROAD
WINNEMUCCA, NEVADA

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: S. WARMBROOT
DRAWN BY: SGW
PLOT SCALE: 1" = 100'
SIZE: 11X17
DATE: OCTOBER 2019
CKD BY: L. GREBE
FILE NAME: PLAN_PROF_010.SHT
HDR PROJECT NUMBER: 10140519
PLOT DATE: 10/30/2019

PRELIMINARY

HDR ENGINEERING INC.
412 E. PARKCENTER BLVD.
BOISE, ID 83706

GRASSY MOUNTAIN PROJECT
ROADWAY AND DRAINAGE PLANS
RECONSTRUCTION
STA. 2086+00 TO STA. 2090+50

SHEET IDENTIFICATION
SHEET 25
OF 25

Appendix D
Drainage Analysis

Technical Memorandum

Client:	Calico Resources USA Corp.
Project:	**Grassy Mountain Access Road Design**
Computed By:	Spencer Savage, EIT Luke Grebe, PE
Date:	April 22, 2019
Purpose:	Access Road Drainage Design

Introduction & Background

The Grassy Mountain Access Road Project (Project) consists of designing improvements for the existing access road associated with the Grassy Mountain Mine. The existing road begins at the intersection of Highway 20 and Russell Road and continues south along Cow Hollow Road and Twin Springs Road until reaching the mine. For visual reference, Project Vicinity Maps are shown in Figure 1 and Figure 2. A drainage analysis was performed during the access road design in order to assess drainage patterns and identify locations requiring culverts. A total of 11 locations were identified as locations requiring culverts. The following sections describe the methodologies used during the drainage analysis and the proposed design recommendations.

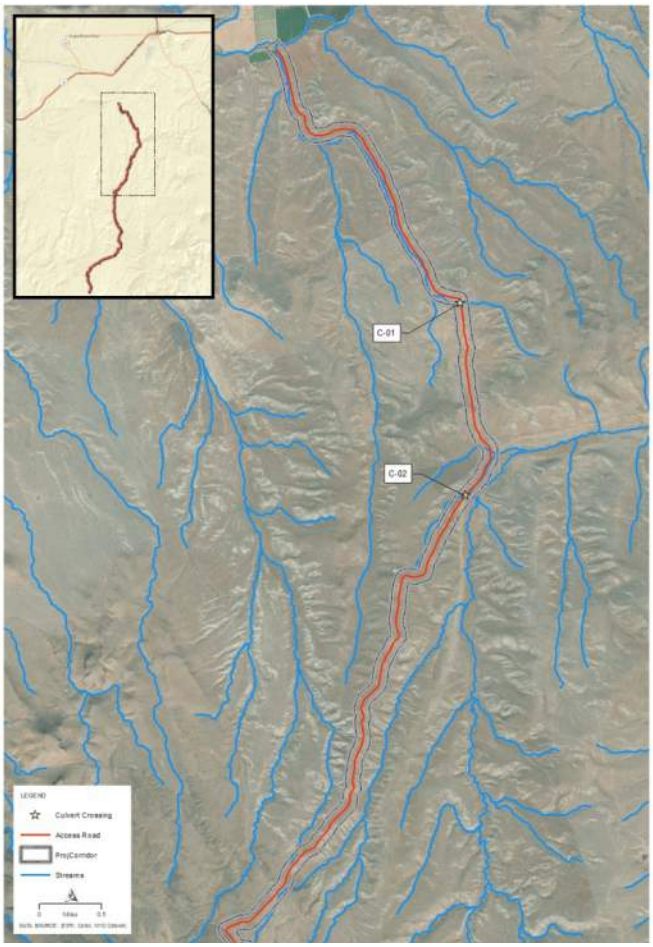


Figure 1. Project Vicinity Map

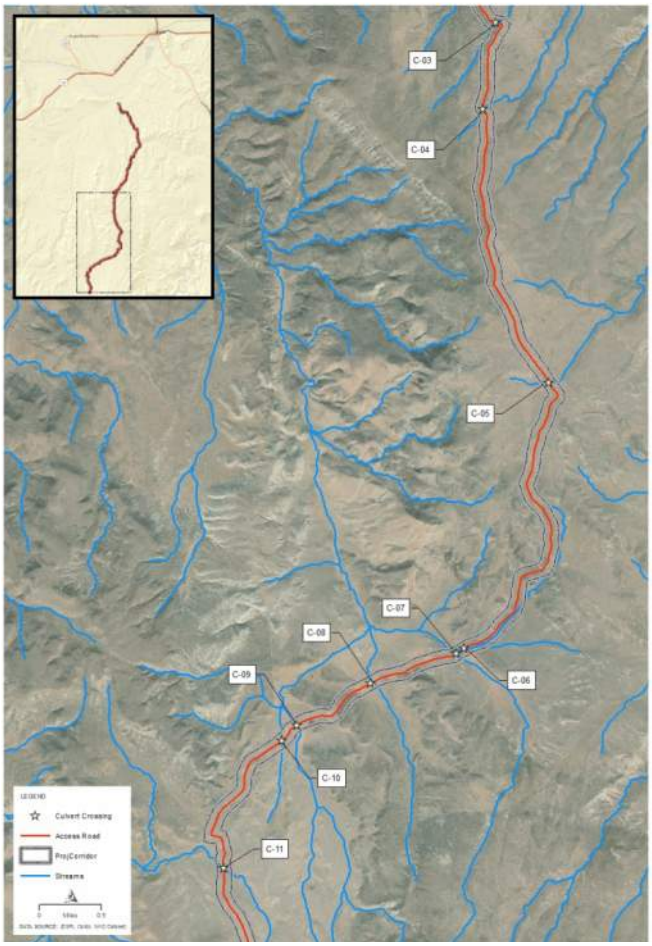


Figure 2. Project Vicinity Map

Assumptions & Design Criteria

Prior to the design of each culvert crossing, design guidance documents from the Bureau of Land Management (BLM) were reviewed in order to establish design assumptions and criteria. More specifically, the guidance documents that were reviewed consisted of the BLM Gold Book Standard (Reference 4) and the BLM Manual MS-9113 Roads (Reference 5). Based upon these two documents, the following assumptions and design criteria were established:

Assumptions

1. Culvert crossings were determined by cross referencing the access road alignment with publically available national hydrography datasets to identify locations where streams intersect the access road.
2. Publically available Digital Elevation Models (DEMs) are sufficient for delineating drainage basins.
3. The Oregon regression equations outlined in the Oregon Water Resources Department Open File Report SW 06-001, *Estimation of Peak Discharges for Rural, Unregulated Streams in Eastern Oregon* (Reference 3) were utilized to calculate peak-flow rates for each drainage basin.
4. For consistency and ease of construction, all culverts will be corrugated metal pipe (CMP).

5. Inlet and outlet protection will consist of hand-placed riprap headwalls. Riprap will be sized (D50) to verify that damage will not occur due to the velocity of the 25-year peak flow. Guidance provided in the *Hydraulic Engineering Circular No. 14 – Hydraulic Design of Energy Dissipators for Culverts & Channels* (HEC-14) (Reference 2) will be used for riprap sizing. To the extent practicable and for ease of construction, a standard D50 will be used for every culvert crossing.
6. All culverts will have end conditions that are projecting from fill.

Design Criteria

1. Culverts will be sized so that no static head is caused during the 10-year event per BLM Gold Book Standard. This requirement is interpreted to mean that the headwater elevation corresponding to the 10-year peak flow must be at or below the crown of the culvert.
2. Culverts will be sized so that no damaging velocities occur during the 25-year event per BLM Gold Book Standard. Where necessary, riprap will be sized to verify that damage will not occur due to the velocity of the 25-year peak flow.
3. The minimum fill height for culverts will be 1.5 times the culvert diameter measured from the culvert invert per BLM Manual 9113 – Roads.
4. Riprap aprons will be required at the culvert inlet and outlet to reduce the likelihood of erosion. The design of the aprons will be based upon the “Hand-Laid Rock Headwalls” diagram shown in Figure 7 of the BLM Gold Book Standard.
5. Ditch relief culverts will have a diameter of 18”. Relief culvert spacing will be based upon Illustration 10 located in the BLM Manual 9113 – Roads.

Hydrologic Analysis

A hydrologic analysis was performed for each culvert crossings in order to estimate peak-flow rates for the 10- and 25-year events. The hydrologic analysis was based upon the regression equations provided in the Oregon Water Resources Department Open File Report SW 06-001, *Estimation of Peak Discharges for Rural, Unregulated Streams in Eastern Oregon*. Eastern Oregon is separated into 6 hydrologic regions and the proposed culvert crossings are located within Region 3 and Region 6. Each hydrologic region has regression equations that incorporate various variables including drainage area and watershed aspect. The contributing drainage areas for each culvert were delineated using publically available Digital Elevation Models (DEM) developed by the U.S. Geological Survey. A summary of the hydrologic analysis and the calculated peak-flow rates are provided in Table 1.

Table 1. Summary of Hydrologic Analysis

Culvert Crossing ID	Station	Hydrologic Region	Drainage Area (mi^2)	Watershed Aspect (degrees)	10-year Peak Flow Rate (cfs)	25-year Peak Flow Rate (cfs)
C-01	305+56.00	3	0.27	-	18	23
C-02	393+79.00	6	0.19	134	14	20
C-03	634+11.00	6	0.34	118	31	44
C-04	675+10.00	6	0.16	109	21	30
C-05	800+15.00	6	0.37	139	21	30
C-06	940+20.00	3	1.23	-	56	72
C-07	944+25.00	3	2.14	-	84	109
C-08	983+55.00	3	1.32	-	59	76
C-09	1021+30.00	3	1.84	-	75	97
C-10	1132+64.00	3	0.23	-	16	21
C-11	1101+19.00	3	3.87	-	130	169

Hydraulic Analysis

A hydraulic analysis was performed for each stream crossing in order to size each culvert to meet the aforementioned design criteria. The culverts were sized using the software program HY8 (Reference 1). A copy of the HY8 analyses is provided in Appendix C. All culverts were designed to be CMP with varying diameters and lengths. In general, the proposed culvert diameters range from 24” to 48”. The culvert size and barrel configuration for each crossing were designed to satisfy the aforementioned design criteria. When possible, multiple barrel culvert configurations were used to optimize conveyance and minimize the reconstructed roadway profile. A summary of the proposed culvert design is provided in Table 2.

Table 2. Summary of Hydraulic Analysis

Stream Crossing ID	Material Type	Diameter	Number of Barrels	Pipe Length (ft)	10-year HW Depth(ft)	25-year Velocity (fps)
C-01	CMP	24”	2	37.0	1.6	9.8
C-02	CMP	24”	2	69.0	1.7	5.8
C-03	CMP	30”	2	40.0	2.0	9.0
C-04	CMP	24”	2	38.0	1.9	6.4
C-05	CMP	24”	2	38.0	1.9	6.4
C-06	CMP	36”	2	40.0	3.0	7.4
C-07	CMP	42”	2	43.0	3.3	8.9
C-08	CMP	48”	1	35.0	3.8	8.7
C-09	CMP	36”	3	35.0	2.5	7.1
C-10	CMP	24”	2	45.0	1.6	5.6
C-11	CMP	42”	3	48.0	3.1	8.0

Riprap Sizing

Each culvert crossing will have a riprap apron at the inlet and outlet to reduce the likelihood of erosion. The dimensions of the riprap apron will be based upon the hand-laid rock headwall drawing shown in Figure 7 within the BLM Gold Book Standard. For visual reference, a snapshot of the drawing is provided in Figure 3.

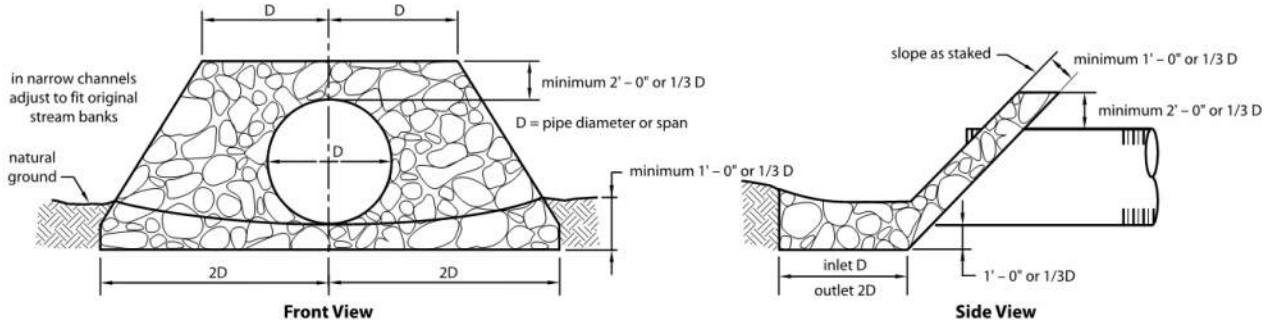


Figure 3. Schematic of Riprap Apron Detail

The riprap size (D50) for each culvert was calculated using equation D.1a located in Appendix D of *HEC-14 – Hydraulic Design of Energy Dissipators for Culverts and Channels*. The equation takes into account peak-flow, culvert diameter, tailwater depth, and flow intensity. The riprap calculations are provided in Appendix D and summarized in Table 3. To improve the efficiency of construction, the riprap sizes were separated into two categories by rounding up the calculated D50 values. Therefore, the two D50 sizes that will be required are 0.5' and 1.0'. It should be noted that these are the minimum D50 values recommended for this project.

Table 3. Summary of Hydraulic Analysis

Stream Crossing ID	Culvert Diameter (ft)	25-year Peak Flow Rate[1] (cfs)	Tailwater Depth (ft)	Calculated D50 (ft)	Assigned D50 (ft)
C-01	2.0	12	0.5	0.3	0.5
C-02	2.0	10	0.7	0.2	0.5
C-03	2.5	22	1.5	0.1	0.5
C-04	2.0	15	0.9	0.2	0.5
C-05	2.0	15	0.3	0.7	1.0
C-06	3.0	36	1.1	0.3	0.5
C-07	3.5	55	1.1	0.4	0.5
C-08	4.0	76	1.2	0.5	0.5
C-09	3.0	32	0.7	0.5	0.5
C-10	2.0	11	0.3	0.5	0.5
C-11	3.5	56	1.9	0.2	0.5

[1] *Peak flows shown in this table reflect the flow passing through each culvert*

Ditch Relief Culverts

Improvements to the access road will also include roadside ditches to accommodate roadway drainage. Multiple ditch relief culverts will be installed along the roadway alignment to maintain natural drainage patterns to the maximum extent practicable. Each ditch relief culvert will have a diameter of 18" per BLM Manual 9113 – Roads. The roadway profile was reviewed to determine the approximate spacing between ditch relief culverts. The spacing requirements were based on Illustration 10 within BLM Manual 9113 – Roads. It should be noted that geotechnical data was not available for the project corridor. Therefore, an erosion index of 20 was assumed for the project to be conservative. The ditch relief culverts are summarized in Table 4.

Table 4. Summary of Ditch Relief Culverts

Begin STA	End STA	Segment Length (ft)	Average Segment Slope (%)	Erosion index	Minimum Culvert spacing (ft)	Number of Culverts
119+25.65	129+64.34	1,039	2.0	20	1,225	1
129+64.34	132+58.74	294	9.0	20	270	2
132+58.74	136+15.09	356	-2.0	20	1,225	1
136+15.09	137+95.69	181	-7.0	20	350	1
137+95.69	173+09.00	3,513	-2.0	20	1,225	3
173+09.00	177+00.00	391	2.0	20	1,225	1
177+00.00	178+60.00	160	4.0	20	610	1
178+60.00	188+34.00	974	-3.0	20	815	2
188+34.00	190+55.00	221	4.0	20	610	1
190+55.00	191+96.00	141	-2.0	20	1,225	1
191+96.00	210+48.00	1,852	2.0	20	1,225	2
210+48.00	283+77.00	7329	2.0	20	1225	6
283+77.00	304+73.00	2,096	3.0	20	815	3
304+73.00	308+00.00	327	2.0	20	1,225	1
308+00.00	311+00.00	300	7.0	20	350	1
311+00.00	315+84.00	484	2.0	20	1,225	1
315+84.00	316+00.00	16	-8.0	20	305	1
316+00.00	324+32.00	832	5.0	20	490	2
324+32.00	331+00.00	668	-3.0	20	815	1
331+00.00	336+00.00	500	4.0	20	610	1
336+00.00	354+00.00	1,800	8.0	20	305	6
354+00.00	371+00.00	1,700	-2.0	20	1,225	2
371+00.00	375+00.00	400	2.0	20	1,225	1
375+00.00	394+00.00	1,900	2.0	20	1,225	2

394+00.00	402+00.00	800	8.0	20	305	3
402+00.00	468+00.00	6,600	5.0	20	490	14
468+00.00	472+00.00	400	-4.0	20	610	1
472+00.00	506+00.00	3,400	2.0	20	1,225	3
506+00.00	535+00.00	2,900	3.0	20	815	4
535+00.00	544+01.00	901	-7.0	20	350	3
544+01.00	563+00.00	1,899	5.0	20	490	4
563+00.00	569+00.00	600	-2.0	20	1,225	1
569+00.00	575+01.00	601	5.0	20	490	2
575+01.00	579+00.00	399	2.0	20	1,225	1
579+00.00	624+00.00	4,500	7.0	20	350	13
624+00.00	631+13.00	713	-2.0	20	1,225	1
631+13.00	635+00.00	387	-11.0	20	220	2
635+00.00	650+00.00	1,500	10.0	20	245	7
650+00.00	656+00.00	600	4.0	20	610	1
656+00.00	663+00.00	700	9.0	20	270	3
663+00.00	695+00.00	3,200	2.0	20	1,225	3
695+00.00	708+04.00	1,304	6.0	20	410	4
708+04.00	737+00.00	2,896	2.0	20	1,225	3
737+00.00	745+00.00	800	2.0	20	1,225	1
745+00.00	751+00.00	600	-4.0	20	610	1
751+00.00	760+00.00	900	2.0	20	1,225	1
760+00.00	801+00.00	4,100	-4.0	20	610	7
801+00.00	807+00.00	600	2.0	20	1,225	1
807+00.00	835+00.00	2,800	3.0	20	815	4
835+00.00	848+16.00	1,316	-3.0	20	815	2
848+16.00	861+00.00	1,284	-6.0	20	410	4
861+00.00	880+00.00	1,900	-8.0	20	305	7
880+00.00	908+00.00	2,800	-6.0	20	410	7
908+00.00	956+00.00	4,800	-4.0	20	610	8
956+00.00	992+77.00	3,677	2.0	20	1,225	4
992+77.00	1005+00.00	1,223	4.0	20	610	3
1005+00.00	1033+00.00	2,800	2.0	20	1,225	3
1033+00.00	1074+00.00	4,100	3.0	20	815	6

1074+00.00	1100+82.00	2,682	2.0	20	1,225	3
1100+82.00	1144+23.00	4,341	3.0	20	815	6
1144+23.00	1146+39.00	216	-3.0	20	815	1
1146+39.00	1152+00.00	561	6.0	20	410	2
1152+00.00	1155+00.00	300	-7.0	20	350	1
1155+00.00	1176+84.00	2,184	3.0	20	815	3

Conclusion

Upon review of the information presented in this report, it can be seen that the culvert diameters range from 24” to 48” and multiple crossings will require more than one barrel. The hydrologic analysis was performed using Oregon Department of Water Resources regression equations in order to estimate the 10- and 25-year peak flow rates. These peak flow rates were then used to hydraulically analyze each culvert in order to determine culvert diameters that would satisfy the aforementioned design assumptions and criteria. Furthermore, the results of the hydrologic and hydraulic analyses were then used to determine appropriate riprap sizes for the inlet and outlet apron protections.

The content included in this report is correct to the best of our knowledge and has been developed in accordance with the standard of care that is customarily followed by a practitioner in this industry. The standard of care was followed for collection and analysis of data, and for modeling efforts performed in support of this report.

The conclusions and recommendations in this report are based on the conditions of the project site and the associated watersheds at the time of this study. Any modifications to the site, man-made or natural, could alter and invalidate the analysis, findings, and recommendations contained herein. Site conditions, upstream or downstream land use changes, climate changes, vegetation changes, maintenance practice changes, or other factors may change over time. Additional analysis or revisions may be required in the future as a result of these changes.

References

1. Federal Highway Administration, HY-8 Version 7.5, July 2016.
2. Federal Highway Administration, Hydrologic Engineering Circular No. 14 (HEC-14), *Hydraulic Design of Energy Dissipators for Culverts & Channels*, July 2006.
3. State of Oregon – Department of Water Resources, Open File Report (OFR) SW 06-001, Estimation of Peak Discharges for Rural, Unregulated Streams in Eastern Oregon, March 2006.
4. U.S. Bureau of Land Management, *The Gold Book: Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, 2007.
5. U.S. Bureau of Land Management, Manual Transmittal Sheet MS-9113 – Roads, May 2015.

Appendix A – Design Standards

Drainage and Drainage Structures

The proper design and construction of structures for the drainage of water from or through the roadway often contributes the most to the long-term success of the road and structure and minimizes maintenance and adverse environmental effects, such as erosion and sediment production. It is vitally important to keep the water off the road.

Road Drainage Design

The most economical control measure should be designed to meet resource and road management objectives and constraints. The economic considerations should include both construction and maintenance costs. The need for drainage structures can be minimized by proper road location. However, adequate drainage is essential for a stable road. A proper drainage system should include the best combination of various design elements, such as ditches, culverts, drainage dips, crown, in-slope or out-slope, low-water crossings, subsurface drains, and bridges.

Surface Drainage

Surface drainage provides for the interception, collection, and removal of water from the surface of roads and slope areas. The design may need to allow for debris passage, mud flows, and water heavily laden with silt, sand, and gravel. Culverts should be designed in accordance with applicable practices adopted by State and Federal water quality regulators under authority of the Federal Clean Water Act (CWA). Culverts should accommodate a 10-year flood without development of a static head and avoid serious velocity damage from a 25-year flood.

Subsurface Road Drainage

Subsurface drainage is provided to intercept, collect, and remove groundwater that may flow into the base course and subgrade; to lower high water tables; or to drain locally saturated deposits or soils.

Drainage Structures

Proper location and design can provide economical and efficient drainage in many cases. However, structural measures are often required to ensure proper and adequate drainage. Some of the most common structures are drainage dips, ditches, road crowning, culverts, and bridges.

Drainage Dips

The primary purpose of a drainage dip is to intercept and remove surface water from the travelway and shoulders before the combination of water volume and velocity begins to erode the surface materials. Drainage dips should not be confused with water bars, which are normally used for drainage and erosion protection of closed or blocked roads. See Figure 5 for an illustration of a typical drainage dip and construction specifications. Spacing of drainage dips depends upon local conditions such as soil material, grade, and topography. The surface management agency should be consulted for spacing instructions.

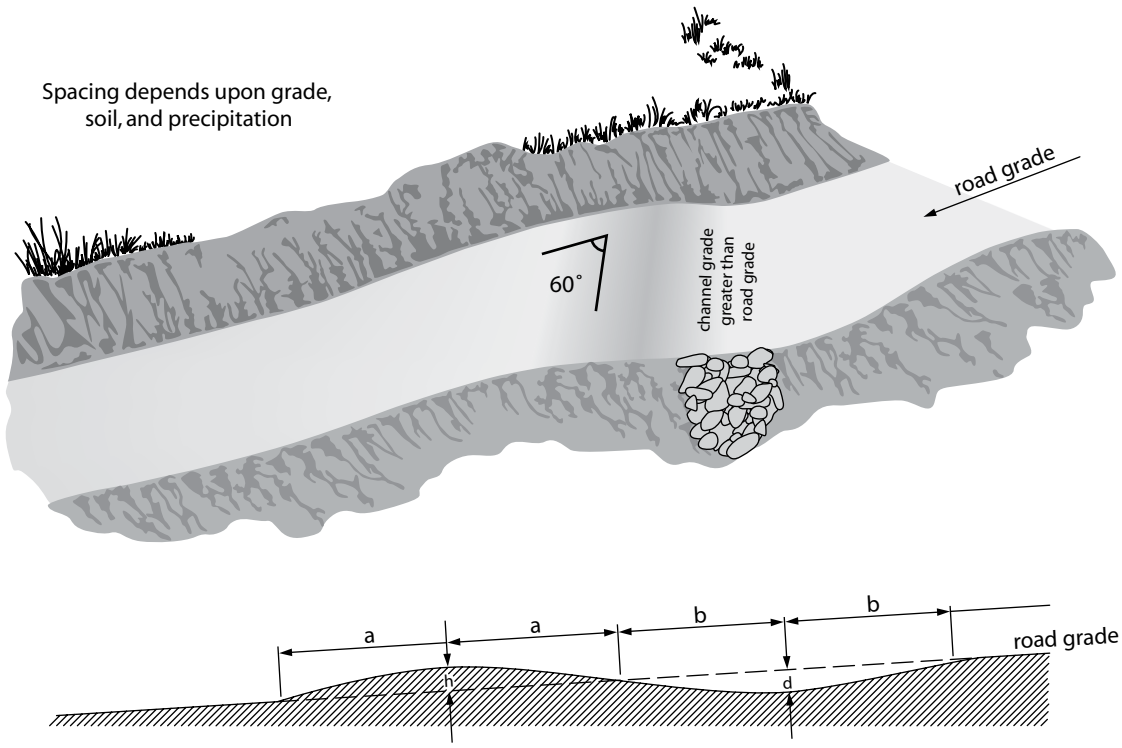
Ditches

The geometric design of ditches must consider the resource objectives for soil, water, and visual quality; maintenance capabilities and associated costs; and construction costs. Ditch grades should be no less than 0.5 percent to provide positive drainage and to avoid siltation. The types of ditches normally used are drainage, trap, interception, and outlet.

Road Crowning

Roads that use crowning and ditching are common and can be used with all road classes, except non-constructed roads. This design provides good drainage of water from the surface of the road.

Drainage of the inside ditch and sidehill runoff is essential if the travelway is to be kept dry and passable during wet weather.



Cross-Section of Waterdip on Center Line

Road Grade	d	h	a	b
2%	0.6'	0.4'	10'	10'
4%	1.0'	0.8'	14'	14'
6%	1.2'	1.4'	16'	18'
8%	2.0'	2.2'	22'	24'

Figure 5. Typical drainage dip and construction specifications.

Culverts

Culverts are used in two applications: in streams and gullies to allow normal drainage to flow under the travelway and to drain inside road ditches. The latter may not be required if drainage dips are used. The location of culverts should be shown on the plan and profile or similar drawings or maps submitted with the APD.

All culverts should be laid on natural ground or at the original elevation of any drainage crossed, except as noted for ditch relief culverts. See Figures 6 and 7 for installation details.

Culverts should have a minimum diameter of 18 inches. The diameter should be determined by the anticipated amount of water that would flow through the culvert. Factors to be considered include the geographic area being drained, soils and slopes in the drainage area, annual precipitation, and likely storm events.

The outlet of all culverts should extend at least 1 foot beyond the toe of any slope. It may be necessary to install rip-rap or other energy dissipation devices at the outlet end of the culvert to prevent soil erosion or trap sediment (see example in the photograph).

Properly sized rock rip-rap at culvert outlets helps reduce water velocity and resulting soil erosion.

Maximum Recommended Culvert Spacing (ft)

Soil Type	Road Grade 2–4%	Road Grade 5–8%	Road Grade 9–12%
Highly erosive granitic or sandy	240	180	140
Intermediate erosive clay or load	310	260	200
Low erosive shale or gravel	400	325	250

Figure 6. Culvert spacing.

All culverts used in the construction of access roads should be concrete, corrugated metal pipe made of steel, or properly bedded and backfilled corrugated plastic pipe. Only undamaged culverts are to be used, and any culvert should be inspected for damage prior to installation. All spots on the pipes where the zinc coating has been injured should be painted with two coats of zinc-rich paint or otherwise repaired as approved by the surface management agency.

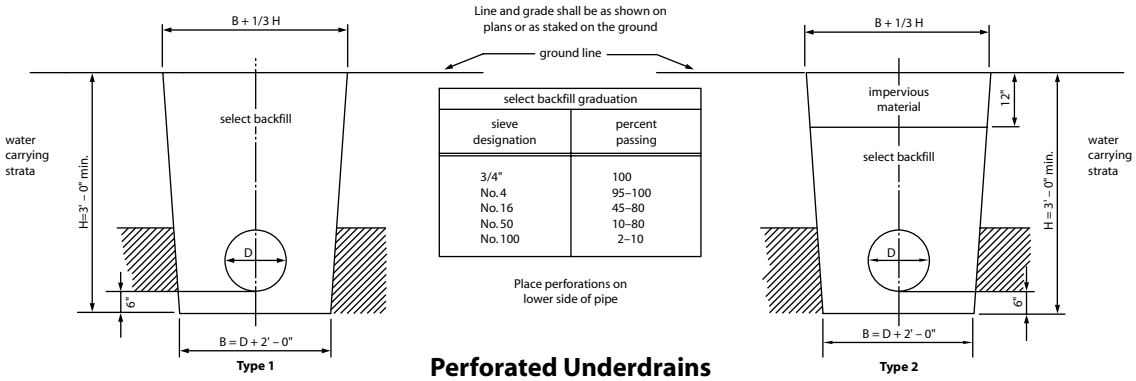
Excavation, bedding, and backfilling of culverts should be conducted according to requirements of the surface management agency and good engineering practices. Compliance with applicable Clean Water Act Best Management Practices and requirements for passage of aquatic species is required.

Ditch Relief Culverts

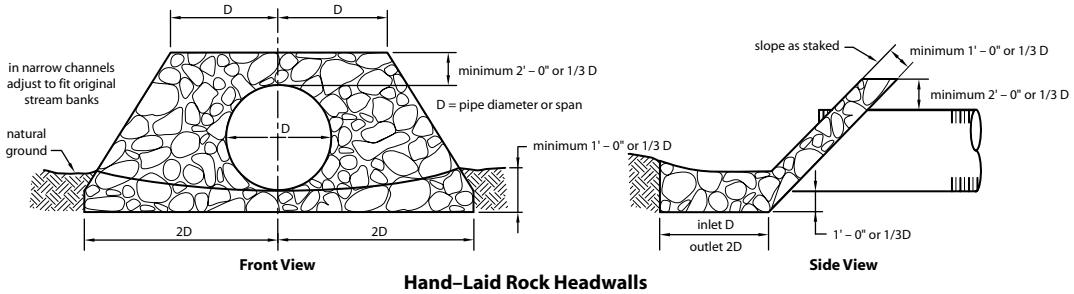
Ditch relief culverts are installed to periodically relieve the ditch line flow by piping water to the opposite side of the road where the flow can be dispersed away from the roadway. The spacing of ditch relief culverts (Figure 6) is dependent on the road gradient, soil types, and runoff characteristics.

A culvert with an 18-inch diameter is the minimum for ditch relief to prevent failure from debris blockage.

The depth of culvert burial must be sufficient to ensure protection of the culvert barrel for the design life of the culvert. This requires anticipating the amount of material that may be lost due to road use and erosion.

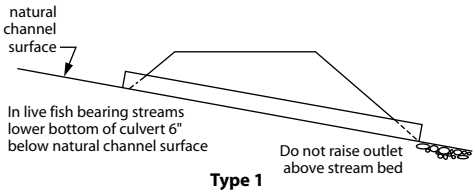


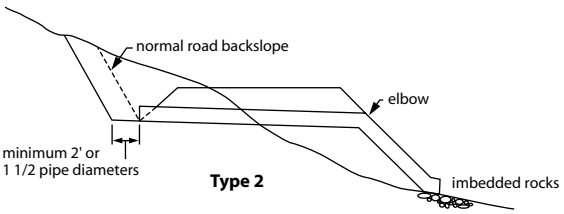
Perforated Underdrains

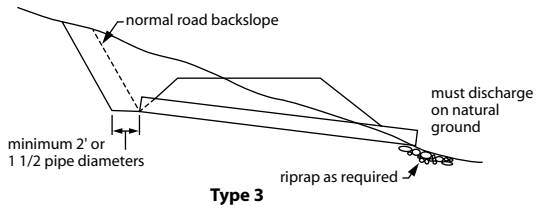


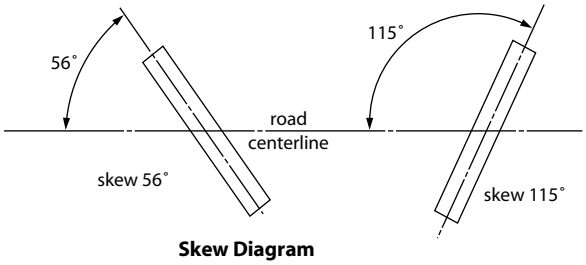
Hand–Laid Rock Headwalls

Culvert Construction Details



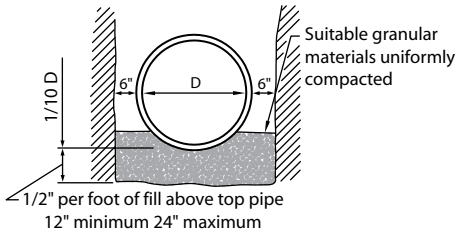




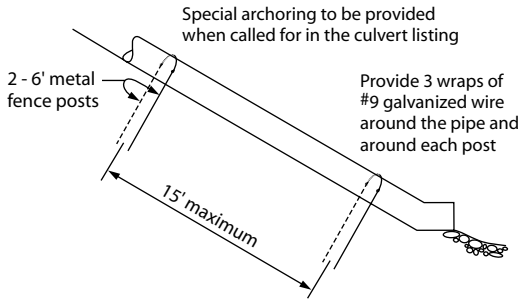


Skew Diagram

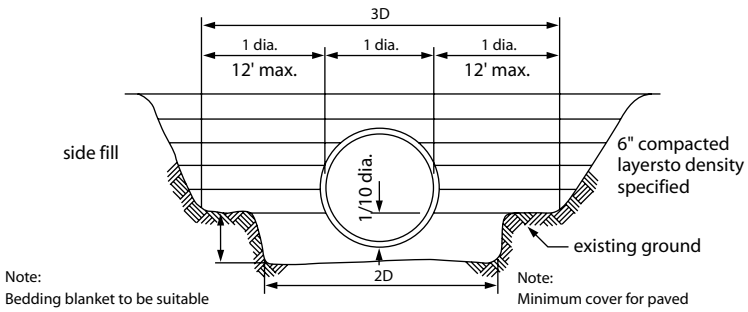
Typical Bedding Details



Rock Foundation



Special Anchoring Type 2 Downdrains



Note:
Bedding blanket to be suitable granular material roughly shaped to fit bottom of pipe

Sidefill

Note:
Minimum cover for paved surface is 12" minimum cover for dirt surface is 18"

Figure 7. Diagrams for proper culvert installation

Ditch relief culverts can provide better flow when skewed with an entrance angle of 45 to 60 degrees with the side of the ditch. The culvert gradient should be greater than the approach ditch gradient. This improves the flow hydraulics and reduces siltation and debris plugging the culvert inlet. Culverts placed in natural drainages can also be used for ditch relief.

Bridges and Major Culverts

Federal Highway Administration (FHA) regulations and BLM and FS road manuals require that on roads open to public travel, all bridges and culverts that in combination span at least 20 feet horizontal distance, must comply with the National Bridge Inspection and Reporting Standards. Thus, BLM and FS manuals require that all such facilities have engineering approval from Regional or State offices. Operators are encouraged to prepare applications requiring major culverts or bridges to allow sufficient time for agency engineering evaluations. Construction of some stream crossings may require a Section 404 Corps of Engineers permit in addition to the approval of the surface management agency.

Wetland Crossings

Wetlands are especially sensitive areas and should be avoided, if possible. Generally, these areas require crossings that prevent unnatural fluctuations in water level. Marshy and swampy terrain may contain bodies of water with no discernible current. The design of culverts for roads crossing these locations requires unique considerations. Construction of some wetland crossings may require a Section 404 Corps of Engineers permit in addition to the approval of the surface management agency.

The culvert should be designed with a flat grade so water can flow either way and maintain its natural water level on both sides. The culvert may become partially blocked by aquatic growth and should be installed with the flowline below the standing water level at its lowest elevation. Special attention must be given to the selection of culvert materials that will resist corrosion.

Low-Water Crossings

Roads may cross small drainages and intermittent streams where culverts and bridges are unnecessary. The crossing can be effectively accomplished by dipping the road down to the bed of the drainage. Site-specific designs and the construction of gravel, rip-rap, or concrete bottoms may be required in some situations. In no case should the drainage be filled so that water will be impounded. Low-water crossings that are not surfaced should not be used in wet conditions. Low-water crossings, in combination with culverts, may be utilized if the crossing is designed such that the structure is stable and self cleaning.

Subdrainage

If water is not removed from the subgrade or pavement structure, it may create instability, reduce load-bearing capacity, increase possible damage from frost action, and create a safety hazard by freezing on the road surface.

Perforated pipe drains and associated filter fabric or aggregate filters may be used when necessary to provide subdrainage. Other methods may be approved by the authorized officer.

Subdrainage systems may effectively reduce final road costs by decreasing the depth of base course needed, thereby reducing subgrade widths. This, in turn, results in less clearing and excavation. Maintenance savings may also be realized as the result of a more stable subgrade.

The solutions to subdrainage problems can be expensive. Road management techniques, such as reducing traffic loads or removing traffic until a subgrade dries out, may be considered as an alternative.

Form 1221-2
(June 1969)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

MANUAL TRANSMITTAL SHEET

Release
9-405

Date
May 4, 2015

Subject

MS 9113 – ROADS

1. Explanation of Material Transmitted: Added: 1.5 Policy, Paragraph B, concerning Federal Lands Transportation Designated Network roads, to be considered as fully "public roads" with added jurisdiction by the Secretary of Transportation.

2. Reports Required: N/A

3. Material Superseded: MS 9113, Release Number 9-390.

4. Filing Instructions: File as directed below.

REMOVE	INSERT
All of Release Number 9-390	9113 (19 pages)

Janine Velasco

Assistant Director,
Business, Fiscal and Information
Resources Management

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Chapter 1 - Overview

1.1 Purpose

This Manual Section provides for: inventory, functional classification, condition assessment, and establishment of maintenance intensities of the Bureau's roads for incorporation into the Bureau Planning System; Bureau road standards; and guidelines for road project planning, design, construction, and maintenance.

1.2 Objectives

The objectives are to:

A. Identify the role each organizational unit plays in providing engineering expertise for the management of BLM road programs. Provide direction for appropriate coordination with other organizations.

B. Provide direction for safe and adequate BLM roads for users.

C. Provide adequate information to ensure that planning, design, construction, maintenance and condition assessment activities for road projects meet BLM needs and are performed in an acceptable manner.

1.3 Authority

The authority for providing road facilities is contained in the Federal Land Policy and Management Act of 1976 (FLPMA), as amended. Also see Manual Sections 9100.03, 9103.03, and 9104.3. Authorities affecting planning, design, construction, maintenance, and condition assessment of roads include:

A. Federal Highway Act of 1962, as amended.

B. Highway Beautification Act of 1965, as amended.

C. Highway Safety Act of 1966, as revised.

D. Surface Transportation Act of 1978, as amended.

E. Surface Transportation Assistance Act of 1982.

F. Government Performance and Results Act of 1993 (GPRA).

1.4 Responsibility

The responsibilities described below are commensurate with those approved functional statements and Manual Sections 9100.04, 9103.04, 9104.04 and 9110.04.

A. The Chief, Division of Business Services, as exercised through the Chief, Engineering and Asset Management Policy Branch, is responsible for:

1. Providing Bureau-wide leadership and guidance for planning, design, construction, maintenance, and condition assessment of roads associated with managing public lands.

2. Establishing Bureau-wide road standards.

3. Developing Bureau-wide systems and standards for road inventory, road classification, and maintenance intensities.

4. Providing overall direction and quality of the Bureau Facilities Asset Management System (FAMS) database for the BLM roads inventory.

5. Coordinating with other Federal agencies, national interest groups, and road associations to ensure that Bureau interests are represented and that the Bureau is kept abreast of the newest developments regarding road-related activities.

B. The Chief, Branch of Engineering and Asset Management, National Operations Center (NOC), is responsible for:

1. Providing stewardship of the Bureau FAMS database for the BLM roads inventory.

2. Providing technical manual and handbook updates and revisions for approval and issuance by WO.

3. Providing technical engineering support to the WO/State/Field Offices, when requested.

4. Providing Contracting Officer's Representative services, on Indefinite Delivery/Indefinite Quantity Architectural and Engineering contracts, when requested on State planning, design, construction, maintenance, and condition assessment projects.

C. The State Engineer in each State is responsible for:

1. Providing State-wide leadership and guidance for planning, design, construction, maintenance, and condition assessment of roads associated with managing public lands within their geographic area of responsibility.

2. Providing overall direction and quality of the State FAMS database for the BLM roads inventory.

3. Ensuring that personnel assigned to road design, construction inspection, and condition assessment duties receive training and are otherwise qualified.

4. Ensuring all road designs are reviewed and approved by qualified individuals before construction work begins.

5. Coordinating with State Department of Transportation, FHWA Regional and Division officials, and various other organizations as necessary to ensure that the statewide road program interests are represented.

D. The District Manager or Field Manager, as appropriate, is responsible for:

1. Coordinating an interdisciplinary review and approval of all route selections for new or relocated routes.

2. Making determinations on the location of new or relocated roads based on environmental and route analysis reports generated by the interdisciplinary review team.

3. Ensuring the overall quality of the District/Field Office FAMS database for the BLM roads inventory.

4. Ensuring that proposed roads are designed and constructed to BLM road standards or approved plan/permit.

E. The District Engineer, Field Engineer, Zone Engineer, or other engineer as designated by the responsible line manager, is responsible for:

1. Accomplishing assigned road project tasks, such as inventory work, condition assessments, designs, design reviews, in a timely manner, within budget, and in conformity with this Manual Section.

2. Assigning construction inspection tasks only to those personnel who have completed the required training or and are otherwise qualified.

3. Recommending training for local personnel to ensure that road design and construction inspection capabilities meet the District or Field Office needs.

4. Coordinating with County road officials, State Department of Transportation (DOT) officials and other appropriate officials to ensure the District or Field Office road program interests are represented.

5. Coordinating with resource specialists to ensure road inventories and condition assessments are accomplished in a timely manner and that the data is properly input into the FAMS database.

1.5 Policy

It is Bureau policy that:

A. Bureau roads must be designed and maintained to an appropriate standard no higher than necessary to accommodate their intended functions; and planning, design, construction, maintenance, and condition assessment activities must be consistent with national policies for safety, esthetics, protection, and preservation of cultural, historic, wildlife, and scenic values, and accessibility for the physically challenged.

B. Bureau roads are for use, development, protection, and administration of public lands and resources. Though administered by a public agency, bureau roads are not currently designated as public roads. Bureau roads are subject to rules and regulations of the Secretary of the Interior, thus, roads may be closed or use restricted to fulfill management objectives such as protecting public health and safety, preserving resources, or in support of security issues. Bureau roads may also be subject to State and other Federal regulations as necessary to protect public health and safety.

   Bureau roads selected for inclusion into the Federal Lands Transportation (FLT) designated network are considered to be fully "Public Roads". While these roads remain under the Secretary of Interior's jurisdiction, FLT roads are also subject to the authorities of the Secretary of Transportation.

   Reclamation/decommissions, closures, and use restrictions, except for emergency reasons, are identified prior to construction or through the Land Use Planning Process. Bureau roads which no longer support management objectives are to be reclaimed/decommissioned.

C. Continuous coordination with other agencies and public road authorities is undertaken to assure that land use, resources, and public interests are represented and that Bureau road management actions and activities are appropriate.

D. The location, design, construction, and maintenance of roads crossing public lands must comply with all applicable Federal laws.

E. All roads controlled by the Bureau must meet appropriate Bureau road standards, whether or not they are constructed by Bureau initiative.

F. All Bureau road designers must be qualified. Roads constructed by non-governmental entities across public lands must be designed by or under the direction of a licensed professional engineer when the Field Manager identifies road safety and resource protection issues warranting an engineering design. Issues the Field Manager should take into consideration include average daily traffic, design speed, topography, soil types, and anticipated amount of use by the public.

G. The acquisition of easements may not be initiated until a route analysis has been completed and approved by the appropriate District or Field Office Manager. Technical approval of easement surveys, easement plats, and legal descriptions for acquisitions is delegated through the State Director and the appropriate line manager to the District or Field Office Engineer or the Chief Cadastral Surveyor. If there are no qualified Field Office Engineers, then delegation of authority goes to the next highest organizational level in engineering.

H. Comprehensive Condition Assessments of Bureau surfaced roads (aggregate, paved, etc.) are performed on a ten-year cycle and inspected after events such as severe storms to determine emergency actions or priority maintenance needs. Non-surfaced roads are inspected as needed on a local basis, or after events such as severe storms, or on a discovery basis. These roads do not include roads which fall within the boundaries of administrative and recreation sites. Roads within these boundaries are assessed during the recreation/administrative site assessments.

   All Bureau roads that have been included in the FLT Designated Network are inspected on a five year cycle.

1.6 Scope of Road Program

The management of public lands and resources is affected by continually changing social, economic, and political needs. As management objectives change, road needs could also change. An effective program to provide a road system needed to support these changing management objectives must be predicated on current and future needs and must allocate limited resources by the most effective method. A current inventory of facilities and a method of measuring their adequacy are basic to managing a road system. The FAMS has been designated as the central repository of all BLM required road condition and inventory data

Chapter 2 - Road Program Management

The management of the road program requires data collection, information dissemination, and inter- and intra- Bureau coordination to determine the need to construct, improve, maintain, acquire, transfer jurisdiction, restrict use, or close and reclaim/decommission certain roads. Coordination is particularly important, since most Bureau roads affect or are affected by resource management decisions or by road management decisions made by other organizations.

2.1 Road Inventory and Condition

The Bureau's official inventory of roads is contained within the FAMS. Guidance on conducting Bureau road condition assessments is contained within H-9113-2.

A. Route Numbers

Use the same route number throughout the length of the route. Do not duplicate route numbers within the State. The State Office may assign blocks of numbers to each District or Field Office to assure that no duplication occurs. Numbers are assigned by the District or Field Office in which the route originates and continues into the other resource area or District or Field Office jurisdiction if the route crosses a boundary.

B. BLM's Transportation System

Changes to the BLM's transportation system, as recorded in FAMS, may occur as part of the formal evaluation and designation process through one of four events:

1. Record of Decision (ROD) – for a Resource Management/Environmental Impact Statement (RMP/EIS) or an amendment of an RMP/EIS.
2. Decision of Record for an Activity Plan, Plan Amendment/Environmental Assessment (EA).
3. Federal Register Notice Action (under authority of 43 CFR 8341.2, 8364.1, 8365.1-6, or 9268.3) that has a follow-up land-use planning action and associated NEPA action.
4. Management decision of appropriate routes in an area that has been designated open to off-highway vehicle use.

2.2 Functional Classification

The Bureau categorizes its roads as Collector Roads, Local Roads, and Resource Roads.

A. Collector Roads

These Bureau roads normally provide primary access to large blocks of land, and connect with or are extensions of a public road system. Collector roads accommodate mixed traffic and serve many uses. They generally receive the highest volume of traffic of all the roads in the Bureau system. User cost, safety, comfort, and travel time are primary road management considerations. Collector roads usually require application of the highest standards used by the Bureau. As a result, they have the potential for creating substantial environmental impacts and often require complex mitigation procedures.

B. Local Roads

These Bureau roads normally serve a smaller area than collectors, and connect to collectors or public road systems. Local roads receive lower volumes, carry fewer traffic types, and generally serve fewer uses. User cost, comfort, and travel time are secondary to construction and maintenance cost considerations. Low volume local roads in mountainous terrain, where operating speed is reduced by effect of terrain, may be single lane roads with turnouts. Environmental impacts are reduced as steeper grades, sharper curves, and lower design speeds than would be permissible on collector roads are allowable.

C. Resource Roads

These Bureau roads normally are spur roads that provide point access and connect to local or collector roads. They carry very low volume and accommodate only one or two types of use. Use restrictions are applied to prevent conflicts between users needing the road and users attracted to the road. The location and design of these roads are governed by environmental compatibility and minimizing Bureau costs, with minimal consideration for user cost, comfort, or travel time.

2.3 Average Daily Traffic (ADT)

For Bureau purpose, the average daily traffic (ADT) is defined as the annual traffic divided by 365 or by the actual number of days the road is open to traffic. The amount of traffic is determined by the number of vehicles passing a point, regardless of the direction of travel. ADT provides some criteria for geometric standards and is used for justifications and in the design of structural elements. ADT is used as one of the factors in determining the functional classification. In determining ADT, consider Seasonal Average Daily Traffic (SADT), such as during hunting season, may necessitate a higher geometric design standard for the road and a seasonally adjusted higher level of maintenance. Functional classification then determines the appropriate geometric standards.

2.4 Emergency Relief for Federally Owned Roads (ERFO)

The Federal Highway Administration (FHWA) has responsibility to administer the Emergency Relief for Federally Owned Toads (ERFO) program. Refer to the FHWA "Emergency Relief for Federally Owned Roads, Disaster Assistance Manual" for guidance on timelines, coordination, and funding. The ERFO Program is intended to help pay the unusually heavy expenses associated with the repair and reconstruction of Federal roads and bridges seriously damaged by a natural disaster over a wide area of catastrophic failure. Restoration in-kind to pre-disaster conditions is expected to be the predominant type of repair.

2.5 Use of Bureau Funds on Non-Bureau Controlled Roads

Appropriated Bureau funds may not be used to construct, improve, or maintain roads not owned or controlled by the Bureau, or otherwise authorized.

Chapter 3 - Road Standards

Standards are values established to ensure adequate uniformity and quality of all roads constructed on lands administered by the Bureau. These standards are applied to all Bureau or non-Bureau initiated road construction, and are used to determine the sufficiency of existing roads.

3.1 Development of Geometric Standards

To determine the appropriate design application, road functional classification should be used. The American Society of Civil Engineers "Local Low Volume Roads and Streets" manual contains information that relates to the Bureau's low-volume roads. The American Association of State Highway and Transportation Officials (AASHTO) "A Policy on Geometric Design of Highways and Streets" is applicable for some of the Bureau roads. In addition, it contains a section addressing 'Special Purpose Roads,' including recreation and resource development roads that may also be applicable to some of the Bureau roads. AASHTO "Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400)" is also applicable for some of the Bureau's roads. Since AASHTO geometric standards for low-volume, low-speed, single-lane roads, and unpaved roads are not always applicable to Bureau roads, coordination with other agencies in addition to those listed above, continues to be the best source of information for the development of realistic standards.

3.2 Relationship Between Standards and Design Element Values

The values for curve radii, vertical curve lengths, sight distance, superelevation rates, and runoff lengths are closely related to design speed. The designer must utilize design element values appropriate to the standard. See H-9113-1 - Road Design Handbook."

3.3 Geometric Standards

Design speed, travelway widths, and maximum grades for various combinations of estimated average daily traffic (ADT), functional classification, and terrain types are shown below.

GEOMETRIC STANDARDS FOR BUREAU ROADS

Functional Classification	Est. 20 Yr. ADT	Terrain	Design Speed		Travelway Width		Maximum Grade	
			Pref.	Min.	Pref.	Min.	Pref.	Max.
Resource	Less Than 20	Level & Rolling	30	*	14	*	8	10*
		Mountainous	15	*	14	*	8	16*
Local	Less Than 100	Level & Rolling	40	30	20	20	6	10
		Mountainous	20	15	14	12	8	15
	More Than 75	Level & Rolling	50	40	24	20	6	10
		Mountainous	30	15	24	20	8	14
Collector	50 - 100	Level & Rolling	50	30	24	20	6	8
		Mountainous	30	20	20	20	8	12
	More Than 100	Level & Rolling	50	40	24	20	6	8
		Mountainous	30	20	24	20	8	12

Note: Design speeds and surface widths chosen are limited to values shown, except that greater widths are allowed when oversized traffic justifies wider widths.
* If preferred design, speed, travelway width, and maximum grade are not feasible for specific resource roads, alternative values are determined by the State Engineer.

3.4 Loadings

Design roads and structures for H-20 or HS-20 loadings, as appropriate, and as specified by the AASHTO. Designs with heavier loadings will be used if the road is used by overweight traffic from adjacent roads.

3.5 Structure Widths

Bridges, culverts, tunnels, cattleguards, and other structures must have a minimum curb-to-curb or rail-to-rail width (whichever is less) of 14 feet for single lane roads and 24 feet for double lane roads, but in all cases not less than the nominal width of the adjacent travelway as measured at right angles to the road centerline.

3.6 Vertical Clearance

Overhead vertical clearance must be a minimum of 16-feet from the traveled way elevation. (See H-9113-1 - Road Design Handbook.)

3.7 Horizontal Clearance

A horizontal clearance of 4-feet from edge of roadway is recommended. (See H-9113-1 - Road Design Handbook.)

3.8 Traffic Control Signs and Markers

Signs and markers placed on or adjacent to the roadway to regulate, inform, or guide vehicle occupants must conform to the requirements of Manual Section 9130 – Sign Manual and the FHWA "Manual on Uniform Traffic Control Devices."

3.9 Easement Widths

The width of easements for Bureau roads is limited to the minimum width necessary for construction and maintenance operations, and for user safety. A minimum width of 50-feet or the width of construction plus 10-feet on each side (whichever is greater) is generally required. Maintain uniform widths through varying ownerships or legal subdivisions whenever possible, rather than allowing frequent width changes.

Chapter 4 - Road Project Planning

Road project planning ensures that the project provides safe and adequate service to the user and is compatible with environmental values. Prior to final selection of a route, alternative locations and environmental factors must be analyzed.

4.1 Route Analysis

Perform a route analysis to identify feasible routes that satisfy the required road function. In cases where an existing road could be acquired, the existing road is an alternative and is assessed with other feasible routes. This ensures that the selected route best meets management needs and is not a short-term solution.

A. Management Requirements

Identify the anticipated vehicle type and traffic volume to include additional traffic that may be attracted to the new route. Identify the functional classification of the road and specific locations that the road must serve. Map any areas that the road must not penetrate because of withdrawals, easements, private lands, or reservations, and identify any other special considerations or constraints on selection of feasible routes.

B. Feasible Route Locations

Plot feasible route locations (those that meet management requirements and the appropriate road standards) on a topographic map. Make route locations as wide as possible, as this gives the greatest freedom in selecting the alignment to ensure free traffic flow, minimal impact on the environment, and relative economy of construction and maintenance.

C. Route Selection Review

Determine the most desirable route locations and analyze these locations for the Field review. Document the reasons for eliminating the less desirable feasible route locations (or portions thereof) from further consideration in the analysis report.

D. Field Review

Perform an in-depth field review for each feasible location. Prior to field review, affected private land must be identified and appropriate documented permission secured to perform any needed survey work, soil borings, etc. For each feasible location, consider environmental impacts, resource value impacts, user cost, safety, construction and maintenance costs, acquisition costs (if applicable), suitability of soil and geology for construction, and any other factors relevant to choosing the best locations. If an existing road is to be acquired, consider construction costs necessary to meet appropriate road standards.

E. Report

Upon completing the field review listed above, the team prepares a report for management review and approval.

4.2 Route Selection

Using the route analysis report and any required environmental analysis, the District/Field Office Manager selects the location. If the route analysis report or the environmental analysis addresses special problems, the selection decision may include specific mitigation requirements or limitations that must be addressed in the design.

4.3 Design

Final design work, whether "in-house," by another agency or by an architectural and engineering firm commences when project planning is complete and the project has been programmed and funded in an approved Annual Work Plan. Work on non-Bureau road designs should normally not begin until the preliminary location has been approved and the road stipulations have been provided to the applicant. Bureau road standards are provided in .2 of this Manual Section and the design guides found in H-9113-1 – Road Design Handbook.

A. Designer Qualifications

Any road designer and reviewer assigned responsibility for the design and/or review of any road must have a working knowledge of highway engineering principles and procedures, and have satisfactorily completed a college or other approved road design course.

All "in-house" designs must receive an independent technical review by a qualified road designer. The State Engineer reviews and determines the procedures and organizational level for such reviews. Roads designed by non-Bureau personnel are approved for technical correctness by a qualified registered engineer or another agency's design chief, and are reviewed by the State Engineer, qualified District engineering personnel, or a qualified reviewer appointed by the District Engineer, to assure that the design meets the appropriate Bureau road standards.

B. Approved Road Design Courses

Satisfactory completion of the following are acceptable for qualifying BLM road design personnel:

1. U.S. Forest Service Basic and Advanced Road Design Courses

2. University Level Engineering Curriculum Road Design Courses

3. Other qualifications approved by the State Engineer

Chapter 5 - Construction

See Manual 9103 - Facility Construction.

5.1 Signing

Roads under construction are required to be signed according to the current edition of the FHWA "Manual of Uniform Traffic Control Devices."

5.2 Inspections

Construction inspection must be done by qualified inspectors regardless of the method of construction, such as force account, contract, timber sale, etc. (See Manual 9103 – Facility Construction)

Chapter 6 - Maintenance

See Manual 9104 - Facility Maintenance.

6.1 Maintenance Management

Follow guidance in Manual 9104 - Facility Maintenance for the establishment of a maintenance management program.

6.2 Maintenance Intensities

Transportation System Assets BLM route Maintenance Intensities provide guidance for appropriate "standards of care" to recognized routes within the BLM. Recognized routes by definition include Roads, Primitive Roads, and Trails carried as assets within the BLM FAMS.

Maintenance Intensities provide consistent objectives and standards for the care and maintenance of BLM routes based on identified management objectives. Maintenance Intensities are consistent with land-use planning management objectives (for example, natural, cultural, recreation setting, and visual). Maintenance Intensities provide operational guidance to field personnel on the appropriate intensity, frequency, and type of maintenance activities that should be undertaken to keep the route in acceptable condition and provide guidance for the minimum standards of care for the annual maintenance of a route.

Maintenance Intensities do not describe route geometry, route types, types of use or other physical or managerial characteristics of the route. Those terms are addressed as other descriptive attributes to a route.

Maintenance Intensities provide a range of management objectives and standards. (See Appendix A – Maintenance Intensities)

Appendix A - Maintenance Intensities

Level 0

Maintenance Description: Existing routes that will no longer be maintained and no longer be declared a route. Routes identified as Level 0 are identified for removal from the Transportation System entirely.

Maintenance Objectives:

- No planned annual maintenance,
- meet identified environmental needs,
- no preventative maintenance or planned annual maintenance activities

Maintenance Funds: No annual maintenance funds

Level 1

Maintenance Description: Routes where minimum (low intensity) maintenance is required to protect adjacent lands and resource values. These roads may be impassable for extended periods of time.

Maintenance Objectives:

- Low (Minimal) maintenance intensity,
- Emphasis is given to maintaining drainage and runoff patterns as needed to protect adjacent lands. Grading, brushing, or slide removal is not performed unless route bed drainage is being adversely affected, causing erosion.
- Meet identified resource management objectives
- Perform maintenance as necessary to protect adjacent lands and resource values
- No preventative maintenance
- Planned maintenance activities limited to environmental and resource protection
- Route surface and other physical features are not maintained for regular traffic. Maintenance Funds: Maintenance funds provided to address environmental and resource protection requirements. No maintenance funds provided to perform preventative maintenance.

Level 2 *Reserved for Possible Future Use*

Level 3

Maintenance Description: Routes requiring moderate maintenance due to low volume use (for example, seasonally or year-round for commercial, recreational, or administrative access). Maintenance Intensities may not provide year-round access but are intended to generally provide resources appropriate to keep the route in use for the majority of the year.

Maintenance Objectives:

- Medium (Moderate) maintenance intensity,
- Drainage structures will be maintained as needed. Surface maintenance will be

conducted to provide a reasonable level of riding comfort at prudent speeds for the route conditions and intended use. Brushing is conducted as needed to improve sight distance when appropriate for management uses. Landslides adversely affecting drainage receive high priority for removal; otherwise, they will be removed on a scheduled basis.

- Meet identified environmental needs
- Generally maintained for year-round traffic
- Perform annual maintenance necessary to protect adjacent lands and resource values
- Perform preventative maintenance as required to generally keep the route in acceptable condition
- Planned maintenance activities should include environmental and resource protection efforts, annual route surface
- Route surface and other physical features are maintained for regular traffic Maintenance Funds: Maintenance funds provided to preserve the route in the current condition, perform planned preventive maintenance activities on a scheduled basis, and address environmental and resource protection requirements.

Level 4 *Reserved for Possible Future Use*

Level 5

Maintenance Description: Route for high (maximum) maintenance due to year-round needs, high volume of traffic, or significant use. Also may include route identified through management objectives as requiring high intensities of maintenance or to be maintained open on a year-round basis.

Maintenance Objectives:

- High (Maximum) maintenance intensity
- The entire route will be maintained at least annually. Problems will be repaired as discovered. These routes may be closed or have limited access due to weather conditions but are generally intended for year-round use.
- Meet identified environmental needs
- Generally maintained for year-round traffic
- Perform annual maintenance necessary to protect adjacent lands and resource values
- Perform preventative maintenance as required to generally keep the route in acceptable condition
- Planned maintenance activities should include environmental and resource protection efforts, annual route surface
- Route surface and other physical features are maintained for regular traffic Maintenance Funds: Maintenance funds provided to preserve the route in the current condition, perform planned preventative maintenance activities on a scheduled basis, and address environmental and resource protection requirements.

Appendix B – Hydrolgoic Calculations

Project: Calico - Grassy Mountain Access Road Design
Task: Hydrologic Analysis - Culverts
Date: 4/22/2019
Calculated By: S. Savage, EIT
Checked By: D. March, PE, CFM

User input
Resulting calculation

Drainage Basin Parameters					Peak Flow for Return Intervals, Q (cfs)	
Crossing ID	Station (Existing)	Flood Region[1]	Drainage Area, DA (mi^2)	Watershed Aspect (degrees)	*10-year*	*25-year*
C-01	305+56.00	3 - Northeast Eastern Oregon	0.27	-	18	23
C-02	393+79.00	6 - Southeast Eastern Oregon	0.19	134	14	20
C-03	634+11.00	6 - Southeast Eastern Oregon	0.34	118	31	44
C-04	675+10.00	6 - Southeast Eastern Oregon	0.16	109	21	30
C-05	800+15.00	6 - Southeast Eastern Oregon	0.37	139	21	30
C-06	940+20.00	3 - Northeast Eastern Oregon	1.23	-	56	72
C-07	944+25.00	3 - Northeast Eastern Oregon	2.14	-	84	109
C-08	983+55.00	3 - Northeast Eastern Oregon	1.32	-	59	76
C-09	1021+30.00	3 - Northeast Eastern Oregon	1.84	-	75	97
C-10	1132+64.00	3 - Northeast Eastern Oregon	0.23	-	16	21
C-11	1101+19.00	3 - Northeast Eastern Oregon	3.87	-	130	169

[1] Flood region determined from Figure 14 in OFR SW 06-001, *Estimation of Peak Discharges for Rural, Ungregulated Streams in Eastern Oregon* , State of Oregon Water Resoureces)

[2] Peak flow rates were calculated using the regression equations described in OFR SW 06-001

Table 23. Prediction equations for estimating peak discharges for ungaged watersheds in flood region 3, northeast eastern Oregon.

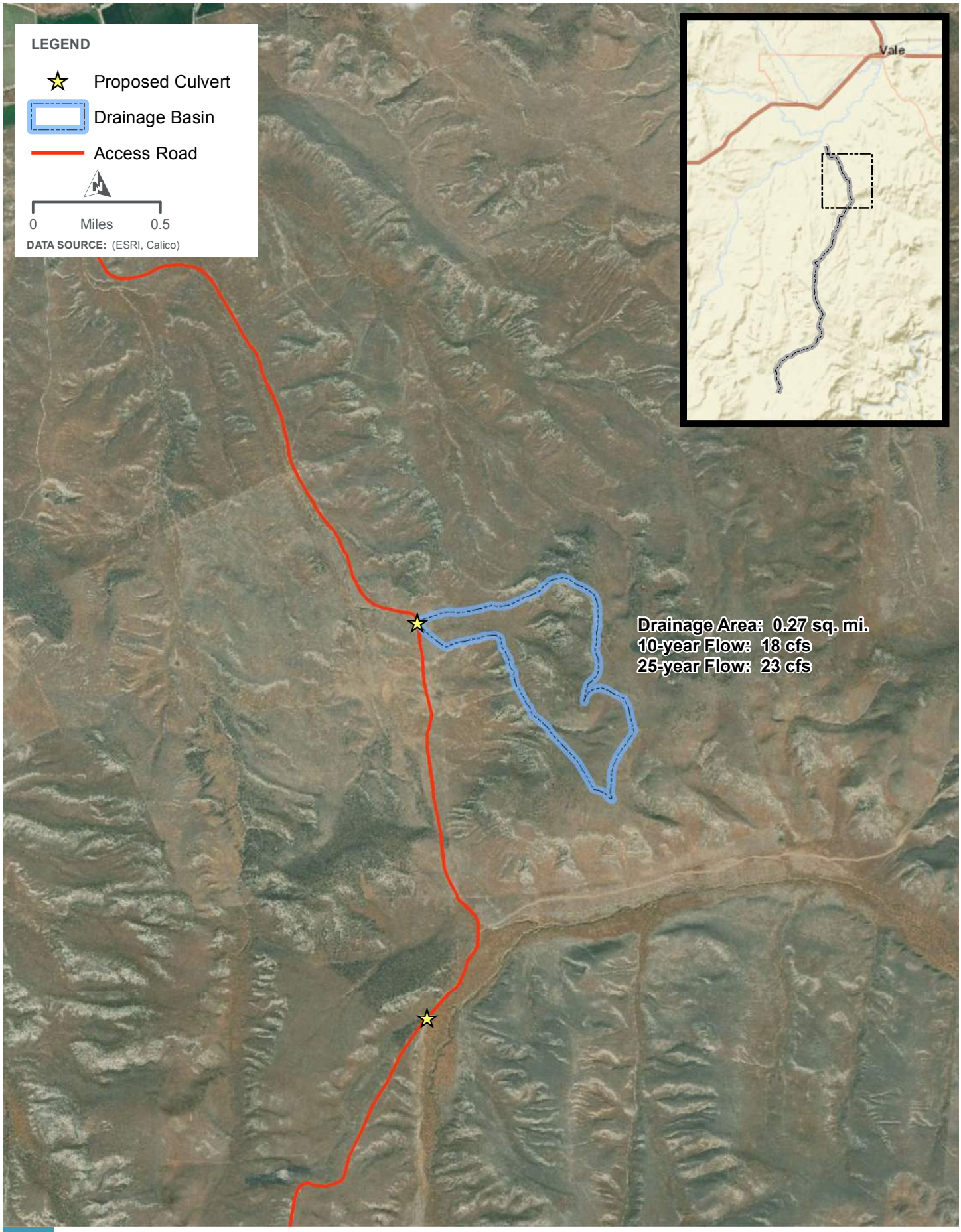
[**Q(n)**, discharge in cubic feet per second for the n-year recurrence interval; **Area**, drainage area, in square miles.]

Prediction equation	Percent standard error of the model, in percent	Average standard error of sampling, in percent	Average prediction error, in percent	Average equivalent years of record
$Q(2) = 21.83\ Area^{0.7546}$	56.8	10.9	58.2	1.3
$Q(5) = 36.80\ Area^{0.7459}$	47.3	10.1	48.6	2.5
$Q(10) = 47.68\ Area^{0.7431}$	44.8	10.2	46.1	3.6
$Q(25) = 61.90\ Area^{0.7415}$	44.3	10.7	45.8	5.2
$Q(50) = 72.81\ Area^{0.7408}$	45.1	11.2	46.8	6.1
$Q(100) = 84.03\ Area^{0.7402}$	46.7	11.8	48.5	6.8
$Q(500) = 111.9\ Area^{0.7388}$	52.2	13.3	54.3	7.7

Table 26. Prediction equations for estimating peak discharges for ungaged watersheds in flood region 6, southeast eastern Oregon.

[**Q(n)**, discharge in cubic feet per second for the n-year recurrence interval; **Area**, drainage area, in square miles; **Aspect**, mean watershed aspect, in degrees.]

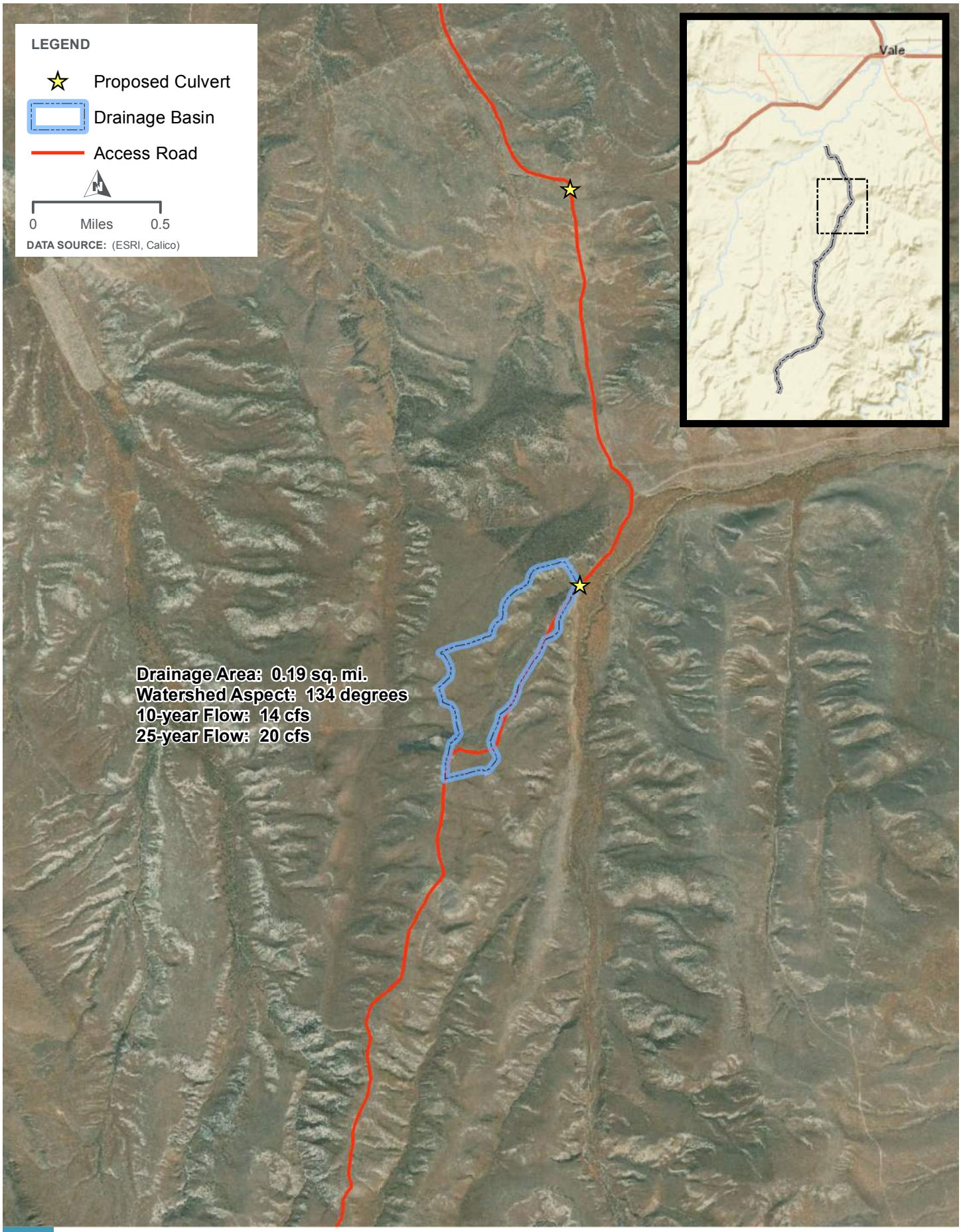
Prediction equation	Percent standard error of the model, in percent	Average standard error of sampling, in percent	Average prediction error, in percent	Average equivalent years of record
$Q(2) = 29.38\ Area^{0.7718}\ (Aspect/100)^{-2.200}$	94.6	32.1	104	1.2
$Q(5) = 75.05\ Area^{0.7796}\ (Aspect/100)^{-2.556}$	76.0	27.6	83.6	1.9
$Q(10) = 112.5\ Area^{0.7873}\ (Aspect/100)^{-2.664}$	69.7	26.4	76.2	2.8
$Q(25) = 164.7\ Area^{0.7977}\ (Aspect/100)^{-2.749}$	66.2	26.1	73.2	4.1
$Q(50) = 207.8\ Area^{0.8051}\ (Aspect/100)^{-2.808}$	66.0	26.6	73.3	4.9
$Q(100) = 255.6\ Area^{0.8120}\ (Aspect/100)^{-2.872}$	67.2	27.4	74.9	5.5
$Q(500) = 389.6\ Area^{0.8267}\ (Aspect/100)^{-3.039}$	73.5	30.1	82.5	6.3



DRAINAGE BASIN MAP

PROPOSED CULVERT C-01

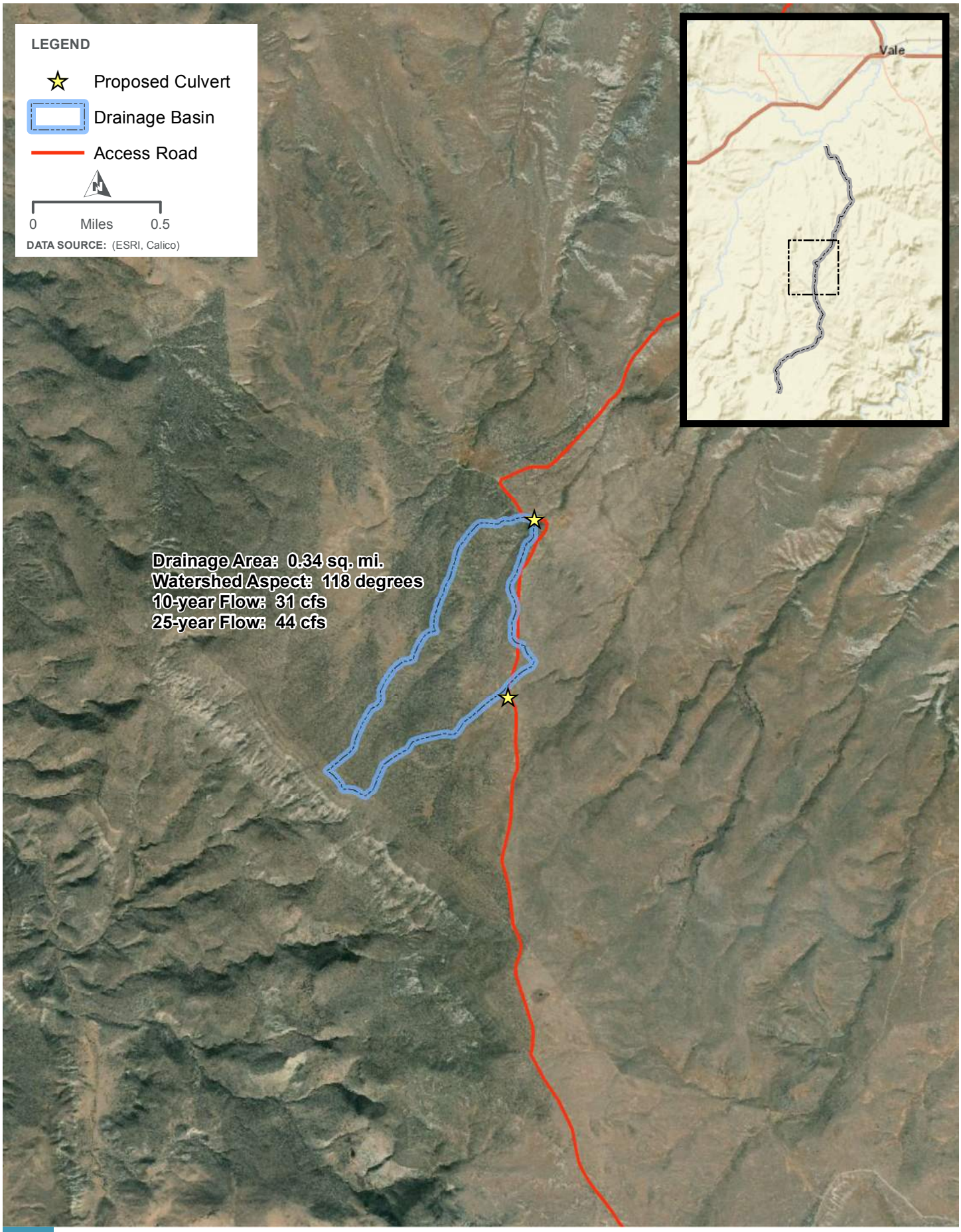
FIGURE B.1



DRAINAGE BASIN MAP

PROPOSED CULVERT C-02

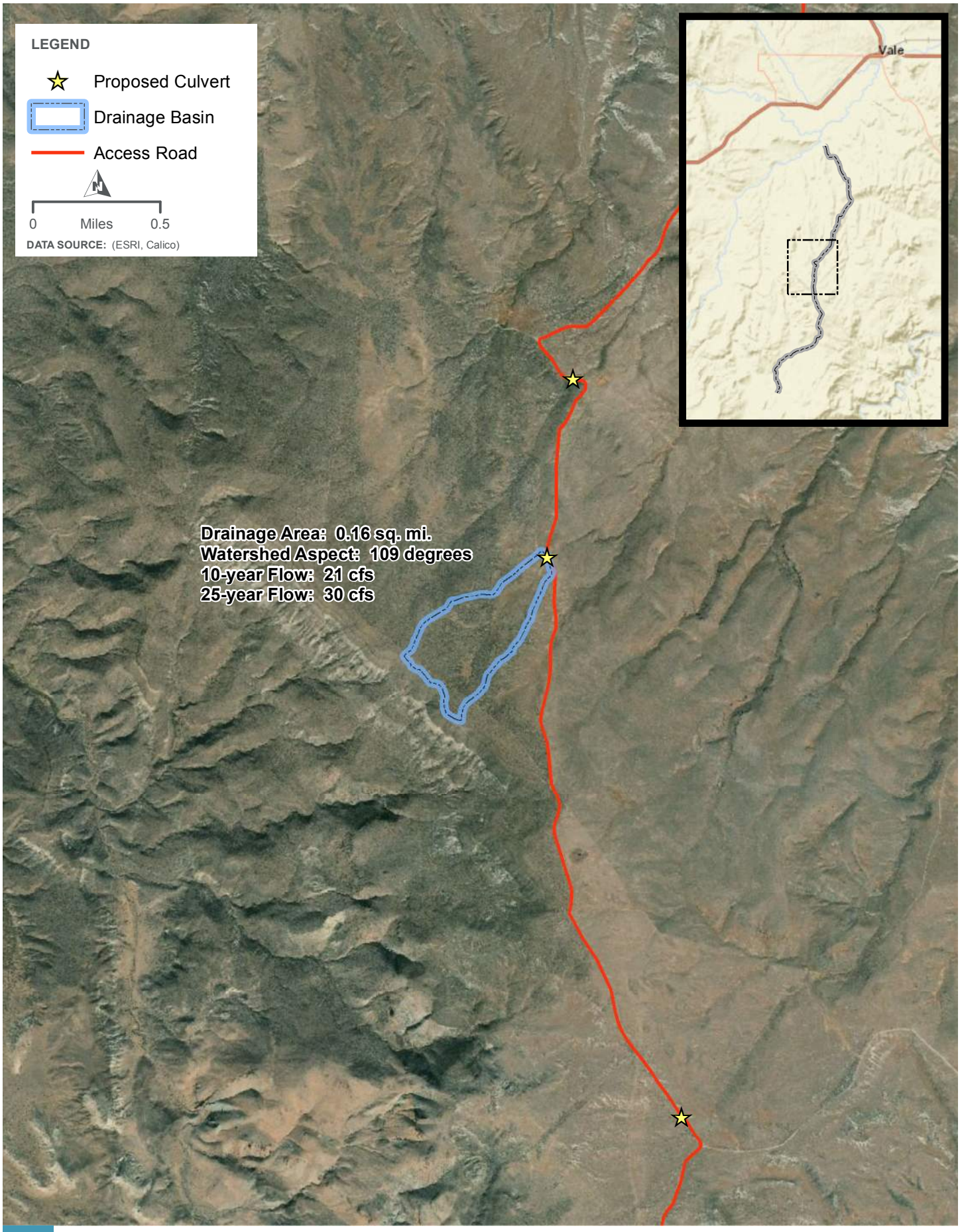
FIGURE B.2



DRAINAGE BASIN MAP

PROPOSED CULVERT C-03

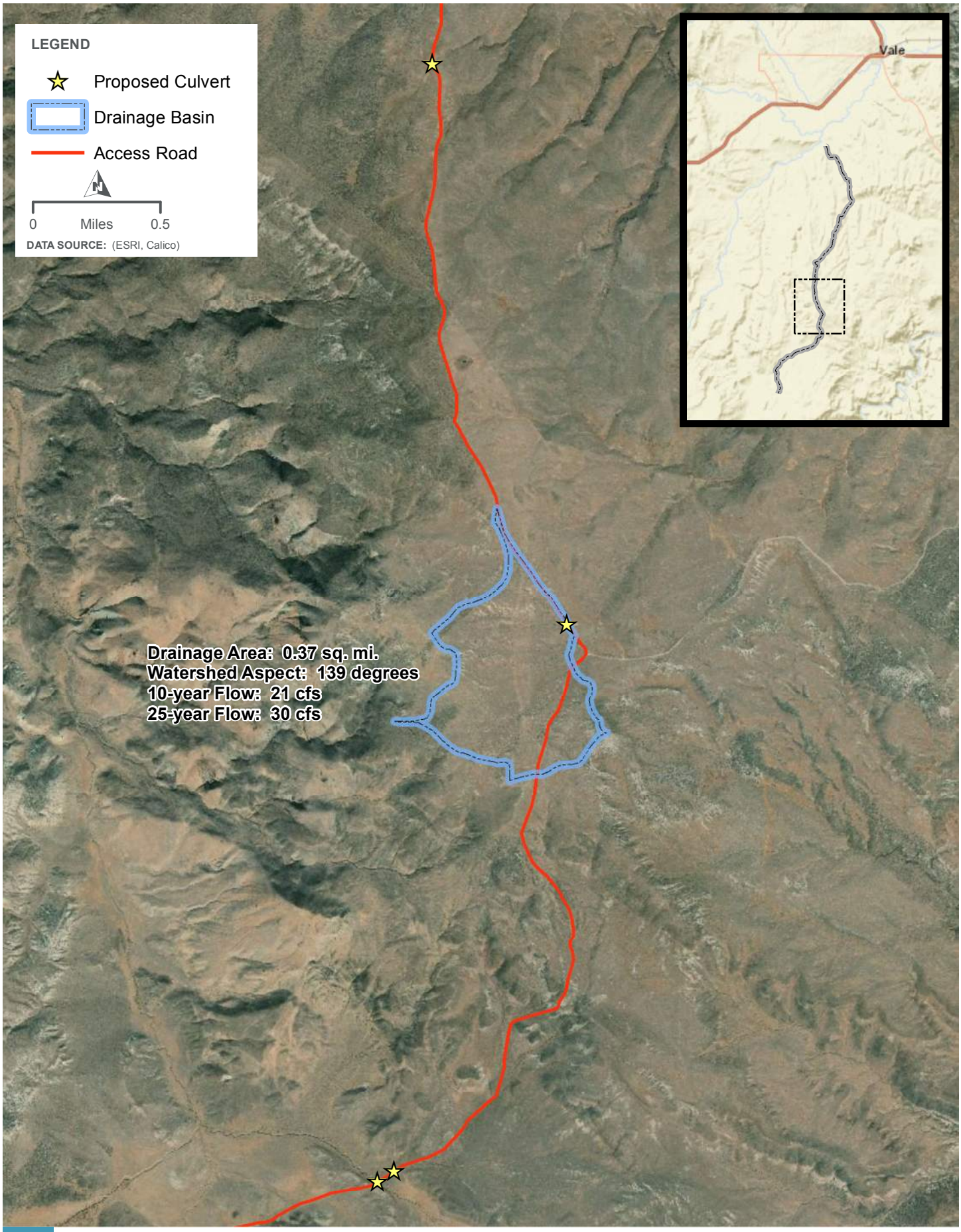
FIGURE B.3



DRAINAGE BASIN MAP

PROPOSED CULVERT C-04

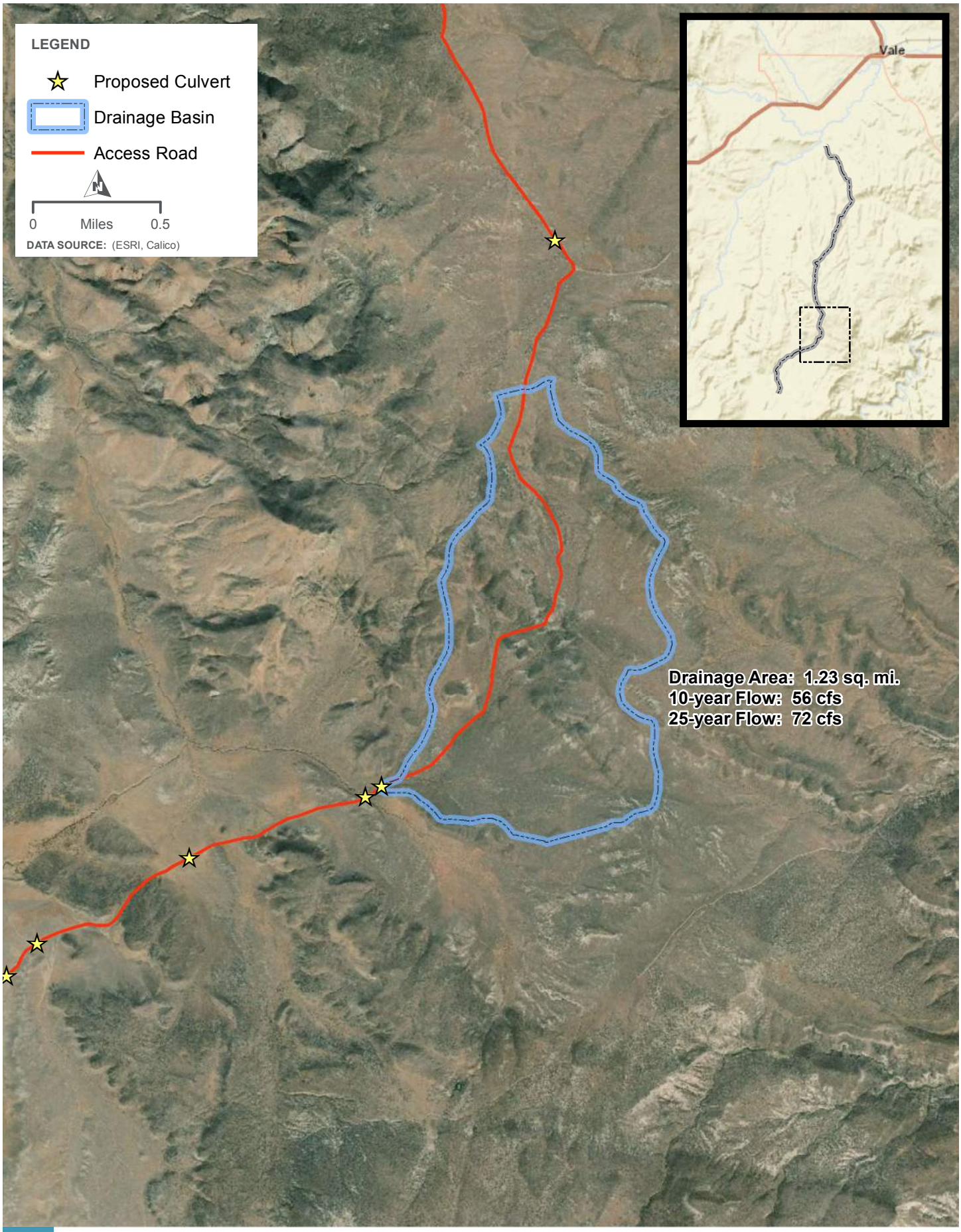
FIGURE B.4



DRAINAGE BASIN MAP

PROPOSED CULVERT C-05

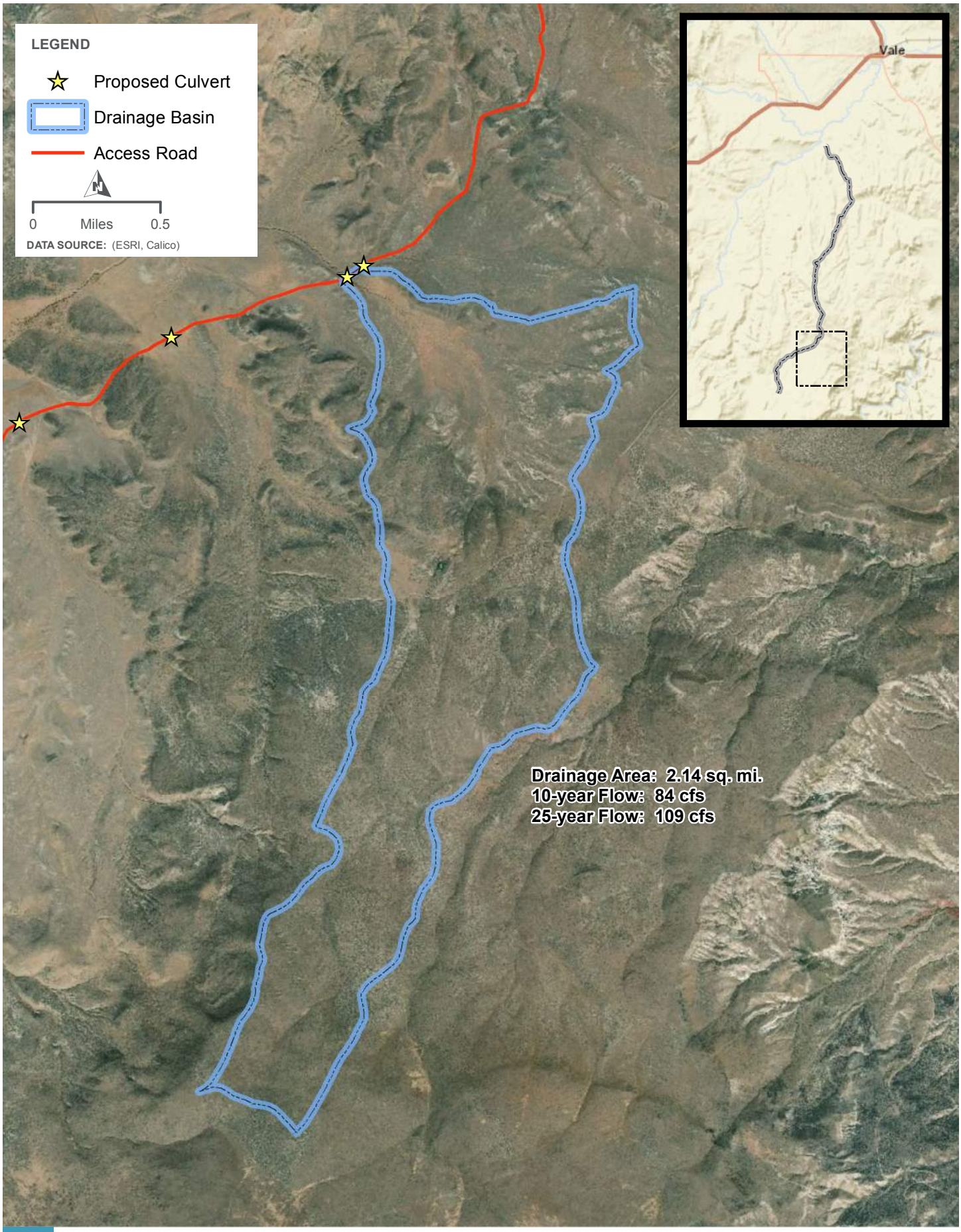
FIGURE B.5



DRAINAGE BASIN MAP

PROPOSED CULVERT C-06

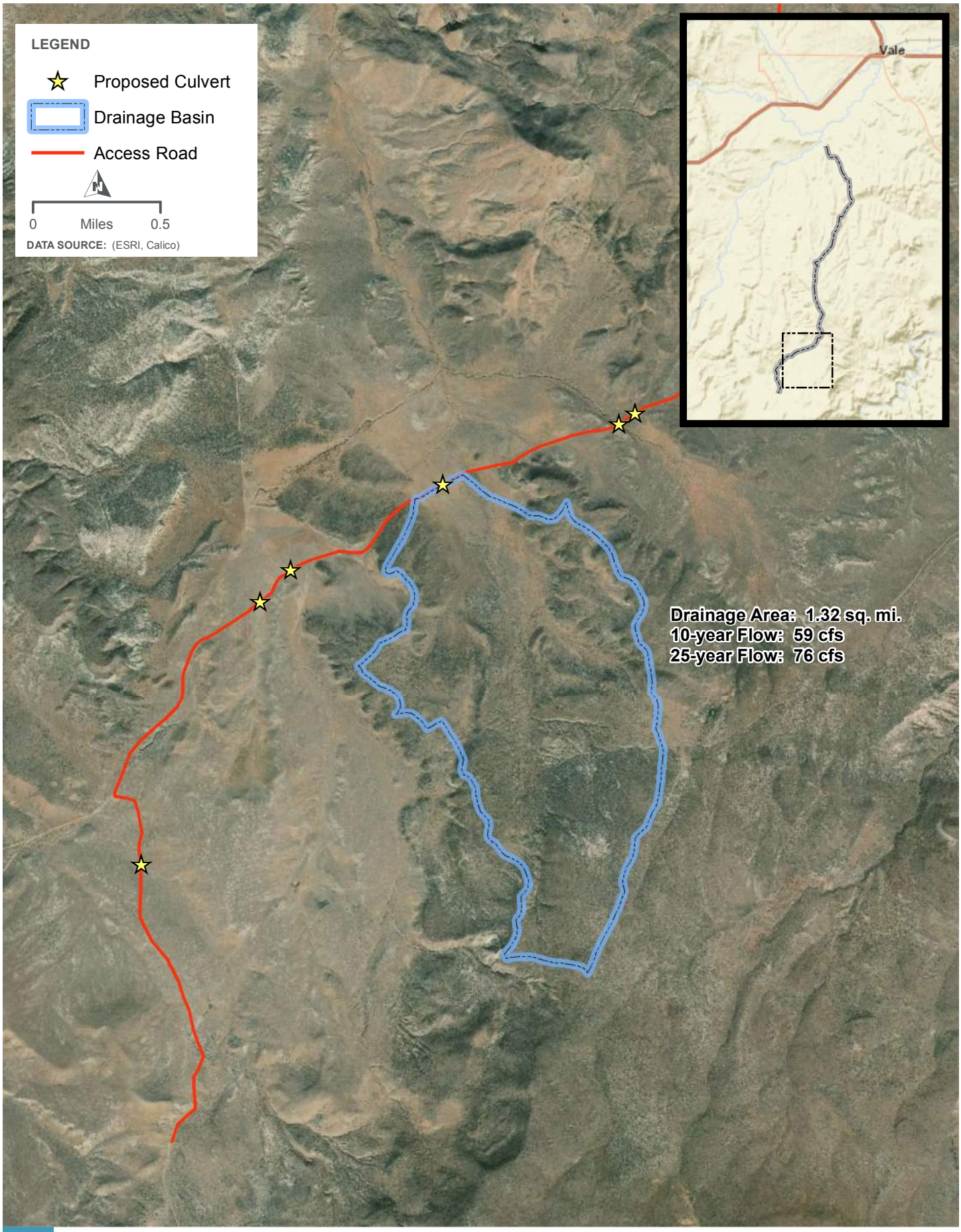
FIGURE B.6



DRAINAGE BASIN MAP

PROPOSED CULVERT C-07

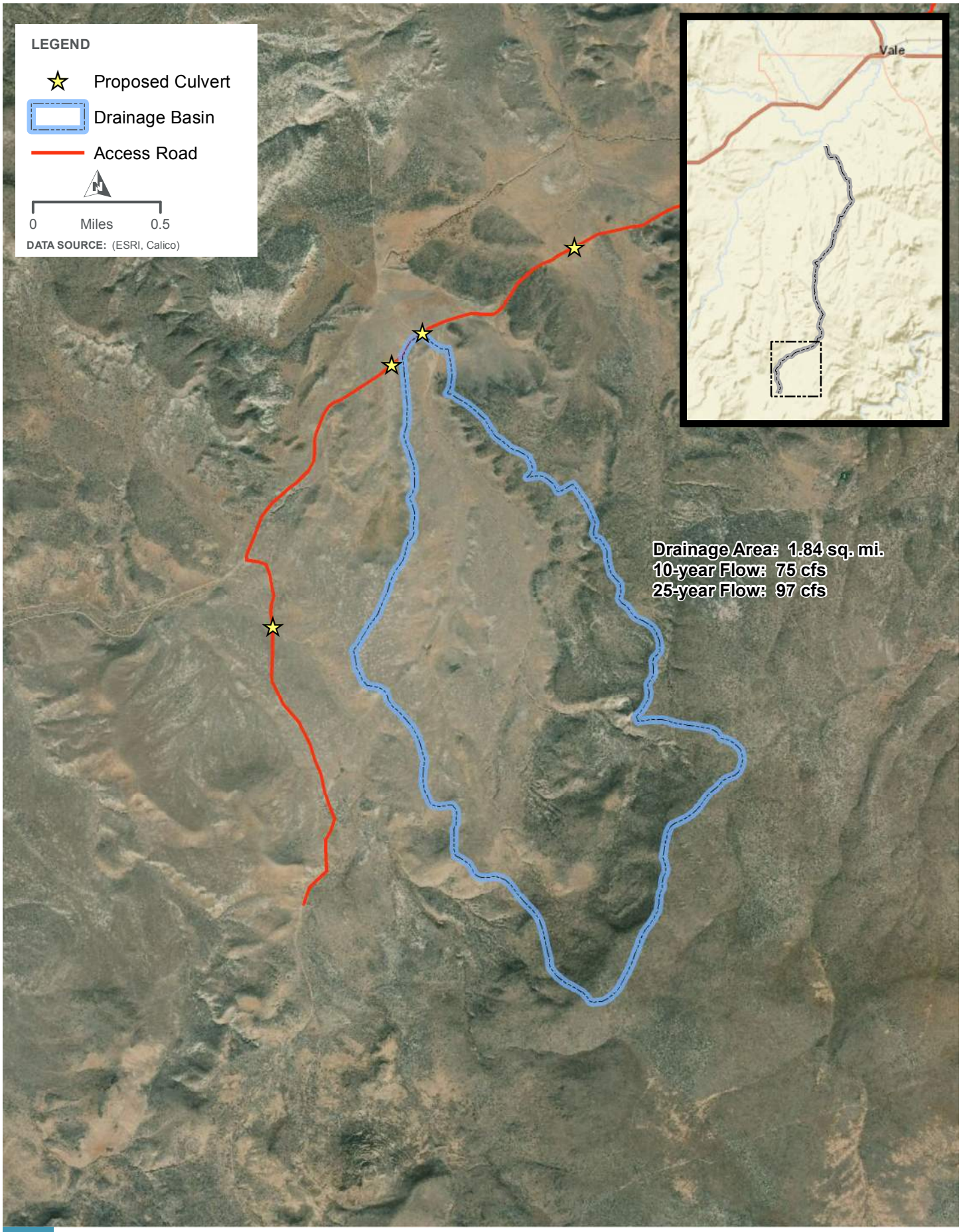
FIGURE B.7



DRAINAGE BASIN MAP

PROPOSED CULVERT C-08

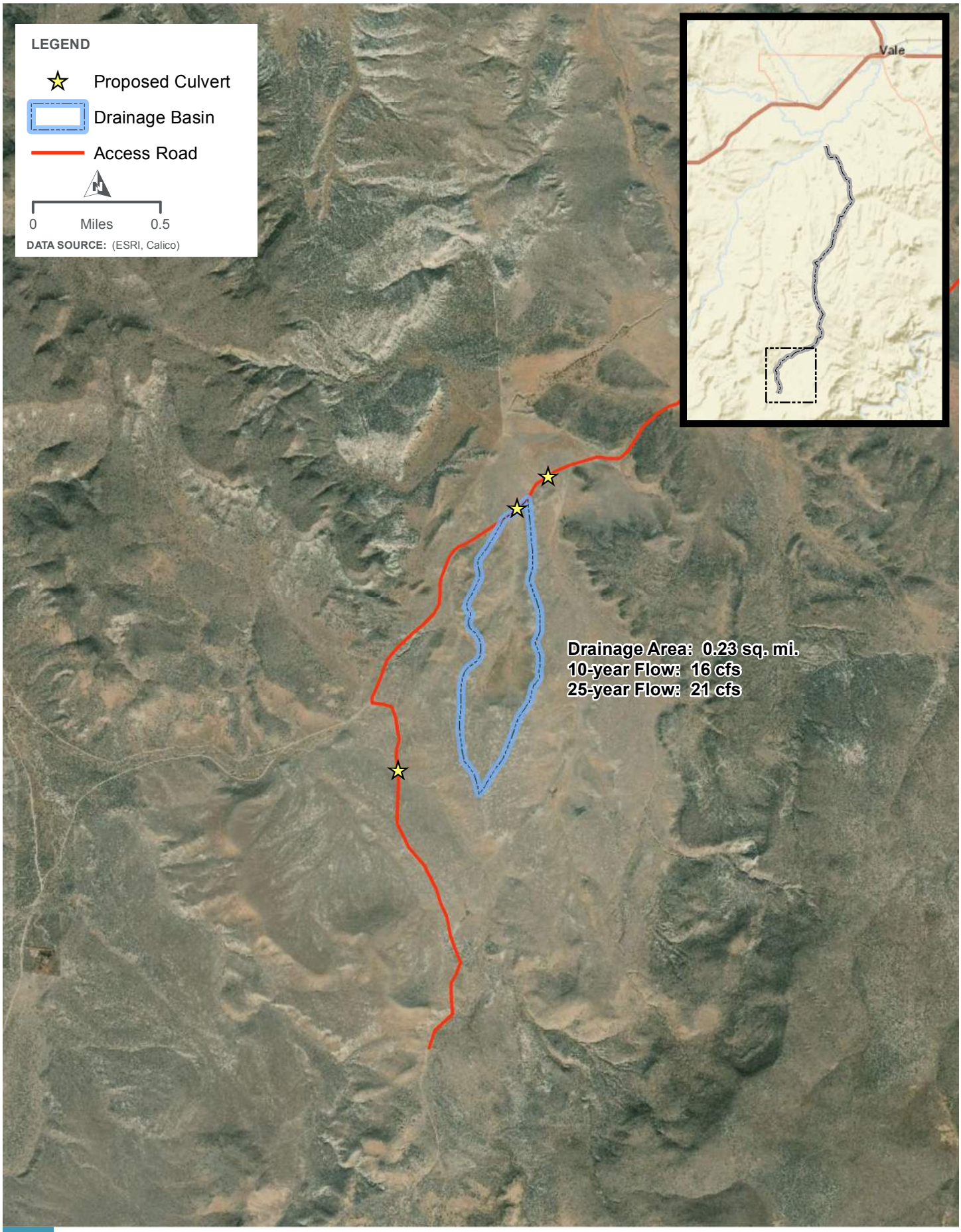
FIGURE B.8



DRAINAGE BASIN MAP

PROPOSED CULVERT C-09

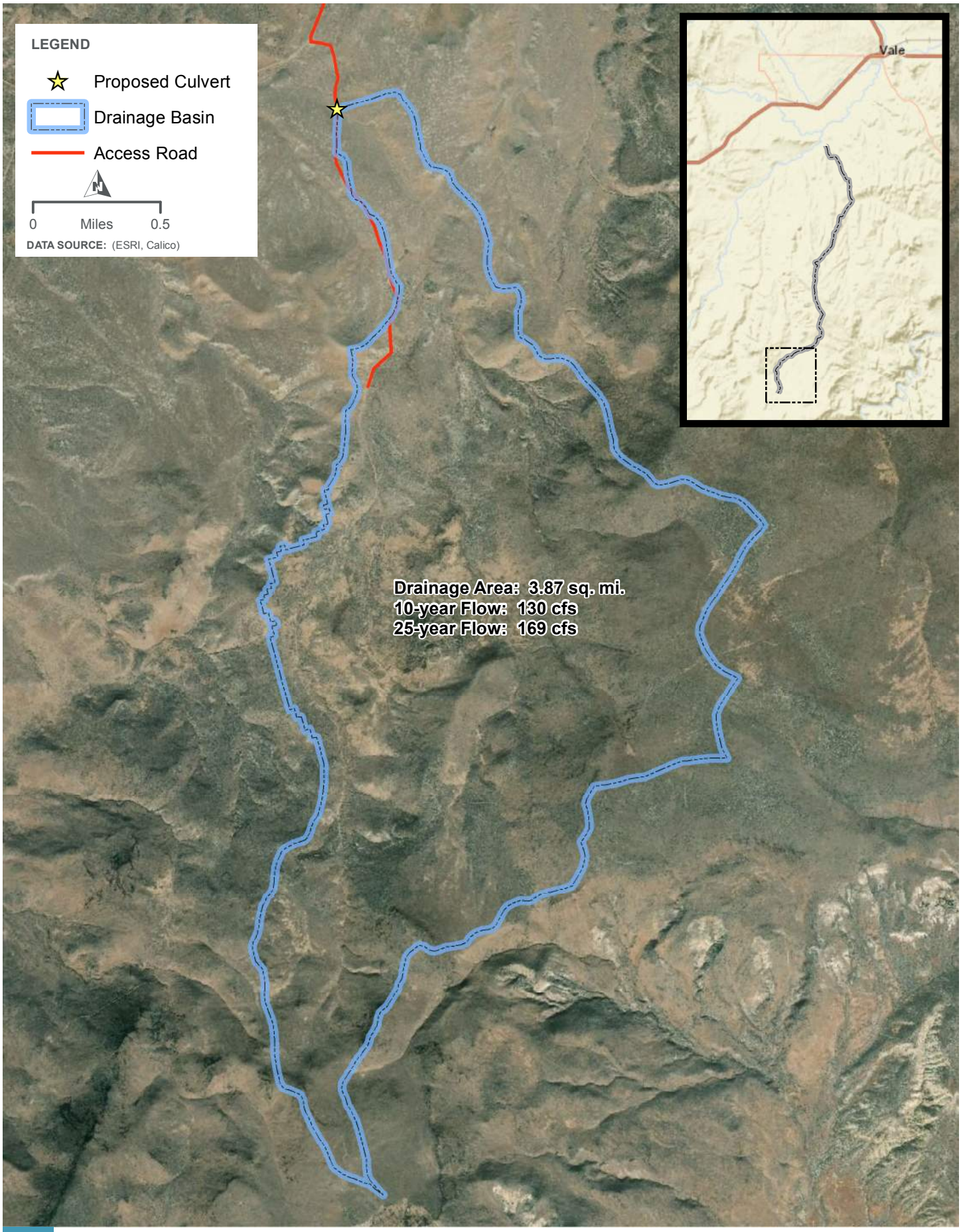
FIGURE B.9



DRAINAGE BASIN MAP

PROPOSED CULVERT C-10

FIGURE B.10



DRAINAGE BASIN MAP

PROPOSED CULVERT C-11

FIGURE B.11

Appendix C – Hydraulic Calculations

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: C-01

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-01 Discharg (cfs)	Roadway Discharge (cfs	Iterations
2554.03	10-yr	18.00	18.00	0.00	1
2554.29	25-yr	23.00	23.00	0.00	1
2555.25	Overtopping	38.43	38.43	0.00	Overtopping

Table 2 - Culvert Summary Table: C-01

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	18.00	18.00	2554.01	1.565	0.079	1-S2n	0.592	1.069	0.672	0.429	9.377	7.518
25-yr	23.00	23.00	2554.29	1.833	0.376	1-S2n	0.673	1.213	0.779	0.470	9.815	7.993

****

Straight Culvert

Inlet Elevation (invert): 2552.46 ft, Outlet Elevation (invert): 2551.23 ft

Culvert Length: 37.02 ft, Culvert Slope: 0.0332

****

Site Data - C-01

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 2552.46 ft
Outlet Station: 37.00 ft
Outlet Elevation: 2551.23 ft
Number of Barrels: 2

Culvert Data Summary - C-01

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: C-01)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
18.00	2551.66	0.43	7.52	8.57	2.86
23.00	2551.70	0.47	7.99	9.39	2.90

Tailwater Channel Data - C-01

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 13.00 (_:1)
Channel Slope: 0.3200
Channel Manning's n: 0.0400
Channel Invert Elevation: 2551.23 ft

Roadway Data for Crossing: C-01

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 2555.25 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 4 - Summary of Culvert Flows at Crossing: C-02

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-02 Discharg (cfs)	Roadway Discharge (cfs	Iterations
2710.80	10-yr	18.00	18.00	0.00	1
2711.12	25-yr	23.00	23.00	0.00	1
2712.40	Overtopping	38.62	38.62	0.00	Overtopping

Table 5 - Culvert Summary Table: C-02

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	18.00	18.00	2710.80	1.687	0.0*	1-S2n	1.011	1.069	1.011	0.589	5.469	2.982
25-yr	23.00	23.00	2711.12	2.010	0.903	5-S2n	1.178	1.213	1.178	0.671	5.790	3.204

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 2709.11 ft, Outlet Elevation (invert): 2707.80 ft

Culvert Length: 69.01 ft, Culvert Slope: 0.0190

****

Site Data - C-02

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 2709.11 ft
Outlet Station: 69.00 ft
Outlet Elevation: 2707.80 ft
Number of Barrels: 2

Culvert Data Summary - C-02

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: C-02)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
18.00	2708.39	0.59	2.98	0.70	0.79
23.00	2708.47	0.67	3.20	0.80	0.80

Tailwater Channel Data - C-02

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 7.00 ft
Side Slope (H:V): 5.50 (_:1)
Channel Slope: 0.0190
Channel Manning's n: 0.0400
Channel Invert Elevation: 2707.80 ft

Roadway Data for Crossing: C-02

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 2712.40 ft
Roadway Surface: Gravel
Roadway Top Width: 48.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 7 - Summary of Culvert Flows at Crossing: C-03

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-03 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3450.57	10-yr	31.00	31.00	0.00	1
3451.07	25-yr	44.00	44.00	0.00	1
3452.00	Overtopping	64.84	64.84	0.00	Overtopping

Table 8 - Culvert Summary Table: C-03

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	31.00	31.00	3450.51	1.962	0.997	1-S2n	0.885	1.326	0.993	1.308	8.250	6.042
25-yr	44.00	44.00	3451.01	2.462	1.547	1-S2n	1.071	1.592	1.219	1.491	8.955	6.595

****

Straight Culvert

Inlet Elevation (invert): 3448.61 ft, Outlet Elevation (invert): 3448.00 ft

Culvert Length: 40.00 ft, Culvert Slope: 0.0153

****

Site Data - C-03

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3448.61 ft
Outlet Station: 40.00 ft
Outlet Elevation: 3448.00 ft
Number of Barrels: 2

Culvert Data Summary - C-03

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: C-03)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
31.00	3449.31	1.31	6.04	4.08	1.32
44.00	3449.49	1.49	6.59	4.65	1.35

Tailwater Channel Data - C-03

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0500
Channel Manning's n: 0.0400
Channel Invert Elevation: 3448.00 ft

Roadway Data for Crossing: C-03

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3452.00 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 10 - Summary of Culvert Flows at Crossing: C-04

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-04 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3668.72	10-yr	21.00	21.00	0.00	1
3669.35	25-yr	30.00	30.00	0.00	1
3670.64	Overtopping	43.31	43.31	0.00	Overtopping

Table 11 - Culvert Summary Table: C-04

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	21.00	21.00	3668.72	1.877	0.0*	1-S2	1.075	1.158	1.075	0.723	5.905	3.128
25-yr	30.00	30.00	3669.35	2.514	1.836	5-S2	1.370	1.392	1.370	0.849	6.355	3.430

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 3666.84 ft, Outlet Elevation (invert): 3666.06 ft

Culvert Length: 37.01 ft, Culvert Slope: 0.0211

****

Site Data - C-04

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3666.84 ft
Outlet Station: 37.00 ft
Outlet Elevation: 3666.06 ft
Number of Barrels: 2

Culvert Data Summary - C-04

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: C-04)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
21.00	3666.78	0.72	3.13	0.95	0.83
30.00	3666.91	0.85	3.43	1.11	0.85

Tailwater Channel Data - C-04

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 3.50 ft
Side Slope (H:V): 8.00 (_:1)
Channel Slope: 0.0210
Channel Manning's n: 0.0400
Channel Invert Elevation: 3666.06 ft

Roadway Data for Crossing: C-04

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3670.64 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 13 - Summary of Culvert Flows at Crossing: C-05

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-05 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3673.73	10-yr	21.00	21.00	0.00	1
3674.46	25-yr	30.00	30.00	0.00	1
3675.65	Overtopping	43.30	43.30	0.00	Overtopping

Table 14 - Culvert Summary Table: C-05

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	21.00	21.00	3673.71	1.878	0.0*	1-S2	1.093	1.158	1.093	0.218	5.787	1.861
25-yr	30.00	30.00	3674.46	2.515	2.606	7-M2	1.398	1.392	1.392	0.270	6.428	2.133

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 3671.85 ft, Outlet Elevation (invert): 3671.09 ft

Culvert Length: 38.01 ft, Culvert Slope: 0.0200

****

Site Data - C-05

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3671.85 ft
Outlet Station: 38.00 ft
Outlet Elevation: 3671.09 ft
Number of Barrels: 2

Culvert Data Summary - C-05

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: C-05)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
21.00	3671.31	0.22	1.86	0.27	0.71
30.00	3671.36	0.27	2.13	0.34	0.74

Tailwater Channel Data - C-05

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 8.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0400
Channel Invert Elevation: 3671.09 ft

Roadway Data for Crossing: C-05

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3675.65 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 16 - Summary of Culvert Flows at Crossing: C-06

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-06 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3236.78	10-yr	56.00	56.00	0.00	1
3237.24	25-yr	72.00	72.00	0.00	1
3238.29	Overtopping	98.86	98.86	0.00	Overtopping

Table 17 - Culvert Summary Table: C-06

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	56.00	56.00	3236.78	2.760	3.035	7-M2	1.723	1.708	1.708	0.988	6.736	3.170
25-yr	72.00	72.00	3237.24	3.346	3.493	7-M2	2.053	1.947	1.947	1.108	7.417	3.385

****

Straight Culvert

Inlet Elevation (invert): 3233.75 ft, Outlet Elevation (invert): 3233.19 ft

Culvert Length: 40.00 ft, Culvert Slope: 0.0140

****

Site Data - C-06

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3233.75 ft
Outlet Station: 40.00 ft
Outlet Elevation: 3233.19 ft
Number of Barrels: 2

Culvert Data Summary - C-06

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 18 - Downstream Channel Rating Curve (Crossing: C-06)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
56.00	3234.18	0.99	3.17	0.86	0.71
72.00	3234.30	1.11	3.38	0.97	0.72

Tailwater Channel Data - C-06

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 7.00 ft
Side Slope (H:V): 11.00 (_:1)
Channel Slope: 0.0140
Channel Manning's n: 0.0400
Channel Invert Elevation: 3233.19 ft

Roadway Data for Crossing: C-06

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3238.29 ft
Roadway Surface: Gravel
Roadway Top Width: 28.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 19 - Summary of Culvert Flows at Crossing: C-07

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-07 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3227.15	10-yr	84.00	84.00	0.00	1
3227.89	25-yr	109.00	109.00	0.00	1
3228.63	Overtopping	130.92	130.92	0.00	Overtopping

Table 20 - Culvert Summary Table: C-07

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	84.00	84.00	3227.15	3.254	1.930	1-S2n	1.768	2.013	1.768	0.990	8.338	4.600
25-yr	109.00	109.00	3227.89	3.989	2.780	5-S2n	2.082	2.305	2.082	1.142	8.856	4.986

****

Straight Culvert

Inlet Elevation (invert): 3223.90 ft, Outlet Elevation (invert): 3223.00 ft

Culvert Length: 43.01 ft, Culvert Slope: 0.0209

****

Site Data - C-07

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3223.90 ft
Outlet Station: 43.00 ft
Outlet Elevation: 3223.00 ft
Number of Barrels: 2

Culvert Data Summary - C-07

Barrel Shape: Circular
Barrel Diameter: 3.50 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 21 - Downstream Channel Rating Curve (Crossing: C-07)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
84.00	3223.99	0.99	4.60	1.30	0.91
109.00	3224.14	1.14	4.99	1.50	0.93

Tailwater Channel Data - C-07

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 14.00 ft
Side Slope (H:V): 4.50 (_:1)
Channel Slope: 0.0210
Channel Manning's n: 0.0400
Channel Invert Elevation: 3223.00 ft

Roadway Data for Crossing: C-07

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3228.63 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 22 - Summary of Culvert Flows at Crossing: C-08

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-08 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3193.91	10-yr	59.00	59.00	0.00	1
3194.54	25-yr	76.00	76.00	0.00	1
3195.50	Overtopping	95.96	95.96	0.00	Overtopping

Table 23 - Culvert Summary Table: C-08

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	59.00	59.00	3193.91	3.751	4.112	7-M2	2.328	2.308	2.308	1.093	7.855	2.797
25-yr	76.00	76.00	3194.54	4.570	4.740	7-M2	2.785	2.637	2.637	1.214	8.651	2.982

****

Straight Culvert

Inlet Elevation (invert): 3189.80 ft, Outlet Elevation (invert): 3189.35 ft

Culvert Length: 35.00 ft, Culvert Slope: 0.0129

****

Site Data - C-08

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3189.80 ft
Outlet Station: 35.00 ft
Outlet Elevation: 3189.35 ft
Number of Barrels: 1

Culvert Data Summary - C-08

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 24 - Downstream Channel Rating Curve (Crossing: C-08)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
59.00	3190.44	1.09	2.80	0.75	0.63
76.00	3190.56	1.21	2.98	0.83	0.64

Tailwater Channel Data - C-08

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 4.00 ft
Side Slope (H:V): 14.00 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0400
Channel Invert Elevation: 3189.35 ft

Roadway Data for Crossing: C-08

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3195.50 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 25 - Summary of Culvert Flows at Crossing: C-09

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-09 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3238.49	10-yr	75.00	75.00	0.00	1
3238.95	25-yr	97.00	97.00	0.00	1
3239.75	Overtopping	125.53	125.53	0.00	Overtopping

Table 26 - Culvert Summary Table: C-09

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	75.00	75.00	3238.49	2.558	2.745	2-M2	1.786	1.609	1.609	0.569	6.473	2.416
25-yr	97.00	97.00	3238.95	3.075	3.200	7-M2	2.154	1.842	1.842	0.662	7.103	2.652

****

Straight Culvert

Inlet Elevation (invert): 3235.75 ft, Outlet Elevation (invert): 3235.40 ft

Culvert Length: 35.00 ft, Culvert Slope: 0.0100

****

Site Data - C-09

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3235.75 ft
Outlet Station: 35.00 ft
Outlet Elevation: 3235.40 ft
Number of Barrels: 3

Culvert Data Summary - C-09

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 27 - Downstream Channel Rating Curve (Crossing: C-09)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
75.00	3235.97	0.57	2.42	0.36	0.59
97.00	3236.06	0.66	2.65	0.41	0.60

Tailwater Channel Data - C-09

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 8.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0400
Channel Invert Elevation: 3235.40 ft

Roadway Data for Crossing: C-09

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3239.75 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 28 - Summary of Culvert Flows at Crossing: C-10

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-10 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3237.40	10-yr	16.00	16.00	0.00	1
3237.70	25-yr	21.00	21.00	0.00	1
3239.00	Overtopping	36.58	36.58	0.00	Overtopping

Table 29 - Culvert Summary Table: C-10

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	16.00	16.00	3237.40	1.570	1.693	2-M2	1.138	1.006	1.006	0.228	5.052	1.354
25-yr	21.00	21.00	3237.70	1.887	1.989	2-M2	1.375	1.158	1.158	0.268	5.569	1.503

****

Straight Culvert

Inlet Elevation (invert): 3235.71 ft, Outlet Elevation (invert): 3235.25 ft

Culvert Length: 45.00 ft, Culvert Slope: 0.0102

****

Site Data - C-10

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3235.71 ft
Outlet Station: 45.00 ft
Outlet Elevation: 3235.25 ft
Number of Barrels: 2

Culvert Data Summary - C-10

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 30 - Downstream Channel Rating Curve (Crossing: C-10)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
16.00	3235.48	0.23	1.35	0.14	0.51
21.00	3235.52	0.27	1.50	0.17	0.52

Tailwater Channel Data - C-10

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 8.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0400
Channel Invert Elevation: 3235.25 ft

Roadway Data for Crossing: C-10

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3239.00 ft
Roadway Surface: Gravel
Roadway Top Width: 31.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 31 - Summary of Culvert Flows at Crossing: C-11

Headwater Elevation (ft)	Discharge Nam	Total Discharg (cfs)	C-11 Discharg (cfs)	Roadway Discharge (cfs	Iterations
3340.83	10-yr	130.00	130.00	0.00	1
3341.44	25-yr	169.00	169.00	0.00	1
3342.00	Overtopping	200.90	200.90	0.00	Overtopping

Table 32 - Culvert Summary Table: C-11

Discharge Name	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwater Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10-yr	130.00	130.00	3340.81	3.089	1.899	1-S2n	1.327	2.046	2.046	1.703	7.192	4.076
25-yr	169.00	169.00	3341.44	3.702	2.576	5-S2n	1.535	2.348	2.348	1.879	7.975	4.352

****

Straight Culvert

Inlet Elevation (invert): 3337.74 ft, Outlet Elevation (invert): 3337.05 ft

Culvert Length: 45.01 ft, Culvert Slope: 0.0153

****

Site Data - C-11

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3337.74 ft
Outlet Station: 45.00 ft
Outlet Elevation: 3337.05 ft
Number of Barrels: 3

Culvert Data Summary - C-11

Barrel Shape: Circular
Barrel Diameter: 3.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 33 - Downstream Channel Rating Curve (Crossing: C-11)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
130.00	3338.75	1.70	4.08	1.59	0.78
169.00	3338.93	1.88	4.35	1.76	0.79

Tailwater Channel Data - C-11

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 11.00 (_:1)
Channel Slope: 0.0150
Channel Manning's n: 0.0400
Channel Invert Elevation: 3337.05 ft

Roadway Data for Crossing: C-11

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 3342.00 ft
Roadway Surface: Gravel
Roadway Top Width: 31.00 ft

Appendix D – Riprap Sizing Calculations

Project: Calico - Grassy Mountain Access Road Design
Project Number: 10162362
Task: Culvert Protection - Riprap Sizing
Date: 4/22/2019
Calculated By: S. Savage, EIT
Checked By: D. March, PE, CFM

RIPRAP SIZING CALCULATION

Stream Crossing ID	Culvert Diameter (ft)	25-yr Design Flow (cfs)	Tailwater Depth (ft)	Calculated D50 (ft)	Assigned D50 (ft)
C-01	2.0	12	0.5	0.3	0.5
C-02	2.0	10	0.7	0.2	0.5
C-03	2.5	22	1.5	0.1	0.5
C-04	2.0	15	0.9	0.2	0.5
C-05	2.0	15	0.3	0.7	1.0
C-06	3.0	36	1.1	0.3	0.5
C-07	3.5	55	1.1	0.4	0.5
C-08	4.0	76	1.2	0.5	0.5
C-09	3.0	32	0.7	0.5	0.5
C-10	2.0	11	0.3	0.5	0.5
C-11	3.5	56	1.9	0.2	0.5

Governing Equation:

$$D_{50} = 0.023 * D * \left(\frac{Q}{a * D^{2.5}}\right) * \left(\frac{D}{TW}\right)^{1.2}$$

Where:

D50 = riprap size (ft)
Q = design discharge (cfs)
D = culvert diameter (ft)
TW = tailwater depth (ft)
a = unit conversion (1.811)

Source: *Appendix D - Riprap Apron Sizing Equations, HEC-14 - Hydraulic Design of Energy Dissipators for Culverts & Channels*

Appendix AD: Well Field Design Report

Well Field Design Report
Grassy Mountain Project

Prepared for

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Prepared by

SPF Water Engineering, LLC
300 East Mallard, Suite 350
Boise, Idaho 83706
(208) 383-4140

July 9, 2019

SPF WATER ENGINEERING

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1. INTRODUCTION

This report presents a well field design for Calico Resources USA Corp's (Calico's) Grassy Mountain Project (Project). This report summarizes Project water demands, summarizes available construction and testing information from existing production wells, and provides potential yield and construction details for new water supply wells.

The source of water for the Project will be groundwater wells:

- Three wells, one existing and two proposed, are currently anticipated to be needed to fill the raw water tank. If the two new wells are not adequate to meet Project water demands, then additional wells will be needed.

- Two other existing wells can be used for local water supply for uses such as dust suppression.

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: the Mine and Process Area and the Access Road Area (Figure 2).

The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM) (Figure 2). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or re-routing, and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be 30 feet wide, which includes a 20-foot wide road travel width (10 feet on either side of the road

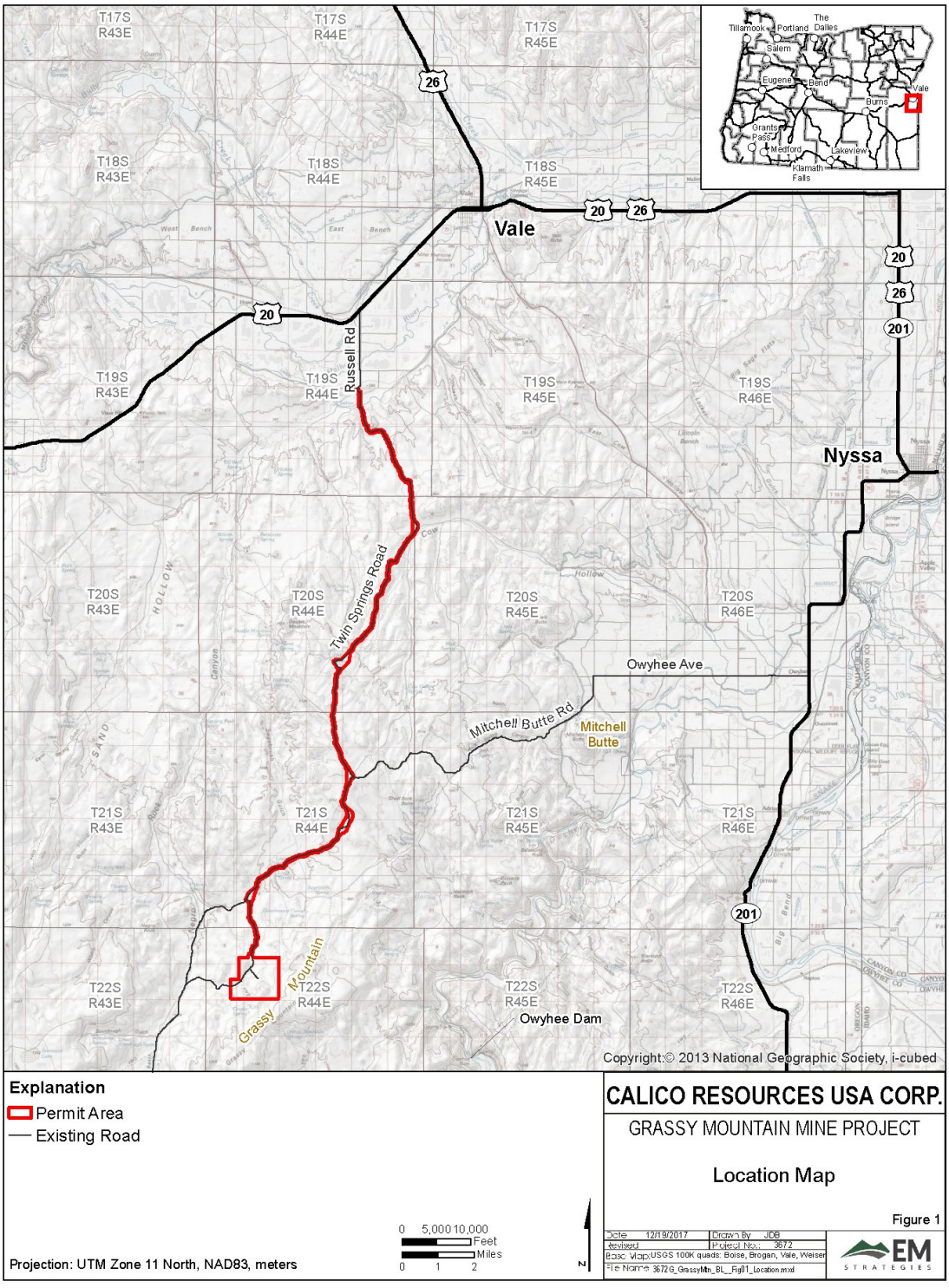

Figure 1. Location map

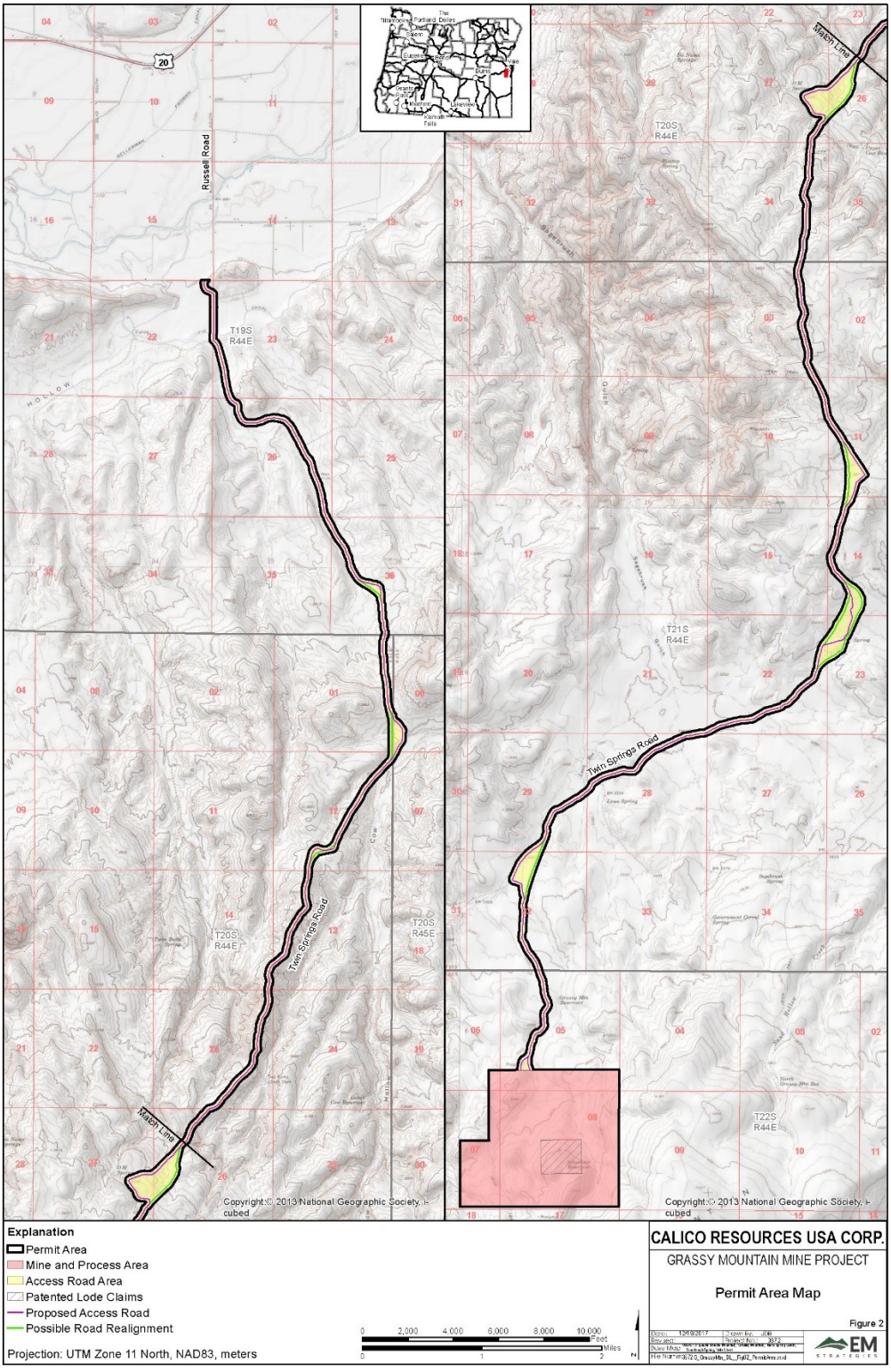

Figure 2. Permit area map

centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

2. WATER DEMANDS

Water is required for the Project for mining, ore processing, fire protection, potable uses, dust suppression, and various other uses. Raw water will be pumped from the groundwater wells to a raw water storage tank, and then piped for use at the Project. It is anticipated that dust suppression uses can be supplied directly from existing wells.

The anticipated total peak raw water supply requirement is 400 gpm, which is expected to be required during the summer months when water cannot be reclaimed from the tailings storage facility. This supply requirement assumes a daily raw makeup water demand of 350 gpm for 12 hours, a daily process water demand of 230 gpm for 22 hours, a daily potable demand of 10 gpm for 24 hours, and other minor water demands. It is also assumed that storage will be provided for peaking and fire flow.

During the rest of the year, the wells will only need to supply 100 gpm of raw makeup water with 250 gpm coming from the tailings storage facility. The anticipated total peak raw water supply requirement during the non-summer months is estimated to be 270 gpm. The annual average daily demand is projected to be about 320 gpm (0.71 cfs, 516 acre-feet per year).

A nominal 237,000-gallon storage tank (total volume) will be installed to address peak water demands and provide 78,000 gallons of water for fire suppression. The tank is proposed to be installed at an elevation of approximately 3,880 feet, with an overflow elevation of about 3,915 feet.

3. GROUNDWATER CHARACTERIZATION

Groundwater in the general vicinity of the proposed mine site is found primarily within unconsolidated and semi-consolidated sandstone and conglomerate units of the Grassy Mountain Formation. The Grassy Mountain Formation generally strikes from east to west and dips towards the north. Discontinuous lenses of higher permeability sandstone and conglomerate form localized and compartmentalized water-bearing units that are interbedded with thick layers of low-permeability clay and clayey siltstone that impede groundwater flow. These sedimentary rocks are locally capped by basalt, alluvium and colluvium. The Grassy Mountain Formation is underlain by fine-grained lithic tuff, the Tuff of Kern Basin. The Grassy Mountain Formation is the host unit for the Grassy Mountain gold and silver deposit. A more detailed description of principal hydrogeological units can be found in the Grassy Mountain Gold Project Groundwater Characterization Report (SPF 2019b).

The aquifer system in the near vicinity of the proposed mine is typically found in silicified sediments or clay with very low hydraulic conductivity and high hydraulic gradients. Production and monitoring wells near the deposit completed in unconsolidated sediments and fractured basalt typically have short-term yields of less than 50 gpm. Long-term aquifer sustainability appears to be limited by negative hydraulic boundaries such as water-bearing zones of limited spatial extent, faulting, and/or silicification. Wells near the deposit completed in clay or silicified sediments have very low yields, generally less than 5 gpm.

The aquifer system to the north and downgradient of the proposed mine occurs in localized sandstone and conglomerate units of the Grassy Mountain Formation. These units are interbedded with thick layers of low-permeability clay and clayey siltstone, which appear to result in a confined aquifer. The Grassy Mountain Formation is underlain by fine-grained lithic tuff.

The aquifer hydraulic conductivity increases downgradient of the proposed mine where the sediments are not silicified. However, aquifer sustainability appears to be still affected by faulting and lithologic variability, with limited data suggesting that the Grassy Mountain Formation thins out moving north from the deposit. The Grassy Mountain fault zone also extends north of the deposit (RQV, 2015). This fault zone acts as a barrier to groundwater flow based on testing of nearby wells; the most productive wells in the area are presumably located on the east side of the Grassy Mountain fault zone.

4. EXISTING PRODUCTION WELLS

4.1. Introduction

There are three existing production wells for the Project: Prod-1, PW-1, and PW-4. These are referred to as Wells 1, 2, and 3 in this report and on Calico's original water right permit #G-10994. A map showing the well locations relative to the proposed mine is included as Figure 3. The existing production wells are described in more detail below.

4.2. Well 1 (Prod-1)

4.2.1. **Well Construction**

Well 1, also referred to as Prod-1, was drilled in 1989 for Atlas Precious Metals. The Oregon Water Resources Department (OWRD) well tag is L-107457 and the OWRD well name is MALH 227. The well driller's report lists a total depth of 425 feet below ground surface (bgs). Well 1 is constructed with 10-inch steel casing (0.250-inch wall thickness) from approximately 2 feet above ground surface to a total depth of 99 feet bgs, and 6-inch Schedule 80 PVC casing from approximately 2 feet above ground surface to a total depth of 245 feet bgs. The well is screened with 6-inch Schedule 80 PVC screen from 145 to 255 feet bgs and from 325 to 355 feet bgs in sandstone with

interbedded blue clay, and from 380 to 420 feet bgs in sandstone. The well driller's report is included in Appendix A.

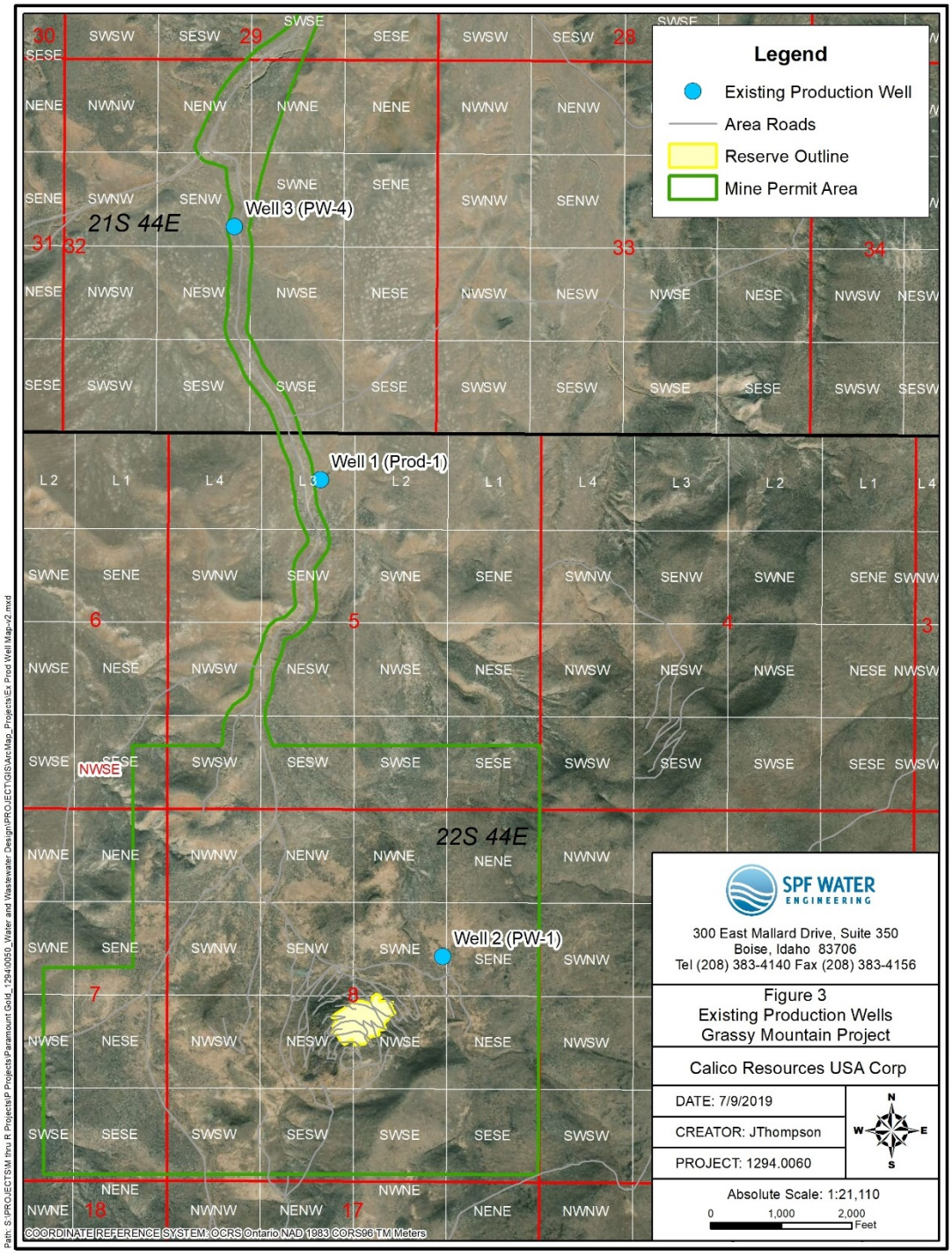

Figure 3. Map of existing production wells

4.2.2. **Well Location**

Well 1 is located in the NE ¼ of the NW ¼ (Lot 3) of Section 5, T22S R44E, refer to Figure 3. The latitude and longitude coordinates of the well are 43°41'29.83" N and 117°21'39.74" W. Well 1 is located about 1.45 miles north of the proposed mine, at an elevation of approximately 3,435 feet.

4.2.3. **Geologic Setting**

The Grassy Mountain Geology and Soils Baseline Report (Abrams 2018) describes the surficial geology in the vicinity of the Project. Figure 4, which includes the Mine and Process Area Geology map from the baseline report, shows that Well 1 is underlain by geologic unit *Tis*, identified as Upper Miocene interbedded conglomerate and siltstone. The geologic unit is reportedly underlain by undifferentiated arkose, siltstone, and conglomerate of the Grassy Mountain Formation (unit *Tgs*). Figure 4 shows concealed faults on either side of Well 1, part of the Grassy Mountain Fault Zone extending north from the deposit.

The Geology and Soils Baseline Report describes the *Tis* unit: *Chert pebble conglomerate and interbedded diatomaceous siltstone. Mainly tuffaceous and arkosic sandstone and siltstone with interbedded conglomerate. Locally becomes finer grained upward into pale, white and yellow claystones and interbedded diatomaceous siltstones. Presumed base of Tis near Grassy Mountain Reservoir contains black chert-pebble and granite-clast conglomerate. Erosional contact with underlying unit Tgs marked by rounded boulders of olivine basalt unit Tgb. Unit is approximately 400 feet thick in mapped area.*

The Geology and Soils Baseline Report describes the *Tgs* unit: *Arkosic sandstones and channel-fill granite clast conglomerates. Mainly white to tan arkosic sandstones. Includes Tgsc, channel fill conglomerates with abundant granite and rhyolite clasts in the upper part of the unit. Uppermost conglomerates locally contain rounded obsidian clasts and rare black chert clasts. Unit Tgs generally becomes finer grained upward and includes white bentonitic clays near the top of the section which, where overlain by unit Tgb often generated large landslide masses. Hot spring activity contemporaneous with the deposition of the arkoses is indicated by sinter beds Tgsn, and sinter boulders containing silicified reeds and wood near the Grassy mountain gold deposit. Unit Tgs is the host for both the Grassy Mountain and Crabgrass gold deposits*

The well driller's report for Well 1 describes brown clay to a depth of 140 feet, underlain by interbedded layers of sandstone and blue clay to the completion depth of 425 feet.

4.2.4. **Water Rights**

Well 1 is listed as an authorized point of diversion on Calico's original water right permit #G-10994. The permit authorizes a total diversion of 2.0 cfs. Calico submitted a Permit Amendment to OWRD on March 27, 2019, which proposes modification to the Points of Appropriation and Place of Use for the authorized 2.0 cfs.

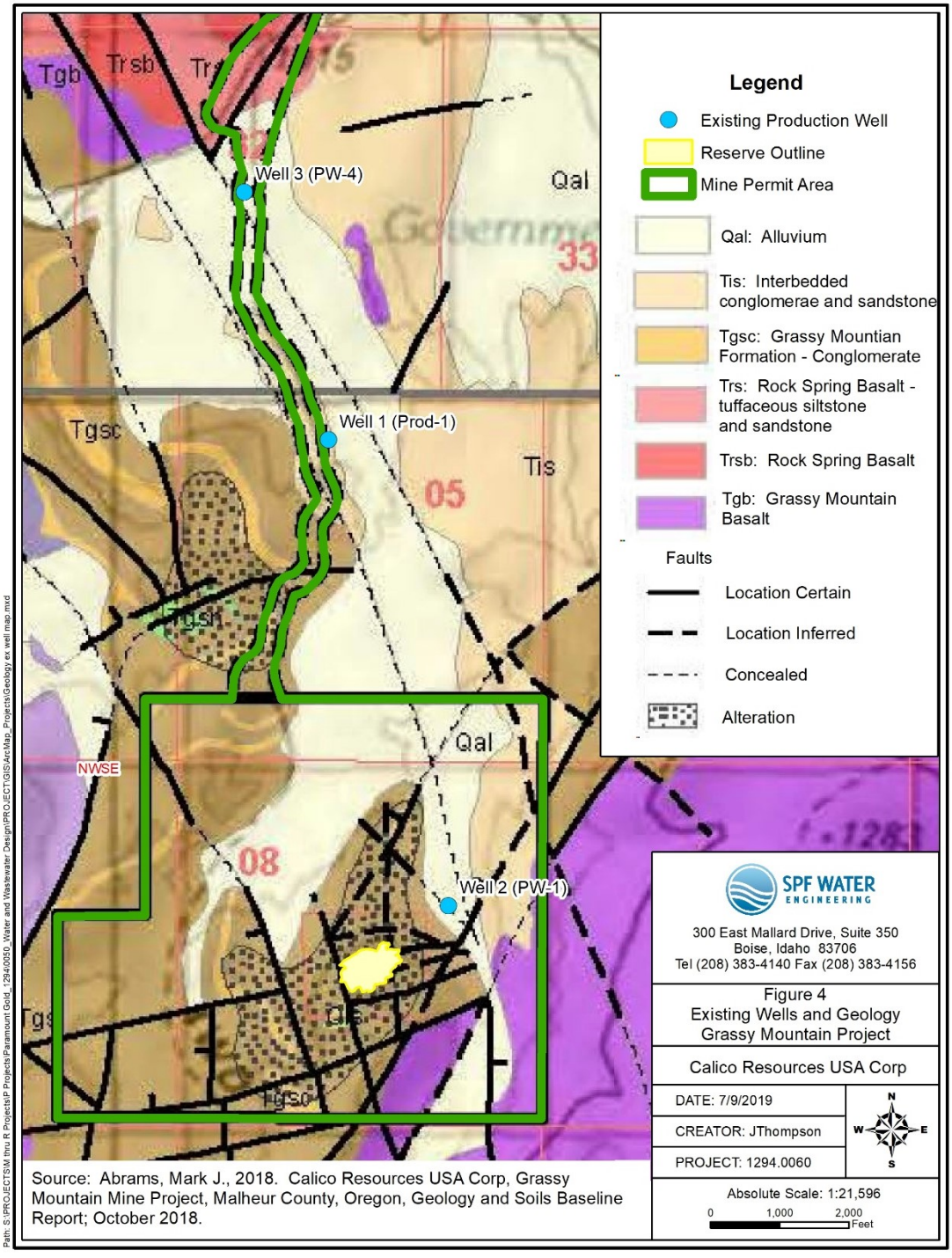

Figure 4. Map of existing wells and surficial geology

4.2.5. **Static Water Level**

Well 1 is normally a flowing artesian well. The flow from this well has been measured quarterly starting in 2013 (SPF 2019a). A plot of the flow data between the 1st Quarter of 2013 and the 4th Quarter of 2018 is presented as Figure 5. Flow has ranged from 1.40 gpm in the 1st Quarter of 2013 (March 17, 2013) to no flow between the 4th Quarter of 2016 (December 21, 2016) and the 3rd Quarter of 2017 (September 26, 2017). The loss of artesian pressure is a result of pumping the well for drill water in November and December 2016 and between March and May 2017.

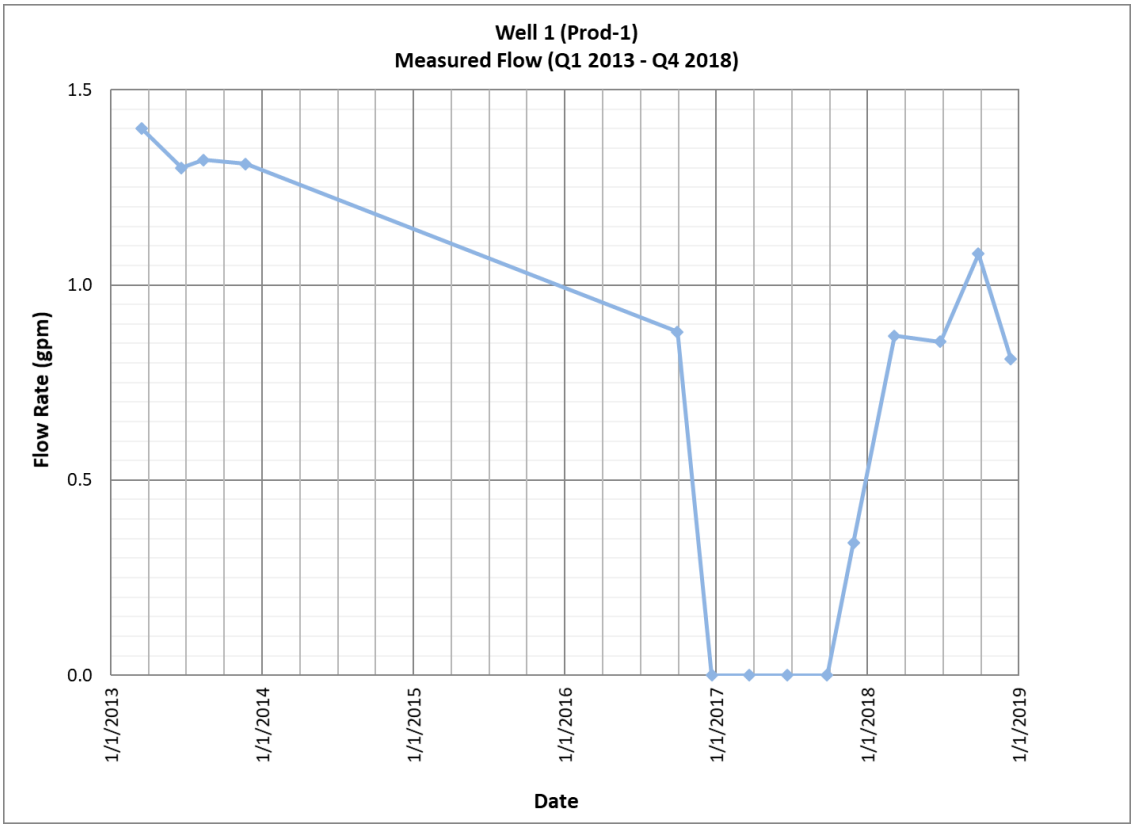

Figure 5. Artesian flows measured at Well 1 (Prod-1)

4.2.6. **Well Testing**

Well 1 was test pumped for 45 hours at 100 gpm between January 14 and 16, 1991, by James M. Montgomery Consulting Engineers, Inc (JMM) as described in JMM 1991. Prior to testing, an artesian pressure of 9 feet was measured above ground surface. At the end of the test, the pumping water level was measured to be 157 feet below the measurement point (bmp, approximately 3 feet above ground surface). Water level recovery was measured for nearly 13 days, with a final water level of 4.65 feet, equal to about 10.65 feet below the pre-test static water level. Testing indicates a well short-

term specific capacity of approximately 0.6 gpm per foot of drawdown. Plots of water levels during pumping and recovery are presented in Appendix B.

Aquifer transmissivity in the immediate area of the well was calculated to be approximately 1,500 gpd/ft. After 1,000 minutes of pumping, the transmissivity declined to approximately 200 gpd/ft. Recovery measurements following pumping indicated a near well bore transmissivity of approximately 1,500 gpd/ft; the transmissivity declined to approximately 220 gpd/ft after nearly a day of recovery. This decline in transmissivity indicates the presence of a negative hydraulic boundary due to thinning of the aquifer, faulting, or a decline in aquifer permeability. The Geology and Soils Baseline Report and Figure 4 identify concealed faults on either side of Well 1. The presence of these faults may be related to the observed decline in aquifer transmissivity during testing of Well 1.

During testing, water levels were monitored in all of the monitoring and production wells within the project area and discharge was measured from six springs in the area. No response was observed at any of the wells or springs.

4.2.7. **Well Capacity**

The long-term yield of Well 1 is estimated to be approximately 30 gpm based off the testing performed in 1991. The long-term pumping water level at 30 gpm is predicted to be about 134 feet bmp, above the top screen section. This pumping water level assumes no interference from nearby pumping wells. If pumping for an extended period of time, the pumping water level should remain above the top of the upper screen to avoid cascading water, air entrainment, and potential pump cavitation. The well should be able to pump for about a month at 50 gpm with the pumping water level dropping about 10 feet into the upper screen section. The short-term yield of Well 1 is estimated to be 100 gpm, with a pumping water level of about 133 feet bmp after one day of pumping. These conclusions are in general agreement with previous investigations (JMM 1991).

4.2.8. **Proposed Use and Recommendations**

It is recommended that Well 1 be used as a local source of water for dust suppression and other water needs. Due to the well's low long-term yield and casing diameter, it is not recommended and may not be possible to equip the well with a pump capable of filling the raw water storage tank.

A 4-inch pump is the largest pump that can fit in the well's 6-inch Schedule 80 PVC casing (inside diameter of 5.761 inches). The well could be equipped with a pump capable of producing 50 gpm at a total dynamic head (TDH) of 160 feet (pumping water level of 150 feet and 10 feet of head for headloss and lift to water truck). This same pump could also produce 80 gpm on a short-term basis at a TDH of 60 feet. An example pump curve is included in Appendix C. Alternatively, the existing pump in the well can continue to be used. The capacity of this existing pump is not known, but it was used to fill water trucks during exploration drilling and appears to be suitable for the use. It is

recommended that the well and discharge piping be housed in a heated enclosure to prevent freezing in the winter.

4.3. Well 2 (PW-1)

4.3.1. **Well Construction**

Well 2, also referred to as PW-1, was drilled in 1989 for Atlas Precious Metals. The OWRD well tag is L-109353 and the OWRD name is MALH 2276. The well driller's report lists a total depth of 555 feet bgs. Well 2 is constructed with 6-inch steel casing (0.250-inch wall thickness) from approximately 3.4 feet above ground surface to a depth of 320 feet bgs and from 340 feet to 400 feet bgs. The well is screened with 6-inch low carbon steel wire-wound screen (30 slot) from 320 feet to 340 feet bgs in brown clay and sand and from 400 feet to 420 feet bgs in coarse sandstone. The well driller's report is included in Appendix A.

4.3.2. **Well Location**

Well 2 is located in the SW ¼ of the NE ¼ of Section 5, T22S R44E. The latitude and longitude coordinates of the well are 43°40'23.24" N and 117°21'15.73" W. Well 2 is located about 1,500 feet northeast of the proposed mine, at an elevation of approximately 3,706 feet. A map showing the well is included as Figure 3.

4.3.3. **Geologic Setting**

The Mine and Process Area Geology map from the Grassy Mountain Geology and Soils Baseline Report, as depicted on Figure 4, shows that Well 2 is underlain by geologic unit *Qal*, identified as Pleistocene and Holocene alluvium. The geologic unit is reportedly underlain by Grassy Mountain Basalt (unit *Tgb*), Upper Miocene interbedded conglomerate and siltstone (unit *Tis*), and undifferentiated Grassy Mountain Formation (unit *Tgs*). Figure 4 shows concealed faults in close proximity and on either side of Well 2.

The Geology and Soils Baseline Report describes the *Qal* unit: *Unconsolidated and generally poorly sorted deposits or gravel, sand and silt accumulated along modern streams, drainages and floodplains.*

The well driller's report for Well 2 describes the surface alluvium to a depth of 190 feet, then basalt to a depth of 315 feet, then sediments to the completion depth of 555 feet.

4.3.4. **Water Rights**

Well 2 is listed as an authorized point of diversion on Calico's original water right permit #G-10994. However, the location of the well on the permit is incorrect. An Application for Permit Amendment was submitted on March 27, 2019, to OWRD that corrects the location of Well 2.

4.3.5. **Static Water Level**

The static water level in Well 2 has been measured quarterly starting in 2013 (SPF 2019a). A plot of the static water level measured in feet bmp between the 1st Quarter of 2013 and the 4th Quarter of 2018 is presented as Figure 6. The static water level in Well 2 varied between approximately 56 and 57 feet bmp (3.38 above ground surface) between the 1st Quarter of 2013 (March 26, 2013) and the 3rd Quarter of 2016 (September 29, 2016). Between the 3rd Quarter of 2016 measurement and the 4th Quarter of 2016 (December 21, 2016) measurement, the water level in the well declined by almost 7 feet. This decline was due to pumping the well for exploration drilling. By the 1st Quarter of 2018 (March 7, 2018), the static water level in the well had returned to above pre-pumping levels. The water level stabilized at a depth of around 54.5 feet bmp through the 4th Quarter of 2018.

Figure 6 also shows static water level measured in GW-1, a monitoring well located about 100 feet east of Well 2. GW-1 is screened from a depth of 135.5 feet to 155.5 feet bgs in a layer of gravel. The static water level in GW-1 follows a similar pattern as Well 2, with a decline of nearly 4 feet between the 3rd Quarter of 2016 and the 4th Quarter of 2016. This response suggests a hydraulic connection between the two wells, despite the difference in completion depths. Well 2 may not be adequately sealed through the upper sediment even though the driller's report notes a volclay bentonite seal from ground surface to a depth of 300 feet bgs. It is also possible that the shallow and deeper alluvial aquifers are interconnected, with leakage from the shallow to deeper aquifer zones.

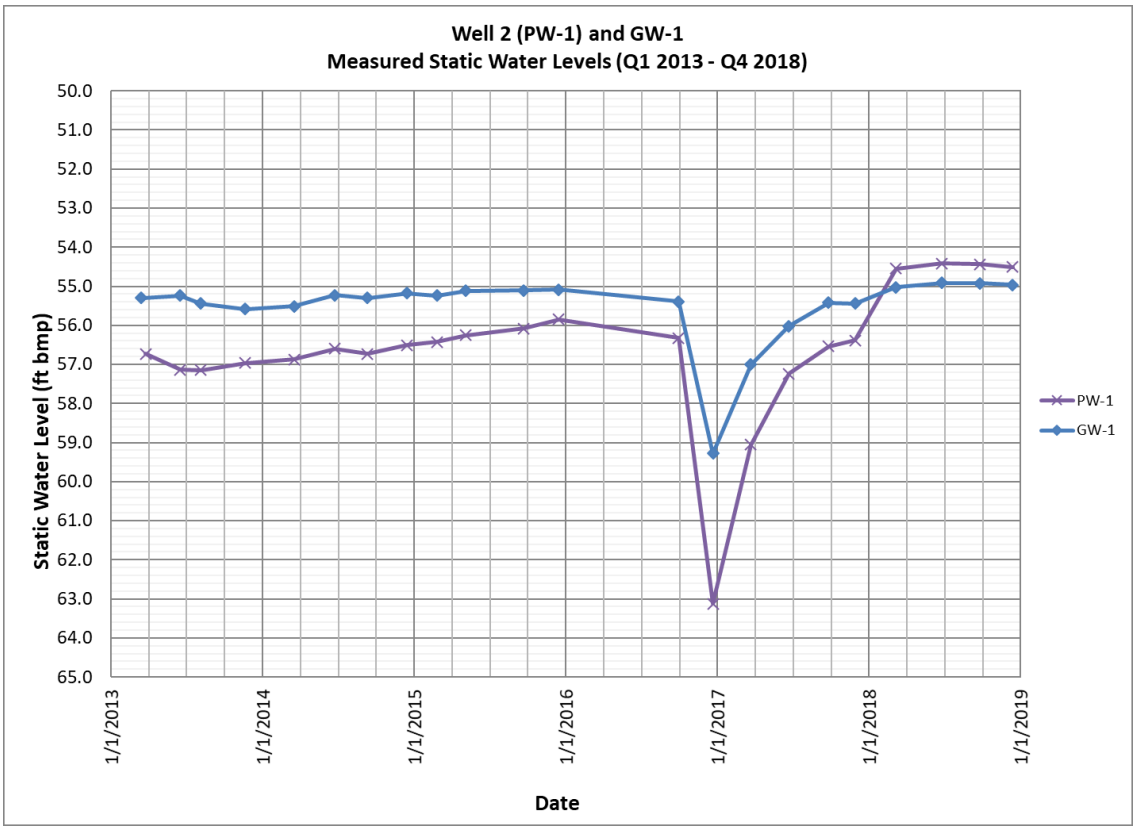

Figure 6. Well 2 (PW-1) and GW-1 static water levels

4.3.6. **Well Testing**

Well 2 was test pumped for 7 days at 30 gpm between January 29, 1991, and February 5, 1991, by JMM as described in JMM 1991. Prior to testing, the static water level was 53.81 feet bmp (top of casing, approximately 3.7 feet above ground surface). The pumping water level after seven days was 282.5 feet, equal to a drawdown of 228.7 feet. The test indicates a well specific capacity of 0.13 gpm/ft. Water level recovery was measured for 5.5 hours, with a final water level measurement of 97.81 feet, equal to 44 feet below the original static water level before testing began. Plots of water levels during pumping and recovery are presented in Appendix B.

The drawdown and recovery response of Well 2 suggests an aquifer transmissivity ranging from 100 to 250 gpd/ft. A negative hydraulic boundary is evident during the recovery of the well, with transmissivity declining from 250 gpd/ft to 100 gpd/ft after approximately 2 hours of recovery. This decline in transmissivity indicates the presence of a negative hydraulic boundary such as pinching of the aquifer, faulting, or a decline in aquifer permeability. Faults have been mapped in close proximity to Well 2 (Figure 4) that may serve as a hydraulic boundary to groundwater flow.

During the Well 2 test, water levels were measured in nearby monitoring well GW-1. The water level in GW-1 dropped nearly 6 feet during test pumping of PW-1 suggesting hydraulic connectivity between the two wells. A plot of the water levels in both wells is included in Appendix B. As noted in Section 4.3.5, a water level response was also observed in GW-1 when PW-1 was used to supply water for exploration drilling. GW-1 is screened about 165 feet higher than PW-1, so this response suggests leakage between the shallower and deeper aquifer zones or inadequate sealing of PW-1.

4.3.7. **Well Capacity**

Test pumping of Well 2 indicates a long-term yield of approximately 25 gpm. The long-term pumping water level at 25 gpm is predicted to be about 284 feet bmp, above the top screen section. This pumping water level assumes no interference from nearby pumping wells. The short-term yield of Well 2 is estimated to be 40 gpm, with a pumping water level of about 315 feet bmp after one day of pumping. These conclusions are in general agreement with previous findings (JMM 1991).

4.3.8. **Proposed Use and Recommendations**

The recommended use of Well 2 is as a local, stand-alone source of water for dust suppression and other water needs. The well's low long-term yield does not make it a good candidate for equipping with a pump and pipeline to fill the raw water storage tank.

Well 2 could be equipped with a pump capable of producing 25 gpm at a total dynamic head (TDH) of 300 feet (pumping water level of 284 feet and 16 feet of head for headloss and lift to water truck). The same pump could also be used to pump 40 gpm at a TDH of 200 feet, which the well should be able to support for about an hour. An example pump curve is included in Appendix C. Well 2 is currently equipped with a pump and has been used for water supply in the past. This pump appears to be suitable for filling water trucks. It is recommended that the well and discharge piping be housed in a heated enclosure to prevent freezing in the winter.

4.4. Well 3 (PW-4)

4.4.1. **Well Construction**

Well 3, also referred to as PW-4, was drilled in 1989 for Atlas Precious Metals. The OWRD well tag is L-109351 and the OWRD name is MALH 2206. The well driller's report lists a total depth of 375 feet bgs. Well 3 is constructed with 6-inch steel casing (0.250-inch wall thickness) from approximately 3.2 feet above ground surface to a depth of 280 feet bgs and from 300 feet to 340 feet bgs. The well is screened with 6-inch low carbon steel wire-wound screen (30 slot) from 280 feet to 300 feet bgs in sandstone and from 340 feet to 360 feet bgs in sandstone and conglomerate. The well driller's report is included in Appendix A.

4.4.2. **Well Location**

Well 3 is located in the SE ¼ of the NW ¼ of Section 32, T21S R44E. The latitude and longitude coordinates of the well are 43°42'5.28" N and 117°21'56.54" W. Well 3 is located about 2.1 miles north of the proposed mine, at an elevation of approximately 3,338 feet. A map showing the well is included as Figure 3.

4.4.3. **Geologic Setting**

Well 3 is underlain by geologic unit *Qal*, identified as Pleistocene and Holocene alluvium, as shown on Figure 4. The geologic unit is reportedly underlain by interbedded conglomerate and siltstone (unit *Tis*), and undifferentiated Grassy Mountain Formation (unit *Tgs*). Figure 4 shows a concealed fault just to the west of Well 3.

The well driller's report for Well 3 describes alluvium to a depth of 175 feet, then interbedded sandstone and clay to the completion depth of 375 feet. Conglomerate is noted with sandstone between a depth of 325 and 365 feet.

Exploration drill hole 26-057 was drilled near Well 3 between 1988 and 1989. This hole encountered conglomerate to 55 feet, clay to 165 feet, layers of siltstone and conglomerate to 445 feet, and then tuff to a depth of 740 feet. The driller noted about 15 gpm of water at a depth of 35 feet, 50 gpm from 150 feet after 30 minutes, and 100 gpm at a depth of 300 feet.

4.4.4. **Water Rights**

Well 3 was not listed as an authorized point of diversion on Calico's original water right permit #G-10994. However, Well 3 was added as a point of diversion on the Application for Permit Amendment submitted to OWRD on March 27, 2019.

4.4.5. **Static Water Level**

The static water level in Well 3 has been measured quarterly since 2013 (SPF 2019a). A plot of the static water level measured in feet bmp between the 1st Quarter of 2013 and the 4th Quarter of 2018 is presented as Figure 7. The static water level in Well 3 typically ranged from 80 to 80.5 feet bmp (3.16 feet above ground surface). The static water level in GW-4, located about 140 southeast of Well 3, typically ranged from 82 to 83 feet bmp (2.32 feet above ground surface).

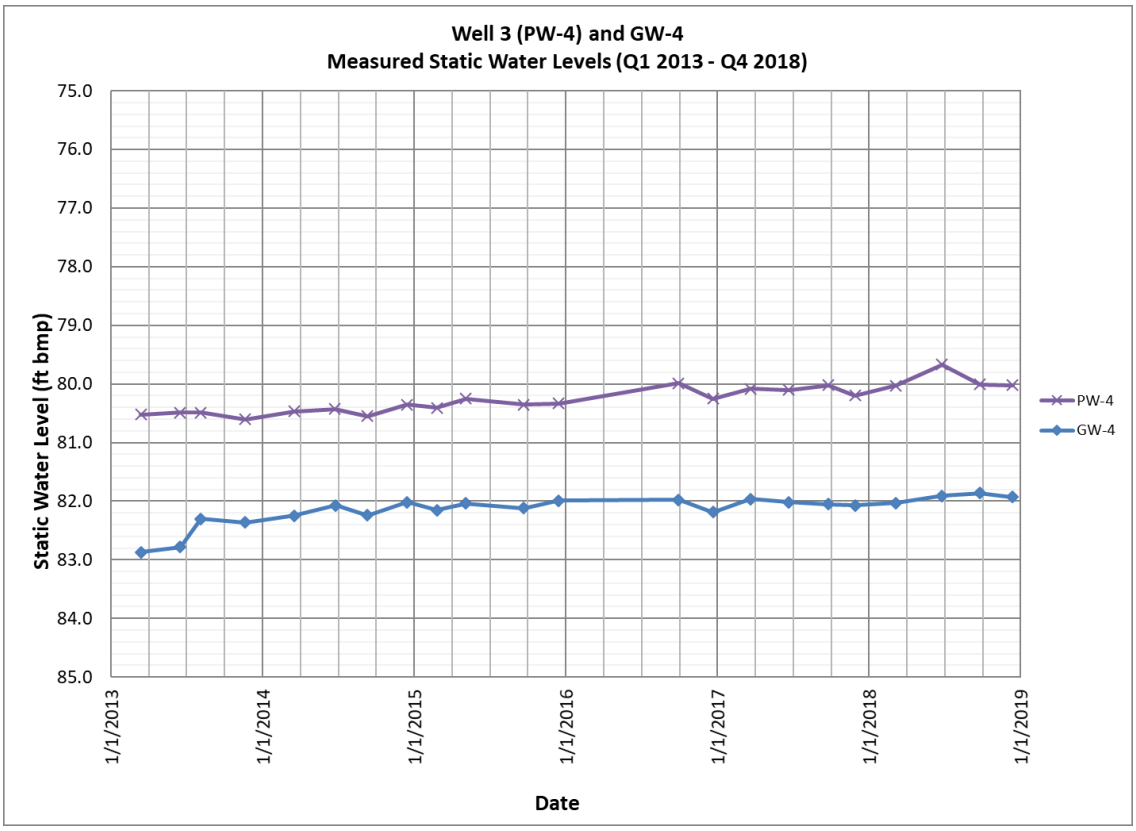

Figure 7. Well 3 (PW-4) and GW-4 static water levels

4.4.6. **Well Testing**

Well 3 was test pumped for a little over 3 days at an average pumping rate of 145 gpm between November 28 and December 1, 1989, by Steffen Robertson and Kirsten Consulting Engineers and Scientists (SRK) as described in SRK 1989. Prior to testing, the static water level was 82.25 feet bmp. The pumping water level after 3 days was 164.76 feet, equal to a drawdown of 82.51 feet. The test indicates a well specific capacity of about 1.8 gpm/ft. Recovery was measured for nearly 4 days, with a final water level about 5 feet below the pre-test static water level. Plots of water levels during pumping and recovery are presented in Appendix B.

During testing of Well 3, water levels were also measured in the nearby monitoring well GW-4. GW-4 is constructed similarly to PW-4, with screen placed from a depth of 280 to 350 feet. The water level in GW-4 dropped over 43 feet during test pumping of PW-4 suggesting hydraulic connectivity between the two wells. A plot of the water levels in both wells is included in Appendix B.

The drawdown and recovery response of Well 3 and GW-4 suggest a near well bore aquifer transmissivity of approximately 3,800 gpd/ft. The transmissivity declined to about 1,700 gpd/ft after approximately 1,000 minutes of pumping, after encountering a

negative hydraulic boundary. Faults have been mapped near Well 2 (Figure 4) that could be restricting groundwater flow to the well.

An aquifer storativity ranging from 7×10^{-5} to 2×10^{-3} was calculated from the test, with the range a product of using pre-boundary conditions or post-boundary conditions. The storativity values suggest that that PW-4 draws water from a confined aquifer.

4.4.7. **Well Capacity**

Test pumping of Well 3 indicates a long-term yield of approximately 200 gpm, with a projected pumping water level after one year of about 260 feet bmp, above the top of the upper screen. This pumping water level assumes no interference from nearby pumping wells. The short-term yield of Well 3 is estimated to be around 250 gpm. The well may be able to produce more but extrapolating higher yields from the test data is subject to errors. These conclusions are in general agreement with previous findings (JMM 1991), but are based on limited data (i.e., a 3-day pumping test in 1989).

While Well 3 is estimated to have a long-term capacity of 200 gpm, actual capacity of the well is limited by casing diameter and pump motor size. The actual capacity of the well is estimated to be 150 gpm, see Section 4.4.10.

4.4.8. **Pumping Interference**

Pumping interference is expected between water supply wells based on the response of monitoring well GW-4 to testing of Well 3. For Well 3, interference from the other supply wells needs to be accounted for. Well 3 is located about 650 feet from proposed Well 4, about 1,400 feet from proposed Well 5, and approximately 980 feet from proposed Well 7.

To estimate drawdown from pumping, a Theis (1935) analysis was performed. Assumptions inherent to the Theis solution are that the aquifer is homogeneous and isotropic, uniform in thickness and areal extent, the aquifer receives no recharge, the pumping well penetrates the full aquifer thickness, water removed by discharge is removed instantaneously, the pumping well is 100 percent efficient, laminar flow exists throughout the aquifer, and that the water table or potentiometric surface has no slope. These assumptions are not applicable to the complex aquifer system in the Project area. However, this method is useful for providing an estimate of interference effects. During the test pumping of the supply wells, water levels in nearby wells will be measured to determine actual drawdown in non-pumping wells.

For the Theis analysis, estimates of aquifer transmissivity and storativity are required along with a pumping rate and duration of pumping. When a negative hydraulic boundary is evident in the test data, aquifer coefficients must be calculated from the early test data before boundary effects are realized (Driscoll 1986). For this analysis, an early-time transmissivity of 3,800 gpd/ft and a storativity of 7×10^{-5} are used based on test pumping data from Well 3.

This analysis assumes Wells 4 and 5 are the primary supply wells. Well 3 should only be needed for a short duration in the event that one of these wells is not operational. If Well 3 is pumped at 150 gpm and Well 4 is the other supply well and is pumped at 250 gpm for a short duration (one week), then the pumping interference in Well 3 is predicted to be about 42 feet. The resultant pumping water level in Well 3 would be the non-interference pumping water level of 175 feet bgs plus 42 feet or 217 feet bgs.

4.4.9. **Water Quality**

Baseline water quality samples were collected from Well 3 on a quarterly basis between the 1st Quarter of 2013 and the 3rd Quarter of 2014 (SPF 2019a). Sampling results show that the groundwater produced from Well 3 exceeds the primary drinking water standard for arsenic of 0.010 mg/L. Arsenic concentrations in samples ranged from 0.0148 to 0.0221 mg/L). If used for potable water supply, treatment will be required to remove arsenic from the water.

Well 3 also produces water that exceeds the secondary drinking water standards for aluminum (0.05 mg/L), iron (0.3 mg/L), manganese (0.05 mg/L), and total dissolved solids (500 mg/L). There is evidence that Well 3 may not be adequately developed. When purge pumped for water quality sampling, the water produced from the well was a black color with a minor amount of sand. Eventually the water would clear up after about 30 minutes of pumping. Incomplete development may be contributing to high concentrations of these constituents. Analysis of the dissolved samples showed much lower concentrations. It is likely that with additional development the water will have much lower concentrations of these analytes, potentially below secondary standards.

4.4.10. **Proposed Use and Recommendations**

Well 3 is recommended to be used as a backup water supply for mining, ore processing, fire protection, potable uses, and various other uses at the mine. This would require equipping the pump with enough head to fill the raw water storage tank. There is an elevation difference of approximately 577 feet between the well ground surface and the tank overflow elevation.

Well 3 is constructed with 6-inch steel casing (inside diameter of 6.125 inches). Therefore, the largest submersible motor that can fit in the well is a nominal 6-inch diameter (5.5-inch outside diameter). Given a 460-volt, 3-phase power supply, a 60-hp, 3,600-rpm motor should be able to fit in the well casing. Therefore, while Well 3 is estimated to have a long-term capacity of 200 gpm, actual capacity of the well is limited by casing diameter and pump motor size. The actual capacity of the well is estimated to be 150 gpm.

It is recommended that Well 3 be equipped with a 5-inch submersible pump and motor capable of producing 150 gpm at a TDH of 900 feet. The TDH assumes a long-term pumping water level of 230 feet, 650 feet of lift and headloss (281 psi wellhead discharge pressure), and 20 feet of safety factor. The assumed pumping water level accounts for short-duration pumping interference. An example pump curve is included

in Appendix C. At a maximum allowable pumping water level of 270 feet, this pump would produce about 145 gpm. The pump can be set on 3-inch column pipe to a depth of 273 feet, above the top of the screen at a depth of 280 feet.

The TDH estimate for the proposed pump is based on an estimate of long-term pumping water level based on a relatively short-duration test conducted 30 years ago. Well 3 has likely not been pumped at a high capacity since the 1989 testing. Given the age of the well and length of time since the well has been pumped at a high capacity, the following actions are recommended:

1. Remove the existing pump (estimated capacity of 30 gpm).
2. Perform a video survey on the well to assess its condition.
3. Clean the well mechanically and/or chemically if the video survey indicates that it is needed. If the casing has excessive mineralization on the casing, it could be difficult to install or remove the pump with 6-inch motor.
4. If the well screens appear plugged, re-develop the well using air-lifting, jetting, swabbing, or surging with a pump.
5. Test pump the well at the target yield of 150 gpm for at least 7 days to confirm long-term pumping water level and better evaluate the effects of negative boundaries. Once the well is test pumped, the permanent pump can be selected.

Well 3 should be equipped with soft start, check valve, pressure relief / surge anticipator valve, flow meter, pressure gauge, isolation valve, and air valve. Given the column pipe and well casing diameter, there is not enough space to install a 1-inch sounding tube that could hold a water level pressure transducer. Therefore, a ½-inch PVC sounding tube and a 3/8-inch PEX air-line tube is recommended to allow for manual water level measurements. Well 3 and associated equipment should be located in a heated metal building. Treatment will be required to remove arsenic from the water if Well 3 is used for potable water supply.

5. PROPOSED PRODUCTION WELLS

5.1. Introduction

The total anticipated raw water demand for the Project is 400 gpm and includes water for mining, ore processing, and potable uses. This total does not include water for dust suppression, which is assumed to be supplied from the existing Wells 1 and 2. Peak water demands and water for fire protection will be provided from storage. Raw water will be suppled from wells, which will be pumped to a raw water storage tank and then distributed for use by gravity.

Current long-term production well capacity is estimated to be about 200 gpm, with 150 gpm derived from Well 3 (PW-4), and the remainder from Well 1 (Prod-1) and Well 2 (PW-1). It is recommended that Well 3 be equipped with a pump for use as a raw water

supply while Wells 1 and 2 are better suited for use as local sources of water (dust suppression, etc).

There is currently a 250-gpm deficit in raw water groundwater supply. A minimum of two, and likely three, new supply wells (Wells 4, 5, and 7) are proposed to serve as primary supply wells, with Well 3 serving as a backup supply. Each of the new wells will be sized to produce 100 to 200 gpm for the life of the mine to meet the total peak raw water supply requirement of 400 gpm.

5.2. Proposed Well Locations

The proposed locations of the new supply wells are shown on Figure 8. Several factors were considered when choosing the locations of new wells, including: hydrogeological conditions, existing production wells, proximity to mine facilities, and the approved Project Permit Area. Each of these factors are described in more detail below.

5.2.1. **Hydrogeological Conditions**

Well 3 is completed in water-bearing layers of sandstone and conglomerate between a depth of 280 and 360 feet bgs. The nearby well GW-4 encountered similar lithology. Exploration drill hole 26-057 was also drilled near PW-4, but not completed as a permanent well. The driller's notes identify layers of siltstone and conglomerate from 165 to 445 feet, and then tuff to a depth of 740 feet. Drilling of PW-4, GW-4 and 26-057 indicate the presence of a relatively productive sandstone and conglomerate aquifer from a depth of approximately 300 to 450 feet.

Well 3 is completed in an aquifer with an estimated near well bore transmissivity of 3,800 gpd/ft. This is higher than the near well bore transmissivities noted for Well 1 (1,500 gpd/ft) and Well 2 (250 gpd/ft). Transmissivity and hydraulic conductivity appear to increase in the area moving away from the silicified deposit.

Testing of Well 3 indicates the presence of a negative hydraulic boundary near the well, causing a decline in effective transmissivity to an estimated 1,700 gpd/ft. However, the impact of the boundary condition was much less than that observed at Well 1 (decline to 200 gpd/ft) and Well 2 (decline to 100 gpd/ft). The cause of the transmissivity decline is not known with certainty, it could be a result of limitations in the size and extent of favorable higher permeable aquifer strata. It could be due to faulting; all of these wells are located near the Grassy Mountain fault zone, which may be acting as a barrier to groundwater flow. In the case of Well 2, sediment silicification in and near the deposit probably contributes to restricted groundwater recharge. While the cause of the transmissivity decline is not known with certainty, it is apparent that the negative impact is lessened farther from the deposit. Hydrogeological conditions appear to favor well locations farther from the deposit based on available evidence.

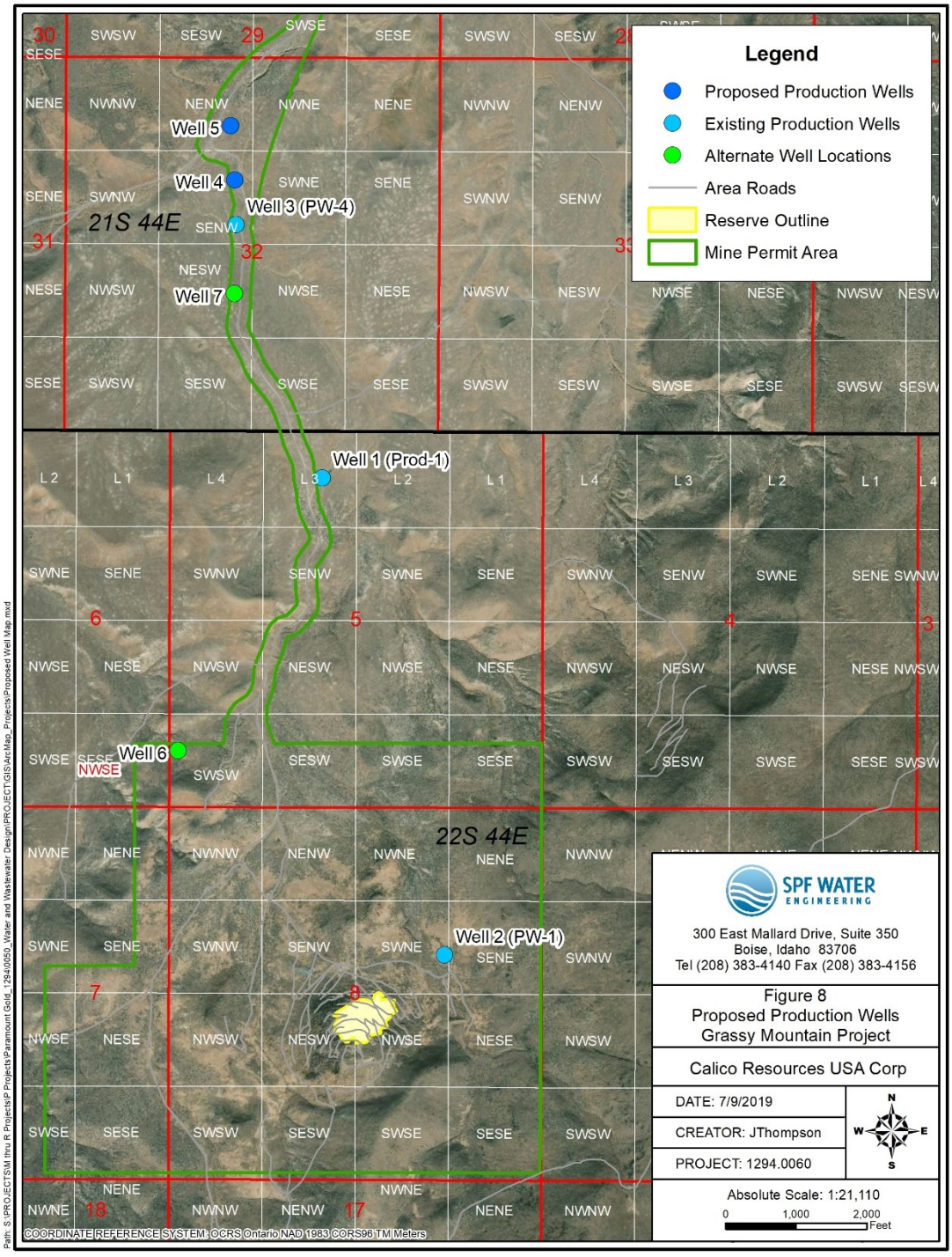

Figure 8. Map of existing and proposed production wells

5.2.2. **Existing Well Capacity**

Well capacity is directly related to aquifer transmissivity. Therefore, it is no surprise that the most productive existing supply well is Well 3 with an estimated long-term yield of approximately 200 gpm. The long-term capacity of the other existing production wells, including Wells 1 and 2, is much lower (30 gpm for Well 1, 25 gpm for Well 2). These results indicate that the area around Well 3 is more likely to support a higher well yield than areas around Wells 1 and 2.

5.2.3. **Proximity to Mine Facilities**

Well 3 is the farthest existing well from the proposed mine, being located about 2.1 miles away. Wells 1 and 2 are closer to the proposed mine, being located about 1.45 miles and 0.3 miles away, respectively. Groundwater development in the area around Well 2 is advantageous from purely a cost and logistical perspective. However, as described above, it is unlikely that a reliable groundwater supply can be developed in the near proximity to the mine that can meet Project water needs.

While Well 3 is located over 2 miles from the proposed mine, this area is believed to provide the best opportunity for developing a reliable and long-term groundwater supply for the proposed mine.

5.2.4. **Permitting Considerations**

The Project Permit Area is defined in the *Third Notice of Intent Pre-Application Phase of a Proposed Mining Operation: Calico Resources USA Corp. Grassy Mountain Gold Project (February 2017)* (EM Strategies, Inc., 2017). The Permit Area includes two parcels, a Mine and Process Area, and an Access Road Area. These are shown on Figure 2 and Figure 3 in the vicinity of the proposed mine.

The Mine and Process Area parcel is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres (EM Strategies, Inc., 2017). The Access Road Area parcel follows an unnamed dirt road and Twin Springs Road in the vicinity of the proposed mine as shown on Figure 3. The width of the Access Road Area is generally 300 feet (150 feet on either side of the access road centerline) to accommodate road improvements and a power line. The Access Road Area is wider in spots to allow for flexibility in the final road alignment.

All Project facilities and associated disturbances are planned to be located within the Permit Area. Therefore, any new water supply wells would also need to be located within the Permit Area. There may be opportunities for groundwater development outside the Permit Area, along Negro Rock Canyon west of the proposed mine and near Poison Spring northwest of the proposed mine (JMM 1991). These locations are not currently planned for water supply exploration or development due to being outside the Permit Area and to distance from the proposed mine.

5.3. Well 4

5.3.1. **Anticipated Well Construction**

Well 4 will be constructed to target water-bearing sandstone and conglomerate layers expected to occur between a depth of approximately 250 and 500 feet bgs. The anticipated maximum depth of the well is 500 feet. It is anticipated that the well will be drilled using the air-rotary method; temporary casing is expected to be needed to a depth of 30 feet through the surface alluvium. Once the surface casing is set, a small diameter pilot hole is planned to 500 feet to confirm total depth, identify location and thickness of water-bearing zones, and to develop a well screen design. The pilot hole is only planned to 500 feet because Well 5, discussed in Section 5.4, will be drilled first and a pilot hole to 1,000 feet is planned.

Well construction will comply with OWRD Well Construction Standards (Oregon Administrative Rules Chapter 690 Division 200). The final borehole size will be a minimum of 14 inches to meet OWRD well construction requirements.

The target yield of Well 4 is 200 gpm; actual yield will be determined after drilling, construction, and long-term test pumping. The well will be constructed with nominal 10-inch mild steel casing to accommodate a nominal 6-inch submersible pump and nominal 8-inch motor that can produce the target yield with enough head to deliver water to the raw water storage tank.

The conceptual design of Well 4 includes 10-inch diameter stainless steel wire-wrap well screen installed through the water-bearing strata. The placement and slot size will be determined after drilling. If Well 3 is used as a reference, 30-slot screen will be required. Once the well casing and screen are set as a single-string with centralizers, silica sand filter pack will be placed opposite the screened interval, with 20 feet of excess to allow for settling. The size of the filter pack will be determined after drilling the pilot hole and inspection of the drill cuttings; Well 3 was constructed with No. 10-20 silica sand. After placement of the filter pack, the annular space between the well casing and bore wall will be sealed with neat cement pumped from the bottom up using a tremie pipe in accordance with OAR 690-210-0140 and OAR 690-210-0170. A very fine sand or bentonite chips will be used as a filter pack seal to prevent grout intrusion into the pack.

Well construction specifications and a conceptual well design for Well 4 are included in Appendix D.

5.3.2. **Well Development and Testing**

Following construction, Well 4 will be developed until the water produced from the well is clear and free from sand or sediment. The well will be test pumped for an extended duration, expected to be 7 to 14 days, to determine long-term well capacity, assess aquifer sustainability and hydraulic characteristics, and evaluate the effects of any

negative boundaries encountered. All nearby wells and springs will be monitored during the test to evaluate the effects of pumping on groundwater levels in the vicinity.

5.3.3. **Well Location**

Well 4 is proposed in the SE ¼ of the NW ¼ of Section 32, T21S R44E. The latitude and longitude coordinates of the proposed well site are 43°42'11.99" N and 117°21'57.01" W. Well 4 would be located about 2.3 miles north of the proposed mine and about 650 feet north of Well 3, at an elevation of approximately 3,330 feet. The proposed well is shown on Figure 8.

Well 4 is located within the Project Permit Area, with Bureau of Land Management property surrounding the Project Permit Area. There are no sanitary hazards, as defined in Oregon Administrative Rules (OAR) 333-061-0050(2) within 100 feet of the proposed well. There are no gravity sewer lines or septic tanks within 50 feet of the proposed well. The proposed well site is not located in an area susceptible to flooding.

5.3.4. **Geologic Setting**

Well 4 is underlain by geologic unit *Qal*, identified as Pleistocene and Holocene alluvium, as shown on Figure 9. The geologic unit is reportedly underlain by interbedded conglomerate and siltstone (unit *Tis*), and undifferentiated Grassy Mountain Formation (unit *Tgs*). Faults are mapped to the north and west of Well 4, as depicted on Figure 9.

5.3.5. **Water Rights**

Well 4 is listed as a point of diversion on the Application for Permit Amendment filed on Calico's original water right permit #G-10994. The Application for Permit Amendment was submitted to OWRD on March 27, 2019.

5.3.6. **Anticipated Well Capacity**

It is assumed that Well 4 will have a long-term specific capacity at least equal to Well 3, about 1 gpm/ft. There is the potential of drilling a well with a higher specific capacity if additional water-bearing zones are encountered, the well is constructed more efficiently (i.e. screen and filter pack sized and placed appropriately), and the well is adequately developed. Conservatively assuming a long-term specific capacity of 1 gpm/ft, a pumping rate of 200 gpm, and a static water level of 70 feet bgs, the long-term pumping water level in the well is expected to be about 270 feet bgs, not accounting for pumping interference. The top of the well screen in Well 3 is at a depth of 280 feet bgs. If Well 4 encounters similar lithology, the projected pumping water level would still be above the top of the screen. If necessary, the well pump could be set in a blank section of 10-inch diameter casing between screen sections.

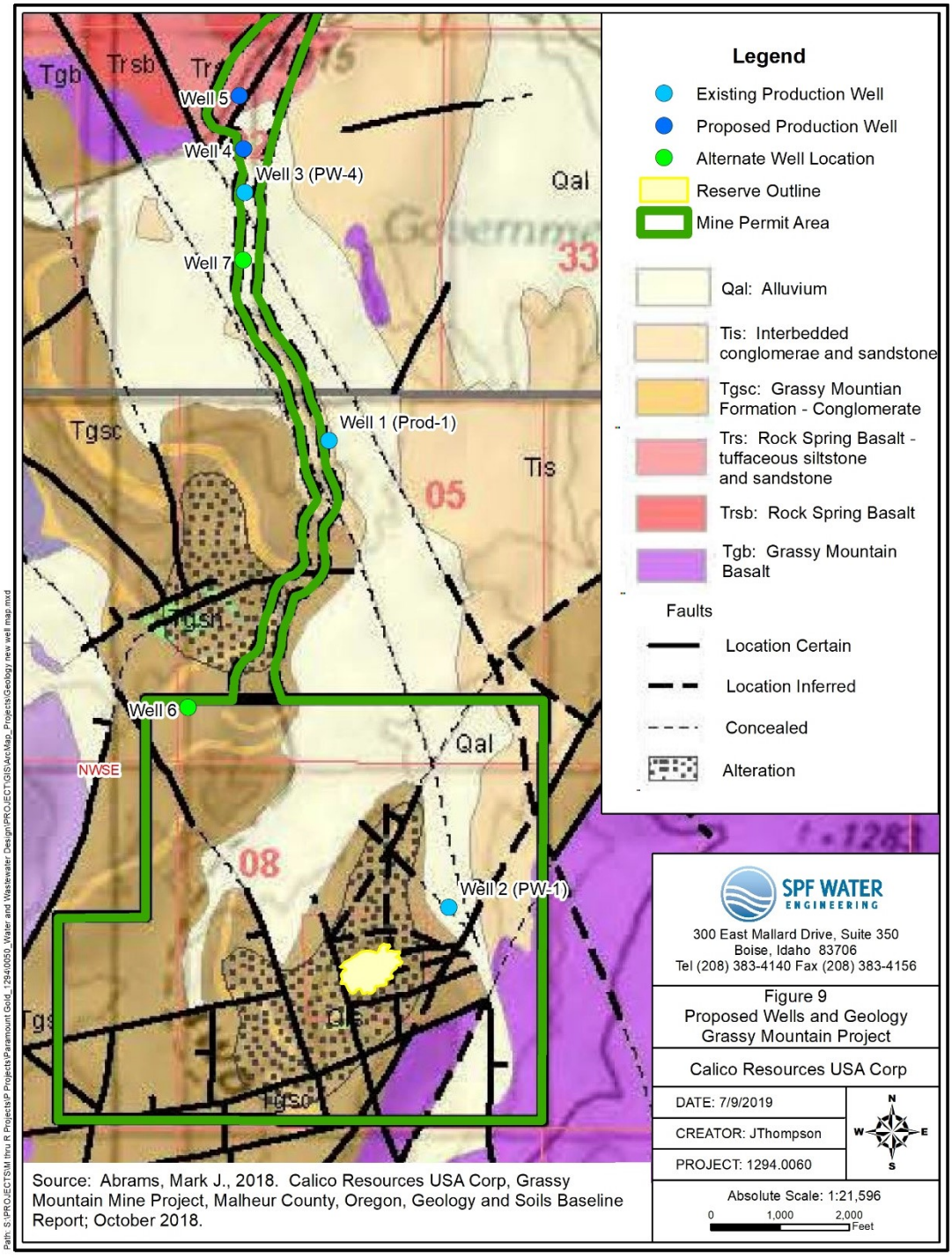

Figure 9. Map of proposed wells and surficial geology

5.3.7. **Pumping Interference**

For Well 4, pumping interference from the other main supply Well 5 needs to be accounted for. Well 5 is proposed to be located about 775 feet north of Well 4. Well 3 is expected to be a backup well, only needed if Wells 4 or 5 are not operational. Therefore, no interference effects are assumed from pumping Well 3.

To estimate drawdown from pumping, a Theis (1935) analysis was performed. For this analysis, an early-time transmissivity of 3,800 gpd/ft and a storativity of $7x10^{-5}$ are used based on test pumping data from Well 3. For the pumping rate, this analysis assumes Well 5 is the primary well, pumping at 200 gpm. The pumping interference in Well 4 is predicted to be about 55 feet after one year of pumping Well 5. If Well 5 is pumped annually at 200 gpm, the required annual pumping rate in Well 4 is estimated to be 120 gpm (the annual average daily water demand is projected to be about 320 gpm). The pumping water level in Well 4 is predicted to be 190 feet bgs after one year of pumping at 120 gpm. Accounting for pumping water level and interference effects, the water level in Well 4 is projected to be 245 feet bgs after one year of pumping. This water level is above the anticipated top of the well screen.

The maximum peak raw water supply demand is estimated to be 400 gpm during the summer months. If both Wells 4 and 5 are pumped at 200 gpm for 5 months, the pumping water level in Well 4 is projected to be 250 feet bgs plus 50 feet of interference drawdown for a total pumping water level of 300 feet bgs. This pumping water level falls below the anticipated top of the upper screen. The anticipated worst-case scenario is pumping Well 4 at 200 gpm for a year, with Well 5 pumped at 200 gpm for 5 months. The pumping water level in Well 5 is estimated to be 320 feet (270 feet plus 50 feet of interference).

If testing of the wells after construction also shows an unacceptable level of drawdown, it is possible to pump less from Wells 4 and 5 and utilize Well 3. For example, if Wells 4 and 5 were each pumped at 150 gpm and Well 3 was pumped at 100 gpm for 5 months, the pumping water level in Well 4 is predicted to be 205 feet bgs plus 37 feet of interference from Well 5 and 26 feet of interference from Well 3, for a total pumping water level of 268 feet, above the anticipated top of the upper screen.

This evaluation of pumping interference relies on assuming a specific capacity for Well 4 and running a Theis analysis that relies on assumptions not entirely applicable to the aquifer in question. However, this evaluation does demonstrate that having three supply wells should provide enough flexibility to meet Project water demands even if specific capacity of the new wells is not improved over Well 3. If after construction and testing it is determined that three wells are not enough, a fourth well (Well 7) could be constructed to provide additional capacity.

5.3.8. **Anticipated Water Quality**

The groundwater produced from Well 4 is anticipated to have similar water quality as the nearby Well 3, given the proximity of the wells and similar target aquifer. The well

is expected to produce water with an arsenic concentration greater exceeding the primary drinking water standard. The well might produce water exceeding secondary drinking water standards for aluminum, iron, manganese, and/or total dissolved solids based on water quality results from Well 3. However, with adequate well development it is likely the concentrations of these constituents will be lower than those observed in Well 3, potentially below the secondary drinking water standard.

5.3.9. **Proposed Use and Recommendations**

Well 4 is recommended to be used as a primary water supply for the proposed mine, and be equipped with a pump with enough head to fill the raw water storage tank. There is an elevation difference of approximately 585 feet between the well ground surface and the tank overflow elevation.

It is recommended that Well 4 be equipped with a 6-inch submersible pump and motor capable of producing 200 gpm at a TDH of 980 feet. The TDH assumes a long-term pumping water level of 270 feet, 640 feet of static lift and headloss (277 psi discharge pressure), 20 feet of safety factor, and 50 feet of pumping interference. A 75-hp pump and motor are anticipated based on these design conditions.

The TDH estimate for preliminary pump selection is considered conservative and is based on an estimate of pumping water level and interference effects. Final pump selection will occur after Well 4 is constructed and test pumped. An example pump curve is included in Appendix C. The pump will be set on 4-inch column pipe.

Well 4 should be equipped with soft start, check valve, pressure relief / surge anticipator valve, flow meter, pressure gauge, isolation valve, and air valve. A nominal 1-inch Schedule 40 flush-thread PVC sounding tube should be installed in the well to the top of the pump to house a water-level pressure transducer. Well 4 and associated equipment should be located in a heated metal building. Treatment will be required to remove arsenic from the water if Well 4 is used for potable water supply.

5.4. Well 5

5.4.1. **Anticipated Well Construction**

Well 5 will be constructed to target water-bearing sandstone and conglomerate layers expected to occur between a depth of approximately 250 and 500 feet bgs. The anticipated maximum depth of the well is 500 feet. Temporary surface casing is anticipated to be required to a depth of 30 feet through the surface alluvium. A small diameter exploratory pilot hole is planned to 1,000 feet to determine if there is a deeper water-bearing zone below 500 feet. Drilling results from exploratory drill hole 26-057, located about 1,500 feet to the south, suggests that there is not a deeper aquifer. This hole encountered tuff between a depth of 445 and 740 feet. However, drilling of the pilot hole is still recommended due to the spatial variability of the aquifer system. Final well design will be based on the results of the pilot hole drilling.

The target yield of Well 5 is 200 gpm; actual yield will be determined after drilling, construction, and long-term test pumping. Well 5 will be constructed similarly as Well 4, with nominal 10-inch mild steel casing and stainless steel wire-wrap well screen. Filter pack will be placed opposite the screened interval. Screen and filter pack selection will be finalized after drilling. Well 5 will be sealed from the top of the filter pack to ground surface with neat cement.

Well construction will comply with OWRD Well Construction Standards (Oregon Administrative Rules Chapter 690 Division 200). Well construction specifications and a conceptual well design for Well 5 are included in Appendix E.

5.4.2. **Well Development and Testing**

Following construction, Well 5 will be developed until the water produced from the well is clear and free from sand or sediment. Following development, the well will be test pumped for an estimated 7 to 14 days. All nearby wells and springs will be monitored during the test to evaluate the effects of pumping on groundwater levels in the vicinity.

5.4.3. **Well Location**

Well 5 is proposed in the NE ¼ of the NW ¼ of Section 32, T21S R44E. The latitude and longitude coordinates of the proposed well site are 43°42'19.02" N and 117°21'57.62" W. Well 5 would be located about 2.4 miles north of the proposed mine and about 775 feet north of Well 4, at an elevation of approximately 3,330 feet. The proposed well is shown on Figure 8.

Well 5 is located within the Project Permit Area. There are no sanitary hazards, as defined in Oregon Administrative Rules (OAR) 333-061-0050(2) within 100 feet of the proposed well. There are no gravity sewer lines or septic tanks within 50 feet of the proposed well. The proposed well site is not located in an area susceptible to flooding.

5.4.4. **Geologic Setting**

Well 5 is underlain by geologic unit *Trs*, identified as Rock Spring Basalt with interbedded tuffaceous siltstone and sandstone (Figure 9). The basalt is reportedly underlain by interbedded conglomerate and siltstone (unit *Tis*) and undifferentiated Grassy Mountain Formation (unit *Tgs*). Faults are mapped to the southeast and west of Well 5 (Figure 9).

5.4.5. **Water Rights**

Well 5 is listed as a point of diversion on the Application for Permit Amendment filed on Calico's original water right permit #G-10994.

5.4.6. **Anticipated Well Capacity**

Well 5 is expected to have a long-term specific capacity of at least 1 gpm/ft based on test pumping of the nearby Well 3. The long-term pumping water level in the well is

conservatively estimated to be about 270 feet bgs, assuming a long-term specific capacity of 1 gpm/ft, a pumping rate of 200 gpm, and a static water level of 70 feet bgs. This pumping water level does not include pumping interference from Well 4.

5.4.7. **Pumping Interference**

Pumping interference between the primary supply wells 4 and 5 is expected. Using the same analysis as described in Section 5.3.7, the pumping interference in Well 5 is predicted to be about 55 feet after one year of pumping Well 4 at 200 gpm. If Well 4 is pumped annually at 200 gpm, the annual pumping rate from Well 5 would need to be 120 gpm with a resultant pumping water level of 190 feet bgs. Accounting for pumping water level and interference effects, the water level in Well 5 is projected to be 245 feet bgs after one year of pumping.

If both Wells 4 and 5 are pumped at 200 gpm for 5 months to meet the peak summer raw water supply demand, the pumping water level in Well 5 is projected to be 250 feet bgs plus 50 feet of interference drawdown for a total pumping water level of 300 feet bgs. The anticipated worst-case scenario is pumping Well 5 at 200 gpm for a year, with Well 4 pumped at 200 gpm for 5 months. The pumping water level in Well 5 is estimated to be 320 feet (270 feet plus 50 feet of interference).

5.4.8. **Anticipated Water Quality**

The groundwater produced from Well 5 is anticipated to produce water with elevated arsenic greater than the primary drinking water standard and might also exceed secondary drinking water standards for aluminum, iron, manganese, and/or total dissolved solids. The water quality from Well 5 is expected to be similar to Well 3, although the concentrations of secondary constituents may be lower with adequate well development.

5.4.9. **Proposed Use and Recommendations**

Well 5 is recommended to be used as a primary water supply for the proposed mine, and be equipped with a pump with enough head to fill the raw water storage tank. There is an elevation difference of approximately 585 feet between the well ground surface and the tank overflow elevation.

It is recommended that Well 5 be equipped with a 6-inch submersible pump and motor capable of producing 200 gpm at a TDH of 980 feet. The TDH assumes a long-term pumping water level of 270 feet, 640 feet of static lift and headloss (277 psi wellhead discharge pressure), 20 feet of safety factor, and 50 feet of pumping interference. A 75-hp pump and motor are anticipated based on these design conditions. This pump selection is preliminary; final pump selection will occur after Well 5 is constructed and test pumped. An example pump curve is included in Appendix C. The pump will be set on 4-inch column pipe.

Well 5 should be equipped with soft start, check valve, pressure relief / surge anticipator valve, flow meter, pressure gauge, isolation valve, air valve, and 1-inch sounding tube with a water-level pressure transducer. Well 5 and associated equipment should be located in a heated metal building. Treatment will be required to remove arsenic from the water if Well 5 is used for potable water supply.

5.5. Well 7

Well 7 will be constructed if the long-term sustainable yield from Wells 4 and 5 are determined to be less than 400 gpm after construction and testing.

5.5.1. **Anticipated Well Construction**

Well 7 will be constructed to target water-bearing sandstone and conglomerate layers expected to occur between a depth of approximately 250 and 500 feet bgs. The anticipated maximum depth of the well is 500 feet. Temporary surface casing is anticipated to be required to a depth of 30 feet through the surface alluvium.

The anticipated yield of Well 7 is 100 gpm based on deeper static water level and bounded aquifer conditions similar to Well 1; actual yield will be determined after drilling, construction, and long-term test pumping. Well 7 will be constructed similarly as Wells 4 and 5, with nominal 10-inch mild steel casing and stainless steel wire-wrap well screen. Filter pack will be placed opposite the screened interval. Screen and filter pack selection will be finalized after drilling. Well 7 will be sealed from the top of the filter pack to ground surface with neat cement.

Well construction will comply with OWRD Well Construction Standards (Oregon Administrative Rules Chapter 690 Division 200).

5.5.2. **Well Development and Testing**

Following construction, Well 7 will be developed until the water produced from the well is clear and free from sand or sediment. Following development, the well will be test pumped for an estimated 7 to 14 days. All nearby wells and springs will be monitored during the test to evaluate the effects of pumping on groundwater levels in the vicinity.

5.5.3. **Well Location**

Well 7 is proposed in the NE ¼ of the SW ¼ of Section 32, T21S R44E. The latitude and longitude coordinates of the proposed well site are 43°41’55.59” N and 117°21’56.85” W. Well 7 would be located about 2.0 miles north of the proposed mine and about 975 feet south of Well 3, at an elevation of approximately 3,375 feet. The proposed well is shown on Figure 8.

Well 7 is located within the Project Permit Area. There are no sanitary hazards, as defined in Oregon Administrative Rules (OAR) 333-061-0050(2) within 100 feet of the proposed well. There are no gravity sewer lines or septic tanks within 50 feet of the proposed well. The proposed well site is not located in an area susceptible to flooding.

5.5.4. **Geologic Setting**

Well 7 is underlain by geologic unit *Qal*, identified as Pleistocene and Holocene alluvium, as shown on Figure 9. The geologic unit is reportedly underlain by interbedded conglomerate and siltstone (unit *Tis*), and undifferentiated Grassy Mountain Formation (unit *Tgs*). Well 7 appears to be bounded by faults to the northeast and southwest (Figure 9).

5.5.5. **Water Rights**

Well 7 is listed as a point of diversion on the Application for Permit Amendment filed on Calico's original water right permit #G-10994.

5.5.6. **Anticipated Well Capacity**

Well 7 is expected to have a long-term specific capacity of at least 0.6 gpm/ft based on test pumping of Wells 1 and 3. The long-term pumping water level in the well is conservatively estimated to be about 290 feet bgs, assuming a long-term specific capacity of 0.6 gpm/ft, a pumping rate of 100 gpm, and a static water level of 120 feet bgs. This pumping water level does not include pumping interference from Wells 3, 4, and 5.

5.5.7. **Pumping Interference**

Well 7 would be expected to be affected by pumping of Wells 4 and 5 (Well 3 would serve as a backup well). Well 7 would be about 1,600 feet from Well 4 and about 2,400 feet from Well 5.

If Wells 4 and 5 are each pumped at 150 gpm and Well 7 is pumped at 100 gpm for 5 months, the resultant pumping water level in Well 7 is estimated to be about 310 feet using the same analysis as described in Section 5.3.7. This value includes a non-interference pumping water level of 253 feet based on a 5-month specific capacity of 0.75 gpm/ft plus 31 feet of interference from Well 4 and 27 feet of interference from Well 5.

For annual pumping impacts (annual average daily demand of 320 gpm), it is assumed that Wells 4 and 5 are each pumped at 135 gpm and Well 4 is pumped at 50 gpm. Under this scenario the long-term pumping water level in Well 7 is predicted to be 260 feet bgs (pumping water level of 200 feet plus 60 feet of combined interference).

The anticipated worst-case scenario is pumping Well 7 at 100 gpm for a year, with Wells 4 and 5 pumped at 150 gpm each for 5 months. The pumping water level in Well 7 is estimated to be 350 feet (290 feet plus 60 feet of interference).

5.5.8. **Anticipated Water Quality**

The groundwater produced from Well 7 is anticipated to produce water with elevated arsenic greater than the primary drinking water standard and might also exceed

secondary drinking water standards for aluminum, iron, manganese, and/or total dissolved solids.

5.5.9. **Proposed Use and Recommendations**

Well 7, if needed, is recommended to be used as a primary water supply for the proposed mine, and be equipped with a pump with enough head to fill the raw water storage tank. There is an elevation difference of approximately 540 feet between the well ground surface and the tank overflow elevation.

It is recommended that Well 7 be equipped with a 7-inch submersible pump and 6-inch motor capable of producing 100 gpm at a TDH of 955 feet. The TDH assumes a long-term pumping water level of 290 feet, 585 feet of lift and headloss (253 psi wellhead discharge pressure), 20 feet of safety factor, and 60 feet of pumping interference. A 50-hp pump and motor are anticipated based on these design conditions. This pump selection is preliminary; final pump selection will occur after Well 7 is constructed and test pumped. An example pump curve is included in Appendix C. The pump will be set on 4-inch column pipe.

Well 7 should be equipped with soft start, check valve, pressure relief / surge anticipator valve, flow meter, pressure gauge, isolation valve, air valve, and 1-inch sounding tube with a water-level pressure transducer. Well 7 and associated equipment should be located in a heated metal building. Treatment will be required to remove arsenic from the water if Well 7 is used for potable water supply.

5.6. Alternate Well Locations

There is one additional water supply well location identified as a point of diversion on the Application for Permit Amendment filed on Calico's original water right permit #G-10994. This location is identified as Well 6 on Figure 8. If Wells 4, 5, and 7, with redundant supply from Well 3, cannot produce enough water to meet the Project long-term peak raw water supply demands, then Well 6 should be considered for groundwater development.

If additional supply is needed in excess of Wells 1 through 7, then potential areas to explore for additional water include along the access road north of Well 5 and in the vicinity of Schweizer Reservoir east of the deposit. In the event productive aquifers are encountered at these or other locations, permit #G-10994 will need to be amended to show additional points of diversions.

6. LIST OF PREPARERS

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7. REFERENCES

Abrams, Mark J., 2018. Calico Resources USA Corp, Grassy Mountain Mine Project, Malheur County, Oregon, Geology and Soils Baseline Report. October 2018.

Driscoll, F.G., 1986. Groundwater and Wells. Johnson Division, St. Paul, MN.

EM Strategies, Inc., 2017. Environmental Baseline Study Work Plans. Grassy Mountain Project. Prepared for Calico Resources USA Corp. Prepared by EM Strategies, Inc., Reno, Nevada. September 22, 2017.

J.M. Montgomery Consulting Engineers, Inc. (JMM), 1991. Phase I Hydrogeologic Report on the Grassy Mountain Mine Project, Malheur County, OR. August 1991.

Red Quill Ventures, LLC (RQV), 2015. Calico Resources USA Corp, Grassy Mountain Project, Geology and Soils Baseline Study; February 2015.

SPF Water Engineering (SPF), 2019a. Grassy Mountain Gold Project Groundwater Resources Baseline Data Report. Prepared by SPF, Boise, Idaho. February 19, 2019.

SPF Water Engineering (SPF), 2019b. Draft Grassy Mountain Gold Project Groundwater Characterization Report. Prepared by SPF, Boise, Idaho.

Steffen Robertson and Kirsten Consulting Engineers and Scientists (SRK), 1989. Pumping Test Production Well PW-4-Procedures and Analyses. Letter to Atlas Precious Metals dated December 29, 1989.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of a well using ground-water storage. Transactions, American Geophysical Union, 16: 519-524.

Attachment A
Well Driller's Reports

Well 1 (PROD-1)

STATE OF OREGON

WATER WELL REPORT

(as required by ORS 537.765)

RECEIVED MAY 1989 WATER RESOURCES DEPT. SALEM, OREGON

MAH 2511

22S/44E/5ab

(START CARD) # 9256

(1) OWNER:

Well Number: SALEM, OREGON

Name Atlas Precious Metals

Address 743 Horizin Ct. Suite 202

City Grand Junction State Co Zip 81506

(2) TYPE OF WORK:

☒ New Well ☐ Deepen ☒ Recondition ☐ Abandon

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable

☒ Other Auger

(4) PROPOSED USE:

☒ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval ☐ Yes ☐ No Depth of Completed Well ____ ft.

Explosives used ☐ Yes ☒ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0	18				
10	18	425				
			Cement grout	0	26	19

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E

☐ Other

Backfill placed from ____ ft. to ____ ft. Material Ft. 's Cement Grout

Gravel placed from 100 ft. to 245 ft. Size of gravel No. 8

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	10"	+2	99	.250	☒	☐	☒	☐
	6"	+2	245	Sch 80	☐	☒	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:

☐ Perforations Method

☒ Screens Type Aardvark Material PVC Sch 80

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
380	420	.020		6"		☐	☐
145	255	325-355				☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
100	40'	300	1 hr.

Temperature of water ____ Depth Artesian Flow Found ____

Was a water analysis done? ☐ Yes By whom ____

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____

Depth of strata: ____

(9) LOCATION OF WELL by legal description:

County Malheur Latitude ____ Longitude ____

Township 22S N or S, Range 44E E or W, WM.

Section 5 NW ¼ NE ¼

Tax Lot ____ Lot ____ Block ____ Subdivision ____

Street Address of Well (or nearest address) ____

(10) STATIC WATER LEVEL:

40' ft. below land surface. Date 12-8-88

Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:

Depth at which water was first found 40'

From	To	Estimated Flow Rate	SWL
140-[illegible]	255	30 gpm	
320	355	50 gpm	
380	415	150 gpm	

(12) WELL LOG:

Ground elevation ____

Material	From	To	SWL
Overburden w/ boulders	0	17	0
Clay brown	17	140	0
Sandstone w/ blue clay	140	255	40
blue clay	255	320	40
Sandstone w/ blue clay	320	355	40
Blue clay	355	380	40
Fruited hard sandstone	380	415	40
Blue clay	415	425	40
=			
12-5-88 - 12-10-88			
+=			
Redone surface seal to 26 feet using method 2 referring to letter sent January 9, 1989			
Drilled around 10" casing to the depth of 26' using method C pumped 19 sacks of cement down hole			
3-30-89 - 3-31-89			
=			
Incorporated to singel log per state request			

Date started 12-5-88 Completed 3-31-89

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

Signed Bob Doty WWC Number 1202

Date 4-10-89

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief. WWC Number 325[illegible]

Signed Bob Doty for Bill Doty Date 4/15/89

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 3/88

Well 2 (PW-1)

JAN 02 1990

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

WATER RESOURCES DEPT
SALEM, OREGON

Malh 2276

22s/44E/8ad

(START CARD) # W-14816

(1) OWNER:

Well Number:

Name Atlas Precious Metals Inc

Address 318 A St.

City Vale State OR Zip 97818

(2) TYPE OF WORK:

☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD

☑ Rotary Air ☐ Rotary Mud ☐ Cable

☐ Other

(4) PROPOSED USE:

☐ Domestic ☐ Community ☑ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes ☐ No ☑ Depth of Completed Well 420 ft.

Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
14 3/4	0	28	PT CEMENT	0	28	19
			VOLCLAY	300	SURFACE	40 Sacks
			BENT PELLETS	295	300	3 BUCKETS

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E

☐ Other TREMIE

Backfill placed from ft. to ft. Material

Gravel placed from 555 ft. to 295 ft. Size of gravel .030

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+2	320	.250	☑	☐	☑	☐
	6"	340	400	"	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:

☐ Perforations Method

☑ Screens Type WIRE WOUND Material LOW CARBON

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
320	340	.030			6"	☐	☑
400	420	.030			6"	☐	☑
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
35		294	1 hr.

Temperature of water 64° F Depth Artesian Flow Found

Was a water analysis done? ☐ Yes By whom

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other

Depth of strata:

(9) LOCATION OF WELL by legal description:

County Malheur Latitude ' " Longitude ' "

Township 22S N or S, Range 44E E or W, WM.

Section 8 SE ¼ NE ¼

Tax Lot Lot Block Subdivision

Street Address of Well (or nearest address)

(10) STATIC WATER LEVEL:

52 ft. below land surface. Date 12-6-89

Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:

Depth at which water was first found

From	To	Estimated Flow Rate	SWL
320	340	20	
400	420	20	
		40	

(12) WELL LOG:

Ground elevation

Material	From	To	SWL
SOIL	0	2	
CLAY	2	10	
BASALT	10	28	
BROWN CLAY	28	55	
SILTSTONE	55	130	
CLAY & GRAVEL	130	173	
CLAY & SAND	173	190	
BASALT	190	315	
BROWN CLAY	315	323	
BROWN CLAY & SAND	323	360	
BROWN SANDSTONE	360	395	
BLACK & RED SAND	395	408	
SANDSTONE COARSE	408	441	
CLAY & GRAVEL	441	447	
CLAY & SAND	447	555	

Date started 11/27/89 Completed 12-1-89

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number

Signed Date

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 544

Signed Larry Burd Date 12/1/89

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Well 3 (PW-4)

JAN 02 1990

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

WATER RESOURCES DEPT.
SALEM, OREGON

Mail 2206

21S/44E/32bd
W-14815

(START CARD) # W-14811

(1) OWNER: Well Number: PW-4
Name ATLAS PRECIOUS METALS
Address 313 A STREET WEST
City VALE State OR Zip 97918

(2) TYPE OF WORK:
☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☒ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☒ No ☐ Depth of Completed Well 375 ft.
Explosives used Yes ☐ No ☒ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
14 3/4	0	40	PORTLAND CEMENT	0	40	19
9 7/8	40	375	VOLCLAY	5	275	40
			CEMENT	0	5	

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from 375 ft. to 370 ft. Material 10-20 MESH
Gravel placed from 370 ft. to 275 ft. Size of gravel 10-20 MESH

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	10"	0	40	.250	☒	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	6 5/8"	0	280	.250	☐	☐	☐	☐
	6 5/8"	300	340	.250	☒	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☒ Screens Type WIRE WOUND Material Low Carbon Steel

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
280	300	.030		6"		☐	☒
340	360	.030		6"		☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
100		350	1 hr.

Temperature of water 62°F Depth Artesian Flow Found —
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☒ Odor ☐ Colored ☐ Other
Depth of strata: 280 STILL USABLE

(9) LOCATION OF WELL by legal description:
County MALHEUR Latitude ° ' " Longitude ° ' "
Township 21S N or S, Range 44E E or W, WM.
Section 32 SE ¼ NW ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address)

(10) STATIC WATER LEVEL:
81 ft. below land surface. Date 11/17/89
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 280'

From	To	Estimated Flow Rate	SWL
280	360	100 gpm	81

(12) WELL LOG: Ground elevation ≅ 3350

Material	From	To	SWL
Alluvium	0	25'	
Clay	25	150'	
Sandy clay	150	175	
Sandstone	175	215	
Clay	215	275	
Sandstone	275	305	
Clay	305	325	
Sandstone and Conglomerate	325	365	
Clay.	365	375	

Date started 11/16/89 Completed 11/20/89

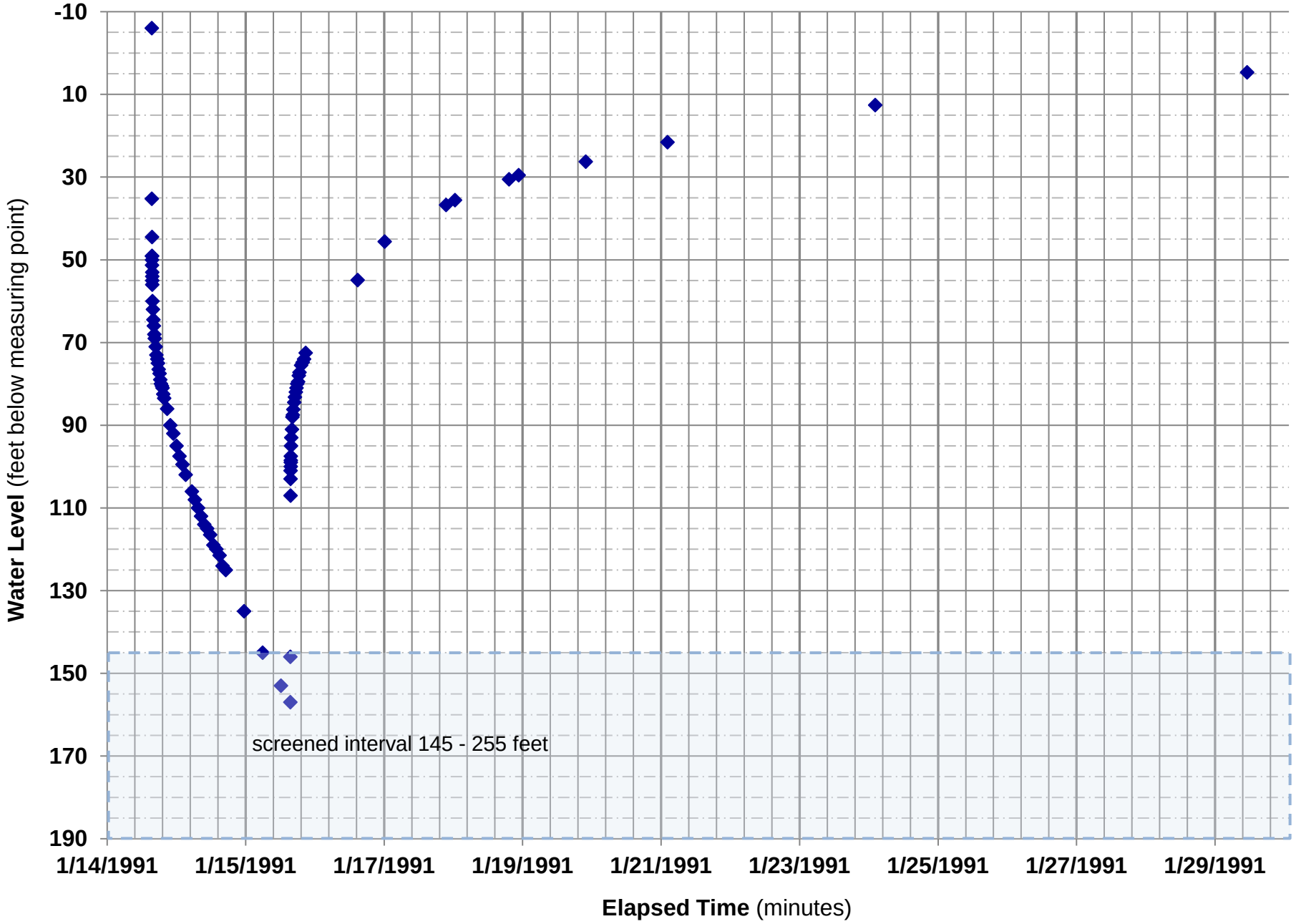
(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
Signed [signature] WWC Number
Date 11/20/89

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
Signed Larry Burd WWC Number 544
Date 11-20-89

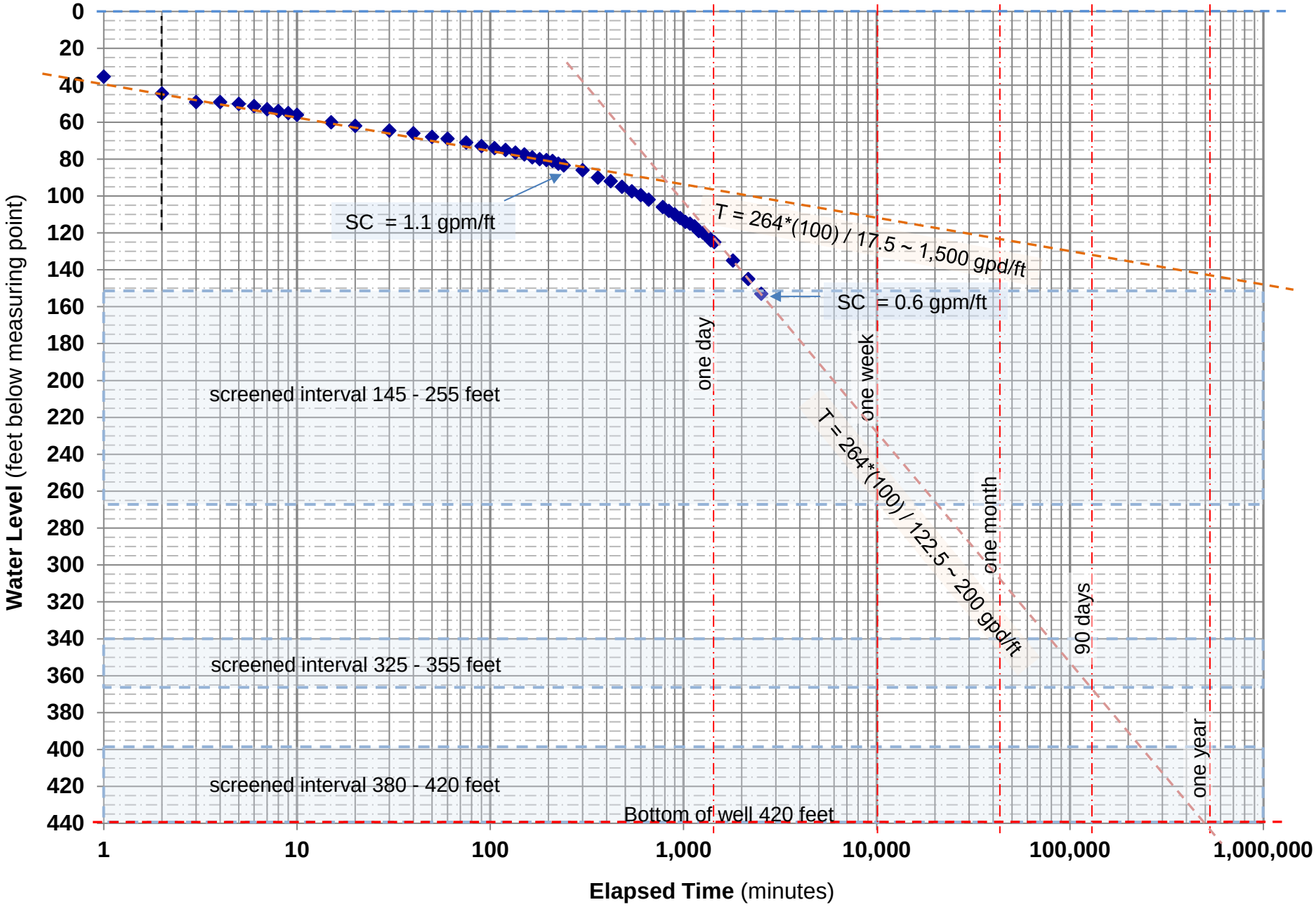
ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 3/85

Attachment B
Test Pumping Plots

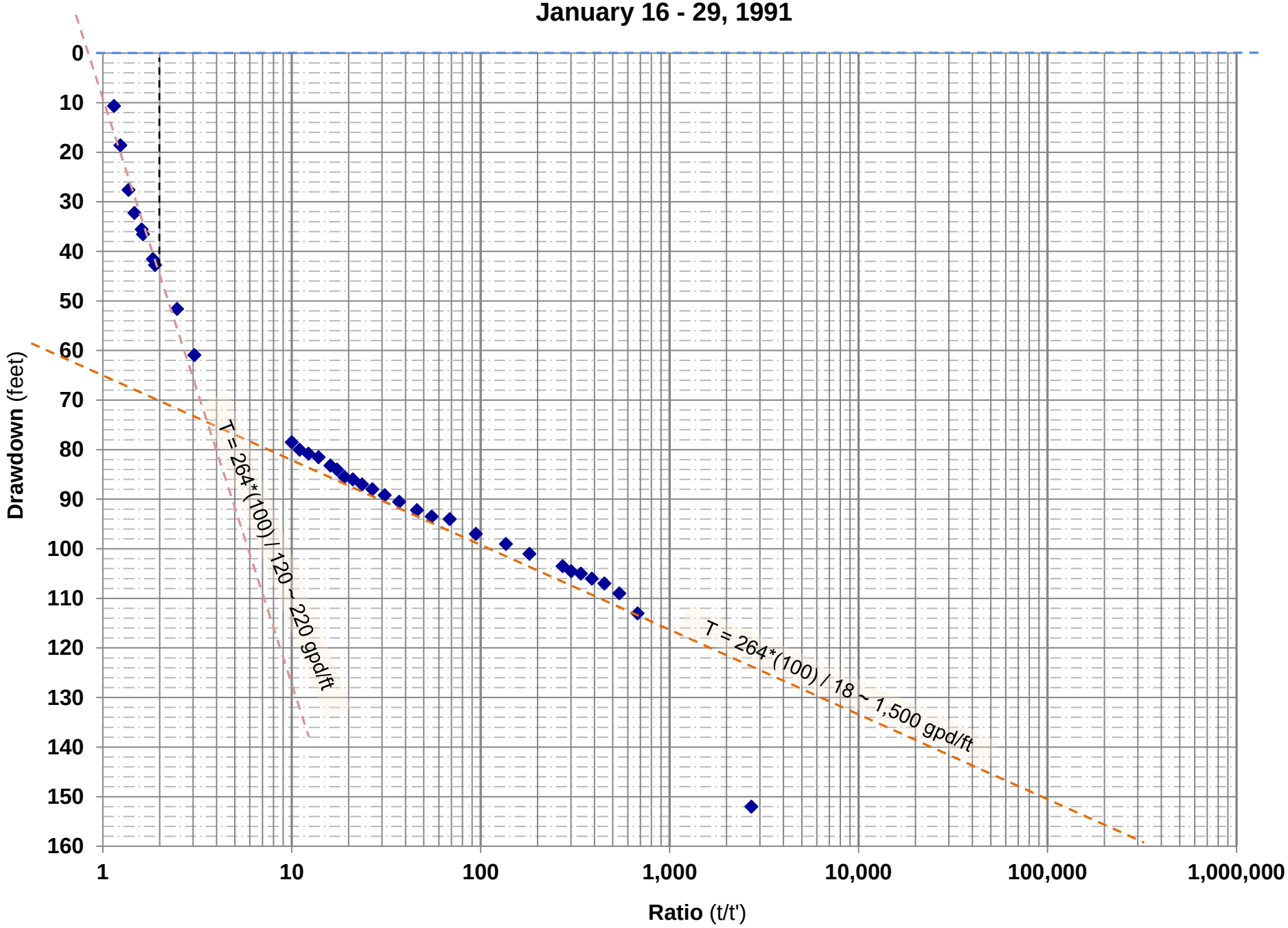
Prod-1 Constant-Rate Discharge Test
Depth to Water Plot, Q~100 gpm
January 14 - 29, 1991



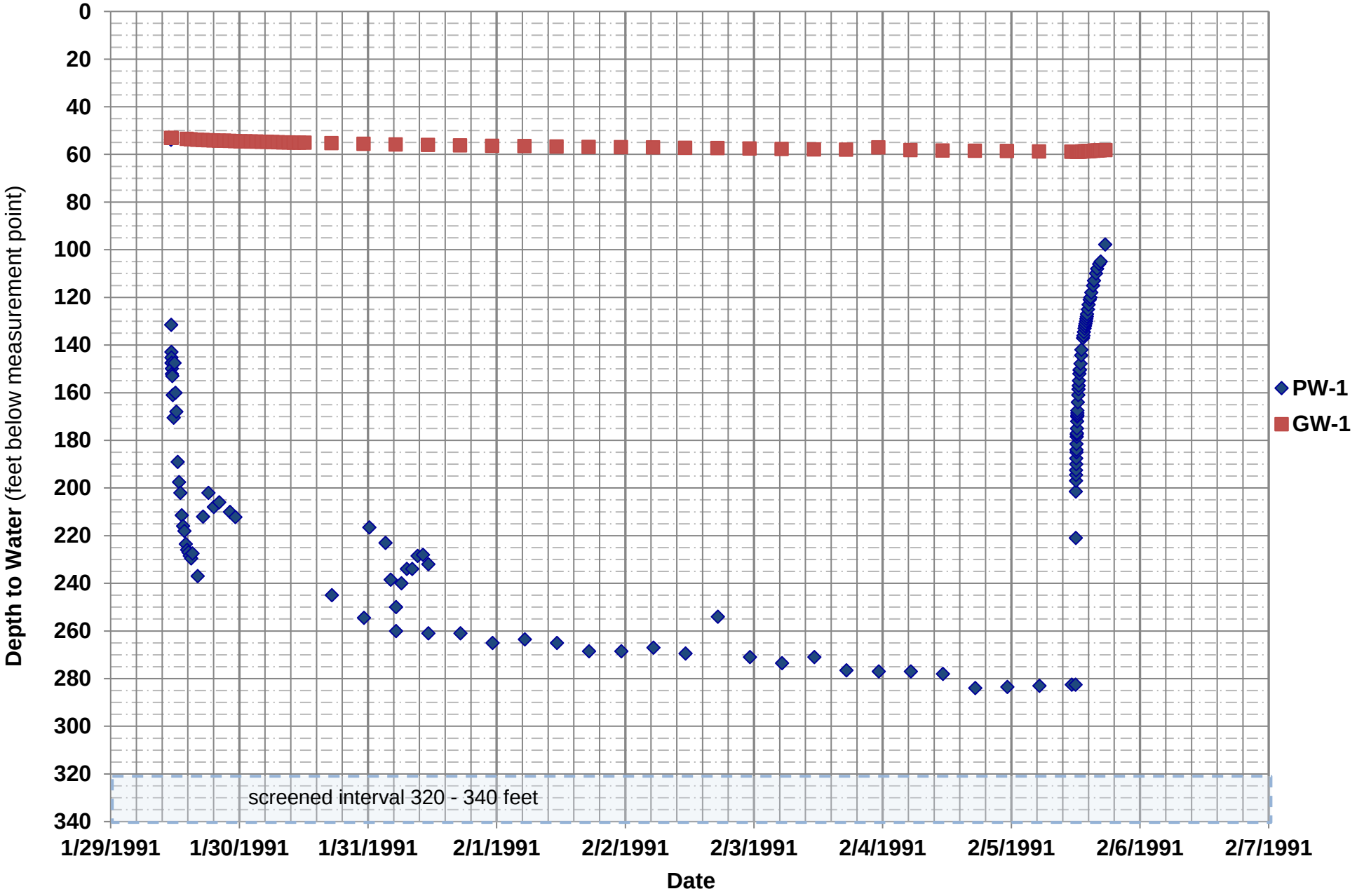
Prod-1 Constant-Rate Discharge Test
Semi-Log Water Level Plot, Q~100 gpm
January 14 - 16, 1991



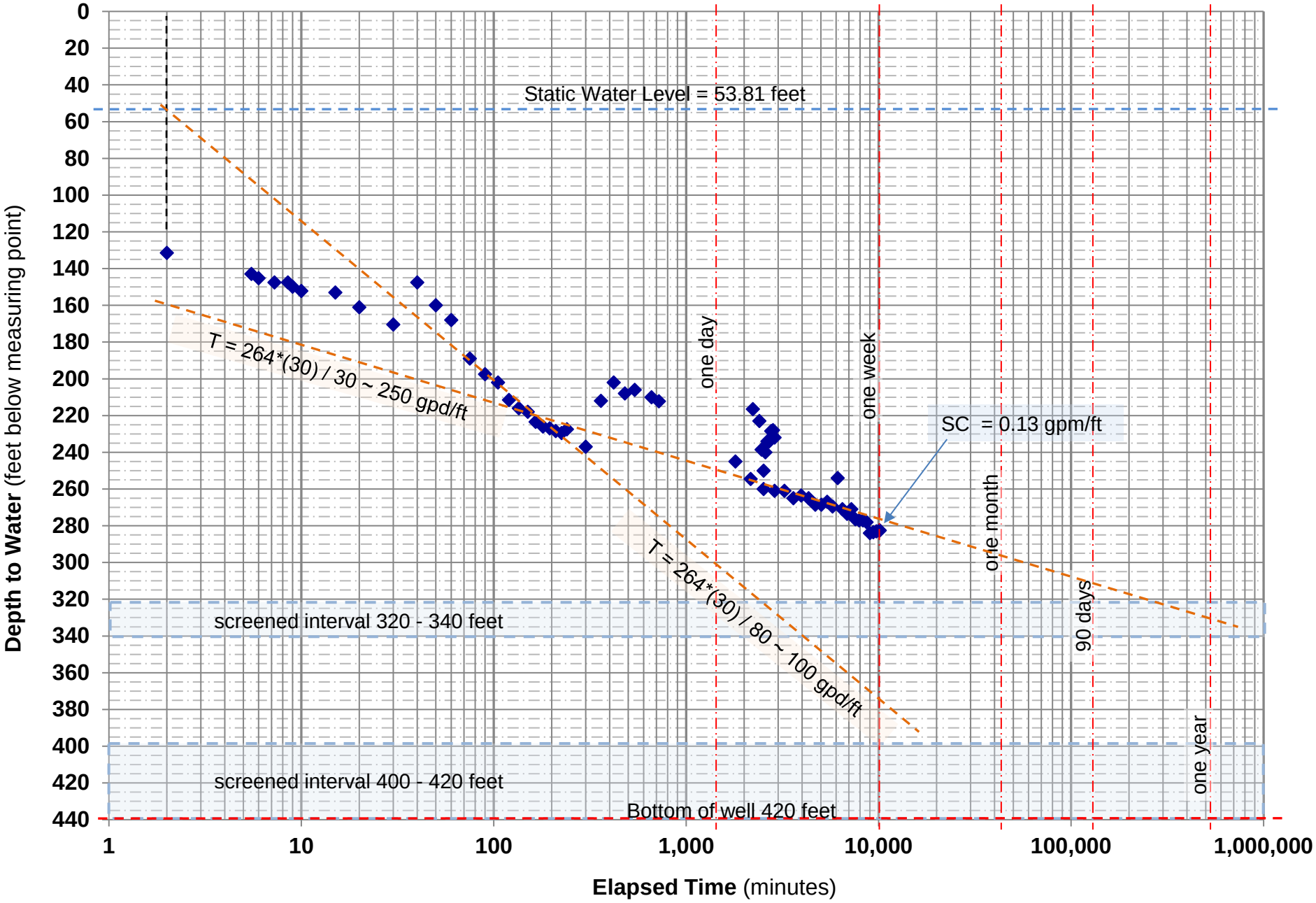
Prod-1 Constant-Rate Discharge Test
Semi-Log Recovery Plot, Q~100 gpm
January 16 - 29, 1991



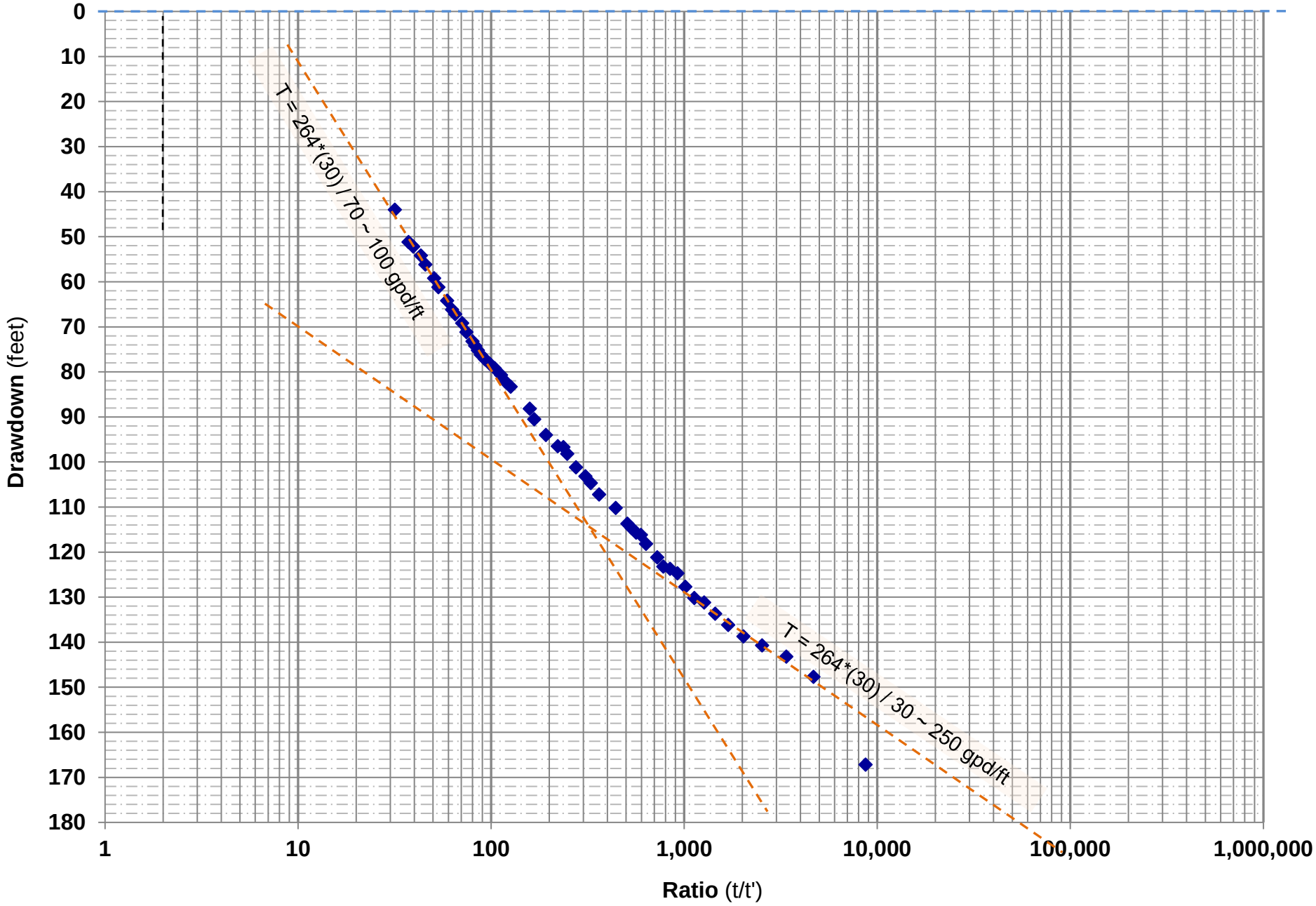
PW-1 Constant-Rate Discharge Test
Depth to Water Plot, Q~30 gpm
January 29 - February 5, 1991



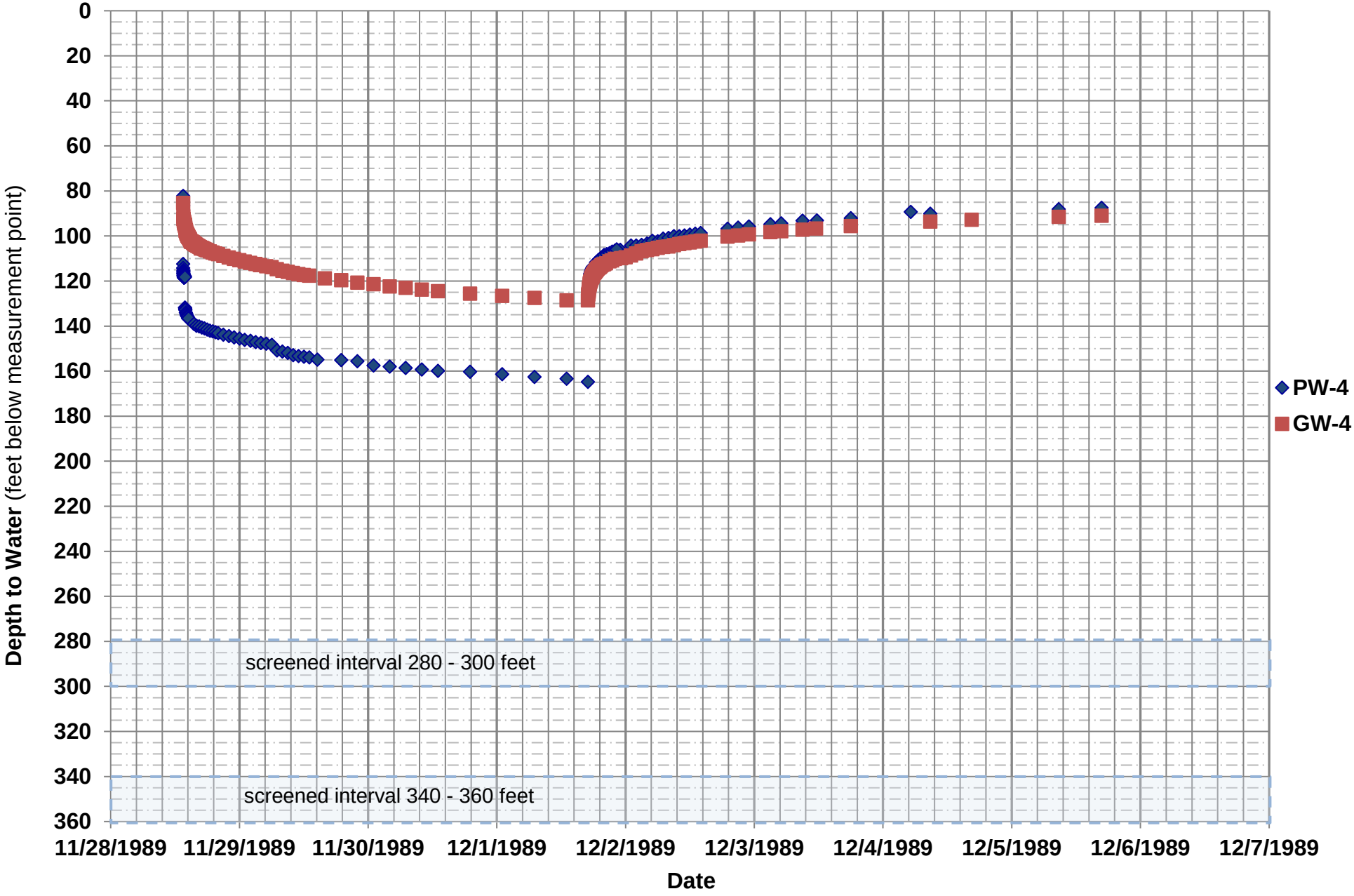
PW-1 Constant-Rate Discharge Test
Semi-Log Water Level Plot, Q~30 gpm
January 29 - February 5, 1991



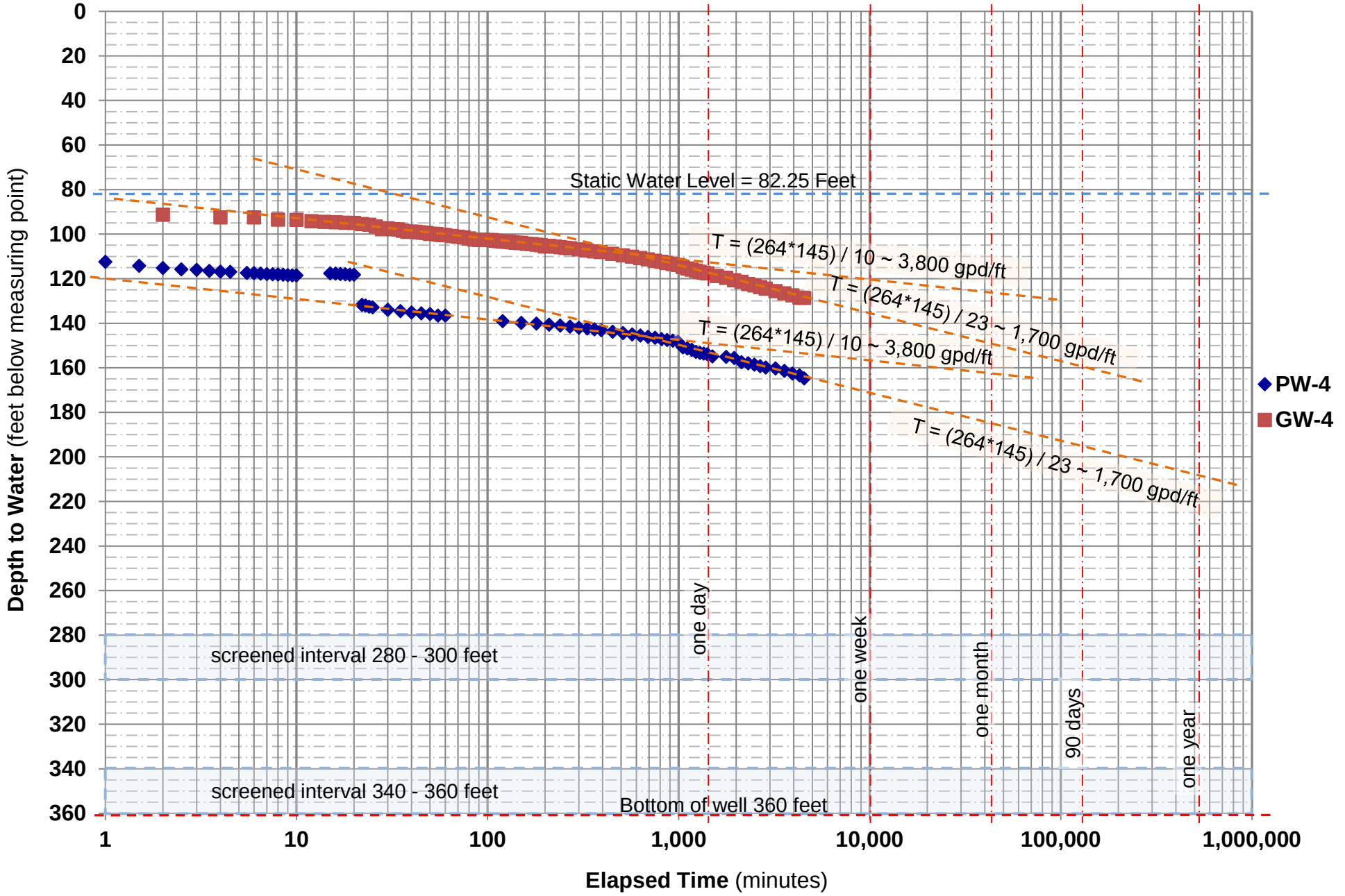
PW-1 Constant-Rate Discharge Test
Semi-Log Recovery Plot, Q~30 gpm
February 5, 1991

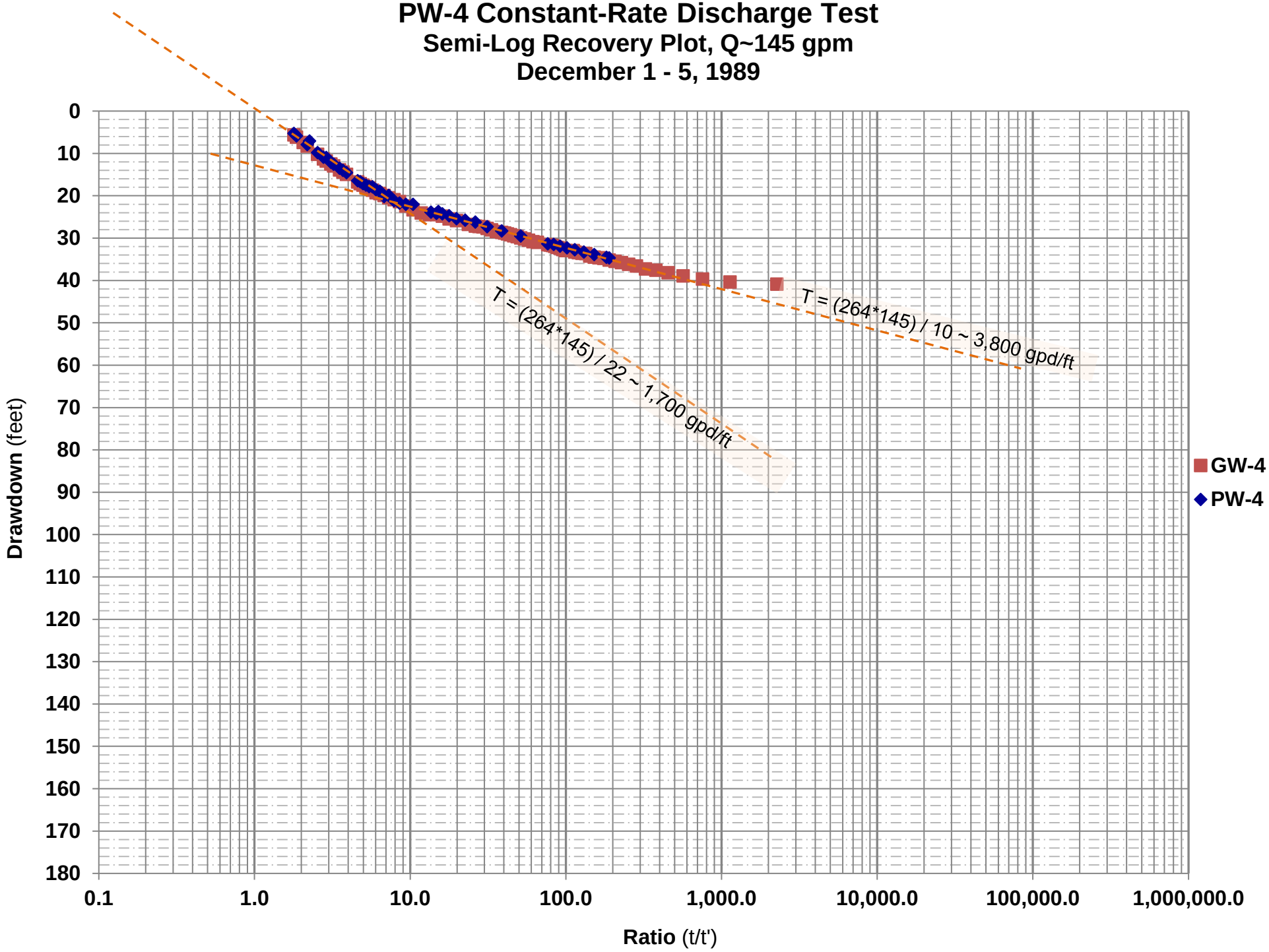


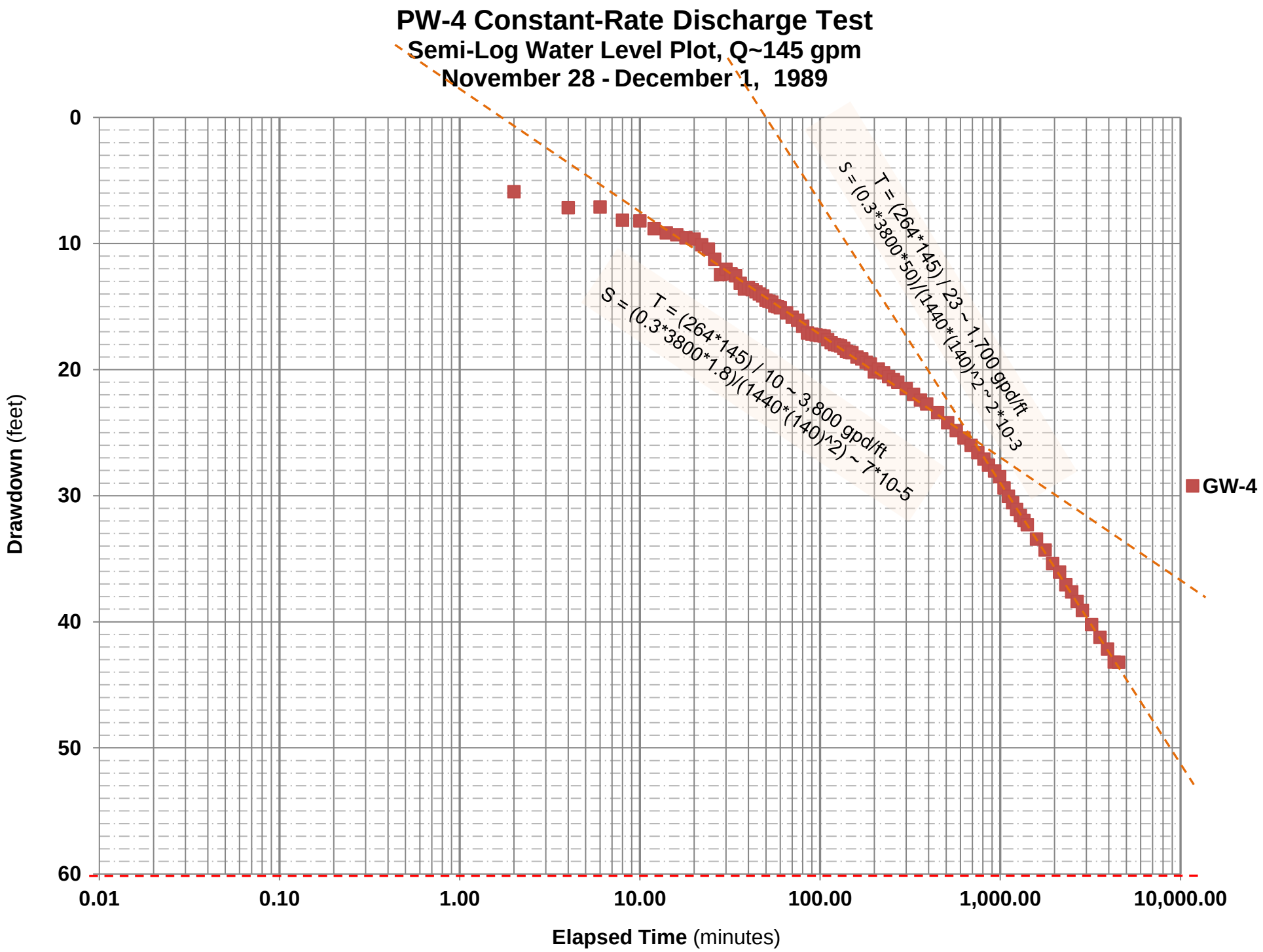
PW-4 Constant-Rate Discharge Test
Depth to Water Plot, Q~145 gpm
November 28 - December 5, 1989



PW-4 Constant-Rate Discharge Test
Semi-Log Water Level Plot, Q~145 gpm
November 28 - December 1, 1989



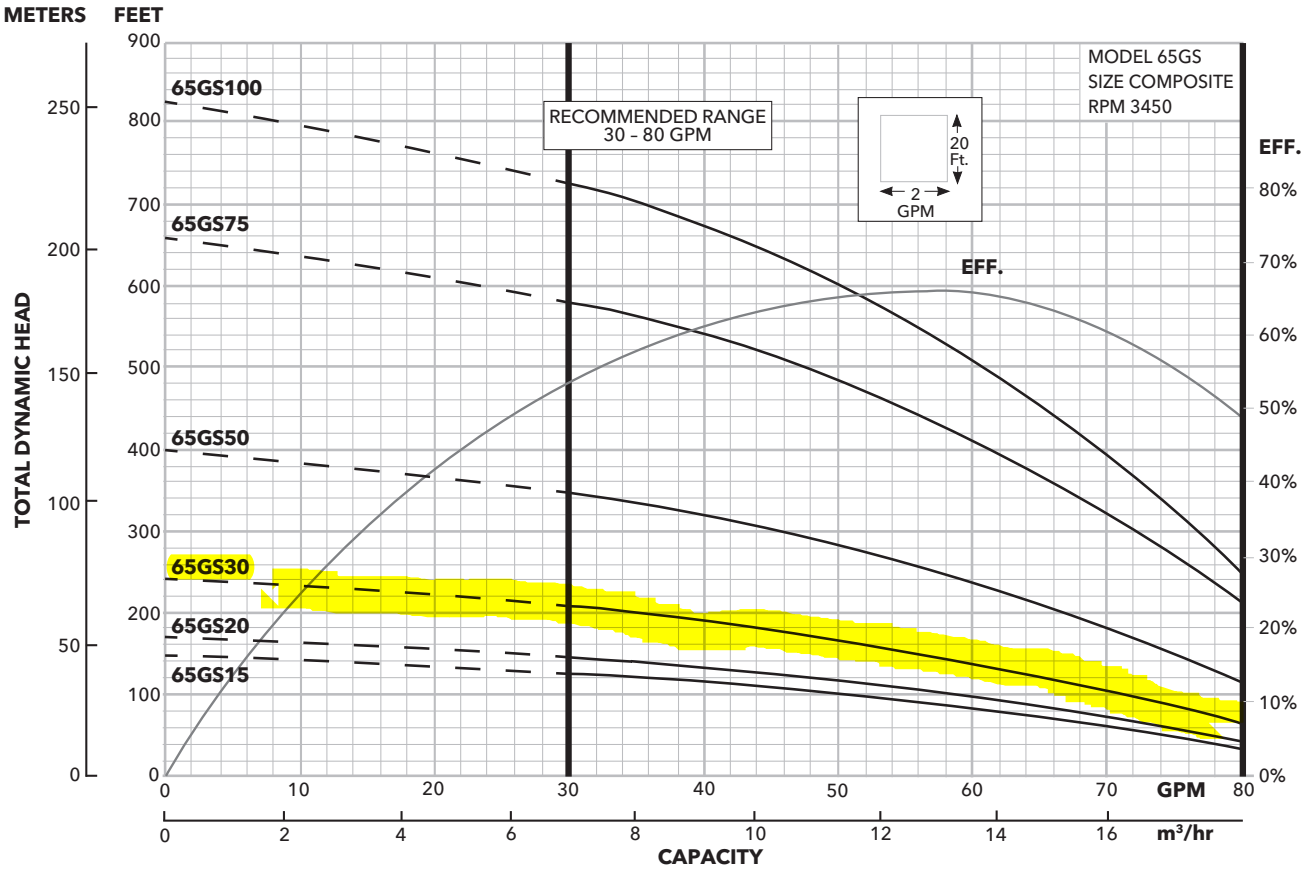

PW-4 Constant-Rate Discharge Test
Semi-Log Recovery Plot, Q~145 gpm
December 1 - 5, 1989
Drawdown (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0.1
1.0
10.0
100.0
1,000.0
10,000.0
100,000.0
1,000,000.0
Ratio (t/t')
T = (264*145) / 22 ~ 1,700 gpd/ft
T = (264*145) / 10 ~ 3,800 gpd/ft
GW-4
PW-4


PW-4 Constant-Rate Discharge Test
Semi-Log Water Level Plot, Q~145 gpm
November 28 - December 1, 1989
T = (264*145) / 23 ~ 1,700 gpd/ft
S = (0.3*3800*50)/(1440*(140)^2 ~ 2*10-3
T = (264*145) / 10 ~ 3,800 gpd/ft
S = (0.3*3800*1.8)/(1440*(140)^2) ~ 7*10-5
GW-4
Drawdown (feet)
0
10
20
30
40
50
60
0.01
0.10
1.00
10.00
100.00
1,000.00
10,000.00
Elapsed Time (minutes)

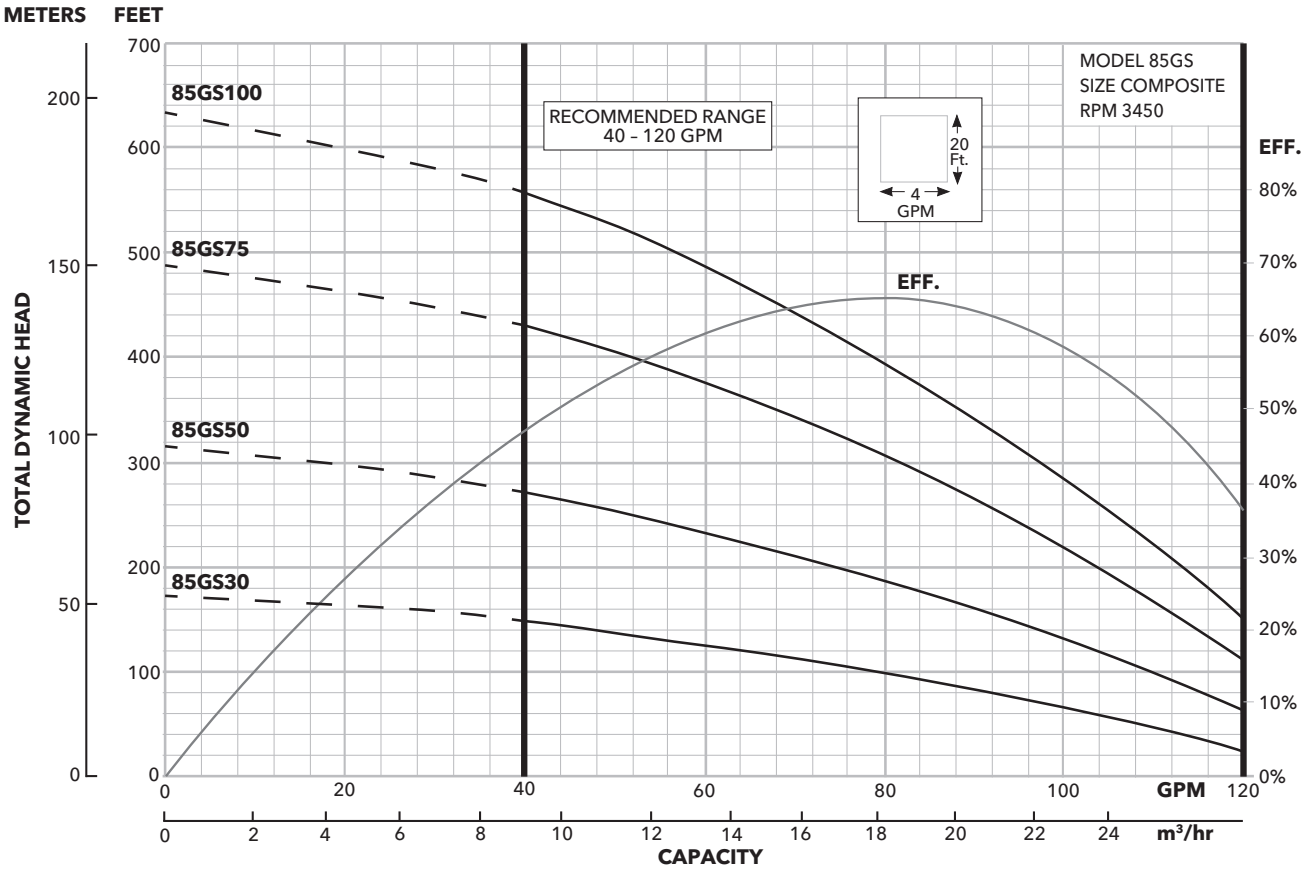
Attachment C
Example Pump Curves

Model 65GS

Example Pump for Well 1 (Prod-1)

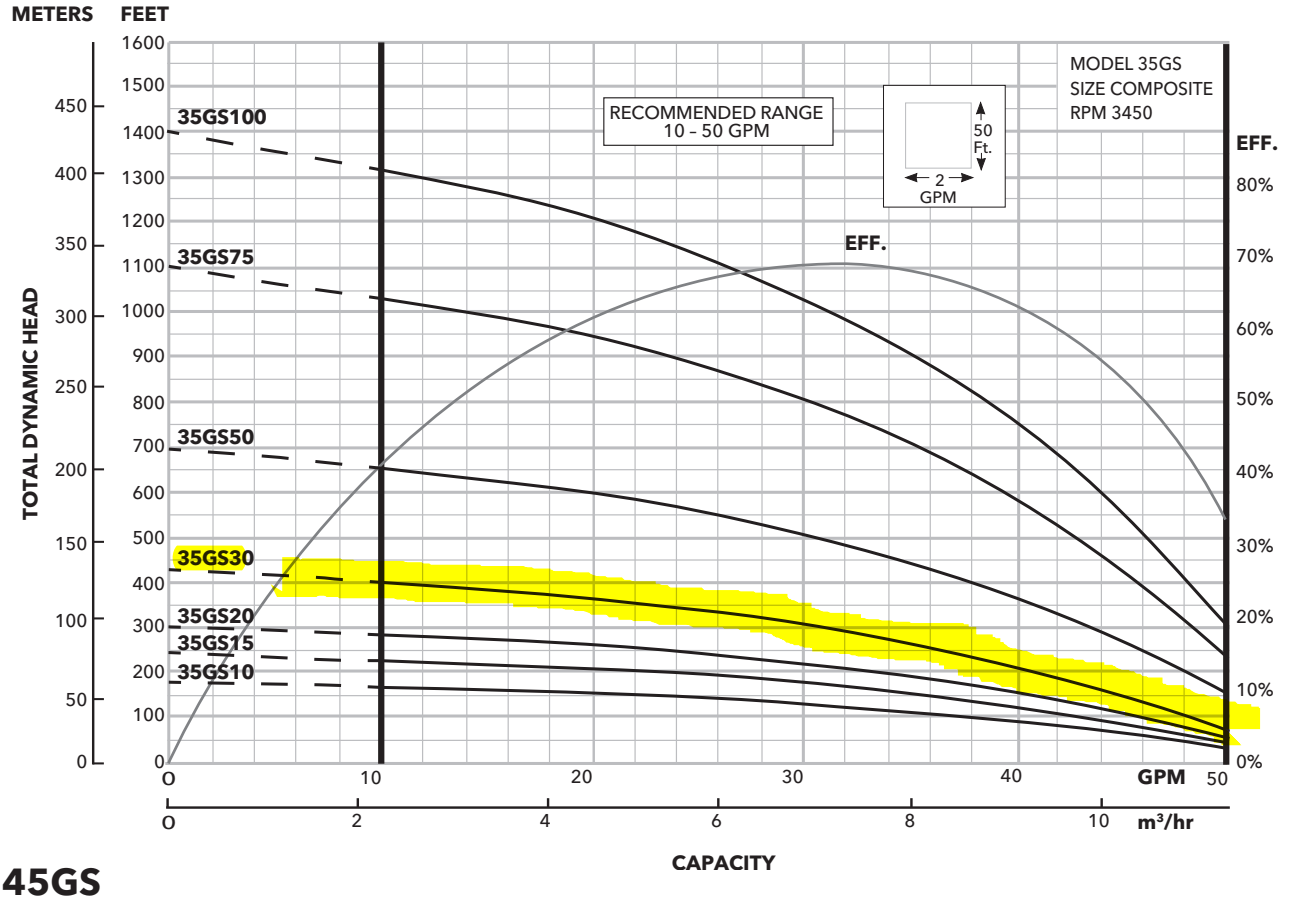


Model 85GS

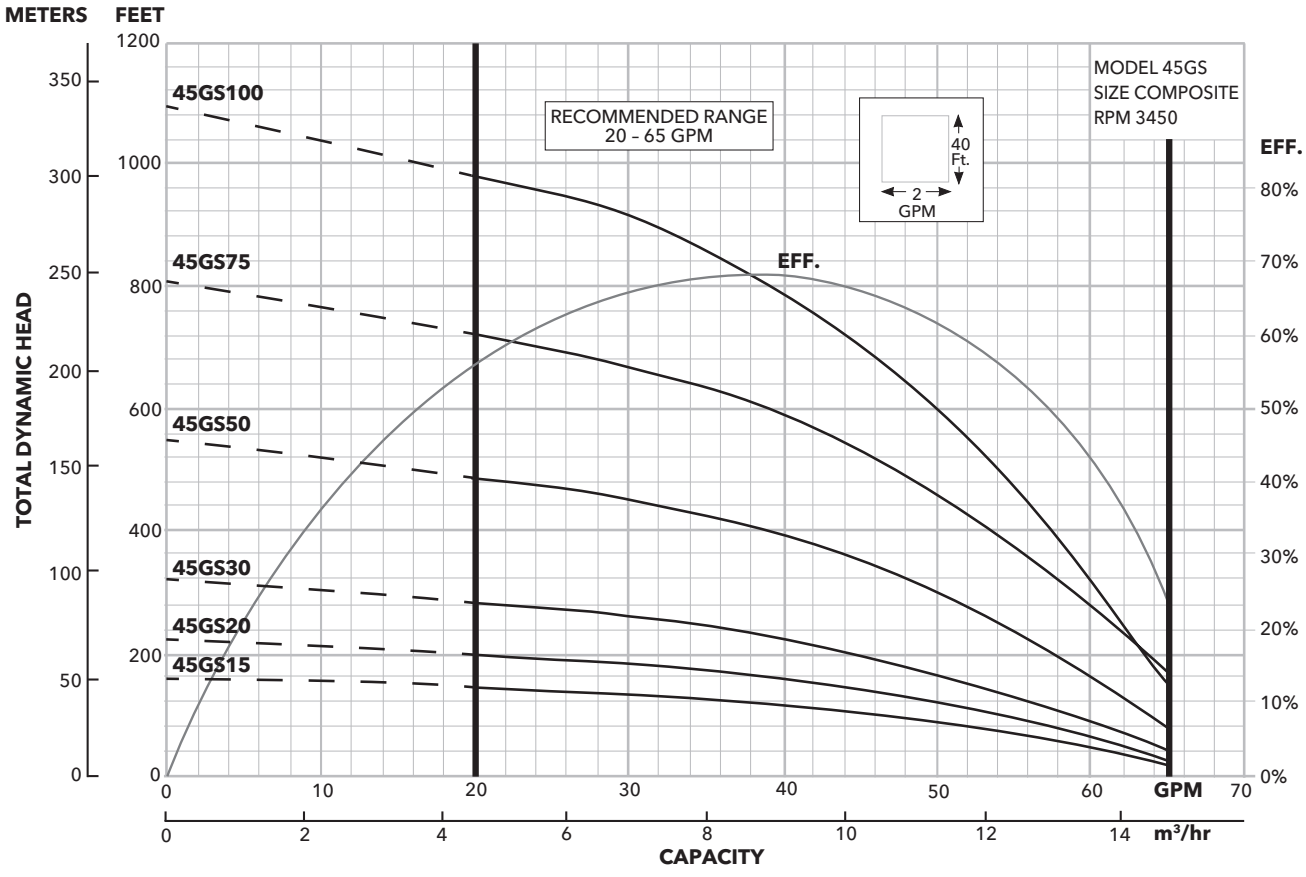


Model 35GS

Example Pump for Well 2 (PW-1)



Model 45GS

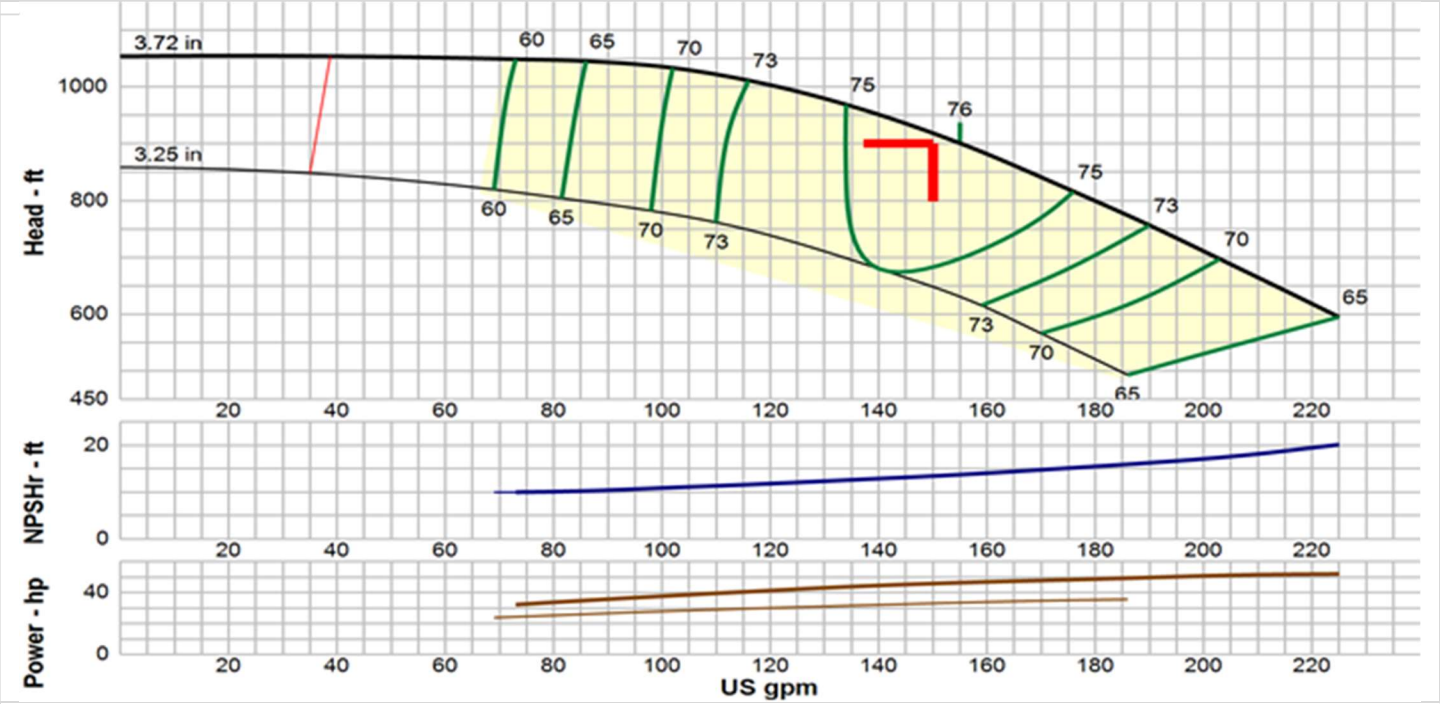


Example Pump for Well 3 (PW-4)

GOULDS WATER TECHNOLOGY a xylem brand

Performance Curve

Product Name: VIS - Submersible Vertical Turbine(Borehole) Pumps
Product Id: GWT_VIS
Quote Number 9003-190319-007



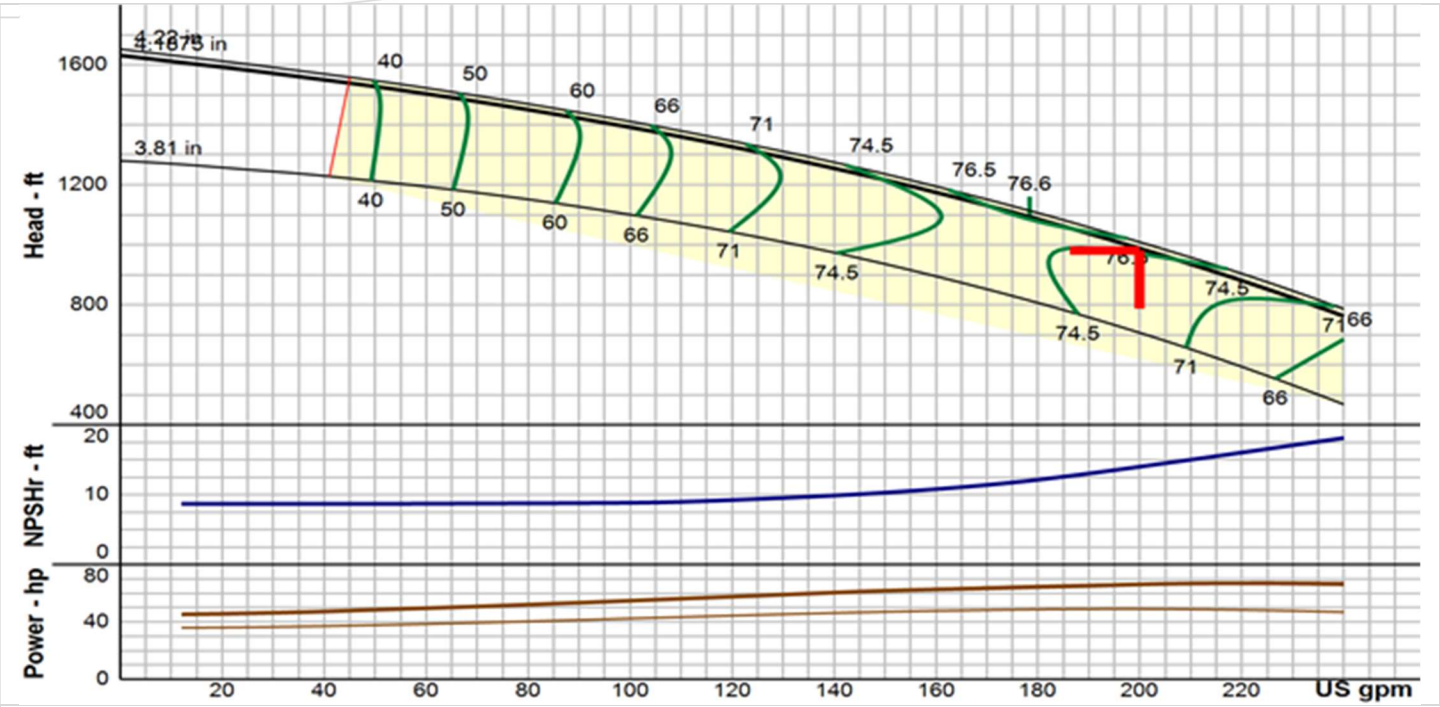
Curve & hydraulic data presented is nominal performance based on ANSI/HI 14.6 acceptance grade 2B. Design values are guaranteed within the following tolerances: Flow ± 8%, Head ± 5%, and optionally either Power + 8% or Efficiency - 5% at manufacturer's discretion.

Series	GWT_VIS	Max Power on Design Curve	52.00 Hp
Size	5CHC	Max Power on Max Imp Trim	52.00 Hp
Additional Size	-	Guaranteed Max Power on Design Curve	56.16 Hp
Speed	3,450 RPM	Guaranteed Max Power on Max Imp Trim	56.16 Hp
Number of Stages	17	Flow at BEP	155 USgpm
Frequency	60 Hz	Head at BEP	901 ft
Impeller Trim	3.72 in	NPSH Required	13.5 ft
Additional Impeller	-	Specified NPSH Avail.	33.17 ft
Impeller Maximum Trim	3.72 in	Specified NPSH Avail. Margin	1.1
Specified Flow	150 USgpm	Min Flow	38.8 USgpm
Specified Head	900 ft	Flow on Max Imp Trim @ Max Power	225 USgpm
Flow at Design	150 USgpm	Shut-Off Head	1,054 ft
Head at Design	900 ft	Shut-Off Disc Pressure	456 psi
Run-Out Flow	null USgpm	Fluid Type	Water
Run-Out Head	null ft	Water Temperature	68 °F
Efficiency at Design	75.80 %	Allowable Sphere Size	0.41 in
Guaranteed Efficiency at Design	72.01 %	Exact Bowl Diameter	5.2 in
Best Efficiency	76 %	Curve Id	E6205CCPC2
Driver Size	60 Hp	Thrust K Factor	1.3 lb/ft
Power at Design	45.90 Hp	Add Thrust K Factor	1.3 lb/ft
Guaranteed Power	49.57 Hp	Max Lateral	0.25 in
Flow on Design Trim @ Max Power	225 USgpm	Total Flow Derate Factor	1
Acceptance Grade	2B	Total Head Derate Factor	1
Service Factor	No	Total Efficiency Derate Factor	1

GOULDS WATER TECHNOLOGY a xylem brand

Performance Curve

Product Name: VIS - Submersible Vertical Turbine(Borehole) Pumps
Product Id: GWT_VIS
Quote Number 9003-190529-022



Curve & hydraulic data presented is nominal performance based on ANSI/HI 14.6 acceptance grade 2B. Design values are guaranteed within the following tolerances: Flow ± 8%, Head ± 5%, and optionally either Power + 8% or Efficiency - 5% at manufacturer's discretion.

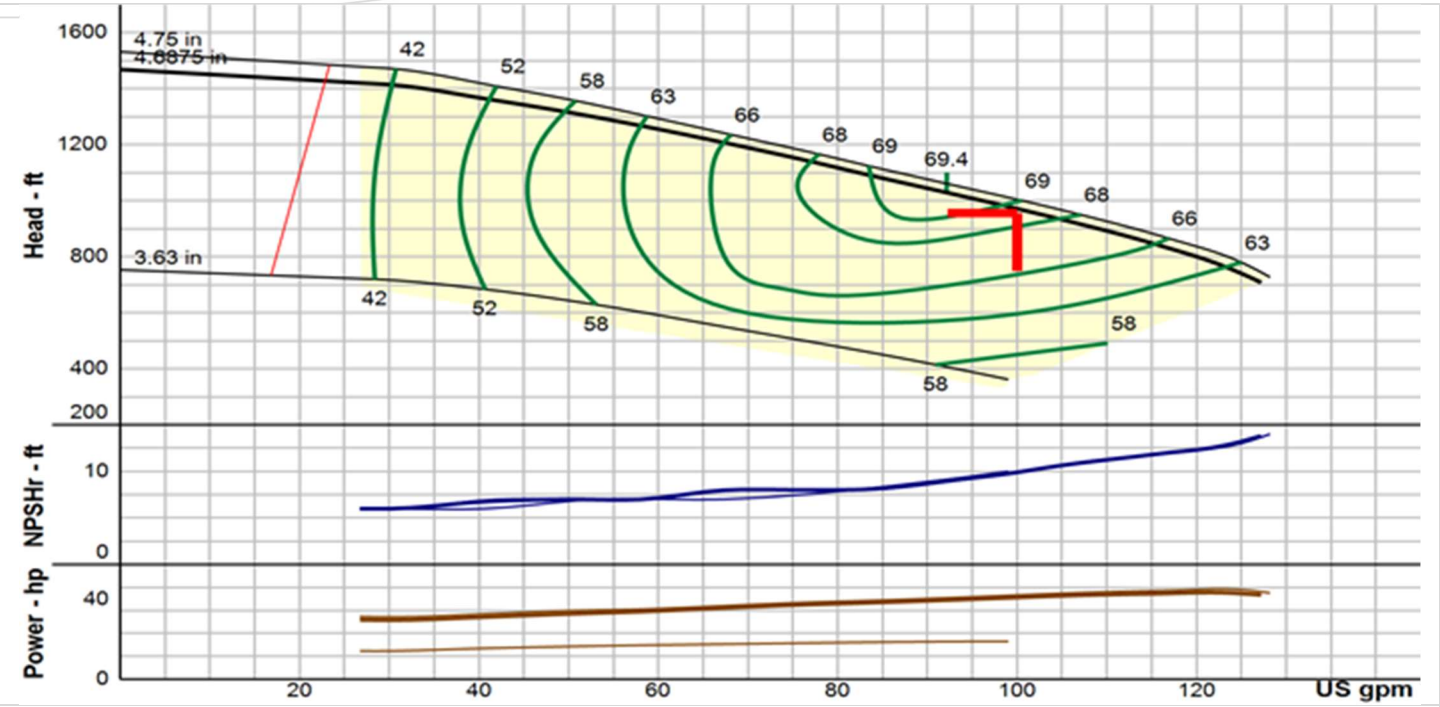
Series	GWT_VIS	Max Power on Design Curve	66.70 Hp
Size	6CLC	Max Power on Max Imp Trim	67.60 Hp
Additional Size	-	Guaranteed Max Power on Design Curve	72.04 Hp
Speed	3,450 RPM	Guaranteed Max Power on Max Imp Trim	73.01 Hp
Number of Stages	20	Flow at BEP	178 USgpm
Frequency	60 Hz	Head at BEP	1,093 ft
Impeller Trim	4.1875 in	NPSH Required	14.1 ft
Additional Impeller	-	Specified NPSH Avail.	33.17 ft
Impeller Maximum Trim	4.22 in	Specified NPSH Avail. Margin	1.1
Specified Flow	200 USgpm	Min Flow	44.6 USgpm
Specified Head	980 ft	Flow on Max Imp Trim @ Max Power	217 USgpm
Flow at Design	200 USgpm	Shut-Off Head	1,631 ft
Head at Design	986 ft	Shut-Off Disc Pressure	706 psi
Run-Out Flow	null USgpm	Fluid Type	Water
Run-Out Head	null ft	Water Temperature	68 °F
Efficiency at Design	75.20 %	Allowable Sphere Size	0.47 in
Guaranteed Efficiency at Design	71.44 %	Exact Bowl Diameter	5.88 in
Best Efficiency	76.6 %	Curve Id	E6206CFPC2
Driver Size	75 Hp	Thrust K Factor	2.1 lb/ft
Power at Design	66.10 Hp	Add Thrust K Factor	2.1 lb/ft
Guaranteed Power	71.39 Hp	Max Lateral	0.25 in
Flow on Design Trim @ Max Power	233 USgpm	Total Flow Derate Factor	1
Acceptance Grade	2B	Total Head Derate Factor	1
Service Factor	No	Total Efficiency Derate Factor	1

Example Pump for Well 7

GOULDS WATER TECHNOLOGY a xylem brand

Performance Curve

Product Name: VIS - Submersible Vertical Turbine(Borehole) Pumps
Product Id: GWT_VIS
Quote Number 9003-190606-011



Curve & hydraulic data presented is nominal performance based on ANSI/HI 14.6 acceptance grade 2B. Design values are guaranteed within the following tolerances: Flow ± 8%, Head ± 5%, and optionally either Power + 8% or Efficiency - 5% at manufacturer's discretion.

Series	GWT_VIS	Max Power on Design Curve	37.70 Hp
Size	7RALC	Max Power on Max Imp Trim	39.10 Hp
Additional Size	-	Guaranteed Max Power on Design Curve	40.72 Hp
Speed	3,450 RPM	Guaranteed Max Power on Max Imp Trim	42.23 Hp
Number of Stages	15	Flow at BEP	92.1 USgpm
Frequency	60 Hz	Head at BEP	1,029 ft
Impeller Trim	4.6875 in	NPSH Required	10 ft
Additional Impeller	-	Specified NPSH Avail.	33.17 ft
Impeller Maximum Trim	4.75 in	Specified NPSH Avail. Margin	1.1
Specified Flow	100 USgpm	Min Flow	23 USgpm
Specified Head	955 ft	Flow on Max Imp Trim @ Max Power	125 USgpm
Flow at Design	100 USgpm	Shut-Off Head	1,469 ft
Head at Design	971 ft	Shut-Off Disc Pressure	636 psi
Run-Out Flow	null USgpm	Fluid Type	Water
Run-Out Head	null ft	Water Temperature	68 °F
Efficiency at Design	68.60 %	Allowable Sphere Size	0.22 in
Guaranteed Efficiency at Design	65.17 %	Exact Bowl Diameter	7.5 in
Best Efficiency	69.4 %	Curve Id	1003-4
Driver Size	50 Hp	Thrust K Factor	1.61 lb/ft
Power at Design	35.70 Hp	Add Thrust K Factor	1.61 lb/ft
Guaranteed Power	38.56 Hp	Max Lateral	0.25 in
Flow on Design Trim @ Max Power	123 USgpm	Total Flow Derate Factor	1
Acceptance Grade	2B	Total Head Derate Factor	1
Service Factor	No	Total Efficiency Derate Factor	1

Attachment D
Well 4 Construction Specifications

TECHNICAL SPECIFICATIONS
RAW WATER SUPPLY WELL 4
GRASSY MOUNTAIN GOLD PROJECT

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials, labor, plant, equipment, tools, supplies, transportation, and appurtenances for drilling, casing, developing, completing, and testing of one raw water supply well (Well 4) at the Grassy Mountain Gold Project (Project) site for Calico Resources USA Corp (the Owner) as specified herein and in accordance with the requirements of the Contract Documents.

B. Approximate depths of drilling and lengths of well casings and screen are to be used for the purpose of price estimation only. Exact depths and lengths may be adjusted by the Engineer depending on subsurface conditions.

C. Work requirements for each well are summarized below. Each item is discussed in subsequent sections of the Specifications.

(1) Mobilize to the work site.
(2) Drill for, furnish, and install 16-inch diameter temporary steel surface casing through the surface sediments to an anticipated depth of 30 feet.
(3) Drill a minimum 14-inch diameter borehole to depth determined by Engineer, installing temporary casing as required to advance the bore.
(4) Furnish and install 10-inch I.D. steel casing (0.365-inch wall thickness) and 10-inch stainless steel well screen as directed by Engineer.
(5) Furnish and install Colorado Silica Sand filter pack and filter pack seal.
(6) Seal the annular space outside the casing with neat cement from the top of the filter pack seal to ground surface, withdrawing the temporary surface casing during installation of the seal.
(7) Develop the well.
(8) Furnish, install, operate, and remove test pump.
(9) Disinfect well.
(10) Demobilize from the work site.

D. All well construction work not specifically addressed in these specifications shall conform to the State of Oregon Water Resources Department (OWRD) Well Construction Standards (Oregon Administrative Rules (OAR) Chapter 690 Division 200, 205, 210, and 217).

E. All materials used for well construction, including drilling fluids, shall be certified to NSF Standard 60, NSF Standard 61, or equivalent.

F. All casing, screens, and materials shall be handled with care to avoid damage. The Contractor's methods of loading, transporting, and unloading materials shall conform to manufacturer recommendations. Casing and screen shall be kept free from dirt and foreign matter. Foreign material, including manufacturer labels, shall be removed from pipe interior prior to installation.

1.02 BEGINNING AND COMPLETION OF WORK

A. The work schedule shall be in accordance with Owner requirements.

1.03 SERVICES FURNISHED BY THE ENGINEER AND OWNER

A. The Owner will provide land and rights-of-way for the Work specified in this Contract. Provisions for access to the Work site will be provided by the Owner. The Contractor shall not enter on or occupy with laborers, tools, equipment, or material any ground outside the property and rights-of-way provided by the Owner unless stated otherwise by the Owner. Other Contractors, employees, or agents of the Owner may enter the work site and premises used by the Contractor for business purposes.

B. The Engineer (as the Owner's Representative) will participate in well testing, evaluation of drilling characteristics, sample examination, and geologic log interpretation, and will advise the Contractor on the final design placement of well casing, surface seal, filter pack and well screen. The Engineer shall be present during placement of well seals and for test pumping.

1.04 WORK SITE

A. The well site is located with the Project Permit Area as defined in the *Third Notice of Intent Pre-Application Phase of a Proposed Mining Operation: Calico Resources USA Corp. Grassy Mountain Gold Project (February 2017)*. The well site is located in a remote area approximately 22 miles south of Vale, Oregon and approximately 70 miles west of Boise, Idaho. The legal description of the well site is the SE ¼ of the NW ¼ of Section 32, Township 21S Range 44E in Malheur County, Oregon. The latitude and longitude coordinates of the proposed well site are 43°42'11.99" N and 117°21'57.01" W. The well site can be accessed from Vale, Oregon or Parma, Idaho via improved dirt road. The well site will be staked prior to Contractor mobilization.

1.05 DRILLING CONDITIONS

A. It is anticipated that drilling will be in clay, gravel, sandstone, conglomerate, and siltstone. Surface alluvium is expected to a depth of 30 feet. Static groundwater level is anticipated to be approximately 70 feet below ground surface. It is the Contractor's responsibility to make his own determination of subsurface conditions.

B. The drilling method for the well shall be determined by the Contractor based on anticipated drilling conditions. If the Contractor chooses to drill by air-rotary, the Contractor shall be prepared to drill by mud rotary if unstable subsurface conditions require it. If the Contractor chooses to drill by mud-rotary, the Contractor shall conduct geophysical logging of the borehole as directed by the Engineer.

C. The Contractor shall be responsible for providing notification to utility owners prior to beginning Work by requesting a facility locate through Oregon Dig Line at 811 or 1-800-332-2344.

D. It is the Contractor's responsibility to become informed about local conditions affecting this Work. Neither the information contained in these specifications, nor gleaned from the Engineer or Owner, or their agents, shall act to relieve the Contractor from any responsibility set forth in the Contract.

1.06 CONTRACTOR QUALIFICATION AND EQUIPMENT

A. The Contractor shall have at least five years of well drilling experience and shall have constructed at least 5 wells of comparable construction. A list of completed comparable projects shall be provided upon request.

B. The Contractor shall hold a valid Oregon Water Supply Well Constructor's License or work under the supervision of a licensed Water Supply Well Constructor.

C. The Contractor is responsible for filing a water well construction notice (start card) with the OWRD prior to commencing well construction. The Contractor is responsible for obtaining all other applicable permits.

D. The Contractor shall submit a list of equipment to be used on the project. The list shall include: (1) manufacturer; (2) load capacities; (3) year of manufacture; and (4) year of purchase by current Owner. The Contractor is responsible for providing equipment capable of performing the Work specified.

E. Damages to the well or surrounding property by the Contractor's equipment, leased or otherwise, shall be repaired or replaced at the Contractor's expense.

F. The Contractor shall have equipment capable of swabbing and airlifting the well to a total depth of 500 feet.

G. Upon completion of the well, the Contractor shall prepare, certify, and submit a water well report (log) to the OWRD and Owner.

1.07 SUBMITTALS

A. The Contractor shall provide submittals for all materials to the Engineer for review and approval prior to their use. The submittals shall be provided in an electronic format. Submittals shall be provided for casing, well screen, centralizers, seal materials, filter pack materials, and drilling fluids and additives. All materials shall be new and unused and in excellent condition.

B. The proposed test pump with curve shall be approved the by the Engineer prior to installation and test pumping.

1.08 CONTRACT DOCUMENTS

A. The form and detail of the various features of the Work are illustrated on the following drawings accompanying and made part of the Contract Documents:

- Figure 1 – Well 4 Location Map
- Figure 2 – Well 4 Conceptual Design

1.09 WATER, POWER, AND SITE IMPROVEMENTS

A. The Contractor shall be responsible for obtaining water supply for drilling. All water used for well construction purposes shall be of potable quality and adequately disinfected to prevent groundwater contamination. Water for drilling may be available from three on-site wells with approval from the Owner. These wells are located about 750 feet (PW-4),0.9 miles (Prod-1),

and 2.7 miles (PW-1) from the well site. These wells are equipped with pumps; the Contractor shall provide a portable generator to operate the pumps.

B. If the Owner does not grant approval to use on-site wells for water supply or the Contractor chooses to obtain water from an alternate source, the Contractor shall provide for the quantity and quality of water required at his own expense. Costs for pumps, water conveyance facilities, or transportation to the Work site shall be borne by the Contractor including all necessary pumps, piping and components.

C. The Contractor shall provide, at his own expense, all necessary piping and components to transfer discharged well water from the well site to a suitable disposal site during well development and testing. The Contractor can assume a suitable disposal site for clean water within 200 feet of the well site. Water must be discharged at least 50 feet from the well site. A plan for water disposal must be provided by the Contractor and approved by the Owner prior to commencing drilling. The BLM will be notified by the Owner of any water discharge on BLM land. Water shall not be discharged to streams, ponds, or lakes without proper regulatory authorization.

D. The Contractor shall provide, at his own expense, all power required for his operations under the Contract.

E. All drilling fluids or water containing drilling fluids must be discharged to a sump provided at the drill site by the Owner. The Contractor shall haul excess drilling fluids to a central disposal site provided by the Owner.

F. Preparation of the drill site and excavation or backfilling of mud pits, ditches, or settling ponds shall be the responsibility of the Contractor. The Contractor shall be responsible for protecting life and property from excavated mud pits and settling ponds and shall backfill pits as soon as drilling and testing operations are complete. Holes, pits, equipment, and chemicals shall be safely stored and fenced per OSHA standards. All materials shall be stored where safe from damage or contamination.

G. The Contractor will be responsible for complying with all applicable erosion and sediment control requirements including applicable erosion control permits. The Contractor shall implement best management practices, including erosion and sediment control (ESC) structures, practices, permits, and plans to meet all project, local, state, and federal requirements for water quality and erosion and sediment control.

1.10 WORKING HOURS AND SAFETY

A. The Contractor shall work on this project in a steady and diligent manner. The Contractor shall, during all work periods, provide an adequate crew of suitably qualified personnel to prevent unnecessary delays in project completion. The Contractor will be required to provide 24-hour per day maintenance of pumping and monitoring equipment during test pumping

B. The Contractor is responsible for compliance with all applicable safety laws of any jurisdictional agency and safety requirements of the Owner.

1.11 FINAL CLEANUP

A. The Contractor shall thoroughly clean the site after completion of the drilling, well construction, and test pumping operations. All excess drilling fluids, debris, and other materials used during

these operations shall be removed and properly disposed of by the Contractor. Backfilled mud pits shall be compacted to 90 percent maximum dry density as determined by Standard Proctor Test (ASTM 698-00).

B. The Contractor shall promptly remove his equipment, temporary facilities, and materials, and leave the site in a condition approved by the Engineer and Owner. The Contractor shall repair any damage to the property or facilities caused by his operations prior to final acceptance of the Work by the Engineer and Owner.

PART 2 - PRODUCTS

2.01 CASING

A. **Temporary Surface Casing:** Temporary surface casing may be used at the Contractor's option. If utilized, temporary surface casing shall be removed during installation of the surface seal.

B. **Well Casing:** The completed well shall be cased with nominal 10-inch I.D. casing from 2.5 feet above existing ground surface to a depth designated by the Engineer. The casing shall be new steel ASTM A-53 or equal with a minimum wall thickness of 0.365 inches. The casing shall be equipped with centralizers at a spacing of no more than 60 feet.

2.02 WELL SCREEN

A. Well screen shall be of the V-slot continuous wire-wound type in 304 stainless steel of 10-inch pipe size. The top of the well screen shall be equipped with a welding ring. The bottom of the well screen shall be equipped with a stainless steel plate bottom or a welding ring for connection to tail pipe. In order to provide adequate collapse, column, and tensile strengths, the screen construction shall include sufficient wire and rod sizes to be compatible with the depth and pressures of the installation, as recommended by the screen manufacturer.

B. Final screen length, slot size, and placement depths will be determined by the Engineer after completion of the borehole and receipt and evaluation of driller's logs and drill cuttings.

2.03 CENTRALIZERS

A. Centralizers shall be provided at nominal 60-foot intervals and at each screen section. Centralizers shall be welded to the casing. A shop drawing of the centralizer shall be submitted to the Engineer for review and approval prior to installation.

2.04 SAND FILTER PACK

A. A sand filter pack shall be placed around the well screen assembly. The filter pack shall be installed opposite the entire length of the screen assembly, and shall extend above the top screen a minimum of 20 feet (unless otherwise directed by the Engineer). The pack shall consist of clean, well-rounded siliceous material with a uniformity coefficient of 2.5 or less, manufactured by Colorado Silica Sand, Inc., Colorado Springs, CO (or approved equal), and conforming to one of the following gradation specifications to be determined following analysis of drill cuttings.

20-40 Filter Sand	16-30 Filter Sand

90-100% passing No. 20 sieve
90-100% retained on No. 40 sieve

90-100% passing No. 16 sieve
90-100% retained on No. 30 sieve

10-20 Filter Sand
90-100% passing No.10 sieve
90-100% retained on No. 20 sieve

8-12 Filter Sand
90-100% passing No. 8 sieve
90-100% retained on No. 12 sieve

6-9 Filter Sand
90-100% passing No.6 sieve
90-100% retained on No. 9 sieve

2.05 FILTER PACK SEAL

A. A filter pack seal shall be installed in the annulus above the filter pack to prevent grout used for the annular seal from infiltrating into the filter pack. The filter pack seal shall include a 5-foot thick layer of bentonite. Material for the bentonite seal shall be 3/8- to 3/4-inch sodium bentonite chips. Bentonite shall be specifically designed for sealing wells.

2.06 WELL SEAL

A. The annulus outside the 10-inch well casing shall be sealed with cement grout. Seal thickness shall meet the requirements of the OWRD Well Construction Standards (OAR 690-210).

B. The grout shall contain between 4.5 and 6 gallons of clean water per 94 pounds of Portland cement. Mix water quality and quantity shall follow manufacturer specifications paying close attention to cement grind and water ratios, eliminating free water. Additives may only be used if approved by OWRD.

C. A 50 percent excess volume of seal material shall be available on site if neat cement is used as seal material.

2.07 WELL HEAD

A. The completed well shall have 10-inch casing to 2.5 feet above existing ground surface. The Contractor shall install a temporary cap on the completed well (welded steel plate with access port).

PART 3 - EXECUTION

3.01 MOBILIZATION AND DEMOBILIZATION

Upon receiving the Notice to Proceed, the Contractor shall move in all tools, equipment, and supplies necessary for the Work, and upon completion of the Work, shall remove all such items from the premises promptly and leave the site in a clean and orderly fashion.

3.02 CONSTRUCTION SEQUENCE

A. The sequence of construction for this project shall consist of the following:

(1) Mobilize to the work site.

(2) Place a 16-inch diameter temporary steel surface casing through the surface alluvium to an anticipated depth of 30 feet.
(3) Drill a minimum 14-inch diameter borehole to depth determined by Engineer, installing temporary casing as required to advance the bore.
(4) Furnish and install 10-inch I.D. steel casing (0.365-inch wall thickness) and 10-inch stainless steel well screen as directed by Engineer.
(5) Furnish and install Colorado Silica Sand filter pack and filter pack seal.
(6) Install neat cement surface seal, withdrawing any temporary surface casing.
(7) Develop the well.
(8) Perform test pumping of the well.
(9) Disinfect the well.
(10) Provide temporary cap on the well and attach well tag.
(11) Clean work site and demobilize equipment.

3.03 DRILLING

A. The drilling method for the well shall be determined by the Contractor based on anticipated drilling conditions. If the Contractor chooses to drill by air-rotary, the Contractor shall be prepared to drill by mud rotary if unstable subsurface conditions require it. If the Contractor chooses to drill by mud-rotary, the Contractor shall conduct geophysical logging of the borehole as directed by the Engineer. The borehole shall be of sufficient diameter to meet the requirements of the OWRD Well Construction Standards (OAR 690-210).

B. The Contractor shall provide for and install temporary casing as required to advance the borehole to the target depth. The cost for temporary casing shall be included in the unit price for drilling or reaming on the bid schedule. The temporary casing shall be removed during backfilling or sealing of the borehole.

C. Drilling fluid properties shall be maintained in such a manner to ensure the structural integrity of the borehole and to circulate drill cuttings representative of the strata penetrated to the ground surface. Drilling fluid additives shall be certified to NSF Standard 60 or 61. A mud kit shall be available for measuring drilling fluid properties throughout the project if applicable.

D. The Contractor shall sample the drill cuttings at 5-foot intervals and at pronounced changes in geologic formation. These samples shall be saved and maintained on the job site in a clean dry area. All samples are to be submitted to the Engineer and Owner. The samples shall be of at least one-gallon size, shall be kept in cloth sample bags or zip-lock style plastic bags, to be provided by the Contractor, and shall be clearly labeled to show the depth and well from which the sample was collected.

E. All drilling fluids shall be managed to protect groundwater from contamination and disposed of in accordance with State and Federal regulations. Method and place of drilling fluid disposal shall be approved by the Owner. Costs incurred in connection with the disposal of drilling fluids and developed water shall be borne by the Contractor. The Owner will provide a sump at the drill site for disposal of drilling fluids. The Contractor shall haul excess drilling fluids to a central disposal site provided by the Owner.

F. The Contractor shall maintain a daily drilling log of the well. Logs and records shall be kept by the Contractor's drillers on forms suitable to the Engineer, which shall indicate each shift worked; the general character, thickness, and type of material penetrated; and the type of all other Work performed, including the exact time spent on each item of Work. Information that shall be listed on the drilling log includes: (1) drilling fluids and additives, including quantity of

materials used and volume of water or drilling fluid lost to the formation; (2) drilling fluid properties, including weight and viscosity (if applicable); (3) type and diameter of bits used for drilling and total footage for each bit; (4) depth where water encountered and an estimate of the quantity of water produced; and (5) any remarks or comments concerning the drilling characteristics of the borehole, including locations of any lost circulation zones. The forms shall be kept on-site for inspection by the Engineer. Forms shall be provided for Engineer approval prior to commencing construction.

G. Copies of the logs shall be available for inspection by the Owner and Engineer at all times. Copies of all logs shall be furnished to the Owner and Engineer following completion of all operations. The Contractor shall prepare, sign, and submit a water well report for each well constructed to the OWRD.

3.04 PLUMBNESS AND ALIGNMENT

A. The Contractor shall construct the well sufficiently straight and plumb to permit free installation and removal of a nominal 6-inch test or production pump with 8-inch motor. The hole shall be drilled to the depth designated by the Engineer with a total deviation of the casing not to exceed one degree per 100 feet of the well. The alignment will be considered satisfactory if the casing will permit the free lowering and raising of a dummy between land surface and the bottom of the 10-inch casing section. The dummy shall be constructed of a 40-foot length of standard 8-inch I.D. pipe. It shall be the responsibility of the Contractor to see that the well is being constructed straight and plumb within these limits at all times. Any indications of inadequate plumbness or alignment during drilling, casing, or pump setting operation shall be cause to require measurement of plumbness or alignment by a method approved the Engineer. No payment shall be made for tests of alignment; any such tests shall be considered subsidiary to other items in this Contract.

B. If the well has unacceptable plumbness or alignment, the Contractor shall undertake remedial measures. Any alignment work required by the Contractor in re-drilling or straightening the well shall be at his sole expense. If a well is deemed unacceptable following remedial measures, then as much casing as can be removed from the well shall be salvaged by the Contractor. Salvaged casing will be the property of the Contractor. The well shall be abandoned in accordance with OWRD requirements (OAR 690-220) at the Contractor's expense. All payments associated with construction of the abandoned well shall be credited to construction of a replacement well.

3.05 GEOPHYSICAL LOGGING

A. Geophysical logging of the borehole will be required if the Contractor drills by mud-rotary. If the Engineer or Owner requests geophysical logging, the Engineer shall be given at least 24 hours of notice of the time when the survey will be run in order to witness the performance of the survey. The logs run shall include normal resistivity (8", 16", 32", and 64"), single point resistivity, specific potential, natural gamma radiation, and temperature.

B. It is the Contractor's responsibility to ensure that the borehole remains open to the total completion depth for geophysical logging.

C. Three full-scale and three reduced-scale printed copies of the logs shall be provided. The logs shall also be provided in electronic format (ASCII or similar) on DVD or CD or transmitted by email.

3.06 INSTALLATION OF WELL CASINGS, SCREEN, AND CENTRALIZERS

A. The permanent well casing shall extend at least 5 feet into a clay confining layer overlying the target water-bearing zone.

B. Welding: Individual lengths of steel casing shall be joined by welding. Welding shall be performed by properly qualified operators following the manufacturer's recommendations and in accordance with AWWA C206. Welds shall penetrate the full thickness of the casing wall.

1. The standards of the American Welding Society, Structural Welding Code (AWS D1.1) shall apply for all welded joint casing and accessories. All welds shall conform to the latest revision of ANSI B31.1.

2. There shall be a minimum of three (3) weld passes on pipe sizes 6-inches and greater.

3. Welded casing joints shall have a tensile strength equal to or greater than that of the casing.

C. Weld Reinforcement: Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions.

D. When complete, the well casing shall extend a minimum of 30 inches above existing grade to provide a casing height of 18 inches above the future well house floor. The top of well casing shall be equipped with a welded steel plate, sanitary well seal, or vented well cap, as approved by the Engineer.

E. Centralizers shall be installed at intervals of no more than 60 feet.

3.07 INSTALLATION OF FILTER PACK

A. A sand filter pack shall be placed opposite the well screen and a maximum of 20 feet above the top of the screen. Filter pack shall be placed using a tremie pipe to avoid bridging and to ensure uniform placement. Potable water may be used to wash filter pack into place. The volume of water used shall be measured and recorded. The level of the filter pack shall be tagged at frequent intervals to confirm that it is not bridging. The top of the filter pack shall be tagged following installation to verify and document final placement depth. The volume of the filter pack shall be monitored during placement to confirm that the pack is not bridging.

B. Following installation, the pack shall be settled by swabbing or other means.

C. The pack shall be disinfected with a minimum 50-ppm chlorine solution prior to installation.

3.08 INSTALLATION OF FILTER PACK SEAL

A. A filter pack seal shall be installed in the annulus above the filter pack to prevent grout used for the annular seal from infiltrating into the filter pack. The filter pack seal shall consist of a 5-foot thick bentonite seal.

B. Material for the bentonite seal shall be 3/8- to 3/4-inch unhydrated sodium bentonite chips below the water table and hydrated sodium bentonite chips above the water table. Bentonite shall be specifically designed for sealing wells.

C. Bentonite chips shall be installed in a slow and continuous manner, with a pour rate of 2 minutes or slower per standard 50-pound bag. Unhydrated bentonite shall be screened across a minimum ¼-inch mesh screen before being introduced into the well. Bentonite chips installed above the water table shall be hydrated after placement with potable water pumped through a tremie pipe.

D. The bentonite seal shall be tagged during placement to determine if the seal is reaching its intended position. Seal level shall be checked by tagging with a sinker bar or other means. The volume of bentonite used shall be compared with the annular space volume to evaluate the potential for bridging. Adequate time shall be provided to allow the bentonite seal to hydrate (1 to 2 hours) prior to placing the grout annular seal.

3.09 INSTALLATION OF WELL SEAL

A. The 10-inch diameter well casing shall be installed in a minimum 14-inch diameter borehole. The annular space between the casing and bore wall shall be sealed with cement grout. The annular seal shall extend from the top of the filter pack seal to ground surface. The seal depth will exceed 18 feet. Any temporary casing shall be withdrawn as the seal is placed.

B. Seal thickness and installation shall meet the requirements of the OWRD Well Construction Standards (OAR 690-210).

C. Cement grout seals shall be installed by the tremie method. The grout shall be pumped into the annular space through a tremie pipe that shall be extended from ground surface to the bottom of the zone being grouted. Grout shall be placed from the bottom up in a continuous operation. The grout pipe shall be slowly raised as the grout is placed, but the discharge end of the tremie pipe must be submerged in the emplaced grout at all times until grouting is complete. The grout pipe shall be maintained full to the surface at all times until completion of the grouting of the entire specified interval.

D. Once grouting is complete, no further work shall be performed on the well for a minimum of 24 hours. No standby or rig time will be paid while grout is setting. The permanent well casing shall not be moved or driven following placement of the grout seal.

E. In the event of borehole collapse prior to placement of the grout, the Contractor shall take whatever steps are necessary to reopen the hole and to place the seal as specified. Any such remedial action shall be conducted at the Contractor's expense.

F. Volumes of seal material placed shall be carefully monitored and checked against calculated volume requirements.

G. The Engineer shall be notified a minimum of 24 hours prior to seal placement, and shall be present during seal placement.

H. Seals shall be installed in a slow and continuous manner, and temporary casing shall be withdrawn as the seal is placed.

3.10 DEVELOPMENT

A. Following seal placement and curing, the well shall be developed by pump surging (rawhiding), mechanical surging using a surge block or swab, air-lift surging, hydraulic jetting, or other methods approved by the Engineer. If the Contractor selects pump surging as the sole means of development and the well does not produce clear water free from sand or the well does not produce the target yield, then the Contractor may be required to perform mechanical development or jetting in addition to surge development. The Contractor shall provide a written log documenting development methods, discharge rates, and duration of each development operation.

B. Mechanical surging shall be performed using a surge block or swab. The outside diameter of the surge block or swab shall be only slightly smaller than the inside diameter of the casing (1/8 to 1/4-inch). Surging of the well shall begin in the casing immediately above the uppermost section of well screen. Initial surging shall be with a long stroke at a slow rate. Surging in the casing section shall continue until no additional appreciable quantity of sand, silt, or clay is brought into the well. Following surging of the casing, the surge block or swab shall be lowered into the lowest screened section and surge development continued. Surge development shall continue upward until the entire screen has been developed. The screen shall be surged in 20-foot sections. Surging shall then be repeated at a faster stroke starting at the bottom of the well. Periodically, the Contractor shall measure and bail from the well all sand, silt, and clay that has accumulated at the bottom. Surging shall continue until no more sediment is bailed from the well and the well produces clear water.

C. Hydraulic jetting shall be performed with a jetting tool to produce a minimum nozzle velocity of 150 feet per second. The jetting tool shall be lowered into the bottom of the screen, rotated slowly and continuously, and slowly raised throughout the entire screen length. Jetting shall be continued until the well produces clear water free from sediment. Simultaneous air-lift pumping may be employed to remove fines from the well.

D. The well may be developed using air-lift surging. For air-lifting, the Contractor shall have a compressor, tubing and eductor pipe to air-lift a minimum of 200 gpm average flow from 500 feet depth. Sufficient tubing or drill stem shall be available to reach the total depth of the well. It is anticipated that air development will take place in a staged manner throughout the lower portion of the well, and thus may include considerable addition and subtraction of pipe. For long screen sections, a double-packer tool shall be used to develop short sections of screen. Periodically, the Contractor shall measure and bail from the well all sand, silt, and clay that has accumulated at the bottom.

E. Final well development shall be performed by alternative pumping and surging with the test pump. The well shall be pumped at a restricted initial pumping rate. As water clears, the pumping rate shall be gradually increased until maximum discharge rate is reached. At regular intervals, the pump shall be stopped and the water in the pump column shall be allowed to surge back through the pump intake. Development pumping shall continue until discharged water is clear and sand free (less than 5 ppm sand at the design capacity of the well), as measured by the Engineer.

F. The Contractor may be required to use a dispersant or other well development additive to achieve satisfactory development. All additives must be approved by the Engineer prior to use.

G. Upon completion of the development, all material shall be thoroughly cleaned from the inside of the casing and screen. Material shall be removed by bailing or by suction pumping. If

removed by pumping, the Contractor shall have sufficient tubing or pipe to reach the total depth of the well.

H. Water containing drilling fluids, chemicals, or sediment must be discharged to a sump provided at the drill site by the Owner. The Contractor shall haul excess drilling fluids to a central disposal site provided by the Owner.

3.11 TEST PUMPING

A. Following completion of development operations, the well shall be allowed to recover for 24 hours, or less if approved by the Engineer, prior to starting the pumping tests. Within the hour prior to the start of test pumping, the Engineer will measure static water level in the well three times no less than 20 minutes apart.

B. Anticipated methods of aquifer testing include: (1) a step-test lasting approximately 8 hours, which will consist of pumping the well at various rates from approximately 50 gpm to the maximum capability of the pump or well; and (2) a constant-rate pumping test lasting a minimum of 7 days. The pumping test duration will be determined by the Engineer. The constant-rate test may be extended to 14 days if the well drawdown trend does not stabilize. Standby time will not be paid for the recovery periods between tests or at the conclusion of test pumping. The Engineer shall be present at the start of test pumping. The Contractor shall be responsible for maintaining a constant pumping rate during the test.

C. The test pump shall be capable of delivering a least 200 gpm from a pumping level of 400 feet. The Contractor shall furnish and install all necessary equipment for testing, including a discharge valve or throttle to control flow rate, orifices or flow meter for accurately measuring the discharge from the well, one nominal 1-inch PVC pipe to the top of the pump to facilitate the installation and removal of an electric-line water-level probe, and a sample tap. The Contractor shall measure and record water level, pumping rate (every hour), and elapsed time as directed by the Engineer. The Contractor shall provide a threaded port for attachment of a Rossum Sand Tester by the Engineer. The Engineer shall be responsible for sand testing.

D. Water level measurements shall be taken with a non-stretch electric-line water-level probe. Measurements during the first ten minutes of pumping shall be timed no more than two minutes apart. Water level measurements from ten to thirty minutes of pumping shall be timed no more than five minutes apart. Between 30 minutes of pumping and 2 hours, drawdown measurements shall be taken no more than 15 minutes apart. For the duration of the test, hourly measurements are acceptable unless otherwise directed by the Engineer.

E. After pumping stops, water level recovery measurements shall be taken for four hours or until the well reaches 90 percent recovery from the maximum drawdown, whichever occurs first. Recovery water level measurements shall be taken on the same schedule as for drawdown measurements.

F. The test pump and column pipe shall be disinfected with a minimum 50-ppm chlorine solution prior to installation in the well.

G. The Contractor shall be responsible for providing power for the test pump. The Contractor shall provide a means for safe refueling during operations to prevent even brief shutdowns during the testing. Shutdowns before the end of the testing procedure in excess of ten (10) percent of the total time anticipated for this testing procedure may require the Contractor to

allow the water level to recover to pre-pumping conditions and re-start the test, as determined by the Engineer.

H. The Contractor shall provide all necessary piping and components to transfer water produced during test pumping to a suitable disposal site. The Contractor can assume a suitable disposal site for clean water within 200 feet of the well site. Water must be discharged at least 50 feet from the well site. A plan for water disposal must be provided by the Contractor and approved by the Owner prior to test pumping.

I. The Engineer shall be responsible for collecting water quality samples during the pumping test. The Engineer shall be responsible for determining whether (1) the well productivity is adequate to meet the project requirements and (2) water quality meets Oregon Health Authority requirements.

3.12 DISINFECTION

A. Upon completion of all well construction activities and removal of test pumping equipment, the Contractor shall disinfect the well using calcium hypochlorite or sodium hypochlorite.

1. Calcium hypochlorite or sodium hypochlorite shall be added to achieve a chlorine concentration of 50 ppm in the well, refer to OAR 690-210-0380. The Contractor shall distribute the disinfecting compound throughout the well to achieve a uniform concentration for “in place” disinfection of the well.

2. Chlorine granules or tablets must be dissolved and placed into the well as a solution.

3. All interior surfaces of the well above the static water level shall be wetted with calcium hypochlorite or sodium hypochlorite solution.

B. Near the end of the constant-rate discharge test, duplicate samples shall be collected by the Engineer and the samples shall be tested for the presence of coliform bacteria. The Contractor shall leave the test pump in the well until test results are reported. If any sample shows the presence of coliform bacteria, the Contractor shall collect duplicate samples (without charging rig or standby time while waiting on sampling results). If the second sampling event shows the presence of coliform bacteria, the Contractor shall re-disinfect the well until duplicate samples show the absence of coliform bacteria.

C. The well shall be capped with a vented well cap or sanitary well seal following disinfection.

D. Chlorinated water shall be disposed of in accordance with federal, state, and local requirements. Where applicable, the Contractor shall obtain appropriate permits from regulatory agencies before discharging chlorinated water to the environment.

3.13 PROTECTION OF WATER QUALITY

A. All water used for drilling and development operations shall be of potable quality.

B. The Contractor shall take all necessary precautions to prevent contamination of the water in the well by the introduction of any foreign substance, including contaminated water, gasoline, oil, etc., and shall conform to all laws or regulations applicable to the protection of water quality.

C. All downhole materials (i.e., casing, pipe, pumps, sand filter pack, drilling tools, etc.) shall be disinfected with a minimum 50-ppm chlorine solution.

3.14 WELL IDENTIFICATION TAG

A. The Contractor shall permanently attach a well identification tag to the well casing within 30 days of well completion. The tag shall be furnished by OWRD and attached so as to be accessible and visible. The tag may be strapped to the casing using stainless steel bands, tag welded, or attached using rivets. The tag shall be installed at least 18 inches above existing grade to be at least 6 inches above the future well house floor.

B. The well identification number shall be recorded on the well driller's report.

3.15 FINAL CLEANUP

A. After completion of all Work associated with this Contract, the Contractor shall clean up the Work site and any property used by his operations to the satisfaction of the Engineer and Owner. The Contractor shall remove and dispose of all excess materials resulting from his work, and shall repair, replace, or restore all property of any type or nature which has been moved, damaged, or altered in any way by his operations, to the satisfaction of the Engineer and Owner. The Contractor shall return all landscape, roadway, and adjoining surfaces to their original condition and appearance as soon as reasonably feasible.

PART 4 - MEASUREMENT AND PAYMENT

4.01 SCOPE

A. The quantities of work or material stated in unit price items of the Bid are supplied only to give an indication of the general scope of the Work; the Engineer does not expressly or by implication agree that the actual amount of work or material will correspond therewith, and reserves the right after award to increase or decrease the quantity of any unit price item of the Work without a change in the unit price, and shall include the right to delete any Bid item in its entirety. Payment for materials and labor will be based on actual quantities furnished, installed, or constructed in accordance with the prices bid for unit price items.

B. The Engineer may terminate Work on the project at any point if, in the Engineer's judgment, the Engineer's or Owner's best interests are not served by continuation. Conditions which may lead to project termination include, but are not limited to, indications of low groundwater development potential as determined during drilling, geophysical logging, and testing. In such an event, the Contractor shall be paid for the value of Work completed at that time on the basis of the unit price and lump sum items listed on the Bid Schedule. In addition, if well construction is terminated by decision of the Engineer, the Contractor may be required to properly abandon the well. The well shall be abandoned in accordance with OWRD requirements (OAR 690-220). Materials used in abandonment shall be paid at invoice cost plus 10 percent to cover handling. Payment for rig time shall be at the bid unit price.

C. No payment shall be made for tests of borehole plumbness and alignment; it shall be the responsibility of the Contractor to ensure that the hole remains within plumbness and alignment specifications.

D. No payment shall be made for drilling fluid materials used during normal drilling operations. All such costs shall be considered to be included in the unit prices listed on the Bid Schedule.

E. No payment shall be made for time or expenses incurred in the recovery or replacement of tools or equipment lost during the drilling phase or any other phase of the Work.

F. No payment shall be made for time, materials, or labor costs incurred during remedial measures or operations in the event the well is of unacceptable plumbness or alignment.

G. No payment shall be made for time, materials, or labor costs incurred in abandoning the well in the event the well is of unacceptable plumbness or alignment following remedial measures, or if lost tools or equipment cannot be recovered from the borehole. The costs incurred for construction of the abandoned well shall be applied to construction of a replacement well.

4.02 MOBILIZATION/DEMOBILIZATION (ITEM 1; LUMP SUM ITEM)

A. Measurement for payment for mobilization/demobilization to and from the work site will be based upon completion of the Work as a lump sum unit. The lump sum price listed on the Bid Schedule shall be full compensation for the moving in of rigs, pumps, equipment, power, labor, fuel, tools, and incidentals necessary to do the Work, and moving out of all such equipment, materials, tools, and incidentals, and well disinfection and final site cleanup upon completion of the Work. For purposes of partial payment, the mobilization portion of this bid item shall be considered as 60% of the total lump sum.

4.03 DRILL MINIMUM 14-INCH DIAMETER BOREHOLE (ITEM 2; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for drilling the borehole will be based upon the number of vertical linear footage drilled below ground surface in accordance with these Contract Documents. Payment for drilling shall constitute full compensation for labor, fuel, bits, temporary casing, drive shoes, welding, drilling fluids, equipment, and incidentals necessary to drill the exploration borehole.

B. This item includes drilling for and placing the 16-inch temporary casing to an expected depth of 30 feet.

C. No payment shall be made for tests of borehole plumbness and alignment; it shall be the responsibility of the Contractor to ensure that the hole remains within plumbness and alignment specifications.

D. No payment shall be made for drilling fluid materials used during normal drilling operations. All such costs shall be considered to be included in the unit prices listed on the Bid Schedule.

E. Payment for drilling fluid materials used in regaining drilling fluid circulation in zones of lost circulation shall be paid at invoice cost plus 10 percent for handling.

F. No payment shall be made for time or expenses incurred in the recovery or replacement of tools or equipment lost during the drilling phase or any other phase of the Work.

G. No payment shall be made for time, materials, or labor costs incurred during remedial measures or operations in the event the well is of unacceptable plumbness or alignment.

H. No payment will be made for time, materials, or labor costs incurred in abandoning the well in the event the well is of unacceptable plumbness or alignment following remedial measures, or

if lost tools or equipment cannot be recovered from the borehole. The costs incurred for construction of the abandoned well shall be applied to construction of a replacement well.

4.04 GEOPHYSICAL LOGGING (ITEM 3, LUMP SUMP ITEM)

A. If geophysical logging is required, measurement for payment for geophysical logging will be based upon completion of the entire work as a lump sum unit, in accordance with these contract documents. Payment for geophysical logging shall constitute full compensation for labor, equipment, and incidentals necessary to perform the logging

B. No rig or standby time will be paid to the Contractor during the time that the Contractor's logging service is being brought to the site, or during the time that the logs are being run.

C. No rig or standby time will be paid to the Contractor following completion of logging during which an exact determination of the final well design will be made by the Engineer.

4.05 FURNISH AND INSTALL 10-INCH WELL CASING (ITEM 4; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement for payment for the nominal 10-inch steel well casing will be based upon the number of linear feet of such pipe actually installed in the borehole in accordance with these Contract Documents. Payment for the 10-inch casing shall constitute full compensation for materials, transportation, labor, fuel, equipment, centralizers, welding materials, and incidentals necessary to furnish and install the well casing.

4.06 FURNISH AND INSTALL 10-INCH WELL SCREEN (ITEM 5; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for furnishing and installing the well screen will be upon the number of linear feet of such well actually installed in the borehole in accordance with these Contract Documents. Payment for the well screen shall constitute full compensation for screen, weld rings, plate bottom, materials, transportation, labor, equipment, and incidentals necessary to furnish and install the well screen.

4.07 FURNISH AND INSTALL SAND FILTER PACK (ITEM 6; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for furnishing and installing the sand filter pack will be based on the linear feet of filter pack actually installed in the well in accordance with these Contract Documents. Payment for filter pack shall constitute full compensations for materials, transportation, labor, equipment, and incidentals necessary to furnish and install the filter pack.

B. This item includes installation of the filter pack seal.

4.08 FURNISH AND INSTALL ANNULAR WELL SEAL (ITEM 7; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for furnishing and installing the well seal will be based upon linear feet of well seal installed in the borehole. Payment for the well seal shall constitute full

compensation for materials, transportation, labor, equipment, and incidentals necessary to furnish and install the seal.

4.09 WELL DEVELOPMENT (ITEM 8; PRICES BASED UPON TIME, HOURS)

A. Measurement for payment for well development will be based on the actual number of hours of development operations. Payment will be made at the unit price listed in the Bid Schedule.

B. No payment shall be made for equipment acquisition, set-up, or installation, or for recovery periods required by the Engineer to ensure thorough well development.

C. Payment for chemicals as may be required by the Engineer to ensure thorough well development shall be reimbursed for the cost of the chemicals actually used at invoice cost plus 10 percent for handling.

4.10 FURNISH, INSTALL, AND REMOVE TEST PUMP AND RELATED EQUIPMENT (ITEM 9; PRICE BASED ON LUMP SUM)

A. Measurement and payment for furnishing, installing, and removing the test pump and related equipment will be based upon completion of the entire Work as a lump sum unit, all in accordance with the requirements of these Contract Documents. Payment for furnishing, installing, and removing will be at the price listed in the Bid Schedule, which price shall constitute full compensation for all work, including installation and removal of pump, motor, generator, cable, controls, valves, orifices, temporary piping, and associated appurtenances.

4.11 TEST PUMPING (ITEM 10; PRICES BASED UPON TIME, HOURS)

A. Measurement and payment for test pumping will be based on the actual number of hours of pumping operations. Payment for test pumping will be made at the unit price listed in the Bid Schedule, and shall constitute full compensation for all labor, fuel, equipment, and materials associated with operating the test pumping equipment.

B. No payment shall be made for standby time during the recovery periods between tests or for time spent transporting or maintaining equipment. All such costs for time and maintenance materials shall be included in the unit price listed in the Bid Schedule.

C. No payment shall be made for time, equipment, or materials used in a test aborted due to power failure or malfunction of pumping equipment.

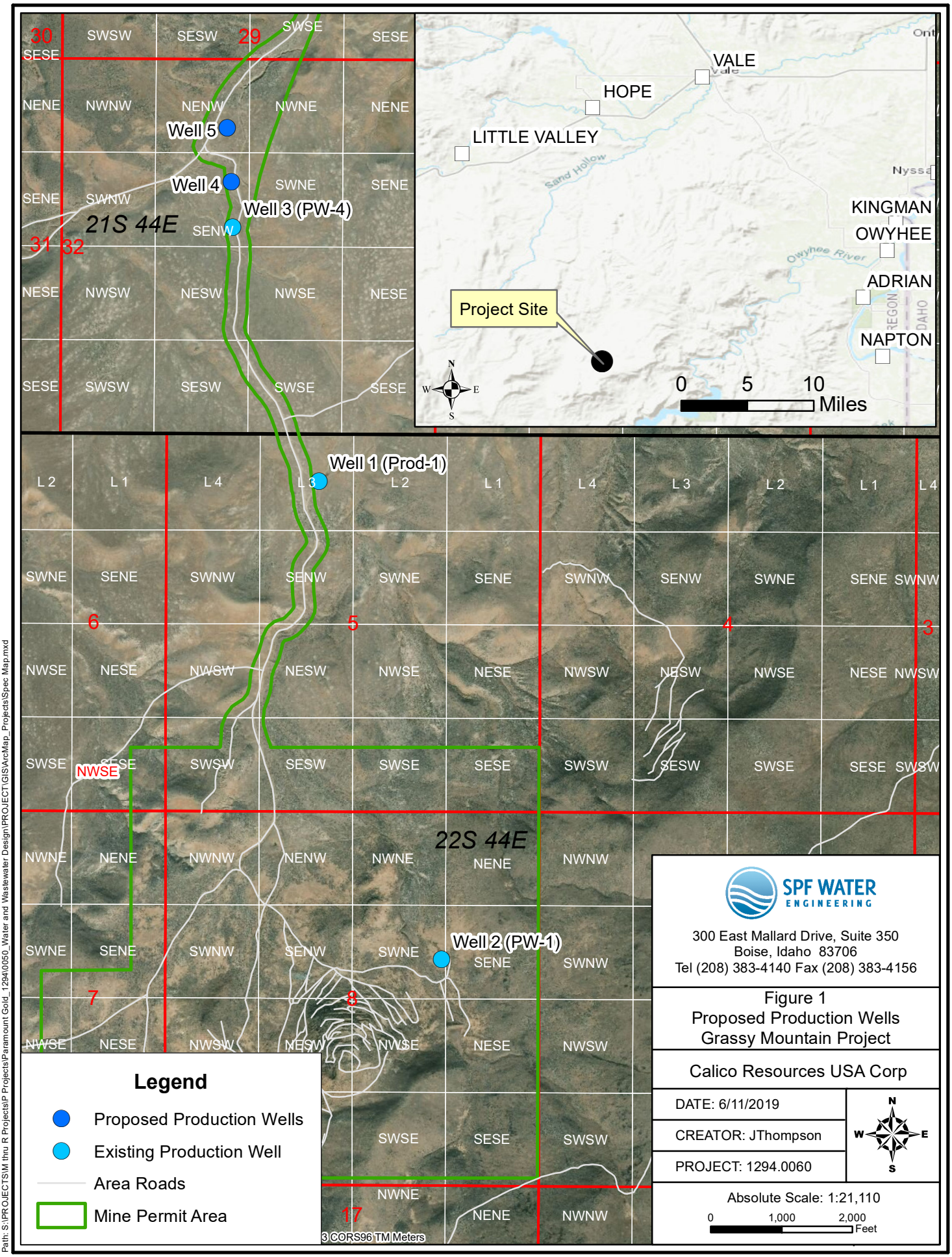
4.12 RIG TIME (ITEM 11; PRICES BASED UPON TIME, HOURS)

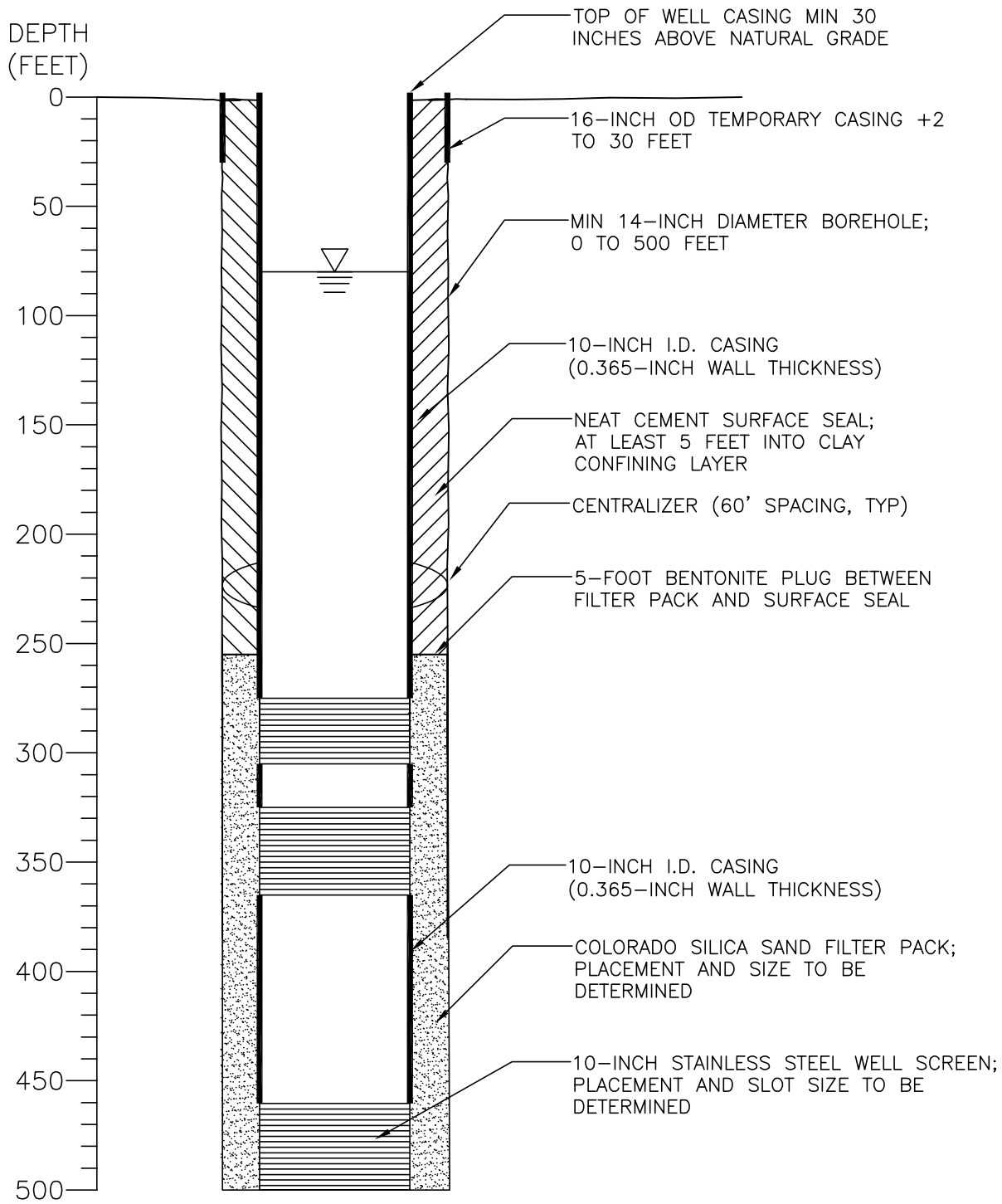
A. Measurement and payment for rig time will be based on the unit price listed on the Bid Schedule. Payment for rig time for additional work specifically directed by the Engineer not otherwise covered in these Contract Documents will be based on the actual number of hours of work done and shall be full compensation for rig, fuel, labor, equipment, and materials normally associated with Contractor's drilling activities. Additional materials, which may be required by the Engineer, shall be paid at the Contractor's invoice cost plus 10 percent for handling.

4.13 PLUGGING AND ABANDONMENT

A. In the event a well, successfully completed in accordance with these Contract Documents, requires plugging and abandonment, the cost for this work will either be negotiated with the Contractor or performed by others. The costs for plugging and abandonment of the well successfully completed in accordance with these Contract Documents shall not be considered as subsidiary to other bid items in the Contract.

- END OF TECHNICAL SPECIFICATIONS -


Well 5
Well 4
Well 3 (PW-4)
Well 1 (Prod-1)
Well 2 (PW-1)
21S 44E
22S 44E
VALE
HOPE
LITTLE VALLEY
KINGMAN
OWYHEE
ADRIAN
NAPTON
Project Site
0 5 10
Miles
Legend
Proposed Production Wells
Existing Production Well
Area Roads
Mine Permit Area
SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156
Figure 1
Proposed Production Wells
Grassy Mountain Project
Calico Resources USA Corp
DATE: 6/11/2019
CREATOR: JThompson
PROJECT: 1294.0060
Absolute Scale: 1:21,110
0 1,000 2,000
Feet
Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\PROJECT\GIS\ArcMap_Projects\Spec Map.mxd



SPF WATER
ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD PROJECT
WATER SUPPLY WELL 4
CONCEPTUAL DESIGN

SCALE: NTS
DRAWN BY: KJN

Figure 2 PROJ #1294.0050

BID SCHEDULE OF ITEMS AND PRICES
RAW WATER SUPPLY WELL 4
GRASSY MOUNTAIN GOLD PROJECT

The Bidder proposes the following schedule of prices for drilling, construction, development, and testing of one raw water supply well (Well 4) for Calico Resources USA Corp in accordance with the technical specifications. The quantities of work or material stated in unit price items of the bid are supplied only to give an indication of the general scope of the work. Payment for materials and labor will be based on actual quantities furnished, installed, or constructed in accordance with the prices bid for unit price items. The Bidder is solely responsible for completing all spaces below. The Bidder is responsible for the inclusion of all overhead and profit costs within each item.

Item	Description	Estimated Quantity	Unit	Unit Price	Total Amount
1	Mobilization and demobilization	1	lump sum	$_____	$_____
2	Drill min 14-inch diameter borehole	500	linear foot	$_____	$_____
3	Geophysical logging	1	lump sum	$_____	$_____
4	Furnish and install 10-inch I.D. casing	402	linear foot	$_____	$_____
5	Furnish and install 10-inch I.D. well screen	100	linear foot	$_____	$_____
6	Furnish and install sand filter pack	250	linear foot	$_____	$_____
7	Furnish and install annular well seal	250	linear foot	$_____	$_____
8	Well development	16	hours	$_____	$_____
9	Furnish, install, and remove test pump and related equipment	1	lump sum	$_____	$_____
10	Test pumping	176	hours	$_____	$_____
11	Rig time	2	hours	$_____	$_____

Total **$_____**

Submitted by: _____
Signature

_____
Title

_____
Company

_____
Address

_____ _____
Oregon Well Constructor's License Telephone Number

Attachment E
Well 5 Construction Specifications

TECHNICAL SPECIFICATIONS
RAW WATER SUPPLY WELL 5
GRASSY MOUNTAIN GOLD PROJECT

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials, labor, plant, equipment, tools, supplies, transportation, and appurtenances for drilling, casing, developing, completing, and testing of one raw water supply well (Well 5) at the Grassy Mountain Gold Project (Project) site for Calico Resources USA Corp (the Owner) as specified herein and in accordance with the requirements of the Contract Documents.

B. Approximate depths of drilling and lengths of well casings and screen are to be used for the purpose of price estimation only. Exact depths and lengths may be adjusted by the Engineer depending on subsurface conditions.

C. Work requirements for each well are summarized below. Each item is discussed in subsequent sections of the Specifications.

(1) Mobilize to the work site.
(2) Drill for, furnish, and install 16-inch diameter temporary steel surface casing through the surface sediments to an anticipated depth of 30 feet.
(3) Drill a 6-inch diameter exploratory pilot borehole to an anticipated depth of 1,000 feet, installing temporary casing as required to advance the bore.
(4) Remove temporary casing and backfill the pilot borehole to the depth determined the Engineer.
(5) Ream the pilot borehole to minimum 14-inch diameter to depth determined by Engineer, installing temporary casing as required to ream the bore.
(6) Furnish and install 10-inch I.D. steel casing (0.365-inch wall thickness) and 10-inch stainless steel well screen as directed by Engineer.
(7) Furnish and install Colorado Silica Sand filter pack and filter pack seal.
(8) Seal the annular space outside the casing with neat cement from the top of the filter pack seal to ground surface, withdrawing the temporary surface casing during installation of the seal.
(9) Develop the well.
(10) Furnish, install, operate, and remove test pump.
(11) Disinfect well.
(12) Demobilize from the work site.

D. All well construction work not specifically addressed in these specifications shall conform to the State of Oregon Water Resources Department (OWRD) Well Construction Standards (Oregon Administrative Rules (OAR) Chapter 690 Division 200, 205, 210, and 217).

E. All materials used for well construction, including drilling fluids, shall be certified to NSF Standard 60, NSF Standard 61, or equivalent.

F. All casing, screens, and materials shall be handled with care to avoid damage. The Contractor's methods of loading, transporting, and unloading materials shall conform to

manufacturer recommendations. Casing and screen shall be kept free from dirt and foreign matter. Foreign material, including manufacturer labels, shall be removed from pipe interior prior to installation.

1.02 BEGINNING AND COMPLETION OF WORK

A. The work schedule shall be in accordance with Owner requirements.

1.03 SERVICES FURNISHED BY THE ENGINEER AND OWNER

A. The Owner will provide land and rights-of-way for the Work specified in this Contract. Provisions for access to the Work site will be provided by the Owner. The Contractor shall not enter on or occupy with laborers, tools, equipment, or material any ground outside the property and rights-of-way provided by the Owner unless stated otherwise by the Owner. Other Contractors, employees, or agents of the Owner may enter the work site and premises used by the Contractor for business purposes.

B. The Engineer (as the Owner's Representative) will participate in well testing, evaluation of drilling characteristics, sample examination, and geologic log interpretation, and will advise the Contractor on the final design placement of well casing, surface seal, filter pack and well screen. The Engineer shall be present during placement of well seals and for test pumping.

1.04 WORK SITE

A. The well site is located with the Project Permit Area as defined in the *Third Notice of Intent Pre-Application Phase of a Proposed Mining Operation: Calico Resources USA Corp. Grassy Mountain Gold Project (February 2017)*. The well site is located in a remote area approximately 22 miles south of Vale, Oregon and approximately 70 miles west of Boise, Idaho. The legal description of the well site is the NE ¼ of the NW ¼ of Section 32, Township 21S Range 44E in Malheur County, Oregon. The latitude and longitude coordinates of the proposed well site are 43°42'19.02" N and 117°21'57.62" W. The well site can be accessed from Vale, Oregon or Parma, Idaho via improved dirt road. The well site will be staked prior to Contractor mobilization.

1.05 DRILLING CONDITIONS

A. It is anticipated that drilling will be in clay, gravel, sandstone, conglomerate, siltstone, and basalt. Surface alluvium is expected to a depth of 30 feet. Static groundwater level is anticipated to be approximately 70 feet below ground surface. It is the Contractor's responsibility to make his own determination of subsurface conditions.

B. The drilling method for the well shall be determined by the Contractor based on anticipated drilling conditions. If the Contractor chooses to drill by air-rotary, the Contractor shall be prepared to drill by mud rotary if unstable subsurface conditions require it. If the Contractor chooses to drill by mud-rotary, the Contractor shall conduct geophysical logging of the borehole as directed by the Engineer.

C. The Contractor shall be responsible for providing notification to utility owners prior to beginning Work by requesting a facility locate through Oregon Dig Line at 811 or 1-800-332-2344.

D. It is the Contractor's responsibility to become informed about local conditions affecting this Work. Neither the information contained in these specifications, nor gleaned from the Engineer or Owner, or their agents, shall act to relieve the Contractor from any responsibility set forth in the Contract.

1.06 CONTRACTOR QUALIFICATION AND EQUIPMENT

A. The Contractor shall have at least five years of well drilling experience and shall have constructed at least 5 wells of comparable construction. A list of completed comparable projects shall be provided upon request.

B. The Contractor shall hold a valid Oregon Water Supply Well Constructor's License or work under the supervision of a licensed Water Supply Well Constructor.

C. The Contractor is responsible for filing a water well construction notice (start card) with the OWRD prior to commencing well construction. The Contractor is responsible for obtaining all other applicable permits.

D. The Contractor shall submit a list of equipment to be used on the project. The list shall include: (1) manufacturer; (2) load capacities; (3) year of manufacture; and (4) year of purchase by current Owner. The Contractor is responsible for providing equipment capable of performing the Work specified.

E. Damages to the well or surrounding property by the Contractor's equipment, leased or otherwise, shall be repaired or replaced at the Contractor's expense.

F. The Contractor shall have equipment capable of swabbing and airlifting the well to a total depth of 1,000 feet.

G. Upon completion of the well, the Contractor shall prepare, certify, and submit a water well report (log) to the OWRD and Owner.

1.07 SUBMITTALS

A. The Contractor shall provide submittals for all materials to the Engineer for review and approval prior to their use. The submittals shall be provided in an electronic format. Submittals shall be provided for casing, well screen, centralizers, backfill materials, seal materials, filter pack materials, and drilling fluids and additives. All materials shall be new and unused and in excellent condition.

B. The proposed test pump with curve shall be approved the by the Engineer prior to installation and test pumping.

1.08 CONTRACT DOCUMENTS

A. The form and detail of the various features of the Work are illustrated on the following drawings accompanying and made part of the Contract Documents:

- Figure 1 – Well 5 Location Map
- Figure 2 – Well 5 Conceptual Design

1.09 WATER, POWER, AND SITE IMPROVEMENTS

A. The Contractor shall be responsible for obtaining water supply for drilling. All water used for well construction purposes shall be of potable quality and adequately disinfected to prevent groundwater contamination. Water for drilling may be available from three on-site wells with approval from the Owner. These wells are located about 1,700 feet (PW-4),1 mile (Prod-1), and 3 miles (PW-1) from the well site. These wells are equipped with pumps; the Contractor shall provide a portable generator to operate the pumps.

B. If the Owner does not grant approval to use on-site wells for water supply or the Contractor chooses to obtain water from an alternate source, the Contractor shall provide for the quantity and quality of water required at his own expense. Costs for pumps, water conveyance facilities, or transportation to the Work site shall be borne by the Contractor including all necessary pumps, piping and components.

C. The Contractor shall provide, at his own expense, all necessary piping and components to transfer discharged well water from the well site to a suitable disposal site during well development and testing. The Contractor can assume a suitable disposal site for clean water within 200 feet of the well site. Water must be discharged at least 50 feet from the well site. A plan for water disposal must be provided by the Contractor and approved by the Owner prior to commencing drilling. The BLM will be notified by the Owner of any water discharge on BLM land. Water shall not be discharged to streams, ponds, or lakes without proper regulatory authorization.

D. The Contractor shall provide, at his own expense, all power required for his operations under the Contract.

E. All drilling fluids or water containing drilling fluids must be discharged to a sump provided at the drill site by the Owner. The Contractor shall haul excess drilling fluids to a central disposal site provided by the Owner.

F. Preparation of the drill site and excavation or backfilling of mud pits, ditches, or settling ponds shall be the responsibility of the Contractor. The Contractor shall be responsible for protecting life and property from excavated mud pits and settling ponds and shall backfill pits as soon as drilling and testing operations are complete. Holes, pits, equipment, and chemicals shall be safely stored and fenced per OSHA standards. All materials shall be stored where safe from damage or contamination.

G. The Contractor will be responsible for complying with all applicable erosion and sediment control requirements including applicable erosion control permits. The Contractor shall implement best management practices, including erosion and sediment control (ESC) structures, practices, permits, and plans to meet all project, local, state, and federal requirements for water quality and erosion and sediment control.

1.10 WORKING HOURS AND SAFETY

A. The Contractor shall work on this project in a steady and diligent manner. The Contractor shall, during all work periods, provide an adequate crew of suitably qualified personnel to prevent unnecessary delays in project completion. The Contractor will be required to provide 24-hour per day maintenance of pumping and monitoring equipment during test pumping

B. The Contractor is responsible for compliance with all applicable safety laws of any jurisdictional agency and safety requirements of the Owner.

1.11 FINAL CLEANUP

A. The Contractor shall thoroughly clean the site after completion of the drilling, well construction, and test pumping operations. All excess drilling fluids, debris, and other materials used during these operations shall be removed and properly disposed of by the Contractor. Backfilled mud pits shall be compacted to 90 percent maximum dry density as determined by Standard Proctor Test (ASTM 698-00).

B. The Contractor shall promptly remove his equipment, temporary facilities, and materials, and leave the site in a condition approved by the Engineer and Owner. The Contractor shall repair any damage to the property or facilities caused by his operations prior to final acceptance of the Work by the Engineer and Owner.

PART 2 - PRODUCTS

2.01 CASING

A. **Temporary Surface Casing:** Temporary surface casing may be used at the Contractor's option. If utilized, temporary surface casing shall be removed during installation of the surface seal.

B. **Well Casing:** The completed well shall be cased with nominal 10-inch I.D. casing from 2.5 feet above existing ground surface to a depth designated by the Engineer. The casing shall be new steel ASTM A-53 or equal with a minimum wall thickness of 0.365 inches. The casing shall be equipped with centralizers at a spacing of no more than 60 feet.

2.02 WELL SCREEN

A. Well screen shall be of the V-slot continuous wire-wound type in 304 stainless steel of 10-inch pipe size. The top of the well screen shall be equipped with a welding ring. The bottom of the well screen shall be equipped with a stainless steel plate bottom or a welding ring for connection to tail pipe. In order to provide adequate collapse, column, and tensile strengths, the screen construction shall include sufficient wire and rod sizes to be compatible with the depth and pressures of the installation, as recommended by the screen manufacturer.

B. Final screen length, slot size, and placement depths will be determined by the Engineer after completion of the borehole and receipt and evaluation of driller's logs and drill cuttings.

2.03 CENTRALIZERS

A. Centralizers shall be provided at nominal 60-foot intervals and at each screen section. Centralizers shall be welded to the casing. A shop drawing of the centralizer shall be submitted to the Engineer for review and approval prior to installation.

2.04 SAND FILTER PACK

A. A sand filter pack shall be placed around the well screen assembly. The filter pack shall be installed opposite the entire length of the screen assembly, and shall extend above the top screen a minimum of 20 feet (unless otherwise directed by the Engineer). The pack shall consist of clean, well-rounded siliceous material with a uniformity coefficient of 2.5 or less, manufactured by Colorado Silica Sand, Inc., Colorado Springs, CO (or approved equal), and

conforming to one of the following gradation specifications to be determined following analysis of drill cuttings.

20-40 Filter Sand 90-100% passing No. 20 sieve 90-100% retained on No. 40 sieve	16-30 Filter Sand 90-100% passing No. 16 sieve 90-100% retained on No. 30 sieve
10-20 Filter Sand 90-100% passing No.10 sieve 90-100% retained on No. 20 sieve	8-12 Filter Sand 90-100% passing No. 8 sieve 90-100% retained on No. 12 sieve

6-9 Filter Sand
90-100% passing No.6 sieve
90-100% retained on No. 9 sieve

2.05 FILTER PACK SEAL

A. A filter pack seal shall be installed in the annulus above the filter pack to prevent grout used for the annular seal from infiltrating into the filter pack. The filter pack seal shall include a 5-foot thick layer of bentonite. Material for the bentonite seal shall be 3/8- to 3/4-inch sodium bentonite chips. Bentonite shall be specifically designed for sealing wells.

2.06 WELL SEAL

A. The annulus outside the 10-inch well casing shall be sealed with cement grout. Seal thickness shall meet the requirements of the OWRD Well Construction Standards (OAR 690-210).

B. The grout shall contain between 4.5 and 6 gallons of clean water per 94 pounds of Portland cement. Mix water quality and quantity shall follow manufacturer specifications paying close attention to cement grind and water ratios, eliminating free water. Additives may only be used if approved by OWRD.

C. A 50 percent excess volume of seal material shall be available on site if neat cement is used as seal material.

2.07 BOREHOLE BACKFILL MATERIAL

A. Non water-bearing zones within the pilot borehole must be backfilled with cement grout or unhydrated bentonite in accordance with OAR 690-220.

B. Unhydrated bentonite shall be 3/8- to 3/4-inch sodium bentonite chips specifically designed for sealing wells.

C. Cement grout shall contain between 4.5 and 6 gallons of clean water per 94 pounds of Portland cement in accordance with OAR 690-210-0310.

2.08 WELL HEAD

A. The completed well shall have 10-inch casing to 2.5 feet above existing ground surface. The Contractor shall install a temporary cap on the completed well (welded steel plate with access port).

PART 3 - EXECUTION

3.01 MOBILIZATION AND DEMOBILIZATION

Upon receiving the Notice to Proceed, the Contractor shall move in all tools, equipment, and supplies necessary for the Work, and upon completion of the Work, shall remove all such items from the premises promptly and leave the site in a clean and orderly fashion.

3.02 CONSTRUCTION SEQUENCE

A. The sequence of construction for this project shall consist of the following:

(1) Mobilize to the work site.
(2) Place a 16-inch diameter temporary steel surface casing through the surface alluvium to an anticipated depth of 30 feet.
(3) Drill a 6-inch diameter exploratory pilot borehole to an anticipated depth of 1,000 feet, installing temporary casing as needed to reach total depth.
(4) Remove temporary casing and backfill the pilot borehole to the depth determined the Engineer.
(5) Ream the pilot borehole to minimum 14-inch diameter to depth determined by Engineer.
(6) Furnish and install 10-inch I.D. steel casing (0.365-inch wall thickness) and 10-inch stainless steel well screen as directed by Engineer.
(7) Furnish and install Colorado Silica Sand filter pack and filter pack seal.
(8) Install neat cement surface seal, withdrawing any temporary surface casing.
(9) Develop the well.
(10) Perform test pumping of the well.
(11) Disinfect the well.
(12) Provide temporary cap on the well and attach well tag.
(13) Clean work site and demobilize equipment.

3.03 DRILLING

A. The drilling method for the well shall be determined by the Contractor based on anticipated drilling conditions. If the Contractor chooses to drill by air-rotary, the Contractor shall be prepared to drill by mud rotary if unstable subsurface conditions require it. If the Contractor chooses to drill by mud-rotary, the Contractor shall conduct geophysical logging of the borehole as directed by the Engineer. The borehole shall be of sufficient diameter to meet the requirements of the OWRD Well Construction Standards (OAR 690-210).

B. The Contractor shall provide for and install temporary casing as required to advance the borehole to the target depth. The cost for temporary casing shall be included in the unit price for drilling or reaming on the bid schedule. The temporary casing shall be removed during backfilling or sealing of the borehole.

C. Drilling fluid properties shall be maintained in such a manner to ensure the structural integrity of the borehole and to circulate drill cuttings representative of the strata penetrated to the

ground surface. Drilling fluid additives shall be certified to NSF Standard 60 or 61. A mud kit shall be available for measuring drilling fluid properties throughout the project if applicable.

D. The Contractor shall sample the drill cuttings at 5-foot intervals and at pronounced changes in geologic formation. These samples shall be saved and maintained on the job site in a clean dry area. All samples are to be submitted to the Engineer and Owner. The samples shall be of at least one-gallon size, shall be kept in cloth sample bags or zip-lock style plastic bags, to be provided by the Contractor, and shall be clearly labeled to show the depth and well from which the sample was collected.

E. All drilling fluids shall be managed to protect groundwater from contamination and disposed of in accordance with State and Federal regulations. Method and place of drilling fluid disposal shall be approved by the Owner. Costs incurred in connection with the disposal of drilling fluids and developed water shall be borne by the Contractor. The Owner will provide a sump at the drill site for disposal of drilling fluids. The Contractor shall haul excess drilling fluids to a central disposal site provided by the Owner.

F. The Contractor shall maintain a daily drilling log of the well. Logs and records shall be kept by the Contractor's drillers on forms suitable to the Engineer, which shall indicate each shift worked; the general character, thickness, and type of material penetrated; and the type of all other Work performed, including the exact time spent on each item of Work. Information that shall be listed on the drilling log includes: (1) drilling fluids and additives, including quantity of materials used and volume of water or drilling fluid lost to the formation; (2) drilling fluid properties, including weight and viscosity (if applicable); (3) type and diameter of bits used for drilling and total footage for each bit; (4) depth where water encountered and an estimate of the quantity of water produced; and (5) any remarks or comments concerning the drilling characteristics of the borehole, including locations of any lost circulation zones. The forms shall be kept on-site for inspection by the Engineer. Forms shall be provided for Engineer approval prior to commencing construction.

G. Copies of the logs shall be available for inspection by the Owner and Engineer at all times. Copies of all logs shall be furnished to the Owner and Engineer following completion of all operations. The Contractor shall prepare, sign, and submit a water well report for each well constructed to the OWRD.

3.04 PLUMBNESS AND ALIGNMENT

A. The Contractor shall construct the well sufficiently straight and plumb to permit free installation and removal of a nominal 6-inch test or production pump with 8-inch motor. The hole shall be drilled to the depth designated by the Engineer with a total deviation of the casing not to exceed one degree per 100 feet of the well. The alignment will be considered satisfactory if the casing will permit the free lowering and raising of a dummy between land surface and the bottom of the 10-inch casing section. The dummy shall be constructed of a 40-foot length of standard 8-inch I.D. pipe. It shall be the responsibility of the Contractor to see that the well is being constructed straight and plumb within these limits at all times. Any indications of inadequate plumbness or alignment during drilling, casing, or pump setting operation shall be cause to require measurement of plumbness or alignment by a method approved the Engineer. No payment shall be made for tests of alignment; any such tests shall be considered subsidiary to other items in this Contract.

B. If the well has unacceptable plumbness or alignment, the Contractor shall undertake remedial measures. Any alignment work required by the Contractor in re-drilling or straightening the

well shall be at his sole expense. If a well is deemed unacceptable following remedial measures, then as much casing as can be removed from the well shall be salvaged by the Contractor. Salvaged casing will be the property of the Contractor. The well shall be abandoned in accordance with OWRD requirements (OAR 690-220) at the Contractor's expense. All payments associated with construction of the abandoned well shall be credited to construction of a replacement well.

3.05 GEOPHYSICAL LOGGING

A. Geophysical logging of the borehole will be required if the Contractor drills by mud-rotary. If the Engineer or Owner requests geophysical logging, the Engineer shall be given at least 24 hours of notice of the time when the survey will be run in order to witness the performance of the survey. The logs run shall include normal resistivity (8", 16", 32", and 64"), single point resistivity, specific potential, natural gamma radiation, and temperature.

B. It is the Contractor's responsibility to ensure that the borehole remains open to the total completion depth for geophysical logging.

C. Three full-scale and three reduced-scale printed copies of the logs shall be provided. The logs shall also be provided in electronic format (ASCII or similar) on DVD or CD or transmitted by email.

3.06 BACKFILL OF EXPLORATORY PILOT BOREHOLE

A. The 6-inch diameter exploratory pilot borehole shall be backfilled to a depth determined by the Engineer.

B. The pilot borehole shall be backfilled with cement grout or unhydrated bentonite in accordance with OAR 690-220. Non water-bearing zones must be backfilled with cement grout or unhydrated bentonite. Documented water-bearing zones can be backfilled with clean gravel. OWRD must approve any continuous gravel placement exceeding 50 feet in length or where the length of gravel placed exceeds 50% of the total length of backfill.

C. Unhydrated bentonite may be placed to a maximum depth of 700 feet through water for casing or bores between 4 and 8 inches in diameter but may be installed deeper with OWRD approval. Unhydrated bentonite may be placed to a maximum depth of 1,000 feet through air for casing or bores between 4 and 8 inches in diameter but may be installed deeper with OWRD approval.

D. Bentonite chips shall be installed in a slow and continuous manner, with a pour rate of 2 minutes or slower per standard 50-pound bag. Unhydrated bentonite shall be screened across a minimum ¼-inch mesh screen during placement. Bentonite chips installed above the water table shall be hydrated after placement in maximum 10-foot lifts with potable water pumped through a tremie pipe

E. The bentonite chips shall be tagged during placement to determine if the chips are reaching their intended position. Seal level shall be checked by tagging with a sinker bar or other means. The volume of bentonite used shall be compared with the annular space volume to evaluate the potential for bridging. Adequate time shall be provided to allow the bentonite seal to hydrate (1 to 2 hours) prior to proceeding with well construction.

3.07 INSTALLATION OF WELL CASINGS, SCREEN, AND CENTRALIZERS

A. The permanent well casing shall extend at least 5 feet into a clay confining layer overlying the target water-bearing zone.

B. Welding: Individual lengths of steel casing shall be joined by welding. Welding shall be performed by properly qualified operators following the manufacturer's recommendations and in accordance with AWWA C206. Welds shall penetrate the full thickness of the casing wall.

1. The standards of the American Welding Society, Structural Welding Code (AWS D1.1) shall apply for all welded joint casing and accessories. All welds shall conform to the latest revision of ANSI B31.1.

2. There shall be a minimum of three (3) weld passes on pipe sizes 6-inches and greater.

3. Welded casing joints shall have a tensile strength equal to or greater than that of the casing.

C. Weld Reinforcement: Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions.

D. When complete, the well casing shall extend a minimum of 30 inches above existing grade to provide a casing height of 18 inches above the future well house floor. The top of well casing shall be equipped with a welded steel plate, sanitary well seal, or vented well cap, as approved by the Engineer.

E. Centralizers shall be installed at intervals of no more than 60 feet.

3.08 INSTALLATION OF FILTER PACK

A. A sand filter pack shall be placed opposite the well screen and a maximum of 20 feet above the top of the screen. Filter pack shall be placed using a tremie pipe to avoid bridging and to ensure uniform placement. Potable water may be used to wash filter pack into place. The volume of water used shall be measured and recorded. The level of the filter pack shall be tagged at frequent intervals to confirm that it is not bridging. The top of the filter pack shall be tagged following installation to verify and document final placement depth. The volume of the filter pack shall be monitored during placement to confirm that the pack is not bridging.

B. Following installation, the pack shall be settled by swabbing or other means.

C. The pack shall be disinfected with a minimum 50-ppm chlorine solution prior to installation.

3.09 INSTALLATION OF FILTER PACK SEAL

A. A filter pack seal shall be installed in the annulus above the filter pack to prevent grout used for the annular seal from infiltrating into the filter pack. The filter pack seal shall consist of a 5-foot thick bentonite seal.

B. Material for the bentonite seal shall be 3/8- to 3/4-inch unhydrated sodium bentonite chips below the water table and hydrated sodium bentonite chips above the water table. Bentonite shall be specifically designed for sealing wells.

C. Bentonite chips shall be installed in a slow and continuous manner, with a pour rate of 2 minutes or slower per standard 50-pound bag. Unhydrated bentonite shall be screened across a minimum ¼-inch mesh screen before being introduced into the well. Bentonite chips installed above the water table shall be hydrated after placement with potable water pumped through a tremie pipe.

D. The bentonite seal shall be tagged during placement to determine if the seal is reaching its intended position. Seal level shall be checked by tagging with a sinker bar or other means. The volume of bentonite used shall be compared with the annular space volume to evaluate the potential for bridging. Adequate time shall be provided to allow the bentonite seal to hydrate (1 to 2 hours) prior to placing the grout annular seal.

3.10 INSTALLATION OF WELL SEAL

A. The 10-inch diameter well casing shall be installed in a minimum 14-inch diameter borehole. The annular space between the casing and bore wall shall be sealed with cement grout. The annular seal shall extend from the top of the filter pack seal to ground surface. The seal depth will exceed 18 feet. Any temporary casing shall be withdrawn as the seal is placed.

B. Seal thickness and installation shall meet the requirements of the OWRD Well Construction Standards (OAR 690-210).

C. Cement grout seals shall be installed by the tremie method. The grout shall be pumped into the annular space through a tremie pipe that shall be extended from ground surface to the bottom of the zone being grouted. Grout shall be placed from the bottom up in a continuous operation. The grout pipe shall be slowly raised as the grout is placed, but the discharge end of the tremie pipe must be submerged in the emplaced grout at all times until grouting is complete. The grout pipe shall be maintained full to the surface at all times until completion of the grouting of the entire specified interval.

D. Once grouting is complete, no further work shall be performed on the well for a minimum of 24 hours. No standby or rig time will be paid while grout is setting. The permanent well casing shall not be moved or driven following placement of the grout seal.

E. In the event of borehole collapse prior to placement of the grout, the Contractor shall take whatever steps are necessary to reopen the hole and to place the seal as specified. Any such remedial action shall be conducted at the Contractor's expense.

F. Volumes of seal material placed shall be carefully monitored and checked against calculated volume requirements.

G. The Engineer shall be notified a minimum of 24 hours prior to seal placement, and shall be present during seal placement.

H. Seals shall be installed in a slow and continuous manner, and temporary casing shall be withdrawn as the seal is placed.

3.11 DEVELOPMENT

A. Following seal placement and curing, the well shall be developed by pump surging (rawhiding), mechanical surging using a surge block or swab, air-lift surging, hydraulic jetting, or other methods approved by the Engineer. If the Contractor selects pump surging as the sole means of development and the well does not produce clear water free from sand or the well does not produce the target yield, then the Contractor may be required to perform mechanical development or jetting in addition to surge development. The Contractor shall provide a written log documenting development methods, discharge rates, and duration of each development operation.

B. Mechanical surging shall be performed using a surge block or swab. The outside diameter of the surge block or swab shall be only slightly smaller than the inside diameter of the casing (1/8 to 1/4-inch). Surging of the well shall begin in the casing immediately above the uppermost section of well screen. Initial surging shall be with a long stroke at a slow rate. Surging in the casing section shall continue until no additional appreciable quantity of sand, silt, or clay is brought into the well. Following surging of the casing, the surge block or swab shall be lowered into the lowest screened section and surge development continued. Surge development shall continue upward until the entire screen has been developed. The screen shall be surged in 20-foot sections. Surging shall then be repeated at a faster stroke starting at the bottom of the well. Periodically, the Contractor shall measure and bail from the well all sand, silt, and clay that has accumulated at the bottom. Surging shall continue until no more sediment is bailed from the well and the well produces clear water.

C. Hydraulic jetting shall be performed with a jetting tool to produce a minimum nozzle velocity of 150 feet per second. The jetting tool shall be lowered into the bottom of the screen, rotated slowly and continuously, and slowly raised throughout the entire screen length. Jetting shall be continued until the well produces clear water free from sediment. Simultaneous air-lift pumping may be employed to remove fines from the well.

D. The well may be developed using air-lift surging. For air-lifting, the Contractor shall have a compressor, tubing and eductor pipe to air-lift a minimum of 200 gpm average flow from 500 feet depth. Sufficient tubing or drill stem shall be available to reach the total depth of the well. It is anticipated that air development will take place in a staged manner throughout the lower portion of the well, and thus may include considerable addition and subtraction of pipe. For long screen sections, a double-packer tool shall be used to develop short sections of screen. Periodically, the Contractor shall measure and bail from the well all sand, silt, and clay that has accumulated at the bottom.

E. Final well development shall be performed by alternative pumping and surging with the test pump. The well shall be pumped at a restricted initial pumping rate. As water clears, the pumping rate shall be gradually increased until maximum discharge rate is reached. At regular intervals, the pump shall be stopped and the water in the pump column shall be allowed to surge back through the pump intake. Development pumping shall continue until discharged water is clear and sand free (less than 5 ppm sand at the design capacity of the well), as measured by the Engineer.

F. The Contractor may be required to use a dispersant or other well development additive to achieve satisfactory development. All additives must be approved by the Engineer prior to use.

G. Upon completion of the development, all material shall be thoroughly cleaned from the inside of the casing and screen. Material shall be removed by bailing or by suction pumping. If

removed by pumping, the Contractor shall have sufficient tubing or pipe to reach the total depth of the well.

H. Water containing drilling fluids, chemicals, or sediment must be discharged to a sump provided at the drill site by the Owner. The Contractor shall haul excess drilling fluids to a central disposal site provided by the Owner.

3.12 TEST PUMPING

A. Following completion of development operations, the well shall be allowed to recover for 24 hours, or less if approved by the Engineer, prior to starting the pumping tests. Within the hour prior to the start of test pumping, the Engineer will measure static water level in the well three times no less than 20 minutes apart.

B. Anticipated methods of aquifer testing include: (1) a step-test lasting approximately 8 hours, which will consist of pumping the well at various rates from approximately 50 gpm to the maximum capability of the pump or well; and (2) a constant-rate pumping test lasting a minimum of 7 days. The pumping test duration will be determined by the Engineer. The constant-rate test may be extended to 14 days if the well drawdown trend does not stabilize. Standby time will not be paid for the recovery periods between tests or at the conclusion of test pumping. The Engineer shall be present at the start of test pumping. The Contractor shall be responsible for maintaining a constant pumping rate during the test.

C. The test pump shall be capable of delivering a least 200 gpm from a pumping level of 400 feet. The Contractor shall furnish and install all necessary equipment for testing, including a discharge valve or throttle to control flow rate, orifices or flow meter for accurately measuring the discharge from the well, one nominal 1-inch PVC pipe to the top of the pump to facilitate the installation and removal of an electric-line water-level probe, and a sample tap. The Contractor shall measure and record water level, pumping rate (every hour), and elapsed time as directed by the Engineer. The Contractor shall provide a threaded port for attachment of a Rossum Sand Tester by the Engineer. The Engineer shall be responsible for sand testing.

D. Water level measurements shall be taken with a non-stretch electric-line water-level probe. Measurements during the first ten minutes of pumping shall be timed no more than two minutes apart. Water level measurements from ten to thirty minutes of pumping shall be timed no more than five minutes apart. Between 30 minutes of pumping and 2 hours, drawdown measurements shall be taken no more than 15 minutes apart. For the duration of the test, hourly measurements are acceptable unless otherwise directed by the Engineer.

E. After pumping stops, water level recovery measurements shall be taken for four hours or until the well reaches 90 percent recovery from the maximum drawdown, whichever occurs first. Recovery water level measurements shall be taken on the same schedule as for drawdown measurements.

F. The test pump and column pipe shall be disinfected with a minimum 50-ppm chlorine solution prior to installation in the well.

G. The Contractor shall be responsible for providing power for the test pump. The Contractor shall provide a means for safe refueling during operations to prevent even brief shutdowns during the testing. Shutdowns before the end of the testing procedure in excess of ten (10) percent of the total time anticipated for this testing procedure may require the Contractor to

allow the water level to recover to pre-pumping conditions and re-start the test, as determined by the Engineer.

H. The Contractor shall provide all necessary piping and components to transfer water produced during test pumping to a suitable disposal site. The Contractor can assume a suitable disposal site for clean water within 200 feet of the well site. Water must be discharged at least 50 feet from the well site. A plan for water disposal must be provided by the Contractor and approved by the Owner prior to test pumping.

I. The Engineer shall be responsible for collecting water quality samples during the pumping test. The Engineer shall be responsible for determining whether (1) the well productivity is adequate to meet the project requirements and (2) water quality meets Oregon Health Authority requirements.

3.13 DISINFECTION

A. Upon completion of all well construction activities and removal of test pumping equipment, the Contractor shall disinfect the well using calcium hypochlorite or sodium hypochlorite.

1. Calcium hypochlorite or sodium hypochlorite shall be added to achieve a chlorine concentration of 50 ppm in the well, refer to OAR 690-210-0380. The Contractor shall distribute the disinfecting compound throughout the well to achieve a uniform concentration for “in place” disinfection of the well.

2. Chlorine granules or tablets must be dissolved and placed into the well as a solution.

3. All interior surfaces of the well above the static water level shall be wetted with calcium hypochlorite or sodium hypochlorite solution.

B. Near the end of the constant-rate discharge test, duplicate samples shall be collected by the Engineer and the samples shall be tested for the presence of coliform bacteria. The Contractor shall leave the test pump in the well until test results are reported. If any sample shows the presence of coliform bacteria, the Contractor shall collect duplicate samples (without charging rig or standby time while waiting on sampling results). If the second sampling event shows the presence of coliform bacteria, the Contractor shall re-disinfect the well until duplicate samples show the absence of coliform bacteria.

C. The well shall be capped with a vented well cap or sanitary well seal following disinfection.

D. Chlorinated water shall be disposed of in accordance with federal, state, and local requirements. Where applicable, the Contractor shall obtain appropriate permits from regulatory agencies before discharging chlorinated water to the environment.

3.14 PROTECTION OF WATER QUALITY

A. All water used for drilling and development operations shall be of potable quality.

B. The Contractor shall take all necessary precautions to prevent contamination of the water in the well by the introduction of any foreign substance, including contaminated water, gasoline, oil, etc., and shall conform to all laws or regulations applicable to the protection of water quality.

C. All downhole materials (i.e., casing, pipe, pumps, sand filter pack, drilling tools, etc.) shall be disinfected with a minimum 50-ppm chlorine solution.

3.15 WELL IDENTIFICATION TAG

A. The Contractor shall permanently attach a well identification tag to the well casing within 30 days of well completion. The tag shall be furnished by OWRD and attached so as to be accessible and visible. The tag may be strapped to the casing using stainless steel bands, tag welded, or attached using rivets. The tag shall be installed at least 18 inches above existing grade to be at least 6 inches above the future well house floor.

B. The well identification number shall be recorded on the well driller's report.

3.16 FINAL CLEANUP

A. After completion of all Work associated with this Contract, the Contractor shall clean up the Work site and any property used by his operations to the satisfaction of the Engineer and Owner. The Contractor shall remove and dispose of all excess materials resulting from his work, and shall repair, replace, or restore all property of any type or nature which has been moved, damaged, or altered in any way by his operations, to the satisfaction of the Engineer and Owner. The Contractor shall return all landscape, roadway, and adjoining surfaces to their original condition and appearance as soon as reasonably feasible.

PART 4 - MEASUREMENT AND PAYMENT

4.01 SCOPE

A. The quantities of work or material stated in unit price items of the Bid are supplied only to give an indication of the general scope of the Work; the Engineer does not expressly or by implication agree that the actual amount of work or material will correspond therewith, and reserves the right after award to increase or decrease the quantity of any unit price item of the Work without a change in the unit price, and shall include the right to delete any Bid item in its entirety. Payment for materials and labor will be based on actual quantities furnished, installed, or constructed in accordance with the prices bid for unit price items.

B. The Engineer may terminate Work on the project at any point if, in the Engineer's judgment, the Engineer's or Owner's best interests are not served by continuation. Conditions which may lead to project termination include, but are not limited to, indications of low groundwater development potential as determined during drilling, geophysical logging, and testing. In such an event, the Contractor shall be paid for the value of Work completed at that time on the basis of the unit price and lump sum items listed on the Bid Schedule. In addition, if well construction is terminated by decision of the Engineer, the Contractor may be required to properly abandon the well. The well shall be abandoned in accordance with OWRD requirements (OAR 690-220). Materials used in abandonment shall be paid at invoice cost plus 10 percent to cover handling. Payment for rig time shall be at the bid unit price.

C. No payment shall be made for tests of borehole plumbness and alignment; it shall be the responsibility of the Contractor to ensure that the hole remains within plumbness and alignment specifications.

D. No payment shall be made for drilling fluid materials used during normal drilling operations. All such costs shall be considered to be included in the unit prices listed on the Bid Schedule.

E. No payment shall be made for time or expenses incurred in the recovery or replacement of tools or equipment lost during the drilling phase or any other phase of the Work.

F. No payment shall be made for time, materials, or labor costs incurred during remedial measures or operations in the event the well is of unacceptable plumbness or alignment.

G. No payment shall be made for time, materials, or labor costs incurred in abandoning the well in the event the well is of unacceptable plumbness or alignment following remedial measures, or if lost tools or equipment cannot be recovered from the borehole. The costs incurred for construction of the abandoned well shall be applied to construction of a replacement well.

4.02 MOBILIZATION/DEMOBILIZATION (ITEM 1; LUMP SUM ITEM)

A. Measurement for payment for mobilization/demobilization to and from the work site will be based upon completion of the Work as a lump sum unit. The lump sum price listed on the Bid Schedule shall be full compensation for the moving in of rigs, pumps, equipment, power, labor, fuel, tools, and incidentals necessary to do the Work, and moving out of all such equipment, materials, tools, and incidentals, and well disinfection and final site cleanup upon completion of the Work. For purposes of partial payment, the mobilization portion of this bid item shall be considered as 60% of the total lump sum.

4.03 DRILL 6-INCH DIAMETER PILOT BOREHOLE (ITEM 2; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for drilling the exploratory pilot borehole will be based upon the number of vertical linear footage drilled below ground surface in accordance with these Contract Documents. Payment for drilling shall constitute full compensation for labor, fuel, bits, temporary casing, drive shoes, welding, drilling fluids, equipment, and incidentals necessary to drill the exploration borehole.

B. This item includes drilling for and placing the 16-inch temporary casing to an expected depth of 30 feet.

C. No payment shall be made for tests of borehole plumbness and alignment; it shall be the responsibility of the Contractor to ensure that the hole remains within plumbness and alignment specifications.

D. No payment shall be made for drilling fluid materials used during normal drilling operations. All such costs shall be considered to be included in the unit prices listed on the Bid Schedule.

E. Payment for drilling fluid materials used in regaining drilling fluid circulation in zones of lost circulation shall be paid at invoice cost plus 10 percent for handling.

F. No payment shall be made for time or expenses incurred in the recovery or replacement of tools or equipment lost during the drilling phase or any other phase of the Work.

G. No payment shall be made for time, materials, or labor costs incurred during remedial measures or operations in the event the well is of unacceptable plumbness or alignment.

H. No payment will be made for time, materials, or labor costs incurred in abandoning the well in the event the well is of unacceptable plumbness or alignment following remedial measures, or

if lost tools or equipment cannot be recovered from the borehole. The costs incurred for construction of the abandoned well shall be applied to construction of a replacement well.

4.04 GEOPHYSICAL LOGGING (ITEM 3, LUMP SUMP ITEM)

A. If geophysical logging is required, measurement for payment for geophysical logging will be based upon completion of the entire work as a lump sum unit, in accordance with these contract documents. Payment for geophysical logging shall constitute full compensation for labor, equipment, and incidentals necessary to perform the logging

B. No rig or standby time will be paid to the Contractor during the time that the Contractor's logging service is being brought to the site, or during the time that the logs are being run.

C. No rig or standby time will be paid to the Contractor following completion of logging during which an exact determination of the final well design will be made by the Engineer.

4.05 BACKFILL PILOT BOREHOLE (ITEM 4; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for backfilling the pilot borehole will be based upon linear feet of borehole requiring backfill. Payment shall constitute full compensation for materials, transportation, labor, equipment, and incidentals necessary to backfill the pilot borehole.

4.06 REAM PILOT HOLE TO MINIMUM 14-INCH DIAMETER BOREHOLE (ITEM 5; PRICES BASED ON LINEAR MEASUREMENT)

B. Measurement and payment for reaming the pilot borehole to minimum 14-inch diameter will be based upon the number of vertical linear footage reamed below ground surface in accordance with these Contract Documents. Payment for drilling shall constitute full compensation for labor, fuel, bits, temporary casing, drive shoes, welding, drilling fluids, equipment, and incidentals necessary to drill the exploration borehole.

C. No payment shall be made for tests of borehole plumbness and alignment; it shall be the responsibility of the Contractor to ensure that the hole remains within plumbness and alignment specifications.

D. No payment shall be made for drilling fluid materials used during normal drilling operations. All such costs shall be considered to be included in the unit prices listed on the Bid Schedule.

E. Payment for drilling fluid materials used in regaining drilling fluid circulation in zones of lost circulation shall be paid at invoice cost plus 10 percent for handling.

F. No payment shall be made for time or expenses incurred in the recovery or replacement of tools or equipment lost during the drilling phase or any other phase of the Work.

G. No payment shall be made for time, materials, or labor costs incurred during remedial measures or operations in the event the well is of unacceptable plumbness or alignment.

H. No payment will be made for time, materials, or labor costs incurred in abandoning the well in the event the well is of unacceptable plumbness or alignment following remedial measures, or if lost tools or equipment cannot be recovered from the borehole. The costs incurred for construction of the abandoned well shall be applied to construction of a replacement well.

4.07 FURNISH AND INSTALL 10-INCH WELL CASING (ITEM 6; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement for payment for the nominal 10-inch steel well casing will be based upon the number of linear feet of such pipe actually installed in the borehole in accordance with these Contract Documents. Payment for the 10-inch casing shall constitute full compensation for materials, transportation, labor, fuel, equipment, centralizers, welding materials, and incidentals necessary to furnish and install the well casing.

4.08 FURNISH AND INSTALL 10-INCH WELL SCREEN (ITEM 7; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for furnishing and installing the well screen will be upon the number of linear feet of such well actually installed in the borehole in accordance with these Contract Documents. Payment for the well screen shall constitute full compensation for screen, weld rings, plate bottom, materials, transportation, labor, equipment, and incidentals necessary to furnish and install the well screen.

4.09 FURNISH AND INSTALL SAND FILTER PACK (ITEM 8; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for furnishing and installing the sand filter pack will be based on the linear feet of filter pack actually installed in the well in accordance with these Contract Documents. Payment for filter pack shall constitute full compensations for materials, transportation, labor, equipment, and incidentals necessary to furnish and install the filter pack.

B. This item includes installation of the filter pack seal.

4.10 FURNISH AND INSTALL ANNULAR WELL SEAL (ITEM 9; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for furnishing and installing the well seal will be based upon linear feet of well seal installed in the borehole. Payment for the well seal shall constitute full compensation for materials, transportation, labor, equipment, and incidentals necessary to furnish and install the seal.

4.11 WELL DEVELOPMENT (ITEM 10; PRICES BASED UPON TIME, HOURS)

A. Measurement for payment for well development will be based on the actual number of hours of development operations. Payment will be made at the unit price listed in the Bid Schedule.

B. No payment shall be made for equipment acquisition, set-up, or installation, or for recovery periods required by the Engineer to ensure thorough well development.

C. Payment for chemicals as may be required by the Engineer to ensure thorough well development shall be reimbursed for the cost of the chemicals actually used at invoice cost plus 10 percent for handling.

4.12 FURNISH, INSTALL, AND REMOVE TEST PUMP AND RELATED EQUIPMENT (ITEM 11; PRICE BASED ON LUMP SUM)

A. Measurement and payment for furnishing, installing, and removing the test pump and related equipment will be based upon completion of the entire Work as a lump sum unit, all in accordance with the requirements of these Contract Documents. Payment for furnishing, installing, and removing will be at the price listed in the Bid Schedule, which price shall constitute full compensation for all work, including installation and removal of pump, motor, generator, cable, controls, valves, orifices, temporary piping, and associated appurtenances.

4.13 TEST PUMPING (ITEM 12; PRICES BASED UPON TIME, HOURS)

A. Measurement and payment for test pumping will be based on the actual number of hours of pumping operations. Payment for test pumping will be made at the unit price listed in the Bid Schedule, and shall constitute full compensation for all labor, fuel, equipment, and materials associated with operating the test pumping equipment.

B. No payment shall be made for standby time during the recovery periods between tests or for time spent transporting or maintaining equipment. All such costs for time and maintenance materials shall be included in the unit price listed in the Bid Schedule.

C. No payment shall be made for time, equipment, or materials used in a test aborted due to power failure or malfunction of pumping equipment.

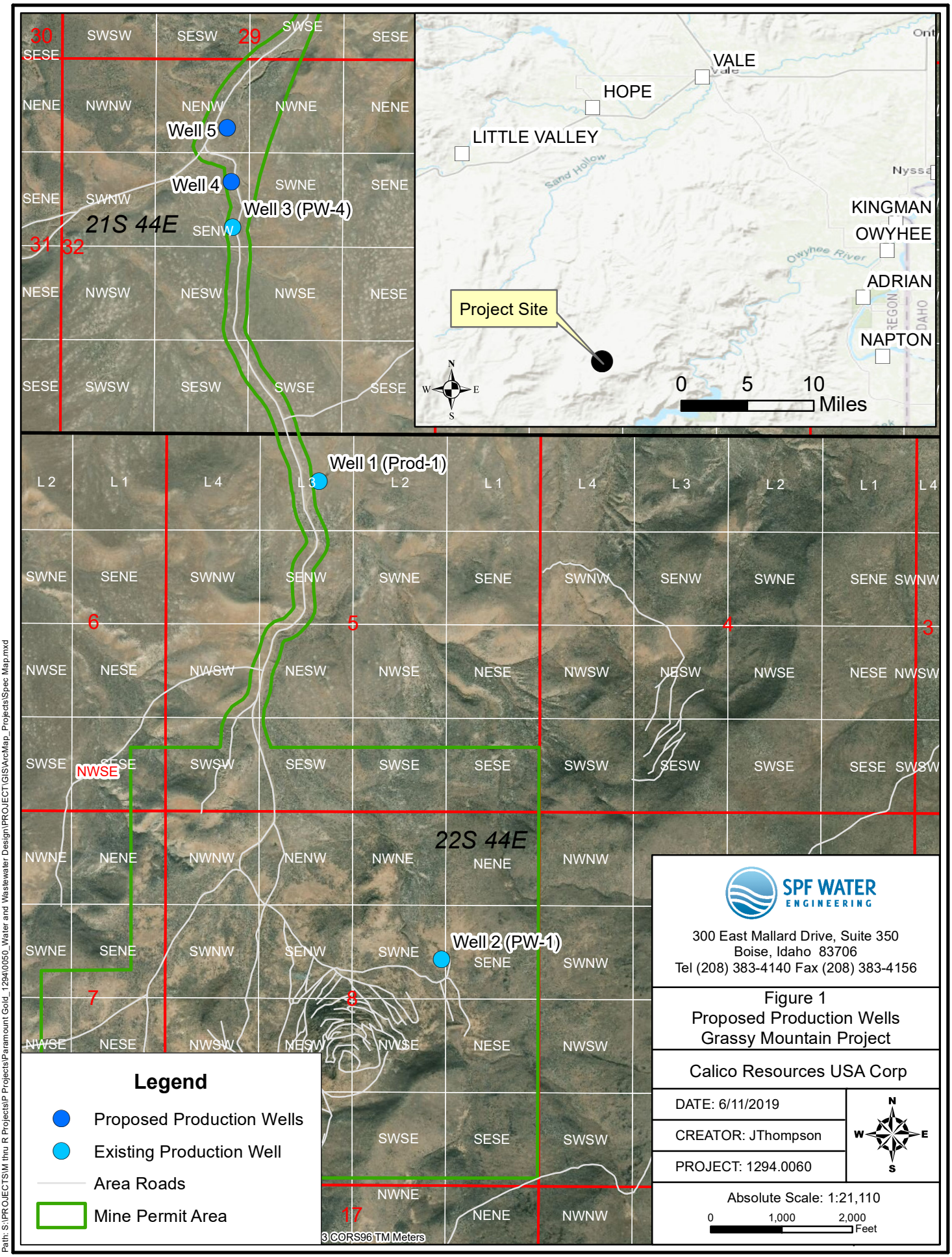
4.14 RIG TIME (ITEM 13; PRICES BASED UPON TIME, HOURS)

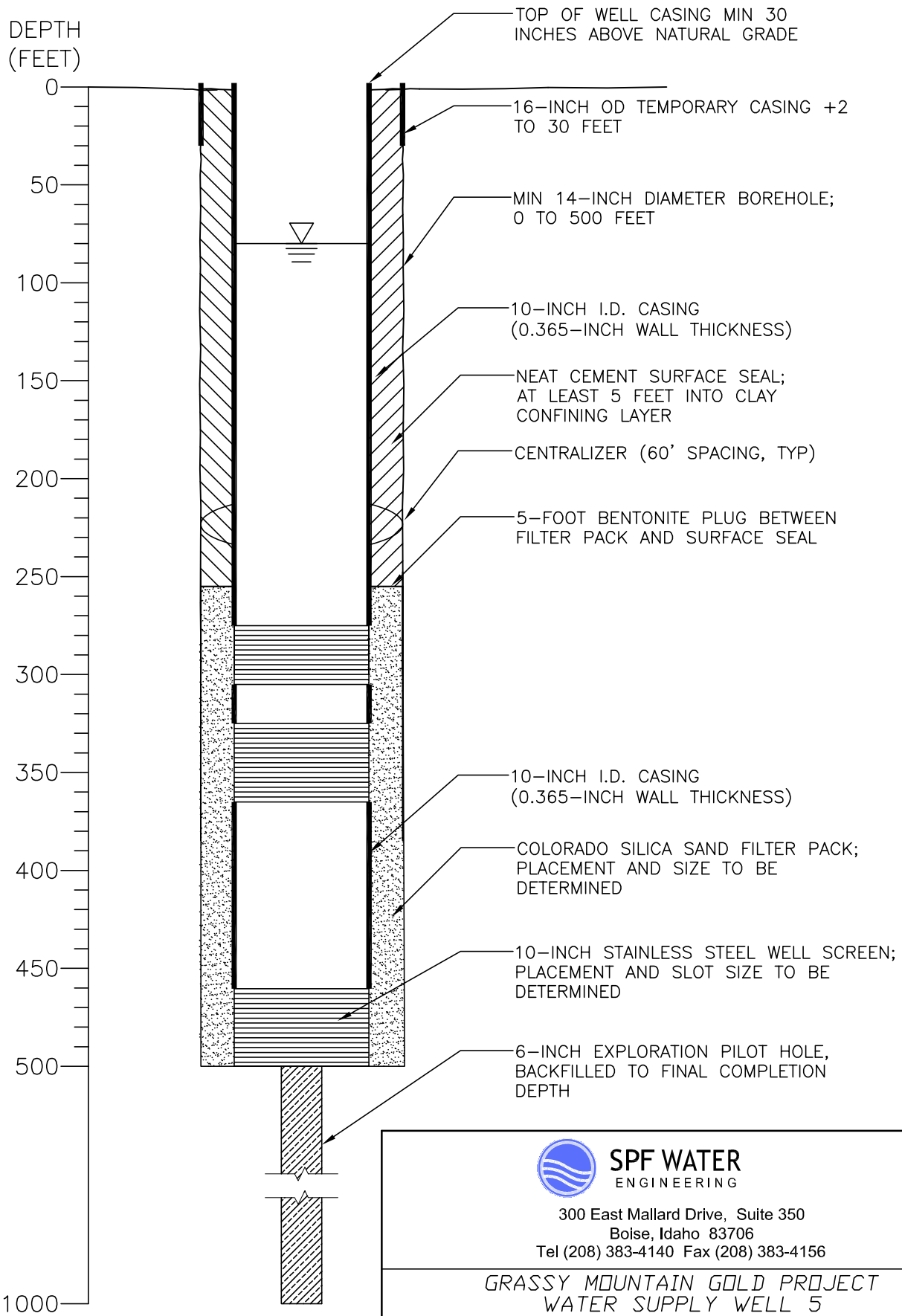
A. Measurement and payment for rig time will be based on the unit price listed on the Bid Schedule. Payment for rig time for additional work specifically directed by the Engineer not otherwise covered in these Contract Documents will be based on the actual number of hours of work done and shall be full compensation for rig, fuel, labor, equipment, and materials normally associated with Contractor's drilling activities. Additional materials, which may be required by the Engineer, shall be paid at the Contractor's invoice cost plus 10 percent for handling.

4.15 PLUGGING AND ABANDONMENT

A. In the event a well, successfully completed in accordance with these Contract Documents, requires plugging and abandonment, the cost for this work will either be negotiated with the Contractor or performed by others. The costs for plugging and abandonment of the well successfully completed in accordance with these Contract Documents shall not be considered as subsidiary to other bid items in the Contract.

- END OF TECHNICAL SPECIFICATIONS -


Well 5
Well 4
Well 3 (PW-4)
Well 1 (Prod-1)
Well 2 (PW-1)
21S 44E
22S 44E
VALE
HOPE
LITTLE VALLEY
KINGMAN
OWYHEE
ADRIAN
NAPTON
Project Site
0 5 10
Miles
Legend
Proposed Production Wells
Existing Production Well
Area Roads
Mine Permit Area
SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156
Figure 1
Proposed Production Wells
Grassy Mountain Project
Calico Resources USA Corp
DATE: 6/11/2019
CREATOR: JThompson
PROJECT: 1294.0060
Absolute Scale: 1:21,110
0 1,000 2,000
Feet
Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\PROJECT\GIS\ArcMap_Projects\Spec Map.mxd



SPF WATER
ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD PROJECT
WATER SUPPLY WELL 5
CONCEPTUAL DESIGN

SCALE: NTS
DRAWN BY: KJN

Figure 2 PROJ #1294.0050

BID SCHEDULE OF ITEMS AND PRICES
RAW WATER SUPPLY WELL 5
GRASSY MOUNTAIN GOLD PROJECT

The Bidder proposes the following schedule of prices for drilling, construction, development, and testing of one raw water supply well (Well 5) for Calico Resources USA Corp in accordance with the technical specifications. The quantities of work or material stated in unit price items of the bid are supplied only to give an indication of the general scope of the work. Payment for materials and labor will be based on actual quantities furnished, installed, or constructed in accordance with the prices bid for unit price items. The Bidder is solely responsible for completing all spaces below. The Bidder is responsible for the inclusion of all overhead and profit costs within each item.

Item	Description	Estimated Quantity	Unit	Unit Price	Total Amount
1	Mobilization and demobilization	1	lump sum	$_____	$_____
2	Drill 6-inch diameter pilot borehole	1,000	linear foot	$_____	$_____
3	Geophysical logging	1	lump sum	$_____	$_____
4	Backfill pilot borehole	500	linear foot	$_____	$_____
5	Ream pilot hole to min 14-inch diameter	500	linear foot	$_____	$_____
6	Furnish and install 10-inch I.D. casing	402	linear foot	$_____	$_____
7	Furnish and install 10-inch I.D. well screen	100	linear foot	$_____	$_____
8	Furnish and install sand filter pack	250	linear foot	$_____	$_____
9	Furnish and install annular well seal	250	linear foot	$_____	$_____
10	Well development	16	hours	$_____	$_____

11	Furnish, install, and remove test pump and related equipment	1	lump sum	$_____	$_____
12	Test pumping	176	hours	$_____	$_____
13	Rig time	2	hours	$_____	$_____
	Total				**$_____**

Submitted by: _____
Signature

_____
Title

_____
Company

_____
Address

_____ _____
Oregon Well Constructor's License Telephone Number

Appendix AE: Water and Wastewater Facilities Preliminary Engineering Design

Grassy Mountain Gold Project
Wastewater Facilities

Preliminary Engineering Report

Prepared for

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Prepared by

SPF Water Engineering, LLC
300 East Mallard, Suite 350
Boise, Idaho 83706
(208) 383-4140

September 13, 2019

RENEWS:
12/31/2020

SPF WATER ENGINEERING

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1. COMPLETE DESCRIPTION OF THE PROPOSAL

Paramount Gold Nevada Corporation has proposed to construct a gold mine in Malheur County, Oregon. A large soil absorption system (LSAS) is proposed for treating up to 3,920 gallons per day (gpd) of domestic wastewater. The LSAS will also receive backwash water from the potable water treatment system. The total daily design flow for the LSAS including arsenic treatment backwash water is 4,320 gpd.

The collection system of the domestic flows includes gravity sewer service lines and gravity mains. The water treatment backwash collection system includes a 4-foot diameter manhole, effluent pumps, and 100 feet of force main to the gravity system. See the Wastewater System Plans in Appendix A.

The primary treatment system includes a two-compartment septic tank. The 8,800-gallon septic tank has been oversized with the capacity to hold two days of storage in the event of a prolonged power outage. The second chamber of the septic tank holds two effluent pumps which provide pressurized doses to the absorption fields.

The proposed treatment system is a LSAS with 3,600 linear feet soil absorption trenches divided into 4 cells, each consisting of 6 trenches. Each dose pressurizes two of the trenches during a cycle. A distribution valve rotates the receiving trench after each pumping cycle.

2. LOCATION OF THE PROJECT

Location of the project, adjacent facilities, and waterways on a USGS topographic map. Include the location and latitude/longitude for all UIC wastewater systems on this map. Also provide a tax lot map for the project.

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: The Mine and Process Area and the Access Road Area (Permit Area) (Figure 2).

The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM) (Figure 2). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

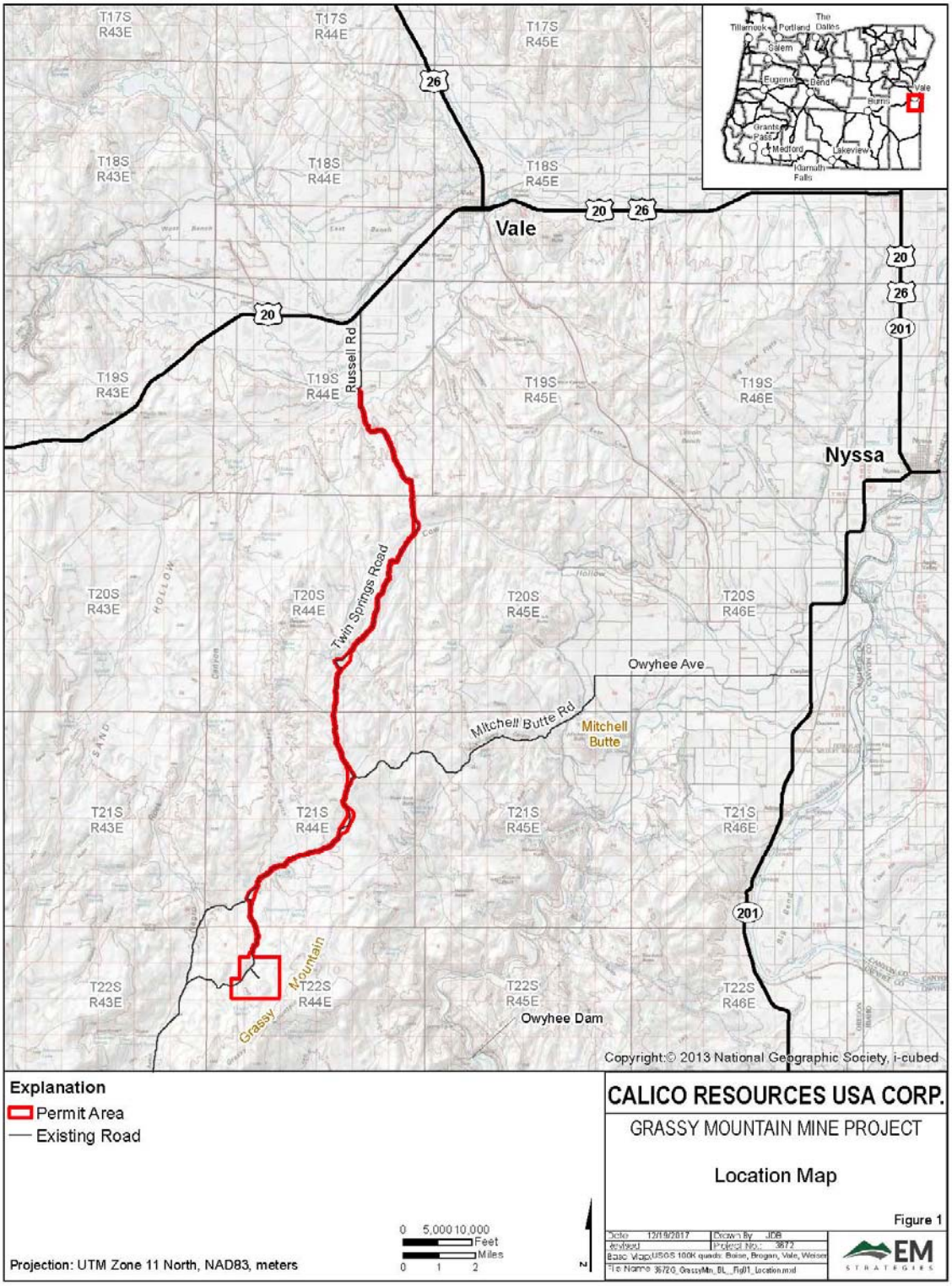


Figure 1. Project Location

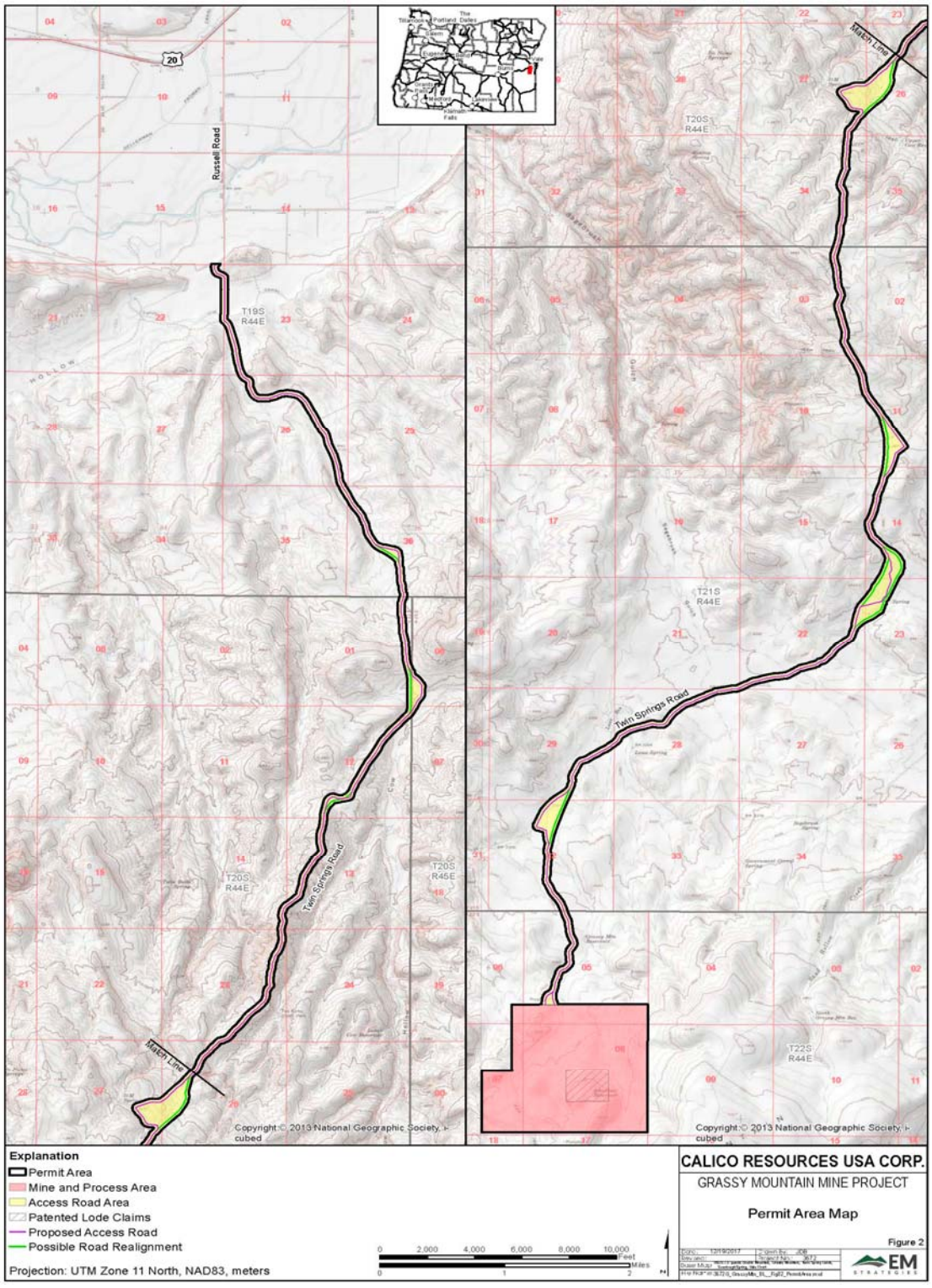


Figure 2. Permit Area

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or rerouting, and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be approximately 30 feet wide, which includes a 20-foot wide road travel width (10 feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

The Mine and Process Area is within two taxlots (Figure 3). The Calico Resources USA owns Taxlot 22S44E00101, while the Primary and Replacement Drainfield Areas are located within Taxlot 22S44E00101, which is owned by USA and administered by BLM.

The UIC wastwewater systems found on this project site include the Primary and Replacement LSAS Drainfield Areas. The latitude /longitude of these corners are provided in Table 1.

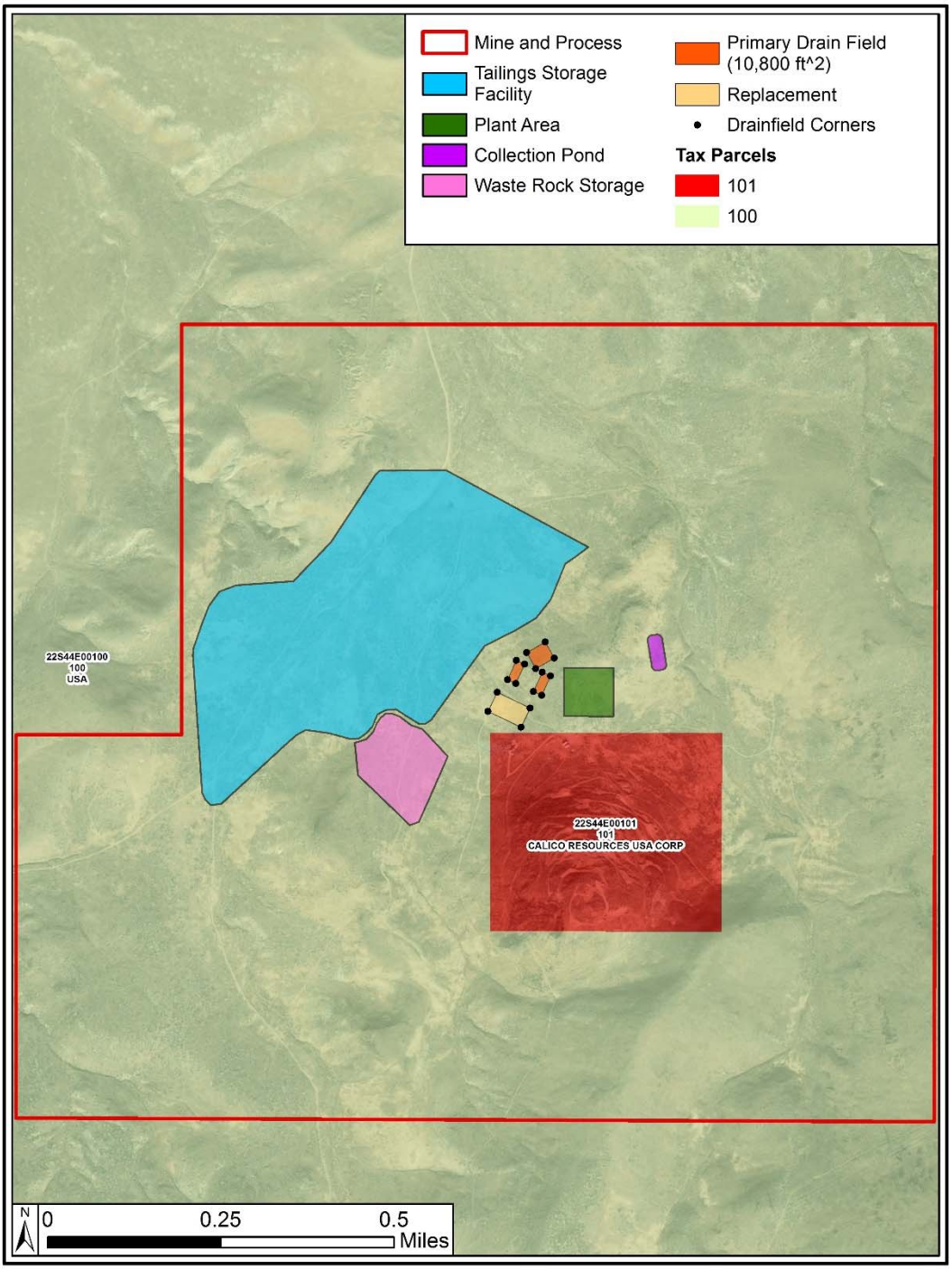


Figure 3. Taxlot and Drainfield Location Map

Table 1. UIC Locations

Primary Drainfield Corners		
Site 1		
P1	43.6746812°	-117.3605409°
P2	43.6743477°	-117.3602779°
P3	43.6741280°	-117.3608108°
P4	43.6744615°	-117.3610730°
Site 2		
P5	43.6742967°	-117.3613719°
P6	43.6742181°	-117.3611314°
P7	43.6738123°	-117.3613829°
P8	43.6738918°	-117.3616231°
Site 3		
P9	43.6740504°	-117.3606215°
P10	43.6739723°	-117.3603799°
P11	43.6735664°	-117.3606343°
P12	43.6736434°	-117.3608720°
Replacement Drainfield Corners		
R1	43.6736275°	-117.3619200°
R2	43.6732969°	-117.3609639°
R3	43.6728941°	-117.3612281°
R4	43.6732263°	-117.3621821°

3. SCHEDULE FOR DEVELOPMENT

Schedule for development, including future expansion plans if applicable.

Once the mine site is developed as proposed, there are no immediate plans for future expansion of the facility. The system is planned for installation TBD after permitting approval.

4. SCHEMATIC DIAGRAMS

Schematic diagrams of waste streams and treatment/disposal facilities. Include the source and quality of drinking water and water used for processing or manufacturing.

The schematic of the waste streams, treatment, and disposal facilities is shown in Figure 4.

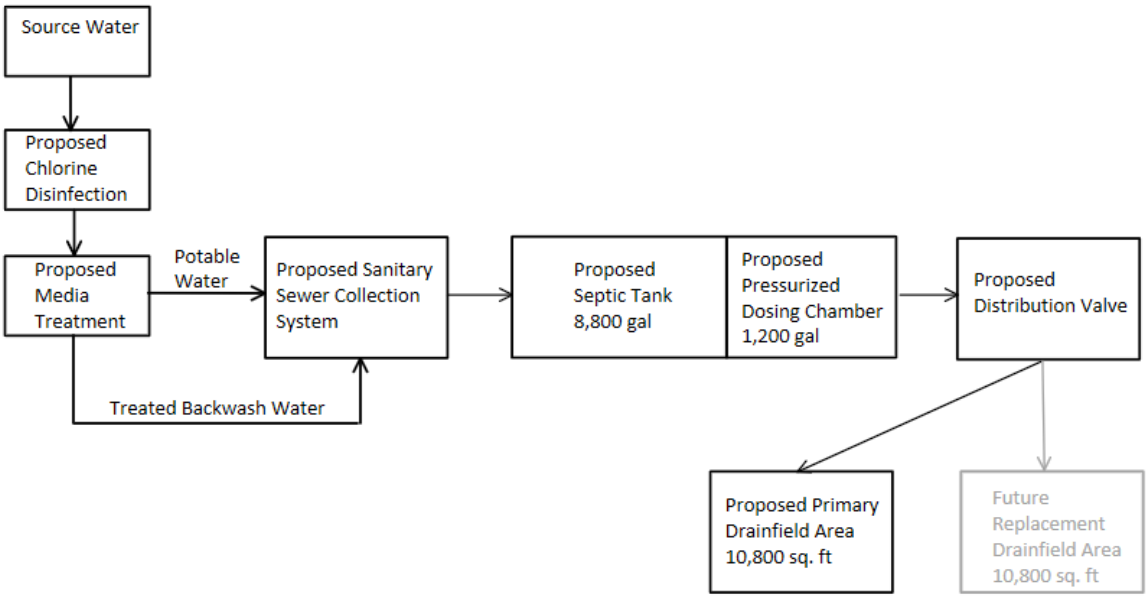


Figure 4. Schematic Diagram

The source water is pumped from a well field located approximately 2 miles north of the Mine Process Area. Representative source water quality results are shown in Table 2.

Potable water is produced by disinfecting with sodium hypochlorite and removing arsenic through adsorption via Bayoxide E33 media. The arsenic will be adsorbed and retained in the media. The treated backwash water quality is proposed to be similar to the raw water with the following exceptions; arsenic levels are expected to be approximately 0.01 mg/L and as a secondary effect of the adsorption process the iron/manganese quantity will also be significantly reduced.

Table 2. Source Water Quality

Analytes in mg/L unless noted. If result is <#, it is less than the MDL. If the result is blank, it was not tested. **Bold** results are over secondary MCL. **Red bold** results are over primary MCL.		GW-4							
Analytes	**MCL**	**3/14/13**	**6/17/13**	**8/6/13**	**11/21/13**	**11/21/13**	**3/18/14**	**6/27/14**	**9/11/14**
Aluminum, dissolved	0.05	0.03	0.04	0.04	0.04	0.05	0.06	0.07	0.05
Aluminum, total	0.05	1.68	0.95	0.68	1.13	0.84	1.09	0.6	0.83
Antimony, dissolved	0.006	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Antimony, total	0.006	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Arsenic, dissolved	0.010	0.0119	0.0115	0.012	0.0118	0.0119	0.0109	0.0109	0.0109
Arsenic, total	0.010	0.0118	0.0118	0.0126	0.0116	0.0113	0.0111	0.0114	0.0116
Barium, dissolved	2	<0.003	0.005	<0.003	0.005	0.005	<0.003	<0.003	<0.003
Barium, total	2	0.01	0.006	0.006	0.008	0.007	0.009	0.003	0.004
Beryllium, dissolved	0.004	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00005	<0.00005
Beryllium, total	0.004	0.00028	0.00014	0.00011	0.00013	0.00009	0.00014	0.00008	0.0001
Bicarbonate as CaCO3	NA	179	178	179	177	177	162	155	189
Bismuth, dissolved	NA	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Bismuth, total	NA	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Boron, dissolved	NA	0.126	0.16	0.14	0.15	0.16	0.12	0.14	0.14
Boron, total	NA	0.13	0.14	0.15	0.14	0.14	0.14	0.14	0.13
Cadmium, dissolved	0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium, total	0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Calcium, dissolved	NA	3.6	4	3.7	3.6	3.5	3.1	3.5	3.4
Calcium, total	NA	4.8	4.2	4.2	4.2	4	4.1	3.9	4
Carbonate as CaCO3	NA	16	16	14	14	14	9	11	14.9
Chloride	250	28.5	28.7	29	27	27	26.9	26.7	25.4
Chromium, dissolved	0.1	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium, total	0.1	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt, dissolved	NA	0.00024	0.00121	0.00009	0.00011	0.00007	0.00047	0.00038	0.0004
Cobalt, total	NA	0.00015	0.00009	0.00007	0.00009	0.00008	0.00008	0.00006	0.00008
Conductivity @25C (umhos/cm)	NA	673	681	682	665	666	696	671	660
Copper, dissolved	1.3	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Copper, total	1.3	<0.0005	0.0006	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005
Cyanide, total	0.2	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Cyanide, WAD	0.2	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluoride	4	2.47	2.3	2.3	2.21	2.21	2.23	2.21	2.13
Gallium, dissolved	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Gallium, total	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hardness as CaCO3	NA	9	11	9	9	9	8	9.6	9.7
Hardness as CaCO3 (dissolved)	NA								
Hardness as CaCO3 (total)	NA								
Hydroxide as CaCO3	NA	<2	<2	<2	<2	<2	<2	<2	<2
Iron, dissolved	0.3	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	0.02
Iron, total	0.3	0.59	0.36	0.28	0.42	0.33	0.41	0.25	0.36
Lead, dissolved	0.015	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Lead, total	0.015	0.0012	0.0008	0.0006	0.0008	0.0007	0.0009	0.0006	0.0008
Lithium, dissolved	NA	0.09	0.1	0.09	0.09	0.09	0.078	0.09	0.091
Lithium, total	NA	0.09	0.09	0.09	0.09	0.09	0.094	0.09	0.091
Magnesium, dissolved	NA	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	0.2	0.3
Magnesium, total	NA	0.3	<0.2	0.2	0.2	<0.2	<0.2	0.2	0.5
Manganese, dissolved	0.05	0.0046	0.0071	0.0048	0.0056	0.0054	0.0055	0.0055	0.0052
Manganese, total	0.05	0.0147	0.0115	0.0098	0.0129	0.0116	0.0101	0.0088	0.0122
Mercury, dissolved (ng/L)	2000	<0.4	0.2	<1	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury, total (ng/L)	2000	4	2	1	1.1	0.5	0.8	0.8	0.6
Molybdenum, dissolved	NA	0.0088	0.0093	0.0094	0.0099	0.0097	0.009	0.0083	0.0096
Molybdenum, total	NA	0.0105	0.0099	0.01	0.0088	0.0088	0.0093	0.0087	0.0099
Nickel, dissolved	NA	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
Nickel, total	NA	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006
Nitrate as N, dissolved	10	<0.02	<0.02	<0.02					
Nitrate/Nitrite as N	10			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate/Nitrite as N, dissolved	10	<0.02	<0.02	<0.02					
Nitrite as N, dissolved	1	<0.01	<0.01	<0.01					
Nitrogen, ammonia	NA	0.08	0.09	0.1	0.07	<0.05	<0.05	<0.05	<0.05
pH (standard units)	NA	8.7	8.7	8.7	8.6	8.7	8.5	8.6	8.6
pH measured at (°C)	NA	21	23	21	21	21	21	22	19.2

Table 2. Source Water Quality (Continued)

Analytes in mg/L unless noted. If result is <#, it is less than the MDL. If the result is blank, it was not tested. **Bold** results are over secondary MCL. **Red bold** results are over primary MCL.		GW-4							
Analytes	**MCL**	**3/14/13**	**6/17/13**	**8/6/13**	**11/21/13**	**11/21/13**	**3/18/14**	**6/27/14**	**9/11/14**
Phosphorus, total	NA	0.03	0.02	0.01	0.02	0.02	0.07	0.02	0.02
Potassium, dissolved	NA	0.7	0.9	0.5	0.7	0.7	0.4	0.7	0.7
Potassium, total	NA	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.9
Total Dissolved Solids	500	420	380	416	400	410	260	390	390
Total Suspended Solids	NA	46	23	22	21	12	33	14	18
Scandium, dissolved	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Scandium, total	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium, dissolved	0.05	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Selenium, total	0.05	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Silver, dissolved	0.10	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Silver, total	0.10	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00005	<0.00005
Sodium, dissolved	NA	147	156	151	145	146	129	141	144
Sodium, total	NA	154	150	152	148	149	152	146	144
Strontium, dissolved	NA	0.02	0.03	0.02	0.02	0.02	0.019	0.018	0.019
Strontium, total	NA	0.03	0.03	0.03	0.03	0.03	0.029	0.021	0.023
Sulfate	250	95.81	93.9	94.9	89.1	89.1	88.3	86.8	81.6
Thallium, dissolved	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Thallium, total	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tin, dissolved	NA	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Tin, total	NA	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0006	0.0001
Titanium, dissolved	NA	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Titanium, total	NA	0.013	0.01	0.007	0.012	0.01	0.013	0.006	0.012
Total Alkalinity	NA	195	194	193	191	191	172	166	204
Uranium, dissolved	0.030		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Uranium, total	0.030		0.0004	0.0002	0.0003	0.0002	0.0003	0.0002	0.0002
Vanadium, dissolved	NA	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0004
Vanadium, total	NA	0.0006	0.0004	0.0002	0.0003	0.0003	0.0005	0.0003	0.0003
Zinc, dissolved	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc, total	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

5. WASTEWATER CHARCTERIZATION

The daily average domestic wastewater design flow is estimated to be 3,920 gpd. This value assumes 112 workers at the mine per day and an average day potable water demand of 35 gpd (based on OAR 340-071-0220 for factories with shower facilities). The plant and mine offices and associated change houses are expected to include showers, wash basins, and toilets. There will not be on-site laundry facilities.

The effluent entering the LSAS will consist of typical residential strength sewage from workers at the mine site. The LSAS will also receive backwash water from the potable water treatment system. The total daily design flow for the LSAS including treatment system backwash water is 4,320 gpd. Currently, one (1) drainfield is proposed, with a replacement area (Figure 3). The drainfield is sized based on a dosing rate of 0.4 gallons per square foot per day for type C soils.

6. PLANS FOR DISPOSAL OF SOLID WASTE AND SLUDGES

Trash will be deposited in dumpsters and hauled away to a permitted landfill by a local commercial garbage service. Septage will be pumped and hauled to a permitted facility by a Department of Environmental Quality licensed pumper.

7. SITE EVALUATION REPORT

Site evaluation report prepared as outlined by OAR 340-071-0150 (onsite sewage disposal or graywater reuse and disposal systems only.)

A site evaluation report (Appendix B) was prepared by Larry Brown of DEQ Eastern Region in May of 2019. The evaluation concluded the absorption are to be Class C soils suitable for a pressurized LSAS to accommodate the proposed design flows. At the time of the evaluation, there was not enough information to determine if pretreatment would also be required. A Water Quality Impact Assessment (WQIA) (Appendix C) was prepared by SPF which concludes that pretreatment will not be required.

8. GROUNDWATER INFORMATION

Groundwater information for all areas where wastewater or sludge will be stored or disposed.

The WQIA (Appendix C) provides detailed groundwater information. The location of the proposed drainfield is north of the mine and approximately 200 feet west and northwest of monitoring wells 59762 and GMW17-31. The geologist lithology log from GMW17-31 shows overburden for the top 8 feet, interbedded sandstone, siltstone, clay, and conglomerate from 8 to 60 feet, clay from 60 to 147 feet, then interbedded arkose, sandstone, siltstone, clay, and tuff from 147 to the bottom at 520 feet. The lithology noted traces of silicification 41 to 60 feet and 92 to 107 feet and indicated the majority of the bore was silicified from 147 feet to the bottom of the bore. Once completed with a screened interval of 458 to 498 feet, GMW17-31 had no measurable water in the well. Overtime, water has seeped into the well to an elevation of approximately 3,222 feet above meal sea level, roughly 500 feet below ground.

Near the proposed Grassy Mountain mine, due to the nature of the silicification and compartmentalization of the aquifer due to faulting, there tends to be deeper water levels. Downgradient of the proposed mine, the silicification decreases. The proposed drainfield is also downgradient of the faulting causing the compartmentalization near the proposed mine. It is expected the effluent from the drainfield will initially migrate downward until reaching less permeable siltstones, clays, or silicified sediments which will cause horizontal movement in the downgradient and down dip (northwest) direction. Once the effluent reaches the water table, estimated to be 3,450 feet above mean sea level, it will travel downgradient in the

northwest direction flowing into the areas with less silicification. The water table is expected to be approximately 100 to 200 feet below ground surface in the vicinity of the drainfield.

A list of wells, locations, construction details, measurement protocols, water level data, and hydrographs are presented in the groundwater baseline report. Well construction details are summarized in Table 3. The location of all the monitoring wells is shown on Figure 5.

Table 3. Well Construction Table

Calico Well ID	OWRD Well Tag Number	OWRD Name	Alternate Name	Drill Method	Depth of First Water (ft)	Well Const. Depth (ft)	Screened Interval (ft)	Well Casing Diameter (in)	TOC Elevation[4]	Elevation Screened Interval (ft)	Water Level Elevation (9/26/2018)	Production (gpm)[2]	Screened Lithology[1]
59760	107462	MALH 2974	Middle Sweizer, TW-1	air rotary	160	203	163-203	6	3762.1	3599-3559	3673.43	+10	fractured basalt
59761	109400	MALH 2993	Lower Sweizer, MW-2	air rotary	100	118	97-117	4	3762.2	3665-3645	3673.48	+50	fractured basalt
59762	109371	MALH 2976, 2985	MW-3	air rotary	626	700	550-660	4	3724.8	3175-3065	3103.4	<1	siltstone
59763	109356	MALH 2994	TW-4	air rotary	277	323	293-323	6	3519.4	3226-3196	3239.03	+5	fractured volcanics
59764	107466	MALH 2986	MW-5	air rotary	270	300	279-299	4	3511.9	3233-3213	3238.24	+10	fractured sandstone
59765		MALH 2979	MW-6	air rotary	29	36	28-36	4	3446.5	3418-3410	dry	dry	shallow sandstone
59766	107468	MALH 2980	MWS-8	air rotary	only damp when drilled	45	25-45	4	3459.7	3435-3415	3426.68	+10	shallow sandstone
59767		MALH 2995	MWS-9	air rotary	dry	40	20-40	4	3495.3	3475-3455	dry	dry	shallow sandstone
59768		MALH 54197	MWS-10	air rotary	21	25	10-25	4	3480.6	3471-3456	3463.46	0.5	shallow sandstone
59770		MALH 2983	MW-11	air rotary	dry when drilled	424	374-424	4	3389.0	3015-2965	3241.71	+0.5	volcanic tuff
59772	109352	MALH 2984	Upper Sweizer, MWS-13	air rotary	125	207	165-205	4	3768.2	3603-3563	3673.5	+50	fractured basalt
26-092-915	109354	MALH 54071		unknown	unknown	915	228-268	2	3710.0	3482-3442	3633.55	unk	unk
57-1		MALH 54195		unknown	unknown	765	108-138	1.25	3770.6	3663-3633	3699.1	unk	unk
57-10		MALH 54196		unknown	unknown	500	126-156	1	3681.1	3555-3525	3635.67	unk	unk
89-2	109360	MALH 54072		unknown	200	425	386-406	2	3293.5	2907-2887	3235.54	unk	unk
Bishop	None	MALH 54046	Rye Field	cable	unknown	482	135-145	12	3391.5	3257-3247	3281	50	coarse gravel
BLM	109398	MALH 2277	Owyhee Ridge	cable	unknown	175	159-166	6	3579.6	3421-3414	3423.95	+12	white sand
GMW17-31	125168	MALH 54404		air rotary	dry when drilled	498	458-498	5	3722.0	3262-3222	3222.6	0	siltstone, sinter, clay
GMW17-32	125169	MALH 54405		air rotary	244	718	678-718	5	3702.1	3026-2986	3082.1	<1	Arkose, siltstone, Clay
GMW17-33	125170	MALH 54406		air rotary	243	338	238-338	5	3702.7	3465-3365	3452.16	<30	sinter, siltstone, tuff
GMW18-34	130031	MALH 54437		air rotary	dry	950	830-890	5	3953.3	3127-3067	dry	dry	Arkose, siltstone, Clay
GW-1	107469	MALH 2281	47-1	air rotary	140	155.5	135.5-155.5	4	3709.1	3573.5-3553.5	3654.18	60	gravel
GW-2	109357	MALH 2279	47-2	air rotary	dry when drilled	325	290-320	4	3827.5	3537-3507	3662.91	0	blue and grey clay
GW-3	107467	MALH 2278	47-3	air rotary	dry when drilled	350	320-350	4	3633.6	3314-3284	3401.68	<1	blue and grey clay
GW-3A		MALH 2579		air rotary	dry	420	380-420	2	3655	3275-3235	dry	dry	silt and clay
GW-3B		MALH 2576		air rotary	dry	340	80-100	2	3626	3546-3526	dry	dry	clay
GW-4	107460	MALH 54073		unknown	50	370	280-350	4	3342.7	3063-2993	3260.85	100	sandstone, congl, clay
GW-5		MALH 54194		air rotary	unknown	265	204-224	2	3413.0	3209-3189	3221.45	<1	tuff, clay
GW-6	109368	MALH 2578		air rotary	145	340	300-340	2	3377.3	3077-3037	3236.16	3-4	sandstone, congl, clay
Prod 1	107457	MALH 2275, 2511		air rotary	145	425	145-255, 325-355, 380-420	6	3436.4	3291-3181, 3111-3081, 3056-3016	3436.41	30-100[3]	sandstone, blue clay, and hard sandstone
PW-1	109353	MALH 2276		air rotary	320	520	320-340, 400-420	6	3709.1	3389-3369, 3309-3289	3654.66	25-35[3]	brown clay and sand; coarse sandstone
PW-4	109351	MALH 2206		air rotary	280	375	280-300, 340-360	6	3341.4	3061-3041, 3001-2981	3261.39	175-250[3]	sandstone and conglomerate

1 - as reported on the drillers log
2 - based on short-term testing by driller during or following construction
3 - based on long-term test pumping
4 - surveyed with the exception of GW-3A, GW-3, GMW-17-31, GMW17-32, GMW17-33, and GMW18-34

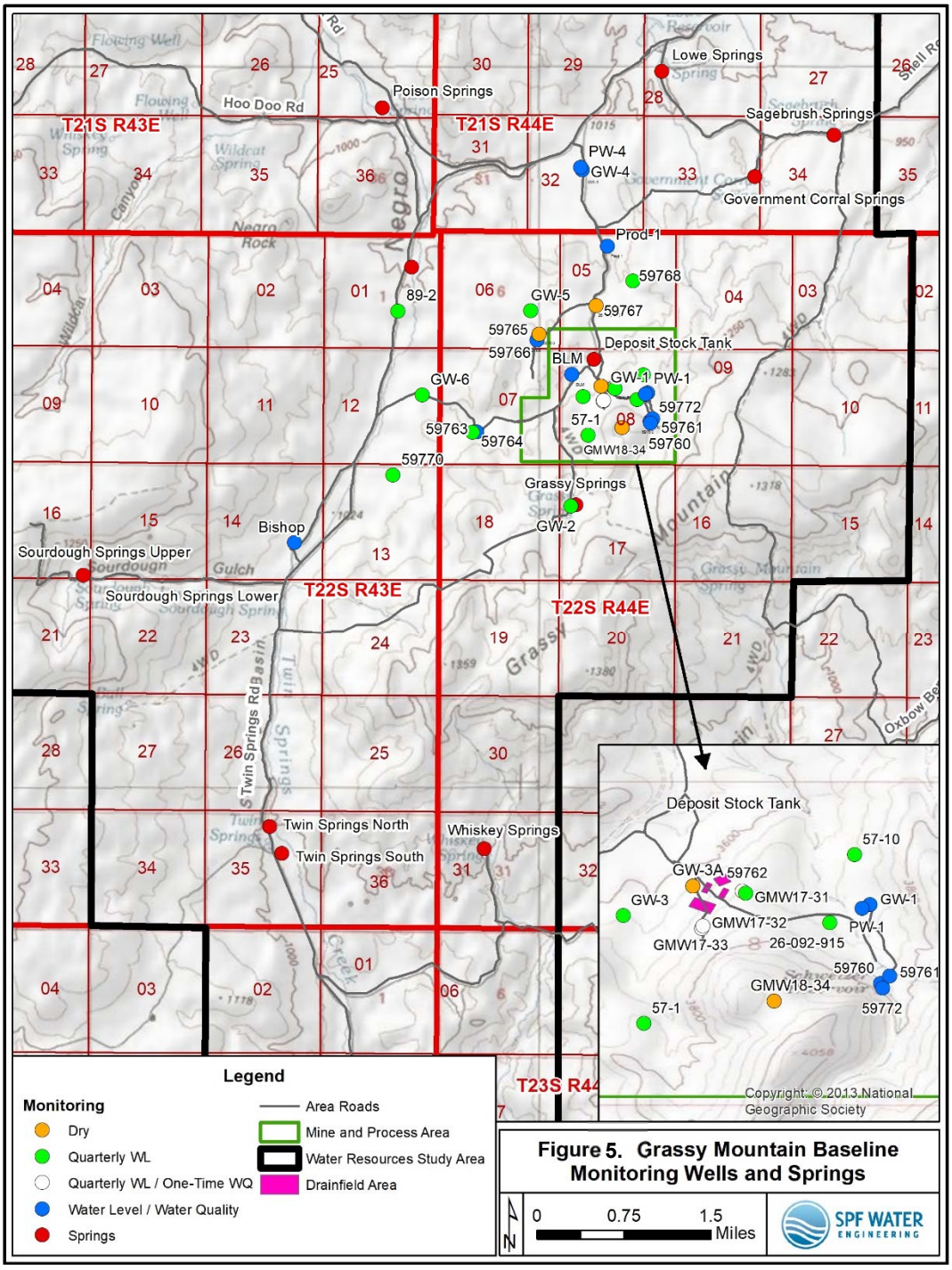


Figure 5. Grassy Mountain Baseline Monitoring Wells and Springs

9. EVAUATION OF GROUNDWATER AND SURFACE WATER IMPACTS

Evaluation of groundwater and surface water impacts and the steps that will be taken to prevent impacts from occurring.

The Level 1 nitrate balance evaluation, WQIA (Appendix C), predicts an increase of 1.76 mg/L in the groundwater nitrate concentration downgradient of the Grassy Mountain Mine Permit Area boundary. The model is based on limited site-specific data and necessary simplifying assumptions. There currently are no drinking water wells in the area. The proposed wells to be used for potable use are or will be located more than 1.6 miles from the drainfield in deeper confined sand layers. A model sensitivity assessment has been performed to address model uncertainty.

Based on the results of the Level 1 nitrate balance evaluation, SPF recommends proceeding with the proposed drainfield design rate of 3,920 gpd of wastewater and a daily design flow of 4,320 to accommodate the estimated monthly water treatment system backflush water. Should new or additional data be collected in support of the design and implementation, refinement of the nitrate balance study and conclusions presented in this report may be warranted.

10. OPERATION AND MAINENANCE PLAN

Operation and maintenance plan that specifies the normal operation parameters of the system.

An Operation and Maintenance (O&M) Manual for the proposed system has been prepared as a separate document for submission, review, and approval with the WPCF permit application. The O&M Manual is included in Appendix D.

Appendix A
Wastewater System Plans

SEPTIC TANK
SEE SHEET C508

123°

0+00
MH – 1
STA: 0+00

MH – 2
STA: 0+84

151°

1+00

10' MIN.
SEPARATION

3700.00

TRANSPORT LINES

STOCKPILE &
RECLAIM AREA

3710.00

3710.00

3710.00

ABSORPTION TRENCH
AREA BOUNDARY
SEE SHEET C401

SEWER SERVICE CLEANOUT
SEE SHEET DETAIL 4
SHEET C506

3708.00

4" SANITARY SEWER
SERVICE LINE

135°

0+00

2+00

MH – 3
STA: 0+00

MH – 3
STA: 2+01

135°

1+00

4" SANITARY SEWER
SERVICE LINE

10' MIN.
SEPARATION

4" SANITARY SEWER
SERVICE LINE

1+91

MH – 3A
STA: 1+91

3706.00

3704.00

3702.00

3-SEWER SERVICE
CONNECTIONS
SEE SHEET DETAIL 5
SHEET C504

3-SEWER SERVICE CROSSINGS
SEE SHEET DETAIL 5 SHEET C506

ELUTION AREA

GOLD ROOM

REAGENT AREA

10' MIN.
SEPARATION

3+00

CIL AREA

WATER SERVICE AREA

GRINDING AREA

SEWER SERVICE CROSSINGS
SEE SHEET DETAIL 5 SHEET C506

MH – 5A
STA: 0+88

FM

FM

10' MIN.
SEPARATION

4+00

5+00

90°

MH – 4
STA: 3+67

MH – 5
STA: 5+65

CRUSHING AREA

TRUCK WASH

6+00

3706.00

3710.00

3720.00

3724.00

3728.00

SEWER SERVICE CONNECTION
SEE SHEET DETAIL 5 SHEET C504

TRUCK WORKSHOP
& WAREHOUSE

4" SANITARY SEWER
SERVICE LINE

TSS

MH – 6
STA: 6+86

6+86

SEWER SERVICE CLEANOUT
SEE SHEET DETAIL 4 SHEET C506

MINE OFFICE &
CHANGE HOUSE

20 0 20 40
SCALE OF FEET

CONSTRUCTION NOTES

1. PROPOSED PAD ELEVATIONS ARE BASED ON THE LANDXML SURFACE PROVIDED TO SPF ON 8/20/2019 BY AUSENCO. IF FINAL PAD ELEVATIONS DIFFER FROM THE ASSUMED ELEVATIONS, CONTRACTOR SHALL ADJUST FINAL MANHOLE AND GRAVITY SANITARY SEWER PIPES ACCORDINGLY. GRADE AREA AROUND EACH MANHOLE TO DIVERT SURFACE WATER AWAY.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION SYSTEM SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
17078
8/22/2019
OREGON
MAR. 13, 2015
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C400

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: GRASSY M'TN_SEWER C400-C404 Plot date: Aug 22, 2019-01:00:54pm CAD User: HWhite.
Xref Filename: | X-TITLE | X-LINEWORK | X-PLANT SITE BASE_7-23-19 | X-TITLE (2) |

CONSTRUCTION NOTES

1. CONTRACTOR SHALL FOLLOW OAR 340-071-0520 RULES AND REGULATIONS.
2. THIS SYSTEM SHALL BE INSTALLED UNDER DRY SOIL CONDITIONS TO REDUCE SMEARING. IF SMEARING OCCURS, THE SMEARED AREAS SHALL BE RAKED.
3. THE SITE OF DISTURBANCE MUST BE RE-SEEDED.
4. BOTH THE INITIAL AND REPLACEMENT ABSORPTION TRENCH AREAS ARE TO BE PROTECTED FROM TRAFFIC, COVER, DEVELOPMENT OR OTHER POTENTIAL DISTURBANCE OF NATURAL SOIL CONDITIONS.
5. THE ABSORPTION TRENCH AREAS MUST NOT BE SUBJECTED TO EXCESSIVE SATURATION DUE TO: BUT NOT LIMITED TO; ARTIFICIAL DRAINAGE OF GROUND SURFACES, ROADS, DRIVEWAYS AND BUILDING DOWN SPOUTS.
6. IF ROADS ARE CUT DOWNSLOPE OF THE ABSORPTION TRENCH AREAS THE CONTRACTOR SHALL PROVIDE A MINIMUM SETBACK OF 50-FT.
7. ABSORPTION TRENCHES SHALL NOT BE CONSTRUCTED WITHIN 100-FT OF A WELL.
8. ALL WORK IN ABSORPTION TRENCH AREAS SHALL BE DONE WITH TRACK MACHINERY. NO WHEELED MACHINERY SHALL BE ALLOWED IN THE ABSORPTION TRENCH AREAS.
9. NO STOCKPILING OF MATERIALS SHALL BE ALLOWED WITHIN THE ABSORPTION TRENCH AREAS.
10. ALL HOLES IN LATERALS SHALL BE ORIENTED DOWN.
11. PROPOSED PAD ELEVATIONS ARE BASED ON THE LANDXML SURFACE PROVIDED TO SPF ON 8/20/2019 BY AUSENCO. IF FINAL PAD ELEVATIONS DIFFER FROM THE ASSUMED ELEVATIONS, CONTRACTOR SHALL ADJUST FINAL MANHOLE AND GRAVITY SANITARY SEWER PIPES ACCORDINGLY. GRADE AREA AROUND EACH MANHOLE TO DIVERT SURFACE WATER AWAY.

ABSORPTION TRENCHES

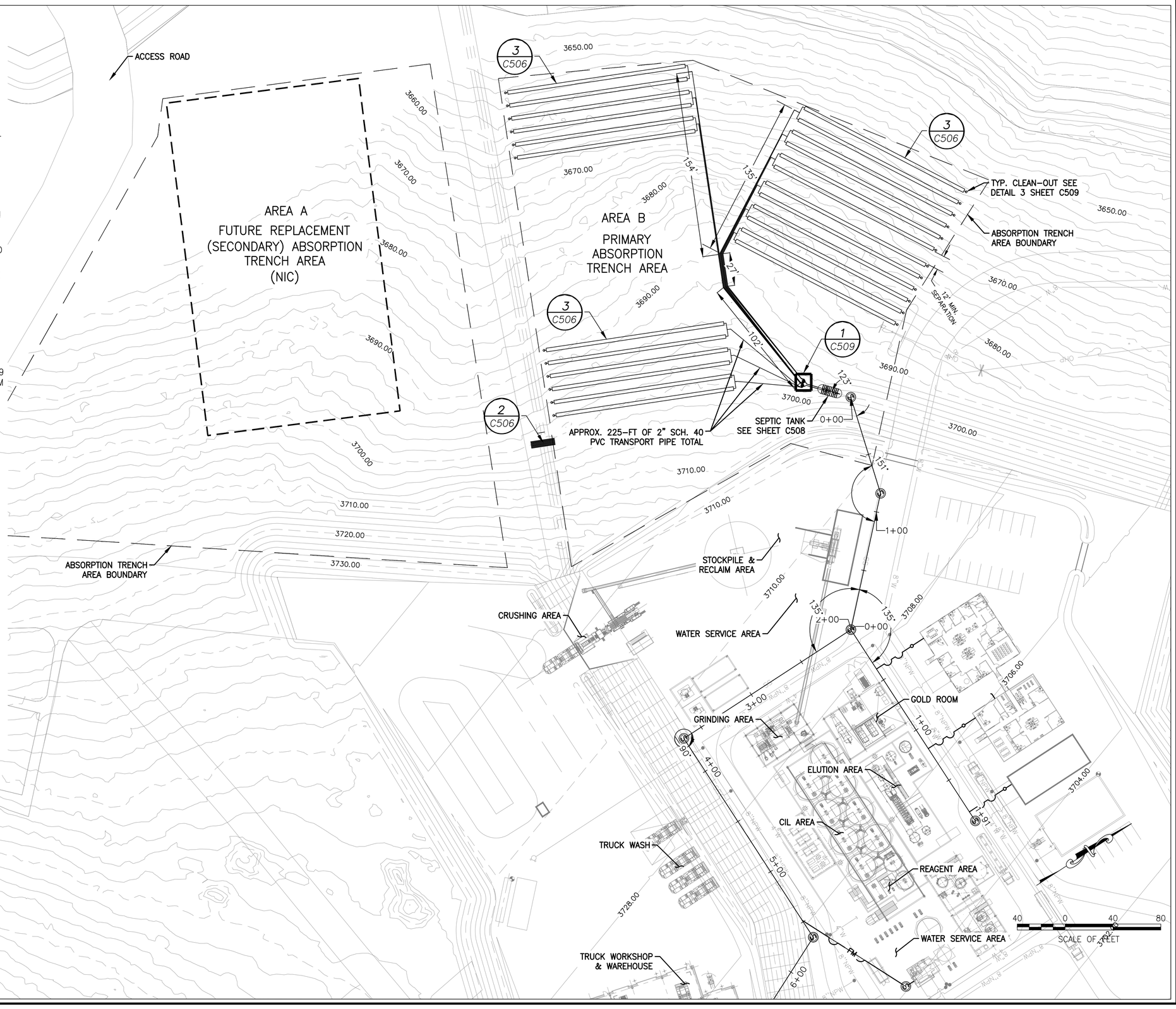
- 150'L X 3'W (24), 10,800 SF
- (4) ZONES PER AREA, 12-FT SPACING BETWEEN ZONES, 6 LATERALS PER ZONE, 2 LATERALS DISCHARGING PER DOSE, 11-FT SPACING BETWEEN LATERALS
- 1/8" DIA. ORIFICES, 4-FT SPACING, 38 ORIFICES PER LATERAL, 228 PER ZONE
- PLAN FOR 5-FT RESIDUAL HEAD AT END OF EACH LATERAL
- FLOW RATE PER ZONE = 60 GPM

PIPING AND VALVES

- TRANSPORT PIPING = 2" SCH. 40, 3168-FT
- MANIFOLD = 2" SCH. 40., 11-FT EACH, 132-FT
- LATERALS = 2" SCH. 40., 150-FT EACH, 3,600-FT

DUPLEX EFFLUENT PUMPS

- OPERATING POINT = 60 GPM @ 60-FT HEAD, APPROX.
- ALTERNATE BETWEEN DOSES
- AT LEVEL BETWEEN "PUMP OFF" AND HIGH LEVEL ALARM, BOTH PUMPS TURN ON
- DOSE ≈ 180 GALLONS, 6 TIMES PER DAY



SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
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Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

ABSORPTION TRENCH & REPLACEMENT AREAS SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
OREGON
MATTHEW W. RASMUSSON
MAR. 13, 2015
EXPIRES: 12/31/2019
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C401

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: GRASSY MTN_SEWER C400-C404 Plot date: Aug 22, 2019-01:01:14pm CAD User: HWhite.
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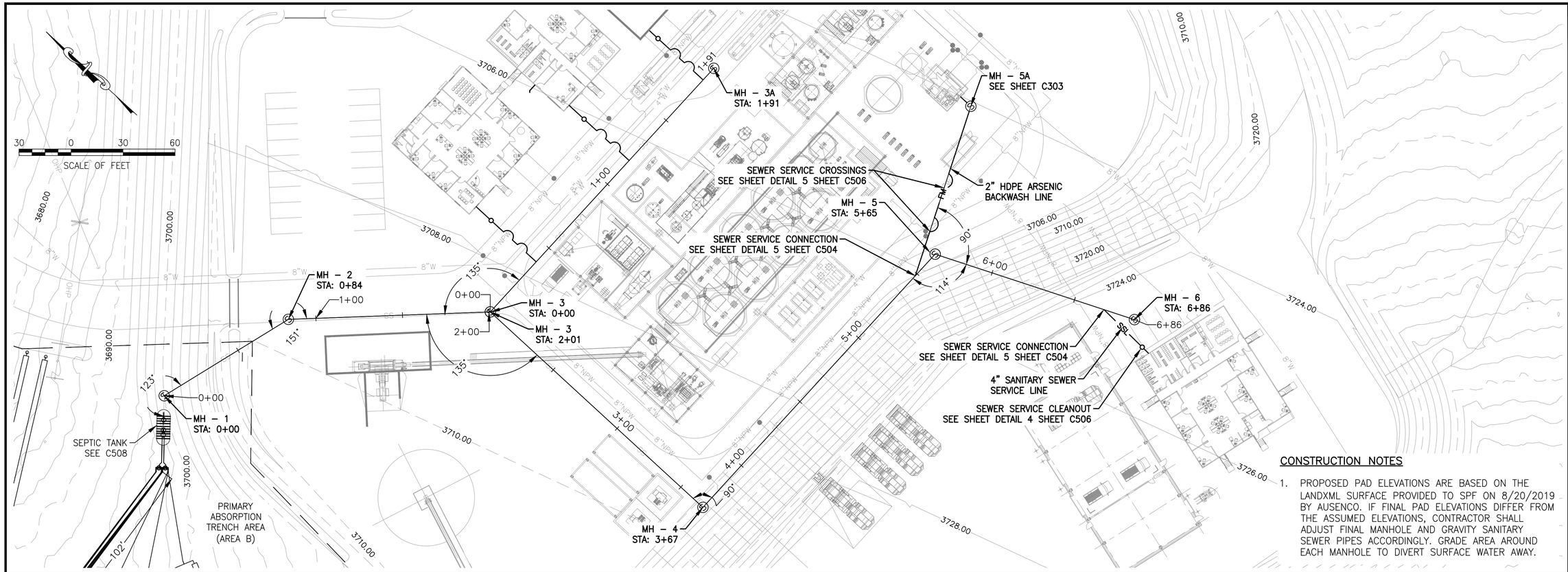
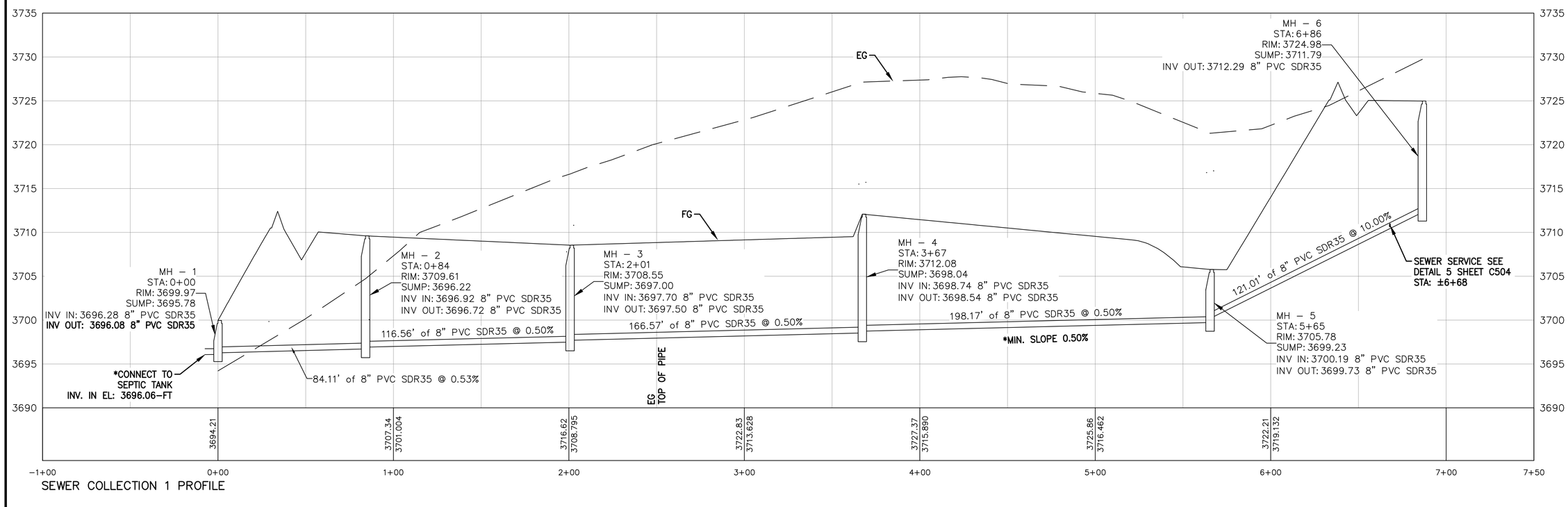


CONSTRUCTION NOTES

1. PROPOSED PAD ELEVATIONS ARE BASED ON THE LANDXML SURFACE PROVIDED TO SPF ON 8/20/2019 BY AUSENCO. IF FINAL PAD ELEVATIONS DIFFER FROM THE ASSUMED ELEVATIONS, CONTRACTOR SHALL ADJUST FINAL MANHOLE AND GRAVITY SANITARY SEWER PIPES ACCORDINGLY. GRADE AREA AROUND EACH MANHOLE TO DIVERT SURFACE WATER AWAY.



SEWER COLLECTION 1 PROFILE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION 1

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
OREGON
MAR. 13, 2015
RENEWS: 12/31/2020

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C402

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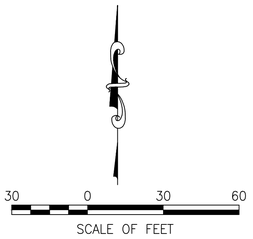

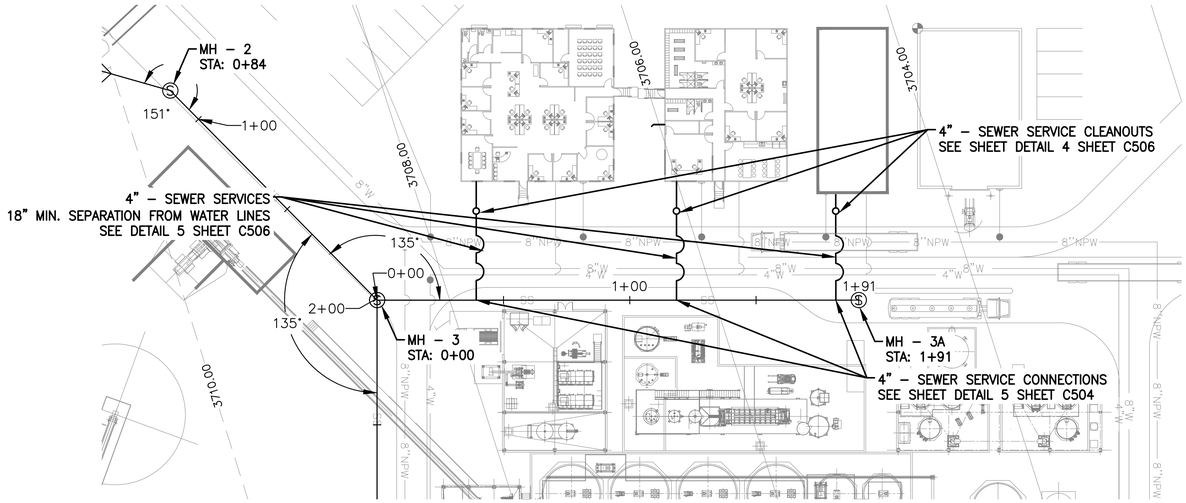

CONSTRUCTION NOTES

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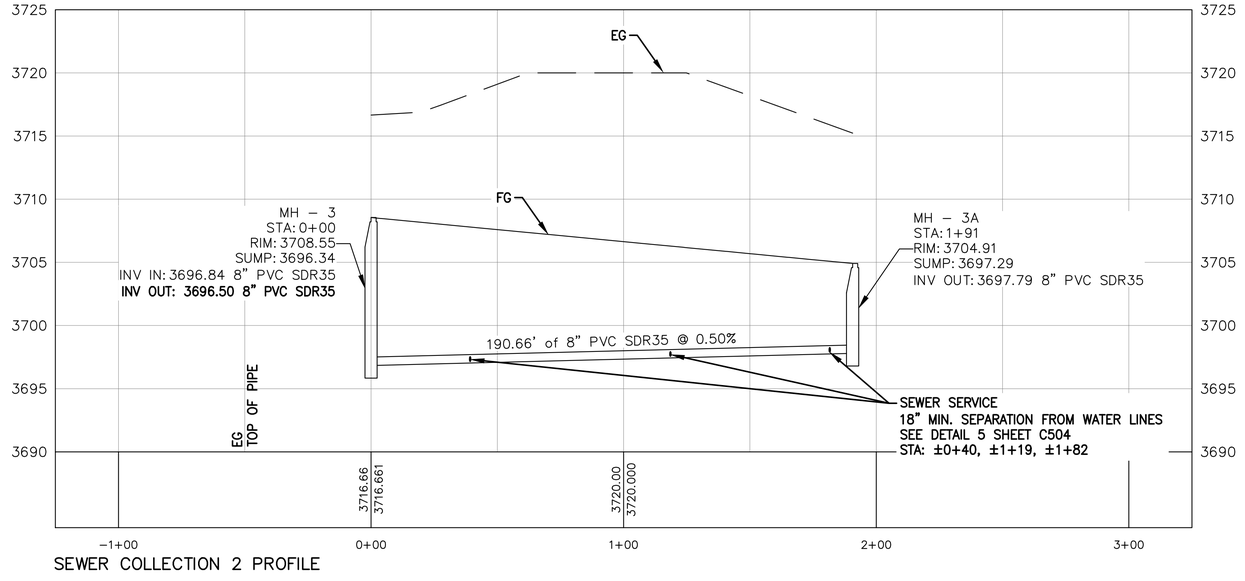

SEWER COLLECTION 2 PROFILE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION 2

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
No. 17872
OREGON
MAR. 13, 2015
8/22/2019
RENEWS: 12/31/2020

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C403

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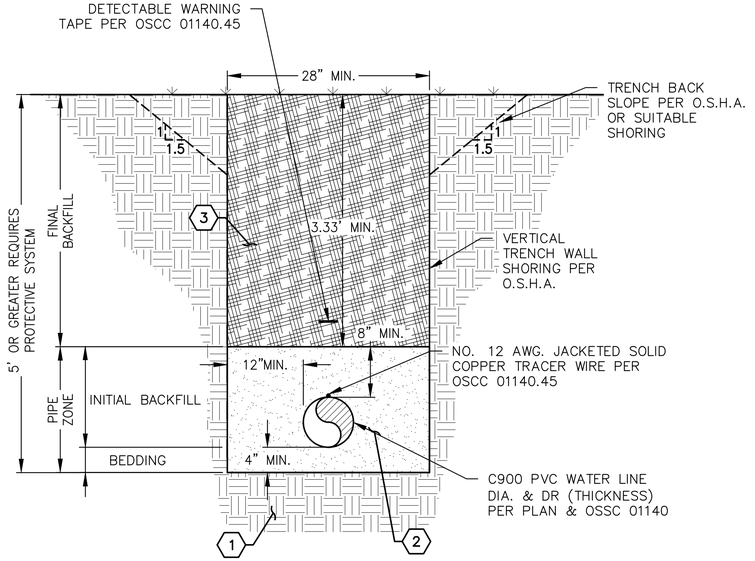
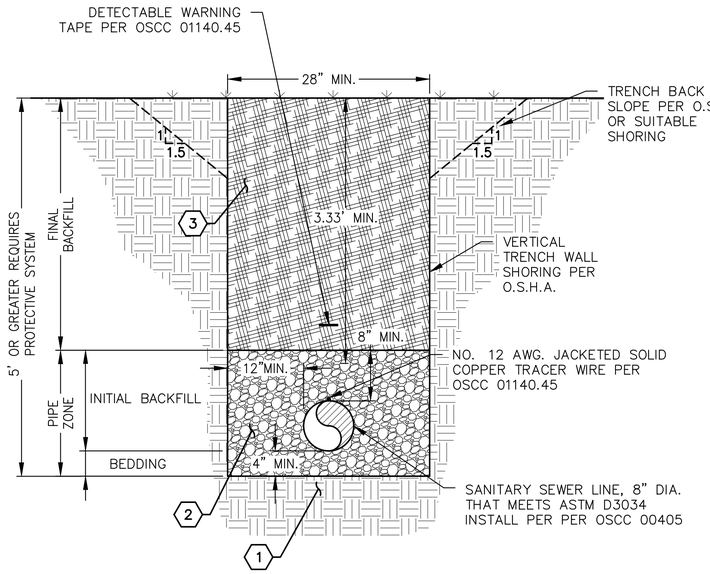


1 WATER LINE TRENCH DETAIL
NOT TO SCALE

LEGEND

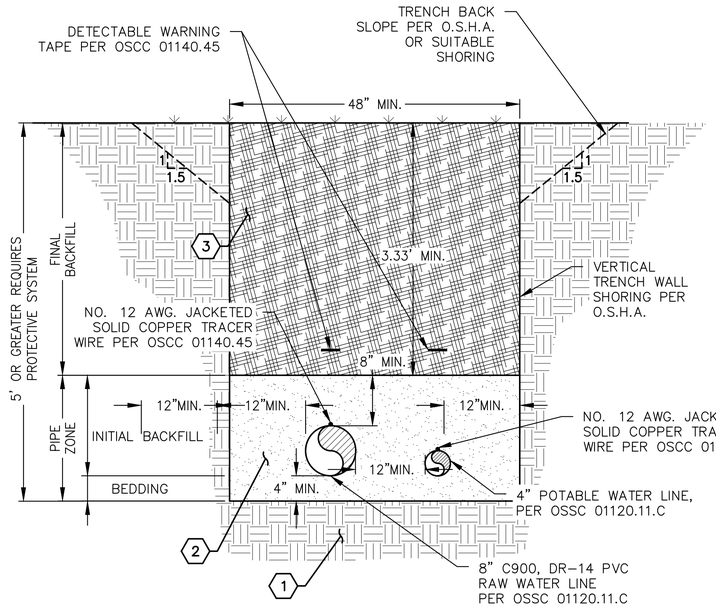
1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE REASONABLY WELL-GRADED, FROM MAXIMUM SIZE TO DUST, SAND WITH 100% PASSING THE 3/8" SIEVE. BEDDING & INITIAL BACKFILL SHALL BE COMPACTED ACCORDING TO ASTM-D698 (STANDARD PROCTOR)
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



2 SANITARY SEWER TRENCH DETAIL
NOT TO SCALE

LEGEND

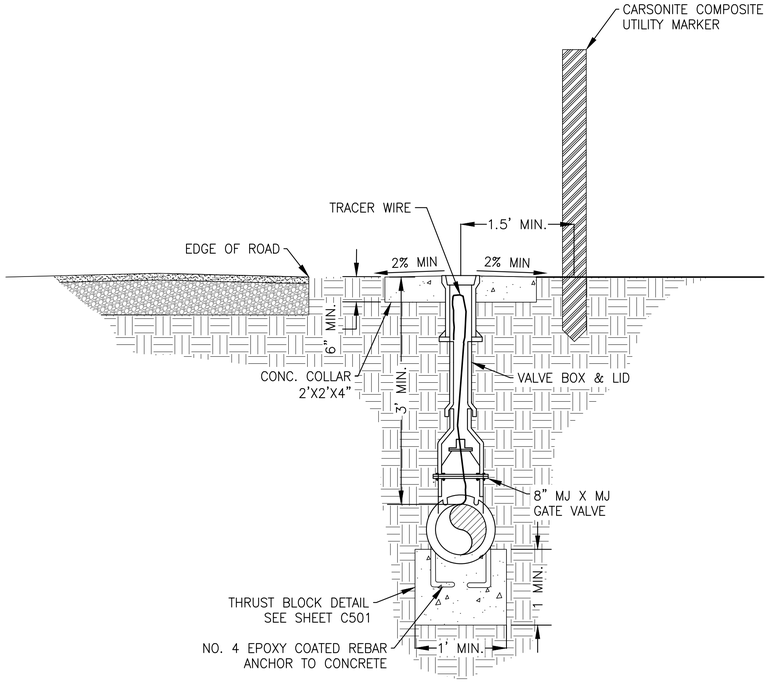
1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE COMMERCIALLY AVAILABLE 3/8" ROCK CHIPS.
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL (NATIVE BACKFILL) ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



3 JOINT TRENCH DETAIL
NOT TO SCALE

LEGEND

1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE REASONABLY WELL-GRADED, FROM MAXIMUM SIZE TO DUST, SAND WITH 100% PASSING THE 3/8" SIEVE. BEDDING & INITIAL BACKFILL SHALL BE COMPACTED ACCORDING TO ASTM-D698 (STANDARD PROCTOR)
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



4 TYP. GATE VALVE & VALVE BOX
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

TRENCH DETAILS

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS			
ITEM	DESCRIPTION	DATE	
0	FINAL PERMIT SET	7/31/19	

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C500

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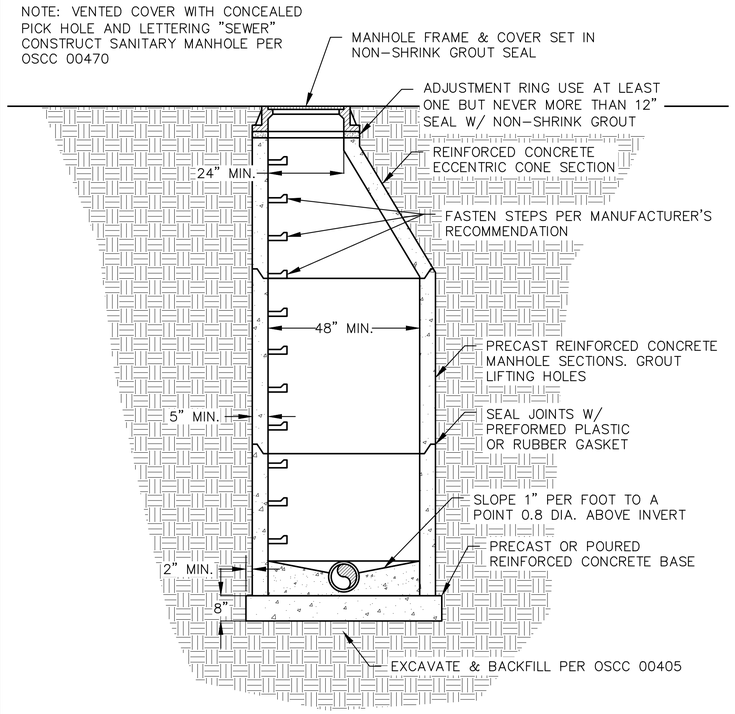
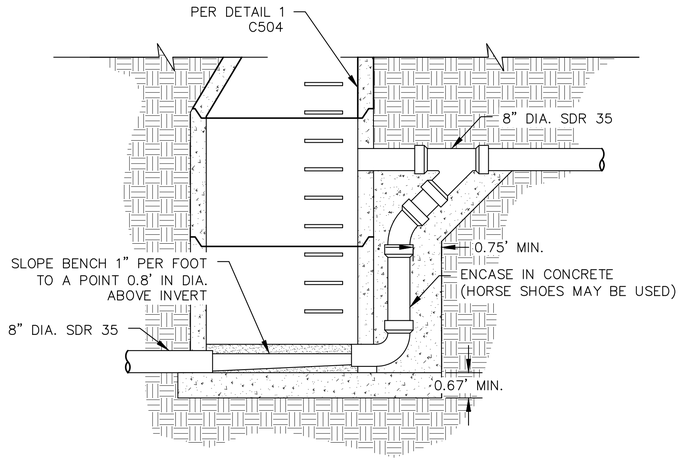
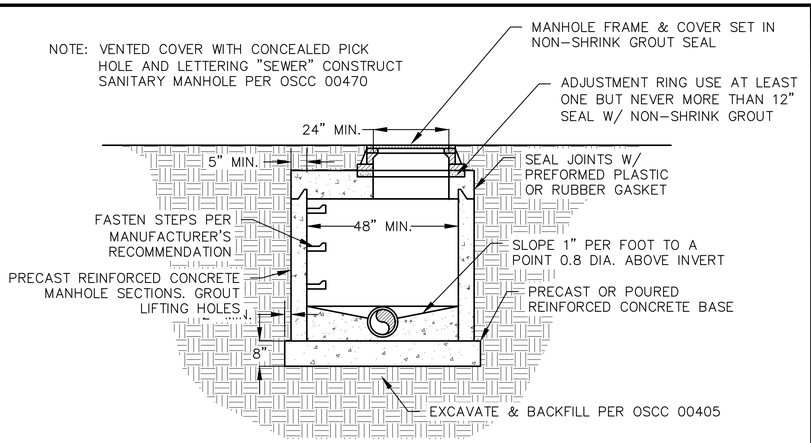


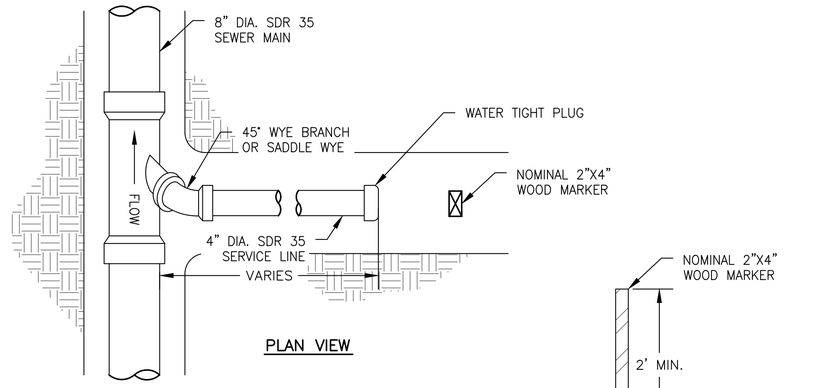
1 — SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



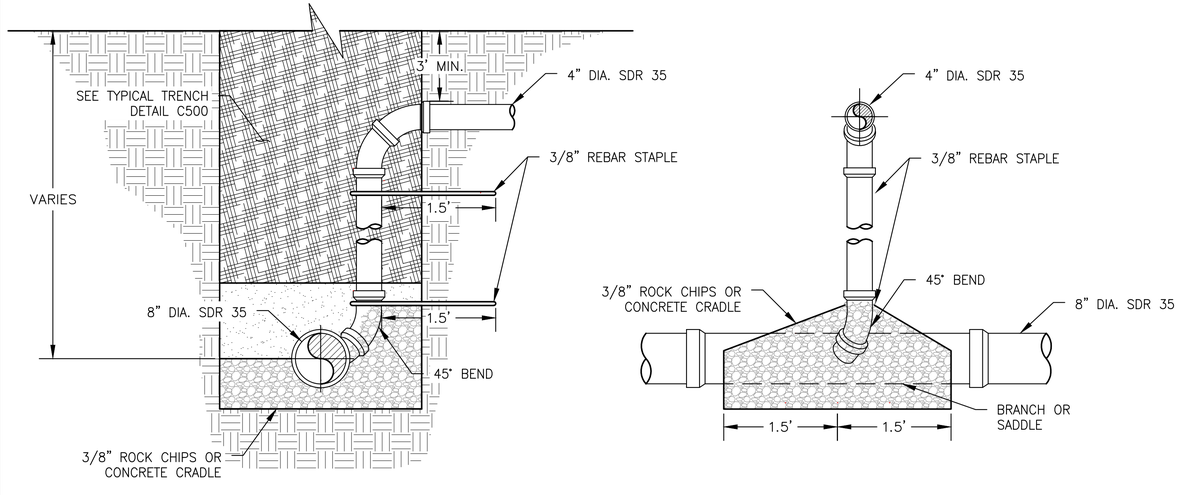
2 — DROP SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



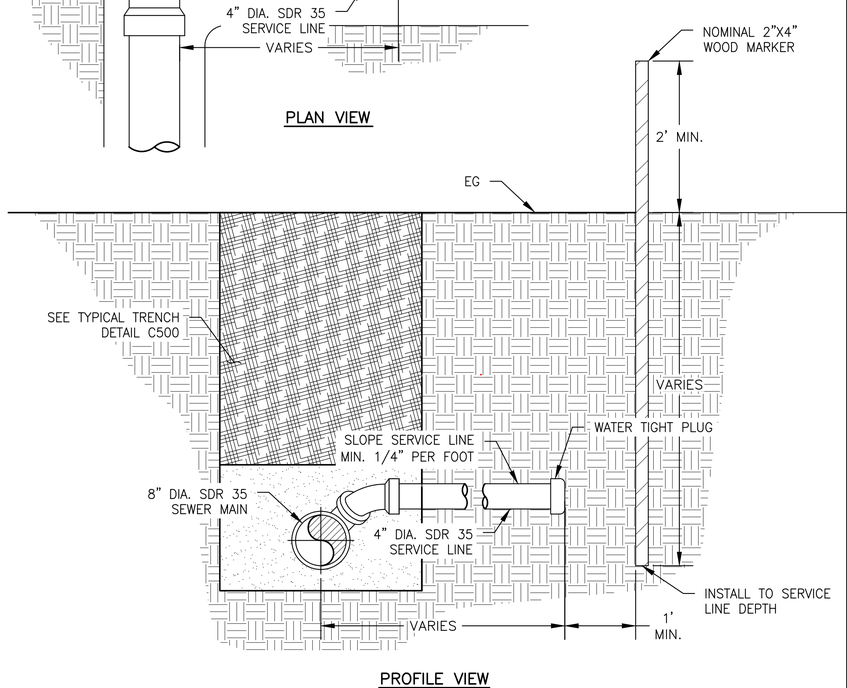
3 — SHALLOW SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



PLAN VIEW



4 — SANITARY SEWER RISER DETAIL
NOT TO SCALE



PROFILE VIEW

5 — SANITARY SEWER SERVICE DETAIL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

PARAMOUNT GOLD NEVADA CORP.
GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SANITARY SEWER DETAILS

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
MAR. 13, 2019
OREGON
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

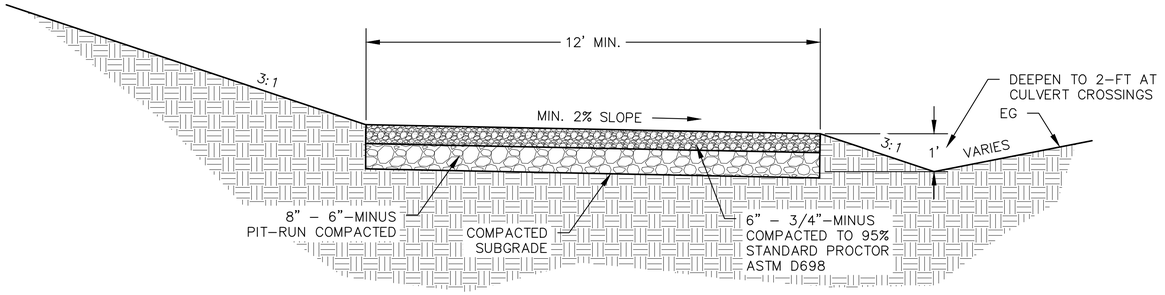
REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

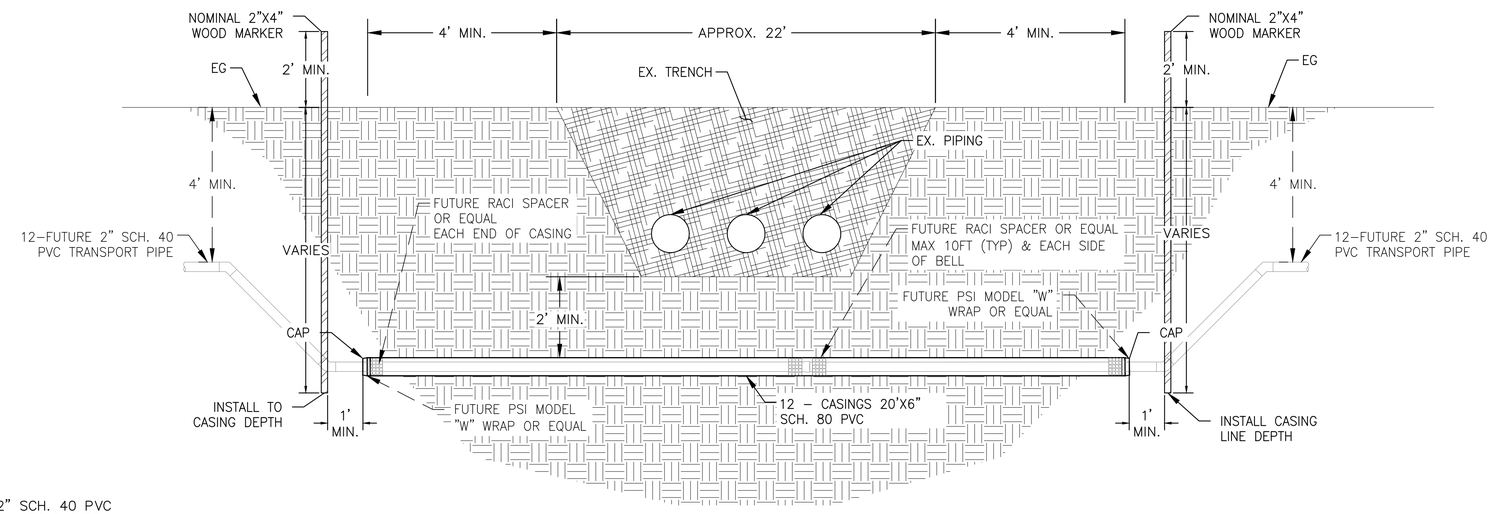
C504

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: DETAILS_GRASSY_hw Plot date: Aug 22, 2019-01:05:14pm CAD User: HWhite.
Xref Filename: | X-TITLE | X-TITLE (2) |

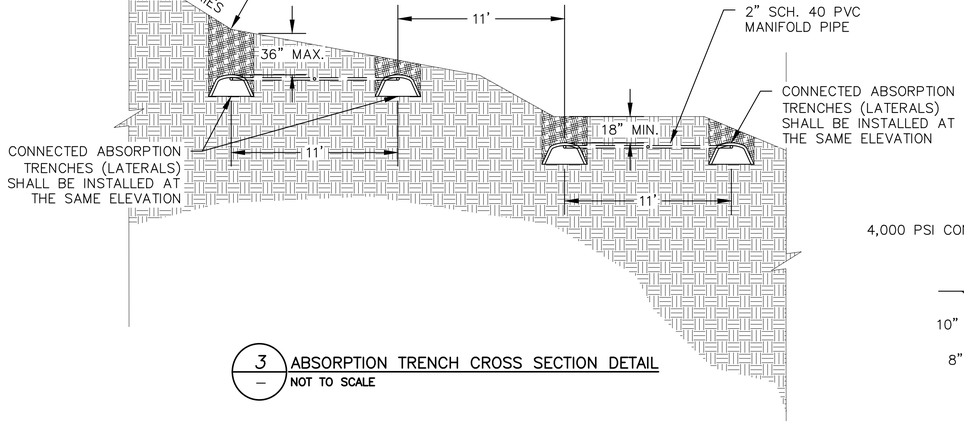


*NOTE: IF ROAD IS IN A CUT SECTION, NO PIT RUN GRAVEL IS REQURED.

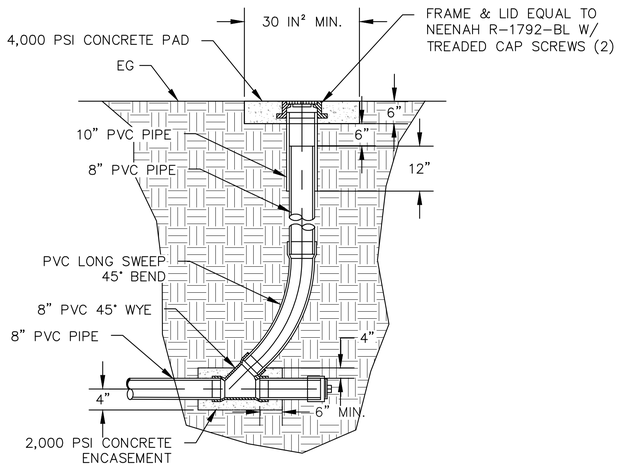
1 — TYP. ROAD CROSS SECTION
NOT TO SCALE



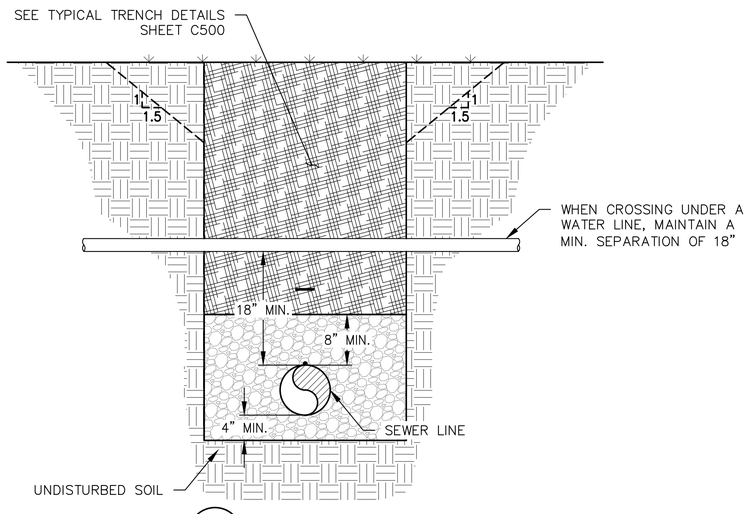
2 — DOSING TRANSPORT PIPE TRENCH CROSSING DETAIL
NOT TO SCALE



3 — ABSORPTION TRENCH CROSS SECTION DETAIL
NOT TO SCALE



4 — SEWER SERVICE CLEAN-OUT TYP. DETAIL
NOT TO SCALE



5 — SEWER/WATER LINE CROSSING TYP. DETAIL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

TYP. ROAD AND SEWER DETAILS

REGISTERED PROFESSIONAL ENGINEER
OREGON
MAR. 13, 2015
MATTHEW W. RASMUSSEN
8/22/2019
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C506

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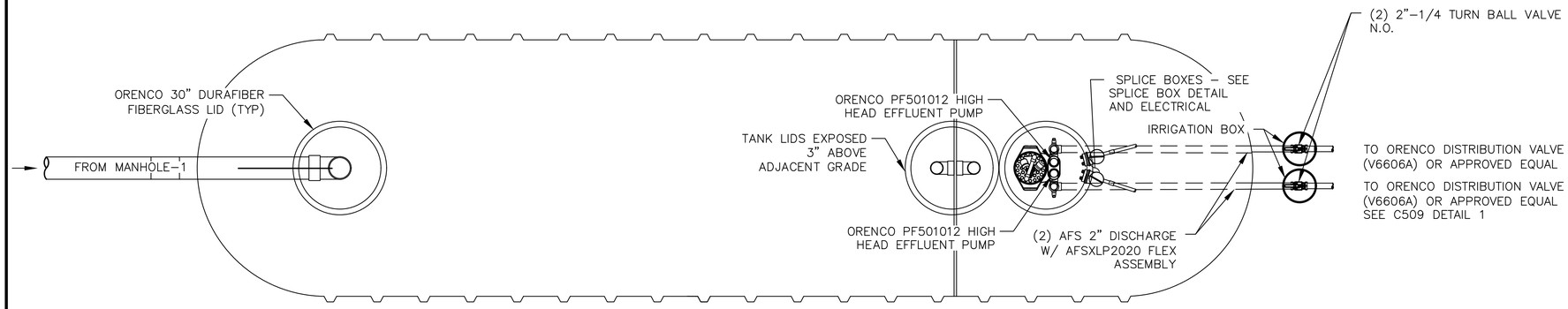
ALL PRODUCT BRANDS THIS SHEET ARE "OR APPROVED EQUAL" ITEMS.
CONTRACTOR TO PROVIDE SUBMITTALS.



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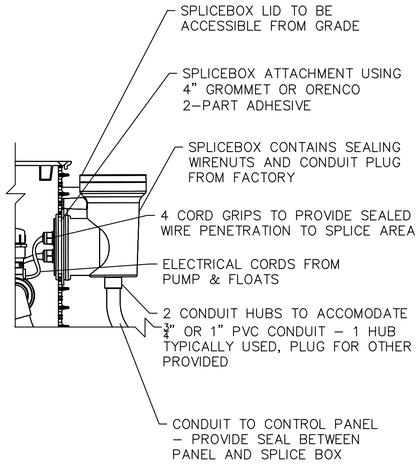

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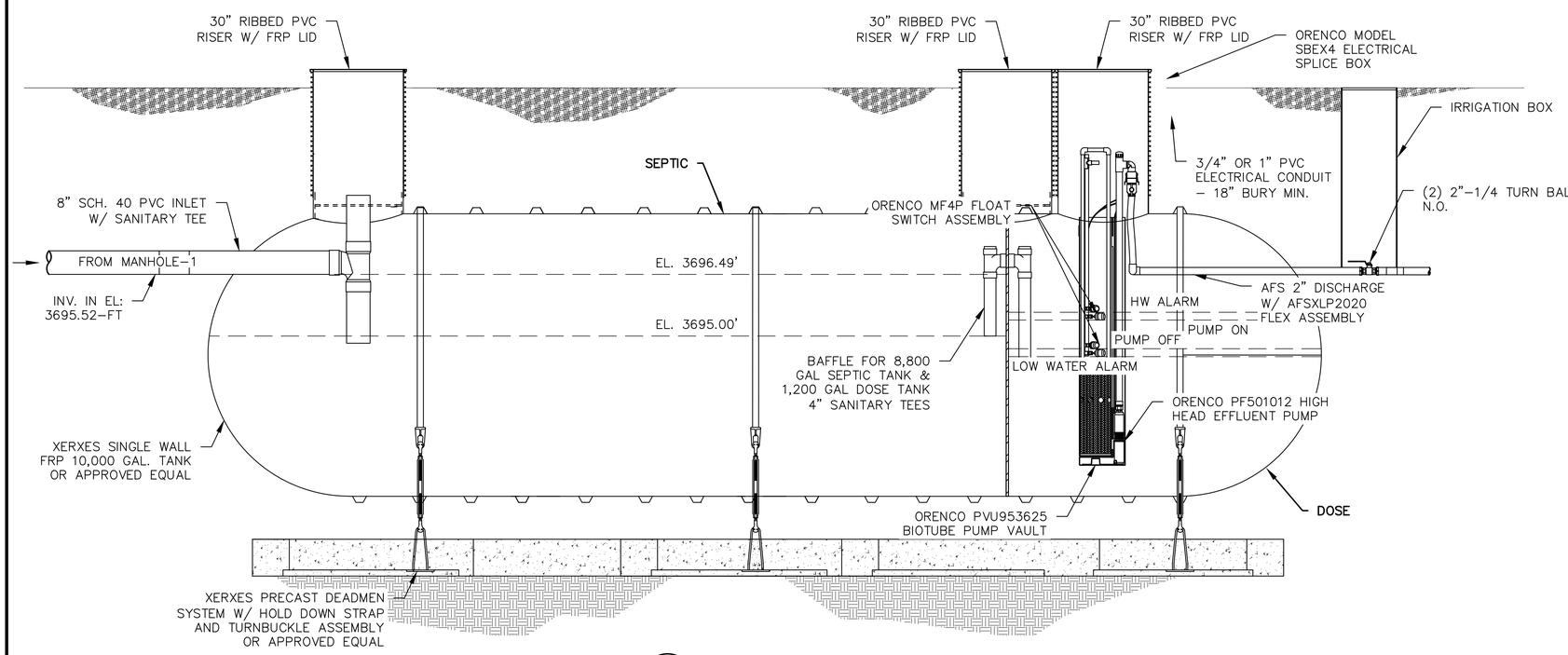

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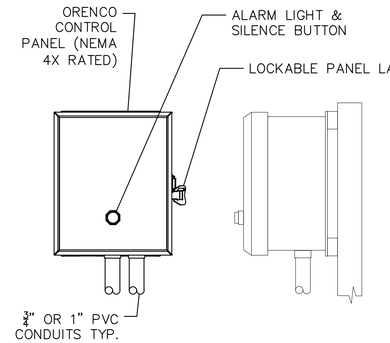
PANEL MOUNTING REQUIREMENTS

- PANEL SHALL BE MOUNTED ON 4X4 WOODEN POST IN LOCATION SHOWN PER SHEET C2 AND ELECTRICAL
- PANEL DIMENSIONS: DAXMVP PANELS: 9.5" HIGH X 7.3" WIDE X 5.4" DEEP



4 — MVPDAX2 DM CONTROL PANEL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEPTIC TANK DETAILS

REGISTERED PROFESSIONAL ENGINEER
OREGON
MAR 13, 2015
MATTHEW W. RASMUSSON
RENEWS: 12/31/2020

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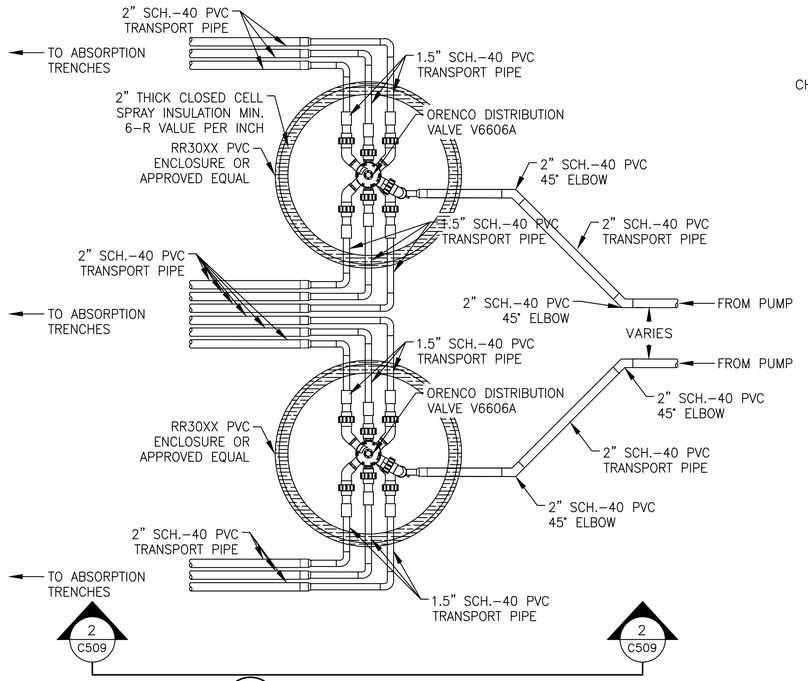

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NOT TO SCALE

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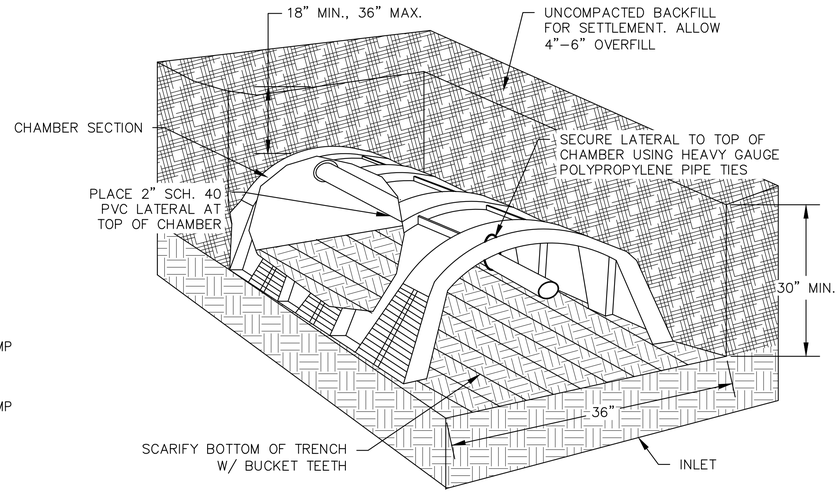
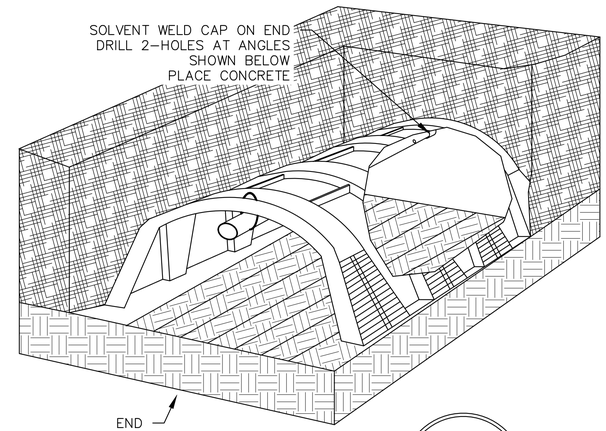
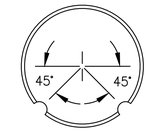
NOT TO SCALE



ISOMETRIC VIEW





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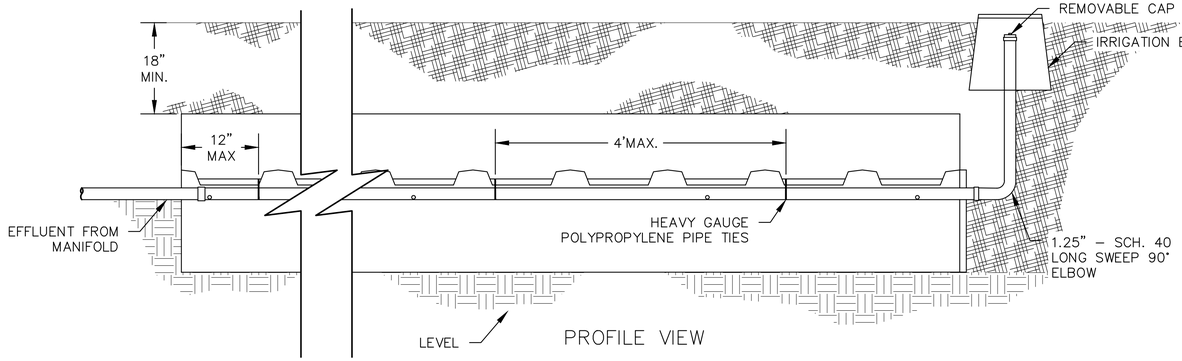
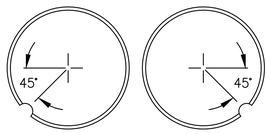


PROFILE VIEW

NOTE: ALTERNATE DIRECTION OF PERFORATION EVERY 4-FT



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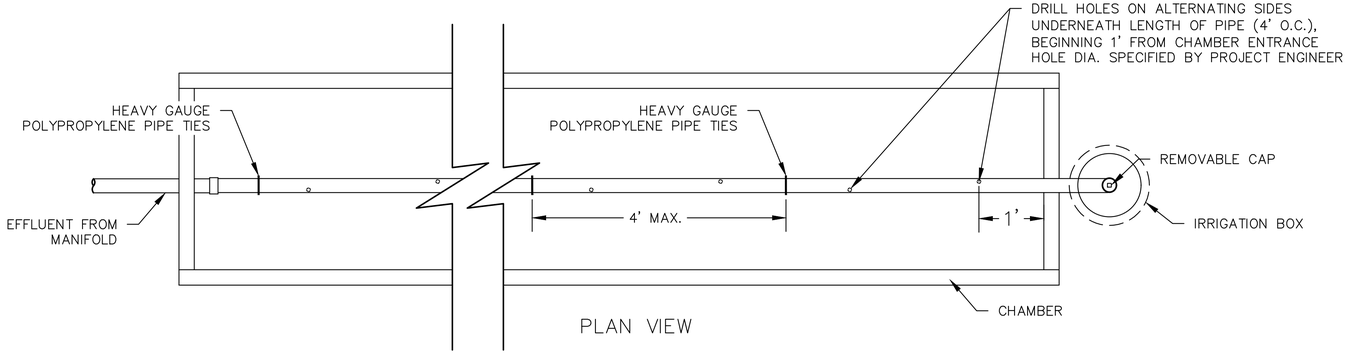

PLAN VIEW

3 — PRESSURE DOSED DRAINFIELD CHAMBER DETAIL
NOT TO SCALE

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Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.
ABSORPTION TRENCH AND CHAMBER DETAILS

REGISTERED PROFESSIONAL ENGINEER
20170??
8/22/2019
OREGON
MAR 13, 2019
MATTHEW W. RASMUSSON
RENEWS: 12/31/2020

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C509

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Xref Filename: | X-TITLE | X-TITLE (2) |

Appendix B
Site Evaluation Report

Matt Rasmusson

From: BROWN Larry <Larry.BROWN@state.or.us>
Sent: Thursday, May 16, 2019 9:19 AM
To: Matt Rasmusson
Cc: GEDDES Craig; Jason Thompson
Subject: Calico/Grassy Mountain Site Evaluation for Onsite sewage treatment and disposal

Follow Up Flag: Follow up
Flag Status: Flagged

Good Morning Matt:

The purpose of the site evaluation was to locate suitable soils in an area that is large enough for both the initial drainfield area and the replacement drainfield area. The criteria used for this site evaluation can be found in Oregon Administrative Rules (OAR) 340-071. Soil test pits and other site features were evaluated during the site visit. In the site inspection, the following features were evaluated:

- Soil types - how well they drain and other evidence of good soil structure for treatment
- Depth to groundwater or if groundwater is present.
- Slopes, escarpments, ground surface variations, topography
- Creeks or springs on the site or adjacent properties
- Whether the soils have been disturbed
- Setbacks from property lines, buildings, water lines, and other utilities
- Other site features that could affect the placement of the on-site septic system.

I have reviewed the site evaluation soil notes from Malheur County and discussed the findings with Craig Geddes. The majority of soils at this site include Class C soils which normally require a minimum of 125 linear feet of disposal trench per 150 gpd flow based on the soil depth observed. If pretreatment is utilized then 50 linear feet of disposal trench per 150 gpd flow would be required. With 10% slopes one would normally need to install a septic system as serial distribution. However, considering the flows and with large systems requiring pressurization, I am requiring equal distribution via a hydrosplitter; 18 to 24 inch trench depths. The 24 inch trench depth limitation is a conservative action due to the presence of a durapan observed at this site. Both areas A and B are approved. Do not extend drainlines past the large sage plant vegetation areas.

This system must be installed under dry soil conditions to reduce smearing. If smearing occurs, the sidewalls are to be raked. The site of disturbance must be reseeded. New vegetative growth (root development) will aid in any compaction/smearing created during the installation process. Both the initial and replacement disposal areas are to be protected from traffic, cover, development or other potential disturbance of natural soil conditions. Any road cuts downslope of the system will require 25 to 50 foot setback between the road cut to the lowest drainline. The area must not be subjected to excessive saturation due to; but not limited to: artificial drainage of ground surfaces, roads, driveways and building down spouts. Placement of a well within 100 feet of the approved areas invalidate this approval. Additionally, any alteration of natural soil conditions (i.e. cutting or filling) in the acceptable area may void this approval as well.

With predicted peak flows of 4,320 gpd, a standard system would require 3,600 linear feet of disposal trench for the initial system, 3,600 linear feet for the repair. In either situation pretreatment could be utilized thus reducing the linear footage requirement to 1,440 linear feet. Large system rules apply as stipulated in OAR 340-071-0520.

Now we need to wait until the written assessment concerning the impact of the proposed system on the quality of public waters and public health is conducted; and accepted and approved by DEQ before finalizing the sewage treatment and disposal septic system requirements.

If you have any questions, please contact me.

Sincerely,

Lawrence (Larry) Brown REHS
Environmental Health Specialist
DEQ Eastern Region - Water Quality Land Application
475 NE Bellevue Drive - Suite 110
Bend, OR 97701
Phone: (541) 633-2025
Fax: (541) 388-8283

Appendix C
Water Quality Impact Assessment

Grassy Mountain Gold Project
Wastewater Facilities

Water Quality Impact Assessment

Prepared for

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Prepared by

SPF Water Engineering, LLC
300 East Mallard, Suite 350
Boise, Idaho 83706
(208) 383-4140

August 13, 2019

exp 5/1/20

SPF WATER ENGINEERING

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1. INTRODUCTION

SPF Water Engineering, LLC (SPF) has prepared a Level 1 nitrate balance evaluation to assess impacts to groundwater quality in support of a proposed wastewater treatment system at the Grassy Mountain Mine Project (Project). A large soil absorption system (LSAS) is proposed for treating 3,920 gallons per day (gpd) of domestic wastewater in Malheur County, Oregon. The Oregon Department of Environmental Quality (ODEQ) requested SPF use the Washington State Department of Health (WDOH) Level 1 nitrate balance spreadsheet for large on-site sewage system (LOSS).

This report presents background (Section 2), field investigation (Section 3), model parameters (Section 4), model results (Section 5), conclusions and recommendations (Section 6), and references (Section 7).

2. BACKGROUND

2.1. Permit Area

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale (Figure 1) and consists of two areas: The Mine and Process Area and the Access Road Area (Permit Area) (Figure 2).

The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres. These patented and unpatented lode mining claims are part of a larger land position that includes 419 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM) (Figure 2). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, Township 22 South, Range 44 East (T22S, R44E) (Willamette Meridian).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (Figure 2). A portion of the Access Road Area is a Malheur County road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (Willamette Meridian). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or rerouting, and a potential powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 2), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be approximately 30 feet wide, which includes a 20-foot wide road travel width (10 feet on either side of the road

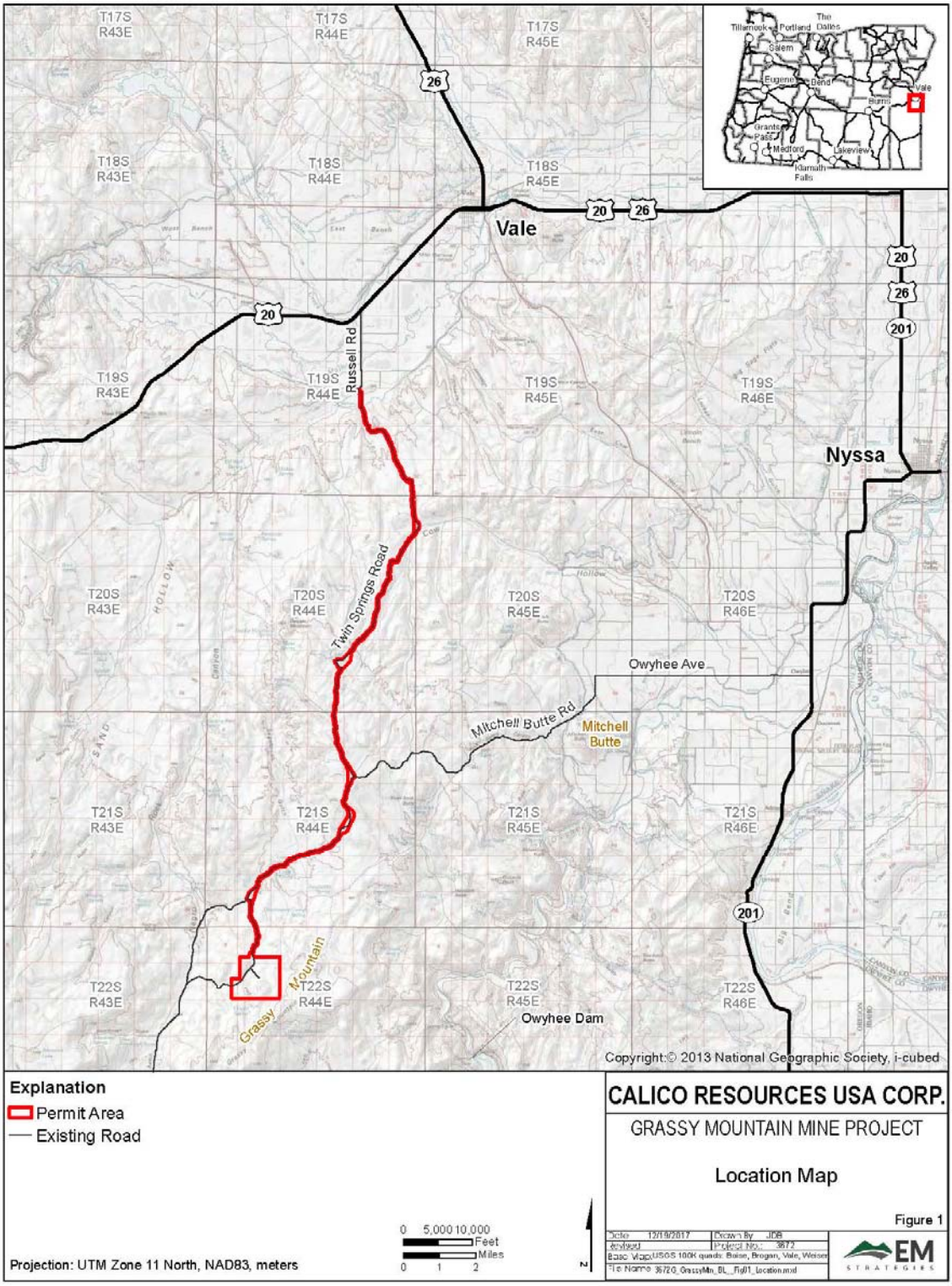


Figure 1. Project Location

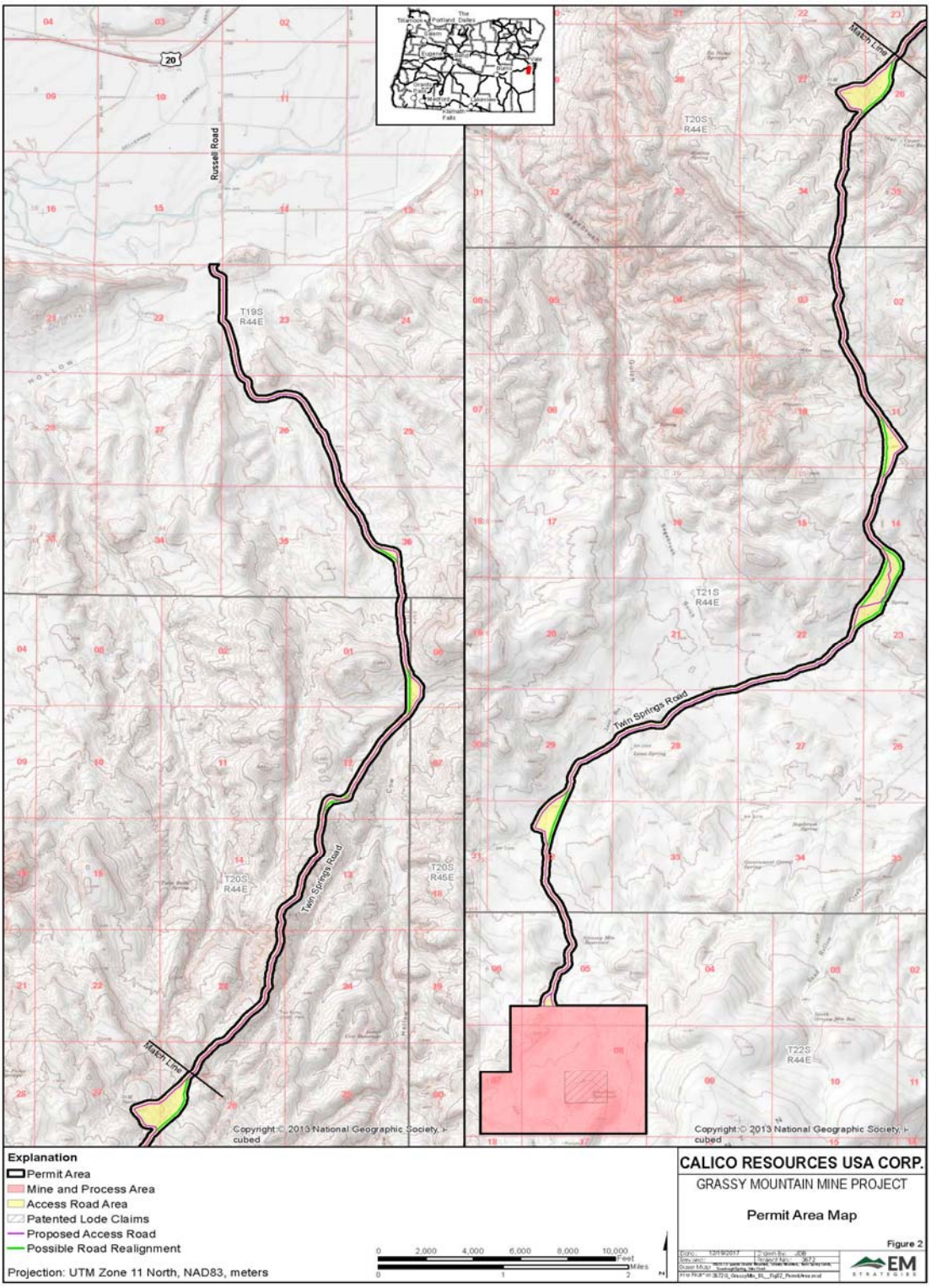


Figure 2. Permit Area

centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres.

2.2. **Anticipated Wastewater Characteristics**

The daily average domestic wastewater design flow is estimated to be 3,920 gpd. This value assumes 112 workers at the mine per day and an average day potable water demand of 35 gpd (based on OAR 340-071-0220 for factories with shower facilities). The plant and mine offices and associated change houses are expected to include showers, wash basins, and toilets. There will not be on-site laundry facilities.

The effluent entering the LSAS will consist of typical residential strength sewage from workers at the mine site. The total nitrogen concentration of the septic tank effluent is assumed to be 60 mg/L, the default value used for the WDOH Level 1 nitrate balance spreadsheet.

The LSAS will also receive backwash water from the potable water treatment system backflush. The total daily design flow for the LSAS including water treatment backwash water is 4,320 gpd. For the nitrate balance study, the daily average domestic wastewater design flow of 3,920 gpd was used; the arsenic backwash water will not contain nitrate levels above the background groundwater concentration. Currently, one (1) drainfield is proposed, with a replacement area (Figure 3). The drainfield is sized based on a dosing rate of 0.4 gallons per square foot per day for type C soils.

2.3. **Vicinity Overview**

The LSAS will be located within the Permit Area on lands administered by BLM. For the purposes of the Level 1 nitrate balance evaluation, the point of compliance for evaluating water quality impacts from the LSAS is the Permit Area boundary, as shown on Figure 3. This point of compliance is considered conservative; there are currently no known downgradient receptors (non-Project) within at least ten miles of the proposed LSAS. The nearest Project water supply well is PW-4, located about 2 miles north of the proposed LSAS. A map of the site layout, as well as measurements done in ESRI ArcMap for the nitrate balance evaluation parameters, is also included in Figure 3.

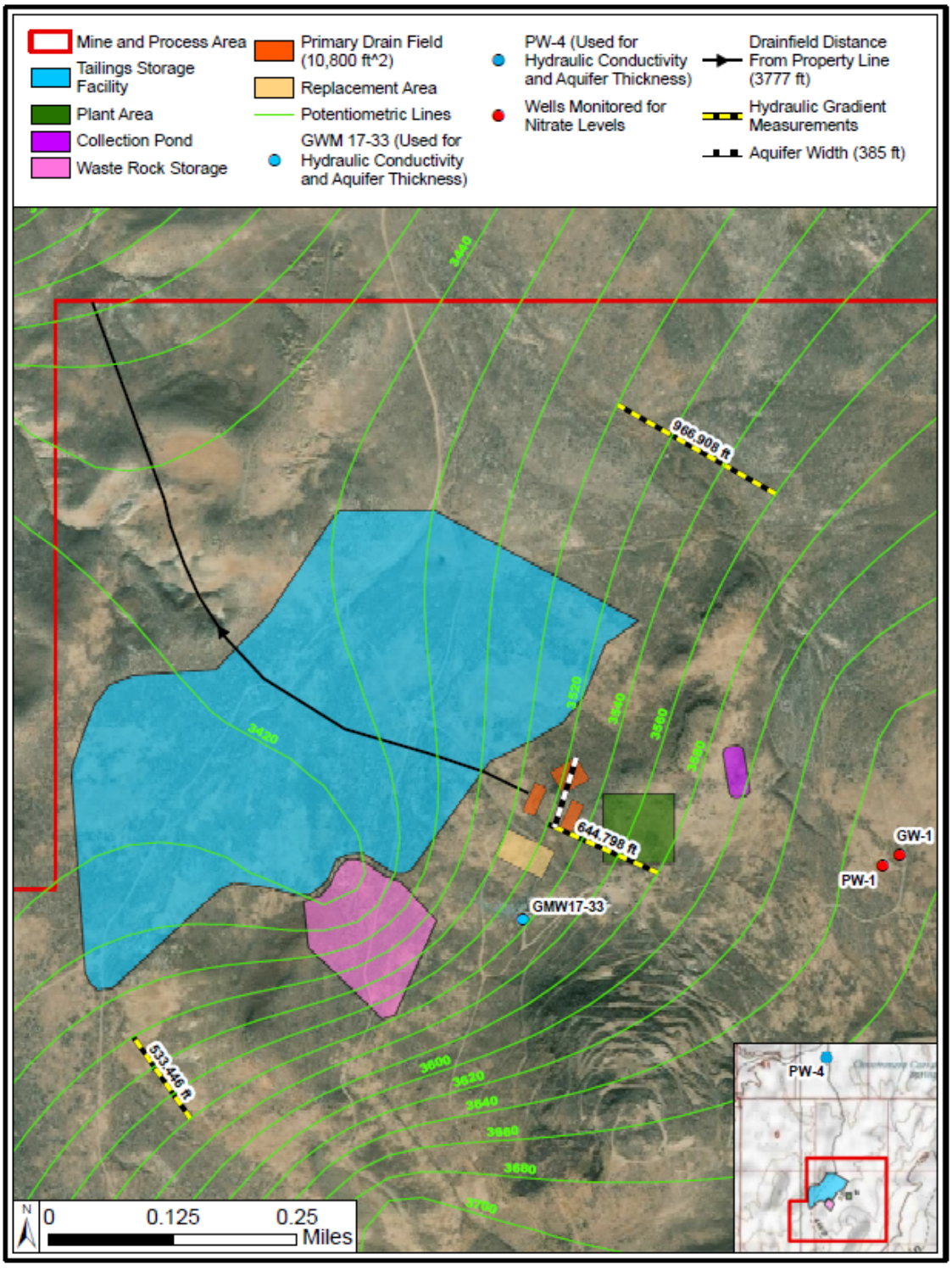


Figure 3. Grassy Mountain Site Plan and Nitrate Balance Study Parameters

2.3.1. Topography

The drainfield site is on a north-northwest facing slope. The percent slope is approximately 12%. Approximately 1,000 feet northwest of the northwestern boundary of the proposed drainfield there is a draw that slopes to the north. This draw will be filled in by a tailings storage facility. The bottom of the draw is approximately 160 feet lower in elevation than the proposed drainfield. The elevation of the proposed septic drainfield varies from 3,655 to 3,697 feet above mean sea level.

2.3.2. Climate

The total annual precipitation for the area is approximately 10 inches, mostly as snow during winter, with higher precipitation amounts between November and June at around one inch each month (refer to Table 1). Between July and October, precipitation is about half of the winter and spring months.

Table 1. Owyhee Dam Mean Precipitation (WRRC, 2017)

OWYHEE DAM, OREGON													
NCDC 1981-2010 Monthly Normals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Precipitation (in.)	0.92	0.76	0.89	0.96	1.16	0.92	0.43	0.38	0.45	0.64	0.92	1.25	9.68

2.3.3. Surface Water Characterization

The closet surface water is an ephemeral stream approximately 1,300 feet to the northwest of the proposed drainfield. This ephemeral stream flows into Negro Rock Canyon Creek which eventually flows into the Malheur River approximately 16 miles north of the site. Due to distance to the nearby surface water and ephemeral characteristics, it is assumed that the drainfield will not have any negative effects on surface water.

2.4. Hydrogeologic Setting

Groundwater in the general vicinity of the proposed mine site is found primarily within unconsolidated and semi-consolidated sandstone and conglomerate units of the Grassy Mountain Formation. The Grassy Mountain Formation generally strikes from east to west and dips towards the north. Discontinuous lenses of higher permeability sandstone and conglomerate form localized and compartmentalized water-bearing units that are interbedded with thick layers of low-permeability clay and clayey siltstone that impede groundwater flow. These sedimentary rocks are locally capped by basalt, alluvium and colluvium. The Grassy Mountain Formation is underlain by a fine-grained lithic tuff, the Tuff of Kern Basin. The Grassy Mountain Formation is the host unit for the Grassy Mountain gold and silver deposit. A more detailed description of principal hydrogeological units can be found in the Grassy Mountain Gold Project Groundwater Characterization Report (SPF 2019b).

The aquifer system in the near vicinity of the proposed mine (except for the non-silicified area GMW17-33 is completed in) is typically found in silicified sediments or clay with very low

hydraulic conductivity and high hydraulic gradients. Production and monitoring wells near the deposit completed in unconsolidated sediments and fractured basalt typically have short-term yields of less than 50 gpm. Long-term aquifer sustainability appears to be restricted by negative hydraulic boundaries caused by faulting or silicification which limits the spatial extent of water-bearing zones. Wells near the deposit completed in clay or silicified sediments have very low yields, generally less than 5 gpm.

The aquifer system to the north/northwest downgradient of the proposed mine occurs in localized sandstone and conglomerate units of the Grassy Mountain Formation. These units are interbedded with thick layers of low-permeability clay and clayey siltstone, which appear to result in a confined aquifer. The Grassy Mountain Formation is underlain by fine-grained lithic tuff. The aquifer hydraulic conductivity increases downgradient of the proposed mine where the sediments are not silicified. However, aquifer sustainability appears to be still affected by faulting and lithologic variability, with limited data suggesting that the Grassy Mountain Formation thins out moving north from the deposit.

2.5. Local Hydrogeology

The location of the proposed drainfield is north of the mine and approximately 200 feet west and northwest of monitoring wells 59762 and GMW17-31 (driller's well reports and geologist lithology are provided in Appendix C). The geologist lithology log from GMW17-31 shows overburden for the top 8 feet, interbedded sandstone, siltstone, clay, and conglomerate from 8 to 60 feet, clay from 60 to 147 feet, then interbedded arkose, sandstone, siltstone, clay, and tuff from 147 to the bottom at 520 feet. The lithology noted traces of silicification 41 to 60 feet and 92 to 107 feet and indicated the majority of the bore was silicified from 147 feet to the bottom of the bore. Once completed with a screened interval of 458 to 498 feet, GMW17-31 had no measurable water in the well. Since construction, water has seeped into the well to an elevation of approximately 3,222 feet above mean sea level, roughly 500 feet below ground.

Near the proposed Grassy Mountain mine, due to the nature of the silicification and compartmentalization of the aquifer due to faulting, there tends to be deeper water levels. Downgradient of the proposed drainfield, the degree of silicification and faulting tends to decrease. It is expected the effluent from the drainfield will initially migrate downward until reaching less permeable siltstones, clays, or silicified sediments which will cause horizontal movement in the downgradient and down dip (northwest) direction. Once the effluent reaches the water table, estimated to be 3,450 feet above mean sea level, it will travel downgradient in the northwest direction flowing into the areas with less silicification. The water table is expected to be approximately 100 to 200 feet below ground surface in the vicinity of the drainfield.

A list of wells, locations, construction details, measurement protocols, water level data, and hydrographs are presented in the groundwater baseline report (SPF, 2019a). Well construction details are summarized in Table 2. The location of all the monitoring wells is shown on Figure 4.

Table 2. Well Construction Table

Calico Well ID	OWRD Well Tag Number	OWRD Name	Alternate Name	Drill Method	Depth of First Water (ft)	Well Const. Depth (ft)	Screened Interval (ft)	Well Casing Diameter (in)	TOC Elevation[4]	Elevation Screened Interval (ft)	Water Level Elevation (9/26/2018)	Production (gpm)[2]	Screened Lithology[1]
59760	107462	MALH 2974	Middle Sweizer, TW-1	air rotary	160	203	163-203	6	3762.1	3599-3559	3673.43	+10	fractured basalt
59761	109400	MALH 2993	Lower Sweizer, MW-2	air rotary	100	118	97-117	4	3762.2	3665-3645	3673.48	+50	fractured basalt
59762	109371	MALH 2976, 2985	MW-3	air rotary	626	700	550-660	4	3724.8	3175-3065	3103.4	<1	siltstone
59763	109356	MALH 2994	TW-4	air rotary	277	323	293-323	6	3519.4	3226-3196	3239.03	+5	fractured volcanics
59764	107466	MALH 2986	MW-5	air rotary	270	300	279-299	4	3511.9	3233-3213	3238.24	+10	fractured sandstone
59765		MALH 2979	MW-6	air rotary	29	36	28-36	4	3446.5	3418-3410	dry	dry	shallow sandstone
59766	107468	MALH 2980	MWS-8	air rotary	only damp when drilled	45	25-45	4	3459.7	3435-3415	3426.68	+10	shallow sandstone
59767		MALH 2995	MWS-9	air rotary	dry	40	20-40	4	3495.3	3475-3455	dry	dry	shallow sandstone
59768		MALH 54197	MWS-10	air rotary	21	25	10-25	4	3480.6	3471-3456	3463.46	0.5	shallow sandstone
59770		MALH 2983	MW-11	air rotary	dry when drilled	424	374-424	4	3389.0	3015-2965	3241.71	+0.5	volcanic tuff
59772	109352	MALH 2984	Upper Sweizer, MWS-13	air rotary	125	207	165-205	4	3768.2	3603-3563	3673.5	+50	fractured basalt
26-092-915	109354	MALH 54071		unknown	unknown	915	228-268	2	3710.0	3482-3442	3633.55	unk	unk
57-1		MALH 54195		unknown	unknown	765	108-138	1.25	3770.6	3663-3633	3699.1	unk	unk
57-10		MALH 54196		unknown	unknown	500	126-156	1	3681.1	3555-3525	3635.67	unk	unk
89-2	109360	MALH 54072		unknown	200	425	386-406	2	3293.5	2907-2887	3235.54	unk	unk
Bishop	None	MALH 54046	Rye Field	cable	unknown	482	135-145	12	3391.5	3257-3247	3281	50	coarse gravel
BLM	109398	MALH 2277	Owyhee Ridge	cable	unknown	175	159-166	6	3579.6	3421-3414	3423.95	+12	white sand
GMW17-31	125168	MALH 54404		air rotary	dry when drilled	498	458-498	5	3722.0	3262-3222	3222.6	0	siltstone, sinter, clay
GMW17-32	125169	MALH 54405		air rotary	244	718	678-718	5	3702.1	3026-2986	3082.1	<1	Arkose, siltstone, Clay
GMW17-33	125170	MALH 54406		air rotary	243	338	238-338	5	3702.7	3465-3365	3452.16	<30	sinter, siltstone, tuff
GMW18-34	130031	MALH 54437		air rotary	dry	950	830-890	5	3953.3	3127-3067	dry	dry	Arkose, siltstone, Clay
GW-1	107469	MALH 2281	47-1	air rotary	140	155.5	135.5-155.5	4	3709.1	3573.5-3553.5	3654.18	60	gravel
GW-2	109357	MALH 2279	47-2	air rotary	dry when drilled	325	290-320	4	3827.5	3537-3507	3662.91	0	blue and grey clay
GW-3	107467	MALH 2278	47-3	air rotary	dry when drilled	350	320-350	4	3633.6	3314-3284	3401.68	<1	blue and grey clay
GW-3A		MALH 2579		air rotary	dry	420	380-420	2	3655	3275-3235	dry	dry	silt and clay
GW-3B		MALH 2576		air rotary	dry	340	80-100	2	3626	3546-3526	dry	dry	clay
GW-4	107460	MALH 54073		unknown	50	370	280-350	4	3342.7	3063-2993	3260.85	100	sandstone, congl, clay
GW-5		MALH 54194		air rotary	unknown	265	204-224	2	3413.0	3209-3189	3221.45	<1	tuff, clay
GW-6	109368	MALH 2578		air rotary	145	340	300-340	2	3377.3	3077-3037	3236.16	3-4	sandstone, congl, clay
Prod 1	107457	MALH 2275, 2511		air rotary	145	425	145-255, 325-355, 380-420	6	3436.4	3291-3181, 3111-3081, 3056-3016	3436.41	30-100[3]	sandstone, blue clay, and hard sandstone
PW-1	109353	MALH 2276		air rotary	320	520	320-340, 400-420	6	3709.1	3389-3369, 3309-3289	3654.66	25-35[3]	brown clay and sand; coarse sandstone
PW-4	109351	MALH 2206		air rotary	280	375	280-300, 340-360	6	3341.4	3061-3041, 3001-2981	3261.39	175-250[3]	sandstone and conglomerate

1 - as reported on the drillers log
2 - based on short-term testing by driller during or following construction
3 - based on long-term test pumping
4 - surveyed with the exception of GW-3A, GW-3, GMW-17-31, GMW17-32, GMW17-33, and GMW18-34

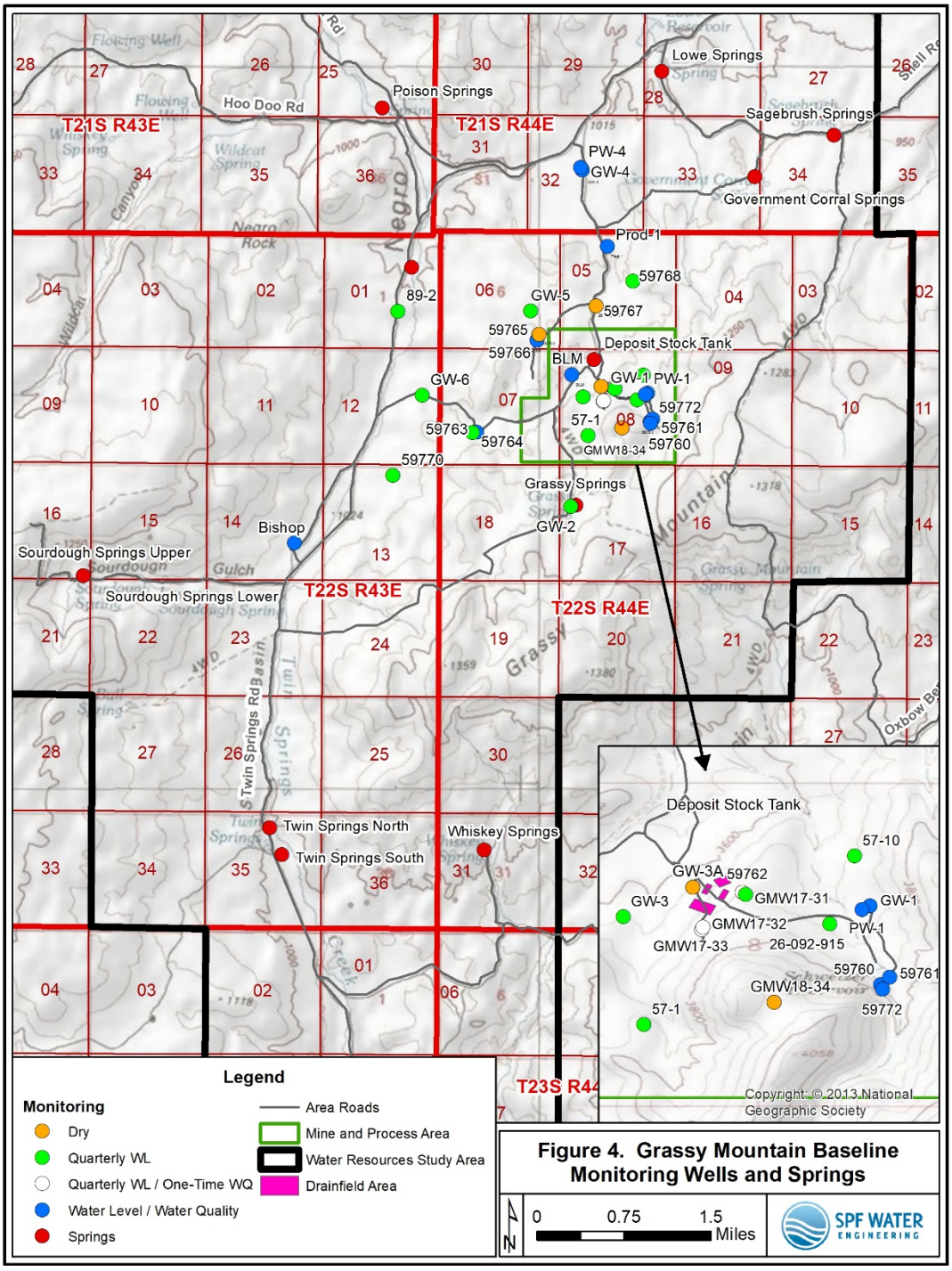


Figure 4. Grassy Mountain Baseline Monitoring Wells and Springs

3. FIELD INVESTIGATION

Field investigations have consisted of recent shallow soil characterization efforts (test pits), pump testing of GMW17-33 and PW-4, and groundwater sampling in wells PW-1 and GW-1.

3.1. Test Pits

Strata advanced 20 soil test pits on April 22 and 23, 2019. Shallow soil characteristics, including soil type and infiltration capacity, were characterized from these test pits. The test pits were divided into three test areas: A, B, and C. Test Area B is where the primary drainfield is located. Test Area A is where the replacement drainfield is located. Test Area C, located approximately 800 feet to the east, was found to be unsuitable for a drainfield location due to impermeable soils. During test pit excavation, groundwater was not encountered. Three field infiltration rate tests were performed, two in Test Area A and one in Test Area B, with all three soils tested to have an infiltration rate of 9 inches per hour. A report prepared by Strata presenting the information gained from the test pits in provided in Appendix D. Larry Brown, with the Oregon Department of Environmental Quality, has also written a site evaluation email based on the test pits and other site features. This email is provided in Appendix E.

3.2. Aquifer Testing

Aquifer test pumping was completed by SPF on December 18, 2017 at GMW17-33 (SPF 2018a). The early-time transmissivity was found to be 900 square-feet per day (sqft/day).

PW-4 pump testing was completed by SRK on November 28, 1989 and documented in a hydrogeologic report by J.M. Montgomery Consulting Engineers (JMM 1991). The early time transmissivity was found to be approximately 508 square-feet per day (sqft/day).

3.3. Upgradient Nitrate Concentrations

Testing for dissolved nitrate levels was done in 2013 by ACZ Laboratories, Inc. for nearby wells GW-1 and PW-1. The laboratory results are provided in Appendix B. This data was used because they are directly upgradient from the drainfield. The average of the measurements was found to be 1.40 mg/L (Table 3).

Table 3. Dissolved nitrate concentrations for PW-1

Upgradient Nitrate in Ground Water	
Total Dissolved Nitrate (mg/L)	
PW-1	GW-1
0.6	2.25
0.62	2.17
0.62	2.15
Average= 1.40	

4. MODEL PARAMETERS

This section describes Level 1 nitrate balance model input parameters (Table 4 and). The WDOH Level 1 nitrate balance spreadsheet for LOSS was used to estimate the impact of the proposed drainfield on groundwater. The model is steady state and uses an Excel spreadsheet format.

Table 4. Nitrate Balance Model Input Parameter Summary

Input Values	Factor	Units	Values	Instructions	Information Source
Nitrate concentration in precipitation	N_R	mg/l as N	0.24	Default	
Total nitrogen concentration in wastewater	N_W	mg/l	60	Default - residential strength	
Soil denitrification	d	unitless	0.1	Default	
Aquifer thickness	b	ft	100	Default or aquifer thickness if known	Nearby Well Logs
Drainfield area	A_D	ft^2	10,800	Primary drainfield area	From Design Data
Distance from drainfield to property boundary	D_{pb}	ft	3,777	Measure in direction of GW flow	
Aquifer width	W_A	ft	385	Perpendicular to GW flow	
Aquifer hydraulic conductivity	K	ft/day	4.430	Measured or literature value	GMW17-33 and PW-4 Pump Test
Hydraulic gradient	i	ft/ft	0.089	If unknown, use 0.001	Potentiometric Map
Recharge	R	in/yr	0.50	Recharge will be a % of ppt	GW Characterization Report
Nitrate concentration of upgradient ground water	N_B	mg/l	1.4	Prefer sampling data	Upgradient Well Sampling
Wastewater volume	V_W	gpd	3,920	Design flows or measured volume	Wastewater Design

4.1. Hydraulic Characterization

Water budget parameters include hydraulic conductivity, hydraulic gradient, aquifer thickness, aquifer width, and natural recharge terms. These parameters are described in more detail below.

4.1.1. Hydraulic Conductivity

Hydraulic conductivity was estimated from GMW17-33 and PW-4 pumping test data. These wells represent the aquifer characteristics predicted to be encountered by effluent from the proposed drain field. GMW17-33 is located near the proposed mine, but in an area with less silicification (representative of the drain field location). PW-4 is located approximately 1.9 miles to the north, in an area with little silicification and the area where the proposed production wells are located. PW-4 is used because it represents the characteristics of the aquifer that the effluent would migrate through to reach any potable water production wells.

The GMW17-33 transmissivity was calculated to be 6,800 gpd per foot (gpd/ft) using the early-time recovery data and 340 gpd/ft using late-time recovery data (Figure 5). The average of the two values in square feet per day calculates out to 477 square feet per day. The aquifer thickness was estimated to be 100 feet based on the screened sections in the well (Appendix C). The hydraulic conductivity was calculated to be 4.77 ft/day by dividing the calculated transmissivity by the estimated aquifer thickness.

The transmissivity for PW-4 was calculated to be approximately 3,800 gpd/ft using the early-time recovery data and 1,700 gpd/ft using late-time recovery data (Figure 56). The average of the two values in square feet per day calculates out to 367 square feet per day. The aquifer thickness was estimated to be 90 feet based on the screened sections in the well (Appendix C). The hydraulic conductivity was calculated to be 4.08 ft/day by dividing the calculated transmissivity by the estimated aquifer thickness.

The two hydraulic conductivities calculated from the well pumping tests were averaged to get a hydraulic conductivity of 4.43 feet/day. This value is considered to be represent a typical hydraulic conductivity for the aquifer system in the vicinity of the drainfield.

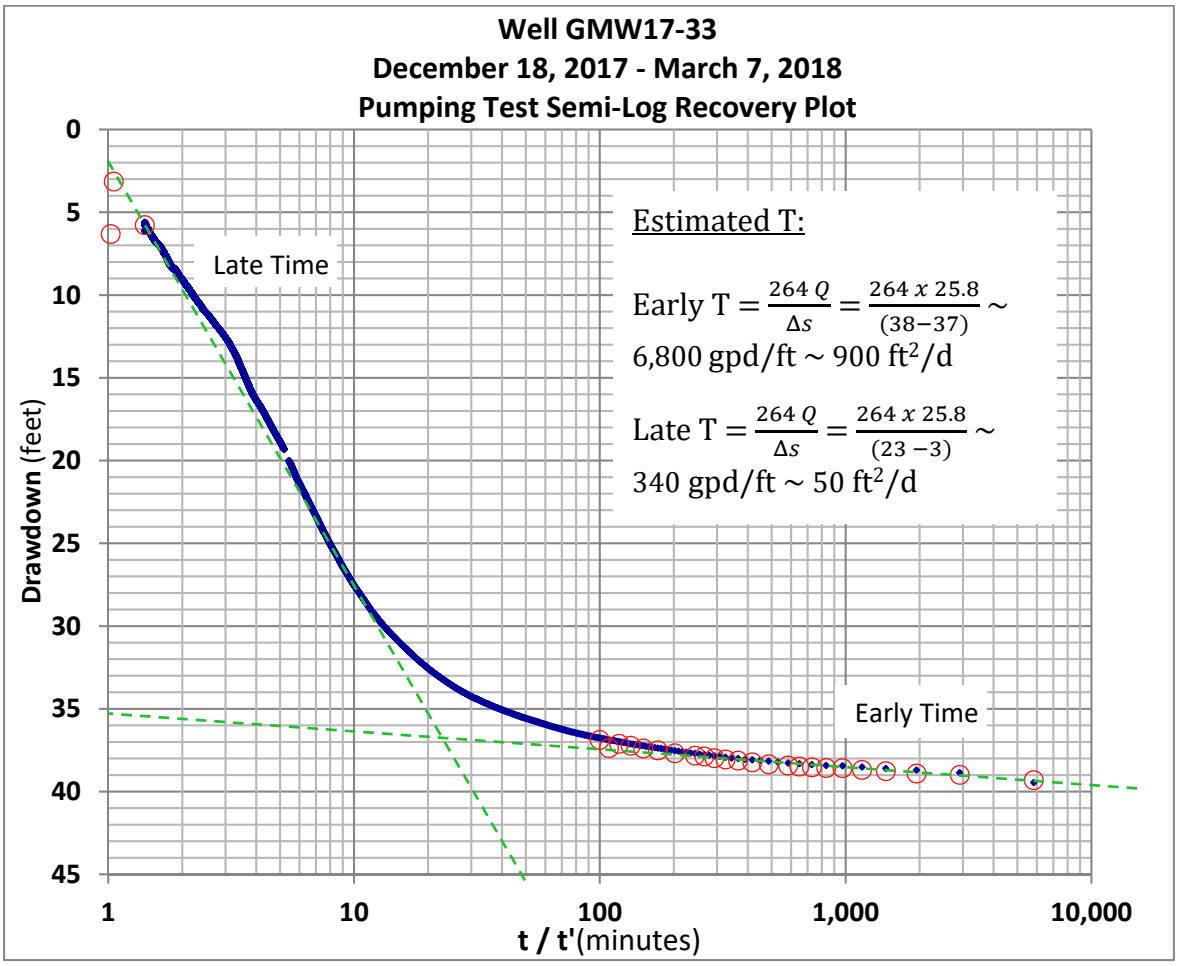


Figure 5. Pumping Test for GMW17-33

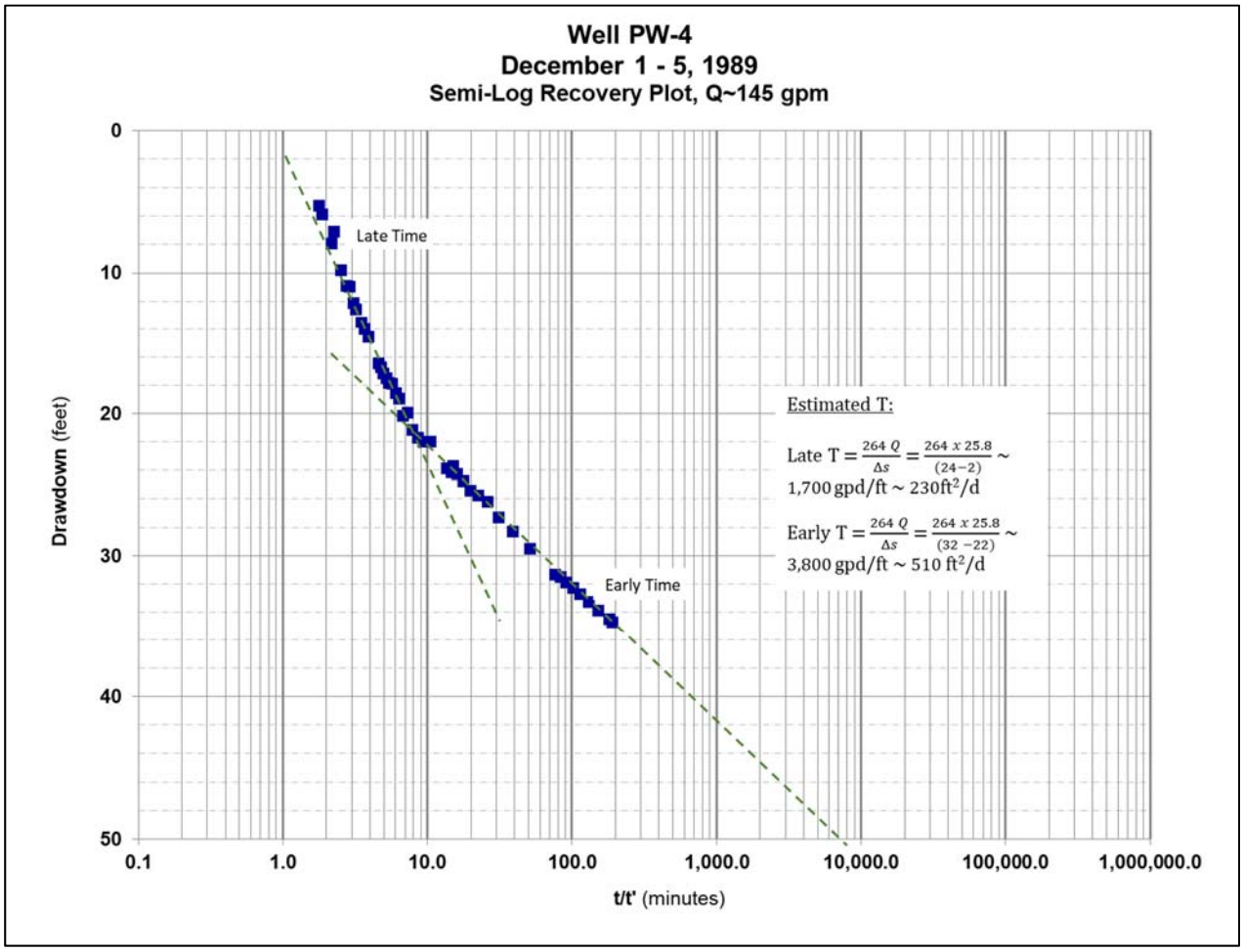


Figure 6. Pumping Test for PW-4

For comparison purposes, the Idaho Department of Environmental Quality's (IDEQ's) Nutrient Pathogen mass-balance spreadsheet provides guidelines for hydraulic conductivity (ft/d) as follows for various unconsolidated sediments:

- Silt and sandy silt (0.003 to 0.3)
- Silty sands and fine sands (0.03 to 3)
- Well-sorted sands and glacial outwash (3-300)
- Well-sorted gravel (30 to 3,000)

The hydraulic conductivities predicted from the two aquifer pumping tests are reflective of the range of literature values for well sorted sands noted above. These values also are consistent

with the literature values for clean sand as well and silty sand according to Freeze and Cherry, 1979 and Bear, 1972 (Table 5).

Table 5. Literature Values for Hydraulic Conductivity

Lithologic Deposit	Freeze and Cherry, 1979		Bear, 1972	
	cm/s	ft/d	cm/s	ft/d
Gravel	10^{-1} - 10^{2}	300 - 300,000	1 - 10^{2}	3,000 - 300,000
Clean sand	10^{-3} - 1	3 - 3,000	10^{-3} - 1	3 - 3,000
Silty sand	10^{-5} - 10^{-1}	0.03 - 300	10^{-7} - 10^{-3}	0.0003 - 3

4.1.2. Hydraulic Gradient

The hydraulic gradient and direction of groundwater flow was determined using the groundwater potentiometric surface map created from the Project monitoring well network (SPF 2019b). Three lines were created perpendicular to the potentiometric lines. The locations were chosen north of the drain field, near the drain field, and south of the drain field to find an average overall hydraulic gradient for the area (Figure 3). The average value is estimated to be 0.089 ft/ft.

4.1.3. Aquifer Thickness

The aquifer thickness was determined from the well logs for GMW17-33 and PW-4 (Appendix C). The screened water-bearing zones were used to estimate aquifer thickness. The shallow sinter, sandstone, and siltstone/clay zones are the portions of the aquifer that the wastewater effluent would be most likely to affect.

4.1.4. Aquifer Width

The aquifer width perpendicular to groundwater flow was estimated based on the direction of groundwater flow determined on the potentiometric map. The aquifer width was found to be 385 ft in ESRI ArcGIS (Figure 3).

4.1.5. Natural Recharge

Annual recharge to groundwater in the vicinity of Grassy Mountain has been estimated in the range of 0.25 to 1 inch based on climatic and topographic conditions (ABC, 1992). These values were supported by ABC's numerical groundwater flow model of Grassy Mountain, with an assigned recharge rate of 0.5 inches per year. For comparison purposes, the IDEQ Nutrient Pathogen mass-balance spreadsheet includes a natural recharge rate calculator using the total annual precipitation (TAP): $(TAP)^2 * 0.0046$). This formula also produces an an annual recharge rate of approximately 0.5 inches per year

4.2. Parcel and Septic System

The Grassy Mountain Mine Permit Area (Figure 2) encompasses approximately 866 acres. The proposed drainfield covers approximately 10,800 ft^2 near the plant area based on a preliminary design rate of 0.4 gpd per square foot of drainfield and a domestic loading rate of 3,920 gpd.

4.3. Nitrogen Budget

The upgradient nitrate concentration in groundwater of 1.40 mg/L was used in the nitrate balance model, as discussed in Section 2.2 above. Model simulated nitrate concentrations at the point of compliance (downgradient boundary) were compared to the background concentration.

Default model values were maintained for the septic tank effluent concentration (60.0 mg/L), soil denitrification (0.1), and nitrate concentration in precipitation (0.24 mg/L).

5. RESULTS

This section provides a summary of the nitrate balance model results and a discussion of the model's sensitivity to certain model inputs.

5.1. Model Results

The nitrate balance model results suggest that average downgradient nitrate concentration in groundwater is not expected to exceed 2 mg/L above the background concentration. For the values considered, the modeled increase above the background concentration was 1.76 mg/L. The Level 1 nitrate balance spreadsheet is provided in Appendix A.

5.2. Sensitivity Assessment

A limited sensitivity assessment was performed for key model parameters including hydraulic conductivity, hydraulic gradient, and aquifer width. The assessment involved increasing and decreasing each model parameter by a factor of 2 and running the model. The results of the sensitivity analysis are presented in Table 6.

Table 6. Sensitivity Assessment Summary for Nitrate Balance Study

Model Parameter	Base Model Value	Adjustment from Base Model	Sensitiviy Value	Increase Above Background Nitrate Concentration
Hydraulic Conductivity (ft/day)	4.43	1/2 decrease	2.22	3.39
		x 2 increase	8.86	0.89
Hydraulic Gradient (ft/ft)	0.089	1/2 decrease	0.045	3.36
		x 2 increase	0.178	0.89
Aquifer Thickness (feet)	100	1/2 decrease	50	3.4
		x 2 increase	200	0.89
Aquifer Width (feet)	385	1/2 decrease	192.5	3.4
		x 2 increase	770	0.89

6. CONCLUSIONS AND RECOMMENDATIONS

The Level 1 nitrate balance evaluation predicts an increase of 1.76 mg/L in the groundwater nitrate concentration downgradient of the Grassy Mountain Mine Permit Area boundary. The model is based on limited site-specific data and necessary simplifying assumptions. There currently are no drinking water wells in the area. The proposed wells to be used for potable use are or will be located more than 1.6 miles from the drainfield in deeper confined sand layers. A model sensitivity assessment has been performed to address model uncertainty.

Based on the results of the Level 1 nitrate balance evaluation, SPF recommends proceeding with the proposed drainfield design rate of 3,920 gpd of wastewater and a daily design flow of 4,320 to accommodate the estimated monthly arsenic treatment system backflush water. Should new or additional data be collected in support of the design and implementation, refinement of the nitrate balance study and conclusions presented in this report may be warranted.

7. REFERENCES

Adrian Brown Consultants, Inc. (ABC), 1992. “Water Resources Technical Memorandum for Atlas Precious Metals Inc. Grassy Mountain Project Environmental Impact Statement”. Prepared for: USDI Bureau of Land Management. Prepared by ABC, Denver, Colorado. June 29, 1992.

Bear, J. 1972. Dynamics of Fluids in Porous Media. Dover Publications, Inc. New York. 764 p.

Freeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice Hall, Englewood Cliffs, NJ. 604 p.

J.M. Montgomery Consulting Engineers, Inc. (JMM), 1991. “Phase I Hydrogeologic Report on the Grassy Mountain Mine Project, Malheur County, OR”.

SPF Water Engineering (SPF), 2018a. GMW17-31, GMW17-33, and GMW17-34 Wells Completion Report. Prepared for Calico Resources. Prepared by SPF, Boise, Idaho. September 12, 2018.

SPF Water Engineering (SPF), 2019a. Grassy Mountain Gold Project Groundwater Vol. I, Baseline Data Report. Prepared by SPF, Boise, Idaho. February 19, 2019.

SPF Water Engineering (SPF), 2019b. Grassy Mountain Gold Project Groundwater Vol. II, Characterization Report. Prepared by SPF, Boise, Idaho. February 19, 2019.

Western Regional Climate Center (WRCC), 2017. Website: wrcc.dri.edu, accessed June 2017.

Appendix A
Nitrate Balance Spreadsheet

Washington State Department of Health

Using Average of GMW17-33 and PW-4 Early and Later Time Data

Large On-Site Sewage System (LOSS) LEVEL 1 NITRATE BALANCE

Project name:	**Grassy Mountain Mine Project**
Address, city and county:	**SE1/4 of NW1/4 of S8, T22S, R44E**
Completed by (name and title):	**Kurt Newbry, Geologist**
Date:	**08/13/2019**

Input Values	Factor	Units	Values	Instructions	Information Source
Nitrate concentration in precipitation	N_R	mg/l as N	0.24	Default	
Total nitrogen concentration in wastewater	N_W	mg/l	60	Default - residential strength	
Soil denitrification	d	unitless	0.1	Default	
Aquifer thickness	b	ft	100	Default or aquifer thickness if known	Nearby Well Logs
Drainfield area	A_D	ft^2	10,800	Primary drainfield area	From Design Data
Distance from drainfield to property boundary	D_{pb}	ft	3,777	Measure in direction of GW flow	
Aquifer width	W_A	ft	385	Perpendicular to GW flow	
Aquifer hydraulic conductivity	K	ft/day	4.430	Measured or literature value	GMW17-33 and PW-4 Pump Test
Hydraulic gradient	i	ft/ft	0.089	If unknown, use 0.001	Potentiometric Map
Recharge	R	in/yr	0.50	Recharge will be a % of ppt	GW Characterization Report
Nitrate concentration of upgradient ground water	N_B	mg/l	1.4	Prefer sampling data	Upgradient Well Sampling
Wastewater volume	V_W	gpd	3,920	Design flows or measured volume	Wastewater Design
Output Values					
Groundwater nitrate value	N_{GW}	mg/l as N	3.16	Point of Compliance (POC)	
Groundwater nitrate value	$N_{GW\ ALT}$	mg/l as N	3.12	Alternative POC	
Increase above background nitrate concentration	$N_{GW\ BI}$	mg/l as N	1.76	Increase from Background	

Appendix B
ACZ Laboratory Results

SPF Water Engineering
Project ID: Calico Winter Sampling
Sample ID: GW-1

ACZ Sample ID: ***L11147-01***
Date Sampled: *03/14/13 18:00*
Date Received: *03/16/13*
Sample Matrix: *Ground Water*

Inorganic Prep

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Cyanide, total	M335.4 - Manual Distillation							03/26/13 17:25	mpb
Cyanide, WAD	SM4500-CN I- distillation							03/26/13 13:01	mpb

Wet Chemistry

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration								
Bicarbonate as CaCO3		146			mg/L	2	20	03/20/13 0:00	abm
Carbonate as CaCO3		5	B		mg/L	2	20	03/20/13 0:00	abm
Hydroxide as CaCO3			U		mg/L	2	20	03/20/13 0:00	abm
Total Alkalinity		151			mg/L	2	20	03/20/13 0:00	abm
Chloride	M300.0 - Ion Chromatography	12.13			mg/L	0.5	2.5	03/22/13 2:01	tcd
Conductivity @25C	SM2510B	414			umhos/cm	1	10	03/20/13 22:49	abm
Cyanide, total	M335.4 - Colorimetric w/ distillation		U	*	mg/L	0.003	0.01	03/27/13 17:43	tcd
Cyanide, WAD	SM4500-CN I-Colorimetric w/ distillation		U	*	mg/L	0.003	0.01	03/26/13 15:32	tcd
Fluoride	M300.0 - Ion Chromatography	0.53		*	mg/L	0.1	0.5	03/22/13 2:01	tcd
Nitrate as N, dissolved	Calculation: NO3NO2 minus NO2	2.25	H		mg/L	0.04	0.2	03/29/13 14:02	calc
Nitrate/Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	2.25	H	*	mg/L	0.04	0.2	03/19/13 20:25	mpb
Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction		UH	*	mg/L	0.01	0.05	03/19/13 19:54	mpb
pH (lab)	SM4500H+ B								
pH		8.3	H		units	0.1	0.1	03/20/13 0:00	abm
pH measured at		20.0			C	0.1	0.1	03/20/13 0:00	abm
Residue, Filterable (TDS) @180C	SM2540C	300			mg/L	10	20	03/19/13 16:37	ljr
Residue, Non-Filterable (TSS) @105C	SM2540D		U	*	mg/L	5	20	03/20/13 15:01	khw
Sulfate	M300.0 - Ion Chromatography	35.82			mg/L	0.5	2.5	03/22/13 2:01	tcd

SPF Water Engineering
Project ID: Calico Winter Sampling
Sample ID: PW-1

ACZ Sample ID: ***L11314-04***
Date Sampled: *03/26/13 11:40*
Date Received: *03/28/13*
Sample Matrix: *Ground Water*

Inorganic Prep

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Cyanide, total	M335.4 - Manual Distillation							04/05/13 11:43	mpb
Cyanide, WAD	SM4500-CN I- distillation							04/03/13 10:30	mpb

Wet Chemistry

Parameter	EPA Method	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration								
Bicarbonate as CaCO3		126			mg/L	2	20	03/30/13 0:00	ljr
Carbonate as CaCO3		4	B		mg/L	2	20	03/30/13 0:00	ljr
Hydroxide as CaCO3			U		mg/L	2	20	03/30/13 0:00	ljr
Total Alkalinity		130			mg/L	2	20	03/30/13 0:00	ljr
Chloride	M300.0 - Ion Chromatography	8.48			mg/L	0.5	2.5	04/21/13 18:15	tcd
Conductivity @25C	SM2510B	347			umhos/cm	1	10	03/30/13 17:37	ljr
Cyanide, total	M335.4 - Colorimetric w/ distillation		U	*	mg/L	0.003	0.01	04/08/13 16:42	bsu
Cyanide, WAD	SM4500-CN I-Colorimetric w/ distillation		U	*	mg/L	0.003	0.01	04/03/13 23:38	pjb
Fluoride	M300.0 - Ion Chromatography	0.50		*	mg/L	0.1	0.5	04/21/13 18:15	tcd
Nitrate as N, dissolved	Calculation: NO3NO2 minus NO2	0.60	H		mg/L	0.02	0.1	04/22/13 16:22	calc
Nitrate/Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	0.60	H	*	mg/L	0.02	0.1	03/28/13 18:18	pjb
Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction		UH	*	mg/L	0.01	0.05	03/28/13 18:18	pjb
pH (lab)	SM4500H+ B								
pH		8.3	H		units	0.1	0.1	03/30/13 0:00	ljr
pH measured at		20.0			C	0.1	0.1	03/30/13 0:00	ljr
Residue, Filterable (TDS) @180C	SM2540C	240			mg/L	10	20	03/29/13 16:43	khw
Residue, Non-Filterable (TSS) @105C	SM2540D	7	B	*	mg/L	5	20	03/30/13 17:04	khw
Sulfate	M300.0 - Ion Chromatography	30.60			mg/L	0.5	2.5	04/21/13 18:15	tcd

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

SPF Water Engineering
Project ID: Calico 2nd Qtr
Sample ID: GW-1

ACZ Sample ID: ***L12799-04***
Date Sampled: *06/17/13 15:40*
Date Received: *06/19/13*
Sample Matrix: *Ground Water*

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Chloride	M300.0 - Ion Chromatography	1	12.5		*	mg/L	0.5	2.5	06/27/13 23:34	tcd
Fluoride	M300.0 - Ion Chromatography	1	0.49	B	*	mg/L	0.1	0.5	06/27/13 23:34	tcd
Nitrate as N, dissolved	Calculation: NO3NO2 minus NO2		2.17	H		mg/L	0.02	0.1	07/01/13 16:17	calc
Nitrate/Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	1	2.17	H	*	mg/L	0.02	0.1	06/19/13 22:10	pjb
Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	1		UH	*	mg/L	0.01	0.05	06/19/13 22:10	pjb
Residue, Filterable (TDS) @180C	SM2540C	1	290		*	mg/L	10	20	06/22/13 10:11	dcw
Sulfate	M300.0 - Ion Chromatography	1	35.1		*	mg/L	0.5	2.5	06/27/13 23:34	tcd

** Please refer to Qualifier Reports for details.*

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

SPF Water Engineering
Project ID: Calico 2nd Qtr
Sample ID: PW-1

ACZ Sample ID: ***L12799-06***
Date Sampled: *06/17/13 18:15*
Date Received: *06/19/13*
Sample Matrix: *Ground Water*

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Chloride	M300.0 - Ion Chromatography	1	8.83		*	mg/L	0.5	2.5	06/28/13 0:27	tcd
Fluoride	M300.0 - Ion Chromatography	1	0.47	B	*	mg/L	0.1	0.5	06/28/13 0:27	tcd
Nitrate as N, dissolved	Calculation: NO3NO2 minus NO2		0.62	H		mg/L	0.02	0.1	07/01/13 16:18	calc
Nitrate/Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	1	0.62	H	*	mg/L	0.02	0.1	06/19/13 22:12	pjb
Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	1		UH	*	mg/L	0.01	0.05	06/19/13 22:12	pjb
Residue, Filterable (TDS) @180C	SM2540C	1	270		*	mg/L	10	20	06/22/13 10:14	dcw
Sulfate	M300.0 - Ion Chromatography	1	32.2		*	mg/L	0.5	2.5	06/28/13 0:27	tcd

** Please refer to Qualifier Reports for details.*

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

SPF Water Engineering
Project ID: Calico 3rd Q sampling
Sample ID: PW-1

ACZ Sample ID: ***L13751-03***
Date Sampled: *08/06/13 14:50*
Date Received: *08/08/13*
Sample Matrix: *Ground Water*

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Chloride	M300.0 - Ion Chromatography	1	8.96		*	mg/L	0.5	2.5	08/15/13 23:48	tcd
Fluoride	M300.0 - Ion Chromatography	1	0.44	B	*	mg/L	0.1	0.5	08/15/13 23:48	tcd
Nitrate as N, dissolved	Calculation: NO3NO2 minus NO2		0.62	H		mg/L	0.02	0.1	08/20/13 13:09	calc
Nitrate/Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	1	0.62	H	*	mg/L	0.02	0.1	08/08/13 19:26	pjb
Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	1		UH	*	mg/L	0.01	0.05	08/08/13 19:26	pjb
Residue, Filterable (TDS) @180C	SM2540C	1	264		*	mg/L	10	20	08/12/13 16:03	mss3
Sulfate	M300.0 - Ion Chromatography	1	33.7		*	mg/L	0.5	2.5	08/15/13 23:48	tcd

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

SPF Water Engineering
Project ID: Calico 3rd Q sampling
Sample ID: GW-1

ACZ Sample ID: ***L13751-04***
Date Sampled: *08/06/13 15:35*
Date Received: *08/08/13*
Sample Matrix: *Ground Water*

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Chloride	M300.0 - Ion Chromatography	1	12.0		*	mg/L	0.5	2.5	08/16/13 16:10	tcd
Fluoride	M300.0 - Ion Chromatography	1	0.45	B	*	mg/L	0.1	0.5	08/16/13 16:10	tcd
Nitrate as N, dissolved	Calculation: NO3NO2 minus NO2		2.150	H		mg/L	0.06	0.3	08/20/13 13:09	calc
Nitrate/Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	3	2.15	H	*	mg/L	0.06	0.3	08/08/13 21:16	pjb
Nitrite as N, dissolved	M353.2 - Automated Cadmium Reduction	1		UH	*	mg/L	0.01	0.05	08/08/13 19:28	pjb
Residue, Filterable (TDS) @180C	SM2540C	1	308		*	mg/L	10	20	08/12/13 16:04	mss3
Sulfate	M300.0 - Ion Chromatography	1	36.7		*	mg/L	0.5	2.5	08/16/13 16:10	tcd

Appendix C
Well Driller Reports

MALH 54406

STATE OF OREGON
MONITORING WELL REPORT **GMW17-33 / MALH 54406** WELL I.D. LABEL# L 125170
(as required by ORS 537.765 & OAR 690-240-0395)
START CARD # 1036990

(1) LAND OWNER

Owner Well I.D. GMW-17-33
First Name _____ Last Name _____
Company CALICO RESOURCES USA CORP
Address P O BO Q
City VALE State OR Zip 97918

(2) TYPE OF WORK

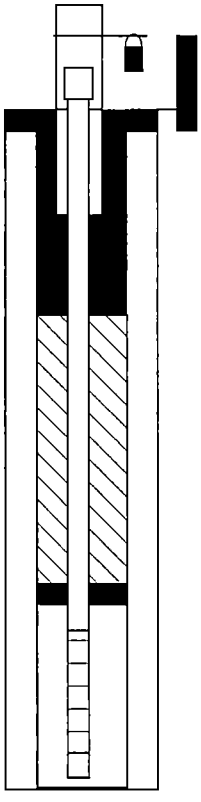
☒ New ☐ Deepening ☐ Conversion ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Hollow Stem Auger ☐ Cable Mud ☐ Reverse Rotary ☐ Other

(4) CONSTRUCTION

Piezometer Well ☐
Depth of Completed Well 340.00 ft. Special Standard ☐



MONUMENT/VAULT Above Ground
From _____ To _____

BORE HOLE
Diameter 16 From 0 To 118

CASING
Dia. 12 From ☒ 3 To 118
Gauge .250 Wld Thrd
Material ◉ Steel ○ Plastic ☒ ☐

LINER
Dia. _____ From ☐ _____ To _____
Gauge _____ Wld Thrd
Material ○ Steel ○ Plastic ☐ ☐

SEAL
From 0 To 118
Material Cement
Amount 69 Sacks Grout weight 15.6

SCREEN
Casing/Liner Casing Material PVC
Diameter 5 From 238 To 338
Slot Size 0.020

FILTER
From 233 To 235 Material SAND SEAL Size of pack 20/40

(5) WELL TESTS

◉ Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20		340	1
40	28	335	2

Temperature 60 °F Lab analysis ☐ Yes
RECEIVED BY OWRD
Supervising Geologist/Engineer SPF Engineering
Water quality concerns? ☐ Yes (describe below)
DEC 21 2017

From	To	Description	Amount	Units

SALEM, OR

(6) LOCATION OF WELL (legal description)

County MALHEUR Twp 22.00 S N/S Range 44.00 E E/W WM
Sec 8 SE 1/4 of the NW 1/4 Tax Lot 101
Tax Map Number _____ Lot _____
Lat ° ' " or 43.67235700 DMS or DD
Long ° ' " or -117.36162400 DMS or DD
◉ Street address of well ○ Nearest address
REFER TO GPS

(7) STATIC WATER LEVEL

	Date	SWL(psi)	+ SWL(ft)
Existing Well / Predeepening			
Completed Well	11/28/2017		243

Flowing Artesian? ☐ Dry Hole? ☐
WATER BEARING ZONES
Depth water was first found 251.00

SWL Date	From	To	Est Flow	SWL(psi)	+ SWL(ft)
11/28/2017	243	338	20		243

(8) WELL LOG

Ground Elevation _____

Material	From	To
brown clay boulders	0	16
brown clay & rock fragments	16	23
redish sandstone, clay strips	23	30
green claystone	30	35
green & red sandstone	35	46
tan & red claystone	46	73
white,yellow & red clay	73	92
tan claystone	92	98
tan clay layers with rock	98	110
bown & red sandstone	110	120
red, white & brown very hard clay	120	172
red clay with brown strips soft	172	185
red clay, bounces on rock	185	200
brown sandstone	200	212
brown clay strips, sandstone	212	220
brown clay	220	225
brown & grey clay	225	230
brown sandstone	230	245
brown clay	245	251

Date Started 11/2/2017 Completed 11/30/2017

(unbonded) Monitor Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon monitoring well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 1896 Date 12/14/2017
Password : (if filing electronically)
Signed TONY HACKETT (E-filed)

(bonded) Monitor Well Constructor Certification
I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon monitoring well construction standards. This report is true to the best of my knowledge and belief.

License Number 1899 Date 12/14/2017
Password : (if filing electronically)
Signed SAM P KINGREY (E-filed)
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK
Form Version:

MONITORING WELL REPORT -
continuation page

WELL I.D. LABEL# L125170

GMW17-33 / MALH 54406 **START CARD # 1036990**

(4) CONSTRUCTION

BORE HOLE

Dia	From	To
12	118	365

FILTER PACK

From	To	Material	Size
235	339	SILICA SAND	8/12

SEAL

Material	From	To	Amt	sacks/ lbs	grout weight
C5	0	233	132	S	14.1

CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
◉	○	5	☒	2	238	sch80	○	◉		☒

SCREENS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn size/ slot width	Slot length	# of slots	Tele/ pipe size

(5) WELL TESTS

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(7) STATIC WATER LEVEL

Water Bearing Zones

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(8) WELL LOG

Material	From	To
fractured black rock	251	290
grey clay	290	295
black, brown fractured rock	295	314
grey clay strips with black rock	314	320
grey clay	320	327
black, grey rock fractured	327	338
brown clay	338	365

RECEIVED BY OWRD

DEC 21 2017

SALEM, OR

Comments/Remarks

Jake Kingrey

David Dutcher

PW-4 / MALH 2206

JAN 02 1990

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

WATER RESOURCES DEPT.
SALEM, OREGON

Malh 2206

21S/44E/32bd
W-14815

(START CARD) # W-14814

(1) OWNER: Well Number: PW-4
Name ATLAS PRECIOUS METALS
Address 313 A STREET WEST
City VALE State OR Zip 97918

(2) TYPE OF WORK:
☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☒ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☒ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☒ No ☐ Depth of Completed Well 375 ft.
Explosives used Yes ☐ No ☒ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
14 3/4	0	40	PORTLAND CEMENT	0	40	19
9 7/8	40	375	VOLCLAY	5	275	40
			CEMENT	0	5	

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from 375 ft. to 370 ft. Material 10-20 MESH
Gravel placed from 370 ft. to 275 ft. Size of gravel 10-20 MESH

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	10"	0	40	.250	☒	☐	☐	☐
Liner:	6 5/8"	0	280	.250	☐	☐	☐	☐
	6 5/8"	300	340	.250	☒	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☒ Screens Type WIRE WOUND Material Low Carbon Steel

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
280	300	.030		6"		☐	☒
340	360	.030		6"		☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
100		350	1 hr.

Temperature of water 62°F Depth Artesian Flow Found —
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☒ Odor ☐ Colored ☐ Other
Depth of strata: 280 STILL USABLE

(9) LOCATION OF WELL by legal description:
County MALHEUR Latitude — Longitude —
Township 21S N or S, Range 44E E or W, WM.
Section 32 SE ¼ NW ¼
Tax Lot — Lot — Block — Subdivision —
Street Address of Well (or nearest address)

(10) STATIC WATER LEVEL:
81 ft. below land surface. Date 11/17/89
Artesian pressure — lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 280'

From	To	Estimated Flow Rate	SWL
280	360	100 gpm	81

(12) WELL LOG: Ground elevation ≅ 3350

Material	From	To	SWL
Alluvium	0	25'	
Clay	25	150'	
Sandy clay	150	175	
Sandstone	175	215	
Clay	215	275	
Sandstone	275	305	
Clay	305	325	
Sandstone and Conglomerate	325	365	
Clay.	365	375	

Date started 11/16/89 Completed 11/20/89

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number
Signed [signature] Date 11/20/89

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. all work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 544
Signed Larry Burd Date 11-20-89

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER

9809C 3/85

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OR 690-240-095)

JAN 26 1994
WATER RESOURCES DEPT.
SALEM, OREGON

MALH 2985 Start Card # 59762

225/44E/8 bd

9

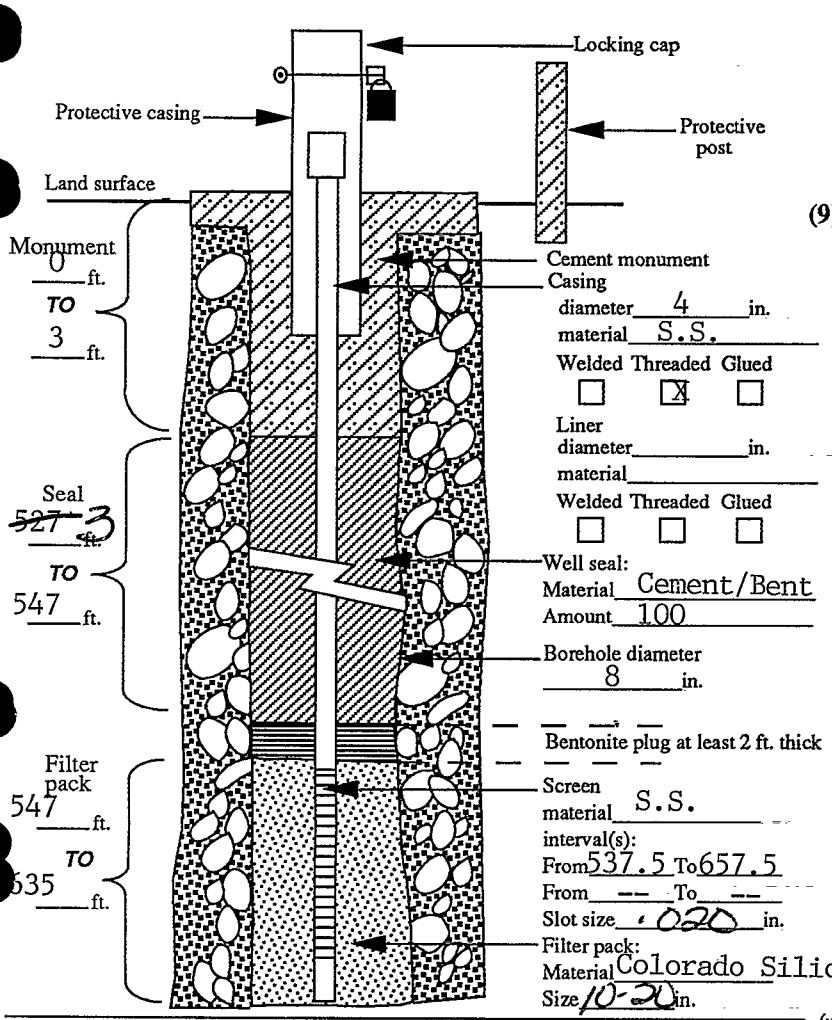
(1) OWNER/PROJECT:
WELL NO. MW-3

Name: Newmont Gold
Address: 318 A Street
City: West Vale State: OR Zip: 97918

(2) TYPE OF WORK:
[X] New construction [ ] Repair [ ] Recondition
[ ] Conversion [ ] Deepening [ ] Abandonment

(3) DRILLING METHOD
[X] Rotary Air [ ] Rotary Mud [ ] Cable
[ ] Hollow Stem Auger [ ] Other

(4) BORE HOLE CONSTRUCTION 59762 / MALH 2976, 2985
Special Standards: Yes [ ] No [X]
Depth of completed well 657.5 ft.



(5) WELL TEST:
[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian
Permeability ---- Yield ---- GPM
Conductivity ---- PH ----
Temperature of water 56 °F/C Depth artesian flow found ---- ft.
Was water analysis done? [ ] Yes [X] No
By whom? ----
Depth of strata to be analyzed. From ---- ft. to ---- ft.
Remarks: See attached sheet for sand pack

Name of supervising Geologist/Engineer: Mike Pappalardo

(6) LOCATION OF WELL By legal description
Well Location: County Malheur
Township 22S (N or S) Range 44E (E or W) Section 8
1. SE 1/4 of NW 1/4 of above section.
2. Street address of well location: Grassy Mountain, Vale OR
3. Tax lot number of well location: Unknown
4. ATTACH MAP WITH LOCATION IDENTIFIED.

(7) STATIC WATER LEVEL:
626 Ft. below land surface. Date 10/29/93
Artesian Pressure ____ lb/sq. in. Date

(8) WATER BEARING ZONES:
Depth at which water was first found ----

From	To	Est. Flow Rate	SWL

(9) WELL LOG:
Ground elevation

Material	From	To	SWL
****See Attached Sheet*******			

RECEIVED
MAR 14 1994
WATER RESOURCES DEPT.
SALEM, OREGON

Date started 10/16/93 Completed 10/29/93

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.
Signed [signature] MWC Number 1098 Date 1/13/94

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
Signed [signature] MWC Number 10096 Date 1-13-94

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

59762 / MALH 2976, 2985

RECEIVED
JAN 26 1994
WATER RESOURCES DEPT.
SALEM, OREGON

RECEIVED
MAR 14 1994
WATER RESOURCES DEPT.
SALEM, OREGON

Newmont Gold
318 A Street
West Vale, OR 97918

Start Card # 59762

(9) Well Log

Material	From	To	SWL
Alluvium sand and cobbles	0	1	
Arkose sandstone buff medium grained course	1	19	
Sandstone orange to buff gray green course to medium grained	19	25	
Sandstone olive green medium grained	25	36	
Sandstone orange to red medium grained to fine	36	42	
Sandy clayey siltstone pink purple/yellow streaks	42	57	
Clayey siltstone light olive green and tan	57	78	
Claystone orange light purple yellow	78	94	
Silicified tan buff and brown	94	109	
Silty claystone purple gray and yellow	109	115	
Clayey siltstone gray/pink/yellow	115	160	
Clayey siltstone orange/yellow/gray	160	178	
Clayey siltstone gray	178	180	
Clayey siltstone tan and gray partial silicification	180	187	
Clayey siltstone tan grading into gray decrease in silicificaiton	187	215	
Clayey siltstone gray grading into tan increaded silicification	215	220	
Clayey siltstone highly silicified tan to brown	220	256	
Clayey siltstone tan grading into gray decreasing silicification from high to moderate	256	305	
Clayey siltstone gray grading into tan increasing silicification	305	312	
Silicified siltstone tan to light brown	312	332	
Clayey siltstone tan to gray	332	345	
Clayey siltstone gray grading into tan with increasing silicification	345	355	
Clayey siltstone tan	355	360	
Clayey siltstone green and brown	360	385	
Clayey siltstone gray and brown	385	401	
Clayey siltstone grey with brown and charcoal mottling	401	435	
" gray	435	501	
Clayey siltstone gray	501	515	
Clayey siltstone charcoal	515	525	
Clayey siltstone gray	525	570	
Clayey siltstone gray charcoal	570	625	
Clayey siltstone gray	625	650	
Silicified siltstone gray	650	700	

Hole was bridging partial sand pack and native materials from 611-635
Native material around screen at 635 - 657

MALH 54404

GMW17-31 / MALH 54404

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-0395)

WELL I.D. LABEL# L 125168

START CARD # 1035606

(1) LAND OWNER

Owner Well I.D. GMW-17-31

First Name _____ Last Name _____

Company CALICO RESOURCES USA CORP.

Address P O BOX Q

City VALE State OR Zip 97918

(2) TYPE OF WORK

[X] New [ ] Deepening [ ] Conversion
[ ] Alteration (repair/recondition) [ ] Abandonment

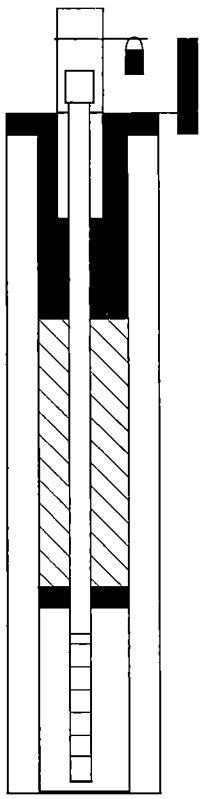
(3) DRILL METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable [ ] Hollow Stem Auger [ ] Cable Mud
[ ] Reverse Rotary [ ] Other _____

(4) CONSTRUCTION

Piezometer Well [ ]

Depth of Completed Well 498.00 ft. Special Standard [ ]



MONUMENT/VAULT Above Ground
From _____ To _____

BORE HOLE
Diameter 16 From 0 To 98

CASING
Dia. 12 From [X] 3 To 98
Gauge .250 Wld Thrd
Material (•) Steel ( ) Plastic [X] [ ]

LINER
Dia. _____ From [ ] _____ To _____
Gauge _____ Wld Thrd
Material ( ) Steel ( ) Plastic [ ] [ ]

SEAL
From 0 To 38
Material Bentonite Chips
Amount 36 Sacks Grout weight _____

SCREEN
Casing/Liner Casing Material PVC
Diameter 5 From 458 To 498
Slot Size 0.020

FILTER
From 453 To 455 Material SAND SEAL Size of pack 20/40

(5) WELL TESTS

( ) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

RECEIVED BY OWRD

Temperature _____ °F Lab analysis [ ] Yes By _____

Supervising Geologist/Engineer SPF Water Engineering DEC 21 2017

Water quality concerns? [ ] Yes (describe below) SALEM, OR

From	To	Description	Amount	Units

(6) LOCATION OF WELL (legal description)

County MALHEUR Twp 22.00 S N/S Range 44.00 E E/W WM
Sec 8 SE 1/4 of the NW 1/4 Tax Lot 100
Tax Map Number _____ Lot _____
Lat ° ' " or 43.67387000 DMS or DD
Long ° ' " or -117.35963000 DMS or DD
( ) Street address of well (•) Nearest address

REFER TO GPS

(7) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening				
Completed Well				

Flowing Artesian? [ ] Dry Hole? [X]

WATER BEARING ZONES Depth water was first found _____

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(8) WELL LOG

Ground Elevation 3711.00

Material	From	To
soft brown clay-top soil	0	3
brown decomposed sand & gravel	3	8
soft light brown sandstone	8	17
hard green sandstone	17	22
med. hard green sandstone	22	28
hard green sandstone	28	41
soft orange sandstone	41	47
soft red sandstone	47	55
sticky red clay	55	60
soft red clay some white clay strips	60	82
hard dark red strips of claystone	82	107
soft red & white clay	107	122
soft tan & red clay	122	142
med. hard red claystone	142	147
hard grey sandstone	147	157
med. hard orange, tan & red claystone	157	177
hard red yellow claystone	177	197
soft red clay	197	202
broken black basalt	202	212

Date Started 8/1/2017 Completed 11/30/2017

(unbonded) Monitor Well Constructor Certification

I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon monitoring well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 1896 Date 12/14/2017
Password : (if filing electronically)
Signed TONY HACKETT (E-filed) Tony Hackett

(bonded) Monitor Well Constructor Certification

I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon monitoring well construction standards. This report is true to the best of my knowledge and belief.

License Number 1899 Date 12/14/2017
Password : (if filing electronically)
Signed SAM P KINGREY (E-filed) Sam P Kingrey
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

Form Version:

MALH 54404

GMW17-31 / MALH 54404

MONITORING WELL REPORT - continuation page

WELL I.D. LABEL# L 125168

START CARD # 1035606

(4) CONSTRUCTION

BORE HOLE

Dia	From	To
10	98	520

FILTER PACK

From	To	Material	Size
455	499	SILICA SAND	8/12

SEAL

Material	From	To	Amt	sacks/ lbs	grout weight
C5	0	453	200	S	14.1
Cement	38	98	41	S	15.6
Cement	499	520	9	S	15.6

CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
	●	5	X	2	458	sch80		●		X

SCREENS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn size/ slot width	Slot length	# of slots	Tele/ pipe size

(5) WELL TESTS

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(7) STATIC WATER LEVEL

Water Bearing Zones

SWL Date	From	To	Est Flow	SWL(psi)	+ SWL(ft)

(8) WELL LOG

Material	From	To
med. hard multicolored sandstone	212	217
soft yellow orange grey clay	217	242
hard layers sandstone grey	242	258
soft tan clay	258	269
strips of grey clay & grey sandstone	269	309
hard brown glassy rock	309	319
soft tan & grey clay	319	336
hard brown glassy rock	336	337
soft tan clay	337	342
hard fractured brown rock	342	351
hard layers brown sandstone w/clay strip	351	385
hard brown rock	385	397
hard int. lyrs sndstne/clay in 1' strips	397	446
brown clay	446	454
hard brown sandstone	454	456
soft brown clay	456	459
hard layers brown sandstone	459	465
brown clay	465	481
hard sandstone brown	481	498
sticky brown clay	498	520

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SALEM, OR

Comments/Remarks

additional drillers 1)Jake Kingrey

2)David Dutcher

CALICO RESOURCES

GRASSY MOUNTAIN PROJECT Page 1 of 5 Hole No. GMW17-31 Depth 520

UTM East _____, North _____ Elev _____ Azimuth / Incline -90

Logged by: M.F. MCGINNIS Drill Type _____ Contractor DOWN RIGHT DRILLING

DATE Start _____ Finish _____ 0=none 1 or tr=trace 2 or W=weak 3 or M=moderate 4 or S=strong 5 or Int=intense

Depth	Lithology Graphic	Lithology	CLAY/ ARG.	Silica	SULF/ pyrite	Qtz Veins	FeOx	CALCITE		Sample Number	Au ppm	Description/Remarks	COLOR
0-3		Ovb	20%	0	0	0	WK	S				OVERBURDEN - MIXED LITHO - CALCAREOUS	BROWN
3-8		Ovb	50%				0	S					OLIVE GRAY GREEN
8-17		Tgls	30%				0	S				SANDSTONE, SLTST & CLAY - CALCAREOUS	
17-22			30%				0	S					
22-28			10%				0	T					
28-41			—				TR	0				90% SANDST 10% SLTST & CLAY BLUE-GREEN - PISTACHIO GREEN	PISTACHI GREEN
41-47		Tgls CONGLOM	—	Tr			WK					SANDST & SLTST SOME ROUNDED CONGLOM PEBBLES TRACE SILIC'D SLTST	BROWN GREEN
47-55		CONGLOM Tgs CLAY	20%	Tr			INT					SANDST, SLTST, CLAY, CONGLOM	BRICK RED
55-60		Tgs CLAY CONGLOM		Tr			INT						"
60-65		CLAY	80%	0			MOD					RED-BROWN CLAY	RED-BROWN & GRA
65-72		CLAY	100				WK						REDDISH GRAY
72-77							WK						
77-82							S					RED CLAY	RED
82-87							INT						
87-92		CLAY	90										
92-97		CLAY	80	Tr								RED CLAY & SILIC'D SLTST/TUFF	RED TAN
97-102		CLAY/ SLTST	70	WK			INT						
102-107			70	WK			M						
107-110		CLAY	100	0			T					LT. GRAY CLAY	GRAY
110-117			100	0			0						

CALICO RESOURCES **GRASSY MOUNTAIN PROJECT** Page 2 of 5 Hole No. GMW17-31 Depth 520

UTM East _____, North _____ Elev _____ Azimuth / Incline -90

Logged by: M.F. McGINNIS Drill Type _____ Contractor _____

DATE Start _____ Finish _____ 0=none 1 or tr=trace 2 or W=weak 3 or M=moderate 4 or S=strong 5 or Int=intense

Depth	Lithology Graphic	Lithology	CLAY/ ARG	Silica	pyrite	Qtz Veins	FeOx			Sample Number	Au ppm	Description/Remarks	COLOR
117 - 122		CLAY	100	0	0	0	W					YELLOW BROWN CLAY	YELLOW BROWN
122 - 127			100				M					RED CLAY	RED BROWN
127 - 132			100				S						RED
132 - 137			100				S						RED
137 - 142			100				S						RED
142 - 147			100				S					90% CLAY 10% SS & SLTST	RED BROWN
147 - 152		SS, ARK SLTST, TUFF	W	TR			W					ARKOSE, SANDSTONE, SILTST, TUFF TUFFACEOUS SLTST RED GREEN, BROWN, TAN WHITE	MULTI
152 - 157			W	TR			W						
157 - 162			W	WK			W					10% SILC'D SLTST & TUFF	
162 - 167			W	WK			T						
167 - 172			W	WK			T						
172 - 177			W	WK			T						
177 - 182			W	WK			T						
182 - 187		AS ABOVE + CLAY	20%	W			T					AS ABOVE PLUS GRAY CLAY	OLIVE GRN & BROWN
187 - 192			20%	W			T						"
192 - 197		SS, ARK SLTST, TUFF TR. SINTER	20%	W			T					SS, SILC'D SLTST & TUFF 20% SINTER W/ SOME MICRO BX	"
197 - 202		SS, ARK SLTST, TUFF 30% SINTER	W	M			T					DITTO 30% SINTER	"
202 - 207		"	W	M			T					DITTO	"
207 - 212		"	W	M			T					DITTO	"
212 - 217		" + CLAY	20%	W			T					DITTO + GRAY CLAY	"

CALICO RESOURCES **GRASSY MOUNTAIN PROJECT** Page 3 of 5 Hole No. GMW17-31 Depth 520

UTM East _____, North _____ Elev _____ Azimuth — Incline -90°

Logged by: M.F. MCGINNIS Drill Type _____ Contractor _____

DATE Start _____ Finish _____ 0=none 1 or tr=trace 2 or W=weak 3 or M=moderate 4 or S=strong 5 or Int=intense

Depth	Lithology Graphic	Lithology	CLAY / ARG	Silica	pyrite	Qtz Veins	FeOx	CALCITE		Sample Number	Au ppm	Description/Remarks	COLOR
217-222		SS, SLTST ARK, TUFF		M	0	0	T	0				SS. SILIC'D SLTST & TUFF — OLIVE GRN, BROWN MAROON, GRN, TAN	MULTI
222-227		↓		M	0	0	W						
227-232		AS ABOVE + CLAY	20% / W	M	TR		W					+ CLAY	
232-237			40% / M	T	0		M					SLTST, TUFF, CLAY — YELLOW-BROWN, TAN, GRAY	YELLOW BRN TAN
237-242			10% / M	0	0		M						
242-247			10% / M	0	TR	↓	M						
247-252		SINTER SLTST	W	S	0	T	T					60% SINTER - CHALCEDONIC 40% SLTST & SILIC'D SLTST — TRACE HAIRLINE QTZ VLTS	TAN WHITE RUSTY
252-257		↓	W	S		0	T						
257-262			W	S		T	W					TRACE HAIRLINE QTZ VLTS	
262-267			W	S		T	W						
267-272		CLAY, SLTST TUFF, SINTER	70%	M	↓	0	W					30% SINTER - CHALCEDONIC 70% CLAY, SLTST, TUFF	
272-277		80% CLAY 20% SLTST TUFF	80%	W	TR		T					80% DK GRAY CLAY W/ F.G. DISS PY 20% SLTST & TUFF FeOx TR-WK	DK. GRAY RUSTY BROWN
277-282		↓	80%	T	3%		T					↓	↓
282-287			80%	T	5%		T						
287-292			80%	W	↓		T						
292-297			80%	W	↓		0						
297-302			80%	W	10%		T						
302-307			80%	0	↓		0						
307-312			80%	0	↓		T						
312-317		↓	80%	W	5%	↓	T	↓				↓	↓

CALICO RESOURCES **GRASSY MOUNTAIN PROJECT** Page 4 of 5 Hole No. GMW17-31 Depth 520

UTM East _____, North _____ Elev _____ Azimuth — Incline -90°

Logged by: M.F. McGINNIS Drill Type _____ Contractor DOWN RIGHT DRILLING

DATE Start _____ Finish _____ 0=none 1 or tr=trace 2 or W=weak 3 or M=moderate 4 or S=strong 5 or Int=intense

Depth	Lithology Graphic	Lithology	CLAY / ARG	Silica	SULF / pyrite	Qtz Veins	FeOx	CALCITE		Sample Number	Au ppm	Description/Remarks	COLOR
317-322		CLAY 10% SINTER	90% / W	O	TR	O	T	O				90% CLAY 10% SINTER	BROWN TAN GRAY
322-327		SINTER	O	S	O		T					SINTER & SILIC'D SLTST WHITE SINTER ? FeOx T	WHITE TAN LT. GRA
327-332		↓	O	S	↓	↓	T	↓				↓	↓
332-337			O	S			T						
337-342		↓	O	S			T						
342-347		SINTER SILIC'D SLTST CLAY	10% / T	T	↓		T					+ CLAY	WHITE TAN RUSTY
347-352		ARK 10% CLAY	10% / W	O	TR		T					ARKOSE - WHITE & TAN FeOx T + CLAY	↓
352-357		ARK 10% CLAY	M	O	O		T						
357-362		ARK TUFF	M	W	↓		T					90% ARKOSE + SILIC'D SLTST 10% TUFF & TUFFACEOUS SLTST FeOx T	
362-367		ARK TUFF	10% / W	W	↓		T					↓	↓
367-372		ARK TUFF	10% / WR	W	TR		T					↓	WHITE RUSTY TAN
372-377		ARK TUFF	W	W	O		T					↓	↓
377-382		ARK TUFF CLAY	10% / W	W	↓		W					ARKOSE, TUFF, SILIC'D SLTST, CLAY FeOx W	
382-387		ARK TUFF CLAY	20% / W	W			W					↓	
387-392		↓	5% / M	M			W					↓	↓
392-397		SINTER	O	S			W					SINTER - TAN, BROWN, DK. BROWN + SILIC'D SLTST FeOx W	TAN BROWN BLACK
397-402		SINTER	O	S			W					↓	↓
402-407		SINTER	O	S			W						
407-412		SINTER	O	S			T					FeOx T	
412-417		SINTER 10% ARK	T	S	↓	↓	T	↓				+ WHITE ARKOSE ↓	↓

CALICO RESOURCES

GRASSY MOUNTAIN PROJECT Page 5 of 5 Hole No. GMW17-31 Depth 520 FT

UTM East _____, North _____ Elev _____ Azimuth / Incline -90°

Logged by: M.F. MCGINNIS Drill Type _____ Contractor DOWN RIGHT DRILLING

DATE Start _____ Finish _____ 0=none 1 or tr=trace 2 or W=weak 3 or M=moderate 4 or S=strong 5 or Int=intense

Depth	Lithology Graphic	Lithology	CLAY / ARG	Silica	pyrite	Qtz Veins	FeOx	CALCITE	Sample Number	Au ppm	Description/Remarks	COLOR
417 - 422		ARK, TUFF SINTER	0 / W	M	0	0	T	0			ARKOSE, TUFF, TUFFACEOUS SLTST, SINTER GRAY, TAN, WHITE, BRN, GREEN	MULTI
422 - 427		↓	5% / W	M	↓	↓	T	T			↓	↓
427 - 432		↓	30% / M	W	↓	↓	T	T			+ 30% CLAY	↓
432 - 437		SLTST TUFF	30% / M	W	↓	↓	T	0			SLTST, TUFF, SILIC'D SLTST	TAN GRAY
437 - 442		↓	30% / M	W	↓	↓	T	0			↓	↓
442 - 447		↓	10% / M	W	2%	↓	T	W			(BROWN BIO → CLAY)	BRN
447 - 452		SLTST CLAY	10% / M	W	0	↓	M	0			SLTST, CLAYSTONE, CLAY FeOx M - BRICK RED CALCITE W THROUGHOUT	TAN GRAY BRICK RED
452 - 457		↓	10% / M	W	↓	↓	T	W			AS ABOVE & 5% SINTER CALC W	TAN GRAY
457 - 462		SLTST CLAY SINTER	10% / M	W	↓	↓	T	W			AS ABOVE & 20% SINTER	↓
462 - 467		SLTST CLAY	20% / S	0	↓	↓	0	W			SLTST, CLAYSTONE, CLAY	↓
467 - 472		↓	20% / S	0	T	↓	0	W			↓	GRAY
472 - 477		↓	20% / S	0	0	↓	0	W			↓	↓
477 - 482		↓	20% / S	0	0	↓	0	0			↓	↓
482 - 487		SLTST TUFF CLAY	10% / S	0	T	↓	0	0			TUFF, TUFFACEOUS, SLTST, CLAY (BROWN BIOTITE → CLAY)	GRAY DK BRN
487 - 492		↓	20% / S	0	0	↓	T	W			↓	↓
492 - 497		SLTST, TUFF CLAY, SINTER	5% / S	W	↓	↓	T	W			SILIC'D SLTST, TUFF, CLAY 10% SINTER	↓
497 - 502		↓	20% / S	W	↓	↓	0	0			↓	↓
502 - 507		↓	5% / S	W	↓	↓	0	0			SLTST, TUFF, CLAY, SCATTERED SINTER	↓
507 - 512		↓	5% / S	T	↓	↓	T	0			↓	↓
512 - 520		↓	5% / S	T	↓	↓	T	W			↓	↓

T.D.

Appendix D
Strata Test Pit Reports

STRATA

May 23, 2019
File: BO19059A

Ms. Nancy Wolverson
Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

RE: **Geotechnical Engineering Evaluation**
Wastewater Drain Field Characterization
Grassy Mountain Mine
Malheur County, Oregon

Hello, Ms. Wolverson:

STRATA is pleased to present our authorized Geotechnical Engineering Evaluation for the proposed septic drain fields for the Grassy Mountain Mine located approximately 22.5 miles southwest of Nyssa, Oregon in Malheur County, Oregon. This report has been developed in accordance with our proposal, dated September 26, 2018. The purpose of our evaluation was to explore the subsurface conditions in areas designated by SPF Water Engineers in order to assist project planning and design of the proposed septic system drain fields.

The following report provides a summary of our investigation of subsurface conditions for sanitary disposal for the proposed development. It is our opinion that geotechnical continuity with the project team throughout construction will help identify suitable soils during excavation for the proposed septic drain field.

The project design, owner, and construction team must read, understand, and implement this report in its entirety. Portions of the report cannot be relied upon individually without the supporting text of remaining sections, appendices and plates. Our opinion is the success of the proposed construction will depend on following the report recommendations, good construction practices, and providing the necessary construction monitoring, testing, and consultation to verify that work has been constructed as recommended.

We appreciate the opportunity to work with Calico Resources USA and SPF Water Engineers and look forward to our continued involvement on this project throughout construction.

Sincerely,
STRATA

Daniel P. Zimmerman

REGISTERED PROFESSIONAL ENGINEER
5-23-19
84139PE

Daniel P. Zimmerman, P.E.
Project Engineer

OREGON
MARCH 9, 2010
DANIEL PETER GADO
EXPIRES: 6-30-2019

Daniel P. Gado

Daniel P. Gado, P.E.
Senior Engineer

DPZ/DPG/tb

8653 West Hackamore Drive, Boise, Idaho 83709 Phone 208.376.8200 Fax 208.376.8201
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Engineering Soil Report

Wastewater Drain Field Characterization
Grassy Mountain Mine
Malheur County, Oregon

Prepared For:

Ms. Nancy Wolverson
Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Prepared By:

STRATA
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Boise, Idaho 83709
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May 23, 2019

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Appendix A: Exploratory Test Pit Logs and Unified Soil Classification System (USCS)
Appendix B: Laboratory Test Results

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Geotechnical Engineering Evaluation
Wastewater Drain Field Characterization
Grassy Mountain Mine
Malheur County, Oregon

INTRODUCTION

STRATA has performed our Geotechnical Engineering Evaluation for the proposed Wastewater Disposal Drain Field for the Grassy Mountain Mine Facility located approximately 21 miles south of the intersection of US 20 and Russell Road, in Malheur County, Oregon. The purpose of our evaluation was to explore the subsurface soil conditions at the project site and prepare geotechnical recommendations to assist project planning, design, and construction. Our geotechnical report could be used for planning the location of a septic drain field on the site. We accomplished our services referencing our authorized geotechnical proposal dated February 21, 2019, and authorized February 21, 2019. To accomplish our evaluation, STRATA performed the following services:

1. Provided geotechnical engineering observation during the excavation and sampling of the test pits. Samples of the various soils encountered were taken for classification and laboratory testing.
2. We performed three infiltration tests in the underlying permeable sand and gravel subsoil in the area of the proposed septic drain fields.
3. Laboratory testing was accomplished on select samples obtained from the test pits. The laboratory testing included grain-size analyses, fines content determinations (percent passing the No. 200 sieve), Atterberg limits, and moisture contents. Laboratory testing was accomplished referencing ASTM standards. Soil samples will be retained for a period of 90 days after completion of our field explorations and then discarded, unless we are notified otherwise.
4. The logs of the test pits and a location plan were prepared.
5. Performed geotechnical engineering analyses and developed recommendations for the feasibility of using on-site soils for infiltration of wastewater for septic drain field design.
6. Prepared a geotechnical engineering evaluation report summarizing our field and laboratory evaluations and engineering analyses for the project. Our report includes conclusions, opinions, and recommendations for the suitability of on-site soils for use as septic drain fields, subsurface infiltration rates, and anticipated ground water level for sanitary disposal areas.

PROJECT UNDERSTANDING

Existing Site Conditions

The project mine site is located approximately 2 miles south of Twin Springs Road and Rock Canyon Road in Malheur County, Oregon. The hilly terrain is covered with grasses and sage brush. The mine site will be located at a conical hill located at the south end of the site. On the hill, multiple primitive, single-lane roads have been constructed. We understand that the site has been considered for mining operation off and on for more than 30 years. Evidence of previous subsurface investigations are visible all over the hill. The hillside is covered with multiple boulders of sandstone, conglomerate, and basalt. Grades lessen to the east, north, and west of the hill. Drainage areas trend south to north to the west and east of the mine site. A spine consisting of surface rock extends to the north of the hill. Additional primitive, single-lane roads cross the site. The road to the mine crosses the spine at the base of the hill and extends to the east and south.

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Planned Septic Drain Field Locations

SPF Water Engineers (SPF) located twenty test pits in three areas to the northwest and northeast of the mine location to identify potential drain field sites. These three drain field site areas were designated areas A, B, and C by SPF. Area A was located north and south of the site entry road on the hillside west of the spine. Area B was located north of the entry road and north of Area A. These two areas were located on a west facing slope. The surface conditions in the vicinity of Area A consisted of grasses and sage brush. Area B surface vegetation was similar to that of Area A, but the surface also contained surficial boulders and cobbles. Area C was on the east side of the spine, north of the entry road on a northeast facing slope. The twenty test pits were located with GPS and staked.

SUBSURFACE EVALUATION PROCEDURES

STRATA accomplished a recent subsurface exploration on April 22, and 23, 2019 via twenty (20) exploratory test pits excavated between 3 and 10 feet below the existing ground surface (BGS). The approximate exploration locations are illustrated on Plate 1, *Exploration Location Plan.* Soil test pit locations were pre-staked by SPF, or established in the field, and located using GPS.

A geotechnical engineer visually evaluated the soil encountered in each test pit and logged the soil profile referencing the Unified Soil Classification System (USCS). We provide a brief USCS explanation in Appendix A to help interpret the terms on the test pit logs. We also provide individual test pit logs in Appendix A. The test pits remained open following the completion of the excavations to make the subsurface conditions available for inspection by Malheur County Health Department inspectors.

We accomplished in-situ infiltration testing in Test Pits TP-A1, TP-A4, and TP-B2 to assist in evaluating the infiltration rates for the granular soils encountered in these test pits. The tests were accomplished by excavating a roughly 6-inch diameter hole to a depth of approximately 6 inches. The bottom of the hole was cleaned and the soil was pre-saturated prior to performing infiltration test. Water depths were recorded at 5-minute intervals for a period of one-half hour. The results of the field infiltration tests are presented in Table 1.

Table 1. Field Infiltration Test Results

Test Pit	USCS Soil Classification	Depth (feet BGS)	Field Infiltration Rate (in/hr)
TP-A1	SP-SM	3.5	9
TP-A4	SP-SM	4	9
TP-B2	SM	2.5	9

SUBSURFACE CONDITIONS

All three drain field site areas generally had a topsoil layer consisting of clay or clayey sand that varied in thickness between 3 and 9 inches. Area A soils generally exhibited near-surface clays and clayey sands overlaying an alluvial permeable granular layer, overlaying soft sedimentary claystones and sandstone. Area A soils exposed near the entry road included fill that was not exposed throughout the test pit. Area B soils exhibited occasional coarse-grained layers underlying the surficial clayey soils, with thicker granular layers present higher on the hillside, in Test Pits TP-B2 and TP-B5. The rock layer underlaying the Area B soils consisted of claystone and sandstone, and were encountered closer to the ground surface,

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in general, than Area A. Area C soils were more clayey, with clayey soils extending from the ground surface down to basalt and claystone. It should be noted that the depths and thicknesses of the various soils encountered on the logs usually vary within the test pits, due to sloping ground surfaces and uneven deposition. We provide more specific discussion of each soil unit encountered below:

Area A Soils

Generally, thin layers of native granular soil above relatively shallow sedimentary rock were encountered in the Area A test pits located southwest of the road. These granular soils appear to be suitable for infiltration.

- **Uncontrolled Fill and Possible Fill – Silty Sand (SM), Poorly-graded Sand with Silt and Gravel (SP-SM), and Poorly-graded Gravel with Sand and Silt (GP-GM)** – Test Pits TP-A1 and TP-A3 were located adjacent to the entry road. We observed poorly-graded sand with silt and gravel (SP-SM) in Test Pit TP-A1 between depths of 2 and 5 feet BGS. The sand observed in Test Pit TP-A1 was not easily identifiable as fill, but we did not observe it in any other test pit. This possible fill was light brown, brown, white and rust, dense, and moist. We encountered sub-rounded and rounded, poorly-graded gravel with sand and silt (GP-GM) soils in TP-A3 that appeared to be imported fill, used to construct the entry road. The gravel encountered in TP-A3 was obviously placed, as it was an approximately 8-inch-thick layer exposed in the north end of the test pit, adjacent to the road at a depth of approximately 3 feet BGS. The gravel fill was medium dense to dense, light brown, and moist. Silty sand (SM) was observed above the layer of gravel in TP-A3. This soil was likely placed during road grading. The silty sand was brown, loose, and moist.
- **Native – Lean/Fat Clay (CL/CH) and Clayey Sand (SC) –** Native lean and fat clay (CL/CH, respectively) and clayey sand (SC) was encountered at the ground surface to depths of between 1 and 4 feet BGS in all but TP-A3. The surficial layers include 3 to 9 inches of topsoil with roots. The clay and sandy clay were brown, dark brown, and reddish-brown, soft to medium stiff near the surface to very stiff with depth, and slightly moist to moist. Clayey Sand (SC) was encountered in Test Pit TP-A4 between depths of approximately 2.5 to 3.5 feet BGS. The clayey sand was light brown, medium dense, and slightly moist.
- **Native – Silty Sand with Gravel (SM), Poorly-graded Gravel with Silt and Sand (GP-GM), Poorly-graded Sand with Silt and Gravel (SP-SM), and Well-Graded Sand with Silt, Gravel and Cobbles (SW-SM) –** We observed poorly-graded gravel with silt and sand (GP-GM) in Test Pit TP-A3 away from the road between depths of approximately 1 to 3.5 feet BGS. This soil was brown, medium dense to dense and moist. We encountered poorly-graded sand with gravel and silt (SP-SM) in Test Pit TP-A4 below the clay and clayey sand from 4 feet BGS to the depth excavated of 5 feet BGS. The depth to this soil varied across the test pit. We encountered silty sand (SM) in Test Pit TP-A5 below the surficial clay layer between depths of 1 and 4 feet BGS and between 1.5 and 3.5 feet in TP-A6. This soil was tan and brown to dark brown, medium dense, and slightly moist to moist. Well-graded sand with silt, gravel, and cobbles (SW-SM) was encountered in Test Pit TP-A6 from 3.5 to 5 feet BGS. The sand was brown, medium dense to dense, and slightly moist.

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- **Sedimentary Claystone and Sandstone –** Weathered sedimentary rock in the form of claystone and sandstone was encountered in every test pit except TP-A4 in the Area A test pits. This sedimentary rock was encountered between 3 feet and 5 feet BGS to the termination depths excavated in these test pits, which ranged from 5 to 9 feet BGS. The weathered sedimentary rock was very stiff to hard, dark brown, white, olive, rust, green and red and slightly moist to moist.
- **Groundwater –** We did not encounter groundwater at the time of exploration. According to Oregon Water Resources Department on-line well log data, groundwater is greater than 200 feet below the ground surface in this area. Groundwater is not expected to influence the proposed drain field in this area.

Area B Soils

Generally, soils encountered in the lower Area B test pits (Test Pits TP-B1, TP-B4A, and TP-B6) were generally not suitable for infiltration. These test pits were in areas where the ground surface contained rock outcroppings or surficial boulders, and suitable infiltration layers were thin or not present. The remaining Area B test pits (TP-B2, TP-B3 and TP-B5) exhibited surficial silty sand and poorly-graded sand with silt soil layers that may be suitable for infiltration.

- **Native – Lean/Fat Clay (CL/CH) and Clayey Sand (SC) –** Native lean and fat clay (CL/CH, respectively) and clayey sand (SC) was encountered at the ground surface to depths of between 2 and 2.5 feet BGS in Test Pits TP-B1, TP-B4A, and TP-B6. The surficial layers include 3 to 12 inches of topsoil with roots. The clay was brown, dark brown, and orangish-brown, medium stiff to very stiff, and moist. Clayey Sand (SC) was encountered in Test Pit TP-B4A from the ground surface to a depth of approximately 1-foot BGS. The clayey sand was dark brown, loose to medium dense, and very moist.
- **Native – Silty Sand with Gravel (SM), Poorly-graded Gravel with Clay and Sand (GP-GC), and Poorly-graded Sand with Silt and Gravel (SP-SM) –** We encountered silty sand (SM) in Test Pits TP-B2, TP-B3, and TP-B5 from the ground surface to depths of between 1.5 and 4 feet BGS. This soil was tan to brown, loose to medium dense, and moist. We observed poorly-graded gravel with clay and sand (GP-GC) in Test Pit TP-B4A between depths of approximately 2.5 to 3 feet BGS underlaying the surficial clayey sand and lean clay. This soil was orangish-brown, medium dense, and moist. Poorly-graded sand with silt (SP-SM) was encountered in Test Pit TP-B5 between 1.5 to 3.5 feet BGS. The sand was olive, medium dense to dense, and moist.
- **Sedimentary Claystone and Sandstone –** Weathered sedimentary rock in the form of claystone and sandstone was encountered in every test pit in the Area B test pits. Claystone and weathered claystone were encountered at 2 feet and 2.5 feet BGS to the depths excavated in Test Pits TP-B1 and TP-B6, respectively. Weathered sandstone and sandstone were observed below the surficial soils in the remaining Area B test pits from depths of 1.5 to 4 feet BGS to the depths to test pit termination depths of 3 to 9.5 feet BGS. The weathered sedimentary rock was very stiff to hard, tan, brown, white, olive, rust, pink and red and slightly moist to moist.
- **Groundwater –** We did not encounter groundwater at the time of exploration. According to Oregon Water Resources Department on-line well log data, groundwater is greater than 200 feet below the ground surface in this area. Groundwater is not expected to influence the proposed drain field in this area.

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Area C Soils

The subsurface conditions observed in Area C were generally not suitable for infiltration. We observed clayey soils overlying basalt and siltstone/claystone in this area. The depth that basalt and siltstone/claystone was encountered was generally between 1 foot and 6 feet BGS. Cobbles and boulders were observed in the near-surface clays is several test pits.

- **Native – Lean/Fat Clay (CL/CH) and Clayey Sand (SC) –** Native lean and fat clay (CL/CH, respectively) was encountered at the ground surface to depths of between 9 inches and 5 feet BGS in every Area C test pit. The surficial layers include 6 to 9 inches of topsoil with roots. The clay was brown, dark brown, and white, medium stiff to very stiff, and slightly moist to very moist. Clayey Sand (SC) was encountered in Test Pit TP-C2 through TP-C4 below the surficial clay layers. The clayey sand was encountered between 2 and 4.5 feet BGS in Test Pit TP-C2, between 2.5 and 4.5 feet in TP-C3, and between 4 and 6 feet BGS in TP-C4. An Atterberg limits test performed on the clayey sand indicated the clay portion consisted of fat clay. The clayey sand was tan, medium dense, and slightly moist to moist.

- **Sedimentary Siltstone/Claystone and Weathered Basalt –** Weathered sedimentary rock in the form of siltstone and claystone was encountered in the higher elevation test pits (Test Pits TP-C1 through TP-C4). Siltstone or claystone was encountered between 3 feet and 6 feet BGS in TP-C1; between 4.5 feet and 10 feet BGS in TP-C2; between 4.5 feet and 6 feet BGS in TP-C3; and between 6 and 10 feet BGS. The weathered sedimentary rock was very stiff, tan, brown, white, and olive, and slightly moist to moist. Weathered basalt was encountered below the surficial clay and clayey sand in Test Pits TP-C5 through TP-C8. The basalt was encountered between depths of 9 inches and 5 feet BGS to the total depths excavated. In Test Pit TP-C7, the basalt was in a soil matrix, meaning it could be weathered in place or indicative of colluvial soils.

- **Groundwater –** We did not encounter groundwater at the time of exploration According to Oregon Water Resources Department on-line well log data, groundwater is greater than 75 feet below the ground surface in this area. Groundwater is not expected to influence the proposed drain field in this area.

We provide a USCS classification summary and specific soil contacts and descriptions on individual test pit logs provided as Appendix A to this report. Subsurface variations may exist between exploration locations and may not be apparent until construction. Test pits only allow us to observe a portion of the site subsurface conditions. Where such variations exist, they may impact our opinions and recommendations presented, as well as construction timing and costs.

LABORATORY TESTING

We returned soil samples collected in the field to our laboratory for further classification and testing. Laboratory testing was accomplished referencing *ASTM* International (ASTM) procedures. We developed our laboratory testing program for this project primarily to evaluate subsurface characteristics and engineering properties. Specifically, we accomplished moisture content, Atterberg Limits, and gradation testing. We present laboratory test results on individual test pit logs located in Appendix A and individual laboratory test results in Appendix B. We will retain soil samples for 90 days and discard after this time period unless we are notified to store the samples for an extended period.

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GEOTECHNICAL OPINIONS AND RECOMMENDATIONS

We present the following geotechnical recommendations to assist infrastructure planning, design, and construction for the proposed septic drain fields at the Grassy Mountain Mine site located south approximately 20 miles south of Vale, Oregon in Malheur County, Oregon, as illustrated on Plate 1. This report provides a summary of our observations and recommendations for design criteria for the septic drain field, which the civil design and construction teams must review to verify the applicability for the planned construction. We base our recommendations on the results of our recent field evaluation, laboratory testing, our experience with similar soil conditions, and our understanding of the proposed construction. Once the location of the drain fields are finalized and a site grading and drainage plan is developed, STRATA must be notified to review these plans to verify our report recommendations have been incorporated into these plans.

Excavation Characteristics

Based on exploration results, it appears the near surface soil and soft sedimentary rock encountered in excavated test pits may be excavated with conventional equipment. Excavations can cave and slough and must be sloped back in accordance with *Occupational Health and Safety Act* (OSHA) guidelines. Fine to coarse-grained soil is expected to be exposed in excavations throughout the development area and should be temporarily sloped at 1.5H:1V (horizontal to vertical) for excavations deeper than 4 feet. Due to the potential for varying soil conditions at the time of construction, we recommend earthwork contractors evaluate each excavation configuration specific to OSHA guidelines and to seek appropriate professional guidance to ensure excavation safety and stability.

Septic Drain Field Sites

We explored three primary areas under consideration for septic drain field design. These areas and the locations of the test pits were identified and located by SPF Water Engineers as shown on Plate 1. Most of test pits in each area had surficial clayey soils that are not suitable for septic system design. Additionally, relatively impermeable sedimentary rock and weathered igneous rock was encountered at relatively shallow depths of 3 to 5 feet BGS within the majority of our test pits. The presence of shallow rock may create design challenges to maintain minimum separation depths from the base of the drain field to relatively impermeable rock below.

In Area A thin layers of potentially suitable infiltration soil were encountered in test pits TP-A1, TP-A3, TP-A4, TP-A5 and TP-A6. Soils considered suitable for infiltration include silty sand (SM), silty gravel, (GM), poorly-graded and well-graded sand and sand with silt (SP, SW, SP-SM, and SW-SM), and poorly-graded and well-graded gravel and gravel with silt (GP, GW, GP-GM, and GW-GM).

In Area B, we observed thin layers of granular soil that are potentially suitable for infiltration in the test pits located along the east side, or upslope (Test Pits TP-B2, TP-B3, and TP- B5). The remaining Area B test pits, and Test Pit TP-A2, were deemed not suitable for infiltration.

In Area C, test pits we did not observe any soil layers suitable for drain field design.

We performed three field infiltration tests—two tests in Area A soils, and one in Area B soils, as shown in Table 1, in the *Subsurface Evaluation Procedure* section of this report. The field infiltration rate for all three soils was approximately 9 inches per hour. We recommend using a maximum design infiltration rate of 4 inches per hour for the suitable infiltration soils identified in Areas A and B as described above.

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STRATA's scope of services does not include detailed design of septic drain fields. The presence of shallow bedrock throughout the study may require importing permeable filter sand above the acceptable native infiltration soils (identified above) to maintain minimum separation depths from the base of the infiltration field to the bedrock below.

Groundwater

Groundwater was not encountered within test pits excavated on site and is anticipated to be at depths greater than 75 feet BGS. Groundwater is not expected to influence the proposed drain field design based on the locations identified in this study.

GEOTECHNICAL DESIGN CONTINUITY

Geotechnical design continuity will be an important aspect of this project's successful completion. In our opinion, geotechnical continuity can occur in the planning, design and construction project aspects. Specifically, we recommend STRATA should be retained to provide geotechnical engineering oversight during excavation to identify suitable soil layers in the area of the drain field.

EVALUATION LIMITATIONS

This report has been prepared to assist project planning, design and construction of the proposed septic drain fields to be located at the Grassy Mountain Mine in Malheur County, Oregon. Our geotechnical findings and opinions have been developed based on the authorized subsurface exploration and laboratory testing, as well as our understanding of the project at this time. Our report findings and recommendations should not be extrapolated to other future site developments without allowing adequate geotechnical consultation by STRATA.

Subsurface variations may exist between exploration locations and may not be apparent until construction. Test pits only allow us to observe a portion of the site subsurface conditions. Where such variations exist, they may impact opinions and recommendations presented in this report, as well as construction timing and costs. Our services consist of professional opinions and findings made in accordance with generally accepted geotechnical engineering principles and practices in southeast Oregon at the time of this report. The geotechnical recommendations provided herein are based on the premise that appropriate geotechnical consultation during subsequent design phases is implemented and an adequate program of tests and observations will be conducted by STRATA during construction to verify compliance with our recommendations and to confirm conditions between exploration locations. This acknowledgment is in lieu of all warranties either express or implied.

The following plates and appendices accompany and complete this report:

Plate 1: Exploration Location Plan
Appendix A: Exploratory Test Pit Logs
Unified Soil Classification System (USCS)
Appendix B: Summary of Laboratory Test Results

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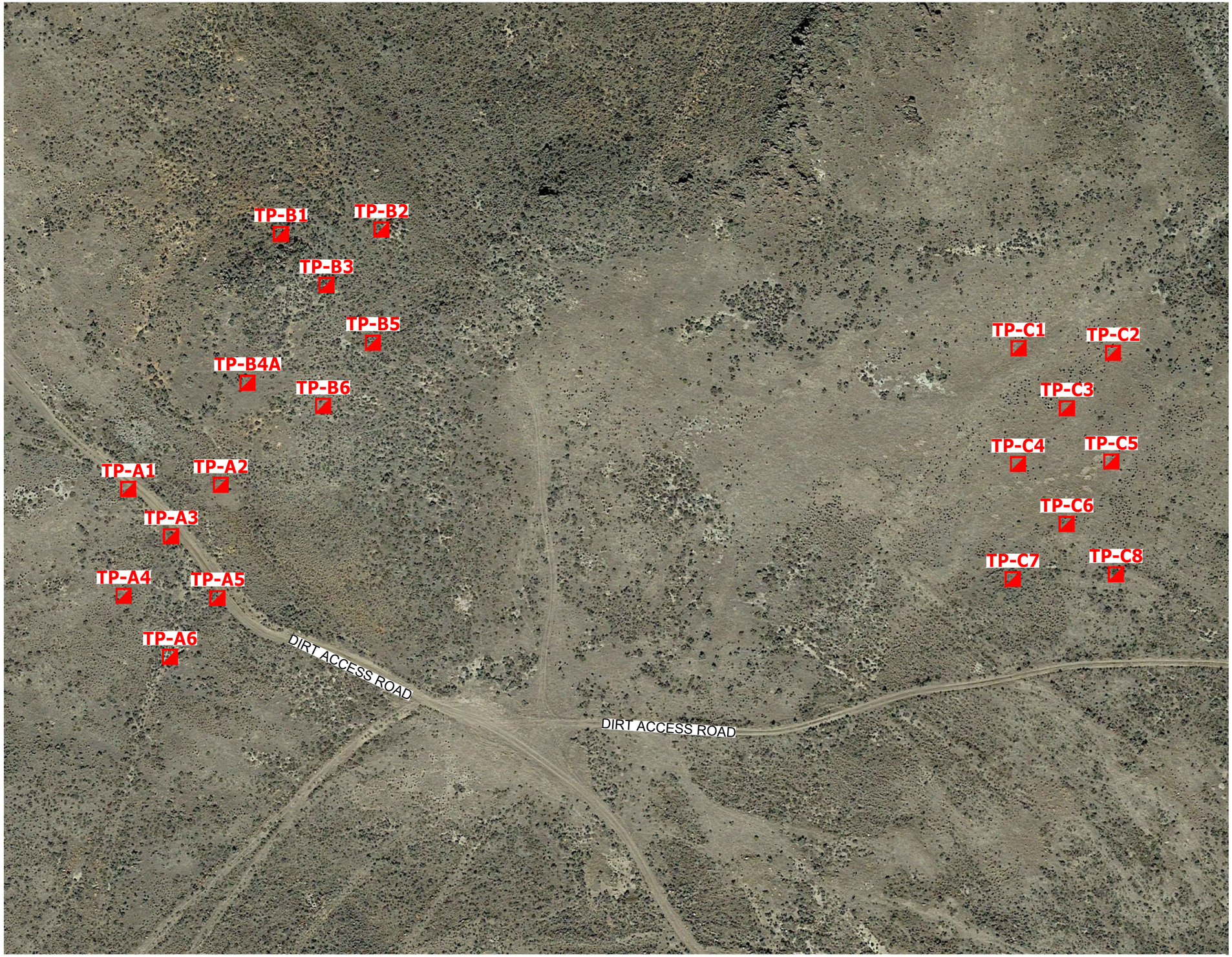
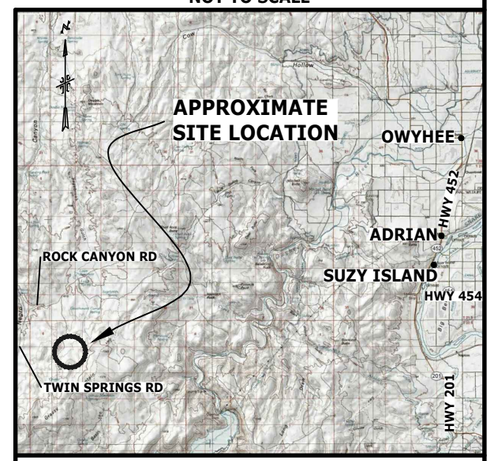


LEGEND

TP-1A — Approximate test pit location observed by STRATA on April 22 and 23, 2019

VICINITY MAP

NOT TO SCALE



EXPLORATION LOCATION PLAN

Wastewater Drain Field Characterization
Grassy Mountain Mine
Mahleur County, Idaho

0 60 120 240

SCALE: 1 inch = 120 ft

STRATA

DRAWING DATE: May 8, 2019

DRAWING BY: M. Taylor | CHECKED BY: D. Zimmerman

Client SPF Water Engineering | Project No. BO19059A | PLATE: 1

THIS PLAN COMPRISES A PORTION OF STRATA'S REPORT AND THE TEXT OF THE REPORT CONTAINS ESSENTIAL INFORMATION: BEFORE UTILIZING THIS PLAN FOR ANY PURPOSE WHATSOEVER, THE REPORT SHOULD BE READ COMPLETELY. THIS PLAN IS INTENDED TO HELP VISUALIZE THE INFORMATION PROVIDED IN THE REPORT. THESE LOCATIONS AND INFORMATION WERE ADDED TO EXISTING PLANS OF THE SITE PREVIOUSLY PREPARED BY OTHERS AND NO CHECK OF ACCURACY, CURRENCY, APPROPRIATENESS, ETC., OF INFORMATION PROVIDED BY OTHERS WAS PERFORMED, SINCE SUCH CHECKS WERE NOT PART OF STRATA'S SCOPE OF SERVICES.

REFERENCE: Image created from Google Earth Pro & Earth Point Topo Map, USGS Quadrangles, Dated 9-28-2015.

5/8/2019 3:35:55 PM - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\DRAFTING\BO19059A PLATE 1.DWG - MARIE TAYLOR

APPENDIX A

Exploratory Test Pit Log and Unified Soil Classification System (USCS)

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, FAT CLAY, (CH) dark brown, stiff, moist	0.0	CH						2.5		43.673480° N -117.361543° W
FAT CLAY, (CH) dark brown, stiff, moist		CH								
(POSSIBLE FILL) POORLY-GRADED SAND WITH SILT AND GRAVEL, (SP-SM) light brown, rust, white, rounded to subrounded, dense, moist	2.5	SP-SM		BG	7.7		6.3			Infiltration test performed at a depth of 3.5 feet BGS Field Infiltration Rate=9 in/hr
CLAYSTONE, dark brown, very stiff, moist, weathered, slickenside	5.0			BG						

Test Pit Terminated at 6.5 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-A1	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, FAT CLAY, (CH) dark reddish-brown, stiff, moist	0.0	CH								43.673465° N -117.361112° W
FAT CLAY, (CH) reddish-brown, stiff, moist		CH								
SILTY LEAN CLAY, (CL) reddish-brown, stiff to very stiff, moist	2.5	CL		BG						
CLAYSTONE, dark brown, rust, olive, white, hard, moist, weathered	5.0									
	7.5									

Test Pit Terminated at 9.0 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-A2
Project: BO19059A	**Date Excavated:** 04-22-2019
Backhoe: TB500RB	**Bucket Width:** 36
Depth to Groundwater: N.E.	**Logged By:** DPZ

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EXPLORATORY TEST PIT LOG

Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, SILTY SAND, (SM) brown, loose, moist	0.0	SM								43.673305° N -117.361362° W Fill north side to approximately 3.5 feet
(NATIVE) - POORLY-GRADED GRAVEL WITH SILT AND SAND, (GP-GM) brown, medium dense to dense, moist		GP-GM		BG	8.8		11.1			With rounded gravel and occasional angler cobbles between 2 and 3.5 feet 8 inch layer imported subbase at 3 feet on north side
CLAYSTONE, rust, dark brown, red, green, white, stiff to hard, moist	2.5									
Test Pit Terminated at 5.0 Feet.	5.0									

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-A3	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL	Atterberg Limits PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, CLAYEY SAND, (SC) dark brown, medium dense, moist	0.0	SC		BG	48.5		27.7	0.75	43	24	43.673109° N -117.361576° W Surficial cobbles and boulders
SANDY LEAN CLAY, (CL) light brown, stiff, slightly moist		CL		BG							
Contact depth varies	2.5										
CLAYEY SAND, (SC) light brown, medium dense, slightly moist		SC		BG	13.1		22.4		50	21	
POORLY-GRADED SAND WITH SILT AND GRAVEL, (SP-SM) tan, medium dense to dense, slightly moist		SP-SM		BG							
				BG	8.1		9.6				Infiltration test performed at a depth of 4 feet BGS Field Infiltration Rate=9 in/hr
Test Pit Terminated at 5.0 Feet.	5.0										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-A4
Project: BO19059A	**Date Excavated:** 04-22-2019
Backhoe: TB500RB	**Bucket Width:** 36
Depth to Groundwater: N.E.	**Logged By:** DPZ

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EXPLORATORY TEST PIT LOG

Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, SANDY LEAN CLAY, (CL) dark brown, soft to medium stiff, moist	0.0	CL								43.673107° N -117.361146° W
COLLUVIUM, SILTY SAND WITH GRAVEL, (SM) brown to dark brown, medium dense, moist	2.5	SM		BG	13.7		10.9			Clay and sandstone pockets
CLAYSTONE AND CLAYEY SANDSTONE, dark brown, hard, moist	5.0									
Test Pit Terminated at 7.5 Feet.	7.5									

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-A5	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) dark brown, soft to medium stiff, moist	0.0	CL								43.672901° N -117.361369° W
LEAN CLAY, (CL) dark brown, soft to medium stiff, moist		CL								
SILTY SAND WITH GRAVEL, (SM) tan, medium dense, slightly moist	2.5	SM								
WELL-GRADED SAND WITH SILT AND GRAVEL, (SW-SM) brown, medium dense to dense, slightly moist		SW-SM		BG	8.4		13.2			
CLAYSTONE, white, brown, very stiff, slightly moist, weathered	5.0			BG				>4.5		

Test Pit Terminated at 5.5 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-A6
Project: BO19059A	**Date Excavated:** 04-22-2019
Backhoe: TB500RB	**Bucket Width:** 36
Depth to Groundwater: N.E.	**Logged By:** DPZ

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EXPLORATORY TEST PIT LOG

Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) brown, very stiff, moist	0.0	CL								43.674312° N -117.360853° W
LEAN CLAY WITH OCCASIONAL COBBLES, (CL) brown, very stiff, moist		CL								
Contact varies										
CLAYSTONE, orange to white, hard, slightly moist, weathered	2.5									
	5.0									
Test Pit Terminated at 6.0 Feet.										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-B1	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, SILTY SAND, (SM) light brown to brown, loose to medium dense, moist	0.0	SM								43.674320° N -117.360400° W
SILTY SAND, (SM) light brown, medium dense, moist	2.5	SM		BG	28.9		28.8		NV NP	Infiltration test performed at a depth of 2.5 feet BGS Field Infiltration Rate=9 in/hr
SANDSTONE, brown and white, hard, slightly moist, weathered	5.0									
	7.5									
Test Pit Terminated at 9.5 Feet.										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-B2
Project: BO19059A	**Date Excavated:** 04-22-2019
Backhoe: TB500RB	**Bucket Width:** 36
Depth to Groundwater: N.E.	**Logged By:** DPZ

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EXPLORATORY TEST PIT LOG

Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, SILTY SAND, (SM) brown, loose, moist	0.0	SM								43.674137° N -117.360650° W
SILTY SAND, (SM) brown, loose, moist		SM								
SANDSTONE TO WEATHERED SANDSTONE, tan, white, very dense, slightly moist	2.5									
Test Pit Terminated at 3.0 Feet.										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-B3	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, CLAYEY SAND, (SC) dark brown, loose to medium dense, very moist	0.0	SC								43.67381° N -117.36101° W
LEAN CLAY, (CL) orangish brown, very stiff, moist		CL								
POORLY-GRADED GRAVEL WITH CLAY AND SAND, (GP-GC) orange-brown, medium dense, moist	2.5	GP-GC		BG						
ROCK, SANDSTONE, red, pink, hard, slightly moist										Highly fractured

Test Pit Terminated at 4.0 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-B4A	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

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USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL	Atterberg Limits PI	Remarks
TOPSOIL, SILTY SAND, (SM) brown, medium dense, moist	0.0	SM									43.673949° N -117.360438° W
SILTY SAND, (SM) brown, medium dense, moist		SM		BG	31.1		20.3		46	13	
POORLY-GRADED SAND WITH SILT AND GRAVEL, (SP-SM) olive, medium dense to dense, moist	2.5	SP-SM		BG	6.2		15.8				
SANDSTONE AND CLAYEY SANDSTONE, olive, white, very dense to hard, moist	5.0										

Test Pit Terminated at 5.5 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-B5
Project: BO19059A	**Date Excavated:** 04-22-2019
Backhoe: TB500RB	**Bucket Width:** 36
Depth to Groundwater: N.E.	**Logged By:** DPZ

STRATA

EXPLORATORY TEST PIT LOG

Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:38 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, FAT CLAY, (CH) dark brown, medium stiff, moist	0.0	CH								43.673733° N -117.360661° W
FAT CLAY, (CH) dark brown, medium stiff, moist		CH								
LEAN CLAY, (CL) tan, stiff, slightly moist		CL								Possible colluvium
CLAYSTONE, rust, brown, white, very stiff, slightly moist, weathered	2.5									
CLAYSTONE, brown, hard, slightly moist										
Test Pit Terminated at 5.0 Feet.	5.0									

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-B6	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:38 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) brown, medium stiff to very stiff	0.0	CL								43.673932° N -117.357471° W
LEAN CLAY, (CL) brown, medium stiff to very stiff		CL								Occasional basalt cobbles between 2 and 3 feet
CLAYSTONE/SILTSTONE, brown, olive, white, very stiff, moist, weathered	2.5									
	5.0									

Test Pit Terminated at 6.0 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C1	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-23-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:38 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL	Atterberg Limits PI	Remarks
TOPSOIL, LEAN CLAY, (CL) dark brown, medium stiff to stiff, moist	0.0	CL									43.673917° N -117.357036° W
LEAN CLAY, (CL) dark brown, medium stiff to stiff, moist		CL									
CLAYEY SAND, (SC) tan, medium dense, slightly moist	2.5	SC		BG	21.6		30.6	2.25	58	29	
SILTSTONE/CLAYSTONE, brown, white, very stiff, moist, weathered	5.0										
	7.5										
Test Pit Terminated at 10.0 Feet.	10.0										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C2
Project: BO19059A	**Date Excavated:** 04-23-2019
Backhoe: TB500RB	**Bucket Width:** 36
Depth to Groundwater: N.E.	**Logged By:** DPZ

STRATA

EXPLORATORY TEST PIT LOG

Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:38 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) dark brown to brown, medium stiff to stiff, moist to very moist	0.0	CL								43.673728° N -117.357246° W
LEAN CLAY, (CL) dark brown to brown, medium stiff to stiff, moist to very moist		CL								
CLAYEY SAND, (SC) tan, medium dense, moist	2.5	SC								
SILTSTONE/CLAYSTONE, brown, tan, very stiff, moist, weathered	5.0									

Test Pit Terminated at 6.0 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C3	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-23-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:38 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) dark brown, medium stiff, moist	0.0	CL								43.673545° N -117.357473° W
LEAN CLAY WITH OCCASIONAL SAND, (CL) dark brown, medium stiff to very stiff, moist	2.5	CL						3.25		
CLAYEY SAND, (SC) tan, medium dense, slightly moist	5.0	SC								
SILTSTONE, tan, white, very stiff, slightly moist, weathered	7.5									
Test Pit Terminated at 10.0 Feet.	10.0									

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C4
Project: BO19059A	**Date Excavated:** 04-23-2019
Backhoe: TB500RB	**Bucket Width:** 36
Depth to Groundwater: N.E.	**Logged By:** DPZ

STRATA

EXPLORATORY TEST PIT LOG

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:38 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) dark brown, medium stiff to very stiff, moist	0.0	CL								43.673549° N -117.357043° W
LEAN CLAY, (CL) dark brown, medium stiff to very stiff, moist	2.5	CL								
BASALT, weathered	5.0									
Test Pit Terminated at 6.5 Feet.										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C5	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-23-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:38 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) brown, stiff, moist	0.0	CL								43.673344° N -117.357248° W
LEAN CLAY WITH SILT, SAND AND COBBLES, (CL) brown, stiff, moist		CL						2.5		
FAT CLAY WITH GRAVEL, (CH) dark brown with white, stiff to very stiff, moist	2.5	CH						2.0		Possible colluvium
Contact varies										
BASALT, weathered	5.0									

Test Pit Terminated at 6.0 Feet.

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C6	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:39 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) dark brown, medium stiff, moist	0.0	CL								43.673164° N -117.357498° W
COLLUVIUM, BASALT, IN A SILT, SAND, AND CLAY MATRIX, cobbles and boulders > 18 inch, or possible weathered in place	2.5									
Test Pit Terminated at 4.5 Feet.										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C7	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

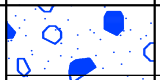
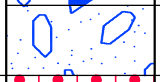
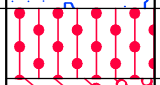
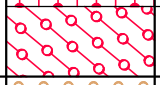
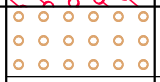
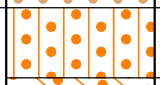
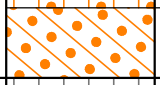
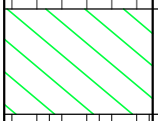
STRATA TEST PIT - STRATA.GDT - 5/21/19 14:39 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

USCS Description	Depth (ft)	U.S.C.S. Class	Symbol	Sample Type	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	Atterberg Limits LL PI	Remarks Note: BGS = Below Ground Surface
TOPSOIL, LEAN CLAY, (CL) dark brown, stiff, very moist	0.0	CL								43.673178° N -117.357023° W
LEAN CLAY WITH SURFICIAL COBBLES, (CL) dark brown, stiff, very moist at surface to slightly moist below 2 feet	2.5	CL								
BASALT, weathered	5.0									
	7.5									
Test Pit Terminated at 8.0 Feet.										

Client: Calico Resources USA Corp.	**Test Pit Number:** TP-C8	STRATA	**EXPLORATORY TEST PIT LOG**
Project: BO19059A	**Date Excavated:** 04-22-2019		
Backhoe: TB500RB	**Bucket Width:** 36		
Depth to Groundwater: N.E.	**Logged By:** DPZ		Sheet 1 of 1

STRATA TEST PIT - STRATA.GDT - 5/21/19 14:39 - V:\STRATA - IDAHO PROJECTS\STRATA - BOISE PROJECTS\2019 PROJECTS\BO19059A - GRASSY MT MINE-CALICO RESOURCES USA\ELECTRONIC LOGS\BO19059A TP LOGS.GPJ

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL NAMES
COARSE GRAINED SOIL	GRAVEL	CLEAN GRAVEL		GW	Well–Graded Gravel, Gravel–Sand Mixtures.
				GP	Poorly–Graded Gravel, Gravel–Sand Mixtures.
		GRAVEL WITH FINES		GM	Silty Gravel, Gravel–Sand–Silt Mixtures.
				GC	Clayey Gravel, Gravel–Sand–Clay Mixtures.
	SAND	CLEAN SAND		SW	Well–Graded Sand, Gravelly Sand.
				SP	Poorly–Graded Sand, Gravelly Sand.
		SAND WITH FINES		SM	Silty Sand, Sand–Silt Mixtures.
				SC	Clayey Sand, Sand–Clay Mixtures.
FINE GRAINED SOIL	SILT AND CLAY LIQUID LIMIT LESS THAN 50%			ML	Inorganic Silt, Sandy or Clayey Silt.
				CL	Inorganic Clay of Low to Medium Plasticity, Sandy or Silty Clay.
				OL	Organic Silt and Clay of Low Plasticity.
	SILT AND CLAY LIQUID LIMIT GREATER THAN 50%			MH	Inorganic Silt, Micaceous Silt, Plastic Silt.
				CH	Inorganic Clay of High Plasticity, Fat Clay.
				OH	Organic Clay of Medium to High Plasticity.
				PT	Peat, Muck and Other Highly Organic Soil.

BORING LOG SYMBOLS

- Standard 2–Inch OD Split–Spoon Sample
- California Modified 3–Inch OD Split–Spoon Sample
- Rock Core
- Shelby Tube 3–Inch OD Undisturbed Sample

GROUNDWATER SYMBOLS

- Groundwater After 24 Hours
- (7–3–07) Indicates Date of Reading
- Groundwater at Time of Drilling

TEST PIT LOG SYMBOLS

- BG — Baggie Sample
- BK — Bulk Sample
- RG — Ring Sample

Shorthand Notation:
BGS = Below Existing Ground Surface
N.E. = None Encountered

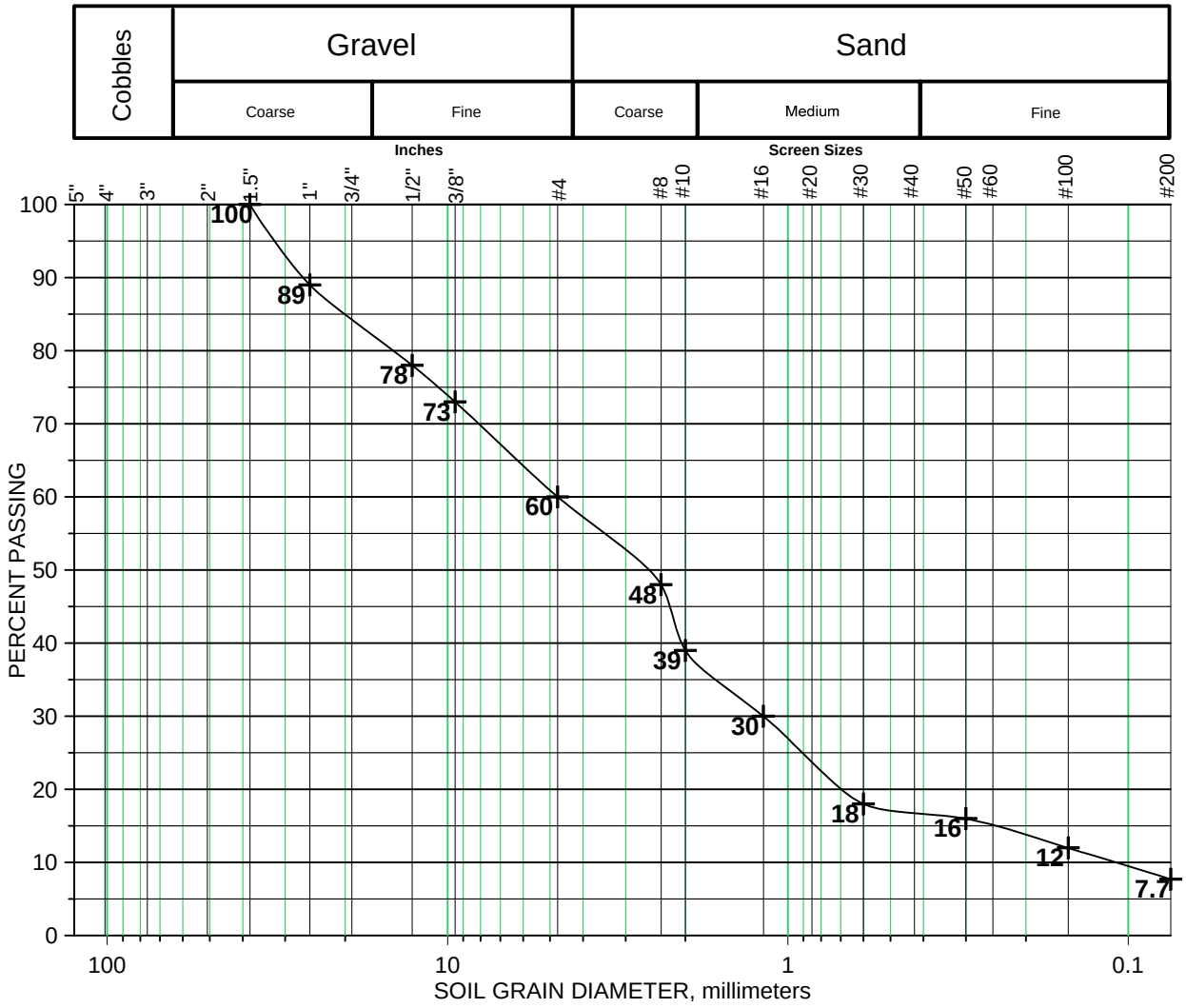
STRATA

APPENDIX B

Summary of Laboratory Test Results

GRADATION ANALYSIS
ASTM D 6913

Project: Grassy Mountain Mine
Client: Calico Resources USA Corp
Project Number: BO19059A
Sample Number: BL190304
Sample Location: TP-A1 @ 2'-3'
Sample Classification: Poorly-graded Sand with Silt and Gravel (SP-SM)
Moisture Content: 6.3%
Date tested: 4/25/19 By: K. Irwin

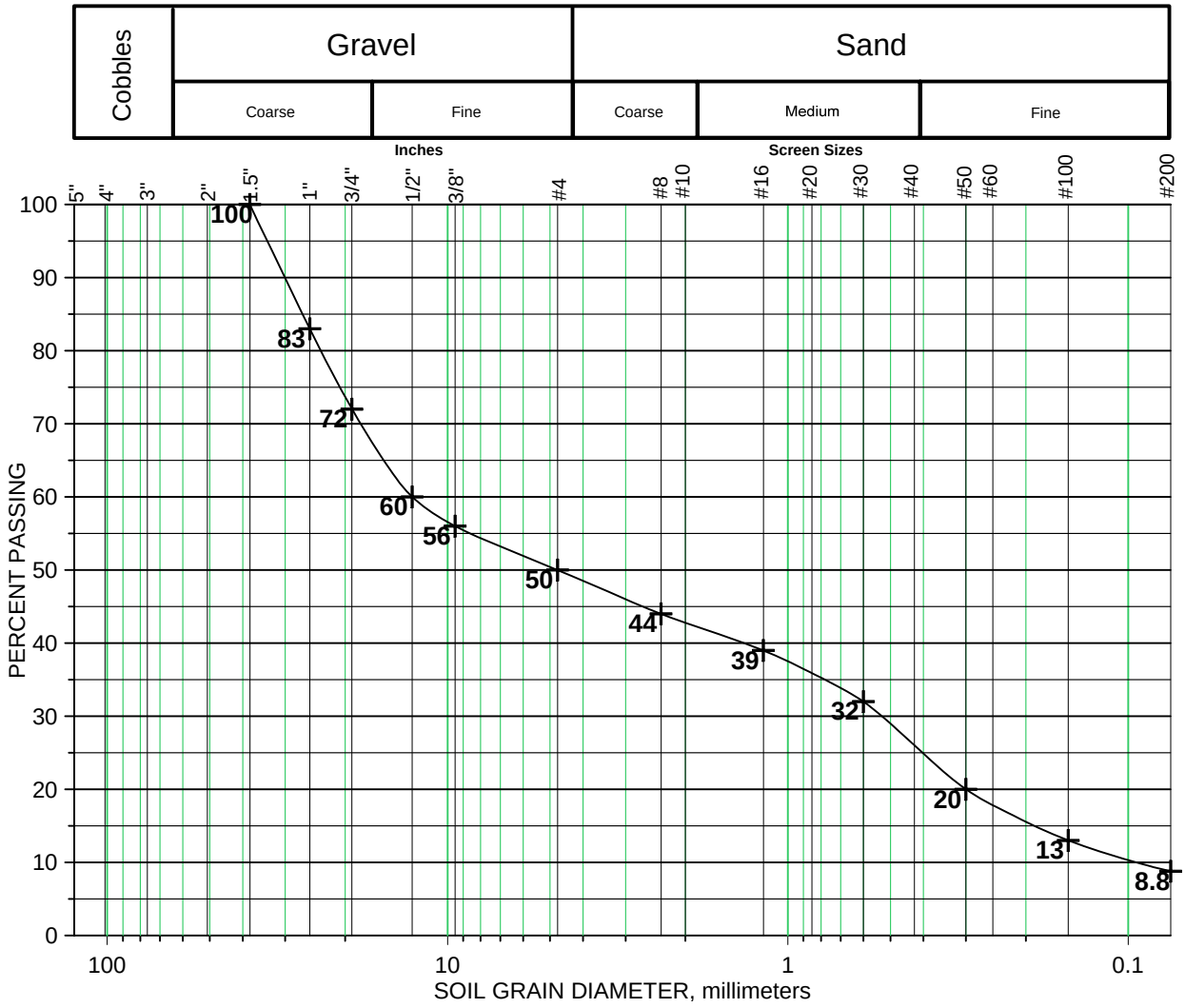


Reviewed by:_____

STRATA

GRADATION ANALYSIS
ASTM D 6913

Project: Grassy Mountain Mine
Client: Calico Resources USA Corp
Project Number: BO19059A
Sample Number: BL190305
Sample Location: TP-A3 @ 1.5'-2.5'
Sample Classification: Poorly-graded Gravel with Silt and Sand (GP-GM)
Moisture Content: 11.1%
Date tested: 4/25/19 By: K. Irwin

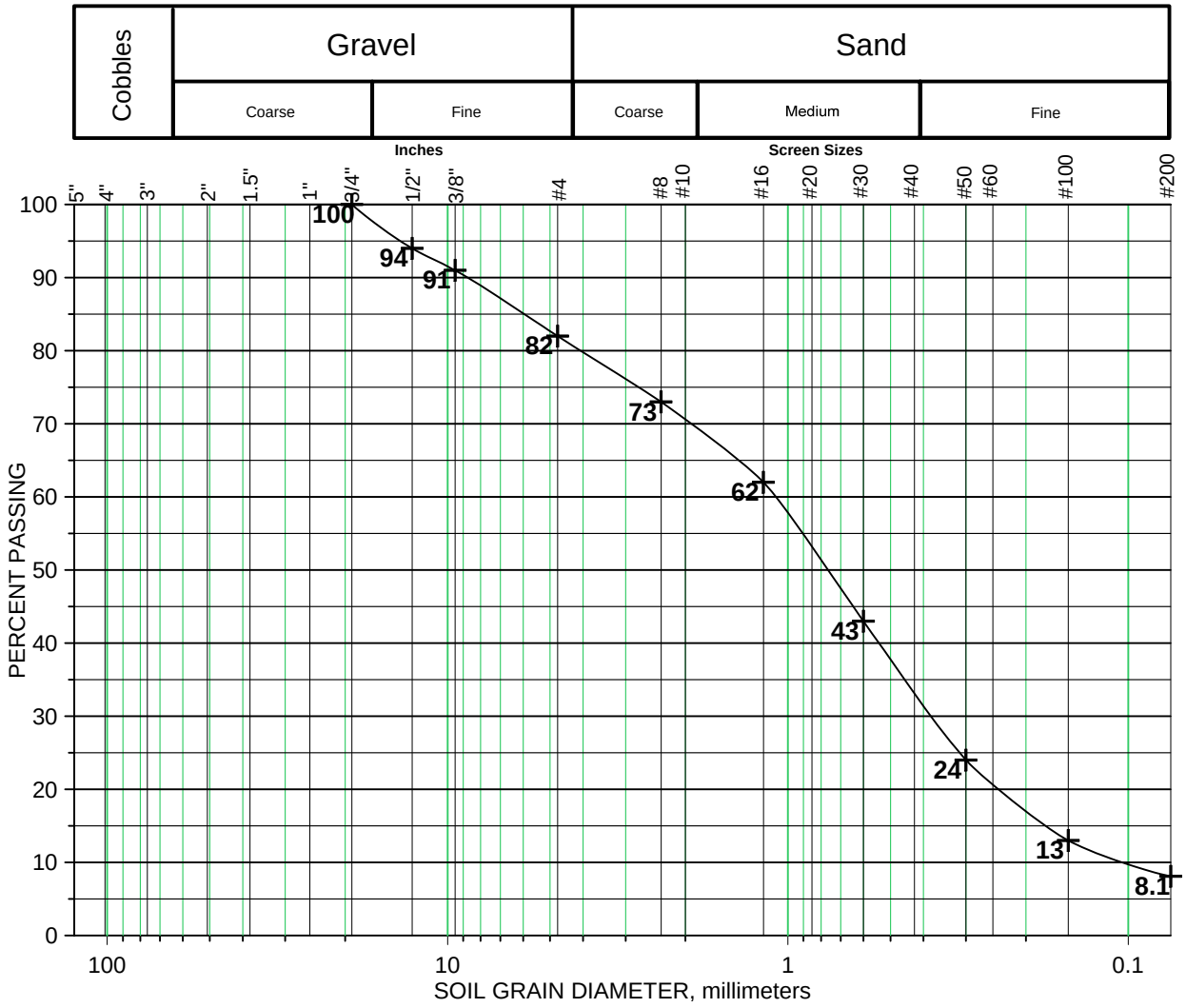


Reviewed by:_____

STRATA

GRADATION ANALYSIS
ASTM D 6913

Project: Grassy Mountain Mine
Client: Calico Resources USA Corp
Project Number: BO19059A
Sample Number: BL190309
Sample Location: TP-A4 @ 4'-5'
Sample Classification: Poorly-graded Sand with Silt and Gravel (SP-SM)
Moisture Content: 9.6%
Date tested: 4/25/19 By: K. Irwin

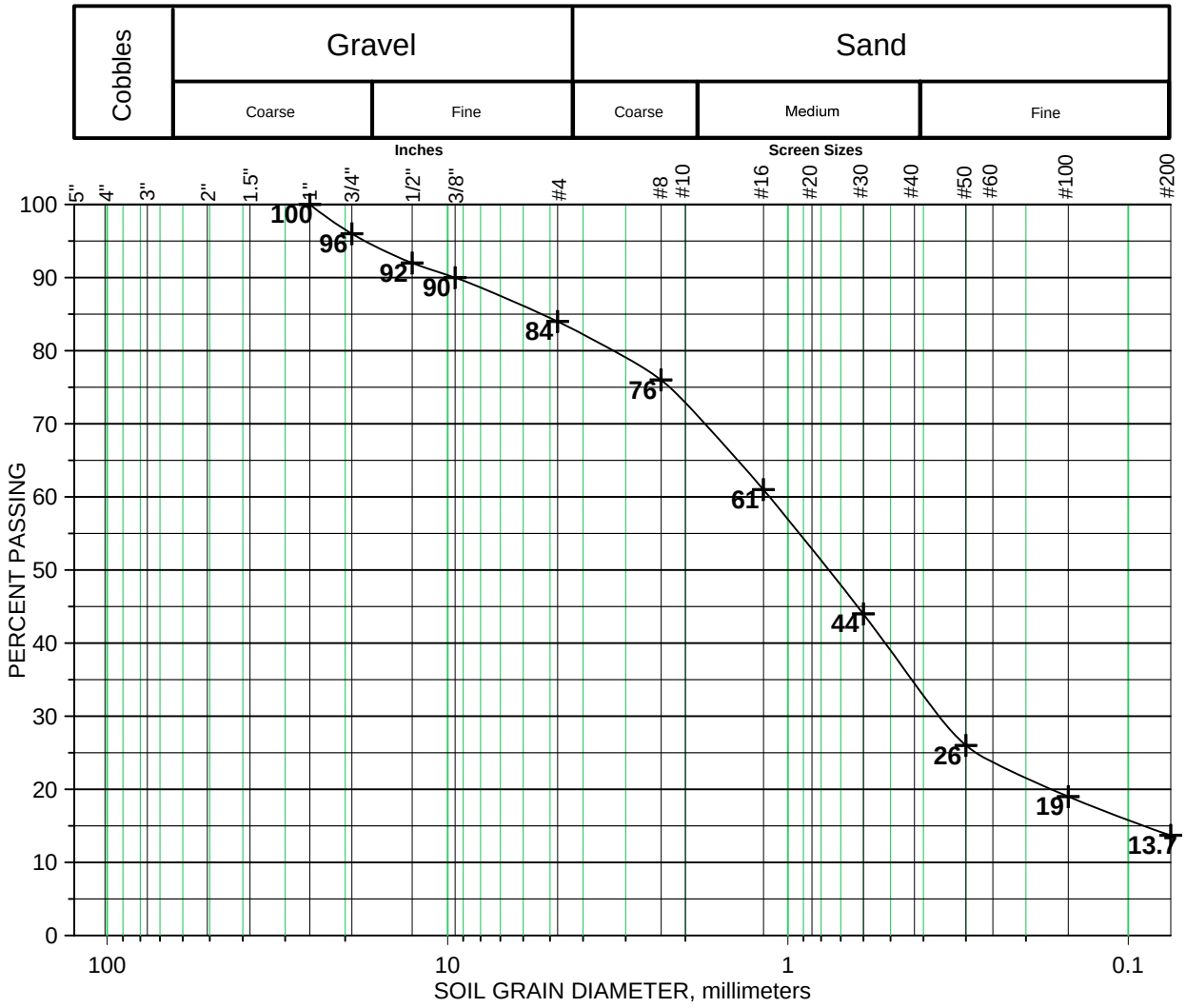


Reviewed by: _____

STRATA

GRADATION ANALYSIS
ASTM D 6913

Project: Grassy Mountain Mine
Client: Calico Resources USA Corp
Project Number: BO19059A
Sample Number: BL190310
Sample Location: TP-A5 @ 3'-4'
Sample Classification: Silty Sand with Gravel (SM)
Moisture Content: 10.9%
Date tested: 4/25/19 By: K. Irwin

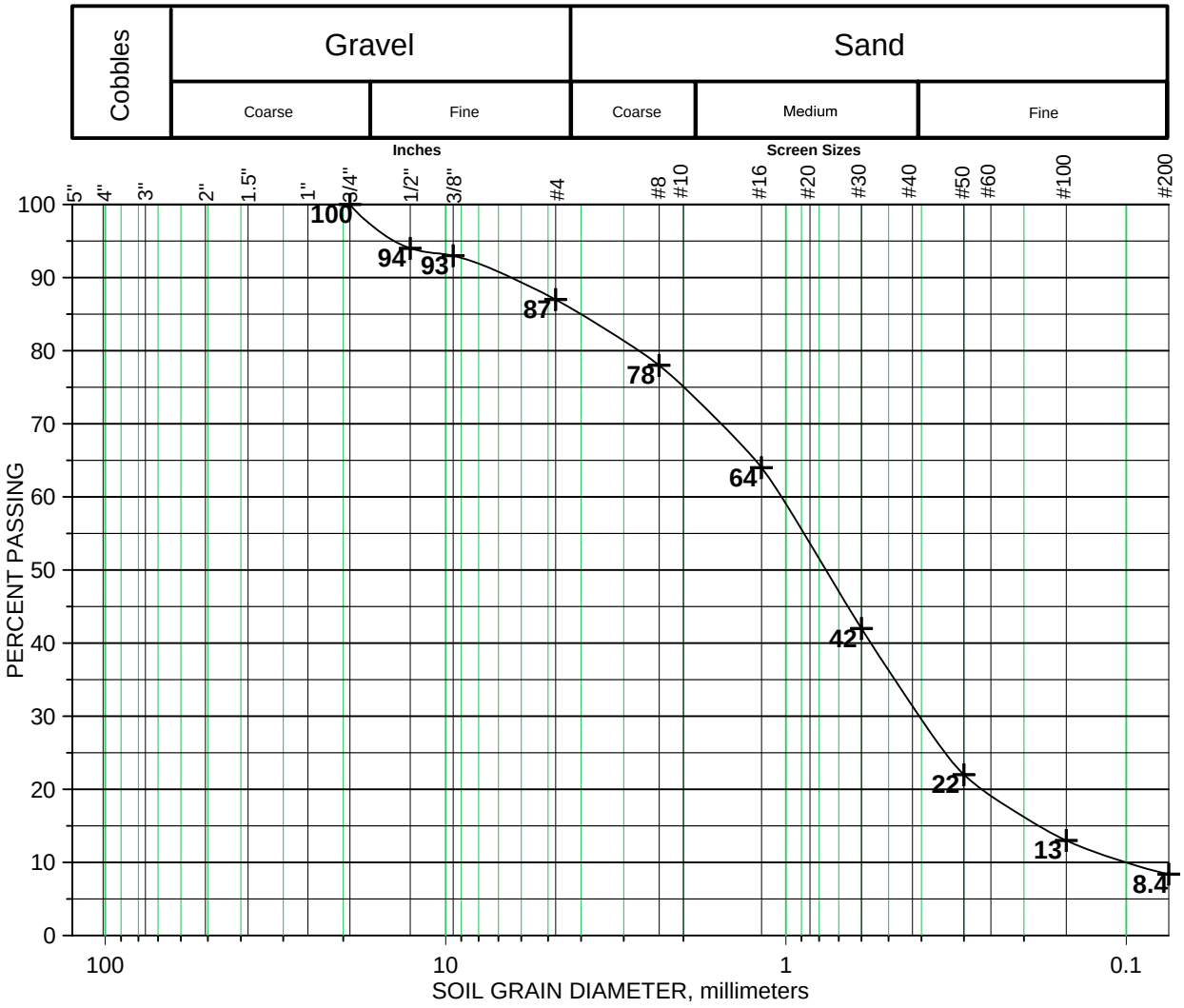


Reviewed by:_____

STRATA

GRADATION ANALYSIS
ASTM D 6913

Project: Grassy Mountain Mine
Client: Calico Resources USA Corp
Project Number: BO19059A
Sample Number: BL190311
Sample Location: TP-A6 @ 4'-5'
Sample Classification: Well-graded Sand with Silt and Gravel (SW-SM)
Moisture Content: 13.2%
Date tested: 4/25/19 By: K. Irwin

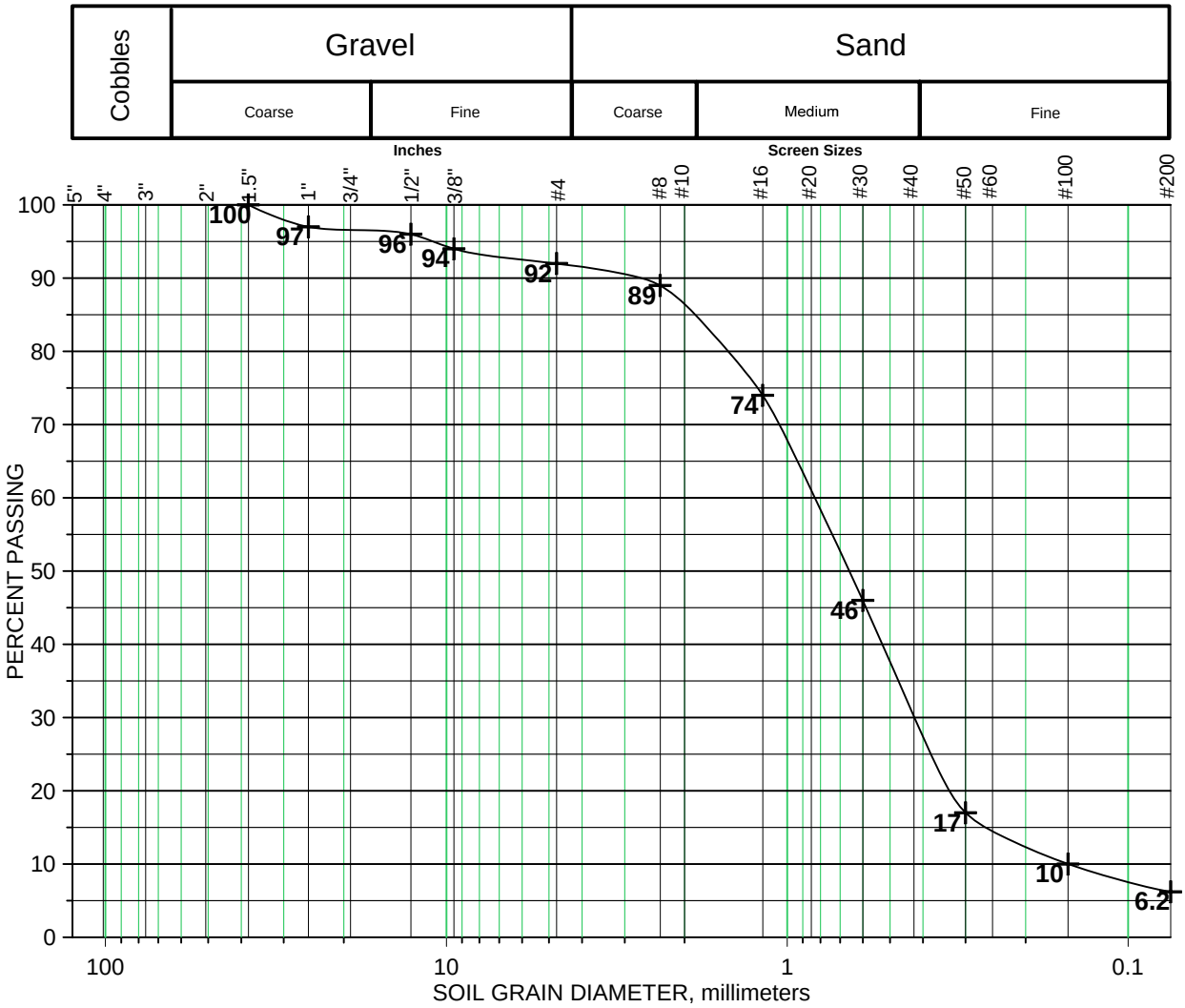


Reviewed by: _____

STRATA

GRADATION ANALYSIS
ASTM D 6913

Project: Grassy Mountain Mine
Client: Calico Resources USA Corp
Project Number: BO19059A
Sample Number: BL190316
Sample Location: TP-B5 @ 3'-3.5'
Sample Classification: Poorly-graded Sand with Silt and Gravel (SP-SM)
Moisture Content: 15.8%
Date tested: 4/25/19 By: K. Irwin



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STRATA

STRATA

Summary of Test Results

Project: Grassy Mountain Mine
Client: Calico Resources USA Corp

Project Number: BO19059A
Date: 5/10/2019

Test Pit	Depth (Feet)	Lab Number	Soil Classification (remarks)	In Situ Moisture, %	Passing No. 200,%	Atterberg Limits LL	Atterberg Limits PI	Fines Class.
TP-A1	2'-3'	BL190304	Poorly-graded Sand with Silt and Gravel (SP-SM)	6.3	7.7	-	-	ML
TP-A3	1.5'-2.5'	BL190305	Poorly-graded Gravel with Silt and Sand (GP-GM)	11.1	8.8	-	-	ML
TP-A4	0'-1'	BL190306	Clayey Sand (SC)	27.7	48.5	43	24	CL
TP-A4	3'-3.5'	BL190307&308	Clayey Sand (SC)	22.4	13.1	50	21	CH
TP-A4	4'-5'	BL190309	Poorly-graded Sand with Silt and Gravel (SP-SM)	9.6	8.1	-	-	ML
TP-A5	3'-4'	BL190310	Silty Sand with Gravel (SM)	10.9	13.7	-	-	ML
TP-A6	4'-5'	BL190311	Well-graded Sand with Silt and Gravel (SW-SM)	13.2	8.4	-	-	ML
TP-B2	3'-4'	BL190312&313	Silty Sand (SM)	28.8	28.9	NV	NP	ML
TP-B5	1'-1.5'	BL190314&315	Silty Sand (SM)	20.3	31.1	46	13	ML
TP-B5	3'-3.5'	BL190316	Poorly-graded Sand with Silt and Gravel (SP-SM)	15.8	6.2	-	-	ML
TP-C2	3'-4'	BL190317&318	Clayey Sand (SC)	30.6	21.6	58	29	CH

Reviewed By: _____

8653 West Hackamore Drive, Boise, Idaho 83709 Phone 208.376.8200 Fax 208.376.8201
www.stratageotech.com

Appendix E
ODEQ Email

Matt Rasmusson

From: BROWN Larry <Larry.BROWN@state.or.us>
Sent: Thursday, May 16, 2019 9:19 AM
To: Matt Rasmusson
Cc: GEDDES Craig; Jason Thompson
Subject: Calico/Grassy Mountain Site Evaluation for Onsite sewage treatment and disposal

Follow Up Flag: Follow up
Flag Status: Flagged

Good Morning Matt:

The purpose of the site evaluation was to locate suitable soils in an area that is large enough for both the initial drainfield area and the replacement drainfield area. The criteria used for this site evaluation can be found in Oregon Administrative Rules (OAR) 340-071. Soil test pits and other site features were evaluated during the site visit. In the site inspection, the following features were evaluated:

- Soil types - how well they drain and other evidence of good soil structure for treatment
- Depth to groundwater or if groundwater is present.
- Slopes, escarpments, ground surface variations, topography
- Creeks or springs on the site or adjacent properties
- Whether the soils have been disturbed
- Setbacks from property lines, buildings, water lines, and other utilities
- Other site features that could affect the placement of the on-site septic system.

I have reviewed the site evaluation soil notes from Malheur County and discussed the findings with Craig Geddes. The majority of soils at this site include Class C soils which normally require a minimum of 125 linear feet of disposal trench per 150 gpd flow based on the soil depth observed. If pretreatment is utilized then 50 linear feet of disposal trench per 150 gpd flow would be required. With 10% slopes one would normally need to install a septic system as serial distribution. However, considering the flows and with large systems requiring pressurization, I am requiring equal distribution via a hydrosplitter; 18 to 24 inch trench depths. The 24 inch trench depth limitation is a conservative action due to the presence of a durapan observed at this site. Both areas A and B are approved. Do not extend drainlines past the large sage plant vegetation areas.

This system must be installed under dry soil conditions to reduce smearing. If smearing occurs, the sidewalls are to be raked. The site of disturbance must be reseeded. New vegetative growth (root development) will aid in any compaction/smearing created during the installation process. Both the initial and replacement disposal areas are to be protected from traffic, cover, development or other potential disturbance of natural soil conditions. Any road cuts downslope of the system will require 25 to 50 foot setback between the road cut to the lowest drainline. The area must not be subjected to excessive saturation due to; but not limited to: artificial drainage of ground surfaces, roads, driveways and building down spouts. Placement of a well within 100 feet of the approved areas invalidate this approval. Additionally, any alteration of natural soil conditions (i.e. cutting or filling) in the acceptable area may void this approval as well.

With predicted peak flows of 4,320 gpd, a standard system would require 3,600 linear feet of disposal trench for the initial system, 3,600 linear feet for the repair. In either situation pretreatment could be utilized thus reducing the linear footage requirement to 1,440 linear feet. Large system rules apply as stipulated in OAR 340-071-0520.

Now we need to wait until the written assessment concerning the impact of the proposed system on the quality of public waters and public health is conducted; and accepted and approved by DEQ before finalizing the sewage treatment and disposal septic system requirements.

If you have any questions, please contact me.

Sincerely,

Lawrence (Larry) Brown REHS
Environmental Health Specialist
DEQ Eastern Region - Water Quality Land Application
475 NE Bellevue Drive - Suite 110
Bend, OR 97701
Phone: (541) 633-2025
Fax: (541) 388-8283

Appendix D
O&M Manual

Grassy Mountain Gold Project
Wastewater Facilities

Operations and Maintenance Manual

Prepared for

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Prepared by

SPF Water Engineering, LLC
300 East Mallard, Suite 350
Boise, Idaho 83706
(208) 383-4140

August 19, 2019

SPF WATER ENGINEERING

Summary and Notice to Contractor

SPF Water Engineering, LLC has prepared a draft Operations and Maintenance (O&M) manual for a wastewater disposal system at the proposed Grassy Mountain Gold Mine in Malheur County, Oregon. The contractor shall update this O&M manual to include component specifications of the As-built system and all deviations from the design plans.

The Mine and Process Area will be located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale. The daily average domestic wastewater design flow is estimated to be 3,920 gpd. This value assumes 112 workers at the mine per day and an average day potable water demand of 35 gpd (based on OAR 340-071-0220 for factories with shower facilities). The plant and mine offices and associated change houses are expected to include showers, wash basins, and toilets. There will not be on-site laundry facilities.

Strata advanced 20 soil test pits on April 22 and 23, 2019. Shallow soil characteristics, including soil type and infiltration capacity, were characterized from these test pits. The test pits were divided into three test areas: A, B, and C. Test Area B is where the primary drainfield is located. Test Area A is where the replacement drainfield is located. Test Area C, located approximately 800 feet to the east, was found to be unsuitable for a drainfield location due to impermeable soils. During test pit excavation, groundwater was not encountered. Three field infiltration rate tests were performed, two in Test Area A and one in Test Area B, with all three soils tested to have an infiltration rate of 9 inches per hour. Larry Brown, with the Oregon Department of Environmental Quality, has also written a site evaluation email based on the test pits and other site features (Appendix A of the PER).

The new wastewater disposal system has been designed to accommodate a daily design flow of 4,320-gallons per day (GPD). The disposal rate for type C soils is 0.4 gpd/SF which results in a 3,600 SF drainfield. Because the design flow is over 2,500 GPD, a pressurized drainfield system was required. The system generally consists of an 8,800 gallon septic tank, a 1,200 gallon dose tank, an effluent filter, duplex effluent pumps, 2-inch PVC transport piping and manifolds and 2-inch PVC laterals with 1/8” orifices. The system is design to dose on demand based on level indicated by a float assembly.

This manual provides information and documents to conduct adequate operation and maintenance of the wastewater disposal system. For reference, the Project Drawing Plan Set is included in Appendix A, Wastewater System Component Specifications are included in Appendix B, Manufacturer Installation, Maintenance and Troubleshooting Manuals are included in Appendix C, and the Wastewater System Inspection Report Form is included in Appendix D.

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Appendix A: Project Design Drawing Set

Appendix B: Wastewater System Component Specifications

Appendix C: Manufacturer Installation, Maintenance, & Troubleshooting Guides

Appendix D: Inspection Report Form

1. WASTEWATER SYSTEM

1.1. Project Components

The Grassy Mountain Gold Site wastewater disposal system consists generally of the following components:

- (1) 8,800 gallon single compartment precast concrete septic tank
- (1) 1,200 gallon dose tank
- (1) 8" diameter Orenco Biotube effluent filter
- (2) 1-hp submersible effluent pumps single phase 230 volt. The pumps are designed to work alternately under normal operation and will both turn on when activated by the high water alarm. The design operating point of each pump is 60-gpm with a total dynamic head of 60-feet.
- (1) Four float control switch assembly consisting of one low level alarm float, an emergency high-level alarm/both pumps on float, and lead pump on and lead pump off floats. The float control switches are UL listed and CSA certified for use in sewage, and are non-mercury mechanical types.
- (1) Duplex control panel with liquid level alarm. The control panel is UL-508 rated, programmable for timed/demand-dosing applications, pump alternation continues during override conditions, and has an audible and a visual alarm with an automatic reset function.
- Flexible pipe connections at septic tank
- 2-inch diameter transport piping and manifolds
- (24) – 150-ft long pressurized distribution laterals with 11-ft spacing. Laterals are 2-inch diameter SCH 40 PVC. Each lateral contains 38, 1/8", orifices at the bottom of the pipe at 4-ft spacing and long sweep elbows at each end for cleanings and maintenance.
- (24) Drainfield absorption trenches. The bed is 10,800 square feet with (2) observation ports. Please see the detail drawing on Sheet C506 in Appendix A of the PER for bed profile specifications.
- Distribution valve
- Ribbed PVC manhole risers

The Oregon Department of Environmental Quality, Chapter 340, Division 71 Onsite Wastewater Treatment Systems was used as a guide for the design.

2. OPERATION AND MAINTENANCE

2.1. Operation

The system owner/operator is responsible for the successful operation of the wastewater system. The primary maintenance responsibilities include monitoring sludge levels in the septic and dose tanks and cleaning the effluent filter. The observation ports within the drainfield should be inspected to check for evidence of ponding.

2.2. Maintenance & Reporting

The owner/operator is responsible for the maintenance and inspection of the wastewater disposal system. The maintenance and inspection of the wastewater system shall be done in accordance with the schedule below and the inspection form provided in Appendix D. Inspections should be conducted at a minimum of every 6-months. Additional inspections may be necessary if any degradation of performance is observed.

The owner/operator is responsible for a minimum of the following:

- Maintaining unobstructed gravity sewer flow from the cleanout to the septic tank
- Maintaining the acceptable sludge levels in the septic chamber
- Ensuring that the pumps are operating properly
- Ensuring that the float switches and alarms are functioning properly
- Inspecting and cleaning effluent filter
- Monitoring of observation ports to look for evidence of ponding
- Maintaining documentation of the inspection and maintenance performed on the wastewater system.

Maintenance & Reporting Schedule		
Activity	**Interval**	**Special Issues Related to Activity**
Test pump alarms	Semi-annually	Ensure test alarms work properly
Inspect septic and dose tank level	Semi-annually	Remove scum and solids if scum fills the air space at the top of the tank and/or sludge fills more than 40% of the tank volume.
Inspect biotube effluent filter	Semi-annually	Clean the filter per manufacturer recommendations and as needed to prevent flow restriction, fouling of pump, and/or plugging of drainfield lateral orifices.
Inspect float switch assembly	Semi-annually	Ensure that the floats are able to operate freely and no corrosion of the floats is occurring. Clean floats per manufacturer recommendations. Replace floats as needed
Flush Pressure Laterals	As required	If pump times are taking longer than they should for the set dose volume, laterals or orifices may be plugged. Contact a maintenance contractor for lateral flushing.
Submit Monitoring and Reporting plan	Required prior to permit issuance	Includes at a minimum, the following reporting activities.
Record Influent Flows	Monthly	Record from dosing system counter
Recording and inspection for ponding through all observation ports	Semi-Annual	Perform inspection during dry weather after pumps have been off for at least 5 minutes. If water is present in the observation ports there is a drainfield permeability issue. If during extremely cold weather, receiving soils may be frozen. If during warmer weather, determine extent of problem by recording which ports have measurable water and report issue to the Health Department. Excavation and partial/whole drainfield refurbishment may be necessary to correct.
Prepare annual pressure distribution system report	Annually	File with the CDHD Director no later than January 31 of each year for the last (12) month period and include section on operation, maintenance and monthly and annual monitoring data.

Table 1 Maintenance & Reporting Schedule

Maintain documentation of the inspection and maintenance performed on the wastewater system for 10 years.

2.3. General Guidelines

The following practices will help to prevent damage to the wastewater system and ensure its proper function.

- Do not permit vehicles to pass over the septic/dose tank or the drainfields. The septic tank is H-20 traffic rated with 3-feet cover; however, the manhole risers are not traffic rated.
- Be aware of the location of the drainfield and do not allow excavation in these areas. Delineate drainfield extents if needed.
- Do not allow any materials or contaminants other than sewage to enter the septic system.
- Follow the operation and maintenance schedule presented in this section.
- Do not plant trees or shrubs on the drainfield, or within the mature rooting radius of the tree or shrub from the drainfield. Trees with roots that aggressively seek water should not be planted at least 50 feet from the drainfield (e.g., poplar, willow, cottonwood, maple, and elm).

3. TROUBLESHOOTING

3.1. General

The information in this section is only a guide in the general determination of the wastewater system problems and their solutions. The manufacturer of the wastewater system products typically will include details of the product's warranty. Read the owner's manual of each product before troubleshooting and/or disassembling as to not damage the product or void warranties. Manufacturer troubleshooting guides provided in Appendix B are to be only used as reference tools. Installation, repairs, and replacements should be done by qualified persons.

4. SAFETY INFORMATION

4.1. Inspections

Maintenance and inspection personnel should have the proper safety equipment and training before performing any maintenance on the wastewater system. The following is a list of safety precautions that maintenance personnel should be aware of when they perform maintenance or troubleshooting of systems.

- Operate equipment safely and in accordance with manufacturer's specifications. Equipment operators should be aware of site personnel at all times to avoid causing injury to others.
- Contact utility companies before excavating at a site. Cover or clearly mark excavated areas that cannot be filled in at the end of the day. Be aware of overhead electrical wires that could come in contact with maintenance equipment.
- Identify where you will dispose or remove raw sewage or septic waste prior to cleaning the system. Use mechanical equipment such as a high-suction vacuum to remove wastes. Do not clean out wastes with bare hands, as it may be hazardous.
- Wear gloves and other protective clothing to handle any mechanical parts or structure components, this will reduce the risk of cuts, abrasions and exposure to disease.
- Never enter a confined space unless you have proper Occupational Health and Safety Administration (OSHA) training and/or permits. Do not enter a confined space until the atmosphere has been checked and proper safety equipment is worn or erected.
- Do not enter tanks without another individual present. If the structural integrity of a tank is questionable, do not enter it.
- Check the ventilation in the septic system before using any ignitable materials. Some septic systems may be sealed and have poor ventilation, posing a safety hazard if vapors come into contact with an open flame.
- Lift manhole lids and other covers with care. Use correct lifting techniques to avoid injury to the back. These items can be very heavy and difficult to maneuver.
- Many very significant diseases, including many that will pass in urine and feces, can be found in sewage. Therefore, septage may contain some or all of them. The bacterial diseases of diarrhea (Salmonella, Shigella, and Clostridium) and Typhoid (Salmonella typhi) may be present. Parasites, such as Pinworm, Roundworm, and Hookworm can often be found, especially in the scum layer. The organisms that cause Amoebic Dysentery, Polio, and Hepatitis could also exist in septage. Do not allow septage to contact bare skin and always wash hands thoroughly after performing inspections.

5. CLOSURE

5.1. Limitations

Recommendations contained in this operations and maintenance manual are based on our calculations, drawings, and our understanding of the proposed system.

This plan has been prepared for specific application to this project in accordance with the generally accepted standards of practice at the time and place our services were provided. No warranty, express or implied, is made.

This report may be used only by the Client for the purposes stated herein. Land use, site conditions (both on- and off-site), or other factors, including advances in the understanding of applied science, may change over time and could materially affect the operations and maintenance.

6. REFERENCES

State of Oregon Dept. of Environmental Quality (ODEQ). November 1, 2017, Chapter 340, Division 71 Onsite Wastewater Treatment Systems

Orenco Systems. 2019. Orenco Systems Website: https://www.orenco.com/document-library, accessed July 2019.

Appendix A
Project Drawing Plan Set

SEPTIC TANK
SEE SHEET C508

123°

0+00
MH – 1
STA: 0+00

MH – 2
STA: 0+84

151°

1+00

10' MIN.
SEPARATION

3700.00

TRANSPORT LINES

STOCKPILE &
RECLAIM AREA

3710.00

3710.00

3710.00

ABSORPTION TRENCH
AREA BOUNDARY
SEE SHEET C401

SEWER SERVICE CLEANOUT
SEE SHEET DETAIL 4
SHEET C506

3708.00

4" SANITARY SEWER
SERVICE LINE

135°

0+00

2+00

MH – 3
STA: 0+00

MH – 3
STA: 2+01

135°

1+00

4" SANITARY SEWER
SERVICE LINE

10' MIN.
SEPARATION

4" SANITARY SEWER
SERVICE LINE

1+91

MH – 3A
STA: 1+91

3706.00

3704.00

3702.00

3-SEWER SERVICE
CONNECTIONS
SEE SHEET DETAIL 5
SHEET C504

3-SEWER SERVICE CROSSINGS
SEE SHEET DETAIL 5 SHEET C506

ELUTION AREA

GOLD ROOM

REAGENT AREA

10' MIN.
SEPARATION

3+00

CIL AREA

WATER SERVICE AREA

GRINDING AREA

SEWER SERVICE CROSSINGS
SEE SHEET DETAIL 5 SHEET C506

MH – 5A
STA: 0+88

FM

FM

10' MIN.
SEPARATION

4+00

5+00

90°

MH – 4
STA: 3+67

MH – 5
STA: 5+65

CRUSHING AREA

TRUCK WASH

6+00

3706.00

3710.00

3720.00

3724.00

3728.00

SEWER SERVICE CONNECTION
SEE SHEET DETAIL 5 SHEET C504

TRUCK WORKSHOP
& WAREHOUSE

4" SANITARY SEWER
SERVICE LINE

TSS

MH – 6
STA: 6+86

6+86

SEWER SERVICE CLEANOUT
SEE SHEET DETAIL 4 SHEET C506

MINE OFFICE &
CHANGE HOUSE

20 0 20 40
SCALE OF FEET

CONSTRUCTION NOTES

1. PROPOSED PAD ELEVATIONS ARE BASED ON THE LANDXML SURFACE PROVIDED TO SPF ON 8/20/2019 BY AUSENCO. IF FINAL PAD ELEVATIONS DIFFER FROM THE ASSUMED ELEVATIONS, CONTRACTOR SHALL ADJUST FINAL MANHOLE AND GRAVITY SANITARY SEWER PIPES ACCORDINGLY. GRADE AREA AROUND EACH MANHOLE TO DIVERT SURFACE WATER AWAY.

SPF WATER ENGINEERING
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Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION SYSTEM SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
17078
8/22/2019
OREGON
MAR. 13, 2015
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C400

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CONSTRUCTION NOTES

1. CONTRACTOR SHALL FOLLOW OAR 340-071-0520 RULES AND REGULATIONS.
2. THIS SYSTEM SHALL BE INSTALLED UNDER DRY SOIL CONDITIONS TO REDUCE SMEARING. IF SMEARING OCCURS, THE SMEARED AREAS SHALL BE RAKED.
3. THE SITE OF DISTURBANCE MUST BE RE-SEEDED.
4. BOTH THE INITIAL AND REPLACEMENT ABSORPTION TRENCH AREAS ARE TO BE PROTECTED FROM TRAFFIC, COVER, DEVELOPMENT OR OTHER POTENTIAL DISTURBANCE OF NATURAL SOIL CONDITIONS.
5. THE ABSORPTION TRENCH AREAS MUST NOT BE SUBJECTED TO EXCESSIVE SATURATION DUE TO: BUT NOT LIMITED TO; ARTIFICIAL DRAINAGE OF GROUND SURFACES, ROADS, DRIVEWAYS AND BUILDING DOWN SPOUTS.
6. IF ROADS ARE CUT DOWNSLOPE OF THE ABSORPTION TRENCH AREAS THE CONTRACTOR SHALL PROVIDE A MINIMUM SETBACK OF 50-FT.
7. ABSORPTION TRENCHES SHALL NOT BE CONSTRUCTED WITHIN 100-FT OF A WELL.
8. ALL WORK IN ABSORPTION TRENCH AREAS SHALL BE DONE WITH TRACK MACHINERY. NO WHEELED MACHINERY SHALL BE ALLOWED IN THE ABSORPTION TRENCH AREAS.
9. NO STOCKPILING OF MATERIALS SHALL BE ALLOWED WITHIN THE ABSORPTION TRENCH AREAS.
10. ALL HOLES IN LATERALS SHALL BE ORIENTED DOWN.
11. PROPOSED PAD ELEVATIONS ARE BASED ON THE LANDXML SURFACE PROVIDED TO SPF ON 8/20/2019 BY AUSENCO. IF FINAL PAD ELEVATIONS DIFFER FROM THE ASSUMED ELEVATIONS, CONTRACTOR SHALL ADJUST FINAL MANHOLE AND GRAVITY SANITARY SEWER PIPES ACCORDINGLY. GRADE AREA AROUND EACH MANHOLE TO DIVERT SURFACE WATER AWAY.

ABSORPTION TRENCHES

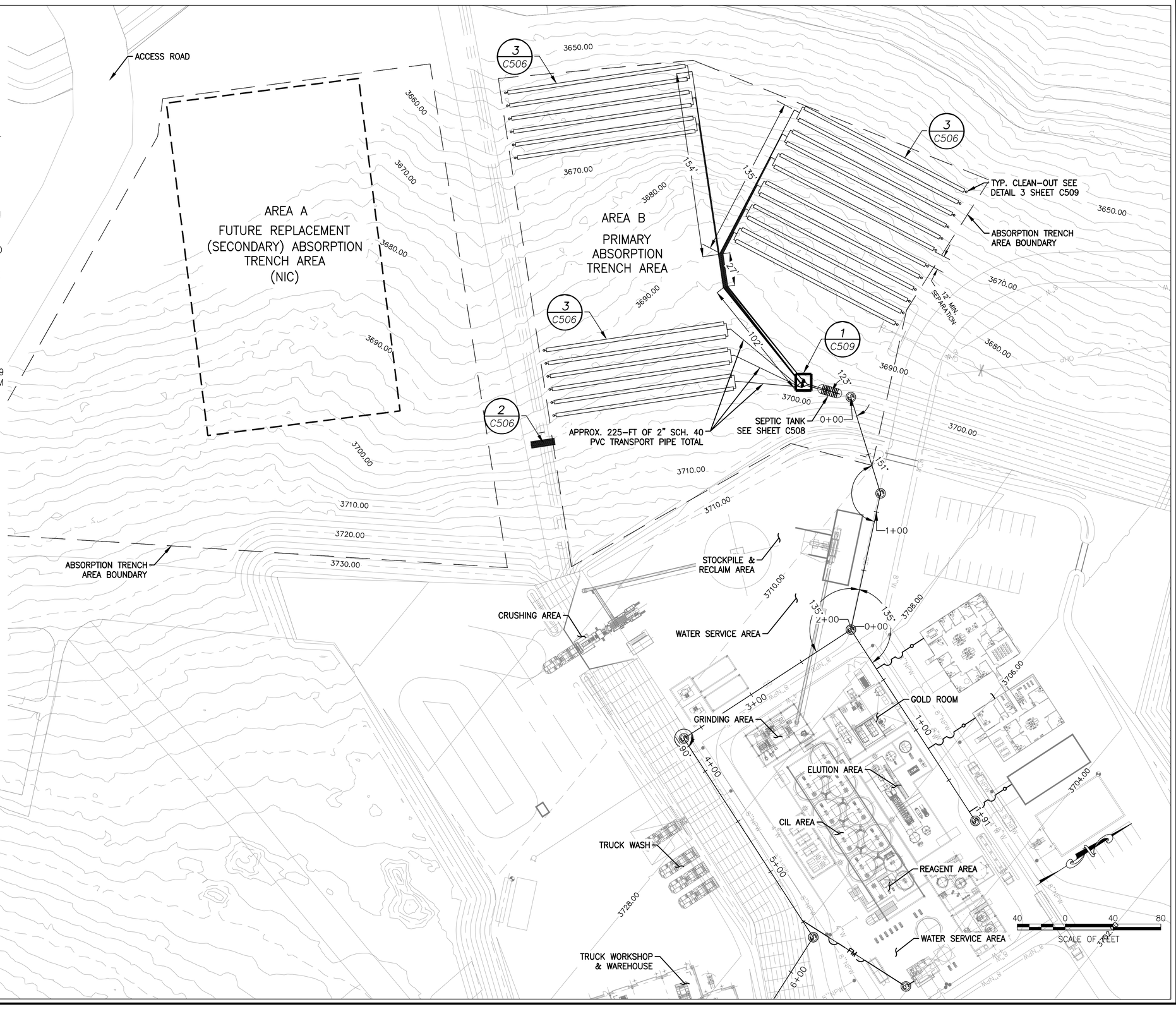
- 150'L X 3'W (24), 10,800 SF
- (4) ZONES PER AREA, 12-FT SPACING BETWEEN ZONES, 6 LATERALS PER ZONE, 2 LATERALS DISCHARGING PER DOSE, 11-FT SPACING BETWEEN LATERALS
- 1/8" DIA. ORIFICES, 4-FT SPACING, 38 ORIFICES PER LATERAL, 228 PER ZONE
- PLAN FOR 5-FT RESIDUAL HEAD AT END OF EACH LATERAL
- FLOW RATE PER ZONE = 60 GPM

PIPING AND VALVES

- TRANSPORT PIPING = 2" SCH. 40, 3168-FT
- MANIFOLD = 2" SCH. 40., 11-FT EACH, 132-FT
- LATERALS = 2" SCH. 40., 150-FT EACH, 3,600-FT

DUPLEX EFFLUENT PUMPS

- OPERATING POINT = 60 GPM @ 60-FT HEAD, APPROX.
- ALTERNATE BETWEEN DOSES
- AT LEVEL BETWEEN "PUMP OFF" AND HIGH LEVEL ALARM, BOTH PUMPS TURN ON
- DOSE ≈ 180 GALLONS, 6 TIMES PER DAY



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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

ABSORPTION TRENCH & REPLACEMENT AREAS SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
OREGON
MATTHEW W. RASMUSSON
MAR. 13, 2015
EXPIRES: 12/31/2019
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

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DRAWN:	JL/SM/KN
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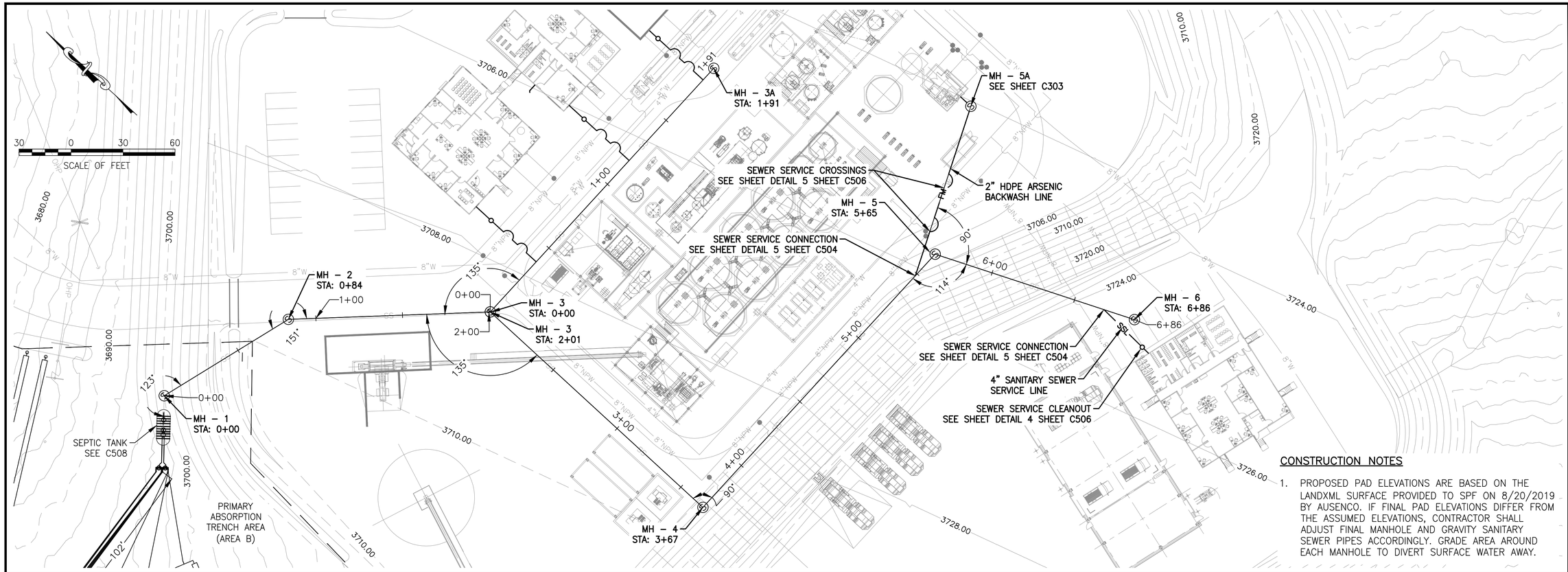

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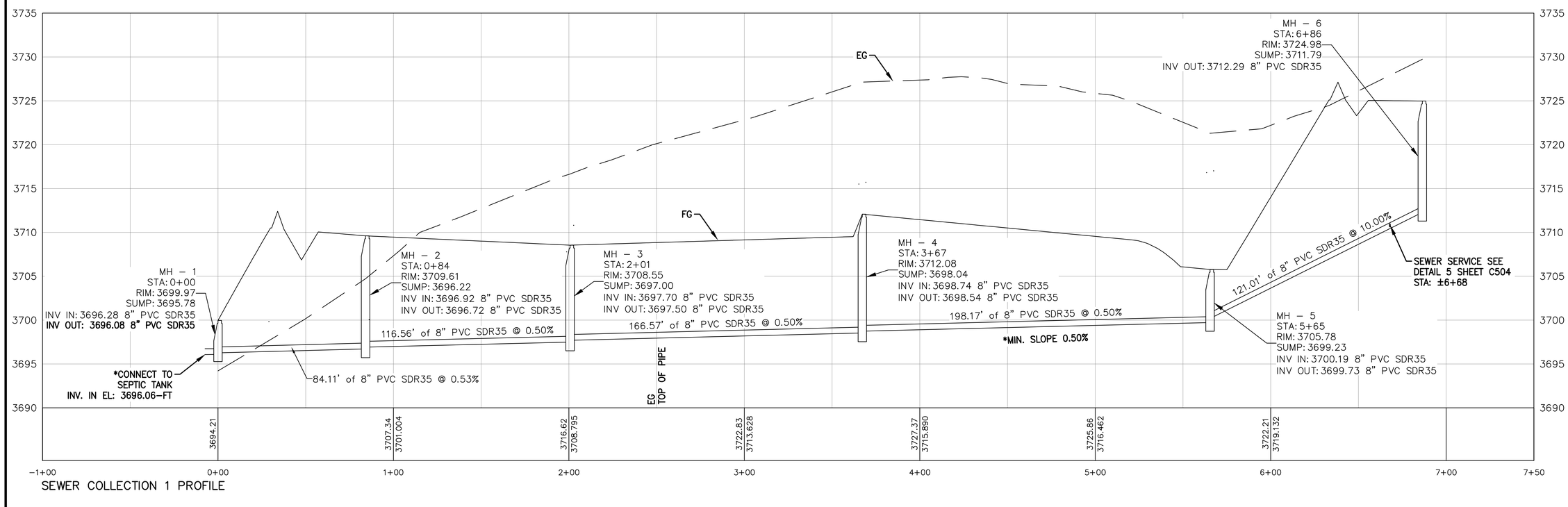

SEWER COLLECTION 1 PROFILE

SPF WATER ENGINEERING
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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION 1

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
OREGON
MAR. 13, 2015
RENEWS: 12/31/2020

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

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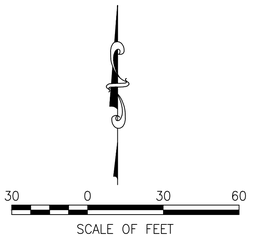

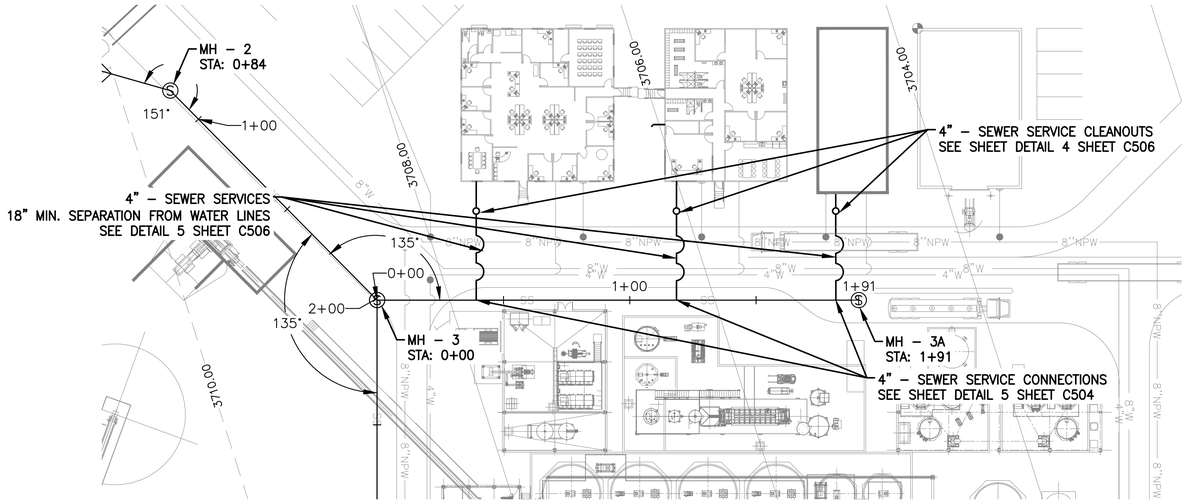

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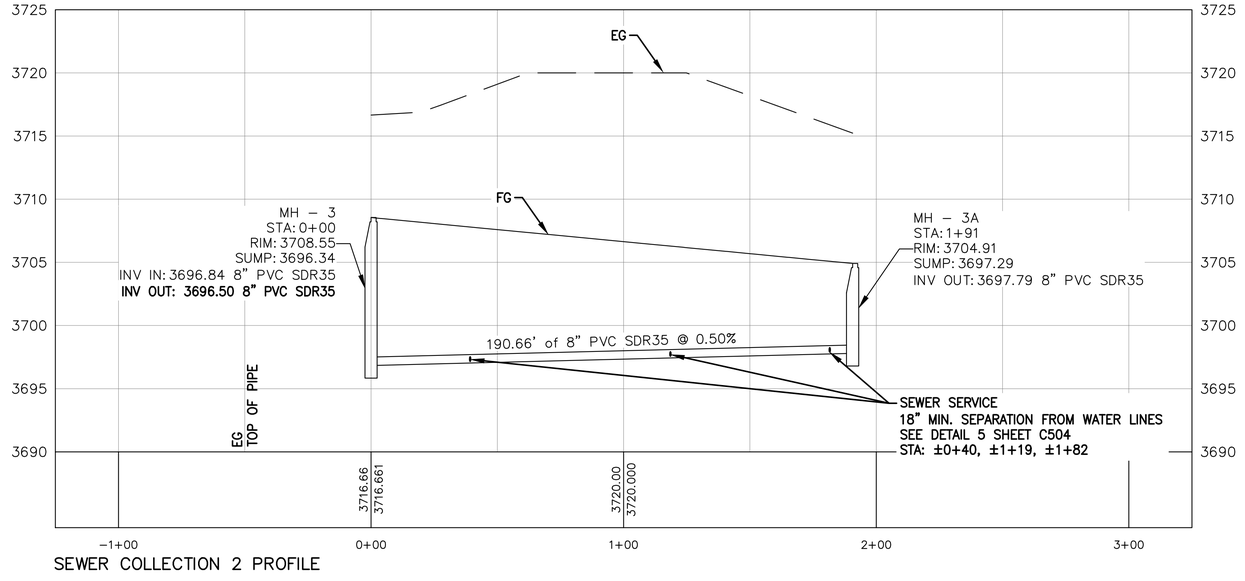

SEWER COLLECTION 2 PROFILE

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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
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SEWER COLLECTION 2

REGISTERED PROFESSIONAL ENGINEER
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No. 17872
OREGON
MAR. 13, 2015
8/22/2019
RENEWS: 12/31/2020

REVISIONS		
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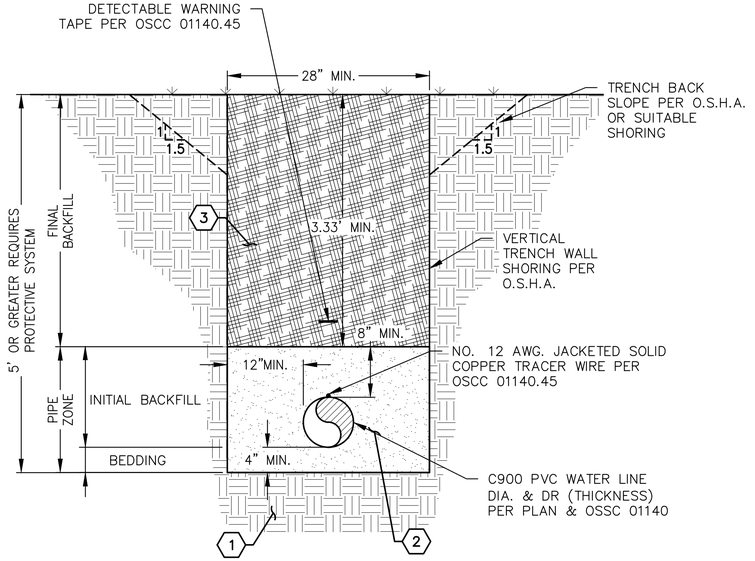
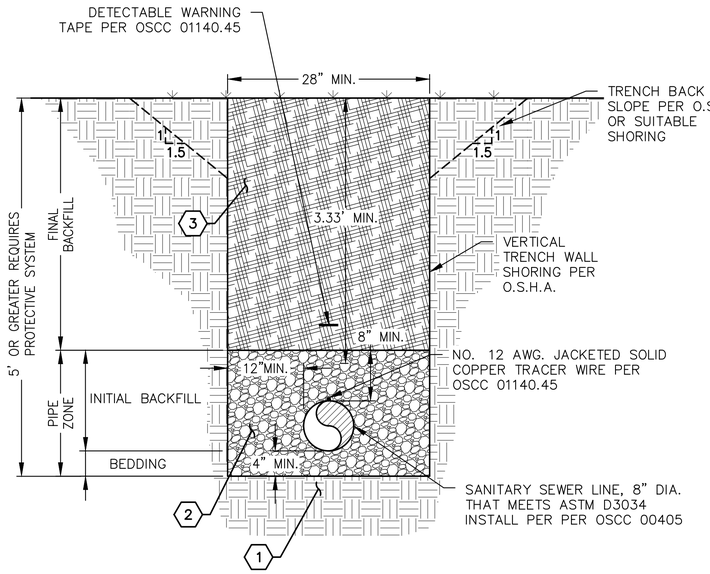


1 WATER LINE TRENCH DETAIL
NOT TO SCALE

LEGEND

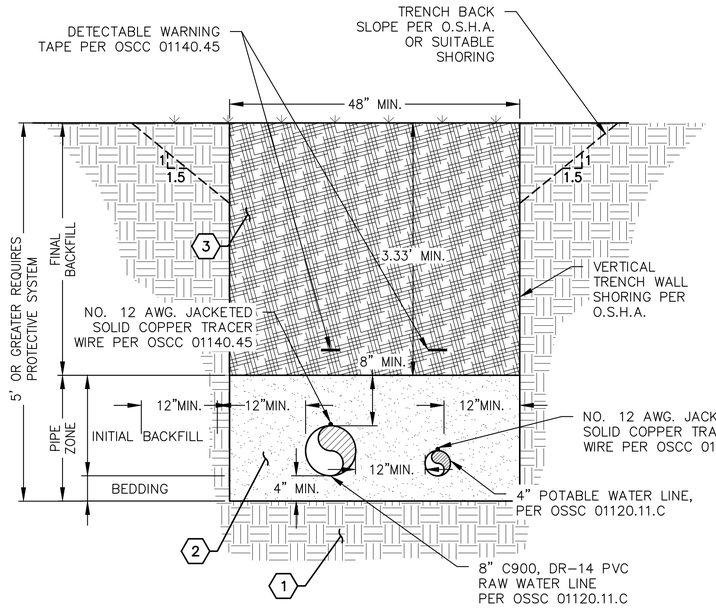
1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE REASONABLY WELL-GRADED, FROM MAXIMUM SIZE TO DUST, SAND WITH 100% PASSING THE 3/8" SIEVE. BEDDING & INITIAL BACKFILL SHALL BE COMPACTED ACCORDING TO ASTM-D698 (STANDARD PROCTOR)
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



2 SANITARY SEWER TRENCH DETAIL
NOT TO SCALE

LEGEND

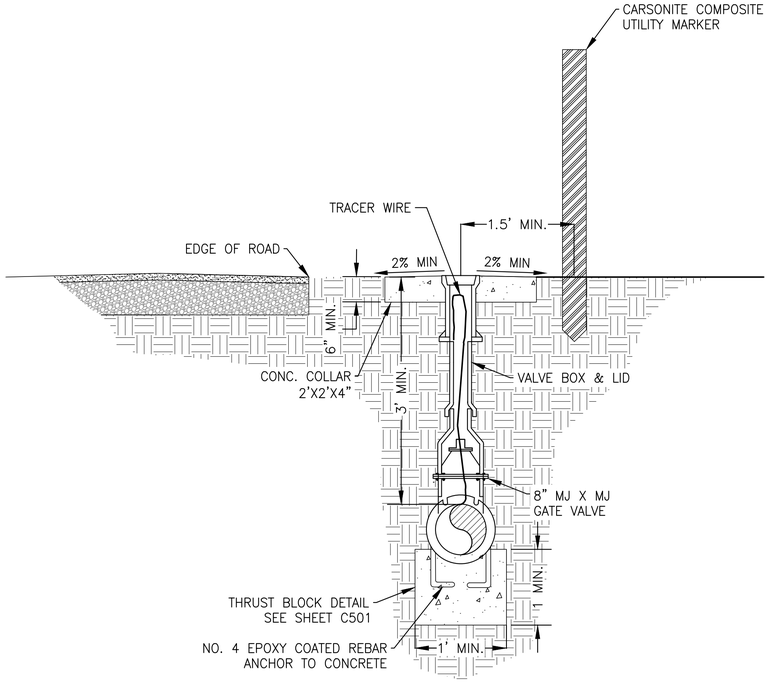
1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE COMMERCIALLY AVAILABLE 3/8" ROCK CHIPS.
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL (NATIVE BACKFILL) ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



3 JOINT TRENCH DETAIL
NOT TO SCALE

LEGEND

1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE REASONABLY WELL-GRADED, FROM MAXIMUM SIZE TO DUST, SAND WITH 100% PASSING THE 3/8" SIEVE. BEDDING & INITIAL BACKFILL SHALL BE COMPACTED ACCORDING TO ASTM-D698 (STANDARD PROCTOR)
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



4 TYP. GATE VALVE & VALVE BOX
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

TRENCH DETAILS

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LEHARS
EXPIRES: 12-31-20

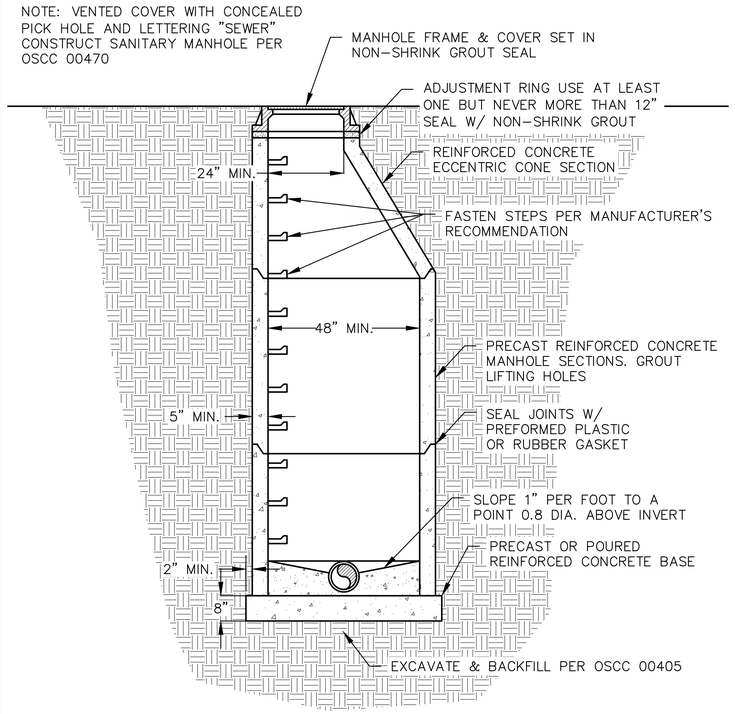
REVISIONS			
ITEM	DESCRIPTION	DATE	
0	FINAL PERMIT SET	7/31/19	

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C500

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: DETAILS_GRASSY_hw Plot date: Aug 22, 2019-03:16:48pm CAD User: HWhite.
Xref Filename: | X-TITLE | X-TITLE (2) |



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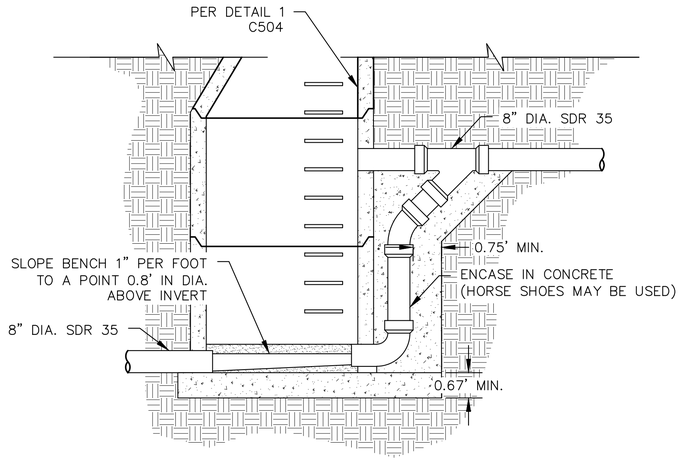
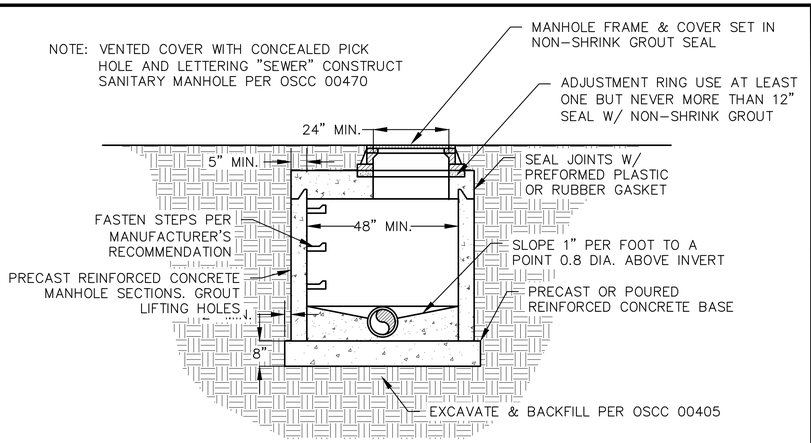
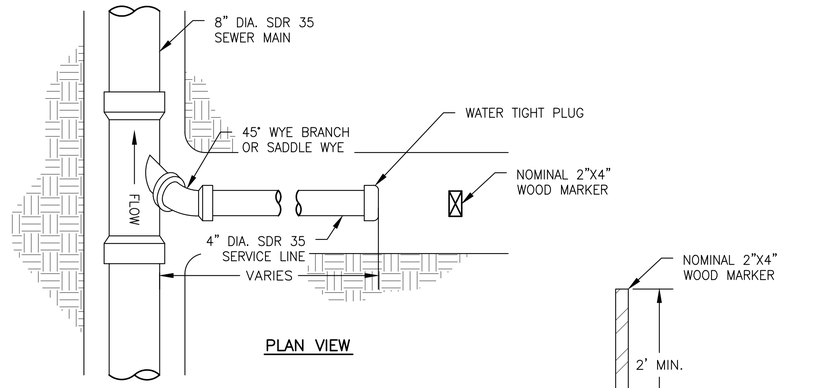
NOT TO SCALE



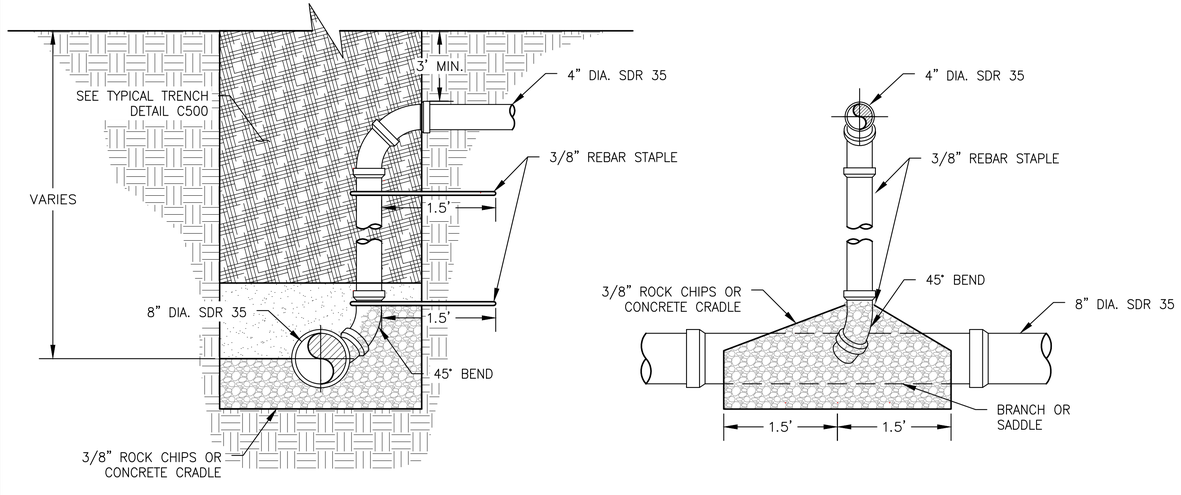
2 — DROP SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



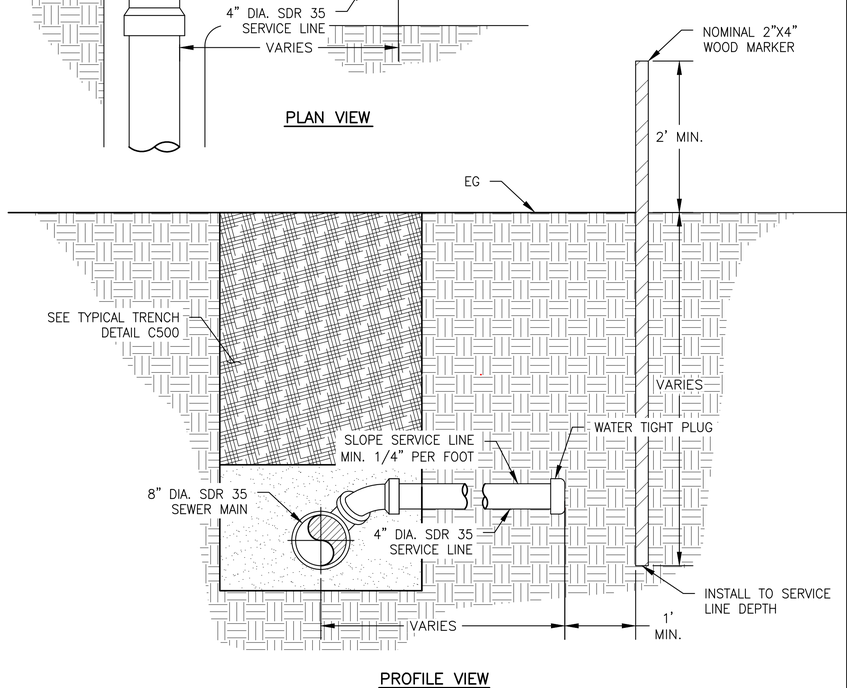
3 — SHALLOW SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



PLAN VIEW



4 — SANITARY SEWER RISER DETAIL
NOT TO SCALE



PROFILE VIEW

5 — SANITARY SEWER SERVICE DETAIL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

PARAMOUNT GOLD NEVADA CORP.
GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SANITARY SEWER DETAILS

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
MAR. 13, 2019
OREGON
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C504

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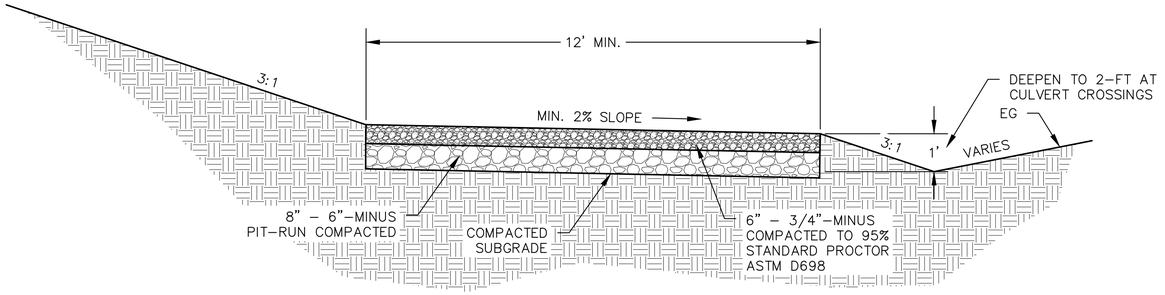
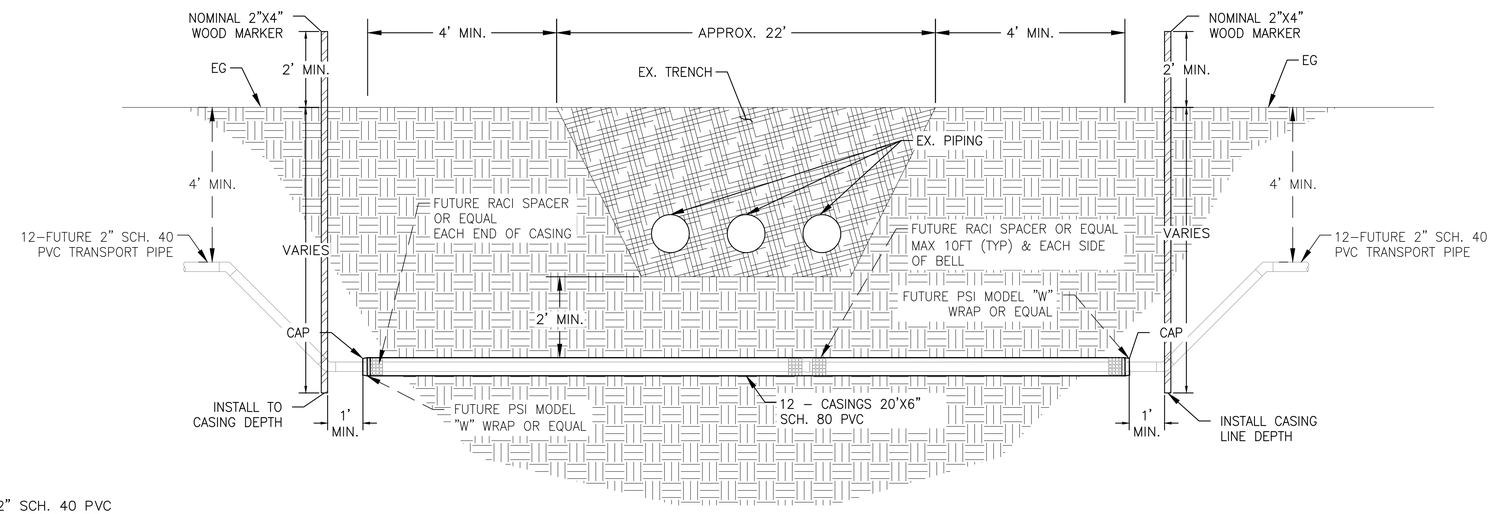
Xref Filename: | X-TITLE | X-TITLE (2) |

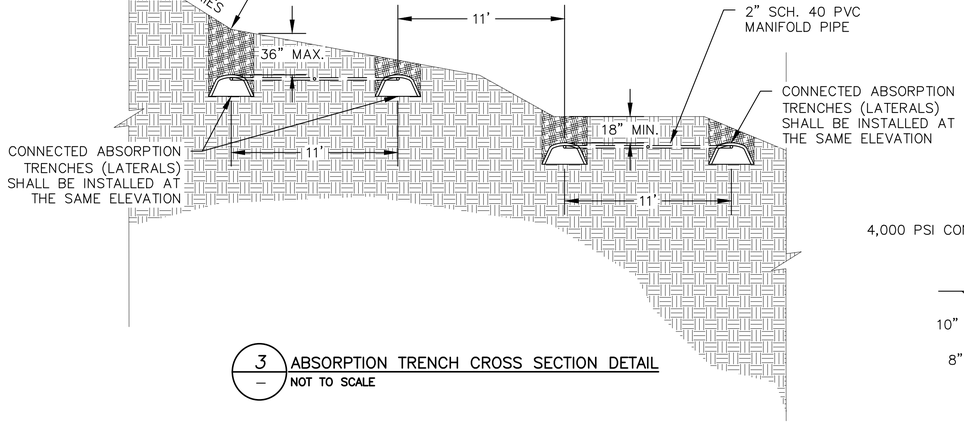


*NOTE: IF ROAD IS IN A CUT SECTION, NO PIT RUN GRAVEL IS REQURED.

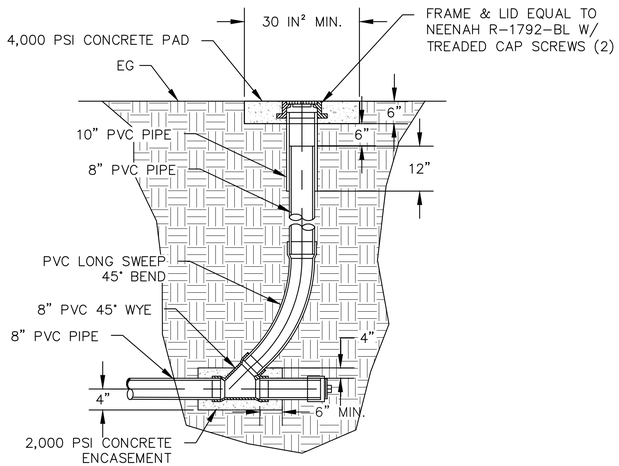
1 — TYP. ROAD CROSS SECTION
NOT TO SCALE



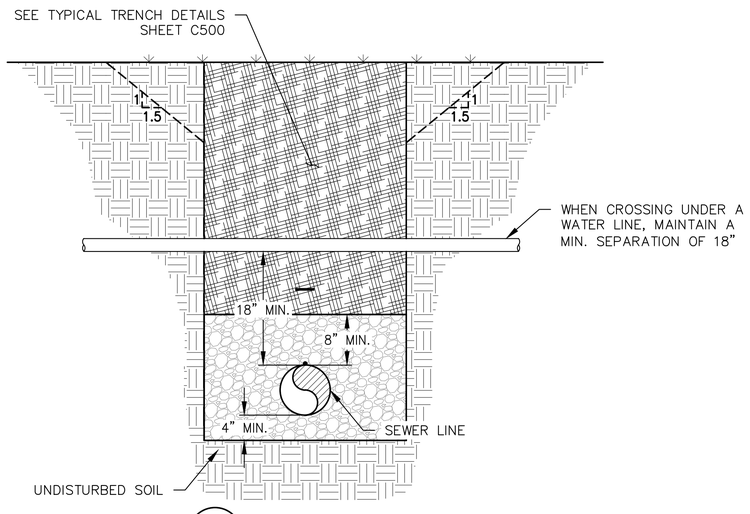
2 — DOSING TRANSPORT PIPE TRENCH CROSSING DETAIL
NOT TO SCALE



3 — ABSORPTION TRENCH CROSS SECTION DETAIL
NOT TO SCALE



4 — SEWER SERVICE CLEAN-OUT TYP. DETAIL
NOT TO SCALE



5 — SEWER/WATER LINE CROSSING TYP. DETAIL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

TYP. ROAD AND SEWER DETAILS

REGISTERED PROFESSIONAL ENGINEER
OREGON
MAR. 13, 2015
MATTHEW W. RASMUSSEN
8/22/2019
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C506

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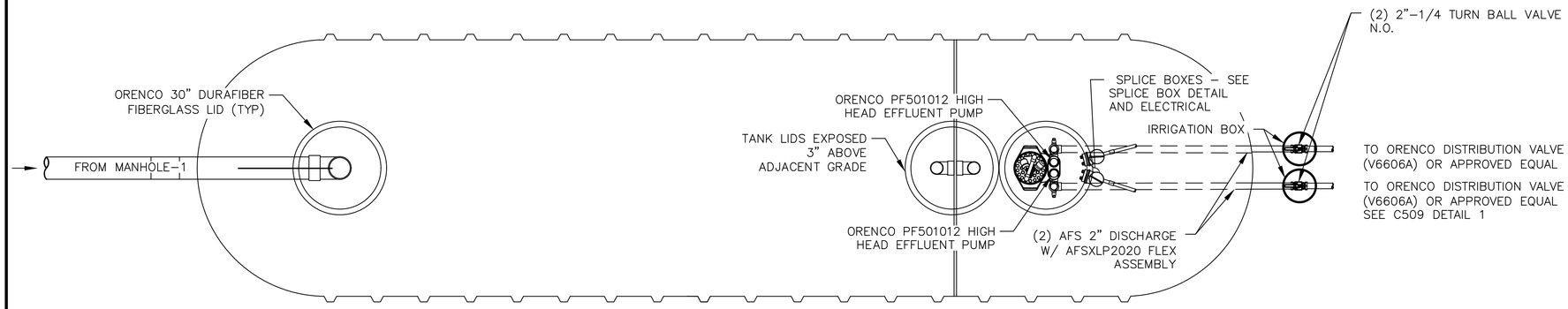
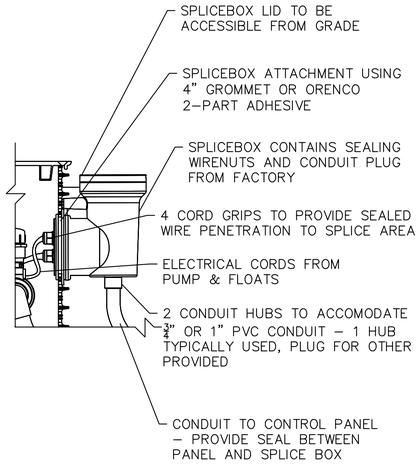
Xref Filename: | X-TITLE | X-TITLE (2) |

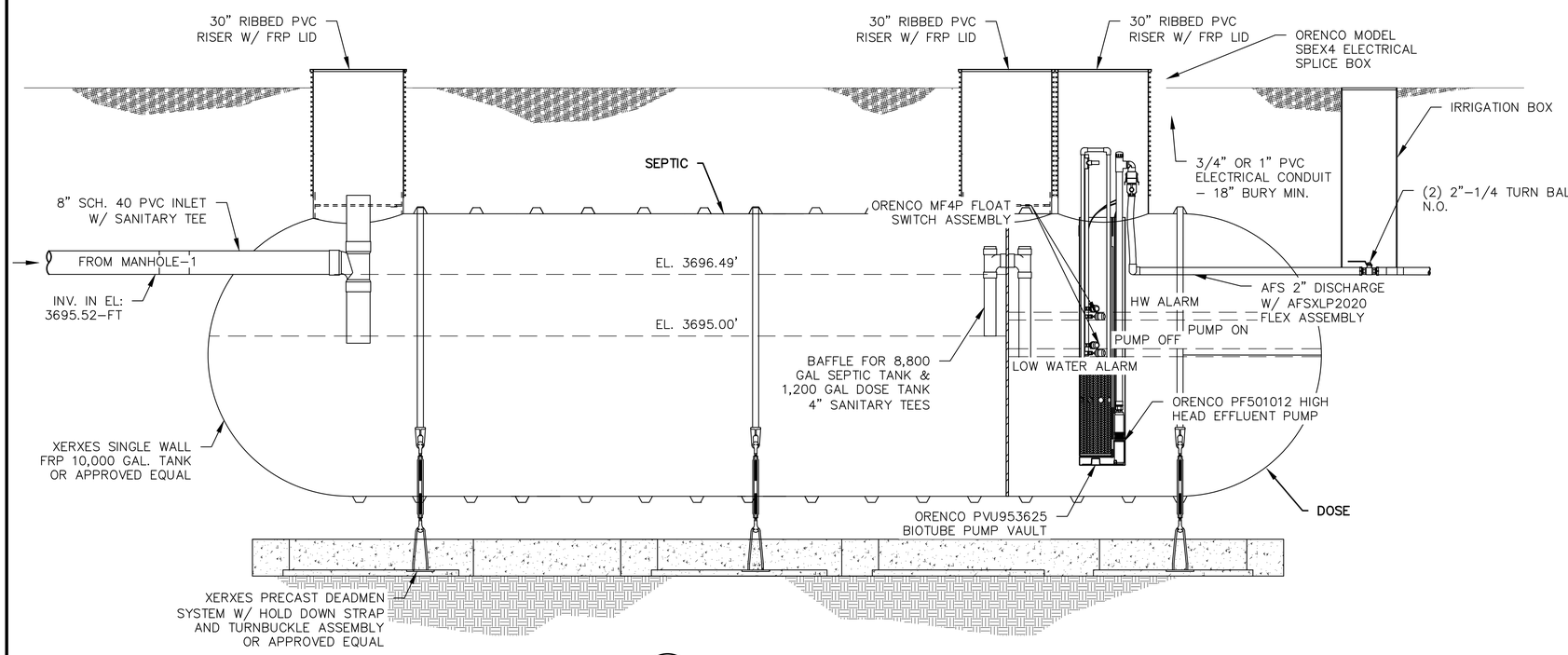
NOTE:
ALL PRODUCT BRANDS THIS SHEET ARE "OR APPROVED EQUAL" ITEMS.
CONTRACTOR TO PROVIDE SUBMITTALS.



1 — 10,000 GAL. FIBERGLASS SEPTIC TANK PLAN VIEW
NOT TO SCALE



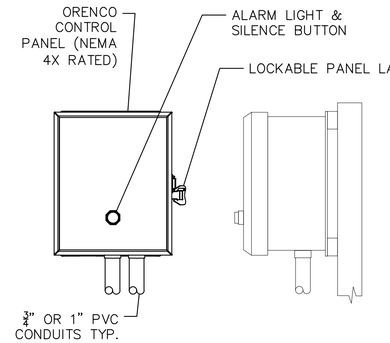
3 — SPLICE BOX DETAILS
NOT TO SCALE



2 — 10,000 GAL. FIBERGLASS SEPTIC TANK PROFILE
NOT TO SCALE

PANEL MOUNTING REQUIREMENTS

- PANEL SHALL BE MOUNTED ON 4X4 WOODEN POST IN LOCATION SHOWN PER SHEET C2 AND ELECTRICAL
- PANEL DIMENSIONS: DAXMVP PANELS: 9.5" HIGH X 7.3" WIDE X 5.4" DEEP



4 — MVPDAX2 DM CONTROL PANEL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEPTIC TANK DETAILS

REGISTERED PROFESSIONAL ENGINEER
OREGON
MAR 13, 2015
MATTHEW W. RASMUSSON
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE–INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C508

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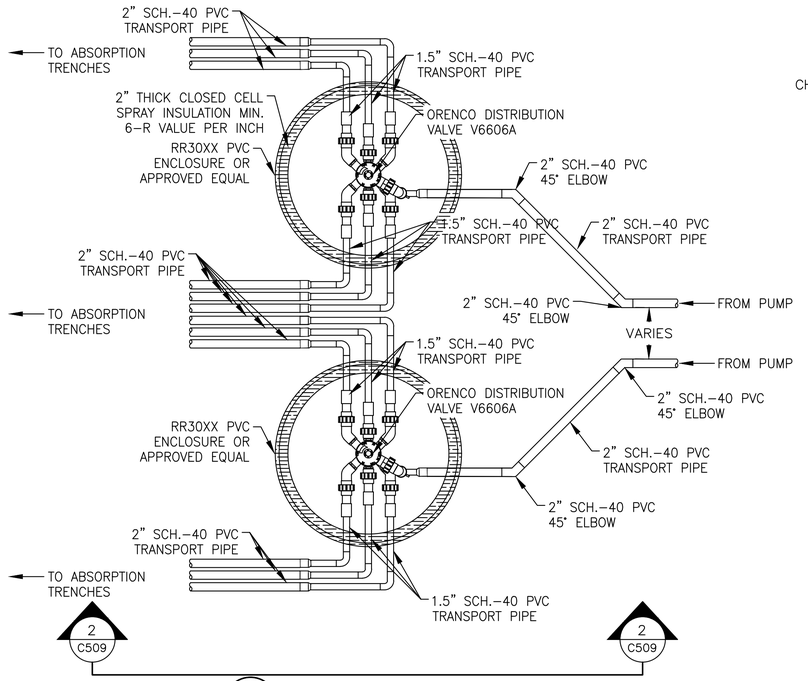
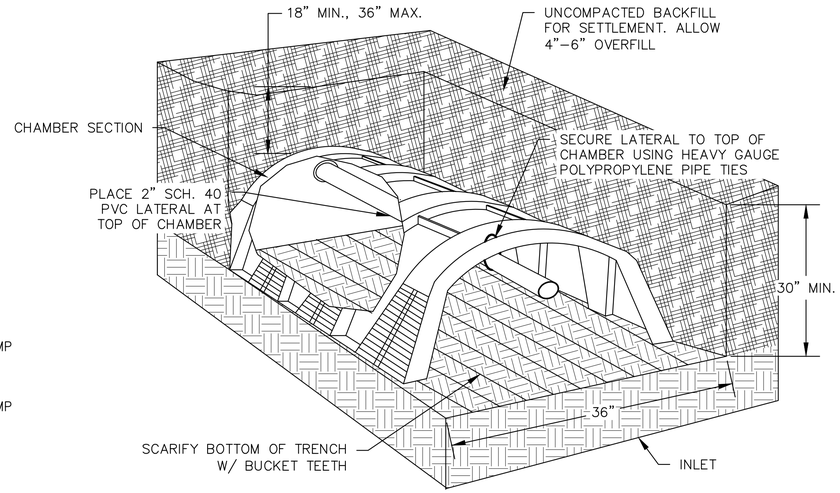
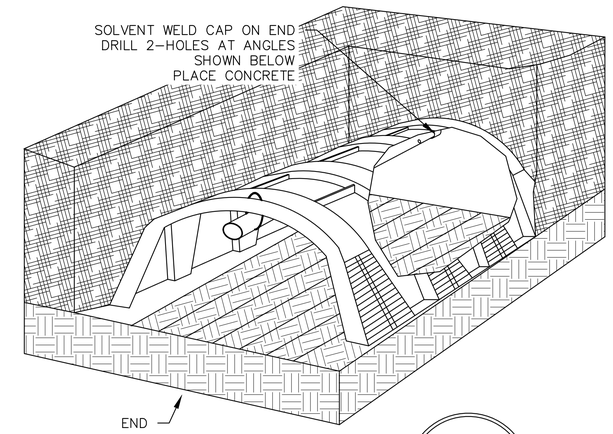


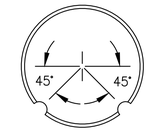
1 — PRESSURE DOSED DRAINFIELD CHAMBER DETAIL
NOT TO SCALE

2 — PRESSURE DOSED DRAINFIELD CHAMBER DETAIL
NOT TO SCALE

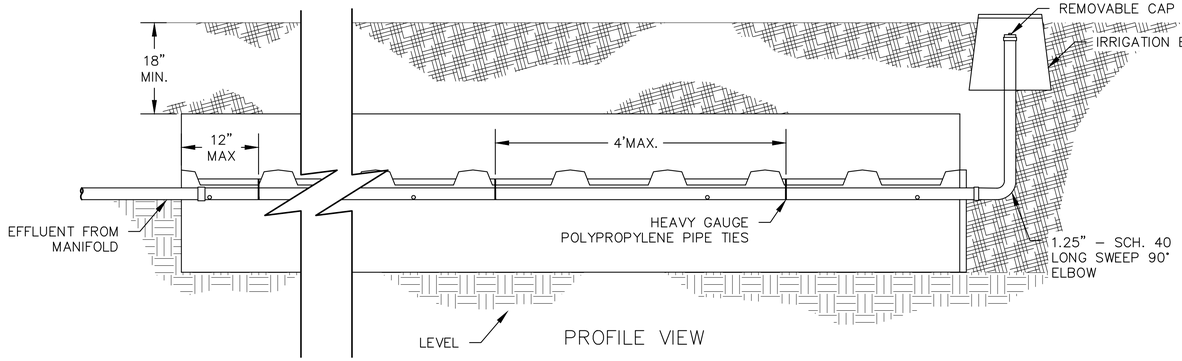


ISOMETRIC VIEW



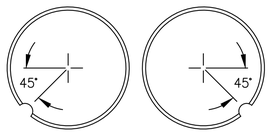


PERFORATIONS END OF PIPE

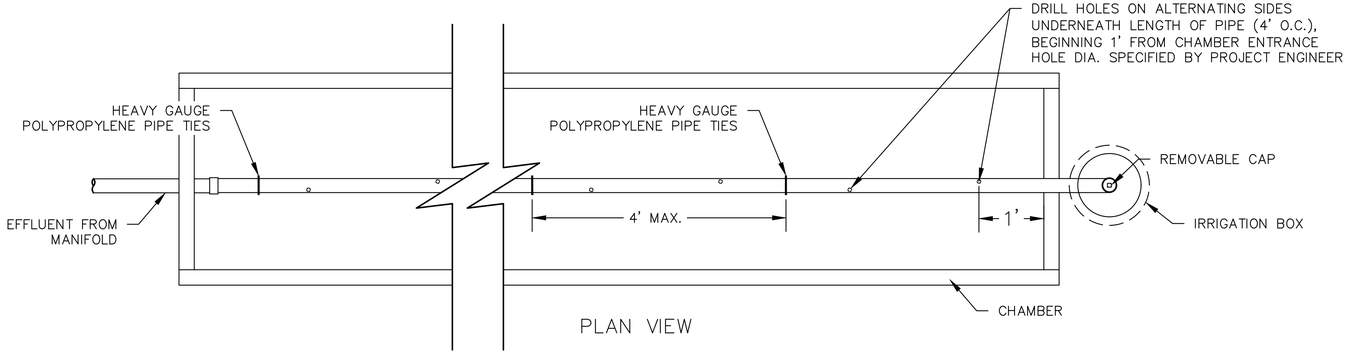


PROFILE VIEW

NOTE: ALTERNATE DIRECTION OF PERFORATION EVERY 4-FT



PERFORATIONS ALONG 2" SCH. 40 PVC PIPE



PLAN VIEW

3 — PRESSURE DOSED DRAINFIELD CHAMBER DETAIL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

ABSORPTION TRENCH AND CHAMBER DETAILS

REGISTERED PROFESSIONAL ENGINEER
20170177
8/22/2019
OREGON
MAR 13, 2019
MATTHEW W. RASMUSSON
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C509

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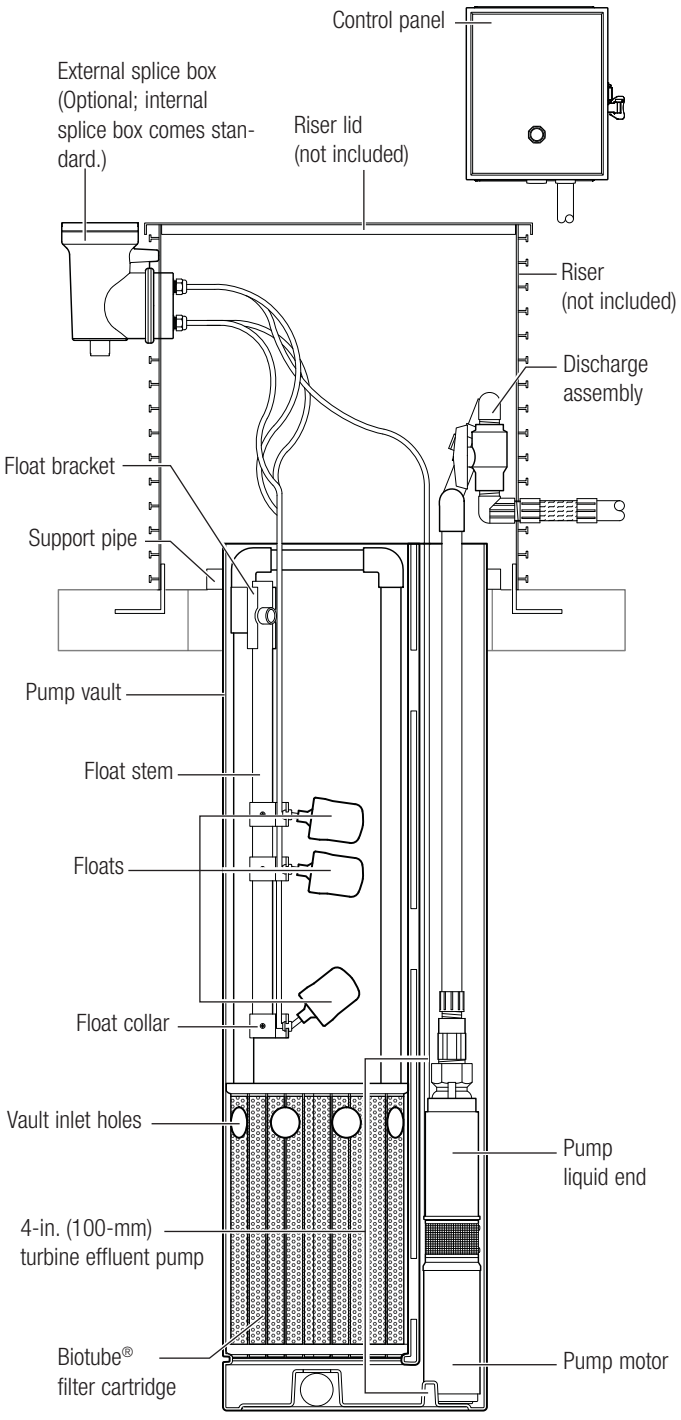
Xref Filename: | X-TITLE | X-TITLE (2) |

Appendix B
Wastewater Disposal System Component Specifications

Technical Data Sheet

Biotube® ProPak™ Pump Package

60-Hz Series Pump Packages



Biotube® ProPak™ pump package components.

Applications

The Biotube ProPak is designed to filter and pump effluent to either gravity or pressurized discharge points. It is intended for use in a septic tank (one- or two-compartment) and can also be used in a pump tank.

The Biotube ProPak is designed to allow the effluent filter to be removed for cleaning without the need to remove the pump vault or pump, simplifying servicing.

Complete packages are available for on-demand or timed dosing systems with flow rates of 10, 20, 30, and 50-gpm* (0.6, 1.3, 1.9, and 3.2 L/sec), as well as with 50 Hz and 60 Hz power supplies.

General

Orenco's Biotube® ProPak™ is a complete, integrated pump package for filtering and pumping effluent from septic tanks. And its patented pump vault technology eliminates the need for separate dosing tanks.

This document provides detailed information on the ProPak pump vault and filter, 4-in. (100-mm) 60-Hz turbine effluent pump, and control panel. For more information on other ProPak components, see the following Orenco technical documents:

- Float Switch Assemblies (NTD-MF-MF-1)
- Discharge Assemblies (NTD-HV-HV-1)
- Splice Boxes (NTD-SB-SB-1)
- External Splice Box (NTD-SB-SB-1)

Standard Models

BPP10DD, BPP20DD, BPP20DD-SX, BPP30TDA, BPP30TDD-SX, BBPP50TDA, BPP50TDD-SX

Product Code Diagram

BPP □ □ - □

Standard options:
Blank = 57-in. (1448-mm) vault height, internal splice box, standard discharge assembly
68 = 68-in. (1727-mm) vault height
SX = external splice box
CW = cold weather discharge assembly
DB = drainback discharge assembly

Panel Application:
DD = demand dosing
TDA = timed dosing, analog timer
TDD = timed dosing, digital timer, elapsed time meter & counters

Pump flow rate (nominal):
10 = 10 gpm (0.6 L/sec)
20 = 20 gpm (1.3 L/sec)
30 = 30 gpm (1.9 L/sec)
50 = 50 gpm (3.2 L/sec)

Biotube® ProPak™ pump vault

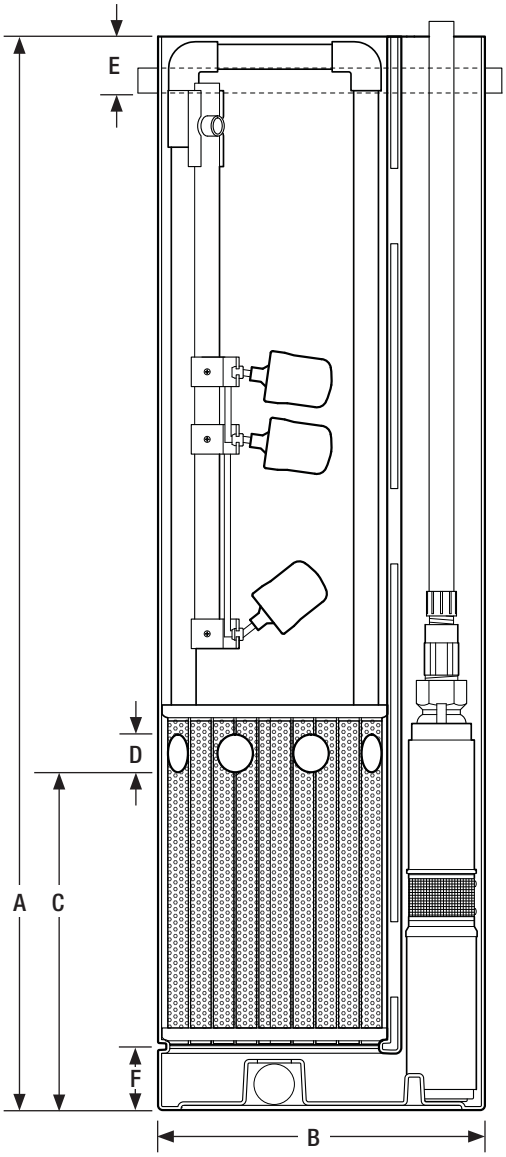
ProPak™ Pump Vault

Materials of Construction	
Vault body	Polyethylene
Support pipes	PVC
Dimensions, in. (mm)	
A - Overall vault height	57 (1448) or 68 (1727)
B - Vault diameter	17.3 (439)
C - Inlet hole height	19 (475)
D - Inlet hole diameter (eight holes total)	2 (50)
E - Vault top to support pipe bracket base	3 (76)
F - Vault bottom to filter cartridge base	4 (102)

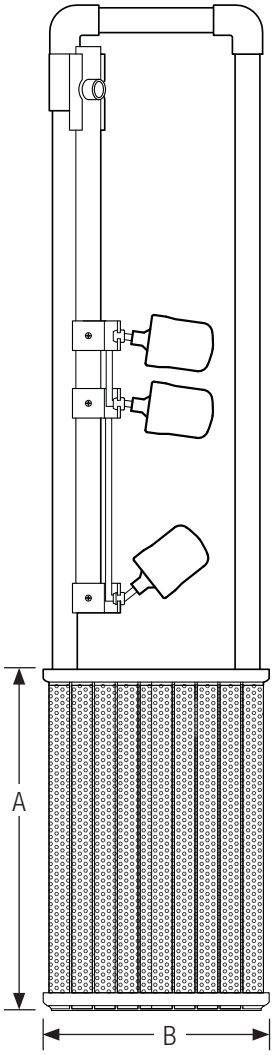
Biotube® Filter Cartridge

Materials of Construction	
Filter tubes	Polyethylene
Cartridge end plates	Polyurethane
Handle assembly	PVC
Dimensions, in. (mm)	
A - Cartridge height	18 (457)
B - Cartridge width	12 (305)
Performance	
Biotube® mesh opening	0.125 in. (3 mm)*
Total filter flow area	4.4 ft^2 (0.4 m^2)
Total filter surface area	14.5 ft^2 (1.35 m^2)
Maximum flow rate	140 gpm (8.8 L/sec)

**0.062-in. (1.6-mm) filter mesh available*



ProPak™ pump vault (shown with Biotube filter and effluent pump)



Biotube® filter cartridge (shown with float switch assembly)

Orenco Systems® Inc. , 814 Airway Ave., Sutherlin, OR 97479 USA • 800-348-9843 • 541-459-4449 • www.orenco.com

Orenco SYSTEMS

Technical Data Sheet

PF Series 60-Hz, 4-inch (100-mm) Submersible Effluent Pumps

Applications

Our 4-inch (100-mm) Submersible Effluent Pumps are designed to transport screened effluent (with low TSS counts) from septic tanks or separate dosing tanks. All our pumps are constructed of lightweight, corrosion-resistant stainless steel and engineered plastics; all are field-serviceable and repairable with common tools; 60-Hz PF Series models are CSA certified to the U.S. and Canadian safety standards for effluent pumps, meeting UL requirements.

Orenco's Effluent Pumps are used in a variety of applications, including pressurized drainfields, packed bed filters, mounds, aerobic units, effluent irrigation, effluent sewers, wetlands, lagoons, and more. These pumps are designed to be used with a Biotube® pump vault or after a secondary treatment system.

C US
LR80980
LR2053896

Powered by Franklin Electric

Features/Specifications

To specify this pump for your installation, require the following:

- Minimum 24-hour run-dry capability with no deterioration in pump life or performance*
- Patented 1⁄8-inch (3-mm) bypass orifice to ensure flow recirculation for motor cooling and to prevent air bind
- Liquid end repair kits available for better long-term cost of ownership
- TRI-SEAL™ floating impeller design on 10, 15, 20, and 30 gpm (0.6, 1.0, 1.3, and 1.9 L/sec) models; floating stack design on 50 and 75 gpm (3.2 and 4.7 L/sec) models
- Franklin Electric Super Stainless motor, rated for continuous use and frequent cycling
- Type SOOW 600-V motor cable

** Not applicable for 5-hp (3.73 kW) models*

Standard Models

See specifications chart, pages 2-3, for a list of standard pumps. For a complete list of available pumps, call Orenco.

Product Code Diagram

PF [50] [10] [1] [2] [ ] - [ ]

Pump, PF Series

Nominal flow, gpm (L/sec):
10 = 10 (0.6) 15 = 15 (1.0)
20 = 20 (1.3) 30 = 30 (1.9)
50 = 50 (3.2) 75 = 75 (4.7)

Horsepower (kW):
03 = ⅓ hp (0.25) 05 = ½ hp (0.37)
07 = ¾ hp (0.56) 10 = 1 hp (0.75)
15 = 1½ hp (1.11) 20 = 2 hp (1.50)
30 = 3 hp (2.24) 50 = 5 hp (3.73)

Frequency:
1 = single-phase 60 Hz
3 = three-phase 60 Hz

Voltage, nameplate:
1 = 115* 200 = 200
2 = 230 4 = 460

Check valve:
Blank = no internal check valve
CV = internal check valve†

Cord length, ft (m):‡
Blank = 10 (3) 20 = 20 (6)
30 = 30 (9) 50 = 50 (15)

* ½-hp (0.37kW) only
† Available for 10 gpm (0.6 L/sec), 1/2 hp (0.37 kW) only
‡ Note: 20-ft cords are available only for single-phase pumps through 1½ hp

Specifications

Pump Model	Design gpm (L/sec)	Horsepower (kW)	Phase	Nameplate voltage	Actual voltage	Design flow amps	Max amps	Impellers	Discharge size and material [1]	Length, in. (mm)	Min. liquid level, [2] in. (mm)	Weight, [3] lb (kg)	Rated cycles/day
PF100511	10 (0.6)	0.50 (0.37)	1	115	120	12.7	12.7	6	1 ¼ in. GFP	23.0 (660)	16 (406)	26 (12)	300
PF100511CV	10 (0.6)	0.50 (0.37)	1	115	120	12.7	12.7	6	1 ¼ in. GFP	23.0 (660)	16 (406)	26 (12)	300
PF100512	10 (0.6)	0.50 (0.37)	1	230	240	6.3	6.3	6	1 ¼ in. GFP	23.0 (660)	16 (406)	26 (12)	300
PF10053200	10 (0.6)	0.50 (0.37)	3	200	208	3.8	3.8	6	1 ¼ in. GFP	23.0 (660)	16 (406)	26 (12)	300
PF100712 [4, 5]	10 (0.6)	0.75 (0.56)	1	230	240	8.3	8.3	8	1 ¼ in. GFP	25.9 (658)	17 (432)	30 (14)	300
PF10073200 [4, 5]	10 (0.6)	0.75 (0.56)	3	200	208	5.1	5.2	8	1 ¼ in. GFP	25.4 (645)	17 (432)	31 (14)	300
PF101012 [5, 6]	10 (0.6)	1.00 (0.75)	1	230	240	9.6	9.6	9	1 ¼ in. GFP	27.9 (709)	18 (457)	33 (15)	100
PF10103200 [5, 6]	10 (0.6)	1.00 (0.75)	3	200	208	5.5	5.5	9	1 ¼ in. GFP	27.3 (693)	18 (457)	37 (17)	300
PF102012 [5, 6, 7, 8]	10 (0.6)	2.00 (1.49)	1	230	240	12.1	12.1	18	1 ¼ in. SS	39.5 (1003)	22 (559)	48 (22)	100
PF102032 [5, 6, 8]	10 (0.6)	2.00 (1.49)	3	230	240	7.5	7.6	18	1 ¼ in. SS	37.9 (963)	20 (508)	44 (20)	300
PF10203200 [5, 6, 8]	10 (0.6)	2.00 (1.49)	3	200	208	8.7	8.7	18	1 ¼ in. SS	37.9 (963)	20 (508)	44 (20)	300
PF150311	15 (1.0)	0.33 (0.25)	1	115	120	8.7	8.8	3	1 ¼ in. GFP	19.5 (495)	15 (380)	23 (10)	300
PF150312	15 (1.0)	0.33 (0.25)	1	230	240	4.4	4.5	3	1 ¼ in. GFP	19.5 (495)	15 (380)	23 (10)	300
PF200511	20 (1.3)	0.50 (0.37)	1	115	120	12.3	12.5	4	1 ¼ in. GFP	22.3 (566)	18 (457)	25 (11)	300
PF200512	20 (1.3)	0.50 (0.37)	1	230	240	6.4	6.5	4	1 ¼ in. GFP	22.5 (572)	18 (457)	26 (12)	300
PF20053200	20 (1.3)	0.50 (0.37)	3	200	208	3.7	3.8	4	1 ¼ in. GFP	22.3 (566)	18 (457)	26 (12)	300
PF201012 [4, 5]	20 (1.3)	1.00 (0.75)	1	230	240	10.5	10.5	7	1 ¼ in. GFP	28.4 (721)	20 (508)	33 (15)	100
PF20103200 [4, 5]	20 (1.3)	1.00 (0.75)	3	200	208	5.8	5.9	7	1 ¼ in. GFP	27.8 (706)	20 (508)	33 (15)	300
PF201512 [4, 5]	20 (1.3)	1.50 (1.11)	1	230	240	12.4	12.6	9	1 ¼ in. GFP	34.0 (864)	24 (610)	41 (19)	100
PF20153200 [4, 5]	20 (1.3)	1.50 (1.11)	3	200	208	7.1	7.2	9	1 ¼ in. GFP	30.7 (780)	20 (508)	35 (16)	300
PF300511	30 (1.9)	0.50 (0.37)	1	115	120	11.8	11.8	3	1 ¼ in. GFP	21.3 (541)	20 (508)	28 (13)	300
PF300512	30 (1.9)	0.50 (0.37)	1	230	240	6.2	6.2	3	1 ¼ in. GFP	21.3 (541)	20 (508)	25 (11)	300
PF30053200	30 (1.9)	0.50 (0.37)	3	200	208	3.6	3.6	3	1 ¼ in. GFP	21.3 (541)	20 (508)	25 (11)	300
PF300712	30 (1.9)	0.75 (0.56)	1	230	240	8.5	8.5	5	1 ¼ in. GFP	24.8 (630)	21 (533)	29 (13)	300
PF30073200	30 (1.9)	0.75 (0.56)	3	200	208	4.9	4.9	5	1 ¼ in. GFP	24.6 (625)	21 (533)	30 (14)	300
PF301012 [4]	30 (1.9)	1.00 (0.75)	1	230	240	10.4	10.4	6	1 ¼ in. GFP	27.0 (686)	22 (559)	32 (15)	100
PF30103200 [4]	30 (1.9)	1.00 (0.75)	3	200	208	5.8	5.8	6	1 ¼ in. GFP	26.4 (671)	22 (559)	33 (15)	300
PF301512 [4, 5]	30 (1.9)	1.50 (1.11)	1	230	240	12.6	12.6	8	1 ¼ in. GFP	32.8 (833)	24 (610)	40 (18)	100
PF30153200 [4, 5]	30 (1.9)	1.50 (1.11)	3	200	208	6.9	6.9	8	1 ¼ in. GFP	29.8 (757)	22 (559)	34 (15)	300
PF301534 [4, 5]	30 (1.9)	1.50 (1.11)	3	460	480	2.8	2.8	8	1 ¼ in. GFP	29.5 (685)	22 (559)	34 (15)	300
PF302012 [5, 6, 7]	30 (1.9)	2.00 (1.49)	1	230	240	11.0	11.0	10	1 ¼ in. SS	35.5 (902)	26 (660)	44 (20)	100
PF30203200 [5, 6]	30 (1.9)	2.00 (1.49)	3	200	208	9.3	9.3	10	1 ¼ in. SS	34.0 (864)	24 (610)	41 (19)	300
PF303012 [5, 6, 7, 8]	30 (1.9)	3.00 (2.23)	1	230	240	16.8	16.8	14	1 ¼ in. SS	44.5 (1130)	33 (838)	54 (24)	100
PF303032 [5, 6, 8]	30 (1.9)	3.00 (2.23)	3	230	240	10.0	10.1	14	1 ¼ in. SS	44.3 (1125)	27 (686)	52 (24)	300
PF305012 [5, 6, 7, 8]	30 (1.9)	5.00 (3.73)	1	230	240	25.6	25.8	23	1 ¼ in. SS	66.5 (1689)	53 (1346)	82 (37)	100
PF305032 [5, 6, 8]	30 (1.9)	5.00 (3.73)	3	230	240	16.6	16.6	23	1 ¼ in. SS	60.8 (1544)	48 (1219)	66 (30)	300
PF30503200 [5, 6, 8]	30 (1.9)	5.00 (3.73)	3	200	208	18.7	18.7	23	1 ¼ in. SS	60.8 (1544)	48 (1219)	66 (30)	300
PF500511	50 (3.2)	0.50 (0.37)	1	115	120	12.1	12.1	2	2 in. SS	20.3 (516)	24 (610)	27 (12)	300
PF500512	50 (3.2)	0.50 (0.37)	1	230	240	6.2	6.2	2	2 in. SS	20.3 (516)	24 (610)	27 (12)	300
PF500532	50 (3.2)	0.50 (0.37)	3	230	240	3.0	3.0	2	2 in. SS	20.3 (516)	24 (610)	28 (13)	300
PF50053200	50 (3.2)	0.50 (0.37)	3	200	208	3.7	3.7	2	2 in. SS	20.3 (516)	24 (610)	28 (13)	300
PF500534	50 (3.2)	0.50 (0.37)	3	460	480	1.5	1.5	2	2 in. SS	20.3 (516)	24 (610)	28 (13)	300
PF500712	50 (3.2)	0.75 (0.56)	1	230	240	8.5	8.5	3	2 in. SS	23.7 (602)	25 (635)	31 (14)	300
PF500732	50 (3.2)	0.75 (0.56)	3	230	240	3.9	3.9	3	2 in. SS	23.7 (602)	25 (635)	32 (15)	300

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Specifications, cont.

Pump Model	Design gpm (L/sec)	Horsepower (kW)	Phase	Nameplate voltage	Actual voltage	Design flow amps	Max amps	Impellers	Discharge size and material [1]	Length, in. (mm)	Min. liquid level, [2] in. (mm)	Weight, [3] lb (kg)	Rated cycles/day
PF50073200	50 (3.2)	0.75 (0.56)	3	200	208	4.9	4.9	3	2 in. SS	23.1 (587)	26 (660)	32 (15)	300
PF500734	50 (3.2)	0.75 (0.56)	3	460	480	1.8	1.8	3	2 in. SS	34.8 (884)	25 (635)	31 (14)	300
PF501012	50 (3.2)	1.00 (0.75)	1	230	240	10.1	10.1	4	2 in. SS	27.0 (686)	26 (660)	35 (16)	100
PF50103200	50 (3.2)	1.00 (0.75)	3	200	208	5.7	5.7	4	2 in. SS	26.4 (671)	26 (660)	39 (18)	300
PF501034	50 (3.2)	1.00 (0.75)	3	460	480	2.2	2.2	4	2 in. SS	26.4 (671)	26 (660)	39 (18)	300
PF501512[4]	50 (3.2)	1.50 (1.11)	1	230	240	12.5	12.6	5	2 in. SS	32.5 (826)	30 (762)	41 (19)	100
PF50153200[4]	50 (3.2)	1.50 (1.11)	3	200	208	7.0	7.0	5	2 in. SS	29.3 (744)	26 (660)	35 (16)	300
PF503012 [4, 5, 7, 8]	50 (3.2)	3.00 (2.23)	1	230	240	17.7	17.7	8	2 in. SS	43.0 (1092)	37 (940)	55 (25)	100
PF50303200 [4, 5, 8]	50 (3.2)	3.00 (2.23)	3	200	208	13.1	13.1	8	2 in. SS	43.4 (1102)	30 (762)	55 (25)	300
PF503034 [4, 5, 8]	50 (3.2)	3.00 (2.23)	3	460	480	5.3	5.3	8	2 in. SS	40.0 (1016)	31 (787)	55 (25)	300
PF505012 [5,6,7,8]	50 (3.2)	5.00 (3.73)	1	230	240	26.2	26.4	13	2 in. SS	65.4 (1661)	55 (1397)	64 (29)	300
PF505032 [5,6,7,8]	50 (3.2)	5.00 (3.73)	3	230	240	16.5	16.5	13	2 in. SS	59.3 (1506)	49 (1245)	64 (29)	300
PF751012	75 (4.7)	1.00 (0.75)	1	230	240	9.9	10.0	3	2 in. SS	27.0 (686)	27 (686)	34 (15)	100
PF751512	75 (4.7)	1.50 (1.11)	1	230	240	12.1	12.3	4	2 in. SS	33.4 (848)	30 (762)	44 (20)	100

1 GFP = glass-filled polypropylene; SS = stainless steel. The 1 ¼-in. NPT GFP discharge is 2 7⁄8 in. octagonal across flats; the 1 ¼-in. NPT SS discharge is 2 1⁄8 in. octagonal across flats; and the 2-in. NPT SS discharge is 2 7⁄8 in. hexagonal across flats. Discharge is female NPT threaded, U.S. nominal size, to accommodate Orenco® discharge hose and valve assemblies. Consult your Orenco Distributor about fittings to connect hose and valve assemblies to metric-sized piping.

2 Minimum liquid level is for single pumps when installed in an Orenco Biotube® Pump Vault or Universal Flow Inducer. In other applications, minimum liquid level should be top of pump. Consult Orenco for more information.

3 Weight includes carton and 10-ft (3-m) cord.

4 High-pressure discharge assembly required.

5 Do not use cam-lock option (Q) on discharge assembly.

6 Custom discharge assembly required for these pumps. Contact Orenco.

7 Capacitor pack (sold separately or installed in a custom control panel) required for this pump. Contact Orenco.

8 Torque locks are available for all pumps, and are supplied with 3-hp and 5-hp pumps.

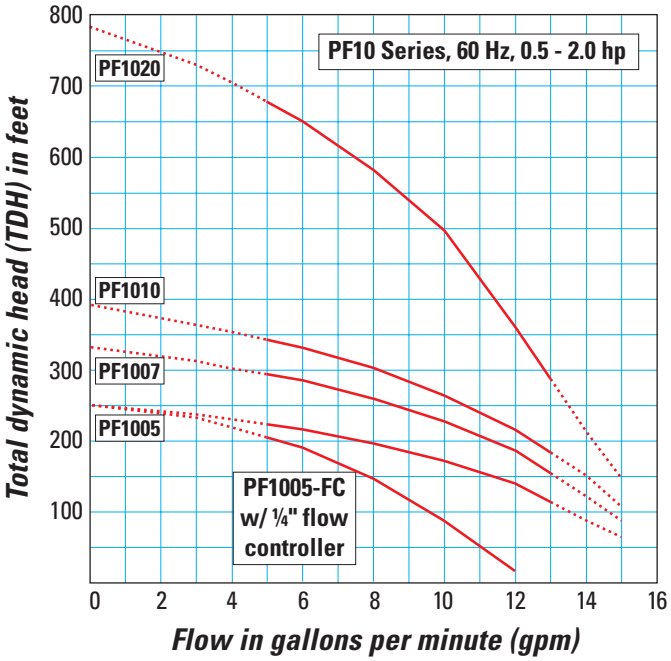
Materials of Construction

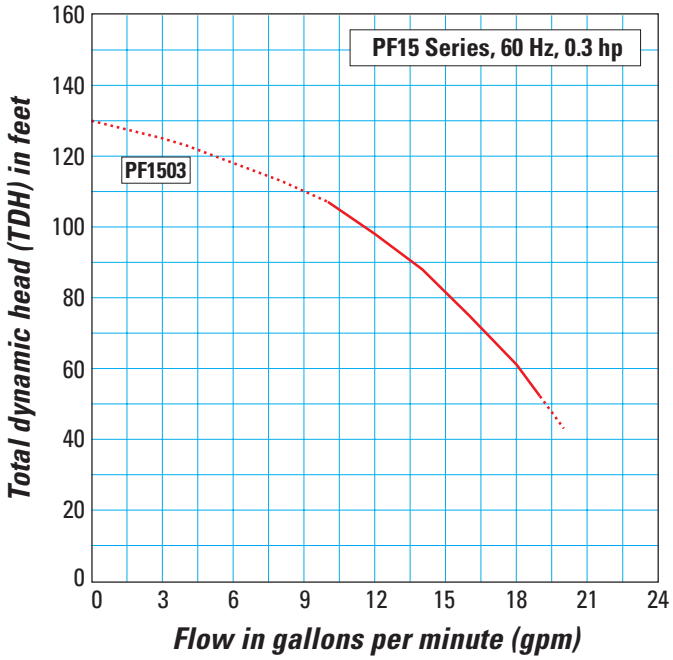
Discharge	Glass-filled polypropylene or stainless steel
Discharge bearing	Engineered thermoplastic (PEEK)
Diffusers	Glass-filled PPO (Noryl GFN3)
Impellers	Celcon® acetal copolymer on 10-, 20, and 30-gpm models; 50-gpm impellers are Noryl GFN3
Intake screen	Polypropylene
Suction connection	Stainless steel
Drive shaft	7/16 inch hexagonal stainless steel, 300 series
Coupling	Sintered stainless steel, 300 series
Shell	Stainless steel, 300 series
Motor	Franklin motor exterior constructed of stainless steel. Motor filled with deionized water and propylene glycol for constant lubrication. Hermetically sealed motor housing ensures moisture-free windings. All thrust absorbed by Kingsbury-type thrust bearing. Rated for continuous duty. Single-phase motors and 200 and 230 V 3-phase motors equipped with surge arrestors for added security. Single-phase motors through 1.5 hp (1.11 kW) have built-in thermal overload protection, which trips at 203-221˚ F (95-105˚ C).

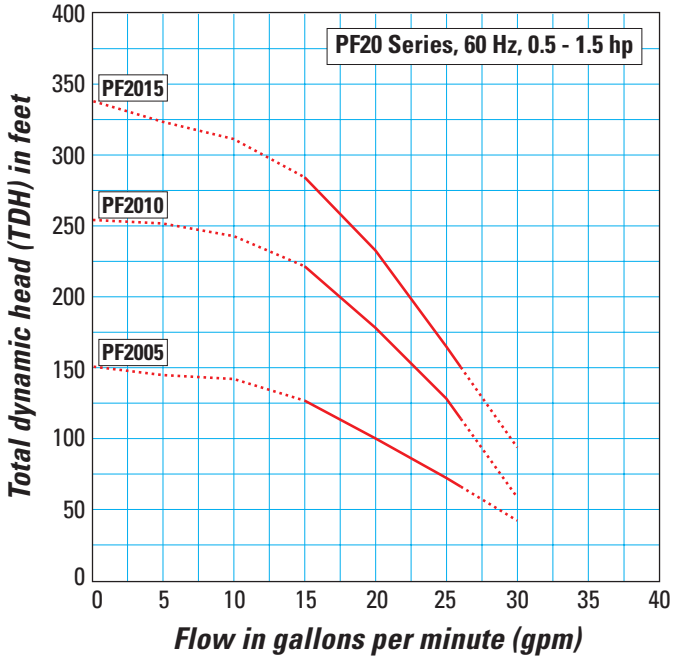
Using a Pump Curve

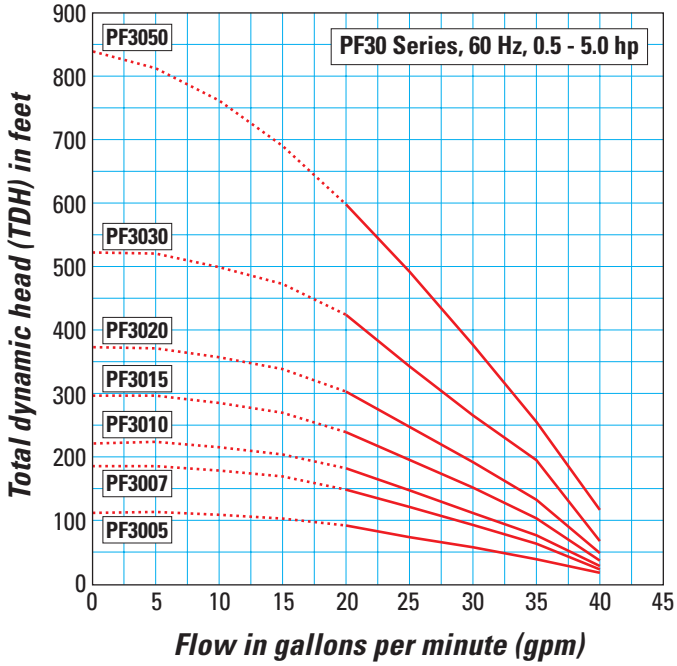
A *pump curve* helps you determine the best pump for your system. Pump curves show the relationship between flow and pressure (total dynamic head, or TDH), providing a graphical representation of a pump's optimal performance range. Pumps perform best at their nominal flow rate. These graphs show optimal pump operation ranges with a solid line and show flow rates outside of these ranges with a dashed line. For the most accurate pump specification, use Orenco's PumpSelect™ software.

Pump Curves









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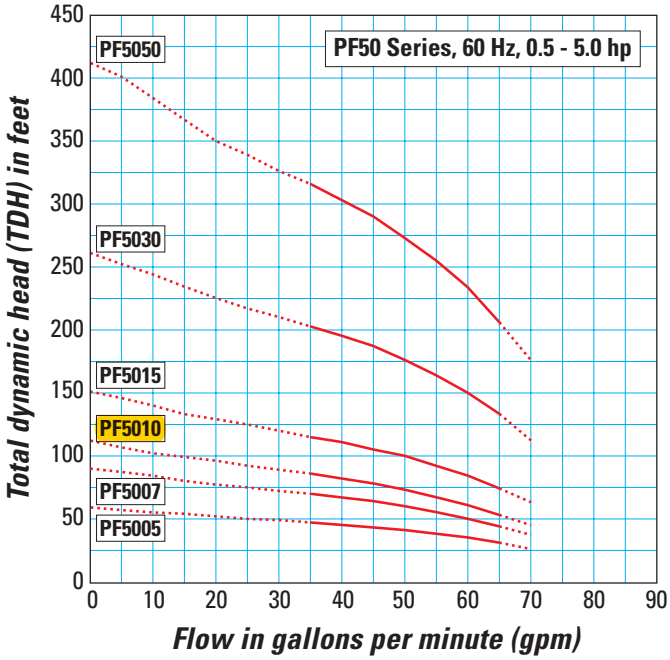
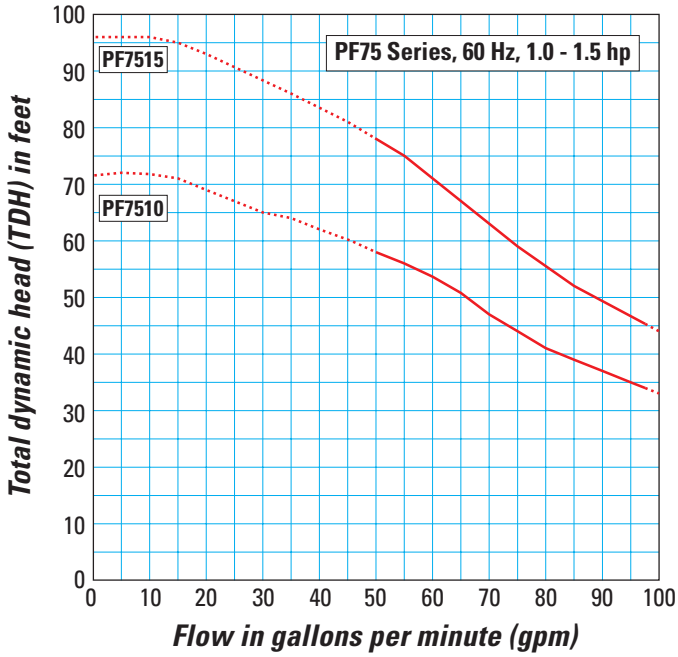
Pump Curves, cont.





Control Panel (Demand Dose)

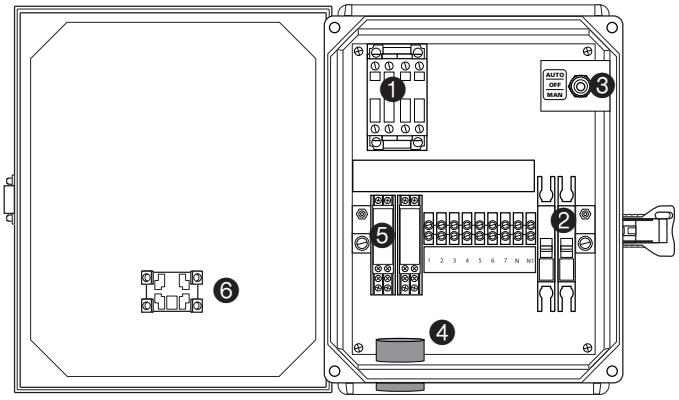
Orenco's ProPak™ demand dose control panels are specifically engineered for the ProPak pump package and are ideal for applications such as demand dosing from a septic tank into a conventional gravity drainfield.

Materials of Construction	
Enclosure	UV-resistant fiberglass, UL Type 4X
Hinges	Stainless steel
Dimensions, in. (mm)	
A - Height	11.5 (290)
B - Width	9.5 (240)
C - Depth	5.4 (135)
Specifications	
Panel ratings	120 V, 3/4 hp (0.56 kW), 14 A, single phase, 60 Hz
1. Motor-start contactor	16 FLA, 1 hp (0.75 kW), 60 Hz; 2.5 million cycles at FLA (10 million at 50% of FLA)
2. Circuit breakers	120 V, 10 A, OFF/ON switch, Single pole
3. Toggle switch	Single-pole, double-throw HOA switch, 20 A
4. Audio alarm	95 dB at 24 in. (600 mm), warble-tone sound, UL Type 4X
5. Audio alarm silence relay	120 V, automatic reset, DIN rail mount
6. Visual alarm	7/8-in. (22-mm) diameter red lens, "Push-to-silence," 120 V LED, UL Type 4X

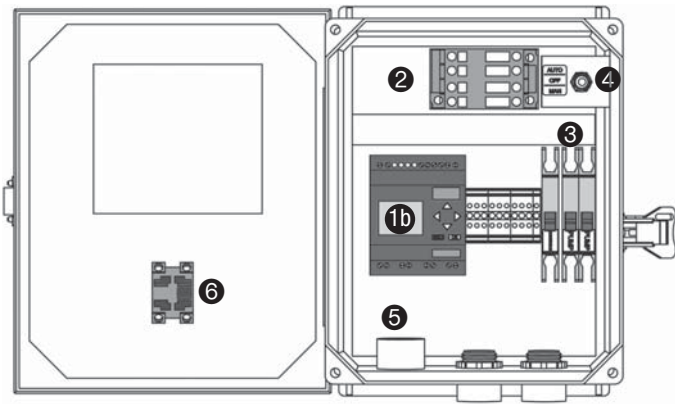
Control Panel (Timed Dose)

Orenco's ProPak timed dose control panels are specifically engineered for the ProPak pump package and are ideal for applications such as timed dosing from a septic tank into a pressurized drainfield or mound. Analog or digital timers are available.

Materials of Construction	
Enclosure	UV-resistant fiberglass, UL Type 4X
Hinges	Stainless steel
Dimensions, in. (mm)	
A - Height	11.5 (290)
B - Width	9.5 (240)
C - Depth	5.4 (135)
Specifications	
Panel ratings	120 V, 3/4 hp (0.56 kW), 14 A, single phase, 60 Hz
Dual-mode	Programmable for timed- or demand-dosing (digital timed-dosing panels only)
1a. Analog timer	120 V, repeat cycle from 0.05 seconds to 30 hours. Separate variable controls for OFF and ON time periods
1b. Digital timer	120-V programmable logic unit with built-in LCD screen and programming keys. Provides control functions and timing for panel operation
2. Motor-start contactor	16 FLA, 1 hp (0.75 kW), 60 Hz; 2.5 million cycles at FLA (10 million at 50% of FLA)
3. Circuit breakers	120 V, 10 A, OFF/ON switch. Single pole 120 V
4. Toggle Switch	Single-pole, double-throw HOA switch, 20 A
5. Audio alarm	95 dB at 24 in. (600 mm), warble-tone sound, UL Type 4X
6. Visual alarm	7/8-in. (22-mm) diameter red lens, "Push-to-silence", 120 V LED, UL Type 4X



Control panel, demand-dose



Control panel, timed-dose (digital timer model shown)

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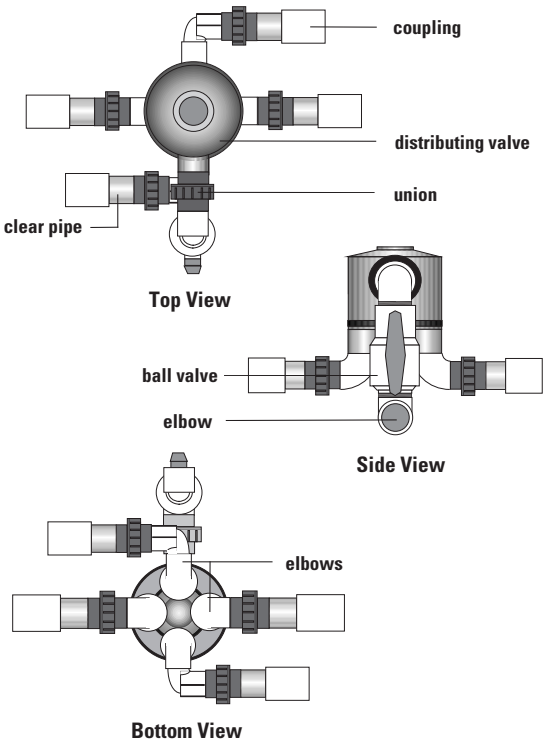
Distributing Valves

Submittal
Data Sheet

Orenco Systems®
Incorporated
1-800-348-9843

Applications

Automatic Distributing Valve Assemblies are used to pressurize multiple zone distribution systems including textile filters, sand filters and drainfields.



General

Orenco's Automatic Distributing Valve Assemblies are mechanically operated and sequentially redirect the pump's flow to multiple zones or cells in a distribution field. Valve actuation is accomplished by a combination of pressure and flow. Automatic Distributing Valve Assemblies allow the use of smaller horsepower pumps on large sand filters and drainfields. For example, a large community drainfield requiring 300 gpm can use a six-line Valve Assembly to reduce the pump flow rate requirement to only 50 gpm.

Orenco only warrants Automatic Distributing Valves when used in conjunction with High-Head Effluent Pumps with Biotube® Pump Vaults to provide pressure and flow requirements, and to prevent debris from fouling valve operation. An inlet ball valve and a section of clear pipe and union for each outlet are provided for a complete assembly that is easy to maintain and monitor. Ideal valve location is at the high point in the system. Refer to Automatic Distributing Valve Assemblies (NTP-VA-1) for more information.

Standard Models

V4402A, V4403A, V4404A, V4605A, V4606A, V6402A, V6403A, V6404A, V6605A, V6606A.

Nomenclature

V □□ □□ A

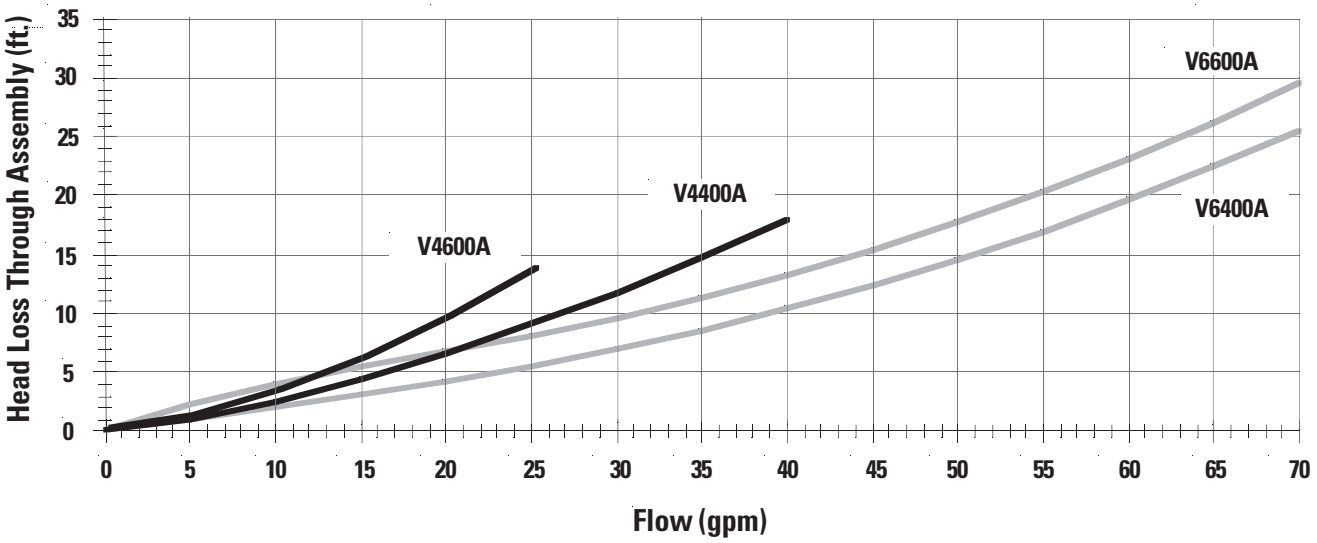
- A — Indicates assembly
- □□ — Number of active outlets
- □□ — Model series:
  - 44 = 4400 series (2-4 outlets)
  - 46 = 4600 series (5-6 outlets)
  - 64 = 6400 series (2-4 outlets)
  - 66 = 6600 series (5-6 outlets)
- V — Distributing valve

Specifications

Materials of Construction

All Fittings:	Sch. 40 PVC per ASTM specification
Unions:	Sch. 80 PVC per ASTM specification
Ball Valve:	Sch. 40 PVC per ASTM specification
Clear Pipe:	Sch. 40 PVC per ASTM specification
V4XXX Distributing Valves:	High-strength noncorrosive ABS polymer and stainless steel
V6XXX Distributing Valves:	High-strength noncorrosive ABS polymer, stainless steel, and die cast metal

Distributing Valves (continued)



Model	Inlet Size (in.)	Outlets Size (in.)	Flow range (gpm)	Max Head (ft.)	Min. Enclosure
V4402A	1.25	1.25	10 - 40	170	VB1217
V4403A	1.25	1.25	10 - 40	170	VB1217
V4404A	1.25	1.25	10 - 40	170	VB1217
V4605A	1.25	1.25	10 - 25	170	RR2418
V4606A	1.25	1.25	10 - 25	170	RR2418
V6402A	1.5	1.5	15 - 100	345	RR2418
V6403A	1.5	1.5	15 - 100	345	RR2418
V6404A	1.5	1.5	15 - 100	345	RR2418
V6605A	1.5	1.5	15 - 100	345	RR2418
V6606A	1.5	1.5	15 - 100	345	RR2418

Appendix C
Manufacturer Installation, Maintenance, and Troubleshooting Guides

This article may describe design criteria that was in effect at the time the article was written. FOR CURRENT DESIGN CRITERIA, call Orenco Systems, Inc. at 1-800-348-9843.

Orenco Automatic Distributing Valve Assemblies

Orenco Systems®
Incorporated
1-800-348-9843

For Wastewater Effluent Systems

Introduction

Orenco's automatic distributing valve assemblies, pressurized with small high-head effluent pumps, are useful for distributing effluent to multiple zones. These zones can be segments of sand filter manifolds, drainfields, or other effluent distribution systems. Distributing valve assemblies can substantially simplify the design and installation of a distribution system and reduce installation costs. This is particularly true where a distributing valve assembly is used instead of multiple pumps and/or electrically operated valves. Additionally, a reduction in long term operation and maintenance costs is realized due to a reduced size and/or number of pumps. More even distribution can be achieved on sloping sites by zoning laterals at equal elevations. This eliminates drainback to lower lines and the unequal distribution of effluent that occurs at the beginning of a cycle.

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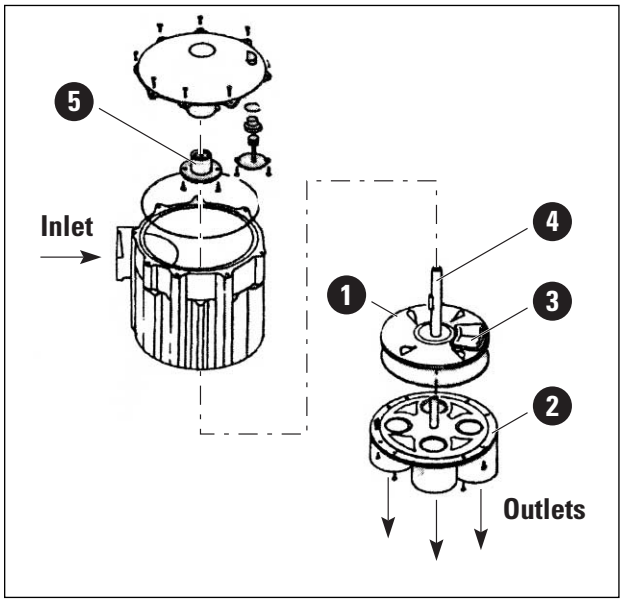

Figure 1:
6000 Series Valve

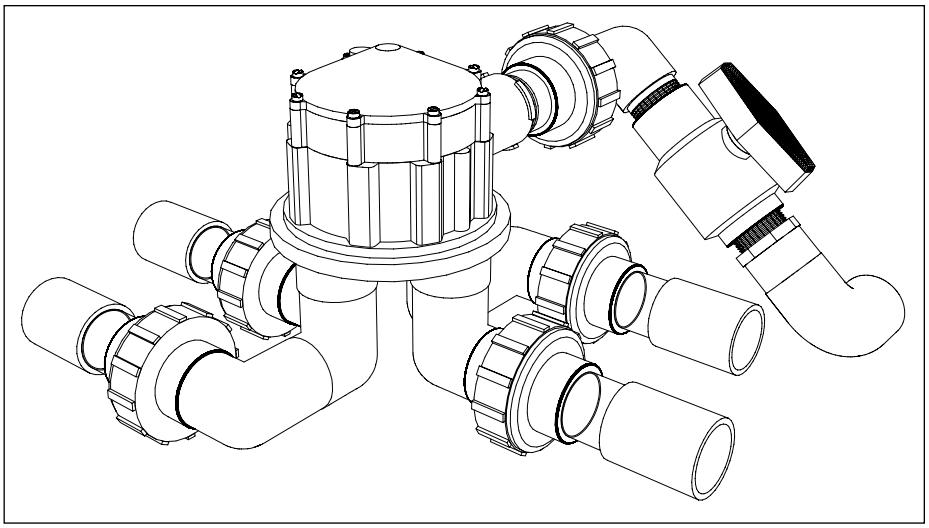

Figure 2:
Orenco Distributing Valve Assembly (6000 Series Valve)

The Distributing Valve Assembly

The Orenco Automatic Distributing Valve Assembly combines the distributing valve itself and several other components to give a complete preassembled unit that is easy to install, monitor, and maintain. Figure 2 shows a complete assembly. Because distributing valves with several outlets can be difficult to line up and glue together in the field, the discharge lines in the assemblies are glued in place at Orenco. The unions (1) allow removal and maintenance of the valve. The clear PVC pipe sections (2) give a visual check of which discharge line is being pressurized. The inlet ball valve (3) allows a quick, simple method to test for proper valve cycling. The ball valve also stops the flow of effluent in case the pump is activated unexpectedly during maintenance or inspection. Check valves may be necessary on the discharge lines. Use of check valves is discussed in the valve positioning section.

Valve Assembly Hydraulics

Liquid flowing through the valve assembly must pass through fairly small openings and make several changes in direction. Because of this, headlosses through the valve assembly are fairly high. Table 1 gives the headloss equations for several different assemblies and Figure 3 shows the graphical representations of these equations. Orenco recommends that high-head turbine pumps be used to pressurize the valve assemblies to ensure enough head is available for proper system operation. High-head turbine pumps are also recommended because the use of a distributing valve usually requires more frequent pump cycling. The high-head turbine pumps are designed for high cycling systems and will outlast conventional effluent pumps by a factor of 10 or more in a high cycling mode. Furthermore, the high-head turbine pump intake is 12 inches or more above the bottom of the pump and tends to prevent any settled solids from being pumped into the distribution valve and obstructing its operation. A minimum flow rate through the distributing valve is required to ensure proper seating of the rubber flap disk. Minimum flow rates for the various models are given in Table 1.

Table 1. Automatic Distributing Valve Assembly Headloss Equations

Model Series	Equation	Operating Range (gpm)
V4400A	$H_L = 0.085 \times Q^{1.45}$	10 - 40
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V6400A	$H_L = 0.0045 \times Q^2 + 3.5 \times (1 - e^{-0.06Q})$	15 - 70
V6600A	$H_L = 0.0049 \times Q^2 + 5.5 \times (1 - e^{-0.1Q})$	15 - 70

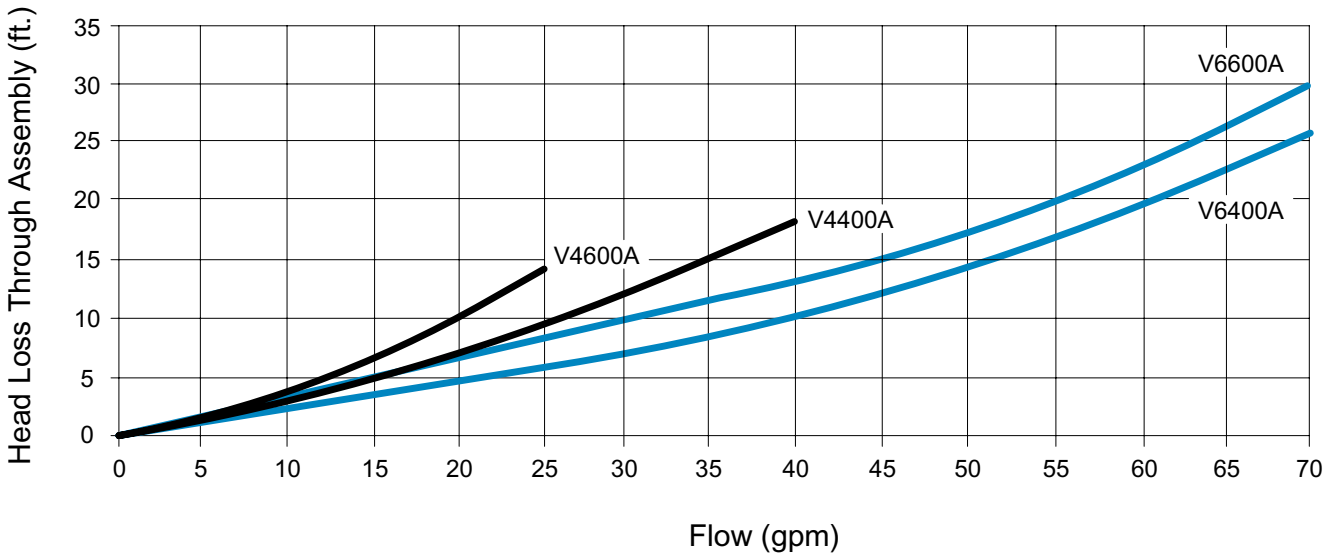

Figure 3:
Automatic distributing valve assembly headloss curves

The Pumping System

Although the distributing valve was designed for the irrigation industry, it has started to gain fairly wide acceptance in the effluent pumping industry. However, because of the mechanical movements of the valve, it is necessary to take steps to prevent solids from reaching the distributing valve that may impede the operation of the valve. Orenco Biotube® Pump Vaults — when properly sized and installed — provide the necessary protection to prevent valve malfunction. The Biotube® pump vault accepts effluent only from the clear zone between a tank's scum and sludge layers and then filters this effluent through a very large surface area screen cartridge. Without this protection in effluent systems, the valve has very little chance of reliable long-term operation.

Valve Positioning

The physical position of the valve in relation to the pump and the discharge point is very important for proper valve operation. The most reliable operation occurs when the valve is placed at the high point in the system and as close to the pump as possible. The transport line between the pump and valve should be kept full if possible. If the line is empty at the beginning of each cycle, pockets of air during filling can cause random rotation of the valve. The valve is particularly vulnerable to this erratic rotation with empty lines that are long and not laid at a constant grade. An ideal valve location is shown in Figure 4.

If the final discharge point is more than about 2 feet above the valve and the system does not drain back into the dosing tank, check valves should be installed on the lines immediately following the valve and a pressure release hole or line should be installed just prior to the valve. This pressure release hole or line can go into a return line to the dosing tank or to a "minidrainfield" near the valve. In order for the valve to rotate reliably, no more than about 2 feet of head should remain against the valve to allow the rubber flap disk to return to its up position. In many cases, it may take from one minute to several minutes for the pressure in the valve to be lowered enough for proper rotation to occur. Special care should be taken when installing systems controlled by programmable timers to ensure cycling does not occur too rapidly. Figure 5 illustrates a valve assembly using check valves. Pumping downhill to the valve should be avoided unless the transport line is very short and the elevation between the discharge line out of the tank and the valve is less than about 2 feet. If the valve is located many feet below the dosing tank, random cycling may occur while the transport line drains through the valve at the end of the cycle. A pressure sustaining valve located just before the distributing valve may overcome this problem in some instances.

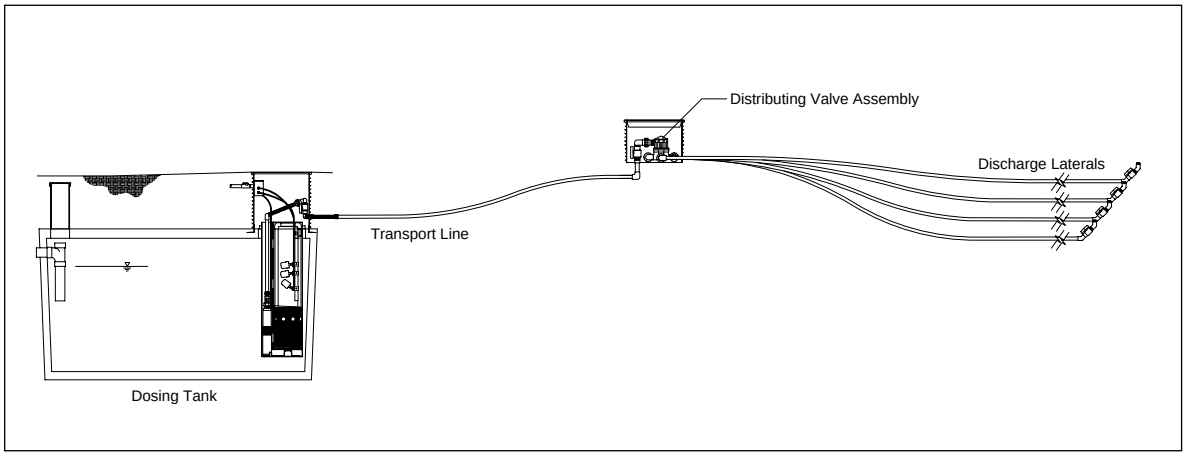

Figure 4:
Ideal valve location

System Startup

Refer to the Hydrotek Valve booklet that is provided with the distributing valve assembly for the sequencing of the valve outlets. The transport line should always be flushed with clean water before installing the valve. Any sand, gravel, or other foreign objects that may have been in the pipe during installation can easily become lodged in the distributing valve, causing malfunction.

With the pump running, alternately close and open the ball valve on the distributing valve assembly to check proper rotation of the valve. (Note: If check valves are used on the lines after the distributing valve, the pump may need to be turned on and off to allow the pressure to be released from the valve.) If visual operation of which zone is operating is not possible, watch the clear pipe on each line for indication of which zone is operating.

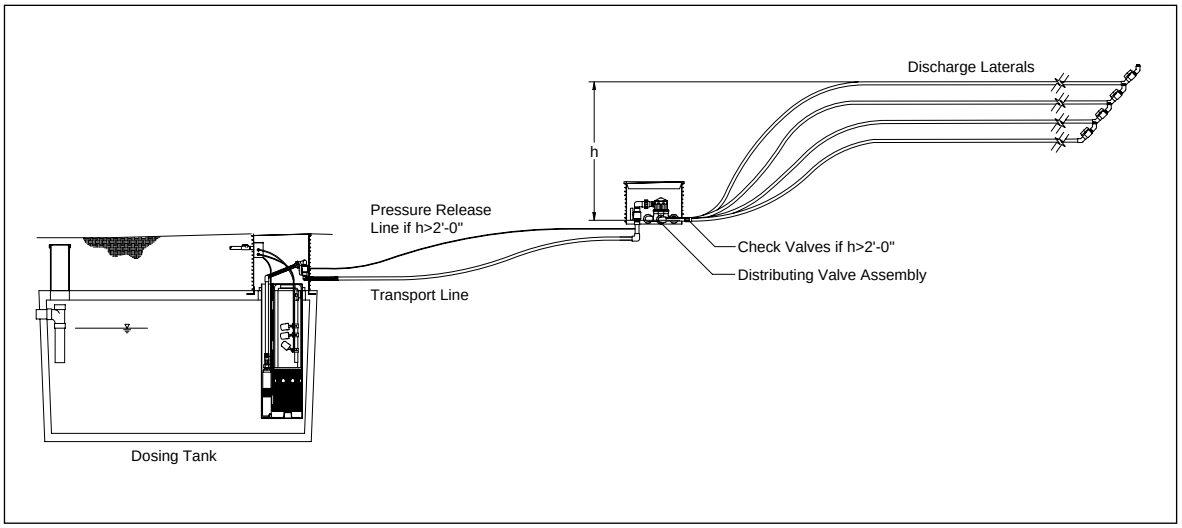

Figure 5:
Valve assembly below final discharge point

Maintenance

Annually check for proper operation by following procedures listed in the Hydrotek Valve booklet and system startup procedures listed above.

Troubleshooting

1. PROBLEM: Valve does not change or cycle to next zone or outlet

CAUSE: The stem and disk assembly is not rotating when water flow is turned off and then back on.

SOLUTION 1: Ensure that there is no debris inside the cam. Clean and carefully reinstall the cam.
SOLUTION 2: If fewer than the maximum number of outlets are being used, check the installation of the cam. Ensure that the stem and disk assembly is not being held down by an improperly installed cam. Refer to the cam replacement instructions.

SOLUTION 3: Remove the valve top and check for proper movement of stem and disk assembly. Check for and remove any debris or foreign objects that may jam or retard the movement of the disk.

SOLUTION 4: Check for freedom of movement of stem and disk assembly up and down over the center pin in bottom of valve. Scale deposits may build up on the pin and hold stem and disk assembly down. Clean pin and again check for freedom of movement.

SOLUTION 5: Be sure that all operating outlets are not capped and that the flow to operating zones is not restricted in any manner. This would cause pressure to build up in the valve and lock the stem and disk assembly in the down position.

SOLUTION 6: The backflow of water from uphill lines may be preventing the valve from cycling properly. This can happen when the valve is placed too far below an elevated line. If the valve cannot be placed close to the high point of the system, a check valve should be installed near the valve in the outlet line that runs uphill from the valve and a drain line installed just prior to the valve to relieve the pressure.

2. PROBLEM: Water comes out of all the valve outlets

CAUSE: Stem and disk assembly not seating properly on valve outlet.

SOLUTION 1: Check for sufficient water flow. A minimum flow rate is required to properly seat the disk as shown in Table 1.

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3. PROBLEM: Valve skips outlets or zones

CAUSE: Pumping into an empty transport line — especially downhill — may cause the valve to skip outlets from pockets of air allowing the rubber flap disk to raise during a cycle.

SOLUTION 1: Keep the transport line full.

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CAUSE: The stem and disk assembly is being advanced past the desired outlet.

SOLUTION 1: Ensure that the correct cam for the desired number of zones is installed and that the outlet lines are installed to the correct outlet ports of the valve as indicated by the zone numbers on the top of the cam.

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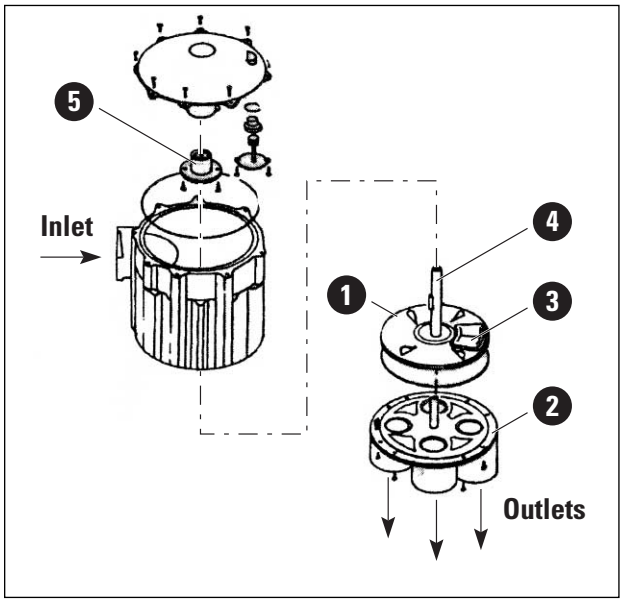
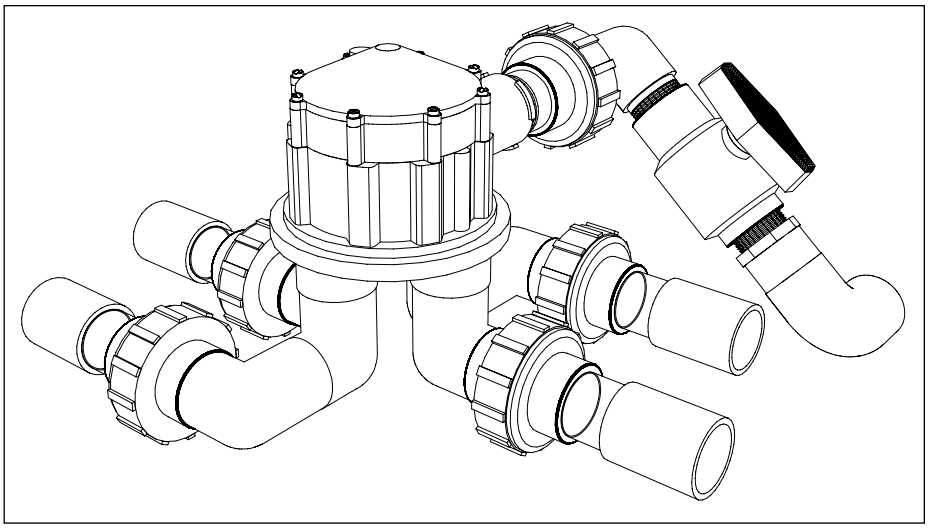


Figure 1:
6000 Series Valve



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Orenco Distributing Valve Assembly (6000 Series Valve)

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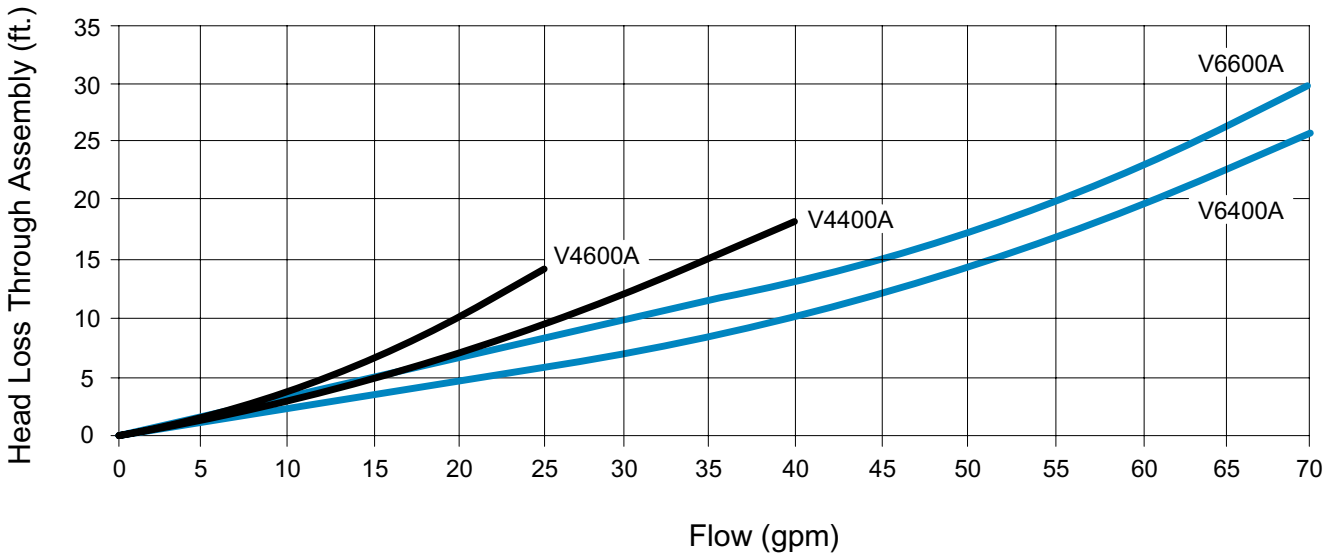

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Automatic distributing valve assembly headloss curves

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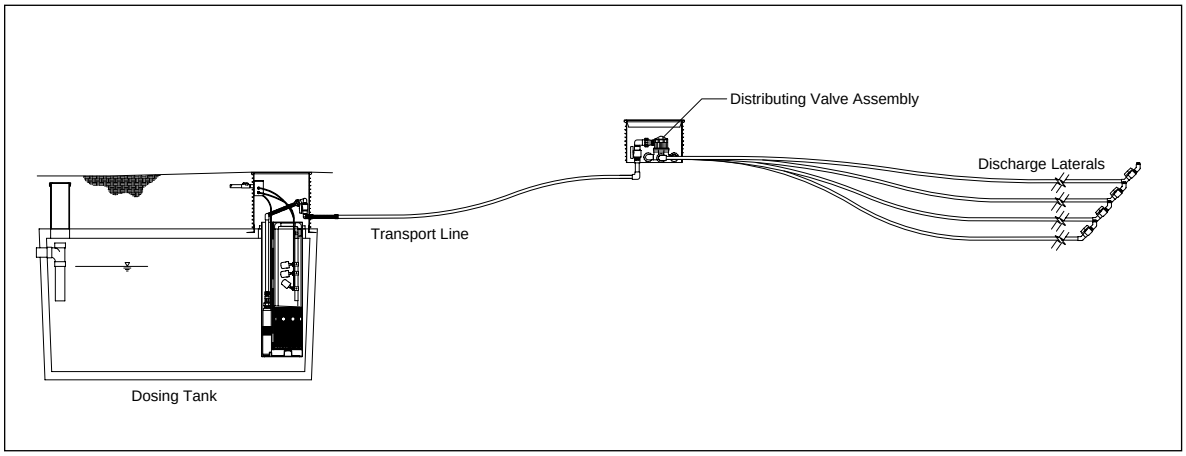

Figure 4:
Ideal valve location

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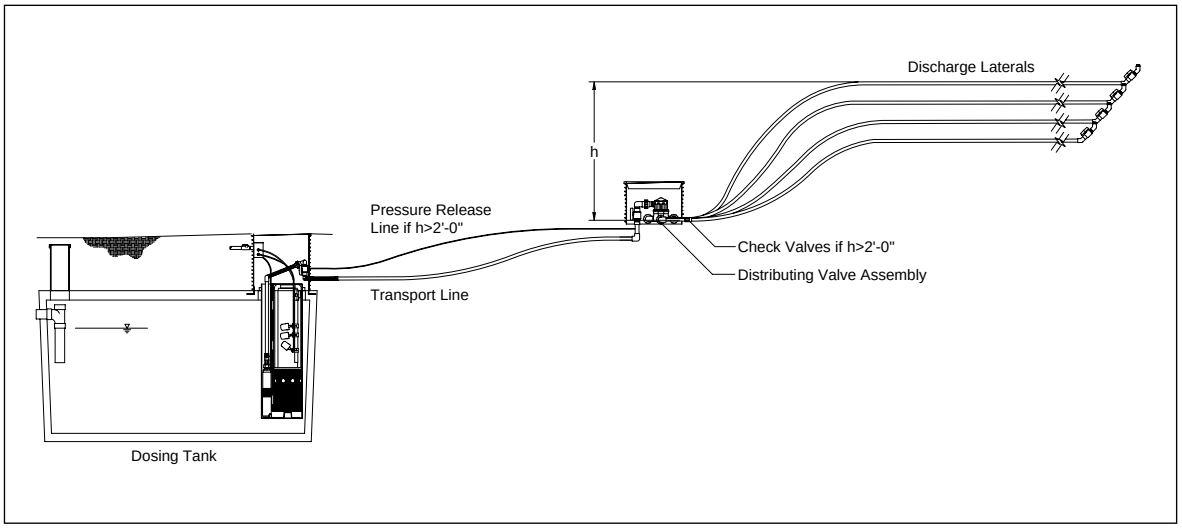

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Valve assembly below final discharge point

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CAUSE: The stem and disk assembly is being advanced past the desired outlet.

SOLUTION 1: Ensure that the correct cam for the desired number of zones is installed and that the outlet lines are installed to the correct outlet ports of the valve as indicated by the zone numbers on the top of the cam.

Orenco® SYSTEMS *Instructions*

Biotube® Effluent Filter Installation

Model FT08 and All Base Inlet Models

(U.S. Patent Nos. 5294635 / 4439323)

Before You Begin

Be sure the tank is empty before you attempt to perform this installation.

In existing tanks or in tanks with short outlet stubs, it may be necessary to extend the tank outlet stub by using a coupling and a pipe section. A coupling may also be needed to bush from 3034 PVC to the Schedule 40 outlet of the filter.

IMPORTANT: *Take proper precautions and wear personal protection equipment (PPE) whenever working in an enclosed area, such as a septic tank.*

Step 1: Dry Fit Vault

Step 1a: Remove the Biotube® filter cartridge from the vault.

Step 1b: Dry fit the vault's outlet to the tank outlet stub.

- Make sure there is enough clearance at the tank opening to remove the Biotube filter cartridge for cleaning and tank pumping.

Step 1c: Remove the vault from the tank outlet stub.

Step 2: Install Vault And Filter

Stainless steel self-drilling screws can be used in place of PVC cement in this step.

Step 2a: Apply PVC cement to the outside of the tank outlet stub and the inside of the vault's outlet.

- Don't use PVC cement if you are using stainless steel screws.

Step 2b: Press the vault into position on the tank stub.

- Make sure the vault is straight and vertical, adjust it if necessary.
- Secure the vault with the stainless steel screws, if you are using this method.

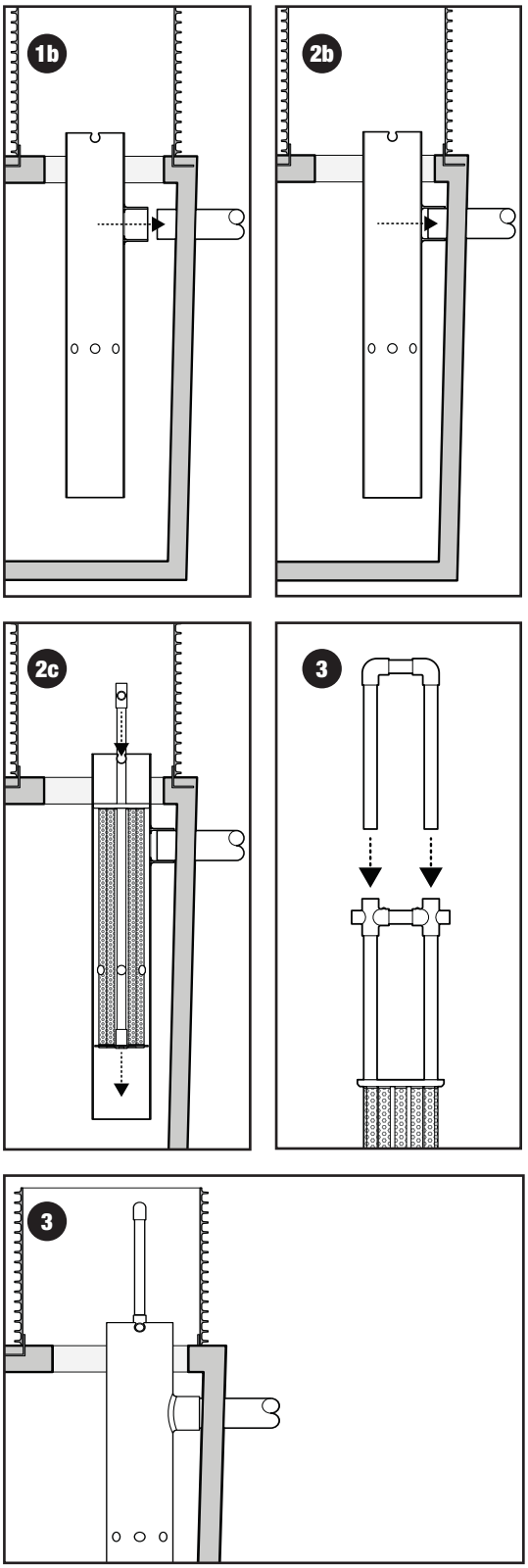
Step 2c: Install the Biotube filter cartridge into the vault.

- Makes sure the handle tees snap into the vault body.

Step 3: Adjust Handle Length, If Necessary

If necessary, extend the filter cartridge's handle to make access easier from the top of the riser.

- Use 1-in. (25-mm) Schedule 40 PVC for the handle extension.
- If the handle extension is longer than 4 feet (1.2 m), make a stiffening "ladder" with tees and horizontal pipe sections.
- Secure the extension on the handle with stainless steel self-drilling screws or PVC cement.



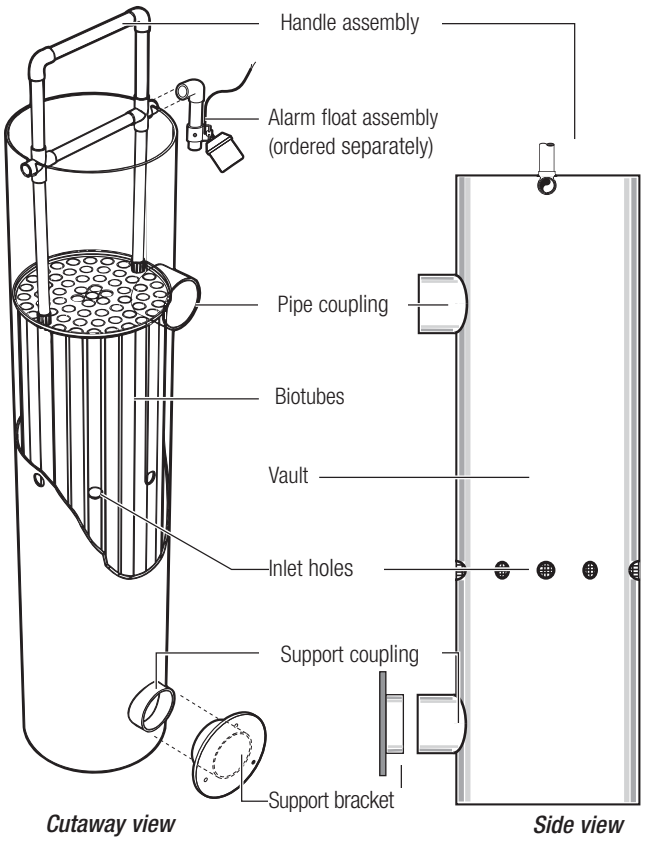
8-in. to 15-in. Dia. Biotube Effluent Filters

Applications

Orenco® 8-inch to 15-inch Biotube® Effluent Filters are designed to remove solids from effluent leaving commercial septic tanks. They can be used in new and existing tanks.

General

Orenco® 8-inch to 15-inch Biotube® Effluent Filters* are used to improve the quality of effluent exiting a commercial septic tank. The Biotube cartridge fits snugly in the vault and is removable for maintenance, the handle assembly snaps into the notches in the top of the vault, and the tee handle can be extended for easy removal of the cartridge. A "base inlet" model (see p. 2) is available for low-profile tanks. An optional slide rail system, available on larger models, simplifies installation and provides tank access for servicing.



** Orenco® Biotube® Effluent Filters are covered under multiple U.S. and international patents.*

Standard Models

FT0854-36, FT1254-36, FT1554-36, FT0822-14B, FT1254-36AR

Product Code Diagrams

FT ☐ ☐ ☐ - 36 ☐

- Float switch bracket and slide rail options:
  Blank = no options selected
  A = float switch bracket installed
  R = slide rail installed†
- Cartridge height, in. (mm):
  36 = 36 (914), standard
- Housing height*, in. (mm):
  48 = 48 (1219)
  54 = 54 (1372)
  60 = 60 (1524)
  66 = 66 (1676-mm)
- Filter diameter, in. (mm):
  08 = 08 (200)
  12 = 12 (300)
  15 = 15 (375)
- Filter mesh option:
  Blank = 1/8-in. (3-mm) filter mesh
  P = 1/16-in. (1.6-mm) filter mesh
- Biotube® effluent filter

* Minimum liquid level (MLL) information:
48-in. (1219-mm) housing for MLL of 37-46 in. (940-1168 mm)
54-in. (1372-mm) housing for MLL of 47-63 in. (1194-1600 mm)
60-in. (1524-mm) housing for MLL of 64-84 in. (1626-2134 mm)
66-in. (1676-mm) housing for MLL of 85-112 in. (2159-2845 mm)

† For 12- and 15-in. (300- and 375-mm) only; use slide rail option when only one access is available for the filter chamber

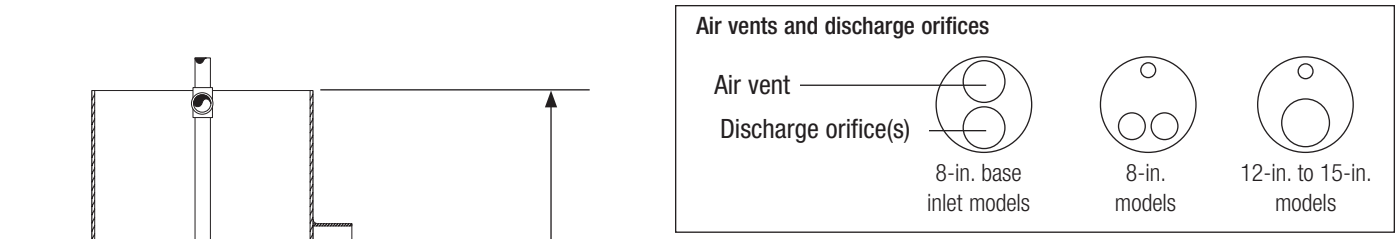
FT ☐ ☐ 22 - 14 B ☐

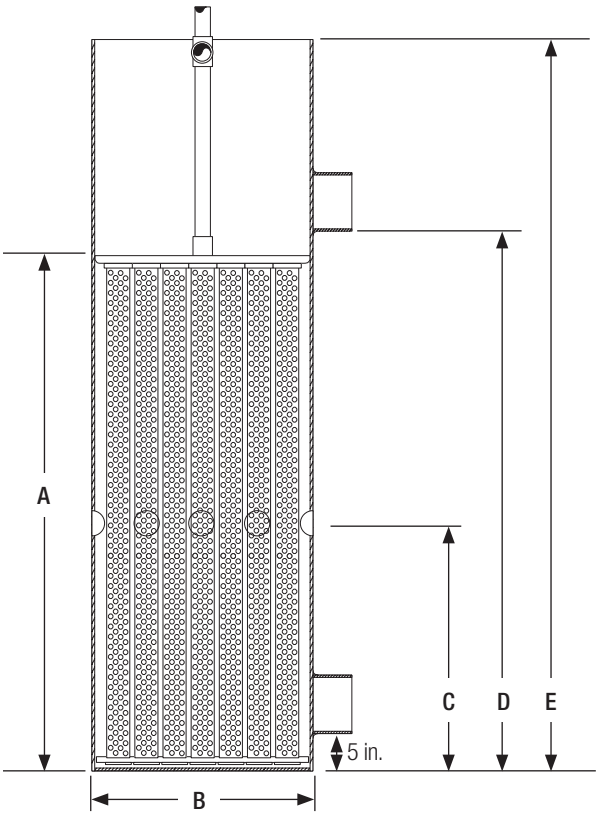
- Float switch bracket and overflow plate options:
  Blank = no options selected
  A = float switch elbow installed
  FSO = overflow plate installed
- Base inlet model
- Cartridge height, in. (mm):
  14 = 14 (356), standard
- Filter housing height, in. (mm):
  22 = 22 (558), standard
- Filter diameter, in. (mm):
  08 = 8 (200)
  12 = 12 (300)
- Filter mesh option:
  Blank = 1/8-in. (3-mm) filter mesh
  P = 1/16-in. (1.6-mm) filter mesh
- Biotube® effluent filter

Materials of Construction

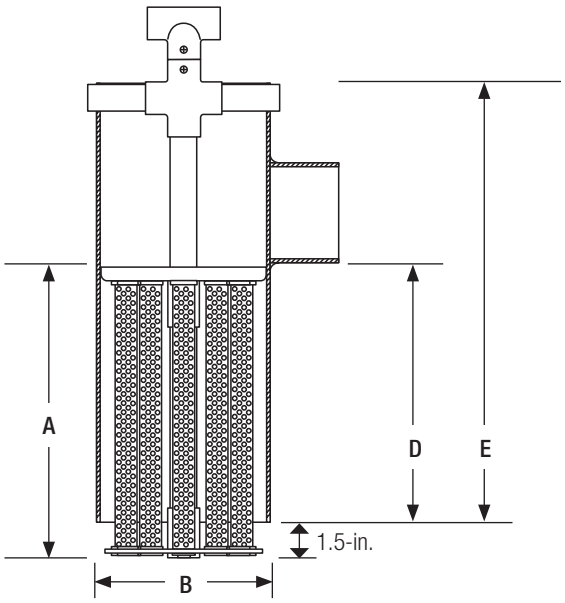
Vault	PVC
Pipe coupling	PVC
Handle components	PVC
Support coupling and bracket	PVC
Biotube® cartridge	Polypropylene and polyethylene

Note: Support coupling and support bracket are available on 12-inch and 15-inch filters only.





Standard model



Base inlet model

Specifications

Model	FT0854-36	FT0822-14B	FT1254-36	FT1254-36AR	FT1554-36
A - Cartridge height, in.	36	14	36	36	36
B - Nominal diameter, in.	8	8	12	12	15
C - Inlet hole height*, in.	22	n/a†	22	22	22
D - Vault base to invert height, in.	38	13	38	38	38
E - Vault height	54	22	54	54	54
Number of inlet holes	8	n/a	8	8	8
Inlet hole diameter, in.	1.375	n/a	1.375	1.375	1.375
Number of discharge orifices	2	1	1	1	1
Discharge orifice diameter, in.	1.125	1.750	2	2	2
Pipe coupling diameter, in.	4	4	4	4	4
Number of air vents	1	1	1	1	1
Air vent diameter, in.	0.75	1.750	0.75	0.75	0.75
Filter surface area‡, ft^2	14.6	6.0	30.0	30.0	50.5
Flow area**, ft^2	4.4	1.8	9.0	9.0	15.2

** Inlet hole height can vary depending on the configuration of the tank. Optimum hole height is 65-75% of the minimum liquid level.*

† No inlet holes required, because influent enters between the vault base and the bottom of the filter cartridge.

‡ Filter area is defined as the total surface area of all individual Biotubes® within the filter cartridge.

*** Flow area is defined as the total open area (area of the mesh openings) of all the individual Biotubes within the filter cartridge.*

Orenco Systems® Inc. , 814 Airway Ave., Sutherlin, OR 97479 USA • 800-348-9843 • 541-459-4449 • www.orenco.com

Appendix D
Inspection Report Form

WASTEWATER SYSTEM INSPECTION REPORT

General Information	
Site Location	**Grassy Mountain, 22 miles SW of Vale, OR**
Facility	**Grassy Mountain Gold Mine**
Date of Inspection	
Inspector's Name(s)	
Inspector's Title(s)	
Weather Information	
Describe the weather at the time of the inspection:	

Inspection Activity	Tested or Inspected	Notes
Test pump alarm. Does the visual alarm work?	❑Yes ❑No	
Test pump alarm. Does the audible alarm work?	❑Yes ❑No	
Test float switches. Do switches activate alarms?	❑Yes ❑No	
Inspect septic tank. Is there air space between the top of the scum layer and the inside top of the tank?	❑Yes ❑No	
Is less than 40% of the septic tank filled with sludge (28-5/8 inches or less from the tank bottom)	❑Yes ❑No	
Is the pumping chamber free of solids? (Floating or settled at the bottom of the tank)	❑Yes ❑No	
Inspect the effluent filter. Is the screen free of scum/solids?	❑Yes ❑No	
Inspect observation ports within the drainfield. Are pipes free of standing water?	❑Yes ❑No	
Check pump cycle counters. Does each pump have approximately the same count?	❑Yes ❑No	

If the answer to any of the questions above is No, then consult the Operations and Maintenance Manual for how to correct the failure or contact the system maintenance contractor/operator.

Print name: _____

Signature: _____

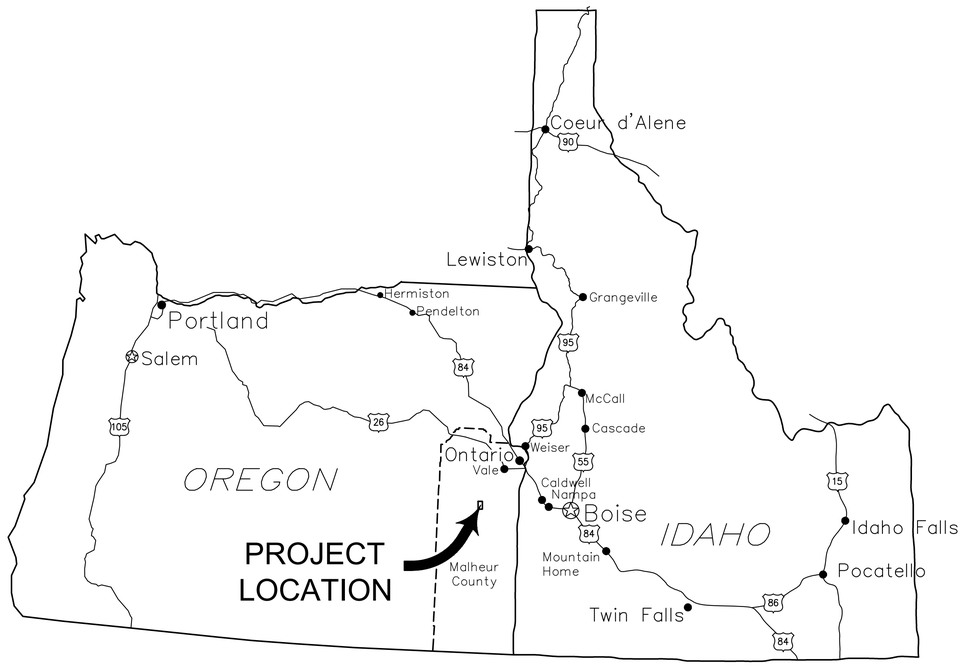
Date: _____

GRASSY MOUNTAIN GOLD MINE

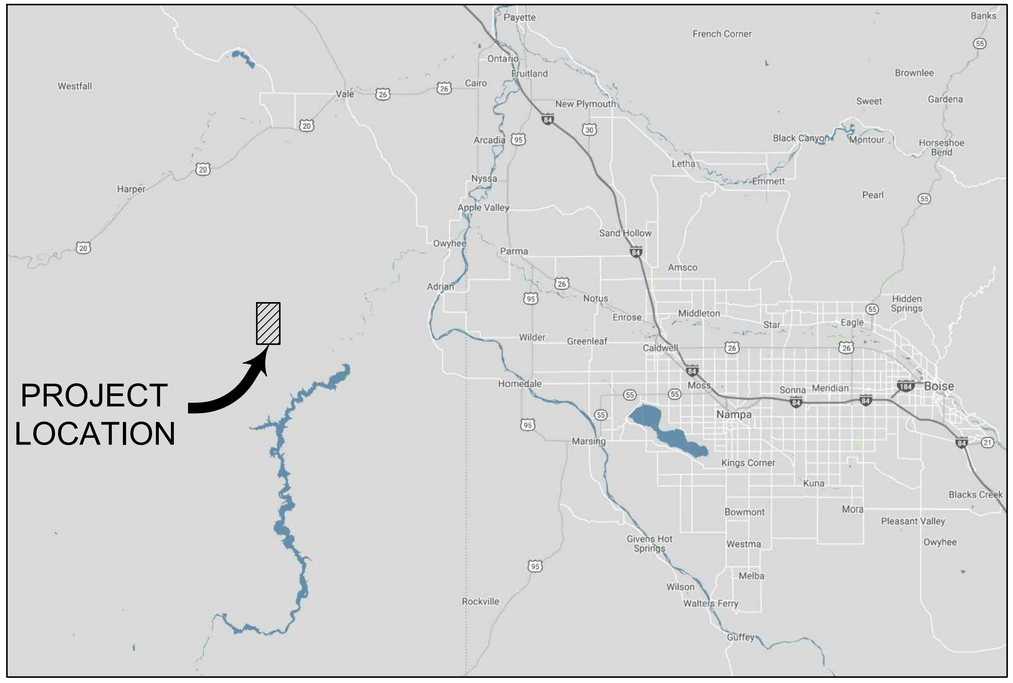
WATER & WASTEWATER SYSTEM

CALICO RESOURCES USA CORP.

MALHEUR COUNTY, OREGON 2019



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NO SCALE

PROJECT TEAM

OWNER
CALICO RESOURCES USA CORP.
ATTN: GLEN VAN TREEK
665 ANDERSON STREET
WINNEMUCCA, NV 89445
PHONE: (775) 625-3600
EMAIL: glen@paramountnevada.com

PLANT DESIGN
AUSENCO MINERALS AND METALS
ATTN: STEPHEN GREGOR, P.E.
855 HOMER STREET
VANCOUVER, BC, CANADA V6B 2W2
PHONE: (604) 684-9311
EMAIL: stephen.gregor@ausenco.com

TSF DESIGN
GOLDER ASSOCIATES INC.
ATTN: CHRIS MACMAHON, P.E.
595 DOUBLE EAGLE COURT, SUITE 1000
RENO, NV 89521
PHONE: (775) 828-9604
EMAIL: chris_macmahon@golder.com

WATER & WASTEWATER
SPF WATER ENGINEERING
ATTN: JASON THOMPSON, P.E.
300 E MALLARD DR, SUITE 350
BOISE, ID 83706
PHONE: (208) 383-4140
EMAIL: jthompson@spfwater.com

MINE DESIGN
MINE DEVELOPMENT ASSOCIATES
ATTN: TOM DYER, P.E.
210 SOUTH ROCK BLVD.
RENO, NV 89502
PHONE: (775) 856-5700
EMAIL: tdyer@mda.com

INDEX OF SHEETS

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C002 GENERAL NOTES, OPERATIONAL DESCRIPTION & CP SPEC.
C003 DESIGN CRITERIA
C100 WATER SYSTEM SITE OVERVIEW
C101 RAW WATER SUPPLY PROFILE OVERVIEW
C102 WELL 3 (PW-4) SITE PLAN
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C104 WELL 5 SITE PLAN
C105 WELL 3 (PW-4) POTENTIAL CONTAMINATION MAP
C106 WELL 4 POTENTIAL CONTAMINATION MAP
C107 WELL 5 POTENTIAL CONTAMINATION MAP
C200 RAW WATER PLAN & PROFILE 0+00 TO 25+00
C201 RAW WATER PLAN & PROFILE 25+00 TO 50+00
C202 RAW WATER PLAN & PROFILE 50+00 TO 75+00
C203 RAW WATER PLAN & PROFILE 75+00 TO 100+00
C204 RAW WATER PLAN & PROFILE 100+00 TO 123+00
C205 RAW WATER PLAN & PROFILE 123+00 TO 147+66 (TANK)
C300 POTABLE AND RAW WATER LOOPS
C301 POTABLE WATER SYSTEM PFD & HGL
C302 WATER TREATMENT MECHANICAL LAYOUT
C303 WATER TREAMENT BACKWASH LIFT STATION
C304 TREATED WATER STORAGE TANK
C400 SEWER COLLECTION SYSTEM SITE PLAN
C401 ABSORPTION TRENCH & REPLACEMENT AREAS SITE PLAN
C402 SEWER COLLECTION 1
C403 SEWER COLLECTION 2
M100 WELL 3 (PW-4) MECHANICAL PLAN & SECTION
M101 WELL 4 MECHANICAL PLAN & SECTION
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M500 MECHANICAL DETAILS
S1.0 GENERAL STRUCTURAL NOTES
S2.0 TREATED WATER STORAGE TANK FOUNDATION PLAN & DETAILS
C500 TRENCH DETAILS
C501 THRUST BLOCK DETAILS
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C503 AIR VALVE DETAILS AND SCHEDULE
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C507 FENCE AND GATE DETAILS
C508 SEPTIC TANK DETAILS
C509 ABSORPTION TRENCH AND CHAMBER DETAILS

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

COVER SHEET

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C001

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: COVER AND GENERAL NOTES Plot date: Aug 22, 2019-01:26:20pm CAD User: HWhite.
Xref Filename: | X-TITLE | X-TITLE (2) |

GENERAL CONSTRUCTION NOTES

1. NO PUBLIC WATER SYSTEM FACILITIES SHALL BE CONSTRUCTED PRIOR TO RECEIPT OF OREGON HEALTH AUTHORITY APPROVAL.
2. CONSTRUCTION SHALL BE PER STATE OR COUNTY STANDARDS FOR PUBLIC WORKS CONSTRUCTION OR PROJECT PLANS/SPECIFICATIONS, WHICHEVER IS MORE STRINGENT.
3. CONTRACTOR SHALL FURNISH AND INSTALL EVERYTHING REQUIRED TO PROVIDE COMPLETE AND OPERABLE FACILITIES AS SHOWN HEREON. IF THERE IS AN OMISSION ON THE PLANS, SUCH OMISSION SHALL NOT BE CONSTRUED TO MEAN THAT THE CONTRACTOR IS NOT REQUIRED TO FURNISH OR PROVIDE EVERYTHING THAT IS NECESSARY TO PROVIDE COMPLETE AND OPERABLE FACILITIES.
4. ANY CHANGES TO THE DESIGN AS SHOWN IN THESE CONSTRUCTION DRAWINGS MUST BE REVIEWED AND APPROVED BY THE ENGINEER AND OWNER BEFORE CHANGES ARE MADE. THIS INCLUDES CHANGES REQUESTED BY THE OWNER'S REPRESENTATIVE AND SUBCONTRACTORS.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING MONUMENTS, OTHER SURVEY MARKERS, STREET SIGNS, UTILITIES, IRRIGATION LINES, PAVEMENT, TREES, FENCES, AND ANY OTHER IMPORTANT OBJECTS ON OR ADJACENT TO THE JOB SITE AS DETERMINED BY THE OWNER'S REPRESENTATIVE OR ENGINEER.
6. CONTRACTOR SHALL CONTACT OREGON DIG LINE 811 OR 1-(800) 332-2344 TO MARK AND IDENTIFY UNDERGROUND UTILITIES PRIOR TO EXCAVATION.
7. CONTRACTOR SHALL LEGALLY DISPOSE OF ALL EXCESS MATERIAL.
8. ALL "OR EQUAL" ITEMS ARE SUBJECT TO REVIEW AND APPROVAL OF THE ENGINEER.
9. CONTRACTOR SHALL PROVIDE, MAINTAIN, AND BE RESPONSIBLE FOR ALL EROSION AND SEDIMENT CONTROL STRUCTURES AND PRACTICES AND MEET THE REQUIREMENTS OF ANY AGENCY HAVING JURISDICTION.
10. CONTRACTOR TO OBTAIN ALL APPLICABLE WATER & WASTEWATER PERMITS.
11. UPON THE COMPLETION OF WORK, THE CONTRACTOR SHALL SUBMIT A SET OF "RED-LINED" RECORD DRAWINGS TO THE ENGINEER.
12. CONTRACTOR SHALL NOTIFY AND COORDINATE WITH THE OWNER'S REPRESENTATIVE PRIOR TO, DURING, AND AT THE COMPLETION OF CONSTRUCTION ACTIVITY.
13. IF WITHIN ONE (1) YEAR FROM THE DATE OF COMPLETION, THE WATER SYSTEM IMPROVEMENTS AND ALL APPURTENANCES OR ANY PART THEREOF INSTALLED AS NEW SHALL PROVE TO BE DEFECTIVE IN INSTALLATION, MATERIAL, OR WORKMANSHIP THE CONTRACTOR SHALL WARRANT REPLACEMENT OR REPAIR TO THE SATISFACTION OF THE OWNER'S REPRESENTATIVE AT NO EXPENSE TO THE OWNER.
14. MATERIALS IN CONTACT WITH POTABLE WATER DISTRIBUTION AND RAW WATER SUPPLY SHALL CONFORM TO APPLICABLE AWWA STANDARDS AND BE CERTIFIED BY AN ACCREDITED ANSI CERTIFICATION BODY TO MEET APPLICABLE ANSI/NSF STANDARDS, INCLUDING BUT NOT LIMITED TO ANSI/NSF STANDARD 61 FOR DRINKING WATER SYSTEM COMPONENTS AND ANSI/NSF STANDARD 372 FOR LEAD CONTENT IN DRINKING WATER SYSTEM COMPONENTS.
15. ALL WATER LINES SHALL BE FILLED, DISINFECTED, BACTERIA TESTED, HYDROSTATICALLY TESTED, AND FLUSHED IN ACCORDANCE WITH SECTION 01140 OF THE CURRENT EDITION OF THE OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION.
16. HYDROSTATIC TEST PRESSURE SHALL BE AT LEAST EQUAL TO 150 PSI OR 10% ABOVE THE WORKING PRESSURE OF THE PIPELINE, WHICHEVER IS GREATER. THE TEST PRESSURE SHALL NOT EXCEED THE PRESSURE RATING OF THE PIPE.
17. ALL CONTRACTORS WORKING ON THE PROJECT ARE RESPONSIBLE FOR COMPLIANCE WITH ALL APPLICABLE SAFETY LAWS OF ALL JURISDICTIONAL BODIES.
18. CONTRACTOR IS RESPONSIBLE FOR ALL PUMP SYSTEM TESTING AND START-UP, IN COORDINATION WITH PUMP CONTRACTOR.
19. ALL PLUMBING SHALL BE INSTALLED IN ACCORDANCE WITH UNIFORM PLUMBING CODE AND ALL APPLICABLE LOCAL AND STATE CODES.
20. SEPARATION DISTANCE BETWEEN SEWER/NON-POTABLE WATER LINES AND POTABLE WATER LINES SHALL BE 10-FT HORIZONTALLY AND 18-IN VERTICALLY.

OPERATIONAL DESCRIPTION

1. THE WATER SUPPLY WELLS WILL FILL THE RAW WATER STORAGE TANK BASED OFF OF TANK LEVEL. EACH WELL WILL BE EQUIPPED WITH A VARIABLE FREQUENCY DRIVE (VFD) AND UL508 CONTROL PANEL. THE RAW WATER TANK WILL BE EQUIPPED WITH A LEVEL SENSOR AND HIGH-LEVEL AND LOW-LEVEL EMERGENCY FLOATS. UNDER NORMAL OPERATION THE LEVEL SENSOR WILL TRANSMIT A TANK LEVEL SIGNAL WIRELESSLY TO EACH WELL PUMP CONTROL PANEL VIA LINE-OF-SIGHT RADIO SIGNAL. THE CONTRACTOR SHALL PROVIDE EXTENDED ANTENNA MASTS AS NEEDED TO TRANSMIT SIGNAL TO THE WELL PUMP CONTROL PANELS.
2. WELLS 4 AND 5 SHALL BE THE MAIN SUPPLY WELLS, OPERATING AS LEAD AND LAG PUMPS. THE PUMP CONTROL PANEL SHALL ALTERNATE LEAD AND LAG PUMP OPERATION BETWEEN WELLS 4 AND 5 BASED ON USER-ADJUSTABLE RUN TIME. THE DEFAULT RUN TIME SHALL BE ONE WEEK.
3. THE LEAD PUMP SHALL START WHEN THE TANK LEVEL DROPS TO THE LEAD PUMP START SETPOINT OF 32 FEET (OPERATOR ADJUSTABLE). THE LEAD PUMP SHALL MAINTAIN THE TARGET SETPOINT OF 33 FEET (OPERATOR ADJUSTABLE) BY VARYING PUMP SPEED AS CONTROLLED BY A VFD. THE LEAD PUMP SHALL STOP AT THE LEAD PUMP STOP SETPOINT OF 34 FEET (OPERATOR ADJUSTABLE).
4. THE LAG PUMP SHALL START WHEN THE TANK LEVEL DROPS TO THE LAG PUMP START SETPOINT OF 30 FEET (OPERATOR ADJUSTABLE). THE LAG PUMP SHALL MAINTAIN THE TARGET SETPOINT OF 33 FEET (OPERATOR ADJUSTABLE) BY VARYING PUMP SPEED AS CONTROLLED BY A VFD, WITH THE LEAD PUMP RUNNING AT FULL SPEED. THE LAG PUMP SHALL STOP AT THE LAG PUMP STOP SETPOINT OF 34 FEET (OPERATOR ADJUSTABLE).
5. WELL 3 SHALL BE THE EMERGENCY BACKUP PUMP. THE BACKUP PUMP SHALL START IF THE MAIN SUPPLY WELLS (WELLS 4 AND 5) CANNOT MAINTAIN TANK LEVEL AND THE WATER LEVEL FALLS TO THE BACKUP PUMP START SETPOINT OF 12 FEET (OPERATOR ADJUSTABLE). THE BACKUP PUMP SHALL MAINTAIN THE TARGET SETPOINT OF 33 FEET (OPERATOR ADJUSTABLE) BY VARYING PUMP SPEED AS CONTROLLED BY A VFD, WITH THE MAIN SUPPLY PUMPS RUNNING AT FULL SPEED. THE BACKUP PUMP SHALL STOP AT THE BACKUP PUMP STOP SETPOINT OF 34 FEET (OPERATOR ADJUSTABLE).
6. WELL PUMPS CAN BE CONTROLLED MANUALLY BY SELECTING "HAND" ON THE HOA SWITCH ON THE CONTROL PANEL.
7. IF THE LEAD PUMP DOES NOT START AT THE LEAD PUMP START SETPOINT FOR ANY REASON INCLUDING LOW WATER LEVEL IN LEAD WELL DURING OPERATION, THE LAG WELL PUMP SHALL OPERATE AND AN ALARM AND FAULT SHALL BE NOTED AT THE LEAD WELL CONTROL PANEL. IF THE LAG PUMP DOES NOT START AT LAG PUMP START SETPOINT FOR ANY REASON INCLUDING LOW WATER LEVEL IN LAG WELL DURING OPERATION, THE BACKUP WELL PUMP SHALL OPERATE AND AN ALARM AND FAULT SHALL BE NOTED AT THE LAG WELL CONTROL PANEL.
8. THE FLOATS IN THE TANK SHALL TRANSMIT A DIGITAL SIGNAL VIA LINE-OF-SIGHT RADIOS TO THE WELL PUMP CONTROL PANELS. ONE FLOAT SHALL SEND A LOW-LEVEL ALARM SIGNAL IF WATER LEVEL REACHES 1 FOOT (ADJUSTABLE) ABOVE THE TANK BOTTOM. THE SECOND FLOAT SHALL SEND A HIGH-LEVEL ALARM SIGNAL IF WATER LEVEL REACHES A HEIGHT OF 34.5 FEET (ADJUSTABLE) OR 0.5 FEET ABOVE THE PUMP STOP SETPOINT. THE LOW-LEVEL FLOAT SHALL START BOTH PUMPS UNTIL THE HIGH-LEVEL FLOAT IS TRIGGERED AND CONTINUE THIS OPERATIONAL CYCLE UNTIL THE LEVEL SENSOR IS OPERATING NORMALLY (REPAIRED OR REPLACED).

PUMP CONTROL PANEL SPECIFICATION

1. EACH PUMP CONTROL PANEL SHALL BE DESIGNED, ASSEMBLED, PROGRAMMED, AND TESTED BY A SINGLE UL-CERTIFIED (UL508A) MANUFACTURING FACILITY, PRIOR TO DELIVERY TO THE JOB SITE. THE PANEL SHALL BE LABELED AS AN "ENCLOSED INDUSTRIAL CONTROL PANEL". THE PANEL MANUFACTURER SHALL HAVE LOCAL SERVICE PERSONNEL AVAILABLE WHO ARE TRAINED AND CERTIFIED TO SERVICE AND TROUBLESHOOT ALL COMPONENTS OF THE PUMP CONTROL PANEL. THE PUMP CONTROL PANEL SHALL BE MANUFACTURED BY PRECISION AUTOMATION OR APPROVED EQUAL.
2. EACH PUMP CONTROL PANEL SHALL HAVE THE FOLLOWING EQUIPMENT:
   a. A VARIABLE FREQUENCY DRIVE (VFD) MEETING THE FOLLOWING REQUIREMENTS:
      i. THE VFD SHALL BE AN 18-PULSE TYPE.
      ii. THE VFD SHALL BE CAPABLE OF ACCEPTING START AND STOP SIGNALS EITHER MANUALLY AT THE CONTROL PANEL (HAND MODE) OR AUTOMATICALLY FROM A TANK LEVEL SENSOR AND FLOAT VIA LINE-OF-SIGHT RADIO SIGNAL. THE VFD SHALL VARY PUMP SPEED TO MAINTAIN THE TARGET TANK LEVEL SETPOINT. SETPOINTS SHALL BE EASILY ADJUSTABLE.
      iii. THE VFD SHALL PROVIDE SOFT START AND STOP, WITH ADJUSTABLE ACCELERATION/DECELERATION TIMES TO MINIMIZE HYDRAULIC SURGES.
      iv. THE VFD SHALL BE COMPATIBLE WITH THE EQUIPMENT IT SERVES AND ADEQUATELY SIZED FOR THE MOTOR MAXIMUM AMPS AND HORSEPOWER INCLUDING SERVICE FACTOR. THE VFD OUTPUT CURRENT MUST EXCEED THE MAXIMUM MOTOR OPERATING CURRENT AT FULL SPEED.
      v. THE VFD SHALL BE SIZED AND RATED TO ACCEPT A 480-VOLT, 3-PHASE INCOMING POWER SUPPLY.
      vi. THE VFD SHALL INCLUDE AN INTEGRAL PID PROCESS CONTROLLER, WHICH SHALL CONTROL ALL SPEED AND SWITCHING OPERATIONS FOR THE PUMP. PROGRAMMED APPLICATIONS SHALL BE STORED IN A NON-VOLATILE PROM SO THAT, IN CASE OF A POWER FAILURE, THE PROGRAM SHALL NOT BE LOST. THE VFD SHALL BE FACTORY PROGRAMMED WITH SOFTWARE WRITTEN SPECIFICALLY FOR PUMPING APPLICATIONS, INCLUDING A PID "SLEEP" FUNCTION AS PART OF THE INTERNAL SOFTWARE WITHIN THE VFD. VFD FUNCTIONS SHALL BE CONTROLLED WITH AN INTEGRAL DIGITAL KEYPAD LOCATED EXTERNALLY ON THE ENCLOSURE DOOR.
      vii. THE PUMP MOTOR SHALL BE FULLY WARRANTABLE BY THE MOTOR MANUFACTURER WHEN USED WITH THE SUPPLIED VFD SYSTEM. VFD SHALL BE PROGRAMMED TO OPERATE THE MOTOR BETWEEN 67% (40 HZ) AND 100% (60 HZ) OF MAXIMUM SPEED. UNDER NO CIRCUMSTANCES SHALL MOTOR OPERATE OUTSIDE OF THIS RANGE.
      viii. THE VFD SHALL BE MANUFACTURED BY ABB ACS SERIES OR APPROVED EQUAL.
   b. A PLC WITH AN HMI TOUCH SCREEN OPERATOR INTERFACE TO ALLOW THE USER TO LOCALLY MODIFY PROGRAMMING. THE SCREEN SHALL BE MINIMUM 4-INCH TFT LCD COLOR TOUCH-SCREEN. THE PLC AND HMI SHALL PROVIDE AT A MINIMUM THE FOLLOWING FUNCTIONS:
      i. USER ADJUSTABLE REAL-TIME CLOCK DISPLAY.
      ii. DISPLAY AND RECORD RUN STATUS OF ALL PUMPS (STOPPED, RUNNING, ALARM/FAULT, IDLE) INCLUDING MOTOR SPEED.
      iii. DISPLAY AND RECORD SYSTEM PRESSURE FROM PRESSURE TRANSDUCER.
      iv. DISPLAY AND RECORD INSTANTANEOUS AND TOTALIZED FLOW FROM FLOW METER.
      v. DISPLAY AND RECORD WELL WATER LEVEL FROM WELL LEVEL SENSOR.
      vi. DISPLAY AND RECORD STORAGE TANK WATER LEVEL FROM TANK LEVEL SENSOR.
      vii. DISPLAY AND RECORD VOLTAGE AND CURRENT.
      viii. DISPLAY AND RECORD FAULT AND/OR ALARM CONDITION AND LOG FAULT WITH TIME AND DATE STAMP, INCLUDING UP TO 256 EVENTS.
      ix. DISPLAY AND RECORD FAULT AND ALARM DIAGNOSTICS.
      x. DISPLAY AND RECORD MOTOR RUN HOURS THAT ARE USER-RESETTABLE.
      xi. PRE-PROGRAMMED START-UP ROUTINES FOR INITIAL START-UP, MAINLINE FILL, POWER OUTAGES, FAULT RE-START. THE ROUTINES SHALL LIMIT AND/OR DELAY PUMP STARTING AND ACCELERATION TO PREVENT EXCESSIVE VELOCITY OR PRESSURE.
      xii. CONTROL LEAD/LAG PUMP OPERATION.
      xiii. RESET BUTTON TO RESTART THE SYSTEM AFTER A SYSTEM SHUTDOWN.
      xiv. ALLOW USER TO ADJUST OPERATING VARIABLES, TIMING, RESTART, AND SLEEP FUNCTIONS.
      xv. ALLOW USER ADJUSTMENT OF ALL SETTINGS RELATING TO THE OPERATION AND PREPROGRAMMED SAFETY FUNCTIONS OF THE PLC.
      xvi. ALLOW FOR UPLOADING, DOWNLOADING, AND SAVING USER-SELECTED VALUES WITH USB FUNCTIONALITY.
      xvii. ANY OTHER FUNCTIONS TO MEET THE INTENDED SYSTEM OPERATION.
   c. A MAIN CIRCUIT BREAKER DISCONNECT SWITCH INTEGRATED INTO THE PANEL. THE DISCONNECT SHALL BE SERVICE ENTRANCE RATED AND SIZED APPROPRIATELY ACCORDING TO UL AND NEC GUIDELINES. THE SWITCH SHALL HAVE AN EXTERNALLY MOUNTED HANDLE THAT IS LOCKABLE IN THE OFF POSITION.
   d. A GREEN ILLUMINATED HOA SELECTOR AND PUSH BUTTON START. IN "HAND" MODE THE RESPECTIVE PUMP WILL RUN CONTINUOUSLY AND IN "AUTO" MODEL IT WILL BE CONTROLLED BY TANK LEVEL.
   e. A MANUAL VFD SPEED CONTROL DIAL.
   f. POWER STATUS, PUMP STATUS, AND SYSTEM ALARM/FAULT INDICATORS.
   g. A MAGNETIC STARTER, WHICH CONSISTS OF A FULL VOLTAGE RATED LINE STARTING CONTACTOR AND THERMAL OVERLOAD RELAY, SO THAT THE MOTOR MAY BE OPERATED ACROSS-THE-LINE MANUALLY IN THE CASE OF VFD FAILURE.
   h. A VOLTAGE MONITOR CAPABLE OF MONITORING OVERVOLTAGE, UNDERVOLTAGE, PHASE IMBALANCE, PHASE LOSS, PHASE REVERSAL AND INCLUDE USER-ADJUSTABLE THRESHOLDS TO PROTECT THE PUMPS FROM POWER QUALITY PROBLEMS BY DISCONNECTING POWER TO THE PUMP MOTORS. THE VOLTAGE MONITOR SHALL AUTOMATICALLY RESET AND RESUME OPERATION WHEN POWER QUALITY IS ACCEPTABLE.
   i. OVER-CURRENT PROTECTION THROUGH APPROPRIATELY-SIZED FUSES OR BREAKERS AS RECOMMENDED BY THE MANUFACTURER.
   j. AN INTERNALLY MOUNTED AC LINE REACTOR OR DC LINK CHOKE (SWINGING CHOKE DESIGN) TO REDUCE INPUT CURRENT HARMONIC CONTENT, PROVIDE PROTECTION FROM POWER LINE TRANSIENTS SUCH AS UTILITY POWER FACTOR CORRECTION CAPACITOR SWITCHING TRANSIENTS AND REDUCE RFI EMISSIONS.
   k. A UL1449 SURGE PROTECTIVE DEVICE.
   l. A SINE-WAVE FILTER OR EQUIVALENT TYPE RLC FILTER TO PROTECT THE SUBMERSIBLE MOTOR AND TO SATISFY SUBMERSIBLE MOTOR WARRANTY CONDITIONS.
   m. HARMONIC FILTERING TO MEET OR EXCEED IEEE-519 RECOMMENDATIONS AS DEFINED AND ENFORCED BY THE POWER COMPANY PROVIDING SERVICE. IT IS THE RESPONSIBILITY OF THE CONTROL PANEL MANUFACTURER TO CORRECT ANY HARMONIC LEVELS THAT DO NOT SATISFY THE REQUIREMENTS OF IEEE-519.
   n. INPUTS TO RECEIVE A TANK LEVEL SIGNAL WIRELESSLY VIA LINE-OF-SIGHT RADIO SIGNAL. WELL PUMP AUTOMATIC OPERATION SHALL BE BASED ON TANK LEVEL.
   o. FIELD CONNECTIONS IN PLACE TO ACCEPT A SIGNAL FROM A FLOW METER, PRESSURE TRANSDUCER, WELL LEVEL SENSOR, AND TANK LEVEL SENSOR.
   p. ETHERNET COMMUNICATIONS CAPABLE.
   q. VENTILATION FANS AND/OR AIR-CONDITIONING TO PREVENT HIGH AMBIENT TEMPERATURES. THE COOLING SYSTEM SHALL PREVENT THE SOFT STARTER FROM REACHING HIGH AMBIENT TEMPERATURES, WHICH WILL CAUSE TEMPERATURE FAULTS OR WARNINGS AND SHALL BE RATED FOR A MAXIMUM AMBIENT TEMPERATURE OF 104°F. THE COOLING SYSTEM SHALL START AUTOMATICALLY WHENEVER THE SOFT STARTER IS IN OPERATION AND SHUT DOWN AUTOMATICALLY WHEN THE STARTER IS TURNED OFF. THE COOLING SYSTEM SHALL NOT ALLOW DUST OR WATER TO ENTER INSIDE THE PANEL.
   r. FULL COLOR WIRING SCHEMATIC WITH THE WIRE COLORING REFLECTING THE ACTUAL WIRING COLOR.
   s. WARNING LABELS TO WARN THE END-USER OF ELECTRICAL SHOCK, EQUIPMENT FREEZING, EXPLOSION HAZARDS, OR ANY OTHER SAFETY NOTICES AS REQUIRED BY UL AND THE NEC.
   t. UL TYPE 12 ENCLOSURE FOR INDOOR INSTALLATION.
3. EACH WELL PUMP FACILITY SHALL BE EQUIPPED WITH A HIGH FREQUENCY PULSE DISCHARGE FLOW METER. THE FLOW METER SIGNAL SHALL BE TRANSMITTED TO THE PUMP CONTROL PANEL TO DISPLAY FLOW RATE AND TOTALIZED VOLUME. THE TOTALIZER SHALL BE RESETTABLE WITH DATE OF LAST RESET. THE PUMP CONTROL PANEL SHALL DISPLAY ALL FAULTS, INCLUDING HIGH AND LOW FLOW ALARM/FAULTS AND RECORD IN A TREND FILE.
4. THE MAIN SUPPLY WELLS SHALL BE EQUIPPED WITH A WATER LEVEL SENSOR THAT CAN TRANSMIT A 4-20 MA SIGNAL TO THE PUMP CONTROL PANEL. THE SENSOR SHALL BE INSTALLED 5 FEET ABOVE THE TOP OF THE PUMP IN 1-INCH PVC SOUNDING TUBE STRAPPED TO THE PUMP COLUMN PIPE. THE PANEL SHALL DISPLAY AND RECORD WATER LEVEL IN THE WELL AND HIGH/LOW LEVEL ALARMS AND FAULTS. IF A LOW WATER LEVEL IS REACHED DURING OPERATION, THE PUMP CONTROL PANEL SHALL DECLARE A FAULT AND ACTIVATE LAG (FOR LEAD PUMP) OR BACKUP (FOR LAG PUMP). WHEN WATER LEVEL RECOVERS TO 25 FEET (ADJUSTABLE) ABOVE THE TOP OF THE PUMP, THE PUMP CONTROL PANEL SHALL RESUME NORMAL OPERATION. EACH LOW WATER EVENT SHALL BE RECORDED IN A FAULT LOG WITH TIME STAMPS FOR BOTH FAULT AND RECOVERY. THE TREND FILE SHALL BE DOWNLOADABLE TO A FLASH DRIVE AND BE COMPATIBLE WITH EXCEL SPREADSHEET FOR THE END USER.
5. DURING STARTUP, THE CONTRACTOR SHALL DEMONSTRATE THAT ALL EQUIPMENT MEETS THE SPECIFIED PERFORMANCE REQUIREMENTS. THE CONTRACTOR SHALL BE REQUIRED TO HAVE AN EXPERIENCED, COMPETENT, AND FACTORY AUTHORIZED SERVICE PROFESSIONAL FROM THE PUMP CONTROL PANEL MANUFACTURER PRESENT DURING STARTUP TO DEMONSTRATE THAT THE SYSTEM OPERATES AS INTENDED, TROUBLESHOOT ANY ISSUES ENCOUNTERED, AND TO TRAIN THE OWNER ON OPERATION OF THE SYSTEM.

SPF WATER ENGINEERING
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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

GENERAL NOTES, OPERATIONAL DESCRIPTION & CP SPEC.

REGISTERED PROFESSIONAL ENGINEER
97236
7-31-19
OREGON
JANUARY 10, 2014
JUSTIN P. LERAAS
EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C002

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Xref Filename: | X-TITLE | X-TITLE (2) |

PROJECT DESIGN CRITERIA

PARAMETER	UNIT	VALUE
CLASSIFICATION		
SYSTEM CLASSIFICATION		NON-TRANSIENT NON-COMMUNITY
PUBLIC WATER SYSTEM NUMBER		TBD
OPERATOR LEVEL		TBD
NON-POTABLE WATER DEMAND		
PLANT RAW WATER AVERAGE DAY SUMMER DEMAND	GPM	350
	MGD	0.5
PLANT RAW WATER AVERAGE DAY NON-SUMMER DEMAND	GPM	100
	MGD	0.1
PLANT RAW WATER AVERAGE ANNUAL DAILY DEMAND	GPM	204
	MGD	0.3
PLANT RAW WATER DEMAND DURATION	HR/DAY	12
PROCESS WATER AVERAGE DAY DEMAND	GPM	229
	MGD	0.3
PROCESS WATER DEMAND DURATION	HR/DAY	22
FIRE WATER DEMAND	GAL	78,000
	GPM	1,000
POTABLE WATER DEMAND		
NO OF PERSONNEL	NO.	112
PER CAPITA AVERAGE DAY DEMAND	GPD	35
POTABLE WATER AVERAGE DAY DEMAND	GPD	3,920
	MGD	0.004
POTABLE WATER PEAK INSTANTANOUS DEMAND	GPM	100
	MGD	0.14
WATER SUPPLY WELLS		
NUMBER OF ACTIVE WELLS	NO.	3
NUMBER OF MAIN SUPPLY WELLS	NO.	2
NUMBER OF BACKUP SUPPLY WELLS	NO.	1
MAIN WELL NAME		NEW WELL 5 / NEW WELL 4
MAIN WELL DEPTH	FT	500
MAIN WELL CASING	IN	16 (+2-30 FT); 10 (0-300 FT)
MAIN WELL SCREENED INTERVAL	FT	300-500 (NON-CONT)
MAIN WELL STATIC WATER LEVEL	FT	70
MAIN WELL PRODUCTION	GPM	200
MAIN WELL PUMPING WATER LEVEL	FT	270
MAIN WELL SPECIFIC CAPACITY	GPM/FT	1
BACKUP WELL NAME		EXISTING WELL 3 (PW-4)
BACKUP WELL DEPTH	FT	375
BACKUP WELL CASING	IN	10 (0-40 FT); 6 (0-280 FT)
BACKUP WELL SCREENED INTERVAL	FT	280-300; 340-360
BACKUP WELL STATIC WATER LEVEL	FT	80
BACKUP WELL PRODUCTION	GPM	200
BACKUP WELL PUMPING WATER LEVEL	FT	263
BACKUP WELL SPECIFIC CAPACITY	GPM/FT	1
POTABLE WATER BOOSTER PUMP STATION		
TOTAL NUMBER OF PUMPS	NO.	2
DESIGN PUMP CAPACITY (EA.)	GPM	100
DESIGN TOTAL DYNAMIC HEAD	FT	185
DESIGN DISCHARGE PRESSURE	PSI	80
TOTAL CAPACITY	GPM	200
TOTAL FIRM CAPACITY	GPM	100
PUMP POWER (EA.)	HP	5
MOTOR CONTROLS	VARIABLE FREQUENCY	
WASTEWATER FACILITIES		
TYPE		LARGE SOIL ADSORPTION SYSTEM
DESIGN FLOW	GPM	4,320
SOILS TYPE	CLASS	C
DISPOSAL TRENCH LENGTH (NO PRETREATMENT)	FT	3,600
DISPOSAL TRENCH LENGTH (W PRETREATMENT)	FT	1,440

PARAMETER	UNIT	VALUE
WELL PUMPS		
MAIN WELL PUMP TYPE	SUBMERSIBLE	
NUMBER OF MAIN WELL PUMPS	NO.	2
MAIN WELL PUMP DESIGN FLOW	GPM	200
MAIN WELL PUMP DESIGN HEAD	FT	980
MAIN WELL PUMP POWER	HP	75
MAIN WELL PUMP SETTING DEPTH	FT	378
MAIN WELL PUMP MOTOR CONTROLS	SOFT STARTER	
BACKUP WELL PUMP TYPE	SUBMERSIBLE	
NUMBER OF BACKUP WELL PUMPS	NO.	1
BACKUP WELL PUMP DESIGN FLOW	GPM	150
BACKUP WELL PUMP DESIGN HEAD	FT	900
BACKUP WELL PUMP POWER	HP	60
BACKUP WELL PUMP SETTING DEPTH	FT	273
BACKUP WELL PUMP MOTOR CONTROLS	SOFT STARTER	
TRANSMISSION MAIN		
MAIN DIAMETER	IN	8
PIPE MATERIAL		C900 PVC
PRESSURE RATING	PSI	305 (DR-14), 235 (DR-18)
BURY DEPTH	FT	4
RAW WATER STORAGE TANK		
NUMBER	NO.	1
CAPACITY, TOTAL	GAL	237,000
CAPACITY, USABLE	GAL	227,000
DIAMETER	FT	33.85
SIDE WALL HEIGHT	FT	35.19
MAX OPERATING LEVEL	FT	34.19
OVERFLOW LEVEL	FT	34.69
OVERFLOW ELEVATION	FT ASL	3914.69
MIN TANK WATER ELEVATION	FT ASL	3881.00
MIN STATIC PRESSURE AT PROCESS PAD (3710 FT)	PSI	74
CONSTRUCTION TYPE	BOLTED STEEL	
POTABLE WATER STORAGE TANK		
NUMBER	NO.	1
CAPACITY, TOTAL	GAL	13,500
CAPACITY, USABLE	GAL	12,400
DIAMETER	FT	12.0
SIDE WALL HEIGHT	FT	16.0
MAX OPERATING LEVEL	FT	15.4
OVERFLOW LEVEL	FT	15.5
CONSTRUCTION TYPE		WELDED STAINLESS STEEL
ARSENIC TREATMENT SYSTEM		
TYPE		ADSORPTIVE MEDIA
DESIGN FLOW	GPM	10
HEADLOSS	FT	5.0
BACKWASH FREQUENCY	WEEKS	4 TO 6
BACKWASH FLOW	GPM	12
BACKWASH DISPOSAL		SANITARY SEWER
DISINFECTION SYSTEM		
CHEMICAL		SODIUM HYPOCHLORITE
CONCENTRATION	%WT	12.5
BULK STORAGE TANKS	NO.	2 (PRIMARY/BACKUP)
TANK VOLUME (EA.)	GAL	55
TYPICAL DOSE #1	MG/L	5.0
TYPICAL DOSE #2	MG/L	3.0
TYPICAL USAGE #1	GPD	0.16
TYPICAL USAGE #1	GPD	0.10
DAYS STORAGE #1	DAYS	210
METERING PUMPS	NO.	2

SPF WATER ENGINEERING
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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

DESIGN CRITERIA

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LERAARS
EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C003

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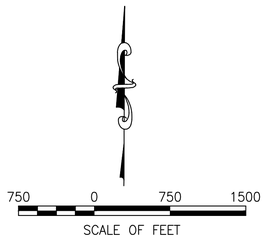

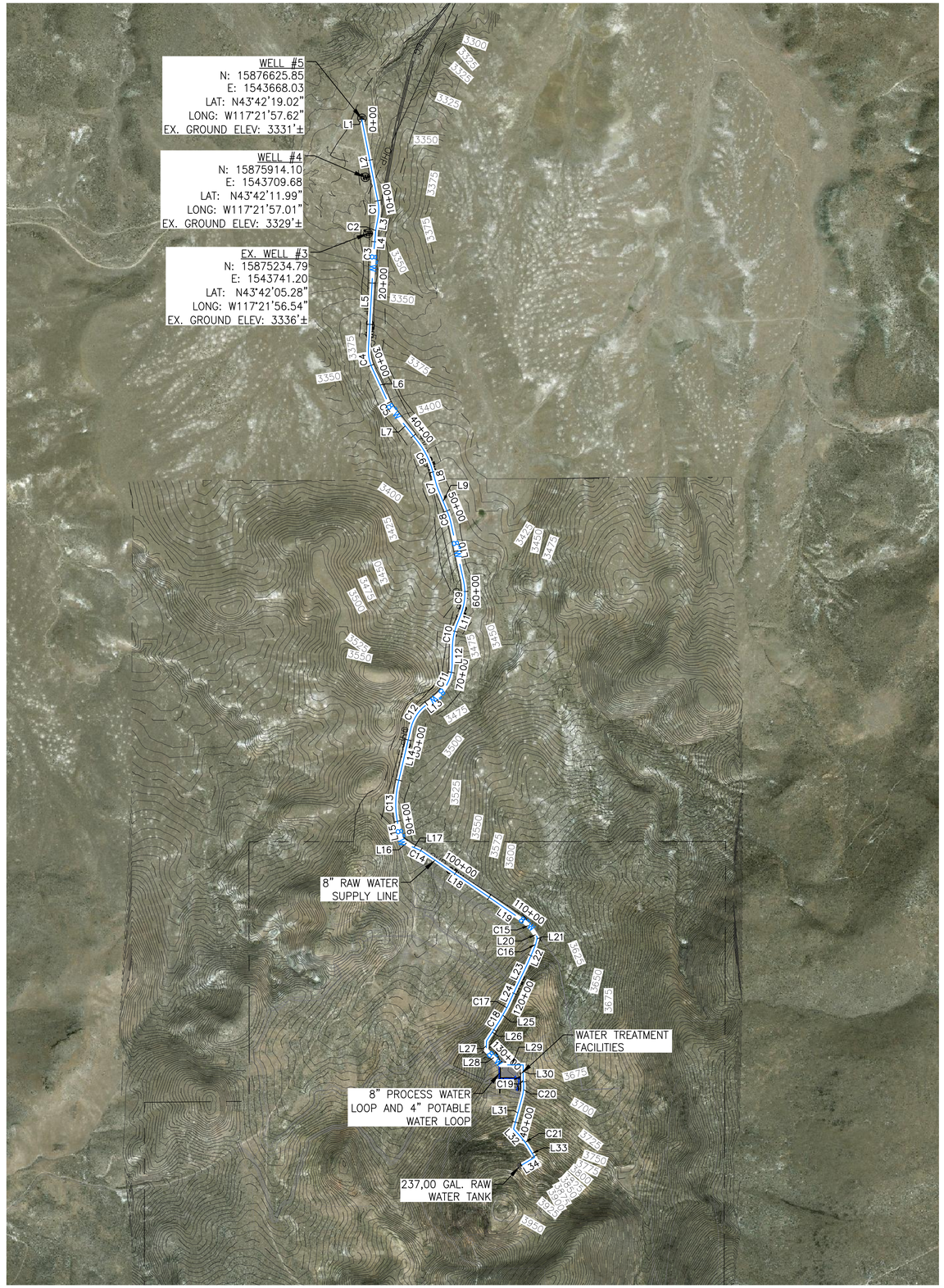

RAW WATER SUPPLY LINE			
Number	Radius	Length	Line/Chord Direction
C1	500.00	185.01	S0° 31' 12.29"E
C2	300.00	26.84	S7° 31' 04.41"W
C3	500.00	15.31	S4° 04' 40.44"W
C4	500.00	245.09	S10° 50' 31.64"E
C5	500.00	118.25	S31° 39' 35.38"E
C6	1000.00	406.33	S26° 47' 39.33"E
C7	500.00	62.83	S18° 45' 12.99"E
C8	500.00	88.14	S17° 18' 12.10"E
C9	700.00	416.13	S4° 46' 38.46"W
C10	700.00	254.13	S11° 24' 26.13"W
C11	500.00	445.49	S26° 31' 52.19"W
C12	500.00	340.74	S32° 31' 57.45"W
C13	1100.00	475.16	S0° 38' 05.60"W
C14	500.00	108.17	S61° 47' 30.79"E
C15	500.00	196.35	S43° 57' 54.44"E
C16	500.00	92.60	S17° 35' 25.93"W
C17	500.00	42.90	S27° 05' 14.17"W
C18	500.00	31.12	S31° 19' 42.18"W
C19	500.00	50.75	S2° 54' 27.84"E
C20	500.00	181.65	S4° 35' 32.16"W
C21	1000.00	200.52	S36° 30' 20.37"E
L1		5.04	S0° 00' 00.00"E
L2		1007.02	S11° 07' 14.34"E
L3		153.75	S10° 04' 49.77"W
L4		268.14	S4° 57' 19.04"W
L5		1129.03	S3° 12' 01.84"W
L6		451.16	S24° 53' 05.12"E
L7		478.97	S38° 26' 05.63"E
L8		154.40	S15° 09' 13.03"E
L9		340.31	S22° 21' 12.94"E
L10		737.93	S12° 15' 11.27"E
L11		134.64	S21° 48' 28.18"W
L12		234.25	S1° 00' 24.09"W
L13		161.28	S52° 03' 20.28"W
L14		683.73	S13° 00' 34.62"W
L15		209.55	S11° 44' 23.42"E
L16		148.87	S56° 44' 23.42"E
L17		66.19	S67° 59' 23.42"E
L18		1017.39	S55° 35' 38.16"E
L19		420.43	S55° 12' 54.44"E
L20		79.99	S32° 42' 54.44"E
L21		38.82	S12° 17' 05.56"W
L22		194.17	S22° 53' 46.31"W
L23		304.74	S25° 32' 37.60"W
L24		274.58	S24° 37' 45.75"W
L25		162.88	S29° 32' 42.58"W
L26		257.12	S33° 06' 41.79"W
L27		113.54	S0° 08' 53.27"W
L28		245.06	S44° 51' 06.73"E
L29		271.37	N90° 00' 00.00"E
L30		157.07	S0° 00' 00.00"E
L31		401.05	S15° 00' 00.00"W
L32		114.26	S42° 15' 00.00"E
L33		112.87	S30° 45' 40.74"E
L34		176.66	S59° 14' 19.26"W

SPF WATER ENGINEERING
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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WATER SYSTEM SITE OVERVIEW

REGISTERED PROFESSIONAL ENGINEER
JUSTIN P. LEPARIS
21236
OREGON
MAY 10, 2016
7-31-19
EXPIRES: 12-31-20

REVISIONS			
ITEM	DESCRIPTION	DATE	
0	FINAL PERMIT SET	7/31/19	

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C100

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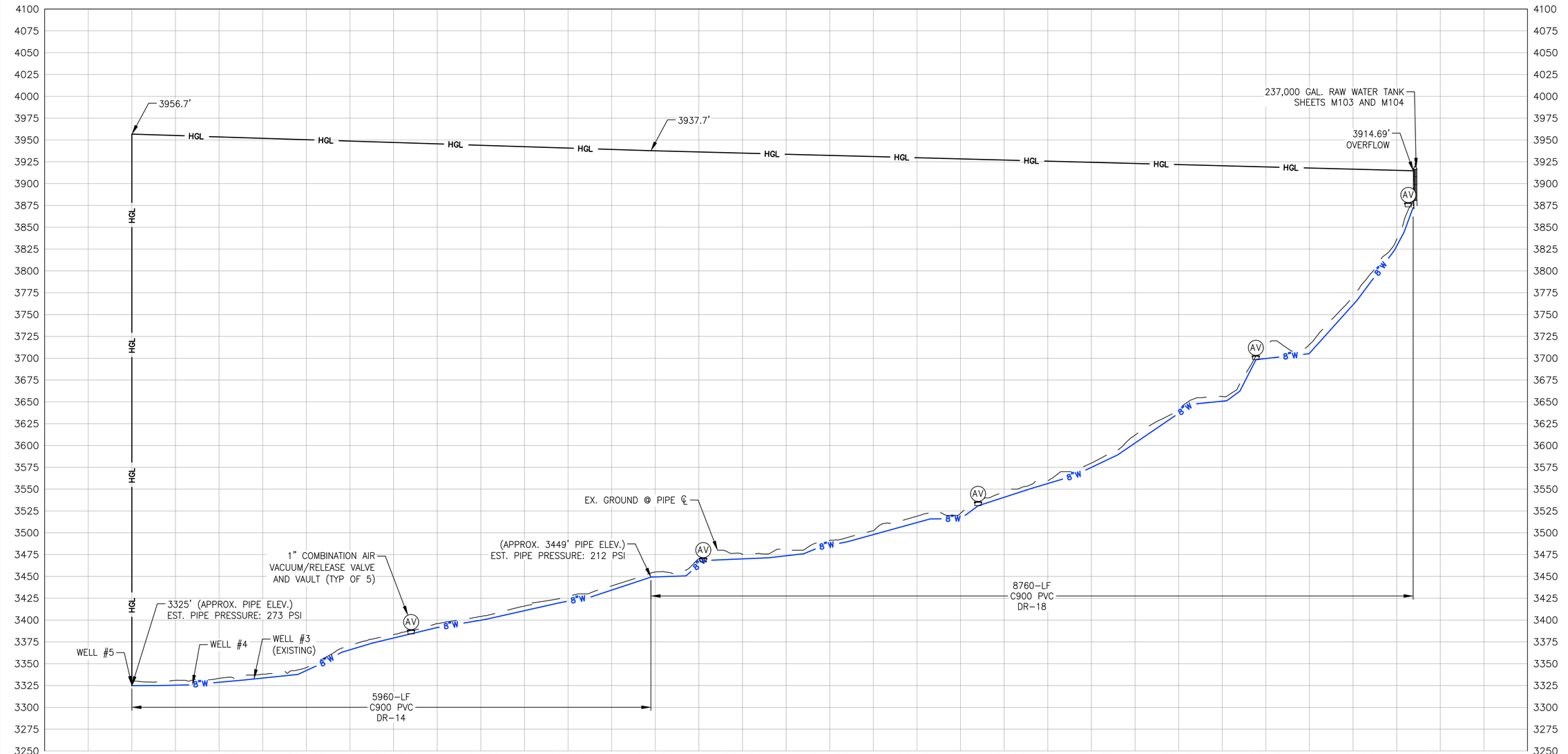

RAW WATER SUPPLY LINE PROFILE

600 0 600 1200
HORIZONTAL SCALE OF FEET

60 0 60 120
VERTICAL SCALE OF FEET

SPF WATER ENGINEERING
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Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER SUPPLY PROFILE OVERVIEW

REGISTERED PROFESSIONAL ENGINEER
81236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LERARIS
EXPIRES: 12-31-20

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C101

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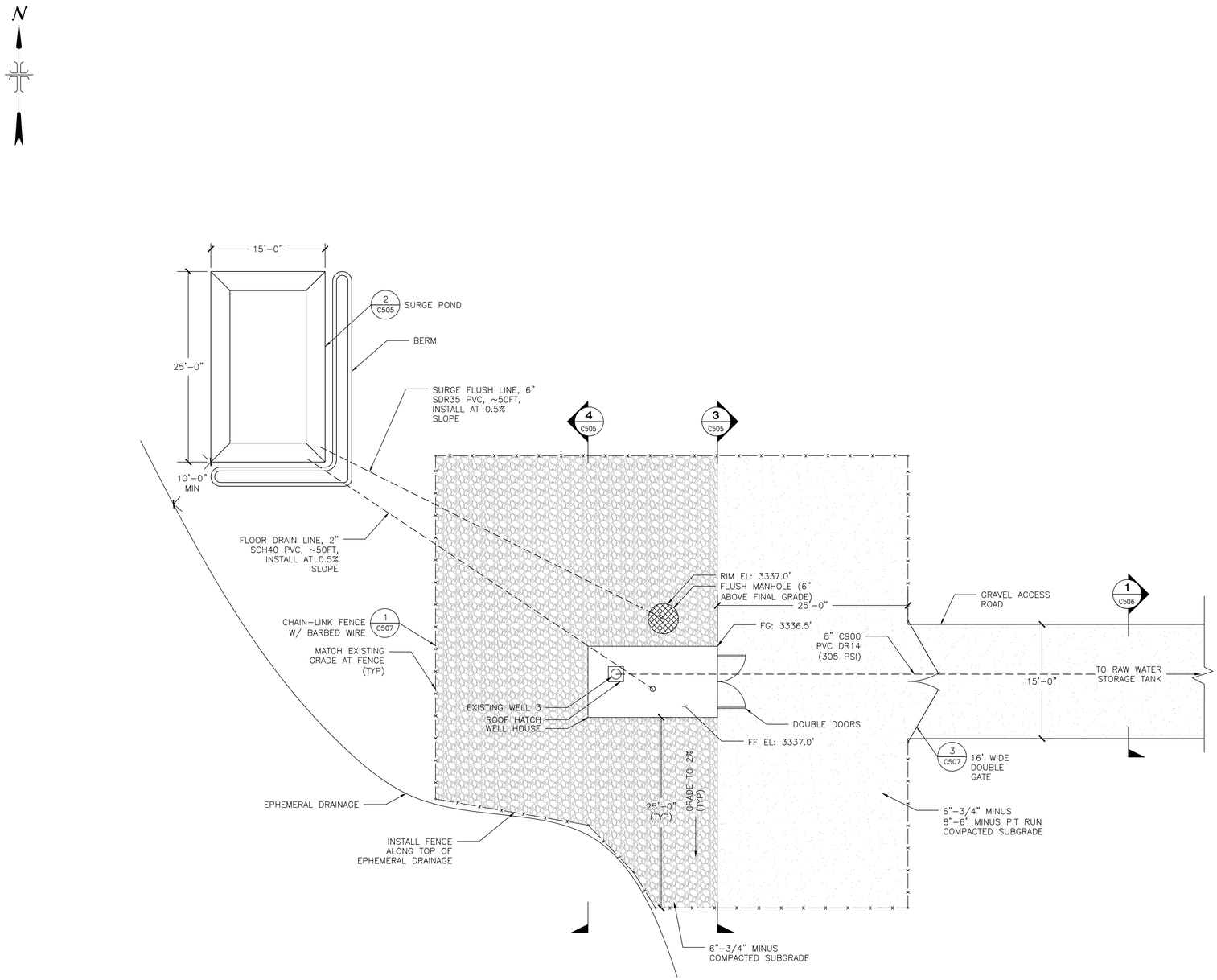

SITE PLAN
SCALE: 1/8"=1'-0"

A
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NOTES:

1. CONTRACTOR SHALL PROVIDE A MINIMUM 4'-0" OF COVER FROM FINISHED GRADE TO TOP OF PIPE FOR ALL UNDERGROUND PRESSURE PIPING AND 2'-0" MINIMUM COVER FOR ALL GRAVITY PIPING.
2. INSTALL PIPE PER DETAIL 1 ON SHEET C-500.
3. THE CONTRACTOR WILL BE RESPONSIBLE FOR ALL COSTS ASSOCIATED WITH THE REQUIRED PIPELINE PRESSURE TESTING. ALL TESTING SHALL BE IN ACCORDANCE WITH AWWA C600 (DUCTILE IRON) AND C905 (PVC). CONTRACTOR TO NOTIFY THE ENGINEER 24 HOURS PRIOR TO CONDUCTING TESTING. HYDROSTATIC TEST PRESSURE SHALL BE AT LEAST EQUAL TO 150 PSI OR 10% ABOVE THE WORKING PRESSURE OF THE PIPELINE, WHICHEVER IS GREATER. THE TEST PRESSURE SHALL NOT EXCEED THE PRESSURE RATING OF THE PIPE.
4. INSTALL THRUST BLOCKS PER SHEETS C501 AND C502 FOR ALL PIPE FITTINGS AND ACCESSORIES.
5. FINISH FLOOR OF WELL HOUSE SHALL BE A MIN. OF 6" ABOVE FINAL GRADE. ELEVATIONS BASED ON EXISTING GROUND ELEVATION OF 3336.0 FEET AND FINAL GRADE OF 3336.5 FEET. IF EXISTING GROUND ELEVATION DIFFERS FROM ASSUMED ELEVATION BASED ON CONTRACTOR SURVEY, CONTRACTOR SHALL ADJUST FINAL GRADE AND FINISHED FLOOR ELEVATION ACCORDINGLY. GRADE AREA AROUND WELL HOUSE TO DIVERT SURFACE WATER AWAY.
6. RAW/POTABLE PIPE SHALL BE DISINFECTED AND TESTED FOR BACTERIA PER AWWA C651 THROUGH C654 AND OAR 333-061-0050 SECTION 10.
7. CONTRACTOR SHALL VERIFY EXISTING LOCATIONS, ELEVATIONS AND MATERIAL TYPES OF ALL UTILITIES AND FEATURES WHERE PROPOSED IMPROVEMENTS CONNECT. NOTIFY ENGINEER IMMEDIATELY OF ANY DISCREPANCIES.
8. THE CONTRACTOR SHALL PROVIDE THE PROJECT ENGINEER WITH A MINIMUM 24-HOUR NOTICE PRIOR TO REQUIRED INSPECTIONS. THE CONTRACTOR SHALL VERIFY INSPECTION REQUIREMENTS WITH THE OWNER AND THE ENGINEER.
9. MORTOR-LINED DUCTILE IRON PIPE SHALL CONFORM TO AWWA C151 AND C104 & SHALL HAVE A MINIMUM PRESSURE CLASS OF 350 PSI. BURIED DI PIPING SHALL BE INSTALLED PER AWWA C600. POLYETHYLENE ENCASE ALL BURIED DUCTILE IRON PIPING. POLYETHYLENE ENCASE AND TAPE ALL METAL BURIED JOINTS AND ASSOCIATED BOLTS AND RESTRAINING DEVICES. ALL BURIED FITTINGS TO BE DI MJ X MJ CONFORMING TO AWWA C110 AND RATED FOR 350 PSI AND BE MECHANICALLY RESTRAINED WITH MEGALUG JOINT RESTRAINTS (OR EQUAL) AND THRUST BLOCKS, UNLESS OTHERWISE INDICATED ON DRAWINGS.
10. BURIED WATER VALVES SHALL BE RESILIENT-SEAT GATE VALVES CONFORMING TO AWWA C-515. ALL BURIED WATER VALVES SHALL BE INSTALLED WITH A STANDARD 5-1/4 INCH DIAMETER, TWO PIECE ADJUSTABLE CAST IRON VALVE BOX, TYLER/UNION SERIES 6855 OR EQUAL. THE CAST IRON COVER SHALL BE MARKED WITH THE WORD "WATER" AS AN INTEGRAL PART OF THE COVER. CONCRETE COLLARS SHALL BE INSTALLED. VALVES SHALL BE RATED FOR A MAXIMUM WORKING PRESSURE OF 350 PSI.
11. THE HORIZONTAL AND VERTICAL SEPARATIONS BETWEEN WATER AND SEWER LINES SHALL COMPLY WITH OAR 333-061-0050, SECTION 9.
12. ALL PVC GRAVITY PIPE SHALL CONFORM TO ASTM D 3034 AND HAVE A MINIMUM WALL THICKNESS OF SDR35. PVC GRAVITY PIPE INSTALLATION SHALL BE PER MANUFACTURER RECOMMENDATIONS, AND THE PLANS WITH THE MORE STRINGENT REQUIREMENTS GOVERNING INSTALLATION. PVC GRAVITY PIPE FITTINGS SHALL BE OF EQUAL OR GREATER PRESSURE CLASS AS THE PIPE.
13. ALL BURIED PIPE SHALL BE INSTALLED WITH COPPER FINDER WIRE, BLUE NO. 12, SUITABLE FOR DIRECT BURIAL. SECURELY FASTEN WIRE TO PIPE EVERY 10' WITH DUCT TAPE. LOCATING WIRE SHALL BE TESTED BY CONTRACTOR IN PRESENCE OF ENGINEER. ALL BURIED PIPE SHALL BE INSTALLED WITH LOCATOR TAPE, 3-INCH WIDE, PLACED BETWEEN 18 INCHES AND 24 INCHES ABOVE THE PIPE. TAPE SHALL BE MARKED AS BEING WATER LINE LOCATOR TAPE.
14. ALL PVC PRESSURE PIPE SHALL BE MANUFACTURED AND TESTED TO AWWA C900 (4 TO 12 INCHES) AND C905 (>12 INCHES). PVC PRESSURE PIPE SHALL BE DR18 (PRESSURE CLASS 235 PSI) OR DR14 (PRESSURE CLASS 305 PSI) AS SHOWN ON THE PLANS. PVC PIPE INSTALLATION SHALL BE PER AWWA C605, AND THE PLANS WITH THE MORE STRINGENT REQUIREMENTS GOVERNING THE INSTALLATION. PVC PIPE FITTINGS SHALL BE OF EQUAL OR GREATER PRESSURE CLASS AS THE PIPE, CEMENT-MORTAR LINED DUCTILE IRON. FITTINGS SHALL BE FLANGED OR MECHANICAL JOINT AS INDICATED ON THE CONTRACT DRAWINGS. DUCTILE IRON FITTINGS SHALL BE POLYETHYLENE ENCASED.
15. INSTALL NO. 10 STAINLESS STEEL RODENT SCREEN ON END OF FLUSH PIPE.
16. CONTRACTOR SHALL VERIFY EXISTING AND PROPOSED ELEVATIONS PRIOR TO CONSTRUCTION.

SPF WATER ENGINEERING
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Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WELL 3 (PW-4) SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C102

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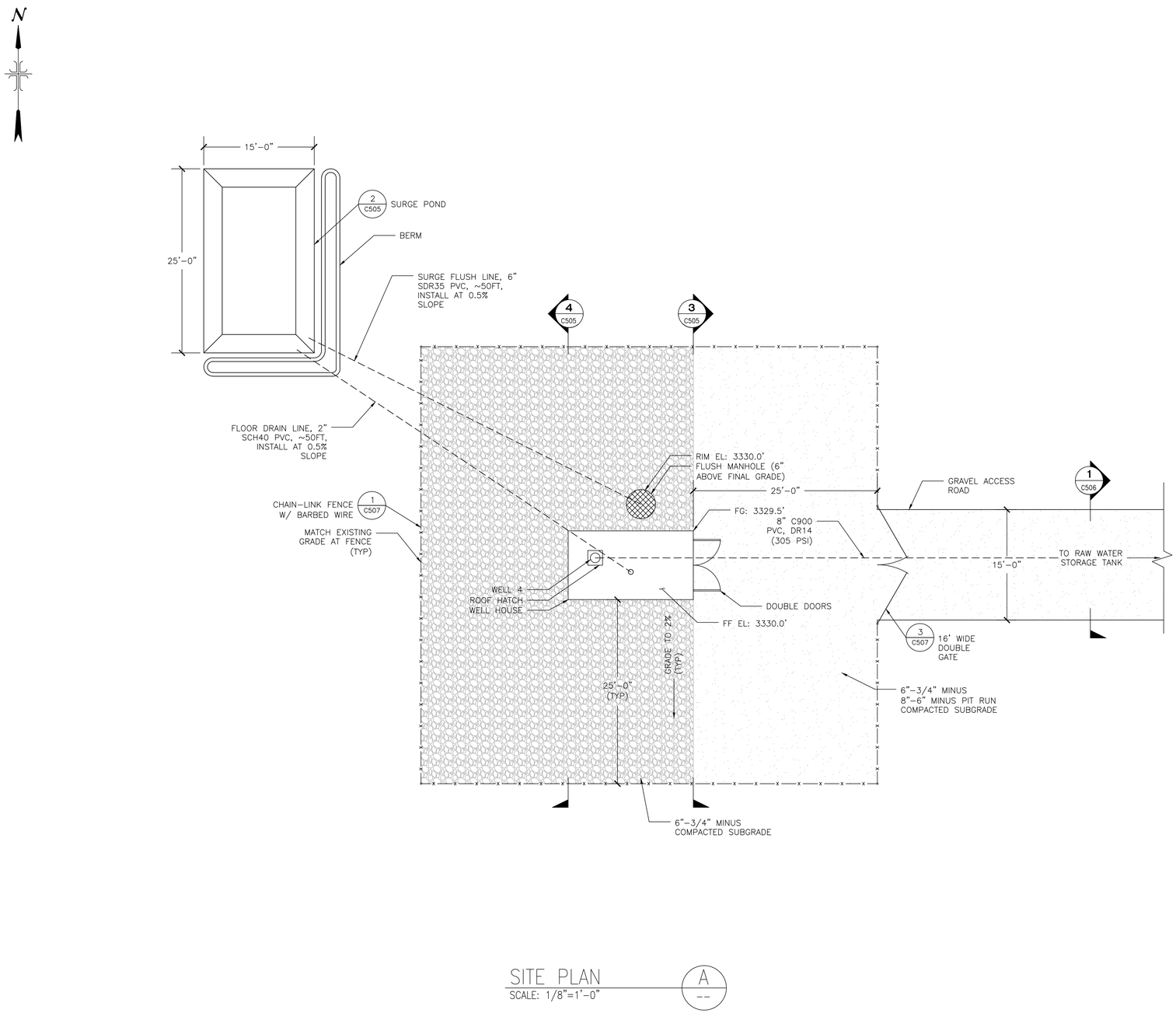

SITE PLAN
SCALE: 1/8"=1'-0"

A
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NOTES:

1. CONTRACTOR SHALL PROVIDE A MINIMUM 4'-0" OF COVER FROM FINISHED GRADE TO TOP OF PIPE FOR ALL UNDERGROUND PRESSURE PIPING AND 2'-0" MINIMUM COVER FOR ALL GRAVITY PIPING.
2. INSTALL PIPE PER DETAIL 1 ON SHEET C500.
3. THE CONTRACTOR WILL BE RESPONSIBLE FOR ALL COSTS ASSOCIATED WITH THE REQUIRED PIPELINE PRESSURE TESTING. ALL TESTING SHALL BE IN ACCORDANCE WITH AWWA C600 (DUCTILE IRON) AND C905 (PVC). CONTRACTOR TO NOTIFY THE ENGINEER 24 HOURS PRIOR TO CONDUCTING TESTING. HYDROSTATIC TEST PRESSURE SHALL BE AT LEAST EQUAL TO 150 PSI OR 10% ABOVE THE WORKING PRESSURE OF THE PIPELINE, WHICHEVER IS GREATER. THE TEST PRESSURE SHALL NOT EXCEED THE PRESSURE RATING OF THE PIPE.
4. INSTALL THRUST BLOCKS PER SHEETS C501 AND C502 FOR ALL PIPE FITTINGS AND ACCESSORIES.
5. FINISH FLOOR OF WELL HOUSE SHALL BE A MIN. OF 6" ABOVE FINAL GRADE. ELEVATIONS BASED ON EXISTING GROUND ELEVATION OF 3329 FEET AND FINAL GRADE OF 3329.5 FEET. IF EXISTING GROUND ELEVATION DIFFERS FROM ASSUMED ELEVATION BASED ON CONTRACTOR SURVEY, CONTRACTOR SHALL ADJUST FINAL GRADE AND FINISHED FLOOR ELEVATION ACCORDINGLY. GRADE AREA AROUND WELL HOUSE TO DIVERT SURFACE WATER AWAY.
6. RAW/POTABLE PIPE SHALL BE DISINFECTED AND TESTED FOR BACTERIA PER AWWA C651 THROUGH C654 AND OAR 333-061-0050 SECTION 10.
7. CONTRACTOR SHALL VERIFY EXISTING LOCATIONS, ELEVATIONS AND MATERIAL TYPES OF ALL UTILITIES AND FEATURES WHERE PROPOSED IMPROVEMENTS CONNECT. NOTIFY ENGINEER IMMEDIATELY OF ANY DISCREPANCIES.
8. THE CONTRACTOR SHALL PROVIDE THE PROJECT ENGINEER WITH A MINIMUM 24-HOUR NOTICE PRIOR TO REQUIRED INSPECTIONS. THE CONTRACTOR SHALL VERIFY INSPECTION REQUIREMENTS WITH THE OWNER AND THE ENGINEER.
9. MORTOR-LINED DUCTILE IRON PIPE SHALL CONFORM TO AWWA C151 AND C104 & SHALL HAVE A MINIMUM PRESSURE CLASS OF 350 PSI. BURIED DI PIPING SHALL BE INSTALLED PER AWWA C600. POLYETHYLENE ENCASE ALL BURIED DUCTILE IRON PIPING. POLYETHYLENE ENCASE AND TAPE ALL METAL BURIED JOINTS AND ASSOCIATED BOLTS AND RESTRAINING DEVICES. ALL BURIED FITTINGS TO BE DI MJ X MJ CONFORMING TO AWWA C110 AND RATED FOR 350 PSI AND BE MECHANICALLY RESTRAINED WITH MEGALUG JOINT RESTRAINTS (OR EQUAL) AND THRUST BLOCKS, UNLESS OTHERWISE INDICATED ON DRAWINGS.
10. BURIED WATER VALVES SHALL BE RESILIENT-SEAT GATE VALVES CONFORMING TO AWWA C-515. ALL BURIED WATER VALVES SHALL BE INSTALLED WITH A STANDARD 5-1/4 INCH DIAMETER, TWO PIECE ADJUSTABLE CAST IRON VALVE BOX, TYLER/UNION SERIES 6855 OR EQUAL. THE CAST IRON COVER SHALL BE MARKED WITH THE WORD "WATER" AS AN INTEGRAL PART OF THE COVER. CONCRETE COLLARS SHALL BE INSTALLED. VALVES SHALL BE RATED FOR A MAXIMUM WORKING PRESSURE OF 350 PSI.
11. THE HORIZONTAL AND VERTICAL SEPARATIONS BETWEEN WATER AND SEWER LINES SHALL COMPLY WITH OAR 333-061-0050, SECTION 9.
12. ALL PVC GRAVITY PIPE SHALL CONFORM TO ASTM D 3034 AND HAVE A MINIMUM WALL THICKNESS OF SDR35. PVC GRAVITY PIPE INSTALLATION SHALL BE PER MANUFACTURER RECOMMENDATIONS, AND THE PLANS WITH THE MORE STRINGENT REQUIREMENTS GOVERNING INSTALLATION. PVC GRAVITY PIPE FITTINGS SHALL BE OF EQUAL OR GREATER PRESSURE CLASS AS THE PIPE.
13. ALL BURIED PIPE SHALL BE INSTALLED WITH COPPER FINDER WIRE, BLUE NO. 12, SUITABLE FOR DIRECT BURIAL. SECURELY FASTEN WIRE TO PIPE EVERY 10' WITH DUCT TAPE. LOCATING WIRE SHALL BE TESTED BY CONTRACTOR IN PRESENCE OF ENGINEER. ALL BURIED PIPE SHALL BE INSTALLED WITH LOCATOR TAPE, 3-INCH WIDE, PLACED BETWEEN 18 INCHES AND 24 INCHES ABOVE THE PIPE. TAPE SHALL BE MARKED AS BEING WATER LINE LOCATOR TAPE.
14. ALL PVC PRESSURE PIPE SHALL BE MANUFACTURED AND TESTED TO AWWA C900 (4 TO 12 INCHES) AND C905 (>12 INCHES). PVC PRESSURE PIPE SHALL BE DR18 (PRESSURE CLASS 235 PSI) OR DR14 (PRESSURE CLASS 305 PSI). PVC PIPE INSTALLATION SHALL BE PER AWWA C605, AND THE PLANS WITH THE MORE STRINGENT REQUIREMENTS GOVERNING THE INSTALLATION. PVC PIPE FITTINGS SHALL BE OF EQUAL OR GREATER PRESSURE CLASS AS THE PIPE, CEMENT-MORTAR LINED DUCTILE IRON. FITTINGS SHALL BE FLANGED OR MECHANICAL JOINT AS INDICATED ON THE CONTRACT DRAWINGS. DUCTILE IRON FITTINGS SHALL BE POLYETHYLENE ENCASED.
15. INSTALL NO. 10 STAINLESS STEEL RODENT SCREEN ON END OF FLUSH PIPE.
16. CONTRACTOR SHALL VERIFY EXISTING AND PROPOSED ELEVATIONS PRIOR TO CONSTRUCTION.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WELL 4 SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS			
ITEM	DESCRIPTION	DATE	
0	FINAL PERMIT SET	7/31/19	

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C103

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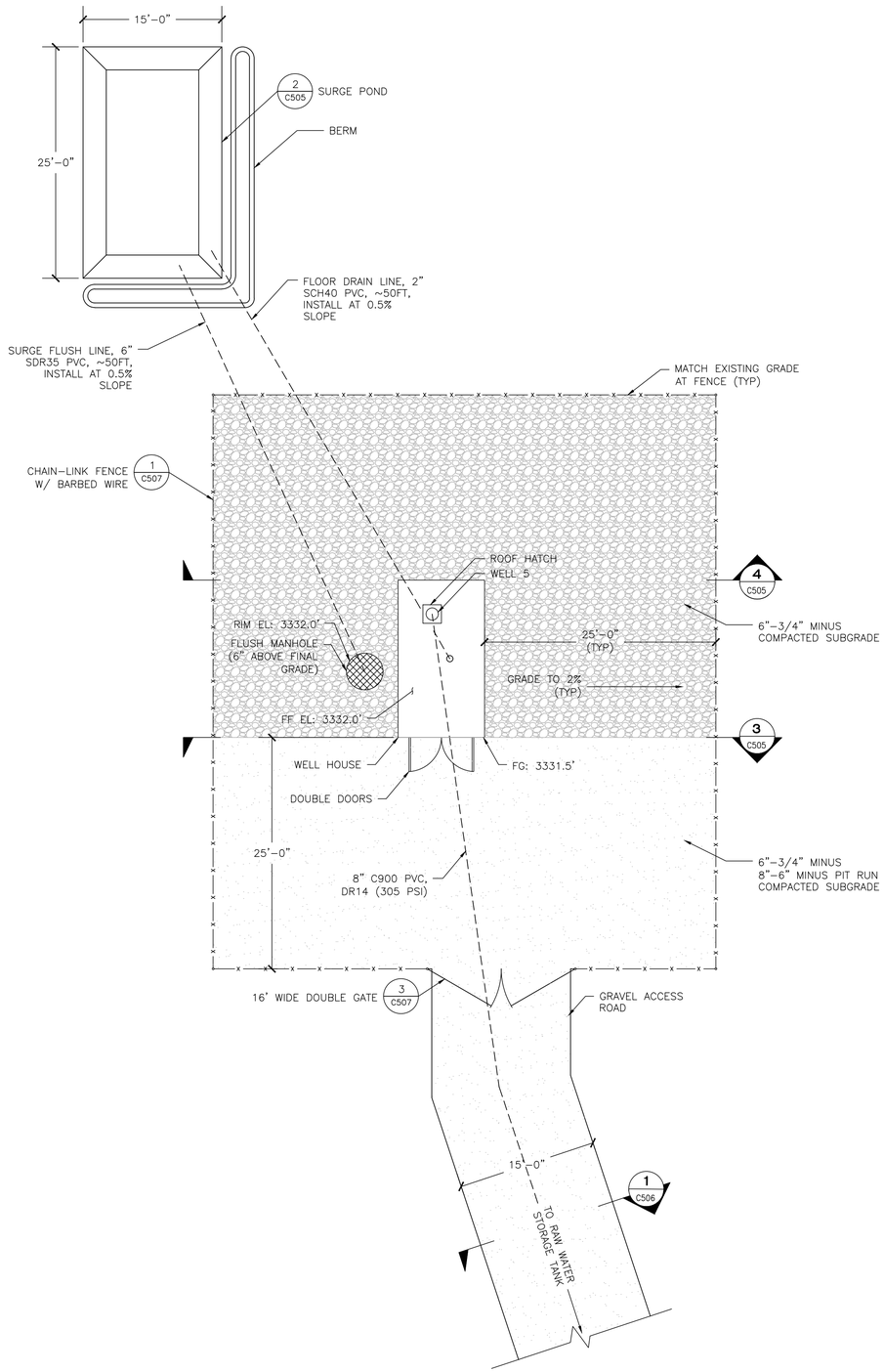

SITE PLAN
SCALE: 1/8"=1'-0"

A
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NOTES:

1. CONTRACTOR SHALL PROVIDE A MINIMUM 4'-0" OF COVER FROM FINISHED GRADE TO TOP OF PIPE FOR ALL UNDERGROUND PRESSURE PIPING AND 2'-0" MINIMUM COVER FOR ALL GRAVITY PIPING.
2. INSTALL PIPE PER DETAIL 1 ON SHEET C500.
3. THE CONTRACTOR WILL BE RESPONSIBLE FOR ALL COSTS ASSOCIATED WITH THE REQUIRED PIPELINE PRESSURE TESTING. ALL TESTING SHALL BE IN ACCORDANCE WITH AWWA C600 (DUCTILE IRON) AND C905 (PVC). CONTRACTOR TO NOTIFY THE ENGINEER 24 HOURS PRIOR TO CONDUCTING TESTING. HYDROSTATIC TEST PRESSURE SHALL BE AT LEAST EQUAL TO 150 PSI OR 10% ABOVE THE WORKING PRESSURE OF THE PIPELINE, WHICHEVER IS GREATER. THE TEST PRESSURE SHALL NOT EXCEED THE PRESSURE RATING OF THE PIPE.
4. INSTALL THRUST BLOCKS PER SHEETS C501 AND C502 FOR ALL PIPE FITTINGS AND ACCESSORIES.
5. FINISH FLOOR OF WELL HOUSE SHALL BE A MIN. OF 6" ABOVE FINAL GRADE. ELEVATIONS BASED ON EXISTING GROUND ELEVATION OF 3331.0 FEET AND FINAL GRADE OF 3331.5 FEET. IF EXISTING GROUND ELEVATION DIFFERS FROM ASSUMED ELEVATION BASED ON CONTRACTOR SURVEY, CONTRACTOR SHALL ADJUST FINAL GRADE AND FINISHED FLOOR ELEVATION ACCORDINGLY. GRADE AREA AROUND WELL HOUSE TO DIVERT SURFACE WATER AWAY.
6. RAW/POTABLE PIPE SHALL BE DISINFECTED AND TESTED FOR BACTERIA PER AWWA C651 THROUGH C654 AND OAR 333-061-0050 SECTION 10.
7. CONTRACTOR SHALL VERIFY EXISTING LOCATIONS, ELEVATIONS AND MATERIAL TYPES OF ALL UTILITIES AND FEATURES WHERE PROPOSED IMPROVEMENTS CONNECT. NOTIFY ENGINEER IMMEDIATELY OF ANY DISCREPANCIES.
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9. MORTOR-LINED DUCTILE IRON PIPE SHALL CONFORM TO AWWA C151 AND C104 & SHALL HAVE A MINIMUM PRESSURE CLASS OF 350 PSI. BURIED DI PIPING SHALL BE INSTALLED PER AWWA C600. POLYETHYLENE ENCASE ALL BURIED DUCTILE IRON PIPING. POLYETHYLENE ENCASE AND TAPE ALL METAL BURIED JOINTS AND ASSOCIATED BOLTS AND RESTRAINING DEVICES. ALL BURIED FITTINGS TO BE DI MJ X MJ CONFORMING TO AWWA C110 AND RATED FOR 350 PSI AND BE MECHANICALLY RESTRAINED WITH MEGALUG JOINT RESTRAINTS (OR EQUAL) AND THRUST BLOCKS, UNLESS OTHERWISE INDICATED ON DRAWINGS.
10. BURIED WATER VALVES SHALL BE RESILIENT-SEAT GATE VALVES CONFORMING TO AWWA C-515. ALL BURIED WATER VALVES SHALL BE INSTALLED WITH A STANDARD 5-1/4 INCH DIAMETER, TWO PIECE ADJUSTABLE CAST IRON VALVE BOX, TYLER/UNION SERIES 6855 OR EQUAL. THE CAST IRON COVER SHALL BE MARKED WITH THE WORD "WATER" AS AN INTEGRAL PART OF THE COVER. CONCRETE COLLARS SHALL BE INSTALLED. VALVES SHALL BE RATED FOR A MAXIMUM WORKING PRESSURE OF 350 PSI.
11. THE HORIZONTAL AND VERTICAL SEPARATIONS BETWEEN WATER AND SEWER LINES SHALL COMPLY WITH OAR 333-061-0050, SECTION 9.
12. ALL PVC GRAVITY PIPE SHALL CONFORM TO ASTM D 3034 AND HAVE A MINIMUM WALL THICKNESS OF SDR35. PVC GRAVITY PIPE INSTALLATION SHALL BE PER MANUFACTURER RECOMMENDATIONS, AND THE PLANS WITH THE MORE STRINGENT REQUIREMENTS GOVERNING INSTALLATION. PVC GRAVITY PIPE FITTINGS SHALL BE OF EQUAL OR GREATER PRESSURE CLASS AS THE PIPE.
13. ALL BURIED PIPE SHALL BE INSTALLED WITH COPPER FINDER WIRE, BLUE NO. 12, SUITABLE FOR DIRECT BURIAL. SECURELY FASTEN WIRE TO PIPE EVERY 10' WITH DUCT TAPE. LOCATING WIRE SHALL BE TESTED BY CONTRACTOR IN PRESENCE OF ENGINEER. ALL BURIED PIPE SHALL BE INSTALLED WITH LOCATOR TAPE, 3-INCH WIDE, PLACED BETWEEN 18 INCHES AND 24 INCHES ABOVE THE PIPE. TAPE SHALL BE MARKED AS BEING WATER LINE LOCATOR TAPE.
14. ALL PVC PRESSURE PIPE SHALL BE MANUFACTURED AND TESTED TO AWWA C900 (4 TO 12 INCHES) AND C905 (>12 INCHES). PVC PRESSURE PIPE SHALL BE DR18 (PRESSURE CLASS 235 PSI) OR DR14 (PRESSURE CLASS 305 PSI). PVC PIPE INSTALLATION SHALL BE PER AWWA C605, AND THE PLANS WITH THE MORE STRINGENT REQUIREMENTS GOVERNING THE INSTALLATION. PVC PIPE FITTINGS SHALL BE OF EQUAL OR GREATER PRESSURE CLASS AS THE PIPE, CEMENT-MORTAR LINED DUCTILE IRON. FITTINGS SHALL BE FLANGED OR MECHANICAL JOINT AS INDICATED ON THE CONTRACT DRAWINGS. DUCTILE IRON FITTINGS SHALL BE POLYETHYLENE ENCASED.
15. INSTALL NO. 10 STAINLESS STEEL RODENT SCREEN ON END OF FLUSH PIPE.
16. CONTRACTOR SHALL VERIFY EXISTING AND PROPOSED ELEVATIONS PRIOR TO CONSTRUCTION.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WELL 5 SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C104

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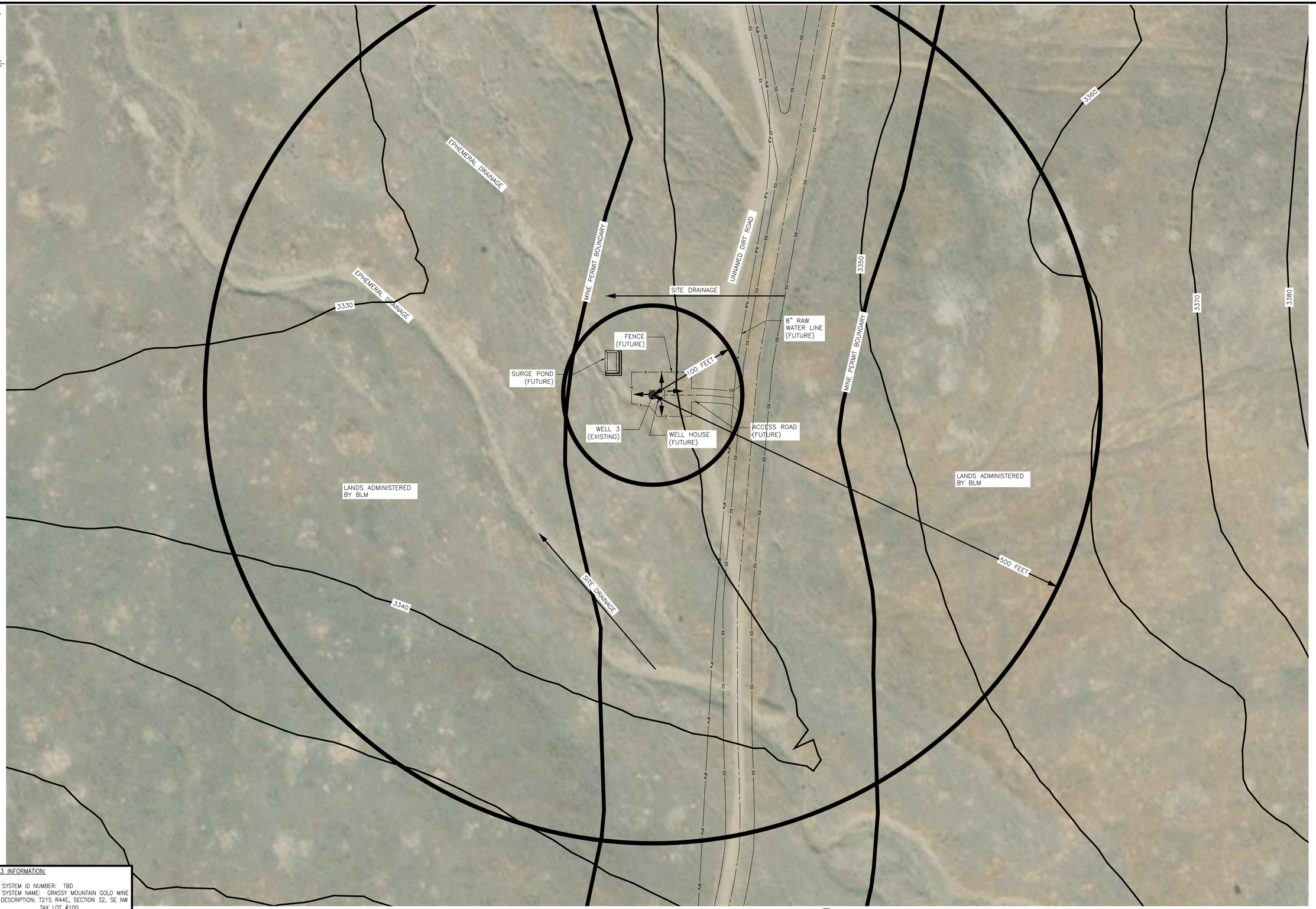

WELL 3 INFORMATION:

WATER SYSTEM ID NUMBER: TBD
WATER SYSTEM NAME: GRASSY MOUNTAIN GOLD MINE
LEGAL DESCRIPTION: T21S R44E, SECTION 32, SE NW TAX LOT #100
LATITUDE: 43 DEG 42' 5.28" N
LONGITUDE: 117 DEG 21' 56.54" W

POTENTIAL CONTAMINATION WELL SITE PLAN

SCALE: 1:600

A
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SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WELL 3 (PW-4) POTENTIAL CONTAMINATION MAP

REGISTERED PROFESSIONAL ENGINEER
7-31-19
21236
OREGON
MAY 10, 2016
JUSTIN P. LEBARON
EXPIRES: 12-31-20

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C105

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Xref Filename: | X-TITLE (2) |

WELL 4 INFORMATION:

WATER SYSTEM ID NUMBER: TBD
WATER SYSTEM NAME: GRASSY MOUNTAIN GOLD MINE
LEGAL DESCRIPTION: T21S R44E, SECTION 32, SE NW
TAX LOT #100
LATITUDE: 43 DEG 42' 11.99" N
LONGITUDE: 117 DEG 21' 57.01" W

POTENTIAL CONTAMINATION WELL SITE PLAN A
SCALE: 1:600

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WELL 4 POTENTIAL CONTAMINATION MAP

REGISTERED PROFESSIONAL ENGINEER
81236
OREGON
MAY 10, 2016
JUSTIN P. LEBARON
EXPIRES: 12-31-20
7-31-19

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C106

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: 1 X-TITLE (2) 1
Xref Filename: 1 X-TITLE (2) 1

WELL 5 INFORMATION:

WATER SYSTEM ID NUMBER: TBD
WATER SYSTEM NAME: GRASSY MOUNTAIN GOLD MINE
LEGAL DESCRIPTION: T21S R44E, SECTION 32, NE NW TAX LOT #100
LATITUDE: 43 DEG 42' 19.02" N
LONGITUDE: 117 DEG 21' 57.62" W

POTENTIAL CONTAMINATION WELL SITE PLAN (A)
SCALE: 1:600

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WELL 5 POTENTIAL CONTAMINATION MAP

REGISTERED PROFESSIONAL ENGINEER
81236
OREGON
MAY 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20
7-31-19

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C107

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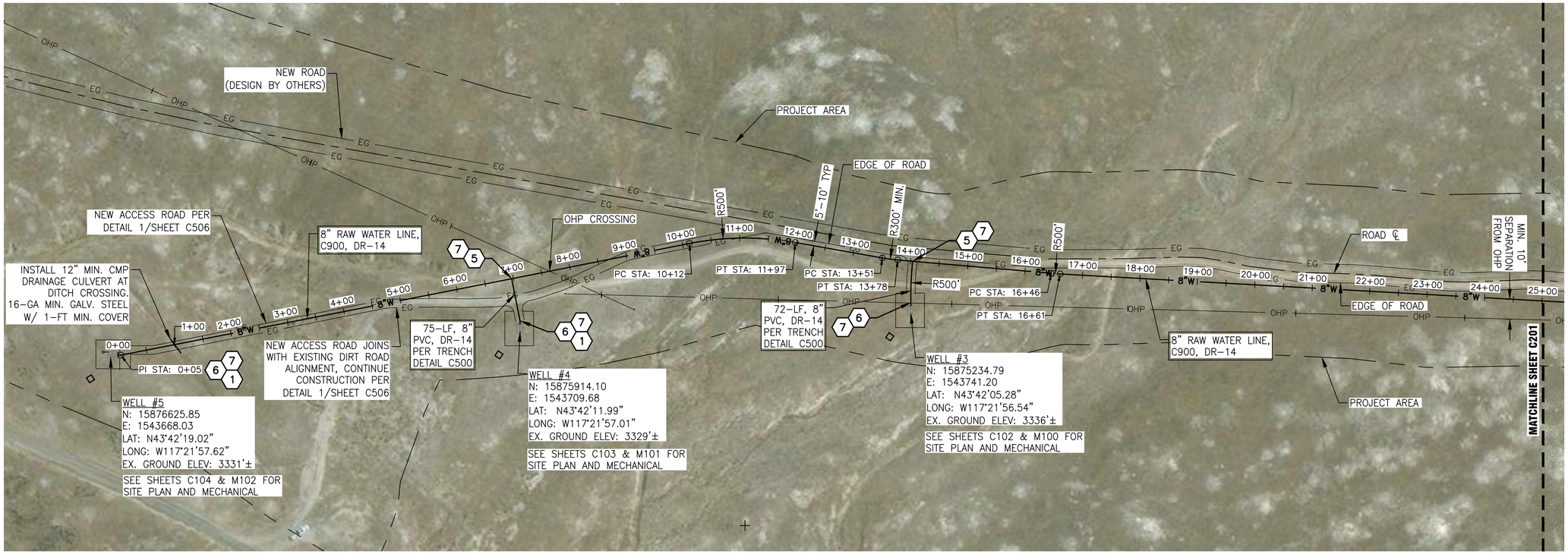
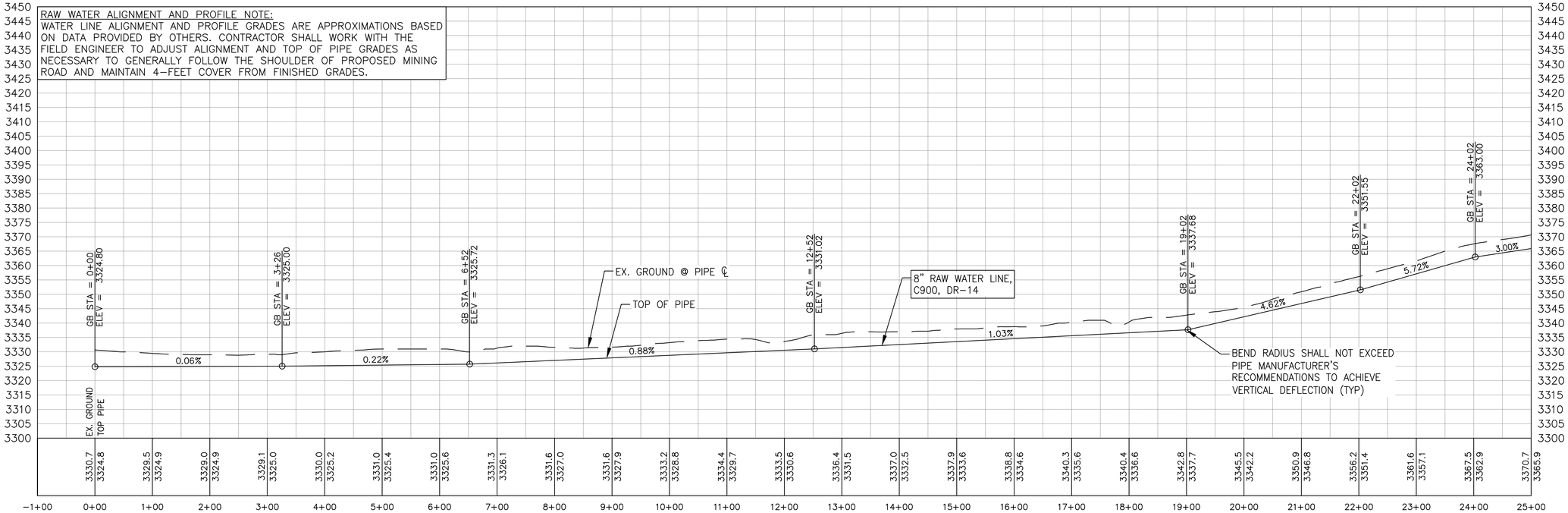


FITTINGS (#)

1. 8"–11.25° BEND
2. 8"–22.5° BEND
3. 8"–45° BEND
4. 8"–90° BEND
5. 8X8 TEE
6. 4X8 REDUCER, MECHANICALLY RESTRAINED
7. THRUST BLOCK–C501

RAW WATER ALIGNMENT AND PROFILE NOTE:
WATER LINE ALIGNMENT AND PROFILE GRADES ARE APPROXIMATIONS BASED ON DATA PROVIDED BY OTHERS. CONTRACTOR SHALL WORK WITH THE FIELD ENGINEER TO ADJUST ALIGNMENT AND TOP OF PIPE GRADES AS NECESSARY TO GENERALLY FOLLOW THE SHOULDER OF PROPOSED MINING ROAD AND MAINTAIN 4–FEET COVER FROM FINISHED GRADES.



RAW WATER SUPPLY LINE PROFILE

100 0 100 200 — HORIZONTAL SCALE OF FEET
20 0 20 40 — VERTICAL SCALE OF FEET
5X VERT. EXAGGERATION

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER PLAN & PROFILE 0+00 TO 25+00

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LERAIRIS
EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C200

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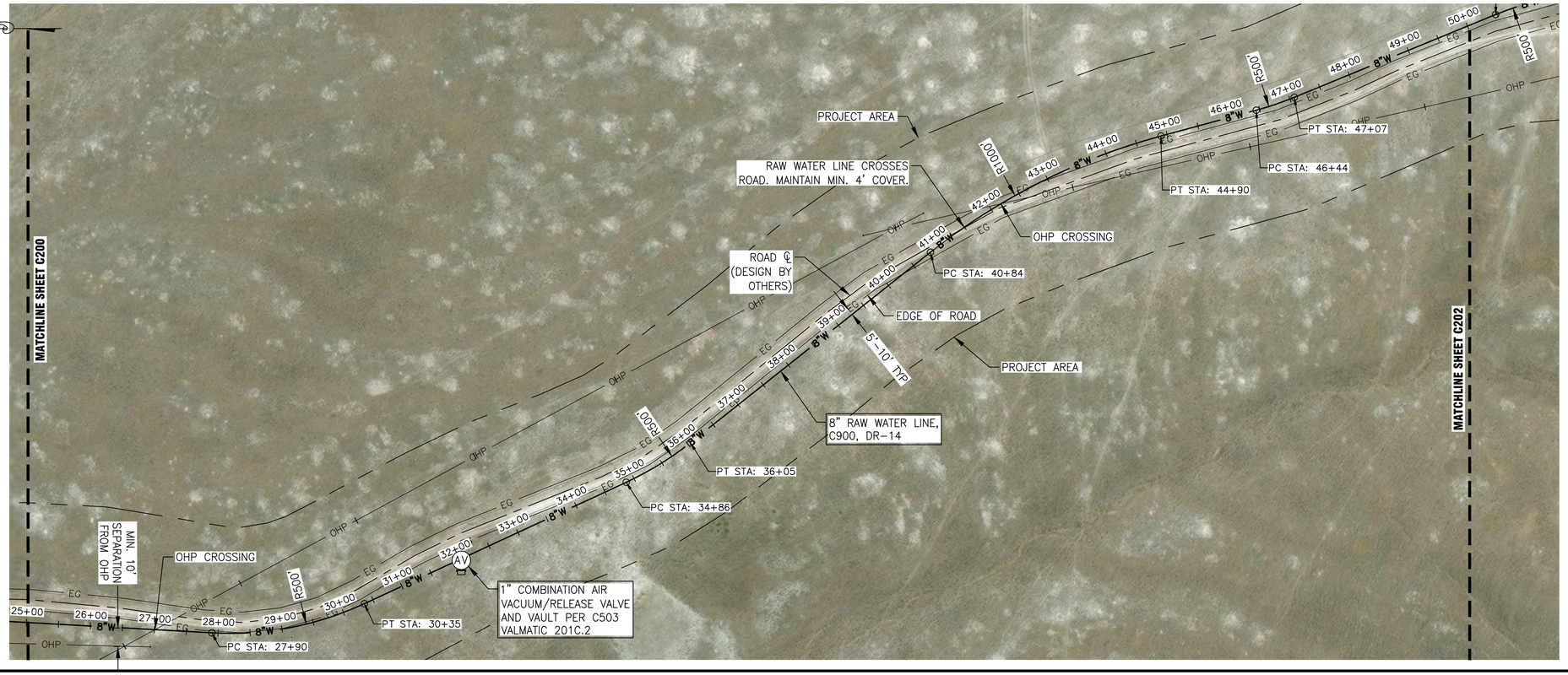
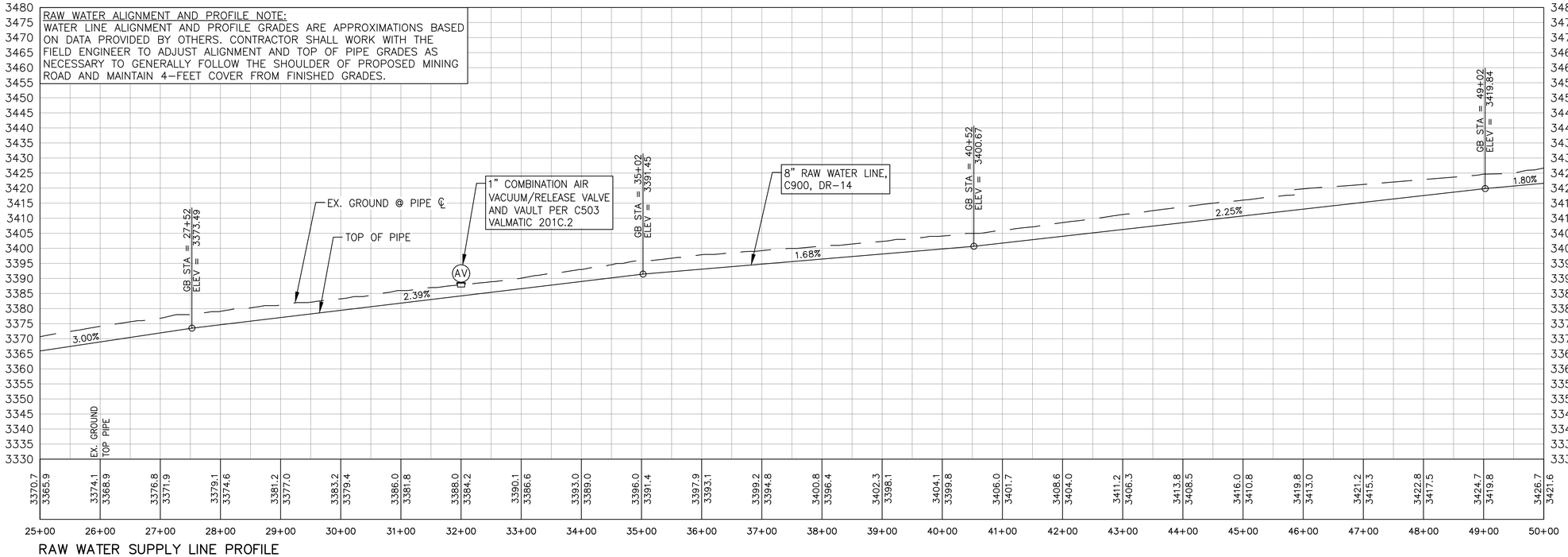


RAW WATER ALIGNMENT AND PROFILE NOTE:
WATER LINE ALIGNMENT AND PROFILE GRADES ARE APPROXIMATIONS BASED ON DATA PROVIDED BY OTHERS. CONTRACTOR SHALL WORK WITH THE FIELD ENGINEER TO ADJUST ALIGNMENT AND TOP OF PIPE GRADES AS NECESSARY TO GENERALLY FOLLOW THE SHOULDER OF PROPOSED MINING ROAD AND MAINTAIN 4-FEET COVER FROM FINISHED GRADES.



HORIZONTAL SCALE OF FEET

VERTICAL SCALE OF FEET

5X VERT. EXAGGERATION

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER PLAN & PROFILE 25+00 TO 50+00

REGISTERED PROFESSIONAL ENGINEER
17236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C201

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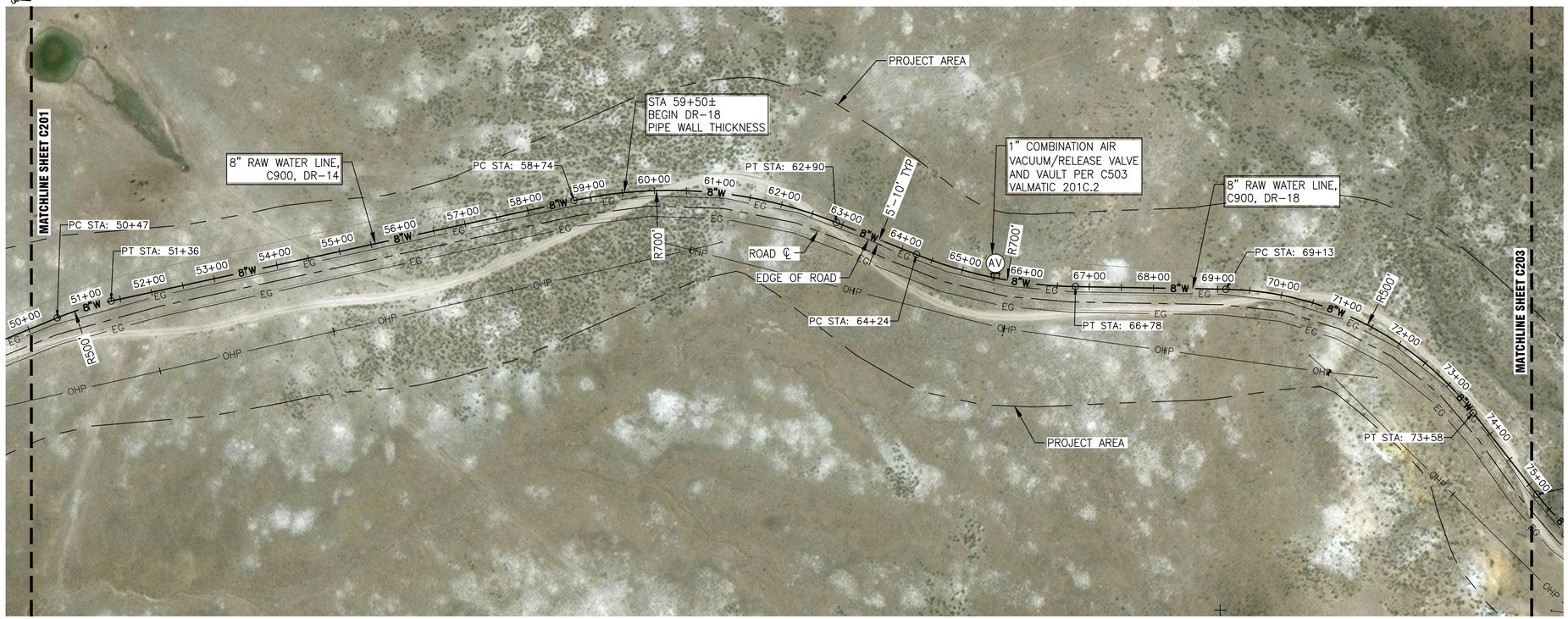

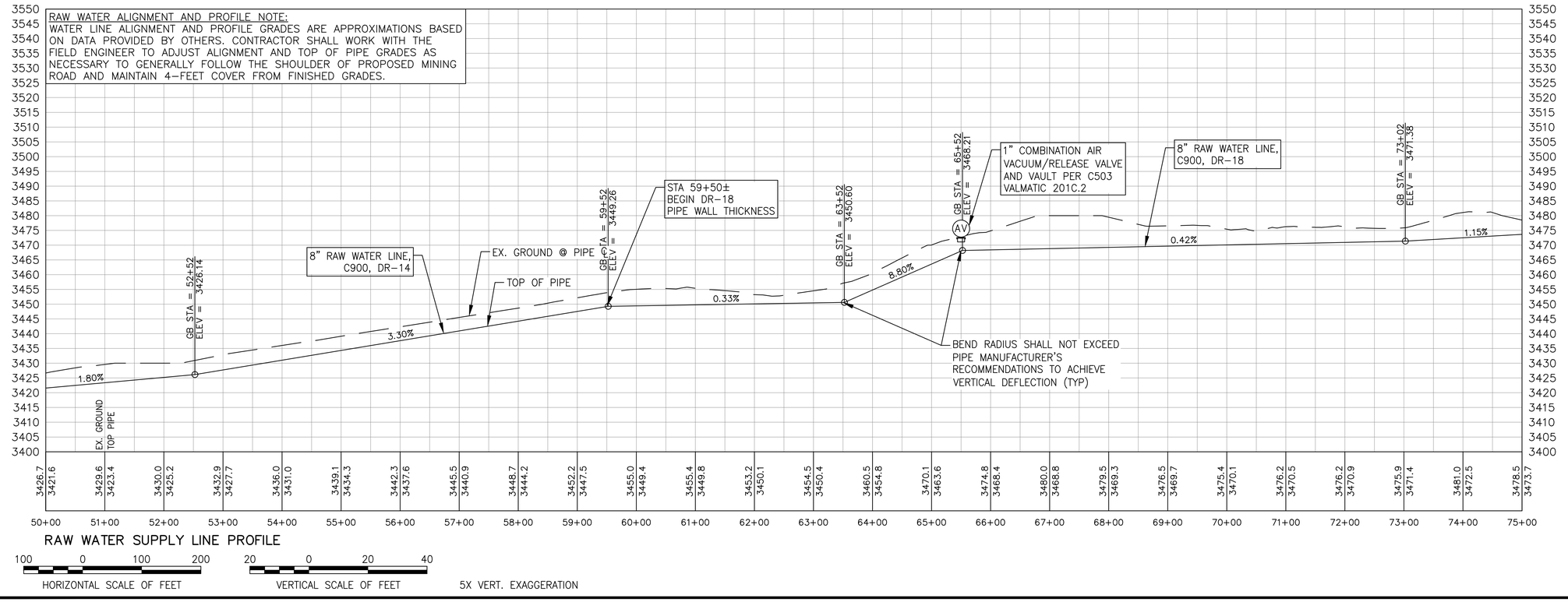

RAW WATER SUPPLY LINE PROFILE

100 0 100 200 HORIZONTAL SCALE OF FEET

20 0 20 40 VERTICAL SCALE OF FEET

5X VERT. EXAGGERATION

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER PLAN & PROFILE 50+00 TO 75+00

REGISTERED PROFESSIONAL ENGINEER
17236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C202

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: GRASSY MTN SITE-P&P Plot date: Aug 22, 2019-02:46:51pm CAD User: HWhite.
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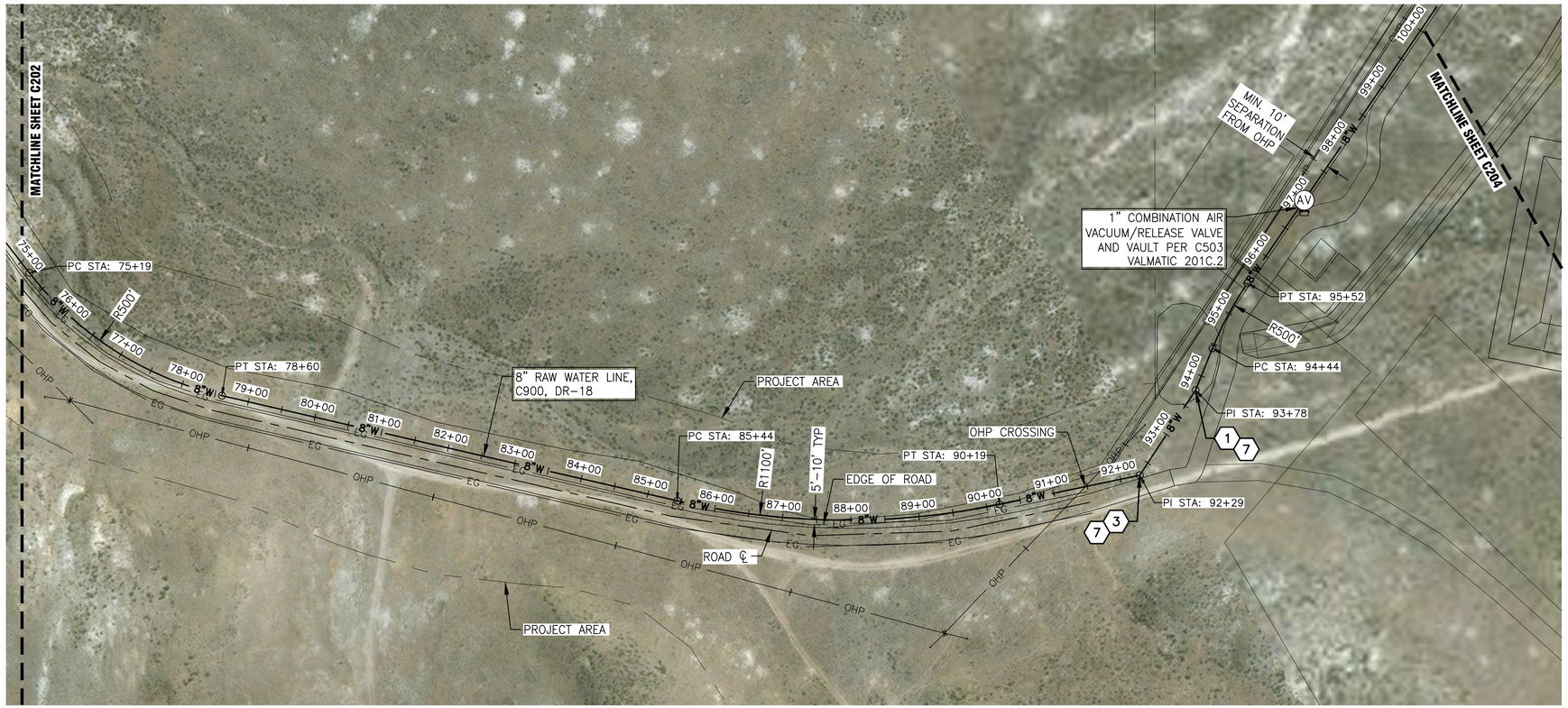

FITTINGS (#)

1. 8"–11.25° BEND
2. 8"–22.5° BEND
3. 8"–45° BEND
4. 8"–90° BEND
5. 8X8 TEE
6. 4X8 REDUCER, MECHANICALLY RESTRAINED
7. THRUST BLOCK–C501

RAW WATER ALIGNMENT AND PROFILE NOTE:
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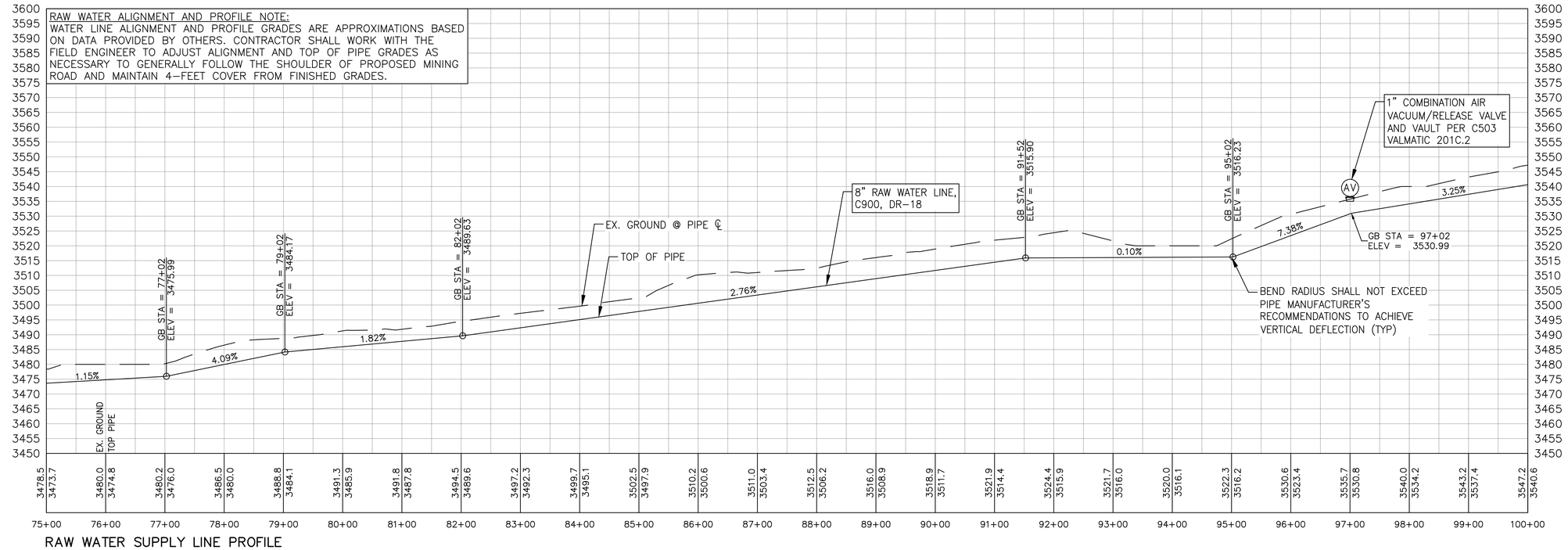

RAW WATER SUPPLY LINE PROFILE

100 0 100 200
HORIZONTAL SCALE OF FEET

20 0 20 40
VERTICAL SCALE OF FEET

5X VERT. EXAGGERATION

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER PLAN & PROFILE 75+00 TO 100+00

REGISTERED PROFESSIONAL ENGINEER
7-31-19
21236
OREGON
MAY. 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE–INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C203

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: GRASSY MTN SITE-P&P Plot date: Aug 22, 2019-02:47:21pm CAD User: HWhite.
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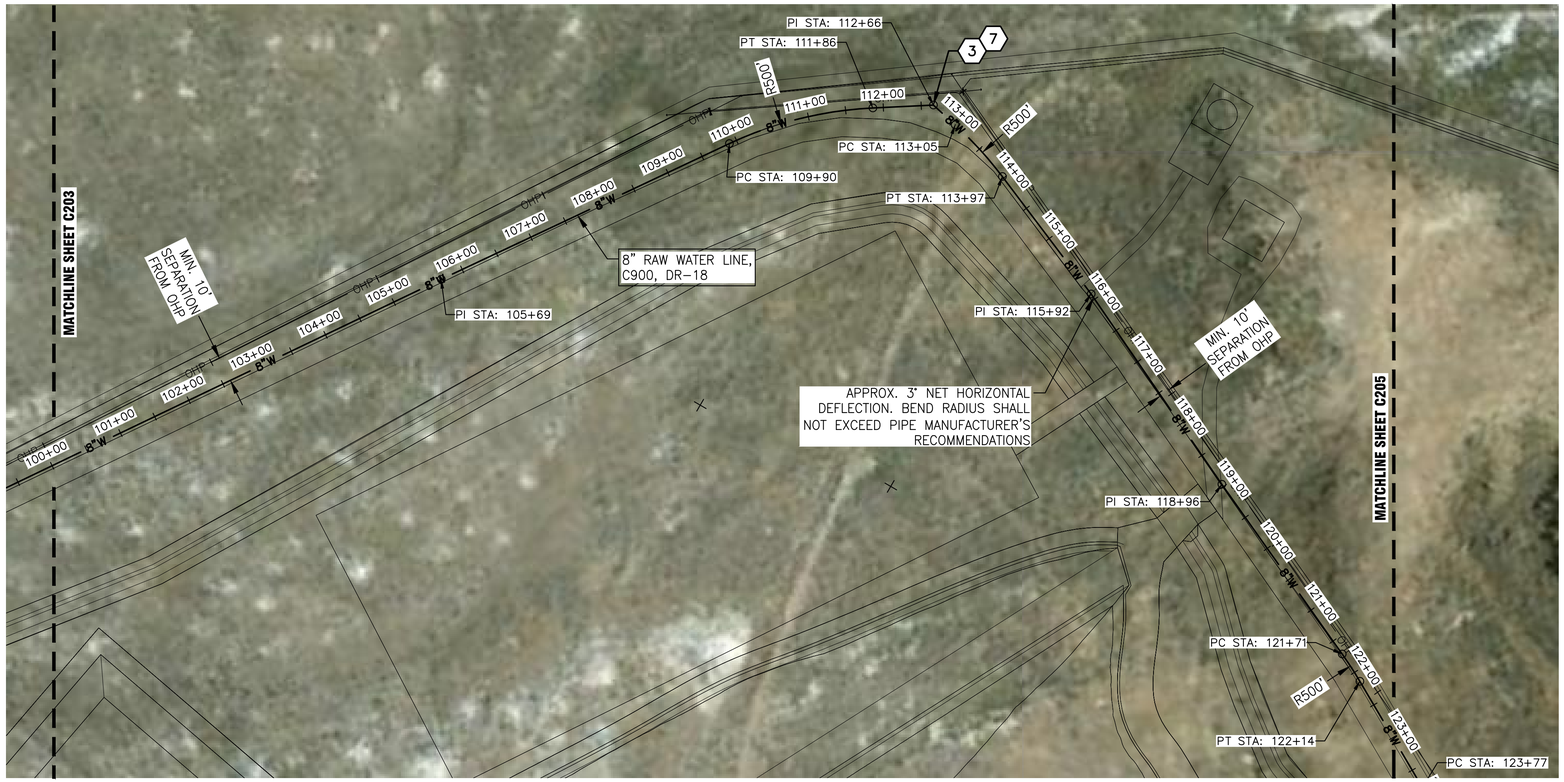
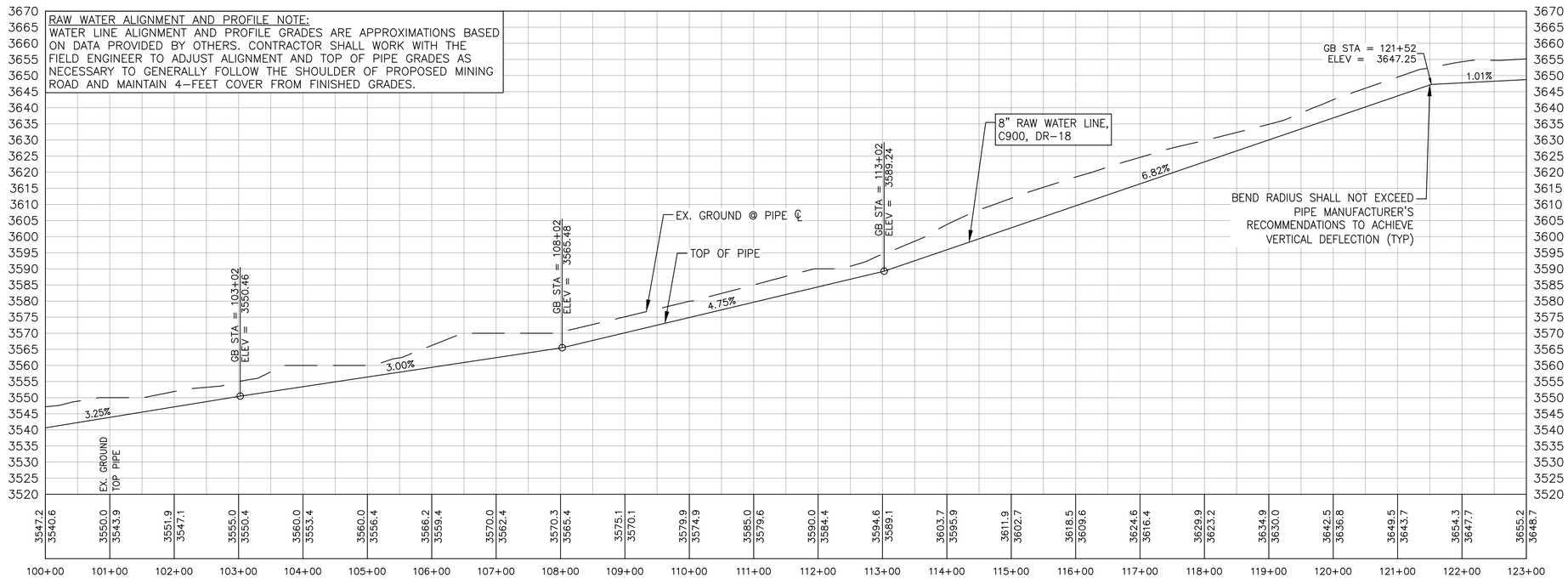


FITTINGS (#)

1. 8"–11.25° BEND
2. 8"–22.5° BEND
3. 8"–45° BEND
4. 8"–90° BEND
5. 8X8 TEE
6. 4X8 REDUCER, MECHANICALLY RESTRAINED
7. THRUST BLOCK–C501

RAW WATER ALIGNMENT AND PROFILE NOTE:
WATER LINE ALIGNMENT AND PROFILE GRADES ARE APPROXIMATIONS BASED ON DATA PROVIDED BY OTHERS. CONTRACTOR SHALL WORK WITH THE FIELD ENGINEER TO ADJUST ALIGNMENT AND TOP OF PIPE GRADES AS NECESSARY TO GENERALLY FOLLOW THE SHOULDER OF PROPOSED MINING ROAD AND MAINTAIN 4–FEET COVER FROM FINISHED GRADES.



RAW WATER SUPPLY LINE PROFILE

100 0 100 200 HORIZONTAL SCALE OF FEET

20 0 20 40 VERTICAL SCALE OF FEET

5X VERT. EXAGGERATION

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER PLAN & PROFILE 100+00 TO 123+00

REGISTERED PROFESSIONAL ENGINEER
JUSTIN P. LERAHS
81236
OREGON
MAY 10, 2016
7-31-19
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C204

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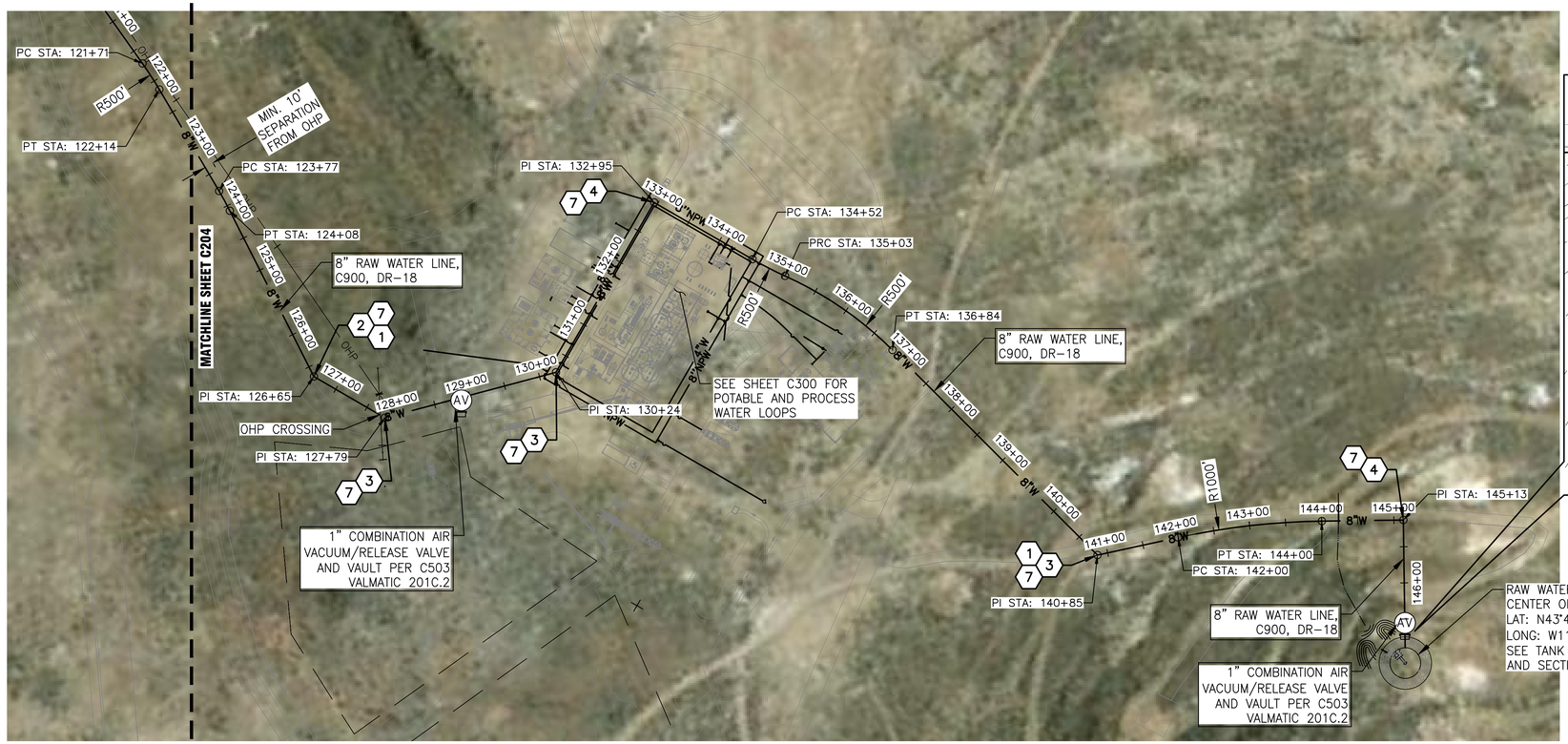
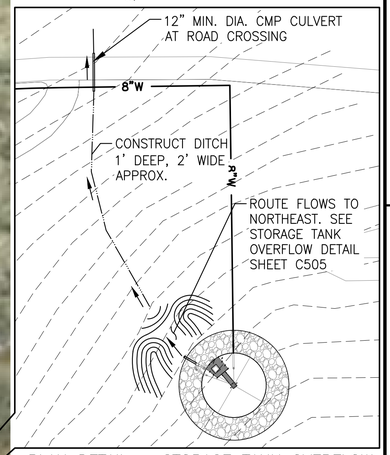
Xref Filename: | X-TITLE | X-LINEWORK | X-PLANT SITE BASE_7-23-19 | X-TITLE (2) |

FITTINGS (#)

1. 8"–11.25° BEND
2. 8"–22.5° BEND
3. 8"–45° BEND
4. 8"–90° BEND
5. 8X8 TEE
6. 4X8 REDUCER, MECHANICALLY RESTRAINED
7. THRUST BLOCK–C501





PLAN DETAIL – STORAGE TANK OVERFLOW

SCALE: 1" = 50'

RAW WATER ALIGNMENT AND PROFILE NOTE:
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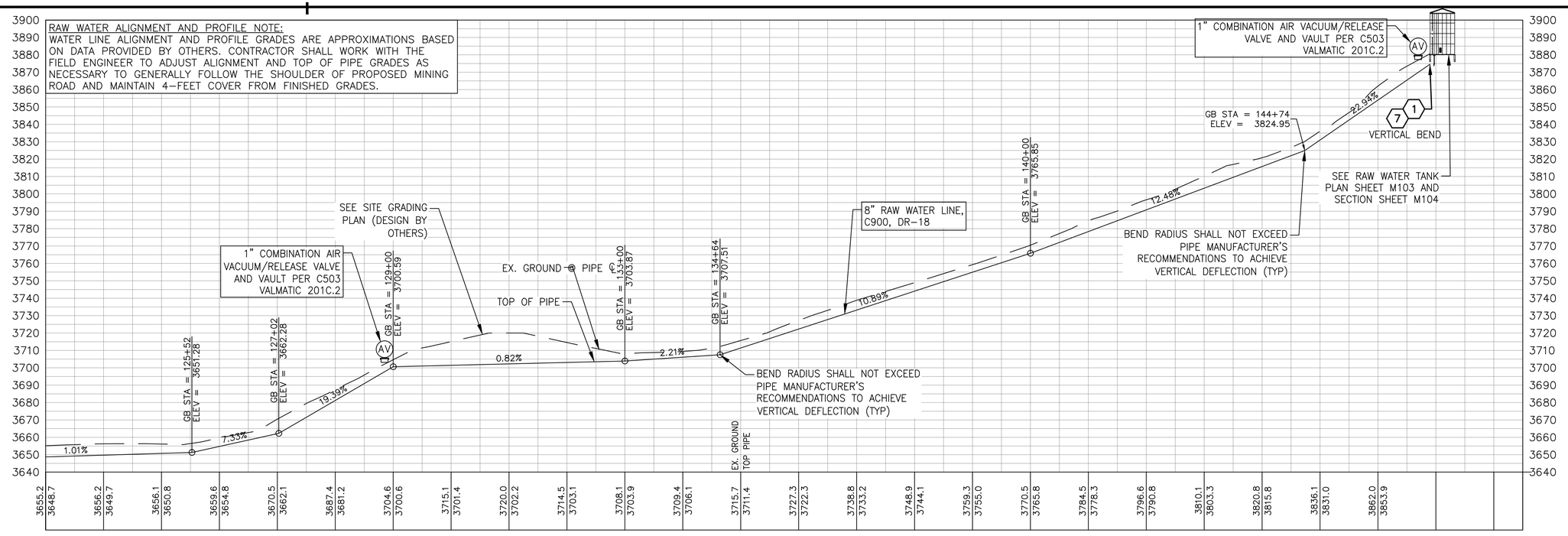

RAW WATER SUPPLY LINE PROFILE

100 0 100 200 — HORIZONTAL SCALE OF FEET

33 1/3 0 33 1/3 66 2/3 — VERTICAL SCALE OF FEET

3X VERT. EXAGGERATION

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER PLAN & PROFILE 123+00 TO 147+66 (TANK)

REGISTERED PROFESSIONAL ENGINEER
JUSTIN P. LEHARIS
17236
OREGON
MAY 10, 2016
7-31-19
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE–INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C205

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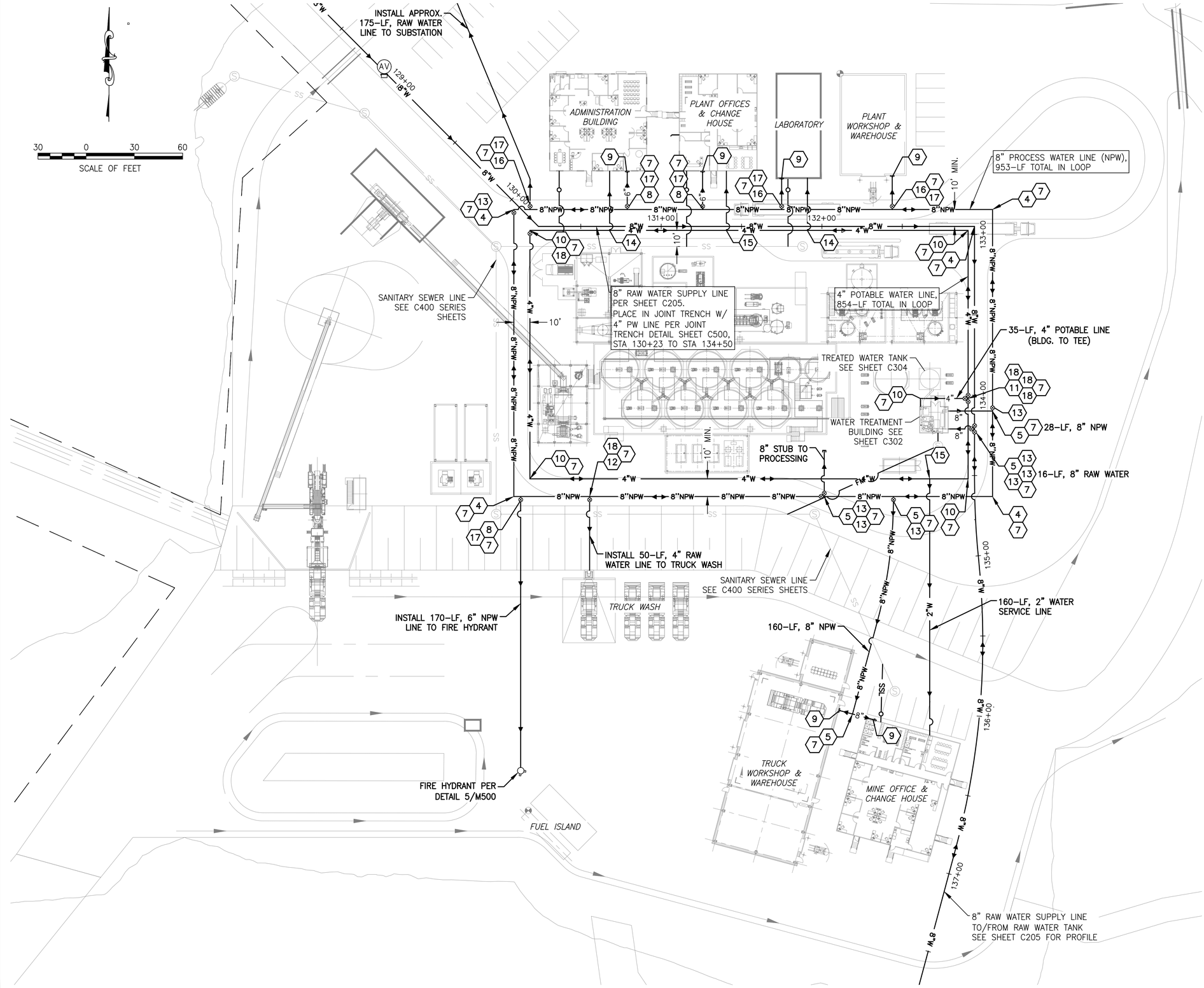

KEYNOTES (#)

1. 8"–11.25° BEND
2. 8"–22.5° BEND
3. 8"–45° BEND (NOT USED THIS SHEET)
4. 8"–90° BEND
5. 8X8 TEE
6. 4X8 RED./INCREASER
7. THRUST BLOCK–C501
8. 8X6 TEE
9. WALL HYDRANT PER 4/M500
10. 4"–90° BEND
11. 4X4 TEE
12. 8X4 TEE
13. 8" GATE VALVE & VALVE BOX
14. 1" WATER SERVICE SADDLE, CORPORATION STOP AND SERVICE LINE.
15. 2" WATER SERVICE SADDLE, CORPORATION STOP AND SERVICE LINE.
16. FIRE SPRINKLER LINE, TEE & LINE SIZE PER FIRE SPRINKLER SYSTEM DESIGN, 6" MIN.
17. 6" MIN. GATE VALVE & VALVE BOX (SIZE PER FIRE SPRINKLER LINE)
18. 4" GATE VALVE & VALVE BOX

NOTES

a. RAW WATER AND PROCESS WATER LINES THIS SHEET SHALL BE C900 PVC, DR-18 INSTALLED PER TRENCH DETAIL SHEET C500

b. 4" POTABLE WATER (PW) LINE THIS SHEET SHALL BE C900 PVC, DR-18 INSTALLED PER TRENCH DETAIL SHEET C500

c. WATER SERVICE LINES TO BE 4710 HDPE, SDR 11

d. POTABLE/NON-POTABLE HORIZONTAL SEPARATION AND CROSSINGS SHALL BE PER OAR 333-061-0050 (9). "NON-POTABLE" SHALL INCLUDE PROCESS WATER LINES.

SPF WATER ENGINEERING
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Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

POTABLE AND RAW WATER LOOPS

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C300

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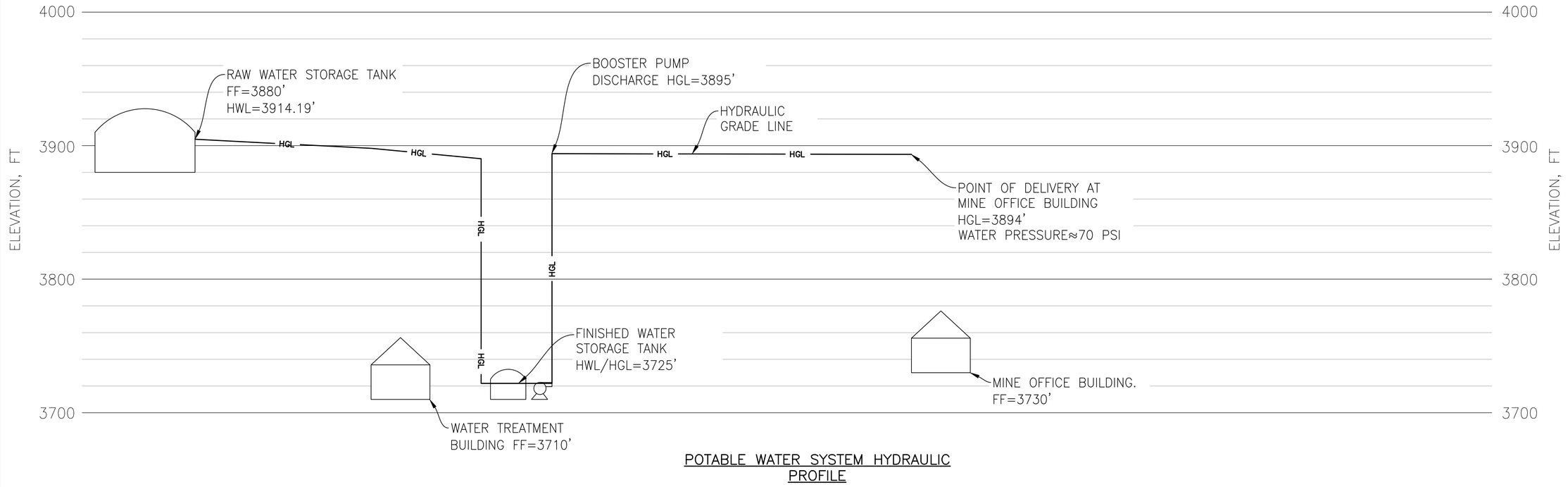
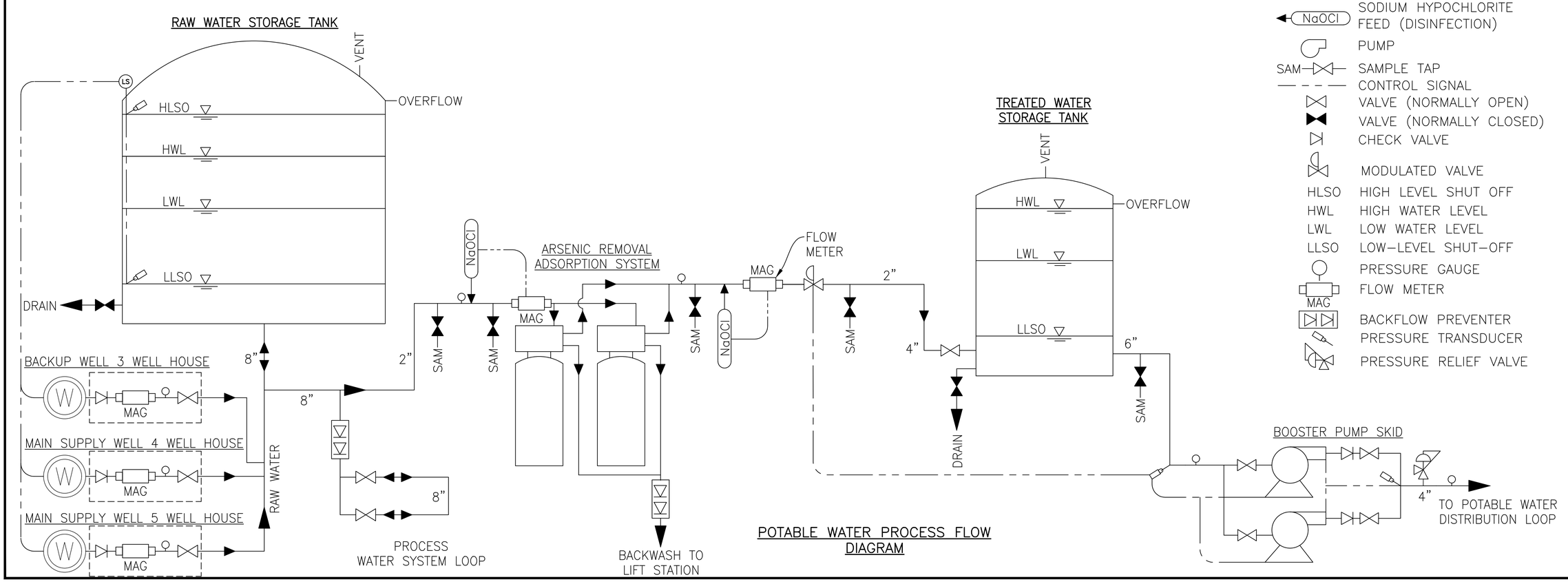


POTABLE WATER SYSTEM HYDRAULIC PROFILE



POTABLE WATER PROCESS FLOW DIAGRAM

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

POTABLE WATER SYSTEM PFD & HGL

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LERAIRS
EXPIRES: 12-31-20

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C301

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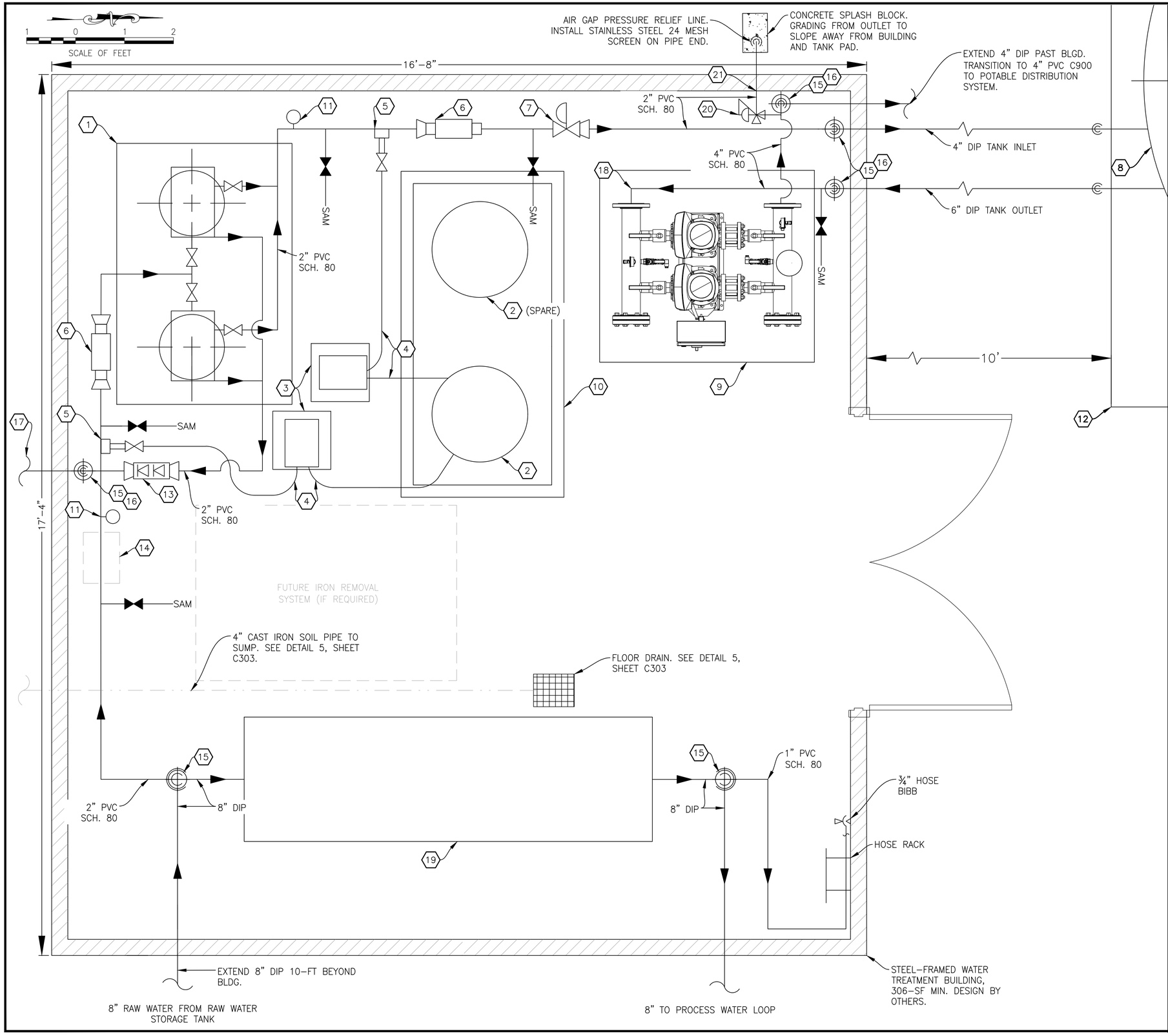
Xref Filename: | XR-TITLE | X-TITLE (2) |



GENERAL NOTES:

1. NO WATER FACILITIES SHALL BE CONSTRUCTED PRIOR TO RECEIPT OF OREGON HEALTH AUTHORITY APPROVAL.
2. MATERIALS IN CONTACT WITH POTABLE WATER MUST BE APPROVED BY THE NATIONAL SANITATION FOUNDATION (NSF), AMERICAN WATER WORKS ASSOCIATION (AWWA), AND STATE PLUMBING CODE.
3. ALL THREADED HOSE BIBBS SHALL BE FITTED WITH AN APPROVED BACKFLOW PREVENTION DEVICE.
4. ALL ABOVE-GRADE WATER SYSTEM PIPING SHALL BE PVC AND VALVES SHALL BE BRASS UNLESS OTHERWISE SPECIFIED.
5. SUPPORT MECHANICAL PIPING AS NECESSARY.
6. ALL PIPE SHALL BE PRESSURE TESTED AND DISNIFECTED PER OAR 333-061-0050.
7. AVOID HIGH POINTS WHEN ROUTING SODIUM HYPOCHLORITE P.E. TUBING.

KEYNOTES (#)

1. ARSENIC REMOVAL ADSORPTION SYSTEM, ADEDGE APU26 WITH E33 ADSORPTION MEDIA, OR APPROVED EQUAL.
2. SODIUM HYPOCHLORITE STORAGE DRUMS (2X 55-GAL).
3. SODIUM HYPOCHLORITE METERING PUMP, PULSATRON MP SERIES LMA2TA-VTC1-500, OR APPROVED EQUAL. FLOW PACE FROM MAGNETIC FLOW METERS.
4. 1/4-IN PE TUBING.
5. SODIUM HYPOCHLORITE INJECTION QUILL; KOFLO PVC CERAMIC QUILL OR APPROVED EQUAL.
6. 1-INCH MAGNETIC FLOW METER, ENDRESS+HAUSER 10W, OR APPROVED EQUAL.
7. 1-INCH MODULATING CONTROL VALVE. ASSURED AUTOMATION 101 SERIES VALVE WITH S4 SERIES ACTUATOR, OR APPROVED EQUAL.
8. WELDED STAINLESS STEEL 13,000-GAL TREATED WATER STORAGE TANK, 12-FT DIA, SUPERIOR STEEL (208) 454-8000 OR APPROVED EQUAL, SEE SHEET C304.
9. DUPLEX BOOSTER PUMP SKID, GRUNDFOS HYDRO MULTI-E 2CRE15-3, WITH 7.5-HP MOTORS, WITH 3-GAL. PRESSURE TANK OR APPROVED EQUAL.
10. SECONDARY CONTAINMENT, ULTRATECH ULTRA-SPILL PALLET PLUS CONTAINMENT PALLET 9610 P2 2-DRUM WITH NO DRAIN, OR APPROVED EQUAL.
11. GLYCERINE FILLED PRESSURE GAUGE (RANGE 0 TO 160 PSI)
12. REINFORCED CONCRETE TANK FOUNDATION. SEE SHEET S1.0 AND S2.0.
13. 1-INCH REDUCED PRESSURE BACKFLOW PREVENTER, WATTS MODEL 007 OR APPROVED EQUAL.
14. FUTURE BAG FILTER, IF REQUIRED.
15. FLOOR PENETRATION PER DETAIL 1, SHEET C303.
16. TRANSITION FROM DIP (BELOW FINISHED FLOOR) TO PVC OR PE (ABOVE FINISHED FLOOR). PLACE ISOLATION VALVE AT TRANSITION.
17. 2" PVC BACKWASH TO LIFT STATION MANHOLE. SEE DETAIL 3, SHEET C303.
18. PRESSURE TRANSDUCER IN TEE FOR POTABLE WATER TANK, RANGE 0-15 PSI. CONNECT TO ACTUATED CONTROL VALVE ON TANK INLET LINE.
19. 8-INCH WATTS REDUCED PRESSURE BACKFLOW PREVENTER ASSEMBLY, SERIES LF909, OR APPROVED EQUAL. PROVIDE NRS GATE VALVES ON INLET AND OUTLET. PROVIDE STRAINER. INSTALL AIR GAP AT RELIEF VALVE OUTLET AND ROUTE TO NEAREST FLOOR DRAIN.
20. PRESSURE RELIEF VALVE 1". CLA-VAL 55B-60 OR APPROVED EQUAL.
21. WALL PENETRATION WITH WATER TIGHT SEAL. BRACE PIPE AS REQUIRED.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WATER TREATMENT MECHANICAL LAYOUT

REGISTERED PROFESSIONAL ENGINEER 91236 7-31-19 OREGON MAY 10, 2016 JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C302

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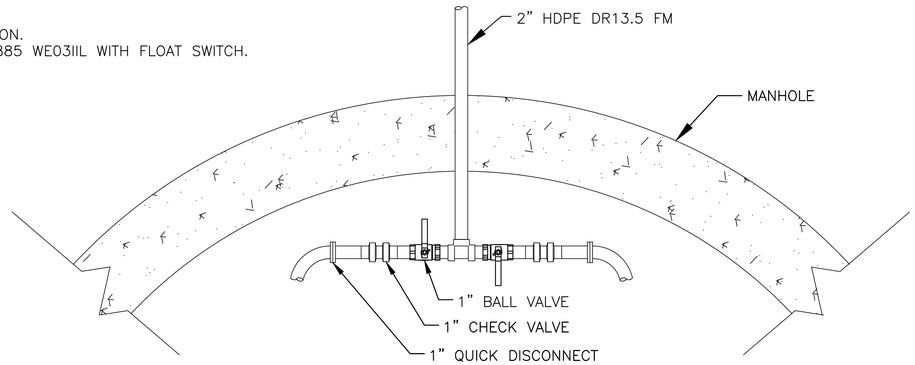
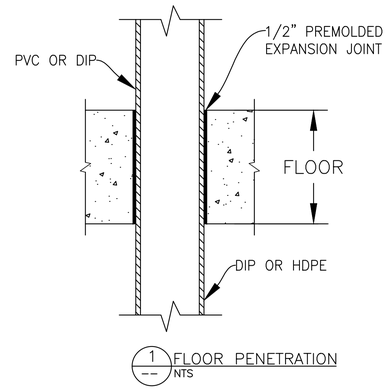
Xref Filename: | XR-TITLE | X-TITLE (2) |

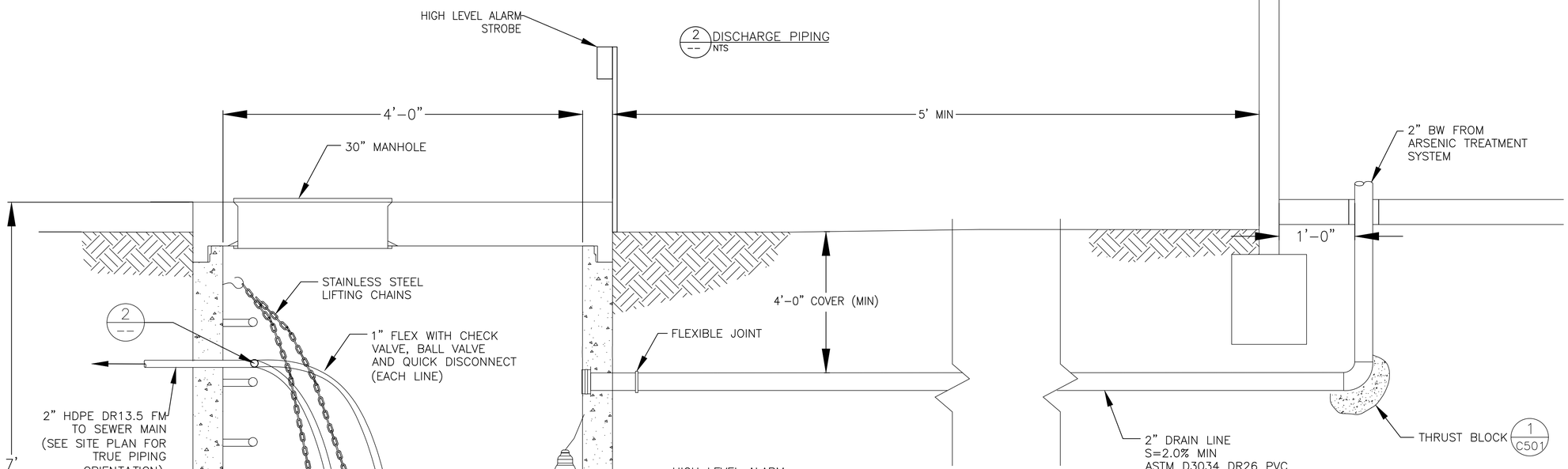
CONSTRUCTION KEYNOTES:
1. GROUT MANHOLE FLOOR AT 10° SLOPE TO PUMP SUCTION.
2. EFFLUENT PUMPS TO BE GOULDS WE SERIES MODEL 3885 WE03IIL WITH FLOAT SWITCH.



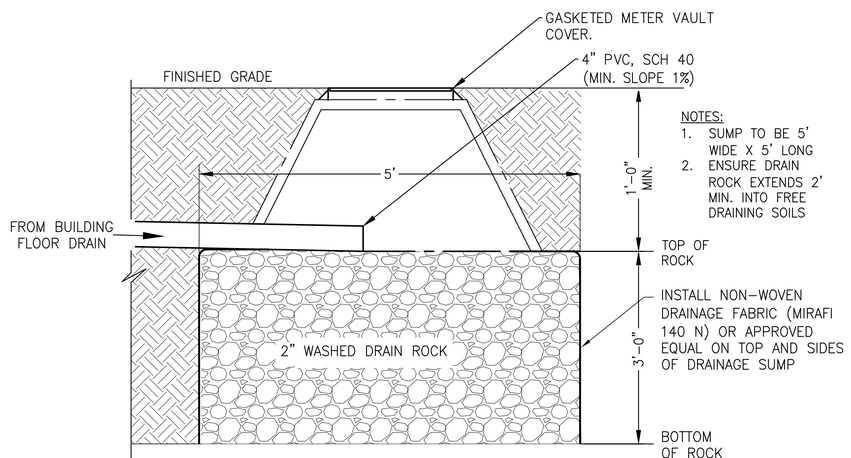
2 DISCHARGE PIPING
NTS



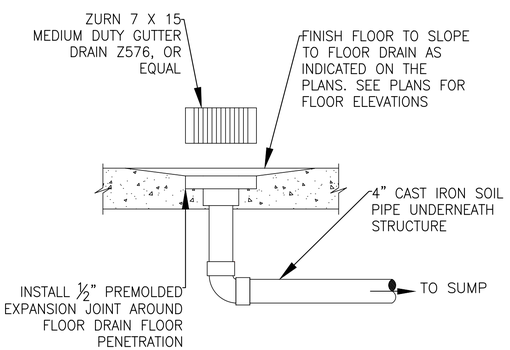
1 FLOOR PENETRATION
NTS



3 BACKWASH MANHOLE
NTS



4 FLOOR DRAIN SUMP
NTS



5 FLOOR DRAIN
NTS

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WATER TREAMENT BACKWASH LIFT STATION

REGISTERED PROFESSIONAL ENGINEER
STATE OF OREGON
MATTHEW W. RASMUSSON
MAR. 13, 2019
RENEWS: 12/31/2020

REVISIONS			
ITEM	DESCRIPTION		DATE
0	FINAL PERMIT SET		8/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C303

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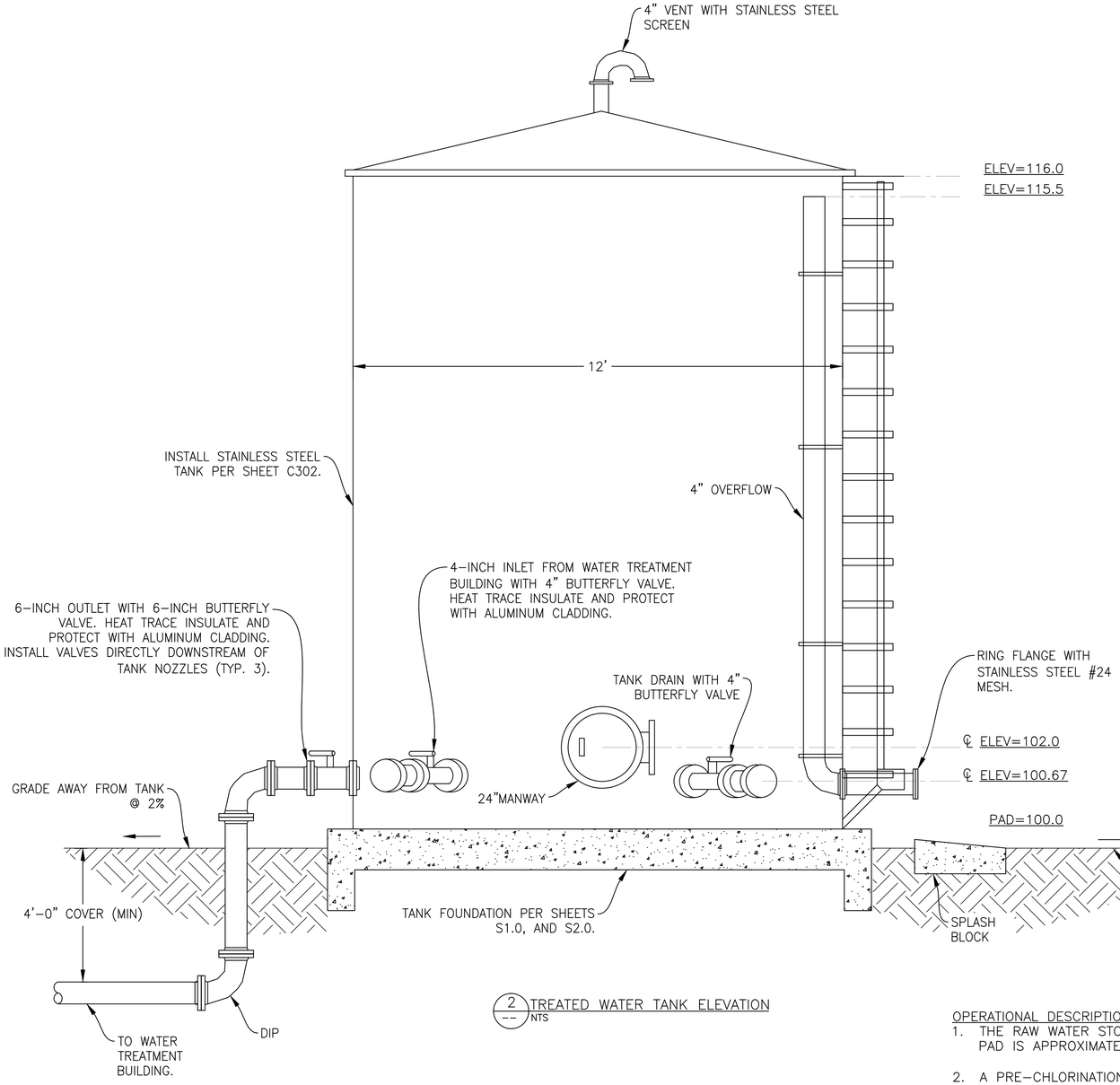
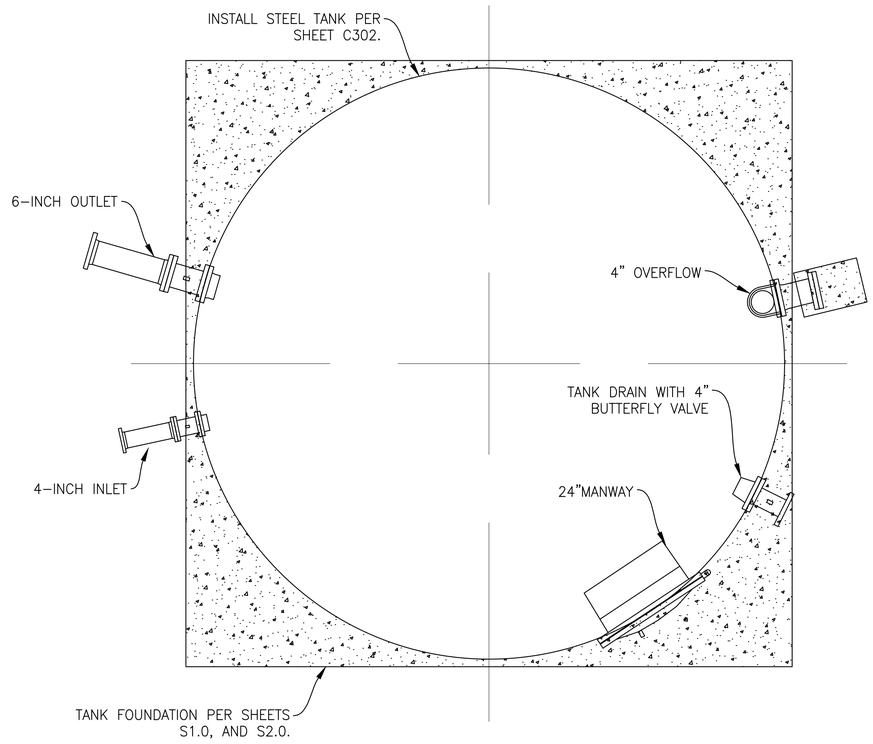


2 TREATED WATER TANK ELEVATION
NTS



1 TREATED WATER TANK PLAN
NTS

NOTES:

1. INSULATION SHALL BE A ONE-PIECE MOLDED GLASS FIBER MATERIAL MANUFACTURED BY SCHULLER, KNAUF, OR OWENS CORNING. PROVIDE ALUMINUM JACKET AND VAPOR BARRIER. THE INSULATION SHALL CONFORM TO ASTM C547. INSULATION SHALL HAVE A THICKNESS OF 2 INCHES.
2. ALUMINUM JACKET SHALL COMPLY WITH ASTM B209 AND SHALL BE A NOMINAL THICKNESS OF AT LEAST 0.020 INCH, WITH AN EMBOSSED FINISH. A FACTORY-APPLIED ASPHALT AND KRAFT PAPER VAPOR BARRIER OR POLYETHYLENE FILM AND KRAFT PAPER BARRIER SHALL EXTEND THE FULL WIDTH OF THE JACKET. JACKETING SHALL BE HELD IN PLACE WITH STAINLESS STEEL SECURING BANDS UNIFORMLY SPACED AT NOT MORE THAN 18 INCHES TO PRODUCE TIGHT JOINTS WITHOUT BULGING.
3. EXTERIOR PIPING SHALL BE PROVIDED WITH 110 VOLT HEAT TRACE SYSTEM DESIGNED TO MAINTAIN TEMPERATURE OF 50°F WITH A ΔT OF 90°F. HEAT TRACE SYSTEM SHALL BE RAYCHEM CHEMELEX AUTO-TRACE, CHROMALOX SRF, OR EQUAL. INSTALLATION SHALL BE PER MANUFACTURER RECOMMENDATIONS AND SHALL CONFORM TO NEC.
4. STEEL PIPE AND FITTINGS SHALL BE PROVIDED W/FLANGES CONFORMING TO ANSI B16.5, PRESSURE CLASS 150. FITTINGS TO BE HDPE OR DUCTILE IRON AS INDICATED ON DRAWINGS, ANSI/NSF APPROVED. HDPE FITTINGS SHALL BE RATED FOR 200 PSI.

OPERATIONAL DESCRIPTION:

1. THE RAW WATER STORAGE TANK WILL PRESSURIZE THE ARSENIC TREATMENT UNIT VIA GRAVITY. THE MINIMUM STATIC PRESSURE AT THE TREATMENT PAD IS APPROXIMATELY 74 PSI, THE MAXIMUM IS 88 PSI.
2. A PRE-CHLORINATION DOSE (FOR SODIUM HYPOCHLORITE) WILL BE INJECTED UPSTREAM OF THE ARSENIC TREATMENT UNIT BASED ON FLOW PACING FROM A MAGNETIC FLOW METER LOCATED ON THE INLET SIDE OF THE ARSENIC TREATMENT UNIT.
3. A POST-CHLORINATION DOSE (FOR SODIUM HYPOCHLORITE) WILL BE INJECTED DOWNSTREAM OF THE ARSENIC TREATMENT UNIT BASED ON FLOW PACING FROM A MAGNETIC FLOW METER LOCATED ON THE OUTLET SIDE OF THE ARSENIC TREATMENT UNIT.
4. TREATED WATER FROM THE ARSENIC TREATMENT UNIT WILL FLOW INTO THE TREATED WATER STORAGE TANK. THE TANK LEVEL WILL BE MODULATED BY A MODULATING CONTROL VALVE (MCV) LOCATED ON THE OUTLET LINE FROM THE ARSENIC TREATMENT UNIT. THE MCV WILL OPERATE BASED ON A PRESSURE TRANSDUCER LOCATED ON THE OUTLET LINE FROM THE TREATED WATER STORAGE TANK (UPSTREAM OF THE BOOSTER PUMP SKID). THE SYSTEM WILL OPERATE BASED ON THE FOLLOWING WATER LEVELS IN THE TREATED WATER TANK:
   - MCV CLOSED: 15-FT (HWL)
   - MCV OPEN: 13-FT (LWL)
   - BOOSTER PUMP SHUTOFF: 3-FT (LSSO)
5. TREATED WATER FROM THE TREATED WATER STORAGE TANK WILL FLOW BY GRAVITY TO THE PRE-PACKAGED BOOSTER PUMP STATION, WHICH WILL PRESSURIZE A PRESSURE TANK AND THEN CONTINUE ON TO THE POTABLE WATER DISTRIBUTION SYSTEM.
6. THE BOOSTER PUMP STATION WILL OPERATE BASED ON A PRESSURE SET POINT VIA A PRESSURE TRANSDUCER ON THE DISTRIBUTION SIDE OF THE BOOSTER PUMP SKID. EACH PUMP WILL BE CONTROLLED BY A VFD TO MAINTAIN CONSTANT PRESSURE WITH VARIABLE DEMAND.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

TREATED WATER STORAGE TANK

REGISTERED PROFESSIONAL ENGINEER
STATE OF OREGON
17236
7-31-19
MAY 10, 2016
JUSTIN P. LERAHS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C304

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: PROCESS FLOW DIAGRAM Plot date: Aug 22, 2019-03:14:32pm CAD User: HWhite.
Xref Filename: | XR-TITLE | X-TITLE (2) |

SEPTIC TANK
SEE SHEET C508

123°

0+00
MH – 1
STA: 0+00

MH – 2
STA: 0+84

151°

1+00

10' MIN.
SEPARATION

3700.00

TRANSPORT LINES

STOCKPILE &
RECLAIM AREA

3710.00

3710.00

3710.00

ABSORPTION TRENCH
AREA BOUNDARY
SEE SHEET C401

SEWER SERVICE CLEANOUT
SEE SHEET DETAIL 4
SHEET C506

3708.00

4" SANITARY SEWER
SERVICE LINE

135°

0+00

2+00

MH – 3
STA: 0+00

MH – 3
STA: 2+01

135°

1+00

4" SANITARY SEWER
SERVICE LINE

10' MIN.
SEPARATION

4" SANITARY SEWER
SERVICE LINE

1+91

MH – 3A
STA: 1+91

3706.00

3704.00

3702.00

3-SEWER SERVICE
CONNECTIONS
SEE SHEET DETAIL 5
SHEET C504

3-SEWER SERVICE CROSSINGS
SEE SHEET DETAIL 5 SHEET C506

ELUTION AREA

GOLD ROOM

REAGENT AREA

10' MIN.
SEPARATION

3+00

CIL AREA

WATER SERVICE AREA

GRINDING AREA

SEWER SERVICE CROSSINGS
SEE SHEET DETAIL 5 SHEET C506

MH – 5A
STA: 0+88

FM

FM

10' MIN.
SEPARATION

4+00

5+00

90°

MH – 4
STA: 3+67

MH – 5
STA: 5+65

CRUSHING AREA

TRUCK WASH

6+00

3706.00

3710.00

3720.00

3724.00

3728.00

SEWER SERVICE CONNECTION
SEE SHEET DETAIL 5 SHEET C504

TRUCK WORKSHOP
& WAREHOUSE

4" SANITARY SEWER
SERVICE LINE

TSS

MH – 6
STA: 6+86

6+86

SEWER SERVICE CLEANOUT
SEE SHEET DETAIL 4 SHEET C506

MINE OFFICE &
CHANGE HOUSE

20 0 20 40
SCALE OF FEET

CONSTRUCTION NOTES

1. PROPOSED PAD ELEVATIONS ARE BASED ON THE LANDXML SURFACE PROVIDED TO SPF ON 8/20/2019 BY AUSENCO. IF FINAL PAD ELEVATIONS DIFFER FROM THE ASSUMED ELEVATIONS, CONTRACTOR SHALL ADJUST FINAL MANHOLE AND GRAVITY SANITARY SEWER PIPES ACCORDINGLY. GRADE AREA AROUND EACH MANHOLE TO DIVERT SURFACE WATER AWAY.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION SYSTEM SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
17078
8/22/2019
OREGON
MAR. 13, 2015
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C400

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: GRASSY M'TN_SEWER C400-C404 Plot date: Aug 22, 2019-01:00:54pm CAD User: HWhite.
Xref Filename: | X-TITLE | X-LINEWORK | X-PLANT SITE BASE_7-23-19 | X-TITLE (2) |

CONSTRUCTION NOTES

1. CONTRACTOR SHALL FOLLOW OAR 340-071-0520 RULES AND REGULATIONS.
2. THIS SYSTEM SHALL BE INSTALLED UNDER DRY SOIL CONDITIONS TO REDUCE SMEARING. IF SMEARING OCCURS, THE SMEARED AREAS SHALL BE RAKED.
3. THE SITE OF DISTURBANCE MUST BE RE-SEEDED.
4. BOTH THE INITIAL AND REPLACEMENT ABSORPTION TRENCH AREAS ARE TO BE PROTECTED FROM TRAFFIC, COVER, DEVELOPMENT OR OTHER POTENTIAL DISTURBANCE OF NATURAL SOIL CONDITIONS.
5. THE ABSORPTION TRENCH AREAS MUST NOT BE SUBJECTED TO EXCESSIVE SATURATION DUE TO: BUT NOT LIMITED TO; ARTIFICIAL DRAINAGE OF GROUND SURFACES, ROADS, DRIVEWAYS AND BUILDING DOWN SPOUTS.
6. IF ROADS ARE CUT DOWNSLOPE OF THE ABSORPTION TRENCH AREAS THE CONTRACTOR SHALL PROVIDE A MINIMUM SETBACK OF 50-FT.
7. ABSORPTION TRENCHES SHALL NOT BE CONSTRUCTED WITHIN 100-FT OF A WELL.
8. ALL WORK IN ABSORPTION TRENCH AREAS SHALL BE DONE WITH TRACK MACHINERY. NO WHEELED MACHINERY SHALL BE ALLOWED IN THE ABSORPTION TRENCH AREAS.
9. NO STOCKPILING OF MATERIALS SHALL BE ALLOWED WITHIN THE ABSORPTION TRENCH AREAS.
10. ALL HOLES IN LATERALS SHALL BE ORIENTED DOWN.
11. PROPOSED PAD ELEVATIONS ARE BASED ON THE LANDXML SURFACE PROVIDED TO SPF ON 8/20/2019 BY AUSENCO. IF FINAL PAD ELEVATIONS DIFFER FROM THE ASSUMED ELEVATIONS, CONTRACTOR SHALL ADJUST FINAL MANHOLE AND GRAVITY SANITARY SEWER PIPES ACCORDINGLY. GRADE AREA AROUND EACH MANHOLE TO DIVERT SURFACE WATER AWAY.

ABSORPTION TRENCHES

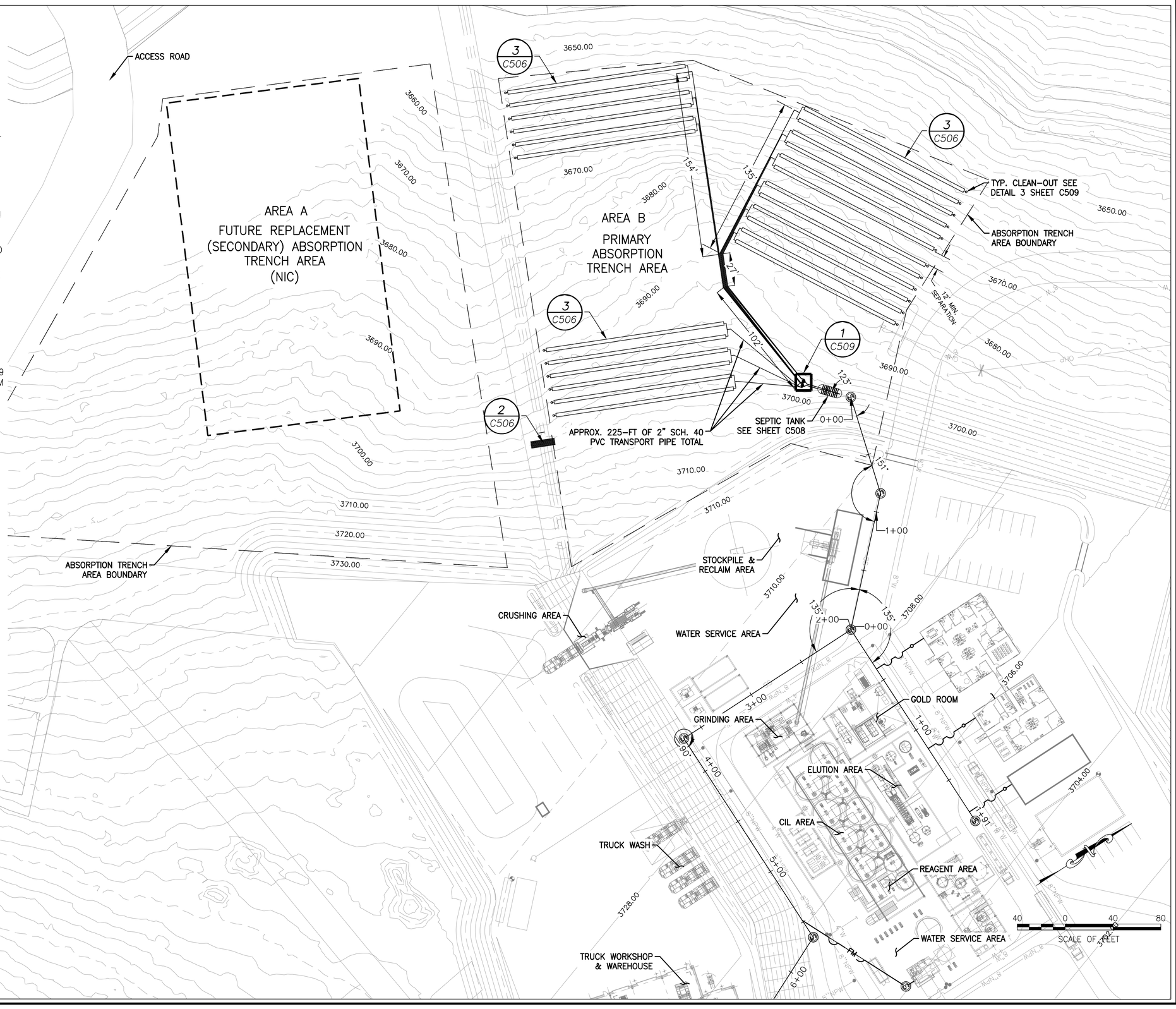
- 150'L X 3'W (24), 10,800 SF
- (4) ZONES PER AREA, 12-FT SPACING BETWEEN ZONES, 6 LATERALS PER ZONE, 2 LATERALS DISCHARGING PER DOSE, 11-FT SPACING BETWEEN LATERALS
- 1/8" DIA. ORIFICES, 4-FT SPACING, 38 ORIFICES PER LATERAL, 228 PER ZONE
- PLAN FOR 5-FT RESIDUAL HEAD AT END OF EACH LATERAL
- FLOW RATE PER ZONE = 60 GPM

PIPING AND VALVES

- TRANSPORT PIPING = 2" SCH. 40, 3168-FT
- MANIFOLD = 2" SCH. 40., 11-FT EACH, 132-FT
- LATERALS = 2" SCH. 40., 150-FT EACH, 3,600-FT

DUPLEX EFFLUENT PUMPS

- OPERATING POINT = 60 GPM @ 60-FT HEAD, APPROX.
- ALTERNATE BETWEEN DOSES
- AT LEVEL BETWEEN "PUMP OFF" AND HIGH LEVEL ALARM, BOTH PUMPS TURN ON
- DOSE ≈ 180 GALLONS, 6 TIMES PER DAY



SPF WATER ENGINEERING
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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

ABSORPTION TRENCH & REPLACEMENT AREAS SITE PLAN

REGISTERED PROFESSIONAL ENGINEER
OREGON
MAR. 13, 2015
MATTHEW W. RASMUSSON
RENEWS: 12/31/2020

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C401

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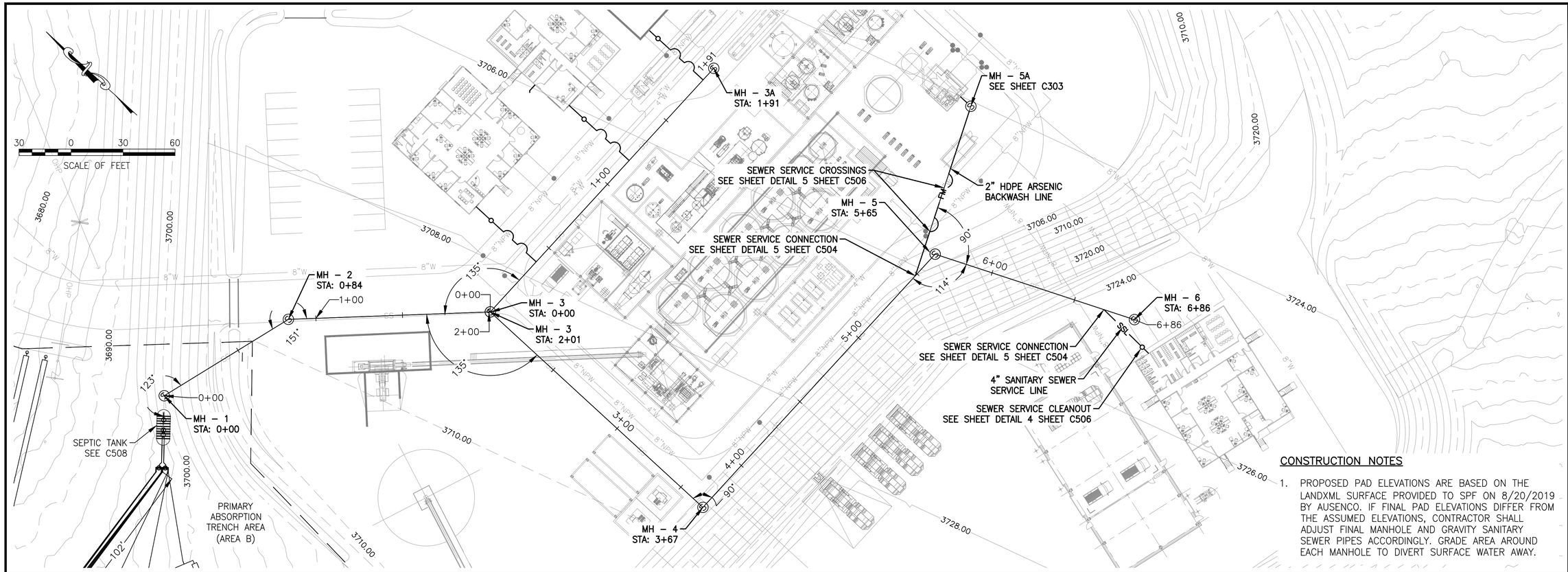

CONSTRUCTION NOTES

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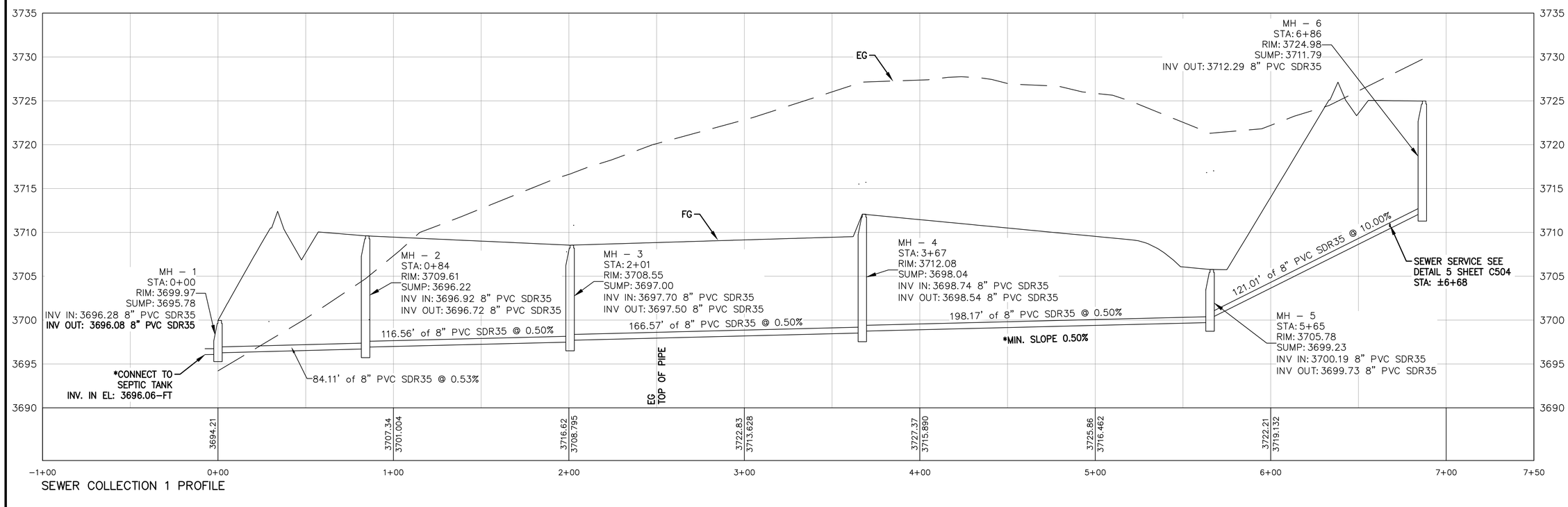

SEWER COLLECTION 1 PROFILE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION 1

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
OREGON
MAR. 13, 2015
9/6/2019
RENEWS: 12/31/2020

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C402

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: GRASSY MTN_SEWER C400-C404 Plot date: Aug 22, 2019-01:01:32pm CAD User: HWhite.
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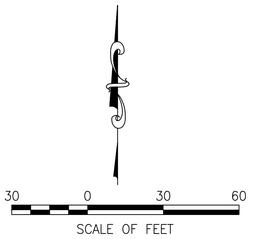

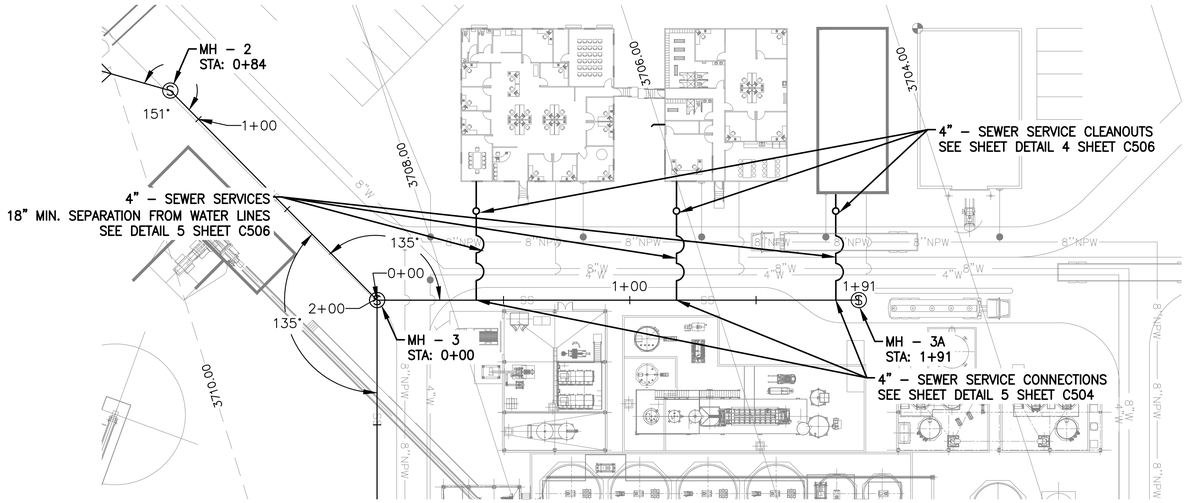

CONSTRUCTION NOTES

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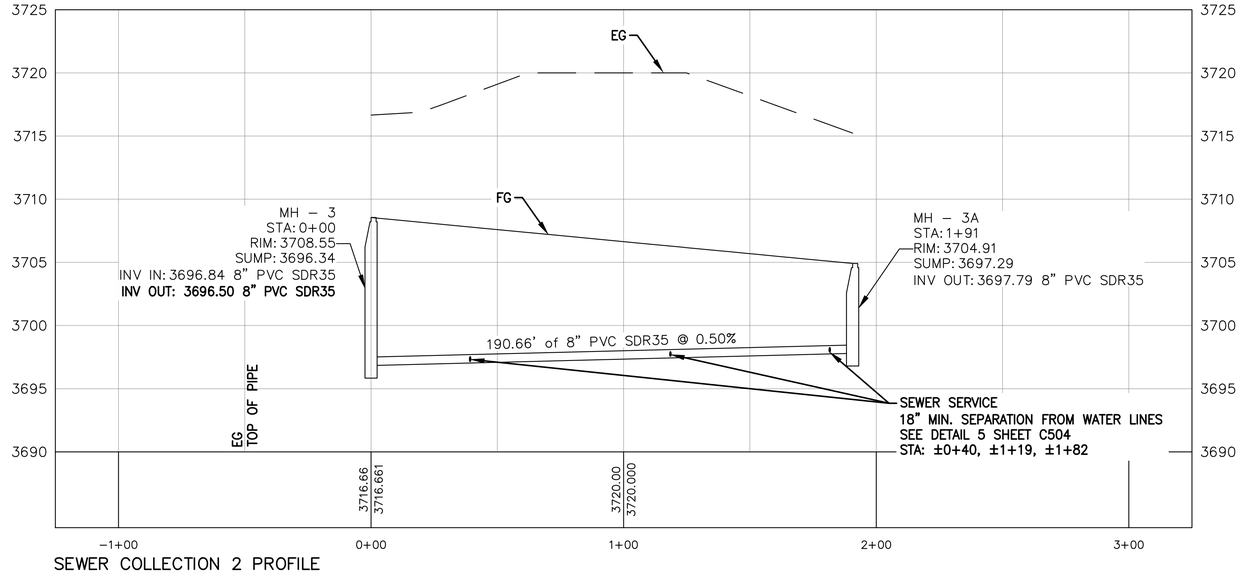

SEWER COLLECTION 2 PROFILE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEWER COLLECTION 2

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
No. 17872
OREGON
MAR. 13, 2015
8/22/2019
RENEWS: 12/31/2020

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C403

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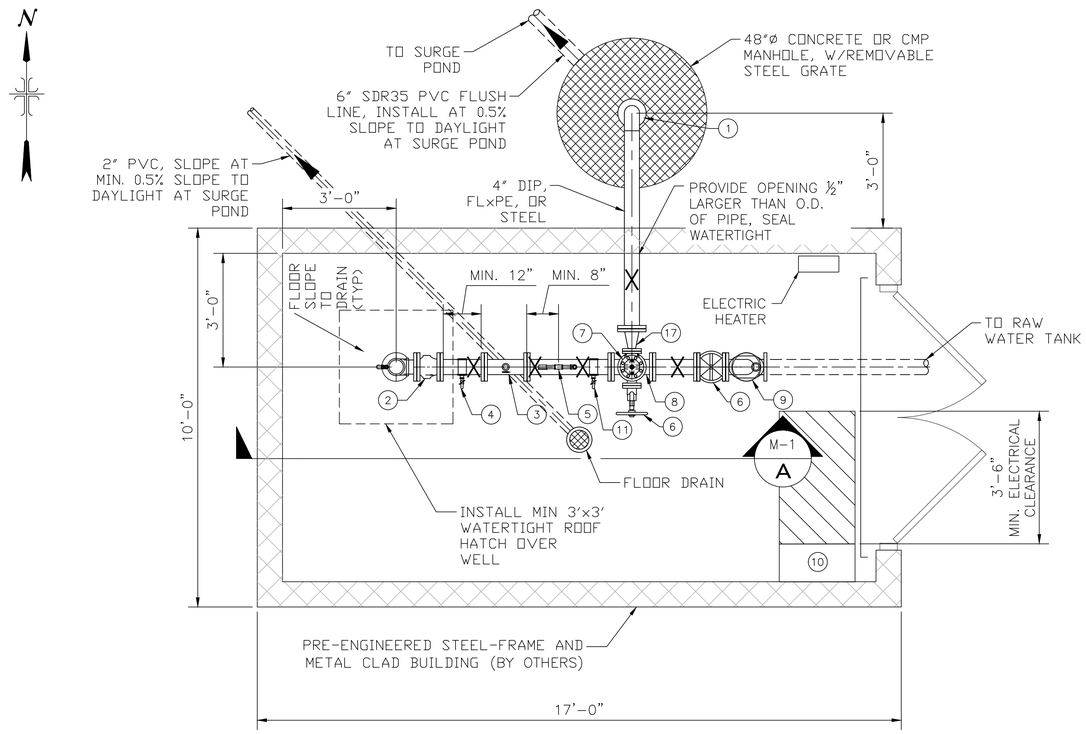
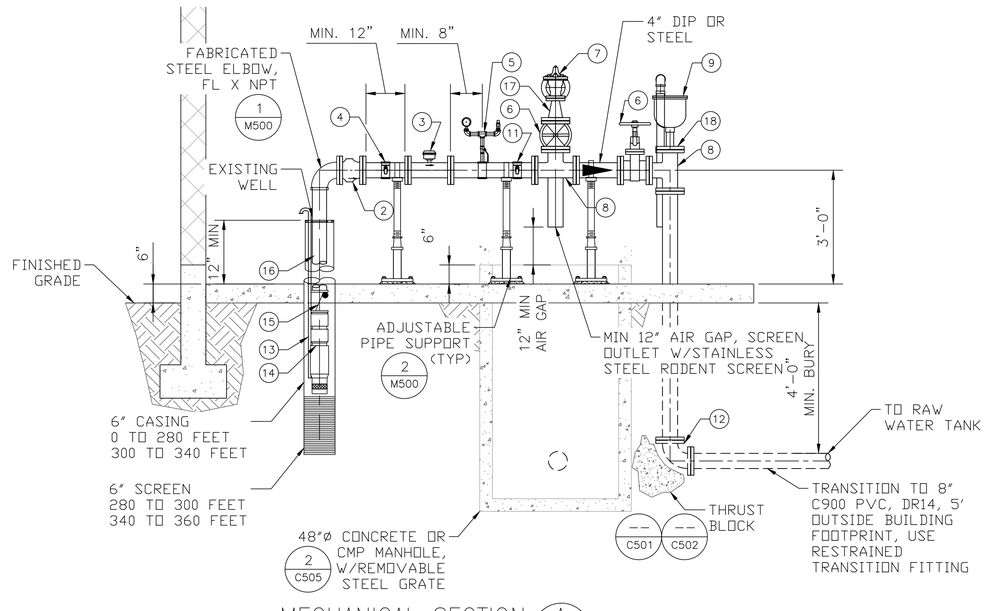


MECHANICAL PLAN (A) — SCALE: 1/2"=1'-0"



MECHANICAL SECTION (A) — SCALE: 1/2"=1'-0"

4 2 0 1 2 3 4 — SCALE IN FEET

SCALE: 1/2"=1'-0"

EQUIPMENT SCHEDULE		
NO	DESCRIPTION	QTY
1	4" D.I. OR STEEL 90° ELBOW	1
2	4" GLOBE STYLE SILENT CHECK VALVE, VAL-MATIC SERIES 1800 OR APPROVED EQUAL	1
3	4" MAGNETIC FLOW METER W/ GROUNDING RINGS, FLG X FLG, BADGER M2000 OR APPROVED EQUAL	1
4	SMOOTH-NOSE SAMPLE TAP W/ SADDLE; PROVIDE PRESSURE REDUCING VALVE SET AT 60PSI	1
5	MECHANICAL PRESSURE GAUGE, OIL-FILLED, 0-400 PSI, W/ISOLATION VALVE AND COMMON SADDLE W/PRESSURE TRANSMITTER	1
6	4" D.I. RESILIENT WEDGE GATE VALVE, FLG X FLG	2
7	2" ANGLE PRESSURE RELIEF AND SURGE ANTICIPATOR VALVE, 300 CLASS, FLG X FLG, CLA-VAL 52-01 BPVKC	1
8	4" D.I. TEE, FLG X FLG X FLG	2
9	1" COMBINATION AIR VALVE W/ ISOLATION VALVE, VAL-MATIC 201C.2, 300 PSI OR APPROVED EQUAL	1
10	WELL PUMP CONTROL PANEL	1
11	HOSE BIB W/ VACUUM BREAKER AND SADDLE; PROVIDE PRESSURE REDUCING VALVE SET AT 60PSI	1
12	4" D.I. 90 ELBOW, MJ X MJ, RESTRAINED	1
13	½" PVC FLUSH-THREAD SOUNDING TUBE & ⅜" PEX AIR LINE	1
14	SUBMERSIBLE PUMP W/MOTOR (GOULDS MODEL 5CHC, 17 STAGES, 3.72" IMPELLER TRIM, 60 HP, OR APPROVED EQUAL)	1
15	3" COLUMN CHECK VALVE, FLOMATIC 80 DI, SET AT 21' ABOVE PUMP	1
16	3" SCH 40 STEEL DROP PIPE	1
17	4" x 2" D.I. CONCENTRIC REDUCER, FL x FL	2
18	4" D.I. BLIND FLANGE	1

NOTES:

1. ALL PIPING FITTINGS AND FLANGES SHALL BE APPROPRIATE FOR 350 PSI UNLESS OTHERWISE NOTED. ALL PIPING SHALL BE PRESSURE TESTED, IN ACCORDANCE WITH AWWA REQUIREMENTS. ENGINEER SHALL BE NOTIFIED OF AND BE PRESENT FOR TESTING. ALL PIPING SHALL BE 4-INCH NOMINAL DIAMETER DIP OR STEEL UNLESS OTHERWISE NOTED. WELL DROP PIPE TO BE 3-INCH SCH 40 STEEL DROP PIPE, FITTINGS, AND COLUMN CHECK SHALL BE RATED FOR 500 PSI.
2. CONTRACTOR SHALL PROVIDE TO ENGINEER SHOP DRAWINGS INDICATING FINAL SELECTED FITTINGS, EQUIPMENT, AND GASKETS. CONTRACTOR IS RESPONSIBLE FOR FIELD VERIFICATION OF FITTING AND EQUIPMENT LOCATIONS AND DIMENSIONS. CONTRACTOR SHALL NOT RELY ON DRAWING SCALE TO VERIFY EQUIPMENT DIMENSIONS.
3. ALL WATERLINES SHALL BE FLUSHED, DISINFECTED AND TESTED FOR BACTERIA IN ACCORDANCE WITH AWWA STANDARD C651. CHLORINATED WATER SHALL BE PROPERLY DISPOSED OF WITH NO DISCHARGE TO SURFACE WATER. CONTRACTOR TO SUBMIT PLAN FOR CHLORINATED WATER DISPOSAL TO THE ENGINEER FOR APPROVAL.
4. PROVIDE SERVICE SADDLE, NYLON COATED DI BODY WITH STAINLESS STEEL DOUBLE STRAP, MUELLER OR EQUAL RATED FOR 350 PSI, AND BRONZE ISOLATION VALVE FOR ALL EQUIPMENT CONNECTED TO MAIN LINE.
5. THE ENDS OF ALL AIR VALVE OUTLET PIPING SHALL BE TERMINATED DOWNWARD AND COVERED W/ 24-MESH CORROSION RESISTANT SCREEN. ROUTE GSP OUTLET PIPING TO NEAREST FLOOR DRAIN. PROVIDE AIR GAP OF 18 INCHES.
6. INSTALL ALL SAMPLE TAPS HORIZONTALLY W/SPECIFIED AIR GAP.
7. ALL D.I.P. TO BE CLASS 53, CEMENT-MORTAR LINED PER AWWA C105. INTERIOR DUCTILE IRON PIPE SHALL BE ORDERED WITH NO EXTERIOR ASPHALTIC SEAL COAT AND SHALL RECEIVE A RUST INHIBITIVE PRIMER AND EPOXY COATING. COLOR TO BE SELECTED BY OWNER.
8. DUCTILE IRON FLANGED FITTINGS SHALL COMPLY WITH ANSI/AWWA C110/A21.10 STANDARD. DUCTILE IRON SPOOLS SHALL HAVE FLANGES COMPATIBLE WITH ANSI/AWWA C115/A21.15 STANDARD. GASKETS SHALL BE APPROPRIATE FOR A WORKING PRESSURE OF 350 PSI. WHERE FLANGED PIPE OR FITTINGS CONNECT TO ANSI CLASS 250 OR 300 FLANGES, COMPATIBLE ASME B16.1 CLASS 250 FLANGES SHALL BE PROVIDED.
9. PIPE SUPPORTS INDICATED BY AN 'X' ARE THE MINIMUM REQUIRED. CONTRACTOR TO PROVIDE ADDITIONAL SUPPORTS AS NEEDED TO ADEQUATELY SUPPORT EQUIPMENT.
10. ALL STEEL PIPE (EXCLUDING DROP PIPE) TO BE STANDARD WEIGHT (SCHEDULE 40 FOR 10-INCH AND SMALLER, 0.375-INCH WALL FOR 12-INCH OR LARGER). ALL STEEL PIPE (EXCLUDING DROP PIPE) TO BE CEMENT MORTAR LINED. ALL EXPOSED STEEL PIPE TO BE COATED WITH RUST INHIBITIVE PRIMER AND EPOXY PAINT PER THE SPECIFICATIONS. COLOR SELECTED BY OWNER.
11. SLOPE FLOORS AT 1% TO FLOOR DRAINS.
12. PRESSURE GAUGES SHALL BE OIL FILLED, 2.5-INCHES IN DIAMETER WITH WHITE LAMINATED DIALS AND BLACK GRADUATIONS. PRESSURE INDICATOR RANGE SHALL BE 0 -400 PSI, UNLESS OTHER WISE INDICATED ON THE DRAWINGS. GAUGE CASE SHALL BE TYPE 304 STAINLESS STEEL WITH BRASS WETTED MATERIALS.EACH PRESSURE GAUGE SHALL BE PROVIDED WITH A BRASS ISOLATION VALVE.
13. INSTALL FLOW METERS WITH UPSTREAM AND DOWNSTREAM STRAIGHT-PIPE DISTANCES PER MANUFACTURER RECOMMENDATION.
14. THE SURGE ANTICIPATOR VALVE SHALL HAVE DUCTILE IRON BODY, CAST IRON DISC AND RETAINER, WITH STAINLESS STEEL SPRING AND TRIM. VALVE SHALL BE RATED FOR 350 PSI. VALVE SHALL BE PROVIDED WITH HIGH PRESSURE PILOT SYSTEM (CRL-60), RATED FOR 100 TO 300 PSI. CRA PILOT SYSTEM SHALL BE RATED FOR 30 TO 300 PSI. PROVIDE INLET PRESSURE GAUGE (0-400PSI), AND X101 POSITION INDICATOR. INTERIOR AND EXTERIOR OF VALVE SHALL BE COATED WITH FUSION BONDED EPOXY. CONNECT PRESSURE SENSING LINE TO PIPING PER MANUFACTURER RECOMMENDATIONS. PRESSURE SENSING LINE SHALL BE 3/4-INCH MINIMUM I.D. COPPER INSTALLED WITH A 2' SLOPE FROM THE VALVE TO THE PIPING TO AVOID AIR POCKETS.
15. GATE VALVES SHALL BE RESILIENT-SEATED GATE VALVES CONFORMING TO ANSI/AWWA C515. RESILIENT-SEATED GATE VALVES SHALL HAVE DUCTILE IRON BODIES WITH FLANGED ENDS, RUBBER-COATED DUCTILE IRON WEDGE, FLANGED DUCTILE IRON BONNET, BRONZE OR COPPER ALLOY STEM, AND TYPE 304 STAINLESS STEEL EXTERIOR VALVE BODY BOLTING. THE VALVE SHALL BE LEAD FREE. GATE VALVES SHALL BE PROVIDED WITH HAND WHEEL OPERATORS FOR ABOVE-GROUND INSTALLATIONS. THE VALVES SHALL BE DESIGNED FOR A WATER WORKING PRESSURE OF NOT LESS THAN 350 PSI UNLESS OTHERWISE NOTED.
16. THE CHECK VALVE SHALL BE OF THE SILENT OPERATING TYPE, GLOBE-STYLE, WITH CAST OR DUCTILE IRON VALVE BODY. THE VALVE SEAT, DISC, AND DISC STEM SHALL BE SILICON BRONZE OR STAINLESS STEEL. THE SPRING AND RETAINING SCREWS SHALL BE TYPE 316 STAINLESS STEEL. THE VALVE SHALL BE LEAD FREE. THE VALVES SHALL BE DESIGNED FOR A WATER WORKING PRESSURE OF NOT LESS THAN 350 PSI UNLESS OTHERWISE NOTED.
17. THE CONTRACTOR IS TO UTILIZE PIPE FITTINGS THAT ARE PROPERLY RESTRAINED.
18. PUMP SHALL BE SET AT APPROXIMATELY 273 FEET BELOW TOP OF WELL.
19. ELECTRICAL CABLE SHALL BE FIRMLY ATTACHED TO THE DROP PIPE AT EACH COUPLING W/STAINLESS STEEL STRAPS. MOTORS CABLE SHALL BE SIZED TO LIMIT VOLTAGE DROP TO LESS THAN 5%.
20. ½" SOUNDER TUBE AND ⅜" AIR LINE SHALL BE ATTACHED TO DROP PIPE WITH STAINLESS STEEL STRAPS EVERY 20 FEET WITHOUT DEFORMING PIPE. TERMINATE AT TOP OF PUMP. INSTALL SOUNDER TUBE AND AIR LINE ON OPPOSITE SIDES OF DROP PIPE.
21. SUPPORT MECHANICAL PIPING AS SHOWN ON DRAWINGS.
22. SUBMERSIBLE PUMP SHALL BE CAPABLE OF PUMPING 150 GPM AT A TOTAL DYNAMIC HEAD OF 900 FEET.
23. THE PUMP BOWL ASSEMBLY SHALL BE CONSTRUCTED OF CLOSE GRAINED CAST IRON, ASTM A48, CLASS 30. THE INTERMEDIATE BOWLS SHALL BE ENAMEL OR EPOXY-LINED. THE IMPELLERS SHALL BE CONSTRUCTED OF TYPE 304 STAINLESS STEEL AND BALANCED TO GRADE G6.3 OF ISO 1940 AS MINIMUM. THEY SHALL BE SECURELY FASTENED TO THE BOWL SHAFT WITH TAPER LOCKS OF C1018 STEEL. THE INLET MOTOR ADAPTER SHALL BE DUCTILE IRON. THE PUMP SHAFT AND COUPLING SHALL BE TYPE 416 STAINLESS STEEL.
24. THE PUMP MOTOR SHALL BE OF THE SUBMERSIBLE TYPE SUITABLE FOR ACROSS-THE-LINE STARTING, DESIGNED FOR AND RATED FOR 460 VOLTS, 3-PHASE, 60 HERTZ. MINIMUM HORSEPOWER IS 60 HP AND MINIMUM MOTOR SPEED IS 3,450 RPM. THE MOTOR SHALL HAVE A SERVICE FACTOR OF 1.15. THE MOTOR SHALL BE SIZED TO DRIVE THE PUMP CONTINUOUSLY OVER THE SPECIFIED OPERATING RANGE WITHOUT THE LOAD EXCEEDING THE NAMEPLATE RATING OF THE MOTOR. THE MOTOR SHALL INCORPORATE A MECHANICAL SEAL TO PREVENT INTRUSION OF ABRASIVES OR OTHER WATER-BORNE CONTAMINANTS. THE MOTOR LEADS SHALL BE OF SUFFICIENT LENGTH SO THAT THEY MAY BE SPLICED ABOVE THE BOWL ASSEMBLY AND THE LEADS SHALL BE PROTECTED BY A TYPE 304 STAINLESS STEEL CABLE GUARD HELD IN PLACE WITH STAINLESS STEEL BANDING.
25. PROVIDE PUMP CONTROL PANEL WITH VFD AND FUSIBLE DISCONNECT FOR 60 HP PUMP. PUMP CONTOL PANEL SHALL BE UL LISTED IN A NEMA 3R ENCLOSURE. PANEL SHALL INCLUDE HOA SWITCH AND PUSH BUTTON START, AND VOLTAGE MONITOR CAPABLE OF MONITORING OVERVOLTAGE, UNDERVOLTAGE, PHASE IMBALANCE, PHASE LOSS, PHASE REVERSAL, REFER TO C002. A UL1449 SPD SHALL BE INSTALLED IN THE PUMP CONTROLLER. PROVIDE RADIO MODULE AND ANTENNA. PANEL SHALL BE MANUFACTURED BY PRECISION AUTOMATION OR APPROVED EQUAL. INSTALL PANEL ON CONCRETE HOUSEKEEPING PAD IN WELL HOUSE.
26. CONTRACTOR TO PROVIDE ELECTRICAL HEATER W/ THERMOSTAT CAPABLE OF MAINTAINING AMBIENT TEMP OF 45°F IN WELL HOUSE. CONTRACTOR TO INSTALL LIGHTS IN WELL HOUSE IN ACCORDANCE WITH LOCAL BUILDING CODE.
27. FINISH FLOOR OF WELL HOUSE SHALL BE A MIN. OF 6" ABOVE FINAL GRADE. GRADE AREA AROUND WELL HOUSE TO DIVERT SURFACE WATER AWAY.
28. ALL BURIED PIPE SHALL BE INSTALLED WITH COPPER FINDER WIRE, BLUE NO. 12, SUITABLE FOR DIRECT BURIAL. SECURELY FASTEN WIRE TO PIPE EVERY 10' WITH DUCT TAPE. LOCATING WIRE SHALL BE TESTED BY CONTRACTOR IN PRESENCE OF ENGINEER. ALL BURIED PIPE SHALL BE INSTALLED WITHLOCATOR TAPE, 3-INCH WIDE, PLACED BETWEEN 18 INCHES AND 24 INCHES ABOVE THE PIPE. TAPESHALL BE MARKED AS BEING POTABLE WATER LINE LOCATOR TAPE.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
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Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.
WELL 3 (PW-4) MECHANICAL PLAN & SECTION

REGISTERED PROFESSIONAL ENGINEER — 91236 — 7-31-19 — OREGON — MAY 10, 2016 — JUSTIN P. LEHARS — EXPIRES: 12-31-20

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

M100

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A
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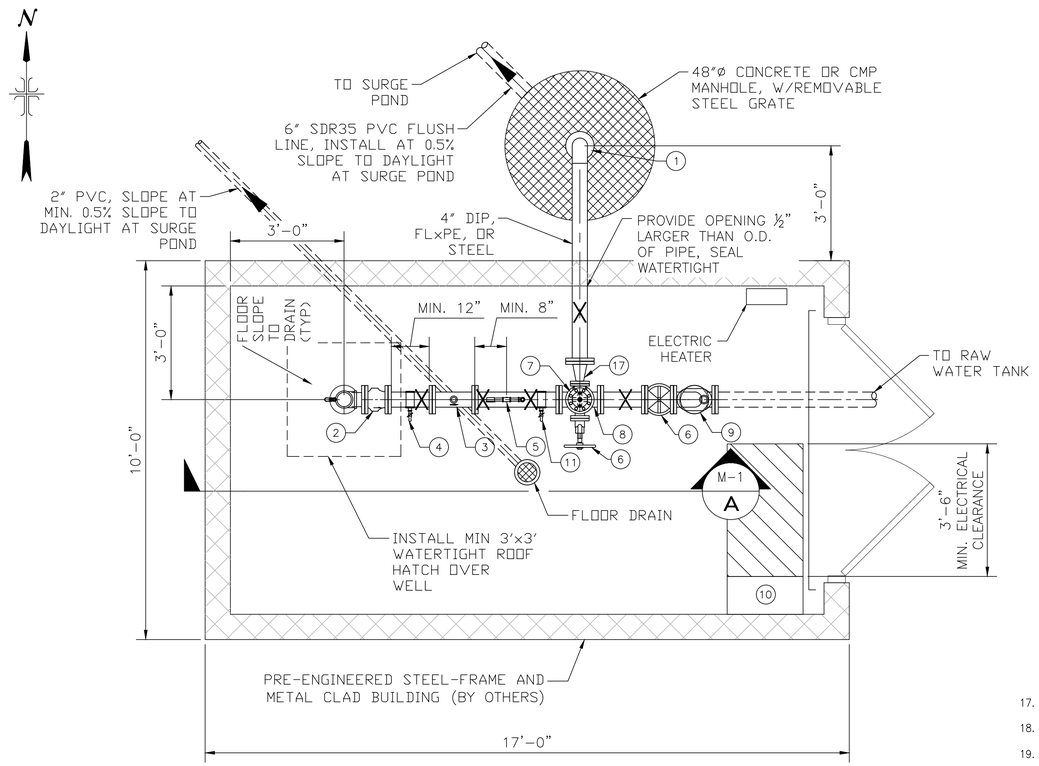
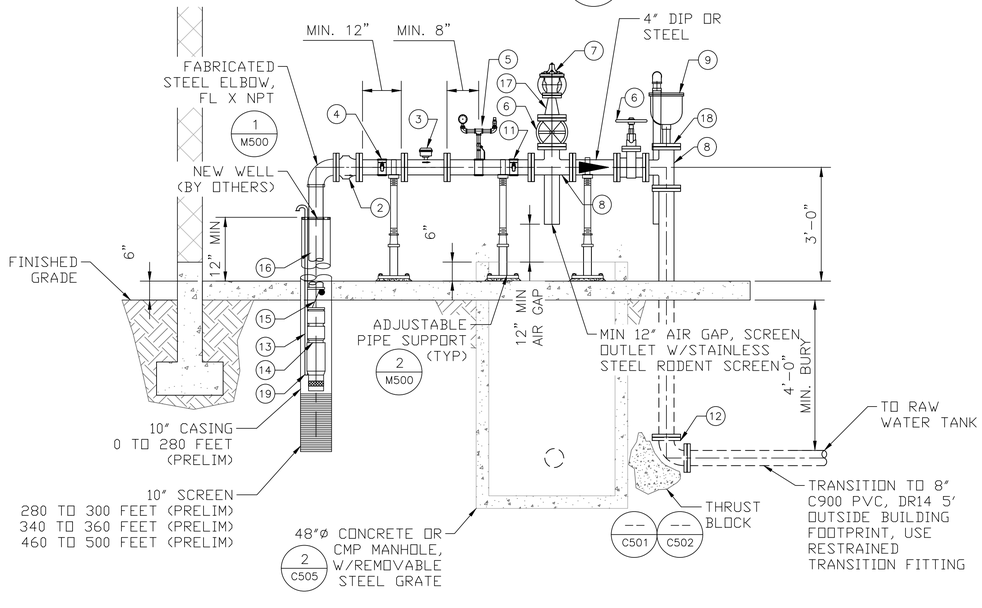


MECHANICAL PLAN A

SCALE: 1/2"=1'-0"



4 2 0 1 2 3 4

SCALE IN FEET

SCALE: 1/2"=1'-0"

MECHANICAL SECTION A

SCALE: 1/2"=1'-0"

EQUIPMENT SCHEDULE		
NO	DESCRIPTION	QTY
1	4" D.I. OR STEEL 90° ELBOW	1
2	4" GLOBE STYLE SILENT CHECK VALVE, VAL-MATIC SERIES 1800 OR APPROVED EQUAL	1
3	4" MAGNETIC FLOW METER W/ GROUNDING RINGS, FLG X FLG, BADGER M2000 OR APPROVED EQUAL	1
4	SMOOTH-NOSE SAMPLE TAP W/ SADDLE; PROVIDE PRESSURE REDUCING VALVE SET AT 60PSI	1
5	MECHANICAL PRESSURE GAUGE, OIL-FILLED, 0-400 PSI, W/ISOLATION VALVE AND COMMON SADDLE W/PRESSURE TRANSMITTER	1
6	4" D.I. RESILIENT WEDGE GATE VALVE, FLG X FLG	2
7	2" ANGLE PRESSURE RELIEF AND SURGE ANTICIPATOR VALVE, 300 CLASS, FLG X FLG, CLA-VAL 52-01 BPVKC	1
8	4" D.I. TEE, FLG X FLG X FLG	2
9	1" COMBINATION AIR VALVE W/ ISOLATION VALVE, VAL-MATIC 201C.2, 300 PSI OR APPROVED EQUAL	1
10	WELL PUMP CONTROL PANEL	1
11	HOSE BIB W/ VACUUM BREAKER AND SADDLE; PROVIDE PRESSURE REDUCING VALVE SET AT 60PSI	1
12	4" D.I. 90 ELBOW, MJ X MJ, RESTRAINED	1
13	1" PVC FLUSH-THREAD SOUNDING TUBE	1
14	SUBMERSIBLE PUMP W/MOTOR (GOULDS MODEL 6CLC, 20 STAGES, 4.1875" IMPELLER TRIM, 75 HP, OR APPROVED EQUAL)	1
15	4" COLUMN CHECK VALVE, FLOMATIC 80 DI, SET AT 21' ABOVE PUMP	1
16	4" SCH 40 STEEL DROP PIPE	1
17	4" x 2" D.I. CONCENTRIC REDUCER, FL x FL	2
18	4" D.I. BLIND FLANGE	1
19	WELL WATER LEVEL SENSOR, IN-SITU LEVEL TROLL 400, 100 PSI, ABSOLUTE	1

NOTES:

1. ALL PIPING, FITTINGS, AND FLANGES SHALL BE APPROPRIATE FOR 350 PSI UNLESS OTHERWISE NOTED. ALL PIPING SHALL BE PRESSURE TESTED, IN ACCORDANCE WITH AWWA REQUIREMENTS. ENGINEER SHALL BE NOTIFIED OF AND BE PRESENT FOR TESTING. ALL PIPING SHALL BE 4–INCH NOMINAL DIAMETER DIP OR STEEL UNLESS OTHERWISE NOTED. WELL DROP PIPE TO BE 4–INCH SCH 40 STEEL DROP PIPE, FITTINGS, AND COLUMN CHECK SHALL BE RATED FOR 500 PSI.
2. CONTRACTOR SHALL PROVIDE TO ENGINEER SHOP DRAWINGS INDICATING FINAL SELECTED FITTINGS, EQUIPMENT, AND GASKETS. CONTRACTOR IS RESPONSIBLE FOR FIELD VERIFICATION OF FITTING AND EQUIPMENT LOCATIONS AND DIMENSIONS. CONTRACTOR SHALL NOT RELY ON DRAWING SCALE TO VERIFY EQUIPMENT DIMENSIONS.
3. ALL WATERLINES SHALL BE FLUSHED, DISINFECTED AND TESTED FOR BACTERIA IN ACCORDANCE WITH AWWA STANDARD C651. CHLORINATED WATER SHALL BE PROPERLY DISPOSED OF WITH NO DISCHARGE TO SURFACE WATER. CONTRACTOR TO SUBMIT PLAN FOR CHLORINATED WATER DISPOSAL TO THE ENGINEER FOR APPROVAL.
4. PROVIDE SERVICE SADDLE, NYLON COATED DI BODY WITH STAINLESS STEEL DOUBLE STRAP, MUELLER OR EQUAL RATED FOR 350 PSI, AND BRONZE ISOLATION VALVE FOR ALL EQUIPMENT CONNECTED TO MAIN LINE.
5. THE ENDS OF ALL AIR VALVE OUTLET PIPING SHALL BE TERMINATED DOWNWARD AND COVERED W/ 24–MESH CORROSION RESISTANT SCREEN. ROUTE GSP OUTLET PIPING TO NEAREST FLOOR DRAIN. PROVIDE AIR GAP OF 18 INCHES.
6. INSTALL ALL SAMPLE TAPS HORIZONTALLY W/SPECIFIED AIR GAP.
7. ALL D.I.P. TO BE CLASS 53, CEMENT–MORTAR LINED PER AWWA C105. INTERIOR DUCTILE IRON PIPE SHALL BE ORDERED WITH NO EXTERIOR ASPHALTIC SEAL COAT AND SHALL RECEIVE A RUST INHIBITIVE PRIMER AND EPOXY COATING. COLOR TO BE SELECTED BY OWNER.
8. DUCTILE IRON FLANGED FITTINGS SHALL COMPLY WITH ANSI/AWWA C110/A21.10 STANDARD. DUCTILE IRON SPOOLS SHALL HAVE FLANGES COMPATIBLE WITH ANSI/AWWA C115/A21.15 STANDARD. GASKETS SHALL BE APPROPRIATE FOR A WORKING PRESSURE OF 350 PSI. WHERE FLANGED PIPE OR FITTINGS CONNECT TO ANSI CLASS 250 OR 300 FLANGES, COMPATIBLE ASME B16.1 CLASS 250 FLANGES SHALL BE PROVIDED.
9. PIPE SUPPORTS INDICATED BY AN 'X' ARE THE MINIMUM REQUIRED. CONTRACTOR TO PROVIDE ADDITIONAL SUPPORTS AS NEEDED TO ADEQUATELY SUPPORT EQUIPMENT.
10. ALL STEEL PIPE (EXCLUDING DROP PIPE) TO BE STANDARD WEIGHT (SCHEDULE 40 FOR 10–INCH AND SMALLER, 0.375–INCH WALL FOR 12–INCH OR LARGER). ALL STEEL PIPE (EXCLUDING DROP PIPE) TO BE CEMENT MORTAR LINED. ALL EXPOSED STEEL PIPE TO BE COATED WITH RUST INHIBITIVE PRIMER AND EPOXY PAINT PER THE SPECIFICATIONS. COLOR SELECTED BY OWNER.
11. SLOPE FLOORS AT 1% TO FLOOR DRAINS.
12. PRESSURE GAUGES SHALL BE OIL FILLED, 2.5–INCHES IN DIAMETER WITH WHITE LAMINATED DIALS AND BLACK GRADUATIONS. PRESSURE INDICATOR RANGE SHALL BE 0–400 PSI, UNLESS OTHER WISE INDICATED ON THE DRAWINGS. GAUGE CASE SHALL BE TYPE 304 STAINLESS STEEL WITH BRASS WETTED MATERIALS. EACH PRESSURE GAUGE SHALL BE PROVIDED WITH A BRASS ISOLATION VALVE.
13. INSTALL FLOW METERS WITH UPSTREAM AND DOWNSTREAM STRAIGHT–PIPE DISTANCES PER MANUFACTURER RECOMMENDATION.
14. THE SURGE ANTICIPATOR VALVE SHALL HAVE DUCTILE IRON BODY, CAST IRON DISC AND RETAINER, WITH STAINLESS STEEL SPRING AND TRIM. VALVE SHALL BE RATED FOR 350 PSI. VALVE SHALL BE PROVIDED WITH HIGH PRESSURE PILOT SYSTEM (CRL–60), RATED FOR 100 TO 300 PSI. CRA PILOT SYSTEM SHALL BE RATED FOR 30 TO 300 PSI. PROVIDE INLET PRESSURE GAUGE (0–400PSI), AND X101 POSITION INDICATOR. INTERIOR AND EXTERIOR OF VALVE SHALL BE COATED WITH FUSION BONDED EPOXY. CONNECT PRESSURE SENSING LINE TO PIPING PER MANUFACTURER RECOMMENDATIONS. PRESSURE SENSING LINE SHALL BE 3/4–INCH MINIMUM I.D. COPPER INSTALLED WITH A 2' SLOPE FROM THE VALVE TO THE PIPING TO AVOID AIR POCKETS.
15. GATE VALVES SHALL BE RESILIENT–SEATED GATE VALVES CONFORMING TO ANSI/AWWA C515. RESILIENT–SEATED GATE VALVES SHALL HAVE DUCTILE IRON BODIES WITH FLANGED ENDS, RUBBER–COATED DUCTILE IRON WEDGE, FLANGED DUCTILE IRON BONNET, BRONZE OR COPPER ALLOY STEM, AND TYPE 304 STAINLESS STEEL EXTERIOR VALVE BODY BOLTING. THE VALVE SHALL BE LEAD FREE. GATE VALVES SHALL BE PROVIDED WITH HAND WHEEL OPERATORS FOR ABOVE–GROUND INSTALLATIONS. THE VALVES SHALL BE DESIGNED FOR A WATER WORKING PRESSURE OF NOT LESS THAN 350 PSI UNLESS OTHERWISE NOTED.
16. THE CHECK VALVE SHALL BE OF THE SILENT OPERATING TYPE, GLOBE–STYLE, WITH CAST OR DUCTILE IRON VALVE BODY. THE VALVE SEAT, DISC, AND DISC STEM SHALL BE SILICON BRONZE OR STAINLESS STEEL. THE SPRING AND RETAINING SCREWS SHALL BE TYPE 316 STAINLESS STEEL. THE VALVE SHALL BE LEAD FREE. THE VALVES SHALL BE DESIGNED FOR A WATER WORKING PRESSURE OF NOT LESS THAN 350 PSI UNLESS OTHERWISE NOTED.
17. THE CONTRACTOR IS TO UTILIZE PIPE FITTINGS THAT ARE PROPERLY RESTRAINED.
18. PUMP SHALL BE SET AT APPROXIMATELY 357 FEET BELOW TOP OF WELL.
19. ELECTRICAL CABLE SHALL BE FIRMLY ATTACHED TO THE DROP PIPE AT EACH COUPLING W/STAINLESS STEEL STRAPS. MOTORS CABLE SHALL BE SIZED TO LIMIT VOLTAGE DROP TO LESS THAN 5%.
20. 1" SOUNDER TUBE SHALL BE ATTACHED TO DROP PIPE WITH STAINLESS STEEL STRAPS EVERY 20 FEET. TERMINATE AT TOP OF PUMP. INSTALL FROM TOP OF WELL TO TOP OF PUMP. THE BOTTOM 20 FEET OF THE TUBE SHALL BE PERFORATED W/ ⅛" HOLES EVERY 6" ON 4 SIDES. THE BOTTOM SHALL BE CAPPED.
21. SUPPORT MECHANICAL PIPING AS SHOWN ON DRAWINGS.
22. SUBMERSIBLE PUMP SHALL BE CAPABLE OF PUMPING 200 GPM AT A TOTAL DYNAMIC HEAD OF 980 FEET. WELL 4 HAS NOT BEEN CONSTRUCTED OR TESTED. PRELIMINARY PUMP SELECTION IS BASED ON ESTIMATES OF WELL SPECIFIC CAPACITY AND INTERFERENCE EFFECTS. FINAL PUMP SELECTION WILL OCCUR AFTER THE WELL IS CONSTRUCTED AND TESTED.
23. THE PUMP BOWL ASSEMBLY SHALL BE CONSTRUCTED OF CLOSE GRAINED CAST IRON, ASTM A48, CLASS 30. THE INTERMEDIATE BOWLS SHALL BE ENAMEL OR EPOXY–LINED. THE IMPELLERS SHALL BE CONSTRUCTED OF TYPE 304 STAINLESS STEEL AND BALANCED TO GRADE G6.3 OF ISO 1940 AS MINIMUM. THEY SHALL BE SECURELY FASTENED TO THE BOWL SHAFT WITH TAPER LOCKS OF C1018 STEEL. THE INLET MOTOR ADAPTER SHALL BE DUCTILE IRON. THE PUMP SHAFT AND COUPLING SHALL BE TYPE 416 STAINLESS STEEL.
24. THE PUMP MOTOR SHALL BE OF THE SUBMERSIBLE TYPE SUITABLE FOR ACROSS–THE–LINE STARTING, DESIGNED FOR AND RATED FOR 460 VOLTS, 3–PHASE, 60 HERTZ. MINIMUM HORSEPOWER IS 75 HP AND MINIMUM MOTOR SPEED IS 3,450 RPM. THE MOTOR SHALL HAVE A SERVICE FACTOR OF 1.15. THE MOTOR SHALL BE SIZED TO DRIVE THE PUMP CONTINUOUSLY OVER THE SPECIFIED OPERATING RANGE WITHOUT THE LOAD EXCEEDING THE NAMEPLATE RATING OF THE MOTOR. THE MOTOR SHALL INCORPORATE A MECHANICAL SEAL TO PREVENT INTRUSION OF ABRASIVES OR OTHER WATER–BORNE CONTAMINANTS. THE MOTOR LEADS SHALL BE OF SUFFICIENT LENGTH SO THAT THEY MAY BE SPLICED ABOVE THE BOWL ASSEMBLY AND THE LEADS SHALL BE PROTECTED BY A TYPE 304 STAINLESS STEEL CABLE GUARD HELD IN PLACE WITH STAINLESS STEEL BANDING.
25. PROVIDE PUMP CONTROL PANEL WITH VFD AND FUSIBLE DISCONNECT FOR 75HP PUMP. PUMP CONTOL PANEL SHALL BE UL LISTED IN A NEMA 3R ENCLOSURE. PANEL SHALL INCLUDE HOA SWITCH AND PUSH BUTTON START, AND VOLTAGE MONITOR CAPABLE OF MONITORING OVERVOLTAGE, UNDERVOLTAGE, PHASE IMBALANCE, PHASE LOSS, PHASE REVERSAL, REFER TO C002. A UL1449 SPD SHALL BE INSTALLED IN THE PUMP CONTROLLER. PROVIDE RADIO MODULE AND ANTENNA. PANEL SHALL BE MANUFACTURED BY PRECISION AUTOMATION OR APPROVED EQUAL. INSTALL PANEL ON CONCRETE HOUSEKEEPING PAD IN WELL HOUSE.
26. CONTRACTOR TO PROVIDE ELECTRICAL HEATER W/ THERMOSTAT CAPABLE OF MAINTAINING AMBIENT TEMP OF 45'F IN WELL HOUSE. CONTRACTOR TO INSTALL LIGHTS IN WELL HOUSE IN ACCORDANCE WITH LOCAL BUILDING CODE.
27. FINISH FLOOR OF WELL HOUSE SHALL BE A MIN. OF 6" ABOVE FINAL GRADE. GRADE AREA AROUND WELL HOUSE TO DIVERT SURFACE WATER AWAY.
28. INSTALL WATER LEVEL SENSOR IN 1" PVC SOUNDING TUBE TO A DEPTH OF 5' ABOVE TOP OF PUMP. PROVIDE BAROMETRIC PRESSURE LOGGER, IN–SITU BARO TROLL IN CONTROL PANEL TO CORRECT FOR BAROMETRIC PRESSURE. LEVEL SENSOR AND BAROMETRIC PRESSURE SENSOR SHALL HAVE A DIRECT READ CABLE FOR A 4–20mA SIGNAL TO PUMP CONTROL PANEL.
29. ALL BURIED PIPE SHALL BE INSTALLED WITH COPPER FINDER WIRE, BLUE NO. 12, SUITABLE FOR DIRECT BURIAL. SECURELY FASTEN WIRE TO PIPE EVERY 10' WITH DUCT TAPE. LOCATING WIRE SHALL BE BETESTED BY CONTRACTOR IN PRESENCE OF ENGINEER. ALL BURIED PIPE SHALL BE INSTALLED WITHLOCATOR TAPE, 3–INCH WIDE, PLACED BETWEEN 18 INCHES AND 24 INCHES ABOVE THE PIPE. TAPESHALL BE MARKED AS BEING POTABLE WATER LINE LOCATOR TAPE.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

WELL 4 MECHANICAL PLAN & SECTION

REGISTERED PROFESSIONAL ENGINEER
JUSTIN P. LERAHS
81236
7-31-19
OREGON
MAY 10, 2016
EXPIRES: 12-31-20

REVISIONS			
ITEM	DESCRIPTION		DATE
0	FINAL PERMIT SET		7/31/19

VERIFY SCALE
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BAR MEASURES ONE–INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

M101

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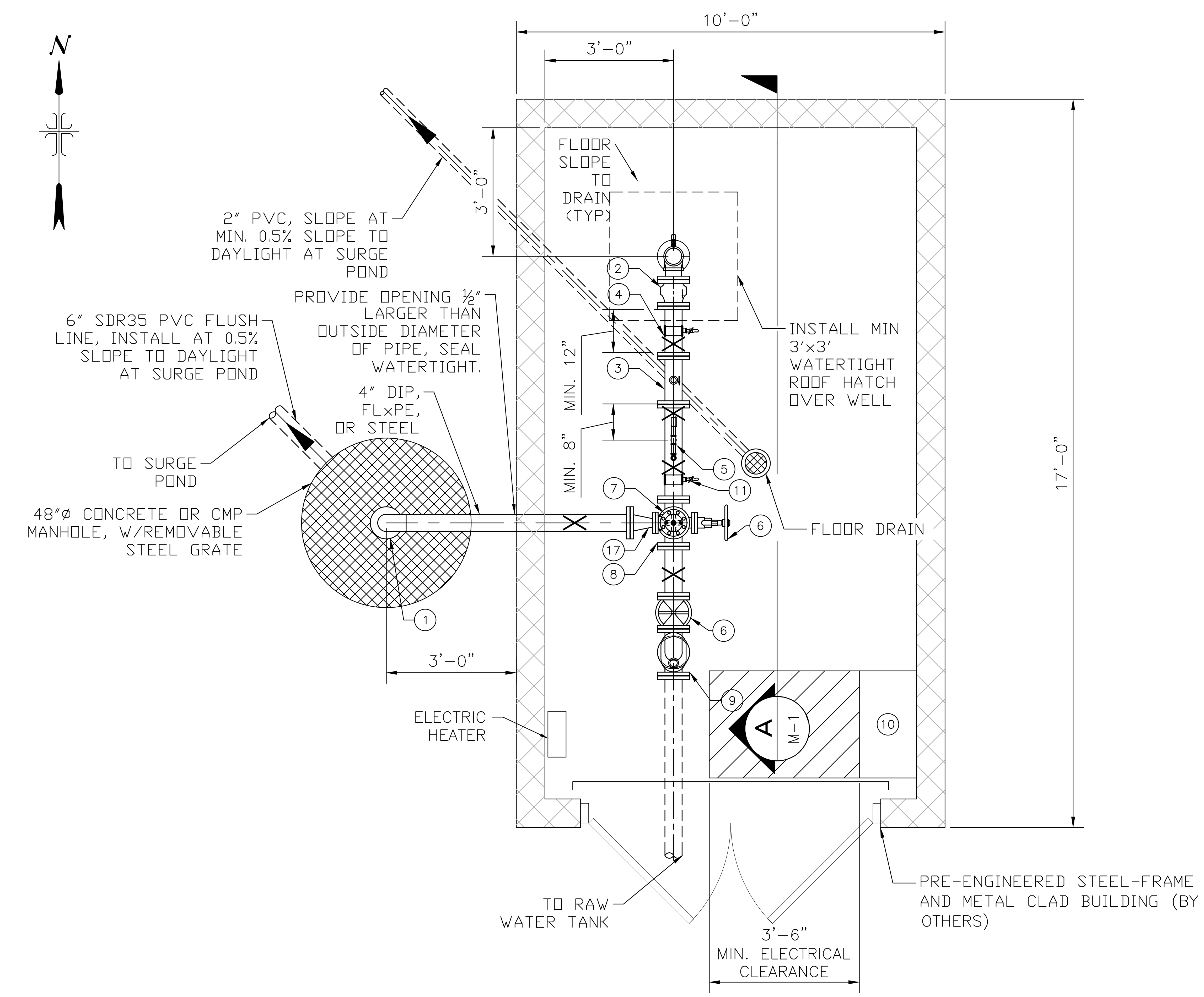
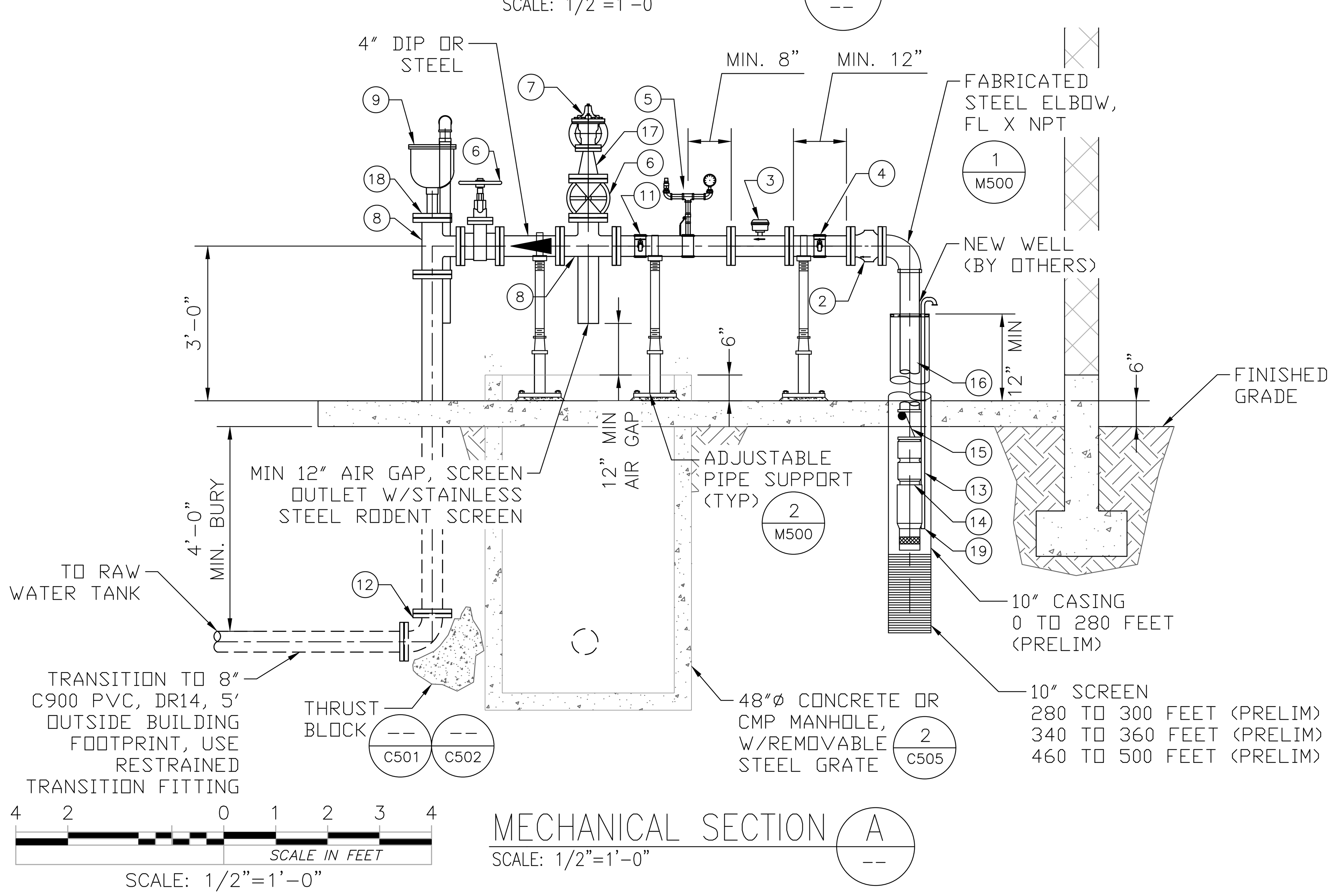


MECHANICAL PLAN (A / --)

SCALE: 1/2"=1'-0"



MECHANICAL SECTION (A / --)

SCALE: 1/2"=1'-0"

EQUIPMENT SCHEDULE		
NO	DESCRIPTION	QTY
1	4" D.I. OR STEEL 90° ELBOW	1
2	4" GLOBE STYLE SILENT CHECK VALVE, VAL-MATIC SERIES 1800 OR APPROVED EQUAL	1
3	4" MAGNETIC FLOW METER W/ GROUNDING RINGS, FLG X FLG, BADGER M2000 OR APPROVED EQUAL	1
4	SMOOTH-NOSE SAMPLE TAP W/ SADDLE; PROVIDE PRESSURE REDUCING VALVE SET AT 60PSI	1
5	MECHANICAL PRESSURE GAUGE, OIL-FILLED, 0-400 PSI, W/ISOLATION VALVE AND COMMON SADDLE W/PRESSURE TRANSMITTER	1
6	4" D.I. RESILIENT WEDGE GATE VALVE, FLG X FLG	2
7	2" ANGLE PRESSURE RELIEF AND SURGE ANTICIPATOR VALVE, 300 CLASS, FLG X FLG, CLA-VAL 52-01 BPVKC	1
8	4" D.I. TEE, FLG X FLG X FLG	2
9	1" COMBINATION AIR VALVE W/ ISOLATION VALVE, VAL-MATIC 201C.2, 300 PSI OR APPROVED EQUAL	1
10	WELL PUMP CONTROL PANEL	1
11	HOSE BIB W/ VACUUM BREAKER AND SADDLE; PROVIDE PRESSURE REDUCING VALVE SET AT 60PSI	1
12	4" D.I. 90 ELBOW, MJ X MJ, RESTRAINED	1
13	1" PVC FLUSH-THREAD SOUNDING TUBE	1
14	SUBMERSIBLE PUMP W/MOTOR (GOULDS MODEL 6CLC, 20 STAGES, 4.1875" IMPELLER TRIM, 75 HP, OR APPROVED EQUAL)	1
15	4" COLUMN CHECK VALVE, FLOMATIC 80 DI, SET AT 21' ABOVE PUMP	1
16	4" SCH 40 STEEL DROP PIPE	1
17	4" x 2" D.I. CONCENTRIC REDUCER, FL x FL	2
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19	WELL WATER LEVEL SENSOR, IN-SITU LEVEL TROLL 400, 100 PSI, ABSOLUTE	1

NOTES:

1. ALL PIPING, FITTINGS, AND FLANGES SHALL BE APPROPRIATE FOR 350 PSI UNLESS OTHERWISE NOTED. ALL PIPING SHALL BE PRESSURE TESTED, IN ACCORDANCE WITH AWWA REQUIREMENTS. ENGINEER SHALL BE NOTIFIED OF AND BE PRESENT FOR TESTING. ALL PIPING, FITTINGS, AND FLANGES SHALL BE 4-INCH NOMINAL DIAMETER DIP OR STEEL UNLESS OTHERWISE NOTED. WELL DROP PIPE TO BE 4-INCH SCH 40 STEEL DROP PIPE, FITTINGS, AND COLUMN CHECK SHALL BE RATED FOR 500 PSI.
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4. PROVIDE SERVICE SADDLE, NYLON COATED DI BODY WITH STAINLESS STEEL DOUBLE STRAP, MUELLER OR EQUAL RATED FOR 350 PSI, AND BRONZE ISOLATION VALVE FOR ALL EQUIPMENT CONNECTED TO MAIN LINE.
5. THE ENDS OF ALL AIR VALVE OUTLET PIPING SHALL BE TERMINATED DOWNWARD AND COVERED W/ 24-MESH CORROSION RESISTANT SCREEN. ROUTE GSP OUTLET PIPING TO NEAREST FLOOR DRAIN. PROVIDE AIR GAP OF 18 INCHES.
6. INSTALL ALL SAMPLE TAPS HORIZONTALLY W/SPECIFIED AIR GAP.
7. ALL D.I.P. TO BE CLASS 53, CEMENT-MORTAR LINED PER AWWA C105. INTERIOR DUCTILE IRON PIPE SHALL BE ORDERED WITH NO EXTERIOR ASPHALTIC SEAL COAT AND SHALL RECEIVE A RUST INHIBITIVE PRIMER AND EPOXY COATING. COLOR TO BE SELECTED BY OWNER.
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9. PIPE SUPPORTS INDICATED BY AN 'X' ARE THE MINIMUM REQUIRED. CONTRACTOR TO PROVIDE ADDITIONAL SUPPORTS AS NEEDED TO ADEQUATELY SUPPORT EQUIPMENT.
10. ALL STEEL PIPE (EXCLUDING DROP PIPE) TO BE STANDARD WEIGHT (SCHEDULE 40 FOR 10-INCH AND SMALLER, 0.375-INCH WALL FOR 12-INCH OR LARGER). ALL STEEL PIPE (EXCLUDING DROP PIPE) TO BE CEMENT MORTAR LINED. ALL EXPOSED STEEL PIPE TO BE COATED WITH RUST INHIBITIVE PRIMER AND EPOXY PAINT PER THE SPECIFICATIONS. COLOR SELECTED BY OWNER.
11. SLOPE FLOORS AT 1% TO FLOOR DRAINS.
12. PRESSURE GAUGES SHALL BE OIL FILLED, 2.5-INCHES IN DIAMETER WITH WHITE LAMINATED DIALS AND BLACK GRADUATIONS. PRESSURE INDICATOR RANGE SHALL BE 0 -400 PSI, UNLESS OTHER WISE INDICATED ON THE DRAWINGS. GAUGE CASE SHALL BE TYPE 304 STAINLESS STEEL WITH BRASS WETTED MATERIALS.EACH PRESSURE GAUGE SHALL BE PROVIDED WITH A BRASS ISOLATION VALVE.
13. INSTALL FLOW METERS WITH UPSTREAM AND DOWNSTREAM STRAIGHT-PIPE DISTANCES PER MANUFACTURER RECOMMENDATION.
14. THE SURGE ANTICIPATOR VALVE SHALL HAVE DUCTILE IRON BODY, CAST IRON DISC AND RETAINER, WITH STAINLESS STEEL SPRING AND TRIM. VALVE SHALL BE RATED FOR 350 PSI. VALVE SHALL BE PROVIDED WITH HIGH PRESSURE PILOT SYSTEM (CRL-60), RATED FOR 100 TO 300 PSI. CRA PILOT SYSTEM SHALL BE RATED FOR 30 TO 300 PSI. PROVIDE INLET PRESSURE GAUGE (0-400PSI), AND X101 POSITION INDICATOR. INTERIOR AND EXTERIOR OF VALVE SHALL BE COATED WITH FUSION BONDED EPOXY. CONNECT PRESSURE SENSING LINE TO PIPING PER MANUFACTURER RECOMMENDATIONS. PRESSURE SENSING LINE SHALL BE 3/4-INCH MINIMUM I.D. COPPER INSTALLED WITH A 2° SLOPE FROM THE VALVE TO THE PIPING TO AVOID AIR POCKETS.
15. GATE VALVES SHALL BE RESILIENT-SEATED GATE VALVES CONFORMING TO ANSI/AWWA C515. RESILIENT-SEATED GATE VALVES SHALL HAVE DUCTILE IRON BODIES WITH FLANGED ENDS, RUBBER-COATED DUCTILE IRON WEDGE, FLANGED DUCTILE IRON BONNET, BRONZE OR COPPER ALLOY STEM, AND TYPE 304 STAINLESS STEEL EXTERIOR VALVE BODY BOLTING. THE VALVE SHALL BE LEAD FREE. GATE VALVES SHALL BE PROVIDED WITH HAND WHEEL OPERATORS FOR ABOVE-GROUND INSTALLATIONS. THE VALVES SHALL BE DESIGNED FOR A WATER WORKING PRESSURE OF NOT LESS THAN 350 PSI UNLESS OTHERWISE NOTED.
16. THE CHECK VALVE SHALL BE OF THE SILENT OPERATING TYPE, GLOBE-STYLE, WITH CAST OR DUCTILE IRON VALVE BODY. THE VALVE SEAT, DISC, AND DISC STEM SHALL BE SILICON BRONZE OR STAINLESS STEEL. THE SPRING AND RETAINING SCREWS SHALL BE TYPE 316 STAINLESS STEEL. THE VALVE SHALL BE LEAD FREE. THE VALVES SHALL BE DESIGNED FOR A WATER WORKING PRESSURE OF NOT LESS THAN 350 PSI UNLESS OTHERWISE NOTED.
17. THE CONTRACTOR IS TO UTILIZE PIPE FITTINGS THAT ARE PROPERLY RESTRAINED.
18. PUMP SHALL BE SET AT APPROXIMATELY 357 FEET BELOW TOP OF WELL.
19. ELECTRICAL CABLE SHALL BE FIRMLY ATTACHED TO THE DROP PIPE AT EACH COUPLING W/STAINLESS STEEL STRAPS. MOTORS CABLE SHALL BE SIZED TO LIMIT VOLTAGE DROP TO LESS THAN 5%.
20. 1" SOUNDER TUBE SHALL BE ATTACHED TO DROP PIPE WITH STAINLESS STEEL STRAPS EVERY 20 FEET. TERMINATE AT TOP OF PUMP. INSTALL FROM TOP OF WELL TO TOP OF PUMP. THE BOTTOM 20 FEET OF THE TUBE SHALL BE PERFORATED W/ ⅛" HOLES EVERY 6" ON 4 SIDES. THE BOTTOM SHALL BE CAPPED.
21. SUPPORT MECHANICAL PIPING AS SHOWN ON DRAWINGS.
22. SUBMERSIBLE PUMP SHALL BE CAPABLE OF PUMPING 200 GPM AT A TOTAL DYNAMIC HEAD OF 980 FEET. WELL 5 HAS NOT BEEN CONSTRUCTED OR TESTED, PRELIMINARY PUMP SELECTION IS BASED ON ESTIMATES OF WELL SPECIFIC CAPACITY AND INTERFERENCE EFFECTS. FINAL PUMP SELECTION WILL OCCUR AFTER THE WELL IS CONSTRUCTED AND TESTED.
23. THE PUMP BOWL ASSEMBLY SHALL BE CONSTRUCTED OF CLOSE GRAINED CAST IRON, ASTM A48, CLASS 30. THE INTERMEDIATE BOWLS SHALL BE ENAMEL OR EPOXY-LINED. THE IMPELLERS SHALL BE CONSTRUCTED OF TYPE 304 STAINLESS STEEL AND BALANCED TO GRADE G6.3 OF ISO 1940 AS MINIMUM. THEY SHALL BE SECURELY FASTENED TO THE BOWL SHAFT WITH TAPER LOCKS OF C1018 STEEL. THE INLET MOTOR ADAPTER SHALL BE DUCTILE IRON. THE PUMP SHAFT AND COUPLING SHALL BE TYPE 416 STAINLESS STEEL.
24. THE PUMP MOTOR SHALL BE OF THE SUBMERSIBLE TYPE SUITABLE FOR ACROSS-THE-LINE STARTING, DESIGNED FOR AND RATED FOR 460 VOLTS, 3-PHASE, 60 HERTZ. MINIMUM HORSEPOWER IS 75 HP AND MINIMUM MOTOR SPEED IS 3,450 RPM. THE MOTOR SHALL HAVE A SERVICE FACTOR OF 1.15. THE MOTOR SHALL BE SIZED TO DRIVE THE PUMP CONTINUOUSLY OVER THE SPECIFIED OPERATING RANGE WITHOUT THE LOAD EXCEEDING THE NAMEPLATE RATING OF THE MOTOR. THE MOTOR SHALL INCORPORATE A MECHANICAL SEAL TO PREVENT INTRUSION OF ABRASIVES OR OTHER WATER-BORNE CONTAMINANTS. THE MOTOR LEADS SHALL BE OF SUFFICIENT LENGTH SO THAT THEY MAY BE SPLICED ABOVE THE BOWL ASSEMBLY AND THE LEADS SHALL BE PROTECTED BY A TYPE 304 STAINLESS STEEL CABLE GUARD HELD IN PLACE WITH STAINLESS STEEL BANDING.
25. PROVIDE PUMP CONTROL PANEL WITH VFD AND FUSIBLE DISCONNECT FOR 75 HP PUMP. PUMP CONTOL PANEL SHALL BE UL LISTED IN A NEMA 3R ENCLOSURE. PANEL SHALL INCLUDE HOA SWITCH AND PUSH BUTTON START, AND VOLTAGE MONITOR CAPABLE OF MONITORING OVERVOLTAGE, UNDERVOLTAGE, PHASE IMBALANCE, PHASE LOSS, PHASE REVERSAL, REFER TO C002. A UL1449 SPD SHALL BE INSTALLED IN THE PUMP CONTROLLER. PROVIDE RADIO MODULE AND ANTENNA. PANEL SHALL BE MANUFACTURED BY PRECISION AUTOMATION OR APPROVED EQUAL. INSTALL PANEL ON CONCRETE HOUSEKEEPING PAD IN WELL HOUSE.
26. CONTRACTOR TO PROVIDE ELECTRICAL HEATER W/ THERMOSTAT CAPABLE OF MAINTAINING AMBIENT TEMP OF 45°F IN WELL HOUSE. CONTRACTOR TO INSTALL LIGHTS IN WELL HOUSE IN ACCORDANCE WITH LOCAL BUILDING CODE.
27. FINISH FLOOR OF WELL HOUSE SHALL BE A MIN. OF 6" ABOVE FINAL GRADE. GRADE AREA AROUND WELL HOUSE TO DIVERT SURFACE WATER AWAY.
28. INSTALL WATER LEVEL SENSOR IN 1" PVC SOUNDING TUBE TO A DEPTH OF 5' ABOVE TOP OF PUMP. PROVIDE BAROMETRIC PRESSURE LOGGER, IN-SITU BARO TROLL IN CONTROL PANEL TO CORRECT FOR BAROMETRIC PRESSURE. LEVEL SENSOR AND BAROMETRIC PRESSURE SENSOR SHALL HAVE A DIRECT READ CABLE FOR A 4-20mA SIGNAL TO PUMP CONTROL PANEL.
29. ALL BURIED PIPE SHALL BE INSTALLED WITH COPPER FINDER WIRE, BLUE NO. 12, SUITABLE FOR DIRECT BURIAL. SECURELY FASTEN WIRE TO PIPE EVERY 10' WITH DUCT TAPE. LOCATING WIRE SHALL BETESTED BY CONTRACTOR IN PRESENCE OF ENGINEER. ALL BURIED PIPE SHALL BE INSTALLED WITHLOCATOR TAPE, 3-INCH WIDE, PLACED BETWEEN 18 INCHES AND 24 INCHES ABOVE THE PIPE. TAPESHALL BE MARKED AS BEING POTABLE WATER LINE LOCATOR TAPE.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER

CALICO RESOURCES USA CORP.

WELL 5 MECHANICAL PLAN & SECTION

REGISTERED PROFESSIONAL ENGINEER 91236 OREGON 7-31-19 MAY 10, 2016 JUSTIN P. LEHARIS EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE

0 1/2 1

BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

M102

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: 1294.0050-MECHANICAL Plot date: Aug 22, 2019-03:27:03pm CAD User: knewsom.
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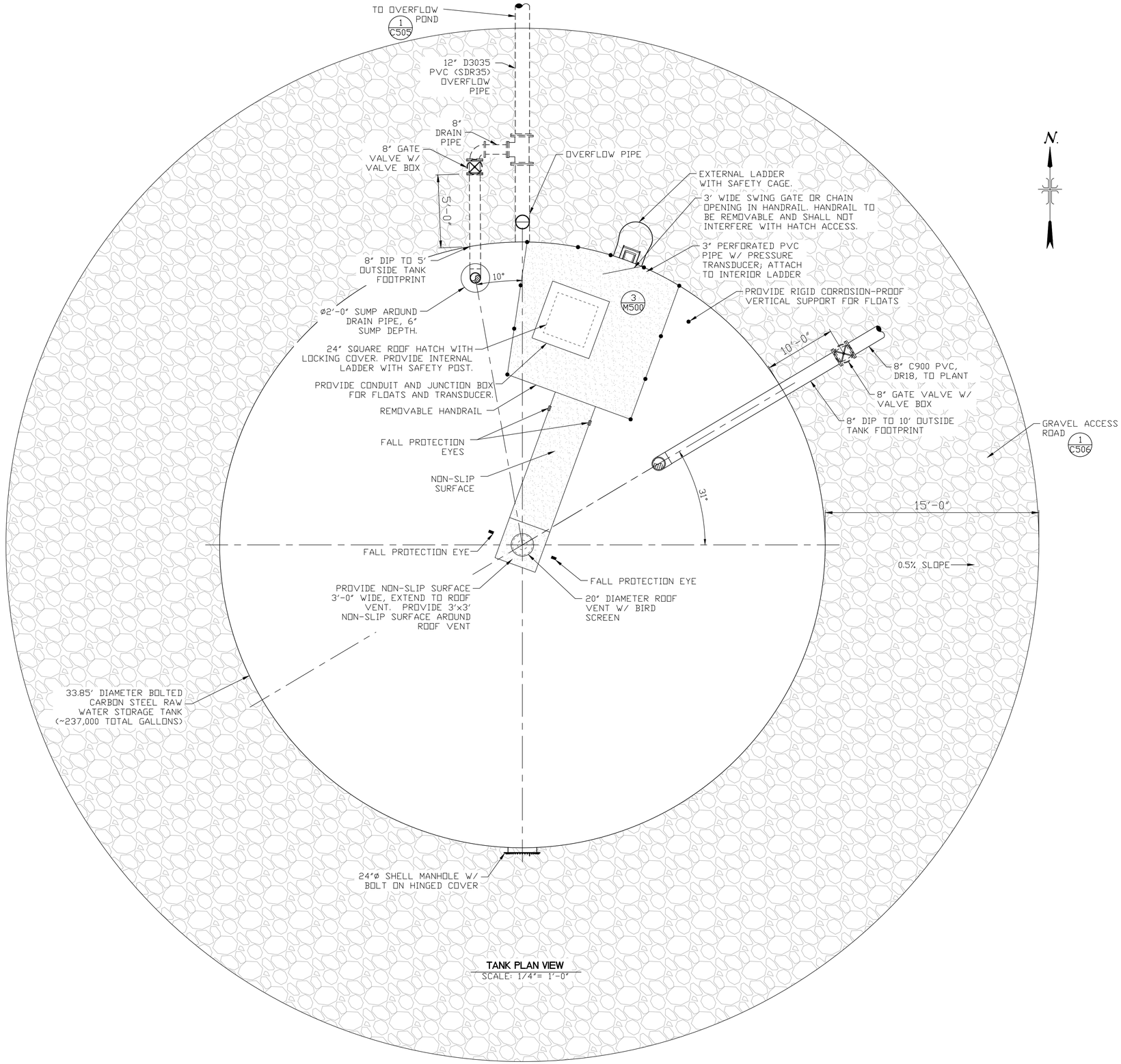

TANK PLAN VIEW
SCALE: 1/4"= 1'-0"

NOTES:

1. RESERVOIR TO MEET THE REQUIREMENTS OF AWWA D103-09. STRUCTURAL DESIGN BY RESERVOIR CONTRACTOR.
2. RESERVOIR FOUNDATION DESIGN BY TANK SUPPLIER TO MEET THE REQUIREMENTS OF AWWA D103-09.
3. RESERVOIR SUBGRADE SHALL BE PREPARED PER THE GEOTECHNICAL REPORT.
4. PLACE ROOF HATCH NEAR OVERFLOW PIPE TO ALLOW INSPECTION OF OVERFLOW THROUGH HATCH.
5. ALL SAFETY AND FALL PROTECTION APPURTENANCES TO BE DESIGNED, FABRICATED, AND INSTALLED BY THE RESERVOIR CONTRACTOR TO MEET ALL APPLICABLE SAFETY LAWS INCLUDING OSHA REGULATIONS.
6. MAINTAIN POSITIVE DRAINAGE AWAY FROM STORAGE TANK.

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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER TANK PLAN

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20

ITEM	DESCRIPTION	DATE
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VERIFY SCALE
0 1/2 1
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PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

M103

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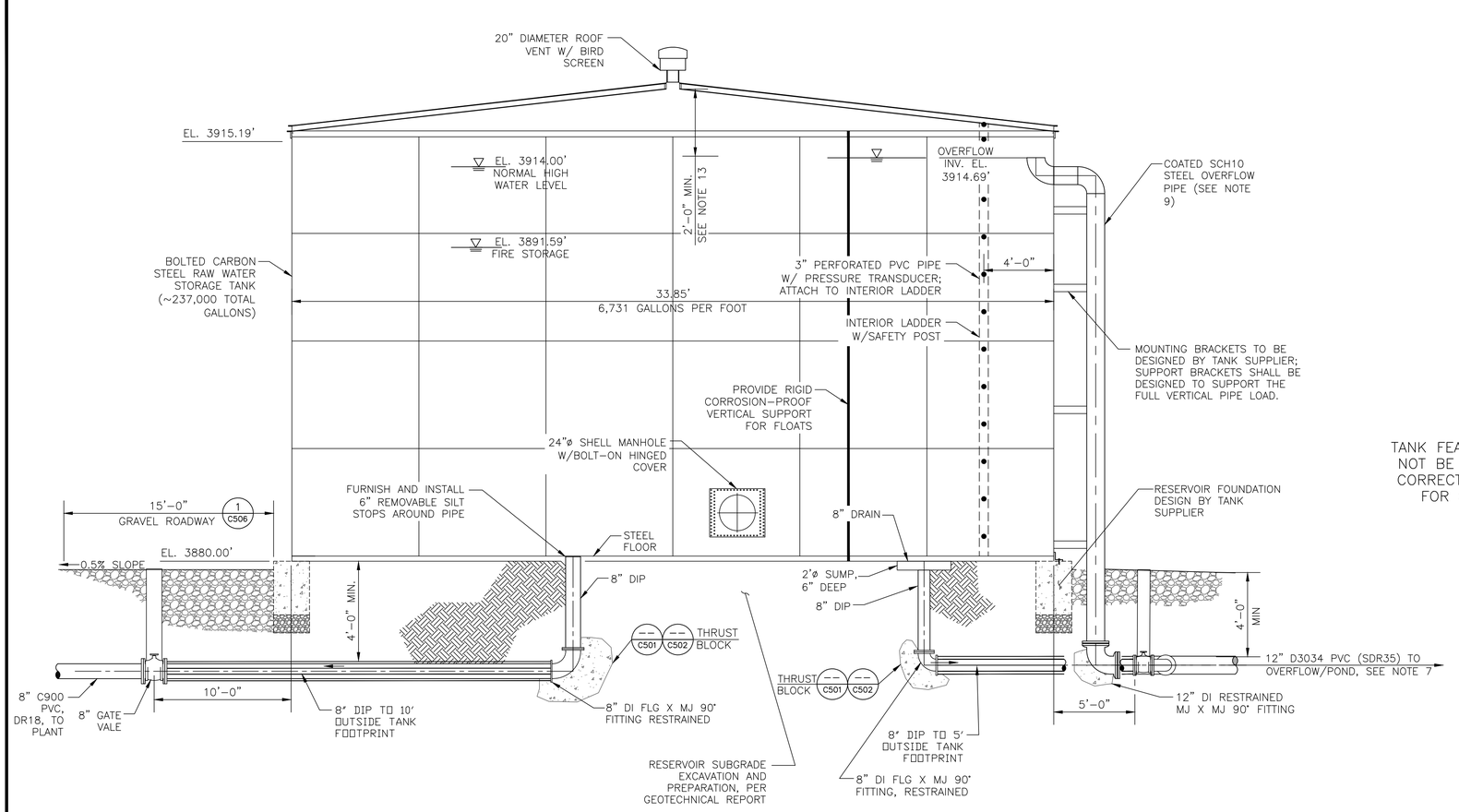
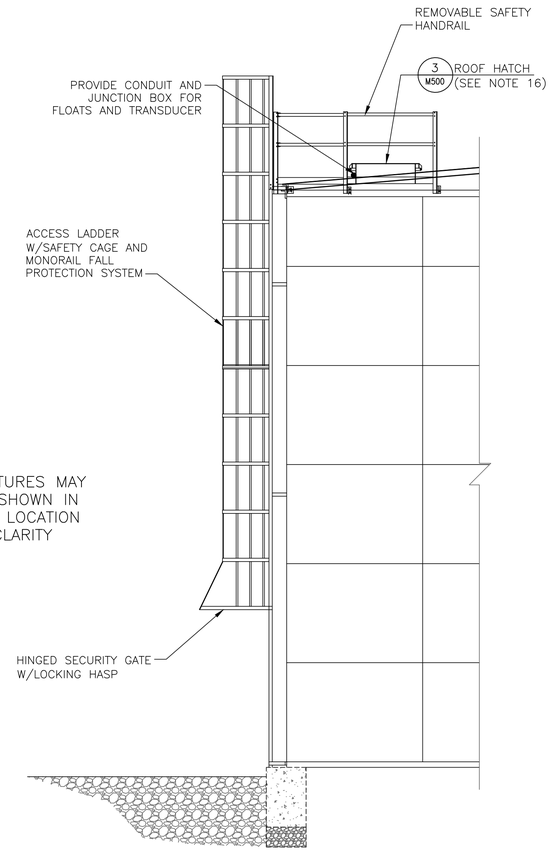


A — TANK ELEVATION
SCALE: NOT TO SCALE

TANK FEATURES MAY NOT BE SHOWN IN CORRECT LOCATION FOR CLARITY



B — EXTERNAL LADDER ELEVATION
SCALE: NOT TO SCALE

NOTES:

1. ALL STRUCTURAL DESIGN BY RESERVOIR CONTRACTOR TO MEET THE REQUIREMENTS OF AWWA D103-09.
2. RESERVOIR FOUNDATION DESIGN BY TANK SUPPLIER TO MEET THE REQUIREMENTS OF AWWA D103-09.
3. RESERVOIR SUBGRADE SHALL BE PREPARED PER THE GEOTECHNICAL REPORT.
4. MINIMUM DEPTH OF COVER OVER PIPES IS 4 FEET, UNLESS OTHERWISE NOTED.
5. ALL PIPING PENETRATIONS AND TANK ACCESSORIES SHALL CONFORM TO AWWA D103 OR D100, WHICHEVER IS APPLICABLE.
6. TANK SHALL BE DISINFECTED PER AWWA C652 AND OAR 333-061-0050(10).
7. THE END OF THE DRAIN OVERFLOW PIPE SHALL BE PROVIDED WITH AN ANGLE-FLAP OR TIDE-FLEX VALVE. PROVIDE AN AIR GAP OF AT LEAST 24-INCHES BETWEEN BOTTOM OF PIPE AND MAXIMUM WATER SURFACE ELEVATION OF OVERFLOW POND..
8. POLYETHYLENE ENCASE BURIED DUCTILE IRON PIPING.
9. OVERFLOW MUST BE CAPABLE OF OVERFLOWING 500 GPM WITH MAXIMUM 0'-6" WATER DEPTH OVER TOP OF OVERFLOW. SIZE AND DESIGN BY RESERVOIR CONTRACTOR.
10. PROVIDE FALL PROTECTION SYSTEM ON RESERVOIR ROOF AS SHOWN ON DRAWINGS.
11. COAT ALL STEEL PIPE (ABOVE AND BELOW GRADE) WITH FUSION BONDED EPOXY.
12. RESERVOIR CONTRACTOR TO PROVIDE LIGHTNING PROTECTION SYSTEM UTILIZING AIR TERMINALS, WIRE AND GROUND RODS ON RESERVOIR. THE SYSTEM SHALL BE DESIGNED AND INSTALLED BY A CERTIFIED LIGHTNING PROTECTION CONTRACTOR.
13. TANK DESIGN SHALL INCLUDE A MINIMUM 24-INCH HEAD SPACE BETWEEN TOP OF OVERFLOW AND BOTTOM OF ROOF STRUCTURE AT CENTER OF TANK.
14. TANK SHALL BE FILLED FROM WELLS BASED ON WATER LEVEL CHANGE AS DETECTED BY WATER LEVEL TRANSDUCER. AN EMERGENCY LOW LEVEL FLOAT SHALL BE INSTALLED TO ACTIVATE WELL PUMPS IF WATER LEVEL DROPS TO 3881 FEET (ADJUSTABLE). AN EMERGENCY HIGH LEVEL FLOAT SHALL BE INSTALLED TO DE-ACTIVATE WELL PUMPS IF WATER LEVEL RISES TO 3914.50 FT (ADJUSTABLE). REFER TO C002 FOR OPERATIONAL DESCRIPTION
15. INTERIOR COATING SHALL BE LIQ FUSION 8000 FBE, 5-9 MILS DFT, NSF/ANSI 61 APPROVED, OR APPROVED EQUAL. EXTERIOR COATING SHALL BE FUSION 8000 FBE + EXT FUSION SDP, 6-10 MILS DFT, OR APPROVED EQUAL. EXTERIOR COLOR PER OWNER.
16. ROOF HATCHES SHALL BE WATERTIGHT AND OVERLAP THE FRAME OPENING BY AT LEAST 2 INCHES. THE FRAME OPENING SHALL EXTEND AT LEAST 4 INCHES ABOVE THE TANK ROOF TO PREVENT SURFACE WATER INTRUSION. EACH HATCH SHALL BE HINGED ON ONE SIDE AND EQUIPPED WITH A LOCKING MECHANISM.
17. PROVIDE HIGH-LEVEL EMERGENCY FLOATS, CONERY 2901-B2-S1-C1, OR APPROVED EQUAL. PROVIDE PRESSURE TRANSDUCER, KELLER LEVELGAGE OR APPROVED EQUAL.
18. INSTALL A RADIO MODULE AND ANTENNA, BANNER DX80G9M6S-PB2, OR APPROVED EQUAL.

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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

RAW WATER TANK SECTION

REGISTERED PROFESSIONAL ENGINEER
7-31-19
91736
OREGON
MAY 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

M104

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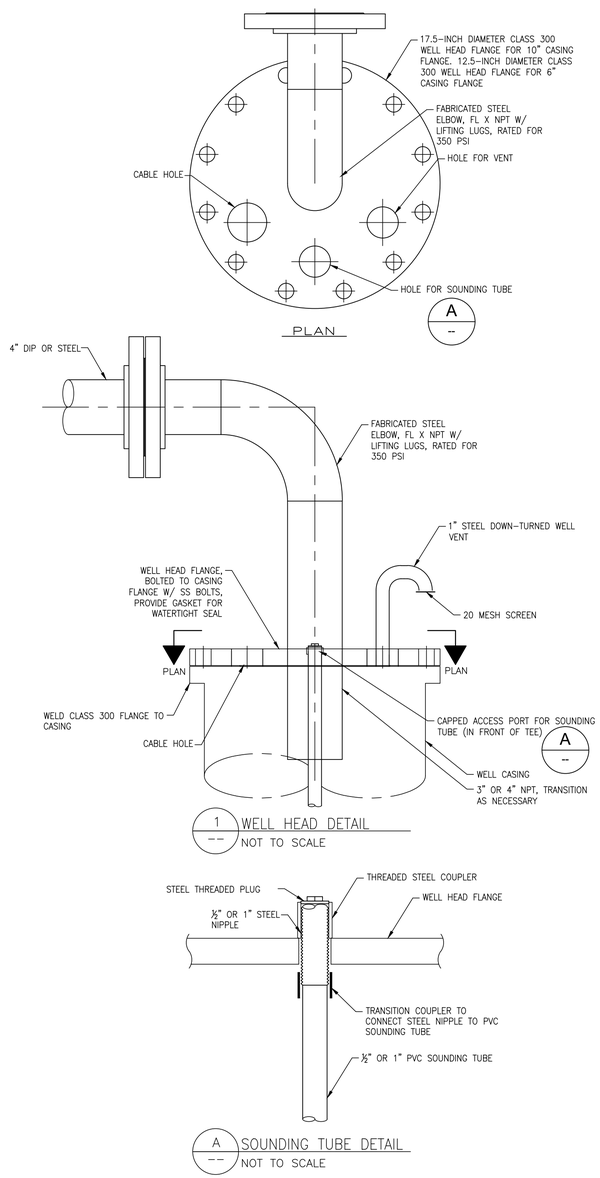
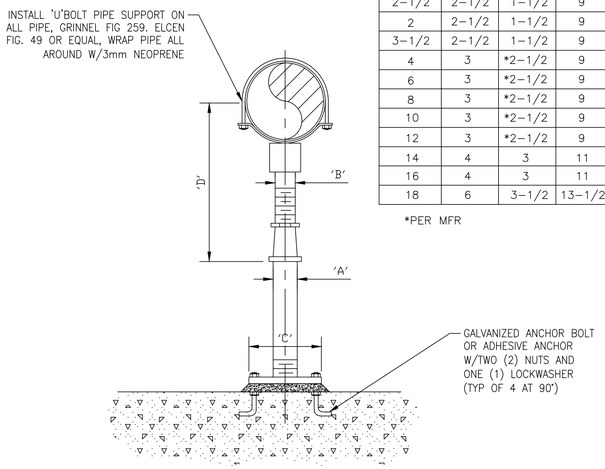
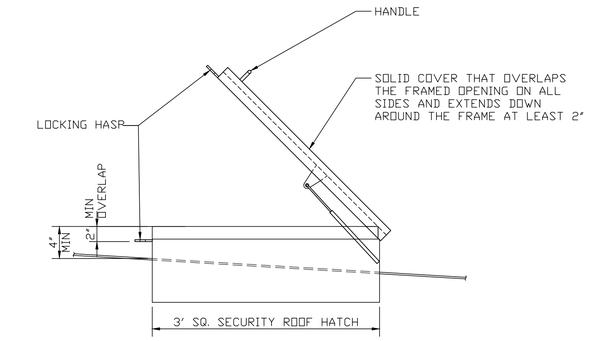




ADJUSTABLE PIPE SUPPORT APPROXIMATE DIMENSIONS IN INCHES					
PIPE SIZE	'A'	'B'	'C'	'D' MINIMUM	'D' MAXIMUM
2-1/2	2-1/2	1-1/2	9	8	13
2	2-1/2	1-1/2	9	8-1/2	13-1/2
3-1/2	2-1/2	1-1/2	9	8-1/2	13-1/2
4	3	*2-1/2	9	9-1/2	14
6	3	*2-1/2	9	10-1/2	15-1/2
8	3	*2-1/2	9	11-1/2	16-1/2
10	3	*2-1/2	9	14-5/8	18-1/4
12	3	*2-1/2	9	15-5/8	19-3/4
14	4	3	11	18-7/8	20-3/4
16	4	3	11	19-7/8	22-1/4
18	6	3-1/2	13-1/2	21-1/4	24

*PER MFR

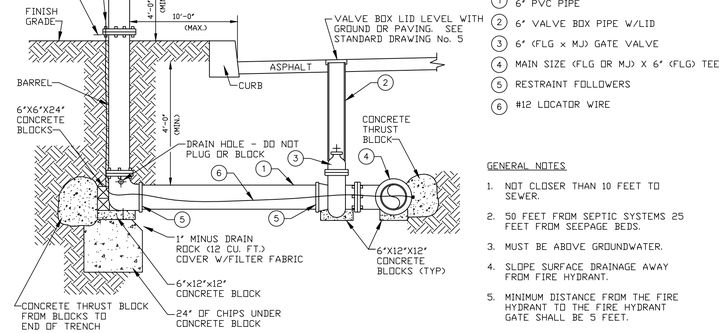
2 PIPE SUPPORT DETAIL
NOT TO SCALE



NOTES:

1. ROOF HATCH SHALL HAVE LOCKING HASP AND CLOSE WATER-TIGHT.
2. HATCH MUST BE HINGED ON ONE SIDE.

3 RESERVOIR ROOF HATCH DETAIL
NOT TO SCALE



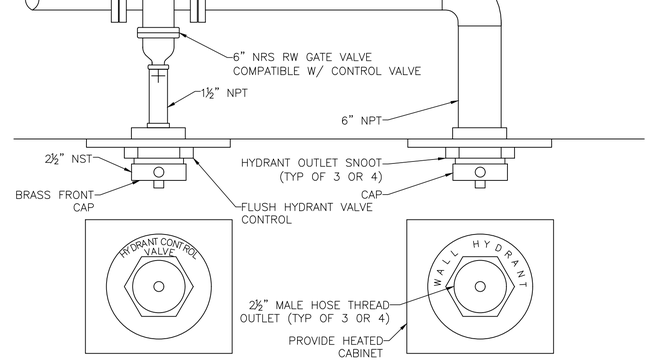
CONSTRUCTION NOTES

1. 6" PVC PIPE
2. 6" VALVE BOX PIPE W/LID
3. 6" (FLG x MJ) GATE VALVE
4. MAIN SIZE (FLG OR MJ) X 6" (FLG) TEE
5. RESTRAINT FOLLOWERS
6. #12 LOCATOR WIRE

GENERAL NOTES

1. NOT CLOSER THAN 10 FEET TO SEWER.
2. 50 FEET FROM SEPTIC SYSTEMS 25 FEET FROM SEEPAGE BEDS.
3. MUST BE ABOVE GROUNDWATER.
4. SLOPE SURFACE DRAINAGE AWAY FROM FIRE HYDRANT.
5. MINIMUM DISTANCE FROM THE FIRE HYDRANT TO THE FIRE HYDRANT GATE SHALL BE 5 FEET.
6. ALL JOINTS SHALL BE RESTRAINED.

5 FIRE HYDRANT DETAIL
NOT TO SCALE



NOTES:

1. WALL HYDRANT SHALL BE FLUSH-TYPE BRASS BODY CONNECTION WITH FEMALE NPT INLET AND MALE HOSE THREAD OUTLET. ALL BUILDINGS SHALL BE PROVIDED WITH WALL HYDRANT WITH 3-WAY OUTLET, EXCEPT FOR MINE OFFICE AND CHANGE-HOUSE, WHICH SHALL BE PROVIDED WITH 4-WAY OUTLET.
2. WALL HYDRANT SHALL BE PROVIDED WITH BRASS CAP AND CHAIN AND IDENTIFICATION PLATE LETTERED "WALL HYDRANT".
3. WALL HYDRANT SHALL BE FM APPROVED.
4. WALL HYDRANT SHALL BE PROTECTED INSIDE HEATED CABINET AND MOUNTED TO EXTERIOR OF BUILDING IN AN ACCESSIBLE AND VISIBLE LOCATION.
5. WALL HYDRANT SHALL BE MANUFACTURED BY AMERICAN FIRE SUPPLY OR APPROVED EQUAL.
6. WALL HYDRANT SHALL BE EQUIPPED W/ SEPERATE FLUSH HYDRANT VALVE CONTROL OR INTEGRATED INDIVIDUAL 2½" F NPT X 2½" M NST GATE VALVE (LOOSE BONNET STYLE).
7. WALL HYDRANT VALVE CONTROL SHALL BE PROVIDED WITH BRASS CAP AND CHAIN AND IDENTIFICATION PLATE LETTERED "HYDRANT CONTROL VALVE."
8. WALL HYDRANT VALVE CONTROL SHALL BE MANUFACTURED BY AMERICAN FIRE SUPPLY OR APPROVED EQUAL.
9. PROVIDE EXTENSION ROD FOR HYDRANT VALVE COMPATIBLE W/ GATE VALVE.
10. FOR BUILDINGS W/ FIRE SPRINKLERS, FIRE SPRINKLER SUPPLY CAN TEE OFF RISER TO WALL HYDRANT. FIRE SPRINKLER DESIGN BY OTHERS.

4 WALL HYDRANT DETAIL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

MECHANICAL DETAILS

REGISTERED PROFESSIONAL ENGINEER
STATE OF OREGON
MAY 10, 2016
JUSTIN P. LEHARIS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

M500

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Xref Filename: I X-TITLE (2) I

GENERAL NOTES:

A. CONSTRUCTION DOCUMENTS:
1. THE CONTRACTOR SHALL REVIEW THE APPROVED CONSTRUCTION DOCUMENTS AND NOTIFY THE ENGINEER OF ANY ERRORS OR DISCREPANCIES PRIOR TO THE START OF CONSTRUCTION.
2. CONTRACTOR IS RESPONSIBLE FOR USING QUALIFIED SUB CONTRACTORS EXPERIENCED IN THIS TYPE OF CONSTRUCTION.
3. THE CONTRACTOR SHALL FURNISH AND INSTALL EVERYTHING REQUIRED TO PROVIDE A COMPLETE STRUCTURE AS SHOWN HEREIN. IF THERE IS AN OMISSION ON THE PLANS, SUCH OMISSION SHALL NOT BE CONSTRUED TO MEAN THAT THE CONTRACTOR IS NOT REQUIRED TO FURNISH OR PROVIDE EVERYTHING THAT IS NECESSARY TO COMPLETE THE PROJECT TO THE MINIMUM REQUIREMENTS OF THE 2015 INTERNATIONAL BUILDING CODE AND ALL OTHER SPECIFICATIONS, CODES AND STANDARDS NOTED ON THE APPROVED CONSTRUCTION DOCUMENTS.
4. THE CONTRACTOR SHALL NOTIFY THE OWNER IMMEDIATELY IF ANY UNIDENTIFIED EXISTING UNDERGROUND UTILITIES ARE DISCOVERED. THE ENGINEER IS NOT RESPONSIBLE FOR THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES WHETHER OR NOT SHOWN ON THE DRAWINGS.
5. THE APPROVED STRUCTURAL DRAWINGS ARE PART OF THE OVERALL CONSTRUCTION DOCUMENT SET AND SHALL BE REFERENCED IN CONJUNCTION WITH OTHER APPROVED CONSTRUCTION DOCUMENTS INCLUDING, BUT NOT LIMITED TO, CIVIL, ARCHITECTURAL, MECHANICAL, ELECTRICAL, LANDSCAPE AND GEOTECHNICAL DOCUMENTS.
   a. SEE ARCHITECTURAL DRAWINGS FOR THE FOLLOWING: HORIZONTAL AND VERTICAL DIMENSIONS NOT SHOWN ON THE STRUCTURAL PLANS. SIZE AND LOCATIONS OF DOOR AND WINDOW OPENINGS. SIZE AND LOCATIONS OF ROOF AND FLOOR OPENINGS. SIZE AND LOCATIONS OF INTERIOR NON-BEARING AND NON STRUCTURAL WALLS. CEILING ASSEMBLIES; WALL, FLOOR AND ROOF FINISHES; AND HANDRAILS.
   b. SEE MECHANICAL, PLUMBING, AND ELECTRICAL DRAWINGS FOR THE FOLLOWING: SIZE AND LOCATION OF PIPES, SLEEVES, AND DUCT PENETRATIONS. EQUIPMENT SIZES AND LOCATION. EQUIPMENT CURBS AND MOUNTING BRACKETS OR ANCHORS.
   c. SEE CIVIL, GEOTECHNICAL, OR LANDSCAPE DRAWINGS AND REPORTS FOR THE FOLLOWING: SITE TOPOGRAPHY, EXCAVATION AND COMPACTION REQUIREMENTS, FINISH GRADE SLOPE AND DRAINAGE, AND SITE ELEVATION.
6. THE STRUCTURAL DRAWINGS REPRESENT THE FINISHED STRUCTURE. THEY DO NOT INDICATE THE METHOD OF CONSTRUCTION. THE CONTRACTOR SHALL PROVIDE ALL MEASURES NECESSARY TO PROTECT THE STRUCTURE DURING CONSTRUCTION. SUCH MEASURES SHALL INCLUDE, BUT ARE NOT LIMITED TO, BRACING AND/OR SHORING FOR LOADS DUE TO CONSTRUCTION EQUIPMENT, ETC. CONTRACTOR AT HIS/HER OWN EXPENSE SHALL ENGAGE PROPERLY QUALIFIED PERSONS TO DESIGN BRACING, SHORING, ETC. OBSERVATION VISITS TO THE SITE BY THE ENGINEER SHALL NOT INCLUDE OBSERVATION OF THE ABOVE NOTED ITEMS.
7. UNDER NO CIRCUMSTANCES CAN STRUCTURAL COMPONENTS BE SUBSTITUTED, OMITTED, SPLICED, OR ALTERED FROM THE APPROVED SET OF CONSTRUCTION DOCUMENTS WITHOUT WRITTEN APPROVAL FROM THE ENGINEER.

B. DIMENSIONS AND NOTATIONS:
1. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALED DIMENSIONS. DO NOT SCALE DRAWINGS.
2. FOR ANY MISSING DIMENSIONS REFER TO THE ARCHITECTURAL DRAWINGS OR THE DRAWINGS OF APPLICABLE TRADE.
3. ABBREVIATIONS USED ON THE APPROVED CONSTRUCTION DOCUMENTS SHALL BE CONSIDERED TYPICAL ABBREVIATIONS FOR THE INDUSTRY. THE CONTRACTOR SHALL BE RESPONSIBLE TO NOTIFY THE ENGINEER IMMEDIATELY OF ANY ABBREVIATIONS THAT ARE UNKNOWN TO THE CONTRACTOR.

C. TYPICAL NOTES AND DETAILS:
1. SPECIFIC NOTES AND DETAILS SHALL TAKE PRECEDENCE OVER STANDARD TYPICAL NOTES AND DETAILS.
2. STANDARD TYPICAL NOTES AND DETAILS ARE TO BE USED WHEN REFERRED TO OR WHEN NO OTHER MORE RESTRICTIVE OR DIFFERENT DETAILS ARE SHOWN ON THE DRAWINGS.
3. WORK NOT PARTICULARLY SHOWN OR SPECIFIED SHALL BE THE SAME AS SIMILAR PARTS THAT ARE SHOWN OR SPECIFIED.

D. SHOP DRAWINGS:
1. SHOP DRAWINGS SHALL BE SUBMITTED TO THE STRUCTURAL ENGINEER IN A TIMELY FASHION PRIOR TO FABRICATION AND CONSTRUCTION. UNLESS OTHERWISE STATED, A MINIMUM OF 5 WORKING DAYS AFTER RECEIPT OF SHOP DRAWINGS SHALL BE CONSIDERED AN ACCEPTABLE TIME PERIOD FOR THE STRUCTURAL ENGINEER REVIEW PROCESS.
2. A MINIMUM OF (2) HARD COPY SETS SHALL BE SUBMITTED TO THE STRUCTURAL ENGINEER FOR REVIEW. THE STRUCTURAL ENGINEER WILL MAINTAIN (1) SET FOR REFERENCE PURPOSES. THE CONTRACTOR SHALL MAINTAIN (1) SET AT THE JOB SITE DURING THE DURATION OF CONSTRUCTION.
3. CONTRACTOR SHALL REVIEW AND STAMP SHOP DRAWINGS PRIOR TO SUBMISSION TO THE STRUCTURAL ENGINEER. CONTRACTOR SHALL REVIEW FOR COMPLETENESS AND COMPLIANCE WITH CONTRACT DOCUMENTS.
4. SHOP DRAWINGS ARE NOT A PART OF THE CONSTRUCTION DOCUMENTS. THE STRUCTURAL ENGINEER REVIEW DOES NOT GIVE PERMISSION TO DEVIATE FROM THE APPROVED CONSTRUCTION DOCUMENTS. WHERE THE SHOP DRAWINGS AND THE CONSTRUCTION DOCUMENTS DIFFER, THE MORE STRICT OF THE TWO SHALL GOVERN UNLESS WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER PERMITS OTHERWISE.

E. INSPECTIONS, SPECIAL INSPECTIONS, AND SITE VISITS (STRUCTURAL OBSERVATIONS):
1. INSPECTIONS BY THE BUILDING OFFICIAL ARE REQUIRED FOR CONSTRUCTION WORK FOR WHICH A PERMIT IS REQUIRED PER SECTION 110 OF THE IBC. CONTRACTOR IS REQUIRED TO COORDINATE AND SCHEDULE ALL REQUIRED INSPECTIONS WITH THE BUILDING OFFICIAL. INSPECTIONS PRESUMING TO GIVE AUTHORITY TO VIOLATE OR CANCEL PROVISIONS OF THE IBC OR OF OTHER ORDINANCES OF THE JURISDICTION SHALL NOT BE VALID.
2. SPECIAL INSPECTIONS ARE IN ADDITION TO, AND DO NOT REPLACE, THE INSPECTIONS BY THE BUILDING OFFICIAL PER CHAPTER 17 OF THE IBC. SPECIAL INSPECTIONS SHALL BE PERFORMED BY A QUALIFIED PERSON TO INSPECT AS REQUIRED ON THESE DOCUMENTS THE MATERIALS, INSTALLATION, FABRICATION, ERECTION OR PLACEMENT OF COMPONENTS AND CONNECTIONS REQUIRING SPECIAL EXPERTISE TO ENSURE COMPLIANCE WITH THE APPROVED CONSTRUCTION DOCUMENTS.
3. SITE VISITS OR STRUCTURAL OBSERVATIONS BY THE STRUCTURAL ENGINEER DOES NOT INCLUDE OR WAIVE THE RESPONSIBILITY OF INSPECTIONS OR SPECIAL INSPECTIONS PER SECTION 110 AND CHAPTER 17 OF THE IBC. SITE VISITS ARE NOT CONTINUOUS OR DETAILED. SITE VISITS DO NOT VALIDATE CONTRACTORS PERFORMANCE, MEANS, OR METHODS. SITE VISITS ARE FOR VISUAL OBSERVATION FOR GENERAL CONFORMANCE TO THE APPROVED CONSTRUCTION DOCUMENTS.

F. CODE REQUIREMENTS:
ALL WORK SHALL CONFORM TO THE MINIMUM STANDARDS OF THE FOLLOWING CODES:
1. 2015 INTERNATIONAL BUILDING CODE (IBC)
2. ANY OTHER REGULATING AGENCIES WHICH MAY HAVE AUTHORITY OVER ANY PORTION OF THE WORK, INCLUDING THE STATE OF OREGON.
3. SPECIFICATIONS, CODES AND STANDARDS NOTED SHALL BE OF THE LATEST APPROVED ISSUE, INCLUDING SUPPLEMENTS, UNLESS NOTED OTHERWISE.
4. CONTRACTOR SHALL BE PROPERLY REGISTERED IN THE STATE OF OREGON PER OREGON STATE LAW.
5. ALL STRUCTURAL MATERIAL MUST HAVE CURRENT ICC-ES REPORTS AVAILABLE UPON REQUEST TO PROVE CODE APPROVAL & INDUSTRY TOLERANCES.

DESIGN CRITERIA:

A. 2014 OREGON SPECIALITY STRUCTURAL CODE (OSSC).
B. 2015 INTERNATIONAL BUILDING CODE (IBC).
1. RISK CATEGORY: II
2. NATURE OF OCCUPANCY: WATER FACILITY
C. DESIGN LOADS:
1. TANK:
   a. LIVE LOAD = 25 PSF (SNOW)
   b. DEAD LOAD = 3000 LBS.
2. SOG:
   a. MAX WATER DEPTH = 15'-6"
   b. WATER LOAD = 1000 PSF
D. IBC SEISMIC DESIGN:
1. SEISMIC DESIGN CATEGORY: C
2. IMPORTANCE FACTOR I_E = 1.00
3. SOIL SITE CLASS: C
4. SEISMIC COEFFICIENTS:
S_S = 0.273 S_{DS} = 0.287
S_1 = 0.102 S_{D1} = 0.163
5. RESPONSE MODIFICATION: Rp = 1
E. IBC WIND LOAD:
1. BASIC DESIGN WIND SPEED = 115 MPH
2. EXPOSURE = C

FOUNDATIONS:

A. MAXIMUM ALLOWABLE FOUNDATION SOIL BEARING PRESSURE:
1. 1500 PSF (DEAD + LIVE LOAD)
2. 1995 PSF (GRAVITY + LATERAL LOAD)
B. THE BOTTOM OF ALL EXTERIOR FOOTINGS SHALL BE 24 INCHES MINIMUM BELOW ADJACENT FINISHED GRADE.
C. STRUCTURAL BACKFILL SHALL BE COMPACTED TO 95 PERCENT OF THE MAXIMUM DENSITY AS DETERMINED BY ASTM D1557. BRACE WALLS AND PIERS AS REQUIRED DURING BACKFILLING OPERATIONS.
D. PRIOR TO CONSTRUCTION, CONTRACTOR SHALL COORDINATE THE CONSTRUCTION DOCUMENTS, INCLUDING THE STRUCTURAL DRAWINGS, WITH THE GEOTECHNICAL REPORT. ANY DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE STRUCTURAL ENGINEER.
E. CONTRACTOR SHALL REFERENCE, AND MAINTAIN AT THE JOB SITE DURING CONSTRUCTION, THE GEOTECHNICAL REPORT PREPARED BY GOLDER ASSOCIATES DATED JUNE 6, 2018.

CONCRETE:

F. REFERENCE STANDARDS:
1. ALL CONCRETE WORK SHALL CONFORM TO THE LATEST EDITION OF ACI 301
2. ALL CONCRETE SHALL BE NORMAL WEIGHT CONCRETE
3. CONCRETE MIX DESIGN SHALL BE ESTABLISHED IN ACCORDANCE WITH CHAPTER 5 OF ACI 318
4. USE LATEST EDITION OF ACI 306R WHEN CONCRETING DURING COLD WEATHER
B. SUBMITTALS:
1. SUPPLY PRODUCT DATA FOR PROPRIETARY MATERIALS AND ITEMS, INCLUDING REINFORCEMENT AND FORMING ACCESSORIES, ADMIXTURES, PATCHING COMPOUNDS, JOINT SYSTEMS, CURING COMPOUNDS AND OTHERS.
2. SHOP DRAWINGS FOR REINFORCEMENT DETAILING, FABRICATING, FOR BENDING, AND PLACING OF CONCRETE REINFORCEMENT SHALL COMPLY WITH ACI 315, MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES. BAR SCHEDULES, STIRRUP SPACING, BENT BAR DIAGRAMS, AND ARRANGEMENT OF CONCRETE REINFORCEMENT SHALL BE SHOWN. INCLUDE SPECIAL REINFORCING REQUIRED FOR OPENINGS THROUGH CONCRETE STRUCTURES.
C. FORMWORK AND FINISHES:
1. FORMWORK: DESIGN, ERECT, SUPPORT, BRACE AND MAINTAIN FORMWORK TO SUPPORT VERTICAL, LATERAL, STATIC AND DYNAMIC LOADS THAT MIGHT BE APPLIED UNTIL STRUCTURE CAN SUPPORT SUCH LOADS.
2. FINAL SLAB SURFACES SHALL RECEIVE A MACHINED STEEL TROWEL FINISH.
3. ANY PROJECTING CORNERS OF COLUMNS, BEAMS, WALLS, PEDESTALS, ETC SHALL BE FORMED WITH A 3/4 INCH CHAMFER.
4. DRY PACK, OR USE NON-SHRINK GROUT, UNDER BASE PLATES, BEARING PLATES, OR SILL PLATES AS REQUIRED FOR A LEVEL AND UNIFORM BEARING SURFACE. MINIMUM GROUT STRENGTH SHALL BE f'c = 7000 PSI, U.N.O.
5. SEPARATE SLABS-ON-GRADE FROM VERTICAL SURFACES WITH JOINT FILLER.
D. MIX DESIGN, STRENGTH, AND ADMIXTURES:
1. 28-DAY COMPRESSIVE STRENGTHS (f'c):
   a. FOOTINGS = 4000 PSI
   b. SLABS-ON-GRADE = 4000 PSI
2. CEMENT II OR I/II PER ASTM C-150
3. MAXIMUM SLUMP:
   a. PRIOR TO ADDITION OF WATER-REDUCING ADMIXTURE = 4"
   b. WITH ADDITION OF WATER-REDUCING ADMIXTURE= 10"
4. MAXIMUM SIZE COARSE AGGREGATE: 3/4 INCHES (PER ASTM C-33)
5. APPROVED ADMIXTURES:
   a. FLYASH PER ASTM C-618
   b. AIR ENTRAINING PER ASTM C-260
   c. WATER REDUCING PER ASTM C-494
E. REINFORCEMENT:
1. REINFORCEMENT FOR CONCRETE:
   a. ALL REINFORCING SHALL BE SUPPORTED IN FORMS SPACED WITH NECESSARY ACCESSORIES AND SHALL BE SECURELY WIRED TOGETHER IN ACCORDANCE WITH THE LATEST EDITION OF THE CRSI "MANUAL OF STANDARD PRACTICE"
   b. DEFORMED BARS - ASTM A615, GRADE 60
2. MINIMUM REINFORCEMENT LAP = 48 BAR DIAMETERS
3. MINIMUM CONCRETE COVER OVER REINFORCEMENT:
   a. CONCRETE CAST AGAINST EARTH = 3"
   b. CONCRETE EXPOSED TO EARTH OR WEATHER = 1 1/2"
   c. CONCRETE NOT EXPOSED TO EARTH OR WEATHER = 3/4"
4. SLAB-ON-GRADE REINFORCEMENT SHALL BE PLACED AT THE MID-DEPTH OF THE SLAB.
F. COORDINATION:
1. COORDINATE ALL UNDER-SLAB MATERIAL SUCH AS SUB-BASE WITH GEOTECHNICAL CONSTRUCTION DOCUMENTS.
2. COORDINATE CONCRETE SURFACE FINISHING WITH ARCHITECTURAL FINISH MATERIALS.
3. REPAIR OR REPLACE DEFECTIVE CONCRETE AS DIRECTED BY THE ARCHITECT, ENGINEER, OR TESTING AGENCY.
4. COORDINATE ALL JOINT SPACING, LAYOUT, FILLER AND SEALANTS.
5. COORDINATE WITH ARCHITECTURAL ANY FINISH SURFACES THAT REQUIRE MOCK-UPS AND ACCEPTANCE PRIOR TO CONSTRUCTION.
6. COORDINATE WITH REQUIRED INSPECTORS, SPECIAL INSPECTORS, AND STRUCTURAL OBSERVERS FOR FIELD QUALITY CONTROL ITEMS AND SCHEDULE NOTIFICATIONS IN A TIMELY FASHION.
G. DEFINITIONS:
1. PERFORMANCE DESIGN - A SET OF INSTRUCTIONS THAT OUTLINES THE FUNCTIONAL REQUIREMENTS FOR HARDENED CONCRETE DEPENDING ON THE APPLICATION. PERFORMANCE DESIGN DOES NOT INCLUDE REQUIREMENTS FOR MEANS AND METHODS AND DOES NOT PROVIDE LIMITATIONS ON THE INGREDIENTS OR PROPORTIONS OF THE CONCRETE MIXTURE. SUBMITTALS FOR PERFORMANCE DESIGN WOULD NOT BE A DETAILS LIST OF MIXTURE INGREDIENTS BUT RATHER A CERTIFICATION THAT THE MIX WILL MEET THE SPECIFICATION REQUIREMENTS, INCLUDING PRE-QUALIFICATION TEST RESULTS.
2. DURABILITY DESIGN - DURABILITY IS THE ABILITY OF CONCRETE TO RESIST WEATHERING ACTION, CHEMICAL ATTACK, AND ABRASION WHILE MAINTAINING IT'S DESIRED ENGINEERING PROPERTIES.
3. STRENGTH DESIGN- BASED ON THE ULTIMATE COMPRESSIVE STRENGTH OF THE CONCRETE NEEDED TO RESIST THE CALCULATED DESIGN LOADS. ANY ADDITIONAL STRENGTH THAT MAY BE PRESENT DUE TO STEEL REINFORCING IS NOT PERMITTED TO BE INCLUDED IN THE CONCRETE STRENGTH DESIGN.

POST INSTALLED ANCHORS IN CONCRETE:

A. POST INSTALLED EPOXY ANCHORS SHALL BE PREAPPROVED BY THE STRUCTURAL ENGINEER PRIOR TO CONSTRUCTION UNLESS SPECIFICALLY DETAILED ON THE DRAWINGS.
B. HOLES MUST BE DRILLED AND CLEANED PER MANUFACTURER'S INSTRUCTIONS. HOLES MUST BE DRY & ANCHORS MUST BE INSTALLED AND SPECIAL INSPECTED PER MANUFACTURER'S INSTRUCTIONS.
C. UNDER NO CIRCUMSTANCES WILL AN EXPANSION BOLT SYSTEM BE APPROVED WITHOUT A CURRENT ICC ES REPORT THAT MEETS THE REQUIREMENTS OF THE GOVERNING JURISDICTION AND IS IN ACCORDANCE WITH AC1 318 APPENDIX D AS ADOPTED BY THE IBC.

SPECIAL INSPECTION PROGRAM:

A. THE OWNER SHALL EMPLOY AN APPROVED AGENCY FOR SPECIAL INSPECTION SERVICES TO PERFORM SPECIAL INSPECTIONS IN ACCORDANCE WITH CHAPTER 17 OF THE IBC.
B. AN APPROVED AGENCY SHALL BE AN ESTABLISHED AND RECOGNIZED AGENCY REGULARLY ENGAGED IN CONDUCTING TESTS OR FURNISHING INSPECTION SERVICES.
C. A SPECIAL INSPECTOR SHALL BE A QUALIFIED PERSON WHO SHALL SHOW COMPETENCE TO THE SATISFACTION OF THE BUILDING OFFICIAL FOR THE INSPECTION OF THE PARTICULAR TYPE OF CONSTRUCTION OR OPERATION REQUIRING SPECIAL INSPECTION. A SPECIAL INSPECTOR SHALL ALSO DEMONSTRATE A THOROUGH WORKING KNOWLEDGE OF CHAPTER 17 OF THE IBC AND CBC AS SUMMARIZED BELOW. IF THERE IS ANY OMISSION ON THE SUMMARIZED LIST BELOW, SUCH OMISSION SHALL NOT BE CONSTRUED TO MEAN THAT THE SPECIAL INSPECTOR IS NOT REQUIRED TO INSPECT EVERYTHING THAT IS NECESSARY TO MEET THE MINIMUM REQUIREMENTS OF THE IBC AND CBC.
D. SPECIAL INSPECTORS SHALL KEEP RECORDS OF INSPECTIONS. THE SPECIAL INSPECTOR SHALL SUBMIT INSPECTION REPORTS TO THE BUILDING OFFICIAL AND THE ENGINEER IN A TIMELY FASHION.
E. SPECIAL INSPECTION REPORTS SHALL INDICATE THAT WORK INSPECTED WAS DONE IN CONFORMANCE TO APPROVED CONSTRUCTION DOCUMENTS. DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION. IF THE DISCREPANCIES ARE NOT CORRECTED, THE DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE BUILDING OFFICIAL AND THE ENGINEER.

SPECIAL INSPECTION:

A. SPECIAL INSPECTION AS HEREIN REQUIRED OF THE FOLLOWING MATERIALS, INSTALLATION, FABRICATION, ERECTION OR PLACEMENT OF COMPONENTS AND CONNECTIONS REQUIRING SPECIAL EXPERTISE TO ENSURE COMPLIANCE WITH APPROVED CONSTRUCTION DOCUMENTS AND REFERENCED STANDARDS.
B. STRUCTURAL OBSERVATION OF THE STRUCTURAL SYSTEM BY THE ENGINEER OF RECORD DOES NOT INCLUDE OR WAIVE THE RESPONSIBILITY FOR THE SPECIAL INSPECTION REQUIRED BY SECTION 109, 1704, OR OTHER SECTIONS OF THE INTERNATIONAL BUILDING CODE.
C. THE SPECIAL INSPECTION STATEMENT ON THIS SHEET LISTS THE ITEMS THAT REQUIRE SPECIAL INSPECTION AND VERIFICATION, THE CODE SECTION- REFERENCE FOR ADDITIONAL INFORMATION, AND THE REQUIRED FREQUENCY OF INSPECTION.

SPECIAL INSPECTION STATEMENT:

A. TO BE USED IN CONJUNCTION WITH CHAPTER 17 OF THE 2015 IBC & 2014 OSSC.

SPECIAL CASES: SECTION 1705.1.1	
INSPECTION OF ADHESIVE ANCHORS IN CONCRETE:	
REQUIRED VERIFICATION & INSPECTION	FREQUENCY
1. VERIFY HOLE DRILLING METHOD; HOLE LOCATION, DIAMETER AND DEPTH; HOLE CLEANING; ANCHORAGE ELEMENT TYPE, MATERIAL, DIAMETER AND LENGTH; ADHESIVE BRAND, TYPE AND EXPIRATION DATE; CONTINUOUS INSPECTION OF ADHESIVE MIXING AND INSTALLATION	CONTINUOUS

CONCRETE CONSTRUCTION: TABLE 1705.3	
REQUIRED VERIFICATION & INSPECTION	FREQUENCY
1. INSPECTION OF REINFORCING STEEL AND PLACEMENT	PERIODIC
2. INSPECTION OF ANCHORS INSTALLED IN HARDENED CONCRETE (21-DAY OLD MIN.), SEE ALSO SPECIAL CASES: 1705.1.1	CONTINUOUS
3. VERIFYING USE OF REQUIRED DESIGN MIX	PERIODIC
4. AT THE TIME FRESH CONCRETE IS SAMPLED TO FABRICATE SPECIMENS FOR STRENGTH TESTS, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE	CONTINUOUS
5. INSPECT FORMWORK FOR SHAPE, LOCATION AND DIMENSION OF THE CONCRETE MEMBER TO BE FORMED	PERIODIC

SHEET INDEX

S1.0	GENERAL STRUCTURAL NOTES
S2.0	FOUNDATION PLAN & DETAILS

GENERAL STRUCTURAL NOTES
SCALE: NTS
1

McClendon Engineering Inc
1412 W. Idaho Street
Suite 240
Boise, Idaho 83702
Tel: 208.342.2919
Fax: 208.331.4568

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA, CORP.

GENERAL STRUCTURAL NOTES

REGISTERED PROFESSIONAL ENGINEER 18922 PE OREGON JAN. 9, 2007 SARAH C. McCLENDON
EXPIRATION DATE: 12/31/20
05/31/19

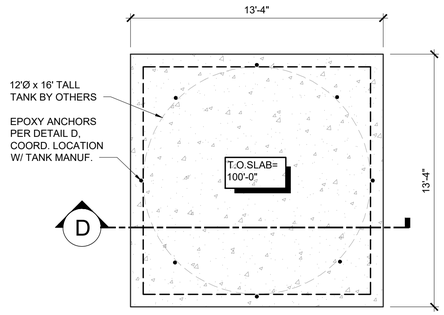
REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	07/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

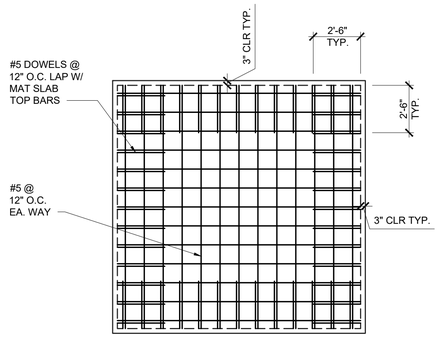
PROJECT:	1041.19
DESIGNED:	WT
DRAWN:	CJH
CHECKED:	SM

S1.0



FOUNDATION PLAN
SCALE: 1/4" = 1'-0"

A



REBAR TOP MAT LAYOUT PLAN
SCALE: 1/4" = 1'-0"

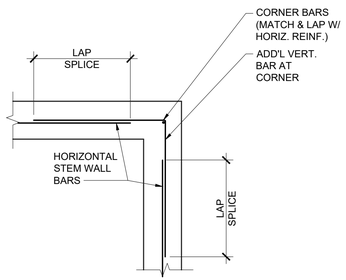
B

FOUNDATION PLAN NOTES:

1. FOR ANY ADDITIONAL DIMENSIONS NOT SHOWN, OR IF ANY DISCREPANCIES ARE FOUND NOTIFY THE ENGINEER IMMEDIATELY .
2. CONTRACTOR TO REVIEW GEOTECH REPORT FOR SPECIAL REQUIREMENTS PRIOR TO POURING CONCRETE.
3. T.O.SLAB = TOP OF CONCRETE SLAB ELEVATION
4. B.O.FTG. = BOTTOM OF FOOTING ELEVATION, 24" MIN. BELOW FINISH GRADE
5. CORNER REINF. IS REQ'D PER DETAIL C

FOUNDATION PLAN LEGEND:

INDICATES 12" CONC. MAT SLAB ON GRADE OVER 6" COMPACTED ¾" MINUS GRAVEL PER GEOTECH REPORT, REINF. PER DETAIL B, C & D..

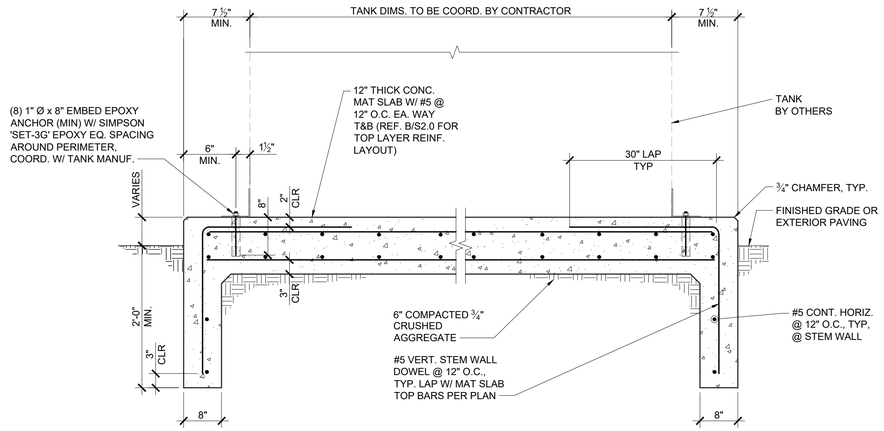


PLAN VIEW

NOTE:
LAP SPLICE LENGTHS (U.N.O.):
CONCRETE WALL: 48 BAR DIA. OR 30" (MIN) WHICHEVER IS GREATER

STEM WALL CORNER REINF.
SCALE: N.T.S.

C



STEM WALL CORNER REINF.
SCALE: 3/4" = 1'-0"

D

FOUNDATION PLAN & DETAILS
SCALE: AS NOTED

2

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA, CORP.

TREATED WATER STORAGE TANK
FOUNDATION PLAN & DETAILS

REGISTERED PROFESSIONAL ENGINEER
18922 PE
OREGON
JAN. 9, 2001
SARAH C. McCLENDON
05/31/19
EXPIRATION DATE: 12/31/20

REVISIONS			
ITEM	DESCRIPTION	DATE	
0	FINAL PERMIT SET	07/31/19	

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1041.19
DESIGNED:	WT
DRAWN:	CJH
CHECKED:	SM

S2.0

McClendon Engineering Inc
1412 W. Idaho Street
Suite 240
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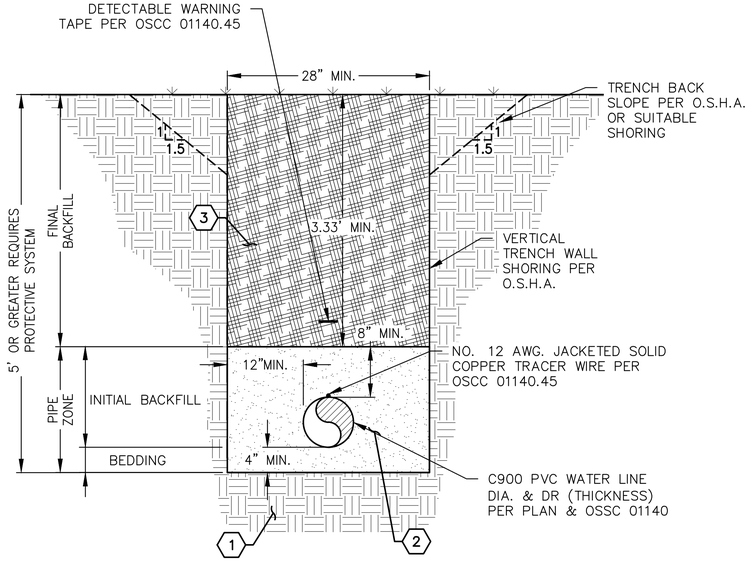
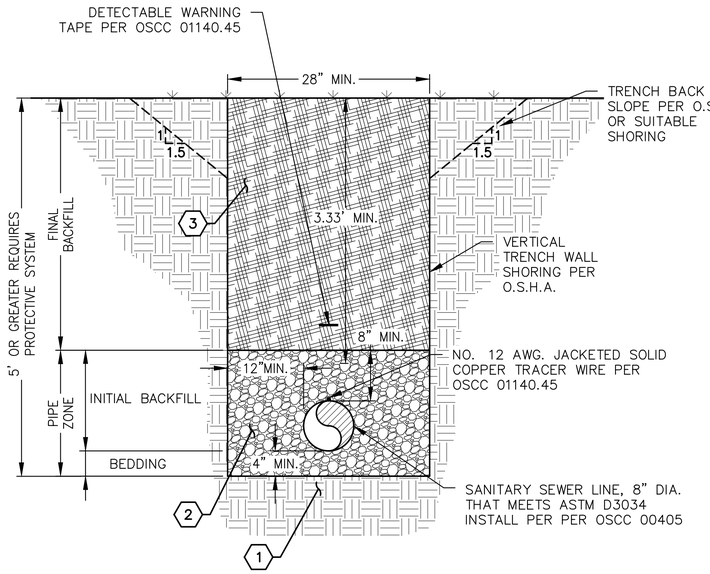
Tel: 208.342.2919
Fax: 208.331.4568



1 WATER LINE TRENCH DETAIL
NOT TO SCALE

LEGEND

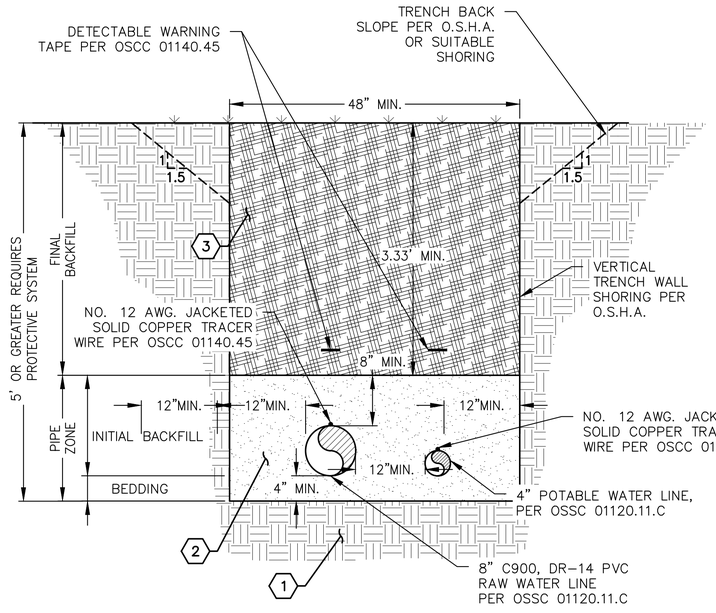
1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE REASONABLY WELL-GRADED, FROM MAXIMUM SIZE TO DUST, SAND WITH 100% PASSING THE 3/8" SIEVE. BEDDING & INITIAL BACKFILL SHALL BE COMPACTED ACCORDING TO ASTM-D698 (STANDARD PROCTOR)
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



2 SANITARY SEWER TRENCH DETAIL
NOT TO SCALE

LEGEND

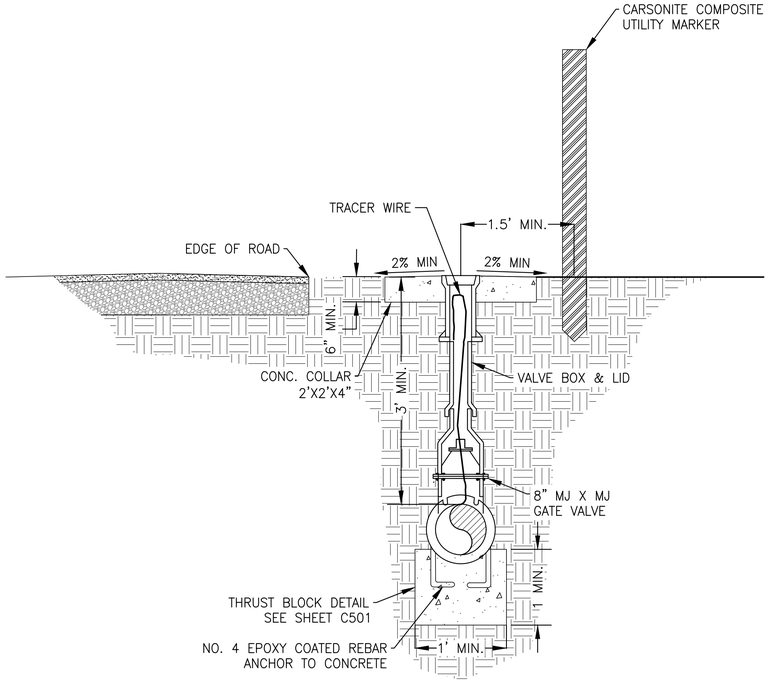
1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE COMMERCIALLY AVAILABLE 3/8" ROCK CHIPS.
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL (NATIVE BACKFILL) ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



3 JOINT TRENCH DETAIL
NOT TO SCALE

LEGEND

1. UNSTABLE SUBGRADE SHALL BE EXCAVATED AND BACKFILLED WITH APPROVED PIPE BEDDING MATERIAL AND COMPACTED PER OSCC 00405.44
2. PIPE BEDDING & INITIAL BACKFILL SHALL BE REASONABLY WELL-GRADED, FROM MAXIMUM SIZE TO DUST, SAND WITH 100% PASSING THE 3/8" SIEVE. BEDDING & INITIAL BACKFILL SHALL BE COMPACTED ACCORDING TO ASTM-D698 (STANDARD PROCTOR)
3. FINAL BACKFILL SHALL BE CLASS A BACKFILL ACCORDING TO OSCC 00405.14.A. FINAL BACKFILL SHALL BE 3" MINUS, FREE OF ORGANIC MATERIAL, FREE OF FROST CHUNKS, AND FREE OF TOXIC WASTE AND HAZARDOUS CHEMICALS. SEE OSCC 00405.12 FOR WET CONDITIONS



4 TYP. GATE VALVE & VALVE BOX
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

TRENCH DETAILS

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS			
ITEM	DESCRIPTION	DATE	
0	FINAL PERMIT SET	7/31/19	

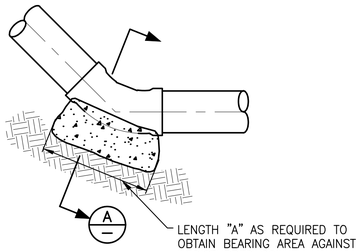
VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

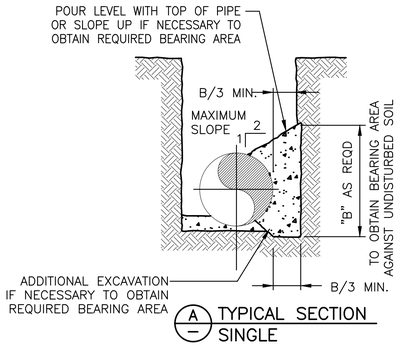
C500

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A Filename: DETAILS_GRASSY_hw Plot date: Aug 22, 2019-03:16:48pm CAD User: HWhite.
Xref Filename: | X-TITLE | X-TITLE (2) |

*NOTE: THRUST BLOCK SCHEDULE SEE SHEET C502

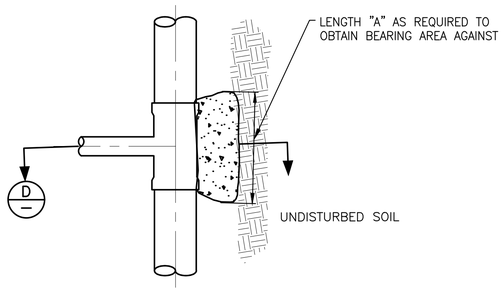


HORIZONTAL BENDS (SINGLE)

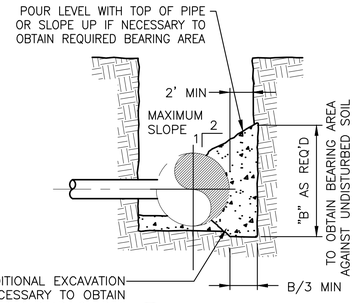


A TYPICAL SECTION SINGLE

1 — TYP. HORIZONTAL BEND THRUST BLOCK DETAIL
NOT TO SCALE



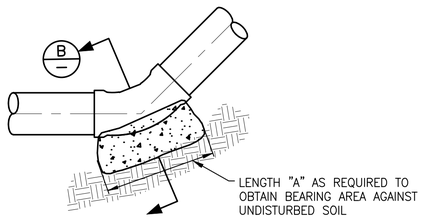
TURNOUT (SINGLE)



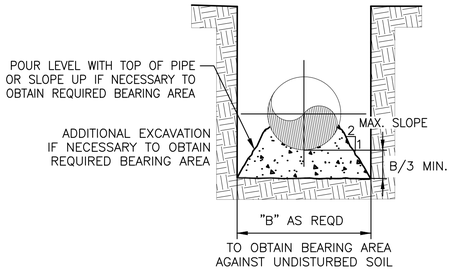
D TYPICAL SECTION SINGLE

4 — TYP. TEE THRUST BLOCK DETAIL
NOT TO SCALE

FORCED CONCRETE
↓ (NO BASE)
LEVEL

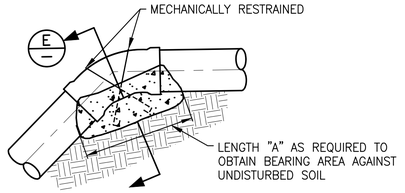


VERTICAL BENDS (SINGLE)

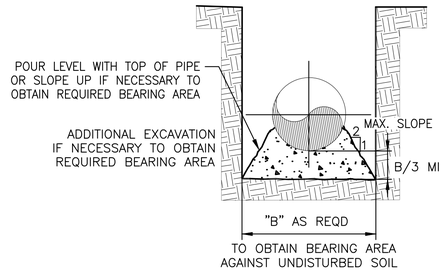


B TYPICAL SECTION SINGLE

2 — TYP. VERTICAL UPWARD BEND THRUST BLOCK DETAIL
NOT TO SCALE

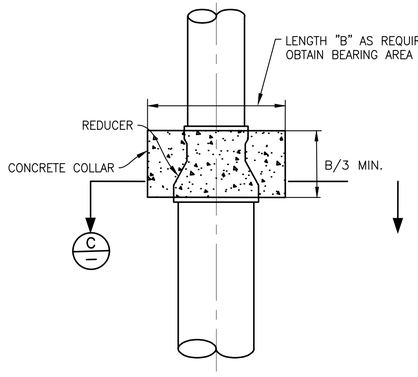


VERTICAL BENDS (SINGLE)

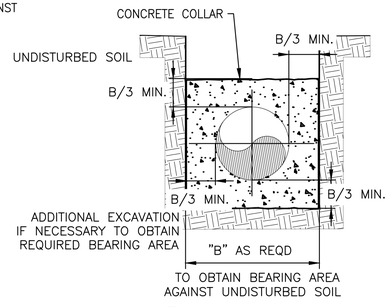


E TYPICAL SECTION SINGLE

5 — TYP. VERTICAL DOWNWARD BEND THRUST BLOCK DETAIL
NOT TO SCALE

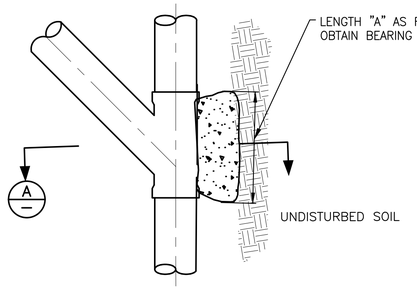


REDUCER (SINGLE)

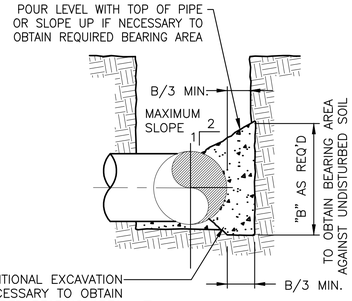


C TYPICAL SECTION SINGLE

3 — TYP. REDUCER THRUST BLOCK DETAIL
NOT TO SCALE



TURNOUT (SINGLE)



A TYPICAL SECTION SINGLE

6 — TYP. WYE THRUST BLOCK DETAIL
NOT TO SCALE

*SEE SHEET C502 FOR THRUST BLOCK SCHEDULE AND NOTES

SPF WATER ENGINEERING
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GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

THRUST BLOCK DETAILS

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY. 10, 2016
JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C501

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Xref Filename: | X-TITLE | X-TITLE (2) |
Filename: DETAILS_GRASSY_hw Plot date: Aug 22, 2019-03:17:10pm CAD User: HWhite.

THRUST BLOCK MINIMUM DIMENSIONS								
NOTE: THIS TABLE IS BASED ON 250-300 PSI MAIN PRESSURE & 2000 PSI SOIL BEARING PRESSURE. STA. 0+00 - STA. 27+50								
DIMENSIONS FOR THRUST BLOCKING								
FITTING SIZES	TEES & PLUGS		90° ELBOW		45° ELBOW & WYES		22.5° ELBOW & REDUCERS	
	A	B	A	B	A	B	A	B
4"	2'-3"	1'-8"	2'-6"	2'-2"	2'-5"	1'-3"	2'-3"	1'-0"
6"	2'-10"	2'-8"	3'-6"	3'-1"	2'-7"	2'-3"	2'-6"	1'-3"
8"	3'-10"	3'-10"	4'-6"	4'-3"	3'-6"	3'-0"	2'-6"	2'-2"
10"	4'-9"	4'-8"	5'-8"	5'-6"	4'-3"	3'-11"	3'-1"	2'-8"
12"	5'-8"	5'-6"	6'-8"	6'-8"	5'-3"	4'-8"	3'-8"	3'-3"
14"	7'-8"	5'-6"	9'-3"	7'-0"	6'-9"	4'-10"	4'-10"	3'-6"

THRUST BLOCK MINIMUM DIMENSIONS								
NOTE: THIS TABLE IS BASED ON MAX 150-250 PSI MAIN PRESSURE & 2000 PSI SOIL BEARING PRESSURE. STA. 27+50 - 112+50								
DIMENSIONS FOR THRUST BLOCKING								
FITTING SIZES	TEES & PLUGS		90° ELBOW		45° ELBOW & WYES		22.5° ELBOW & REDUCERS	
	A	B	A	B	A	B	A	B
4"	2'-1"	1'-7"	2'-4"	2'-0"	2'-2"	1'-1"	2'-1"	0'-11"
6"	2'-8"	2'-6"	3'-2"	2'-10"	2'-4"	2'-1"	2'-4"	1'-1"
8"	3'-6"	3'-6"	4'-2"	3'-11"	3'-2"	2'-9"	2'-4"	2'-0"
10"	4'-3"	4'-3"	5'-2"	5'-0"	3'-11"	3'-7"	2'-10"	2'-6"
12"	5'-2"	5'-0"	6'-1"	6'-1"	4'-9"	4'-3"	3'-5"	2'-11"
14"	7'-0"	5'-0"	8'-5"	6'-5"	6'-2"	4'-5"	4'-5"	3'-2"

THRUST BLOCK MINIMUM DIMENSIONS								
NOTE: THIS TABLE IS BASED ON MAX 0-150 PSI MAIN PRESSURE & 2000 PSI SOIL BEARING PRESSURE. STA. 112+50 - 146+90								
DIMENSIONS FOR THRUST BLOCKING								
FITTING SIZES	TEES & PLUGS		90° ELBOW		45° ELBOW & WYES		22.5° ELBOW & REDUCERS	
	A	B	A	B	A	B	A	B
4"	1'-7"	1'-2"	1'-9"	1'-6"	1'-8"	0'-10"	1'-7"	0'-8"
6"	2'-0"	1'-11"	2'-5"	2'-2"	1'-10"	1'-7"	1'-9"	0'-10"
8"	2'-8"	2'-8"	3'-2"	3'-0"	2'-5"	2'-1"	1'-9"	1'-6"
10"	3'-4"	3'-3"	4'-0"	3'-10"	3'-0"	2'-9"	2'-2"	1'-11"
12"	4'-0"	3'-10"	4'-8"	4'-8"	3'-8"	3'-3"	2'-7"	2'-3"
14"	5'-5"	3'-10"	6'-6"	4'-11"	4'-9"	3'-5"	3'-5"	2'-5"

NOTES:

1. MINIMUM BEARING AREA IS DESIGNED FOR A MAXIMUM SOIL BEARING CAPACITY OF 2,000 POUNDS PER SQUARE FOOT. IF LOW OR HIGH BEARING CAPACITY SOILS ARE ENCOUNTERED, CONTACT THE ENGINEER IMMEDIATELY. IF SOILS WITH LOW BEARING CAPACITY SUCH AS SATURATED SOILS, SOIL CONTAINING A HIGH PERCENTAGE OF CLAY OR ORGANIC MATERIAL ARE ENCOUNTERED AT A THRUST BLOCK LOCATION, THE BEARING AREA MAY NEED TO BE INCREASED OR THE UNSUITABLE SOILS MAY NEED TO BE OVER-EXCAVATED AND REPLACED WITH STRUCTURAL FILL AS APPROVED AND DIRECTED BY THE ENGINEER. THE BEARING AREA MAY BE DECREASED IF HIGHER BEARING CAPACITY IS SUBSTANTIATED BY SOIL BEARING TESTS AS APPROVED AND DIRECTED BY THE ENGINEER.
2. CONCRETE THRUST BLOCKS SHALL BE IN ACCORDANCE WITH THE OSCC 01140.44.
3. THRUST BLOCK IS TO EXTEND TO UNDISTURBED SOIL.
4. ALL FITTINGS SHALL BE COVERED WITH POLYETHYLENE WRAP PRIOR TO POURING THRUST BLOCK.

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

THRUST BLOCK SCHEDULE & NOTES

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LERARIS
EXPIRES: 12-31-20

REVISIONS		
ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C502

Path: S:\PROJECTS\M thru R Projects\P Projects\Paramount Gold_1294\0050_Water and Wastewater Design\2018 A
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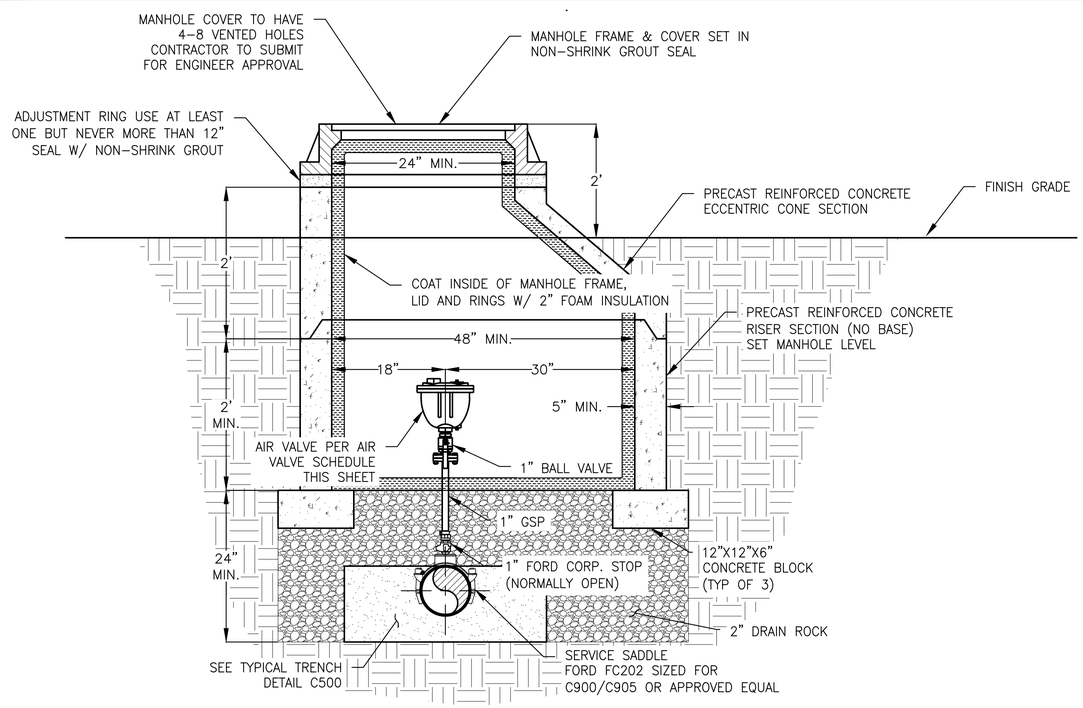
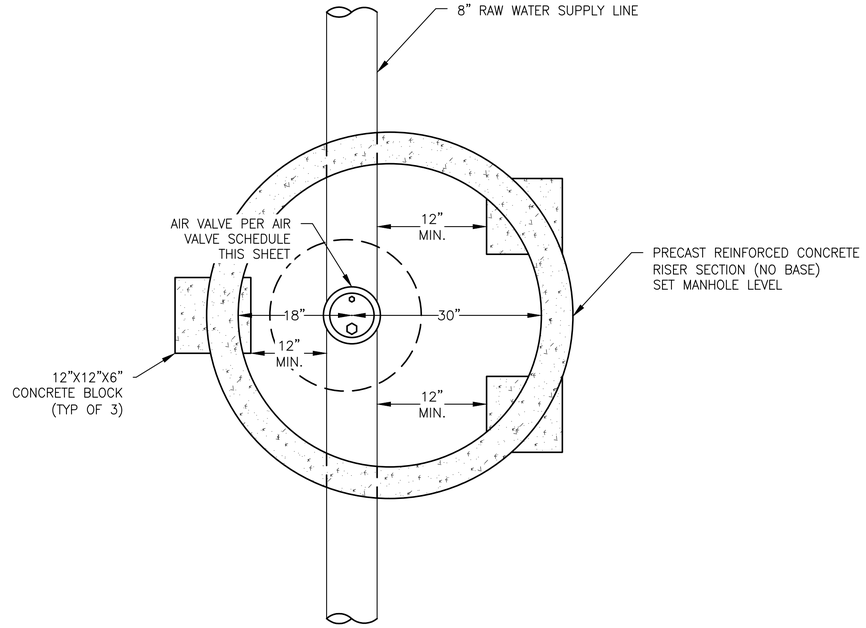


1 — AIR VALVE & AIR VALVE VAULT SECTION DETAIL
NOT TO SCALE



2 — AIR VALVE & AIR VALVE VAULT DETAIL
NOT TO SCALE

MAINLINE AIR VALVE MINIMUM SIZES & LOCATIONS							
VAL-MATIC SERIES	TYPE	SIZE & SMALL ORIFICE DIA. MIN.	PIPELINE	PRESSURE CLASS (PSI)	MAX. GPM	MAIN DIA. (IN)	STATION
201C.2	COMBINATION	1" - 5/64"	MAIN	300	400	8	32+00
201C.2	COMBINATION	1" - 5/64"	MAIN	300	400	8	65+50
201C.2	COMBINATION	1" - 5/64"	MAIN	300	400	8	97+00
201C.2	COMBINATION	1" - 5/64"	MAIN	300	400	8	128+85
201C.2	COMBINATION	1" - 5/64"	MAIN	300	400	8	147+50

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300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
PARAMOUNT GOLD NEVADA

AIR VALVE DETAILS AND SCHEDULE

REGISTERED PROFESSIONAL ENGINEER 91236 7-31-19 OREGON MAY. 10, 2016 JUSTIN P. LEHARS
EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C503

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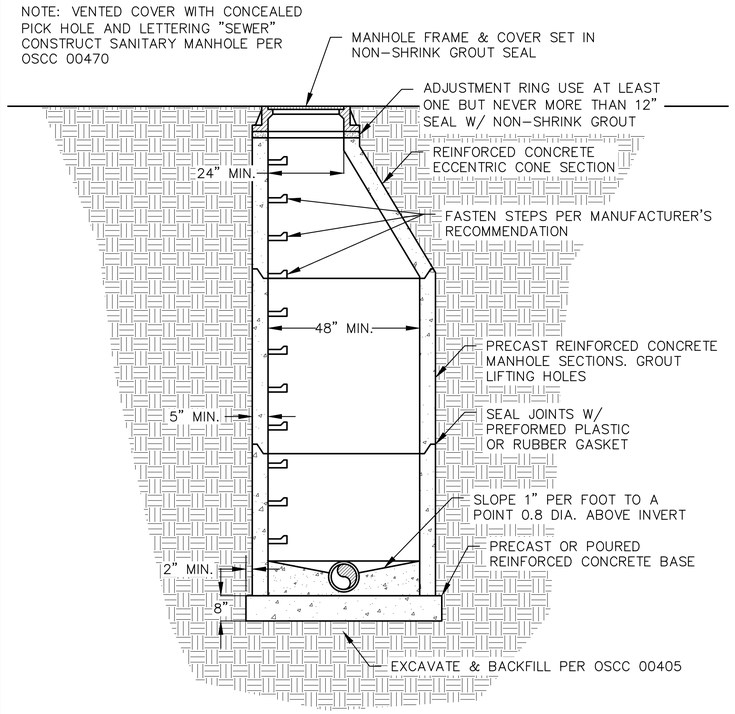
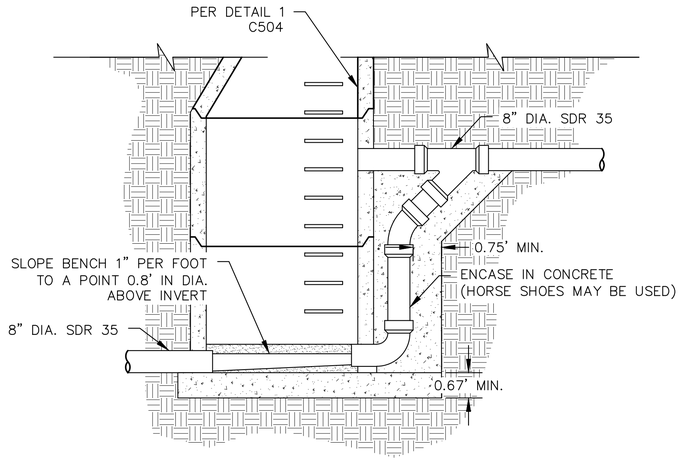
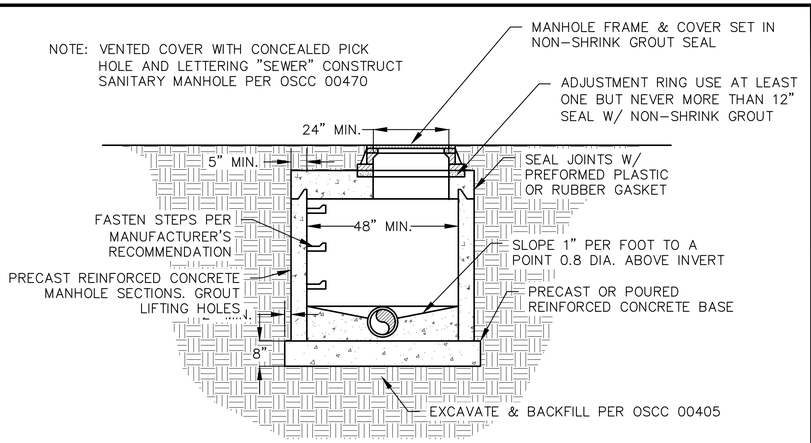


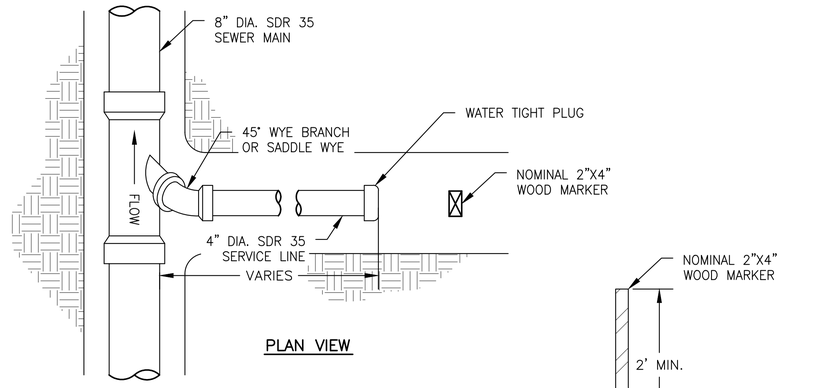
1 — SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



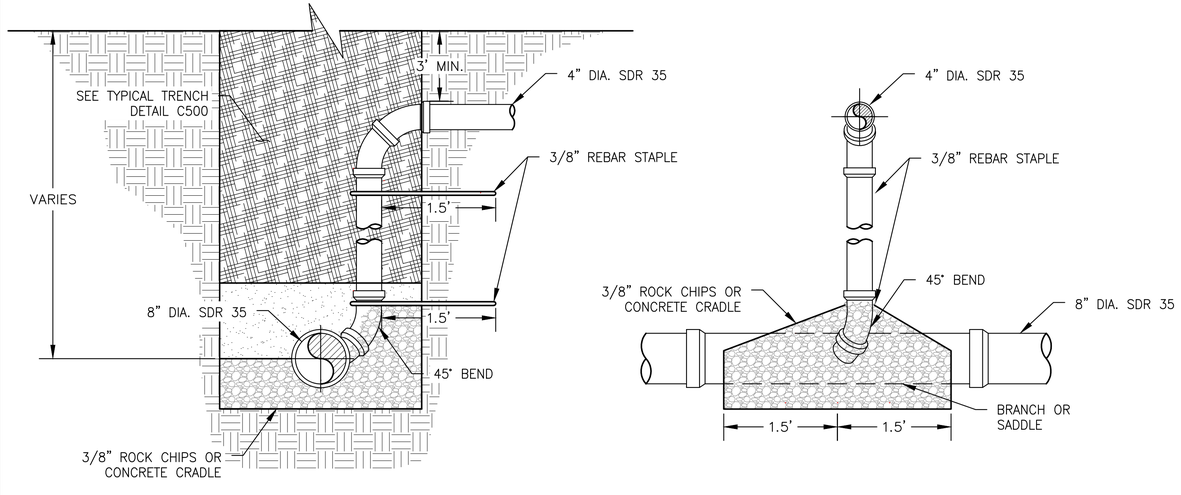
2 — DROP SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



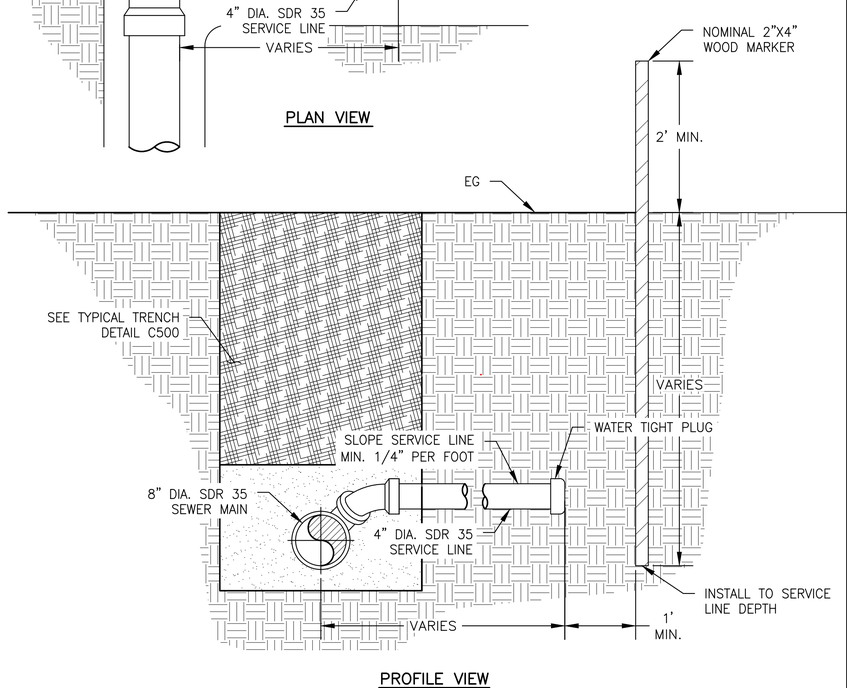
3 — SHALLOW SANITARY SEWER MANHOLE DETAIL
NOT TO SCALE



PLAN VIEW



4 — SANITARY SEWER RISER DETAIL
NOT TO SCALE



PROFILE VIEW

5 — SANITARY SEWER SERVICE DETAIL
NOT TO SCALE

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300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

PARAMOUNT GOLD NEVADA CORP.
GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SANITARY SEWER DETAILS

REGISTERED PROFESSIONAL ENGINEER
MATTHEW W. RASMUSSON
MAR. 13, 2019
OREGON
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C504

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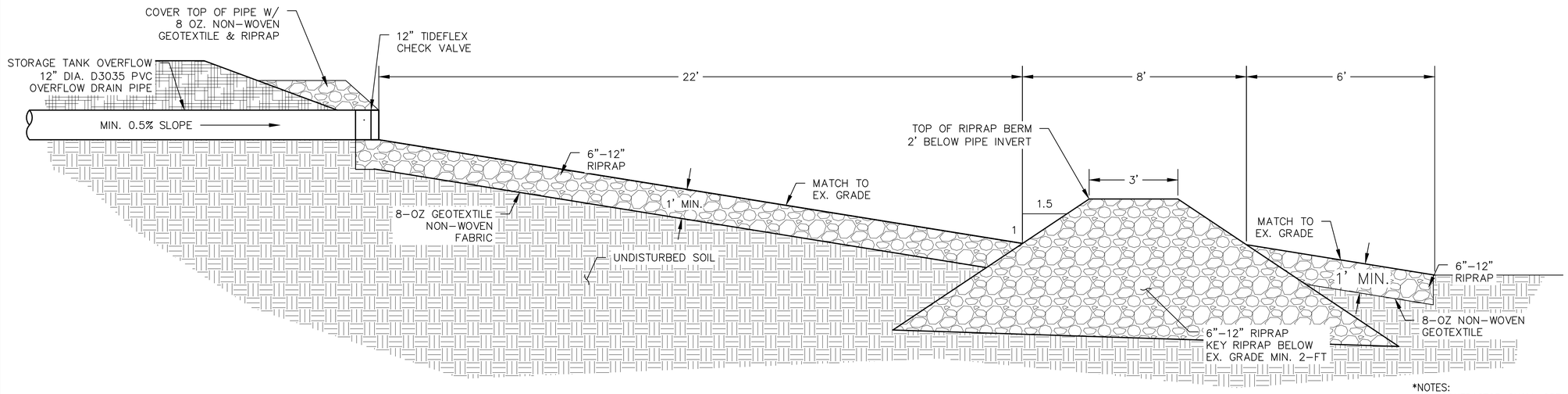
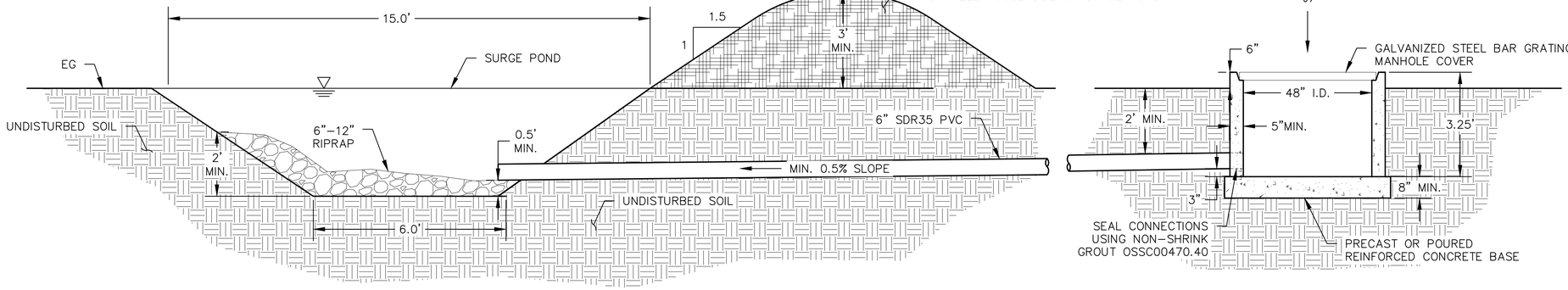
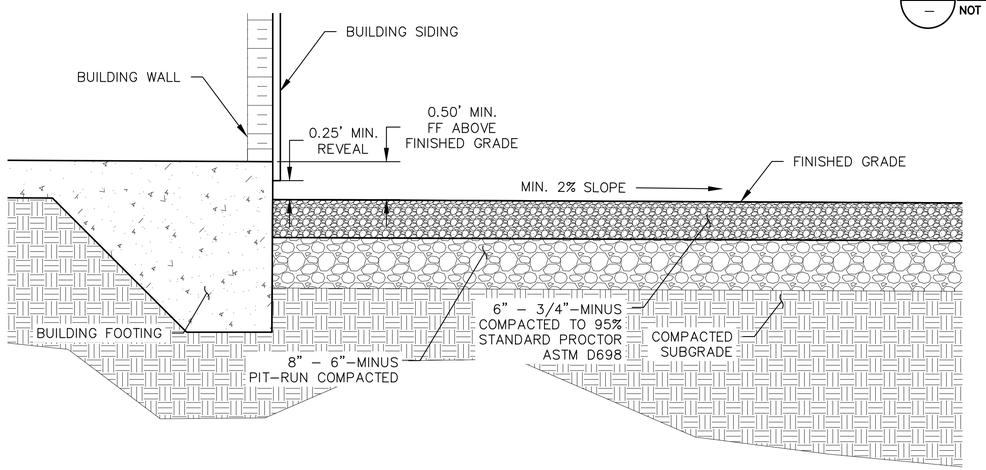


*NOTES:
1. CONTRACTOR SHALL OBTAIN RIPRAP FROM ON-SITE BORROW SOURCES.
2. CONTRACTOR TO PROVIDE AN AIR GAP OF 24" BETWEEN PIPE INVERT & TOP OF RIPRAP BERM

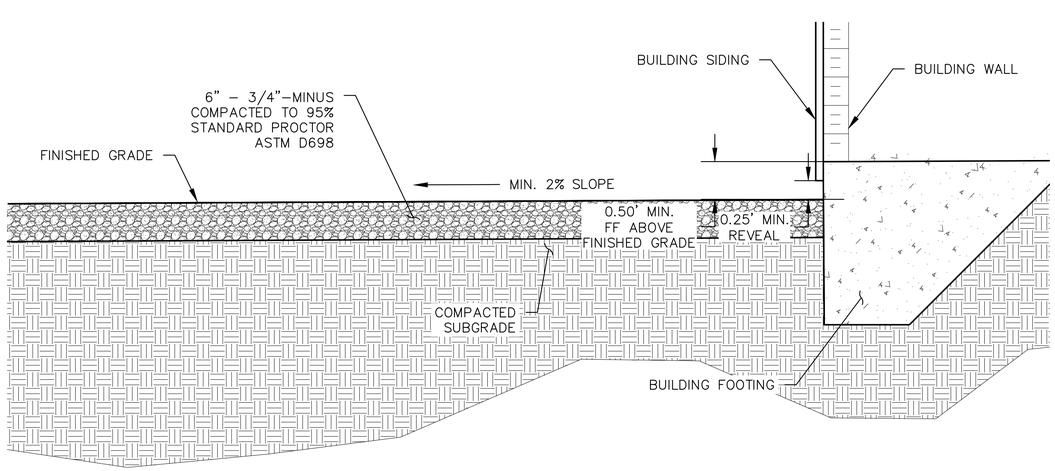
1 — STORAGE TANK OVERFLOW
NOT TO SCALE



2 — SURGE MANHOLE & SURGE POND CROSS SECTION
NOT TO SCALE



3 — TYP. FRONT SITE GRADING
NOT TO SCALE



4 — TYP. BACK SITE GRADING
NOT TO SCALE

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300 East Mallard Drive, Suite 350
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Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

GRADING AND SURGE POND DETAILS

REGISTERED PROFESSIONAL ENGINEER
91236
7-31-19
OREGON
MAY 10, 2016
JUSTIN P. LERAARS
EXPIRES: 12-31-20

REVISIONS			
ITEM	DESCRIPTION	DATE	
0	FINAL PERMIT SET	7/31/19	

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C505

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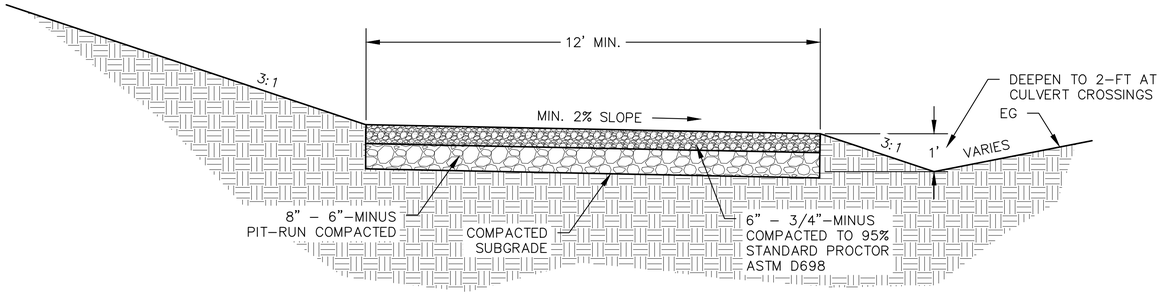
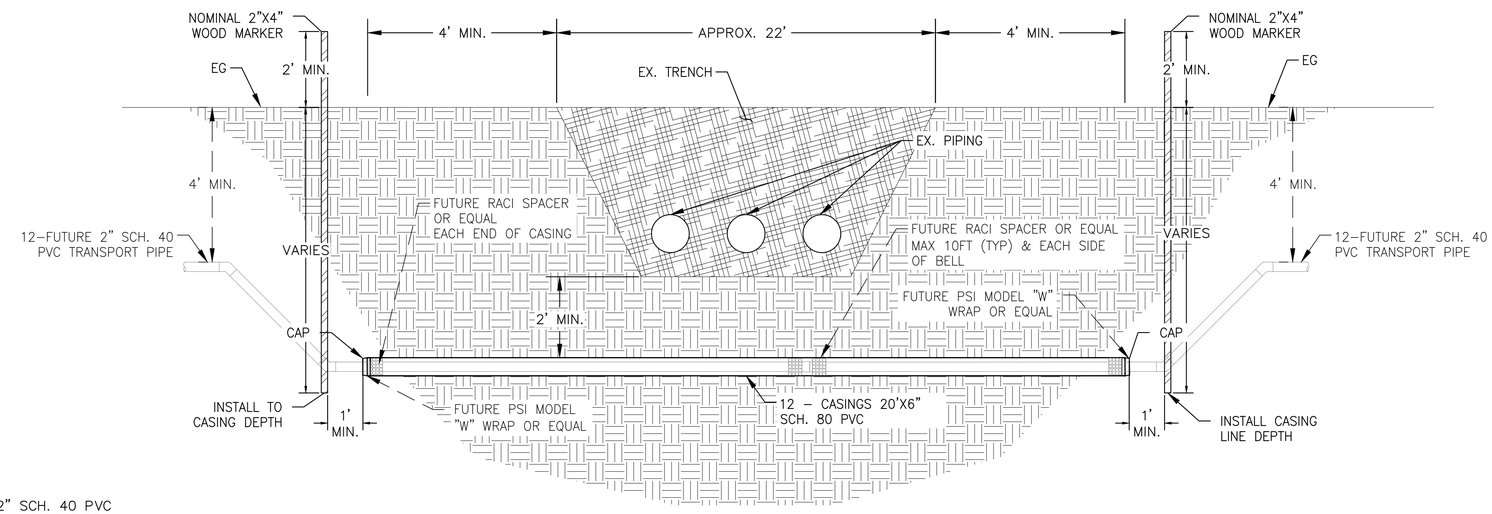
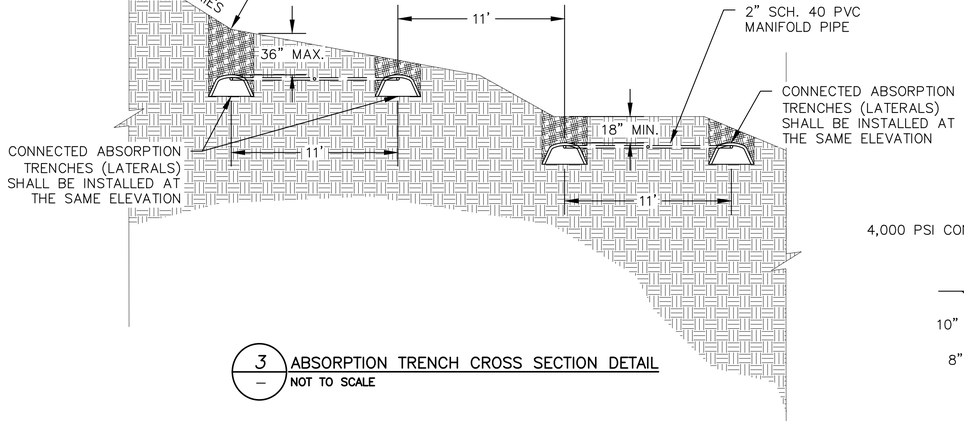


*NOTE: IF ROAD IS IN A CUT SECTION, NO PIT RUN GRAVEL IS REQURED.

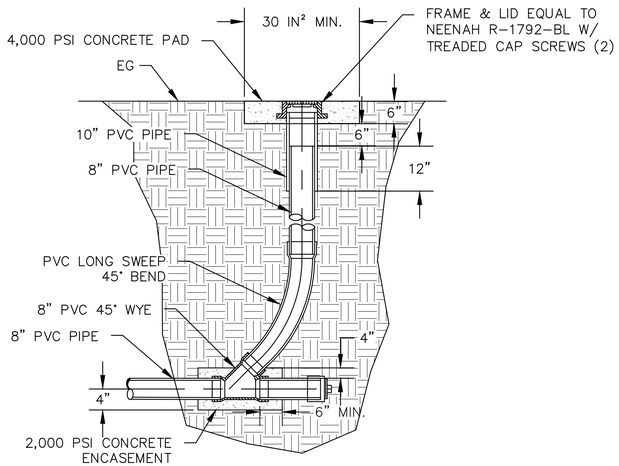
1 — TYP. ROAD CROSS SECTION
NOT TO SCALE



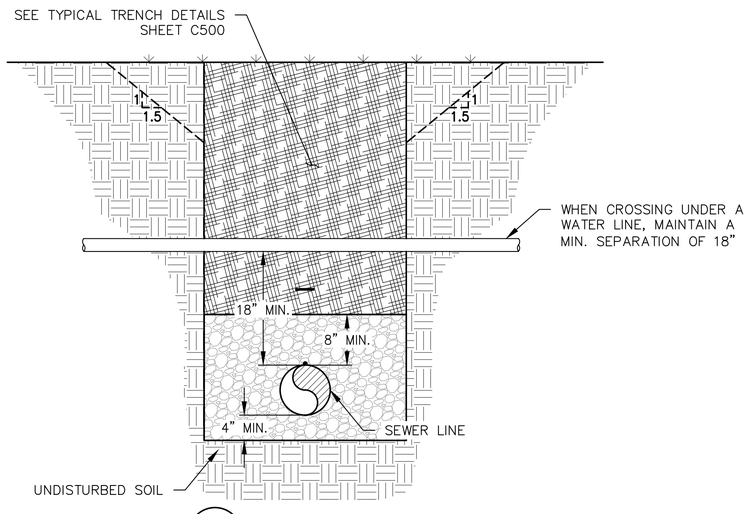
2 — DOSING TRANSPORT PIPE TRENCH CROSSING DETAIL
NOT TO SCALE



3 — ABSORPTION TRENCH CROSS SECTION DETAIL
NOT TO SCALE



4 — SEWER SERVICE CLEAN-OUT TYP. DETAIL
NOT TO SCALE



5 — SEWER/WATER LINE CROSSING TYP. DETAIL
NOT TO SCALE

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300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

TYP. ROAD AND SEWER DETAILS

REGISTERED PROFESSIONAL ENGINEER
OREGON
MAR. 13, 2015
MATTHEW W. RASMUSSEN
8/22/2019
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C506

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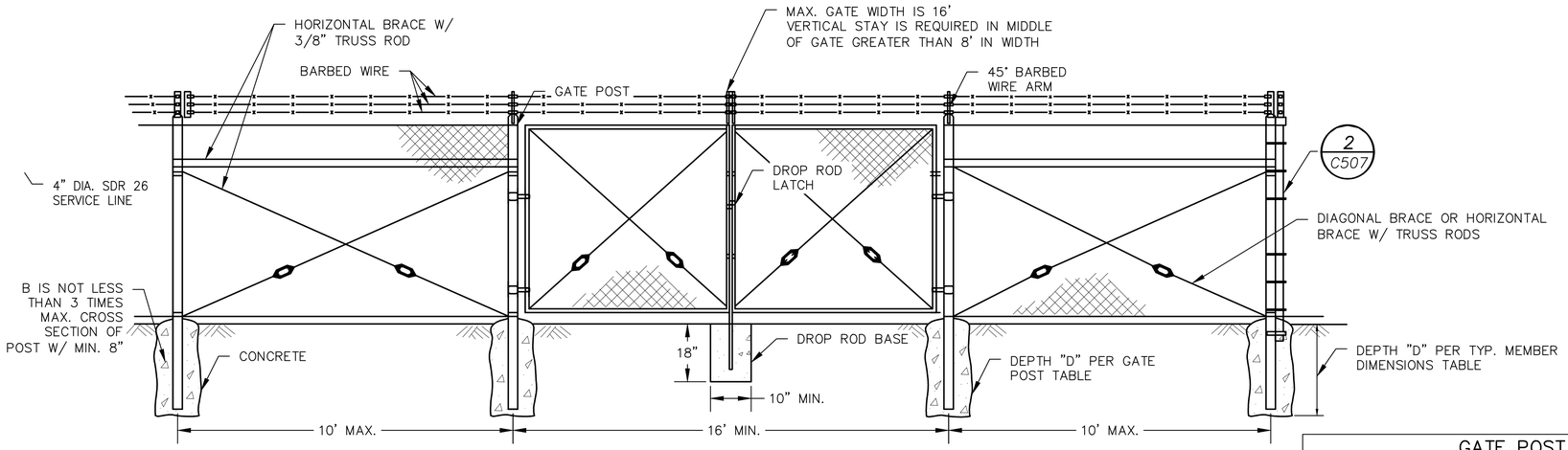
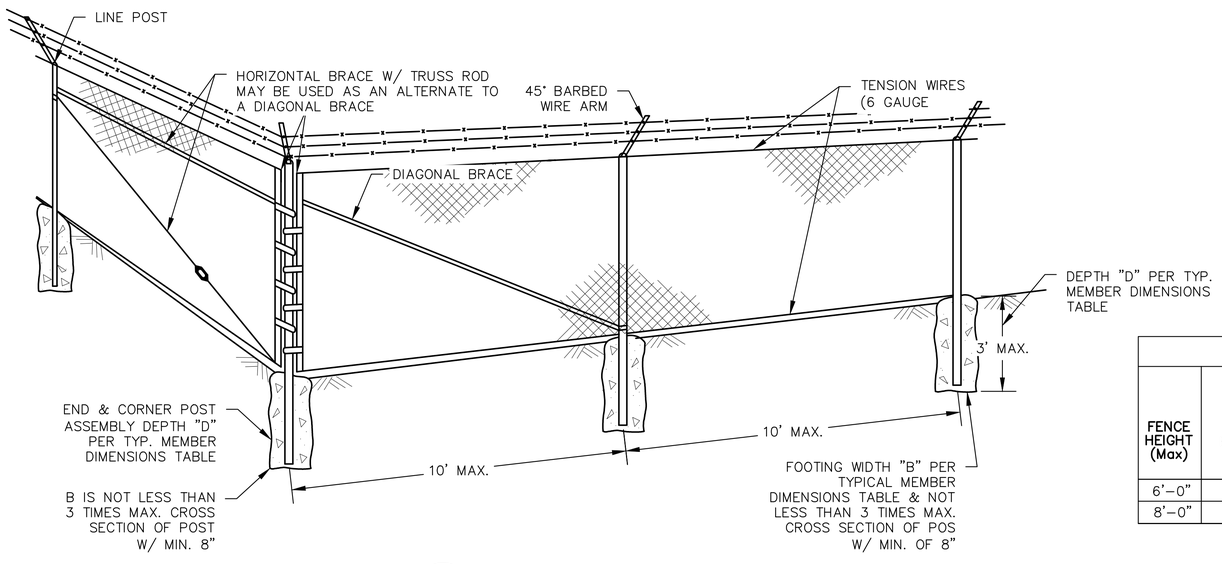


GATE POST					
FENCE HEIGHT (Max)	B (in)	D (ft)	ROUND PIPE		
			SECTION	ROUND OD PIPE	WEIGHT (lb/ft)
6'–0"	12"	2'–6"	3 Std	3.50"	7.58
8'–0"	12"	3'–0"	3 Std	3.50"	7.58



TYPICAL MEMBER DIMENSIONS (See Notes)												
FENCE HEIGHT (Max)	B (in)	D (ft)	LINE POSTS					BRACES				
			ROUND PIPE			ROLL FORMED		ROUND PIPE			ROLL FORMED	
			SECTION	ROUND OD PIPE	WEIGHT (lb/ft)	SECTION	WEIGHT (lb/ft)	SECTION	ROUND OD PIPE	WEIGHT (lb/ft)	SECTION	WEIGHT (lb/ft)
6'–0"	10"	2'–6"	2 Std	2.38"	3.66	1.875" x 1.625"	2.40	2 Std	2.38"	3.66	1.625" x 1.250"	1.35
8'–0"	12"	3'–0"	21/2 Std	2.88"	5.80	3.250" x 2.500"	4.50	2 Std	2.38"	3.66	1.625" x 1.250"	1.35

GENERAL NOTES

A. ALL FENCE AND FENCING MATERIALS SHALL BE GALVANIZED.

B. TRUSS ROD TIGHTENER AND THE NON–TIGHTENING END OF THE TRUSS ROD MAY BE WELDED TO THE GATE.

C. SPACE THE VERTICAL UPRIGHTS EVENLY ON THE GATE LEAF AND INSTALL TRUSS RODS AS SHOWN ON THE UPRIGHT/BRACE PLACEMENT DETAIL. SPACE HORIZONTAL BRACES EVENLY ON THE GATE LEAF.

D. SPACE POSTS EQUAL DISTANCES APART. 10' APART MAXIMUM SPACING UNLESS OTHERWISE DIRECTED ON THE PLANS OR BY THE ENGINEER.

E. SECURELY FASTEN BARBED WIRE ARMS TO THE POSTS.

F. SECURELY FASTEN THE BRACE RAILS AND TRUSS RODS TO POST WITH BRACE BANDS THREADED TAKE–UP ON THE TRUSS RODS.

G. STRETCH THE FENCE FABRIC & BARBED WIRE SMOOTH SO THAT IT HAS A UNIFORM APPEARANCE.

H. SELVAGE THE PLAIN WIRE ENDS ON THE TOP AND BOTTOM OF THE CHAIN LINK FABRIC BY THE TWISTED OR KNUCKLED METHOD. SEE WIRE SELVAGE DETAIL.

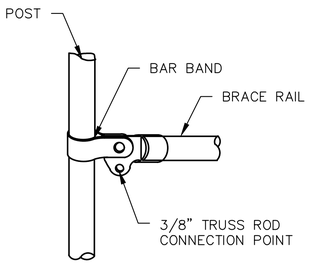
I. SET THE POSTS IN CONCRETE UNLESS OTHERWISE DIRECTED ON THE PLANS.

J. ADJUST THE POST TOP ELEVATIONS TO PROVIDE A SMOOTH VISUAL FENCE PROFILE. INSTALL CORNER POSTS AT HORIZONTAL BREAKS IN THE FENCE OF 15° OR MORE.

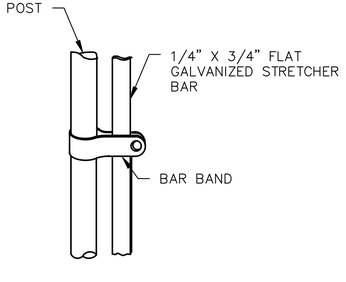
K. THE DESIGN OF THE CHAIN LINK HARDWARE MAY VARY SOMEWHAT FROM THAT SHOWN. ENSURE THAT HARDWARE AND MATERIALS USED ON A SINGLE INSTALLATION ARE UNIFORM AND COMPATIBLE.

L. MAX. GATE WIDTH IS 12' VERTICAL STAY IS REQUIRED IN MIDDLE OF GATE GREATER THAN 8' IN WIDTH.

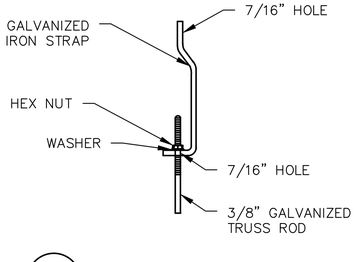
M. MINIMUM SIZED POSTS AND BRACES COMPLYING WITH THE SPECIFICATIONS. LARGER OR HEAVIER POST AND BRACE SIZES MAY BE USED UPON APPROVAL.



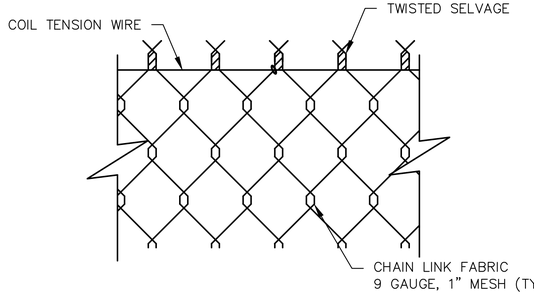
3 — BRACE RAIL DETAIL TYP.
NOT TO SCALE



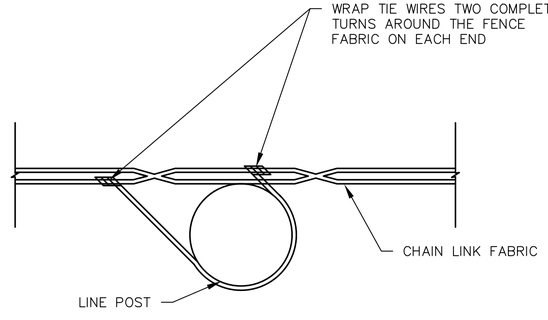
4 — STRETCHER BAR DETAIL TYP.
NOT TO SCALE



5 — TRUSS TIGHTENER DETAIL TYP.
NOT TO SCALE



6 — WIRE SELVAGE DETAIL
NOT TO SCALE



7 — CHAIN LINK FENCE TIE
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

FENCE AND GATE DETAILS

REGISTERED PROFESSIONAL ENGINEER 17236 7-31-19 OREGON MAY 10, 2016 JUSTIN P. LEHARIS EXPIRES: 12-31-20

REVISIONS

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	7/31/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE–INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C507

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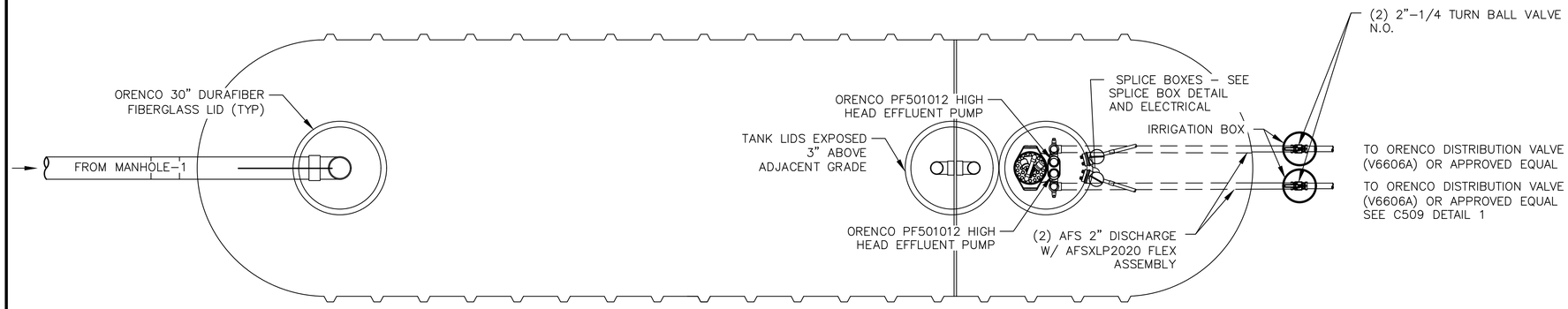
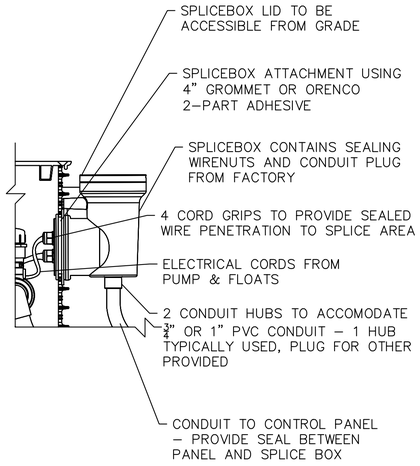
Xref Filename: | X–TITLE | X–TITLE (2) |

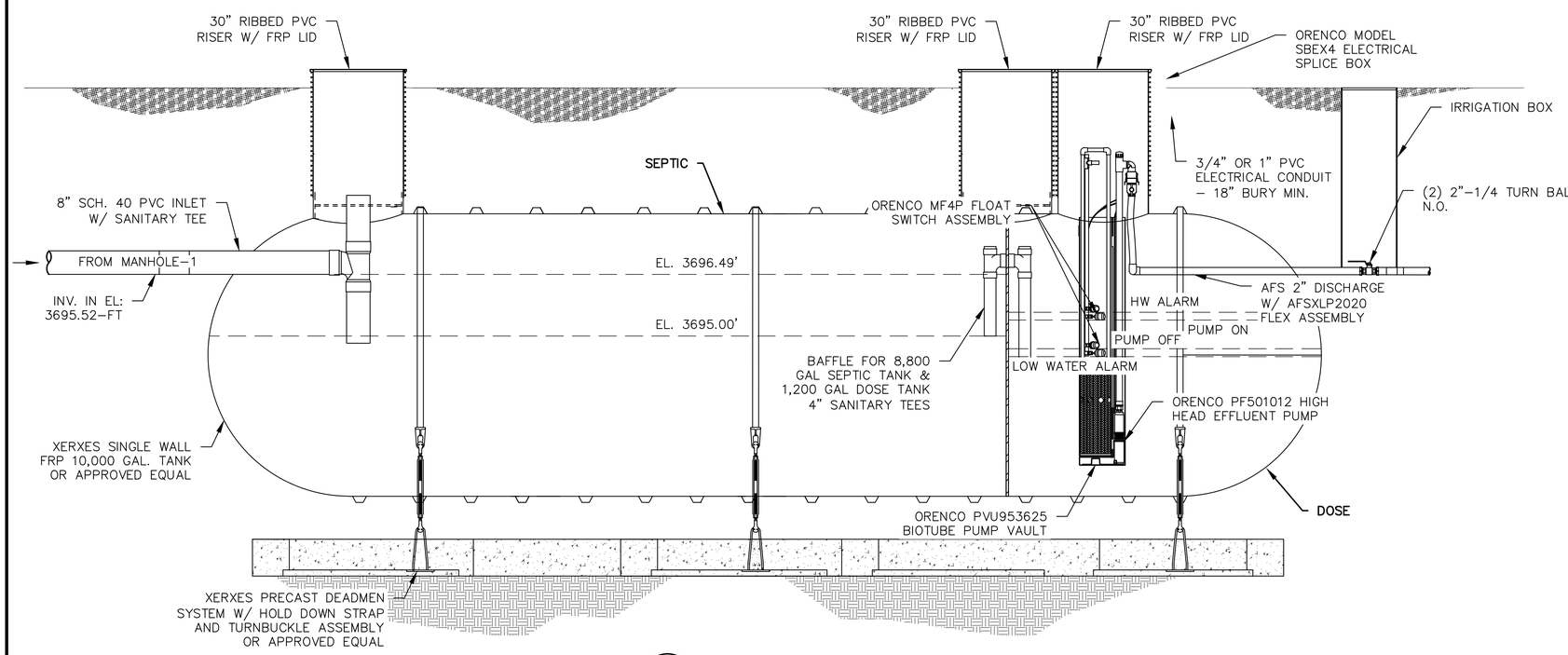
NOTE:
ALL PRODUCT BRANDS THIS SHEET ARE "OR APPROVED EQUAL" ITEMS.
CONTRACTOR TO PROVIDE SUBMITTALS.



1 — 10,000 GAL. FIBERGLASS SEPTIC TANK PLAN VIEW
NOT TO SCALE



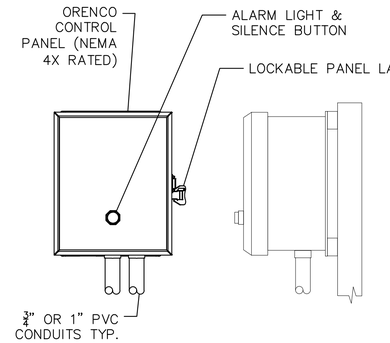
3 — SPLICE BOX DETAILS
NOT TO SCALE



2 — 10,000 GAL. FIBERGLASS SEPTIC TANK PROFILE
NOT TO SCALE

PANEL MOUNTING REQUIREMENTS

- PANEL SHALL BE MOUNTED ON 4X4 WOODEN POST IN LOCATION SHOWN PER SHEET C2 AND ELECTRICAL
- PANEL DIMENSIONS: DAXMVP PANELS: 9.5" HIGH X 7.3" WIDE X 5.4" DEEP



4 — MVPDAX2 DM CONTROL PANEL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.

SEPTIC TANK DETAILS

REGISTERED PROFESSIONAL ENGINEER
OREGON
MAR 13, 2015
MATTHEW W. RASMUSSON
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE–INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C508

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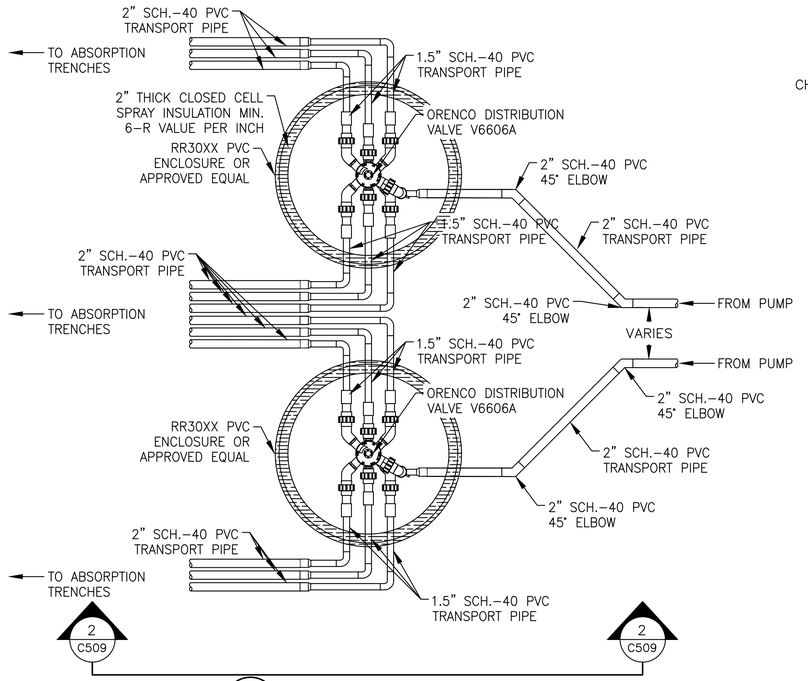
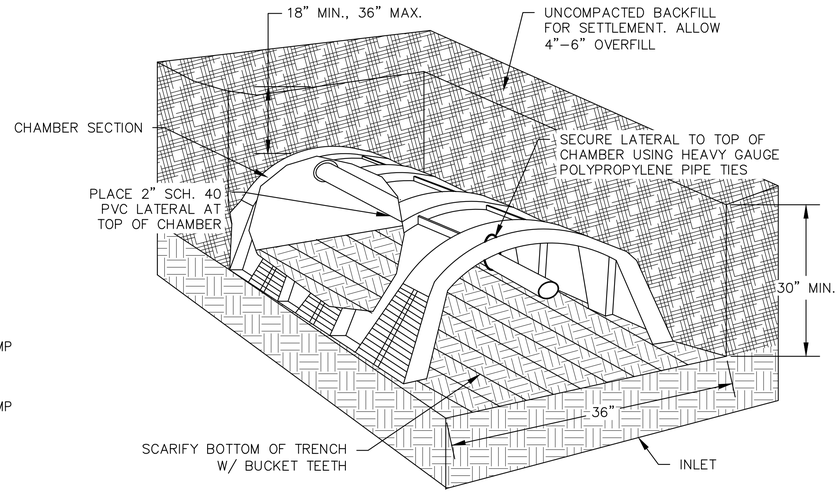
Xref Filename: | X–TITLE | X–TITLE (2) |

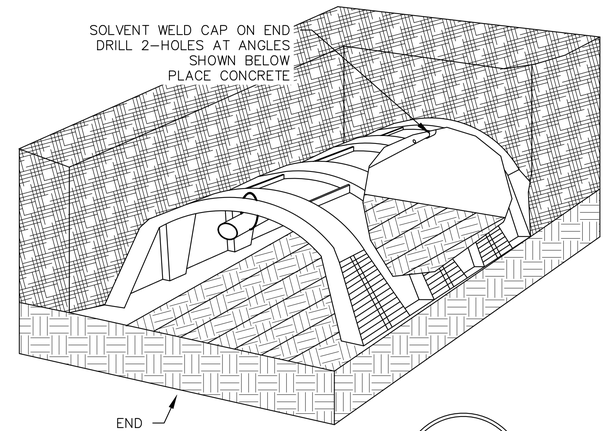


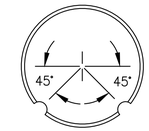
1 — PRESSURE DOSED DRAINFIELD CHAMBER DETAIL
NOT TO SCALE

2 — PRESSURE DOSED DRAINFIELD CHAMBER DETAIL
NOT TO SCALE

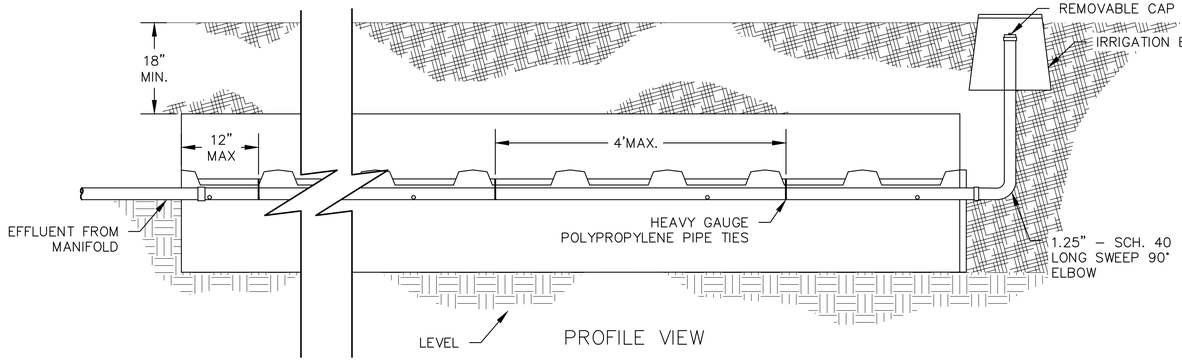


ISOMETRIC VIEW



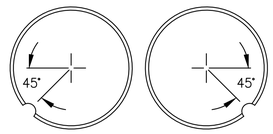


PERFORATIONS END OF PIPE

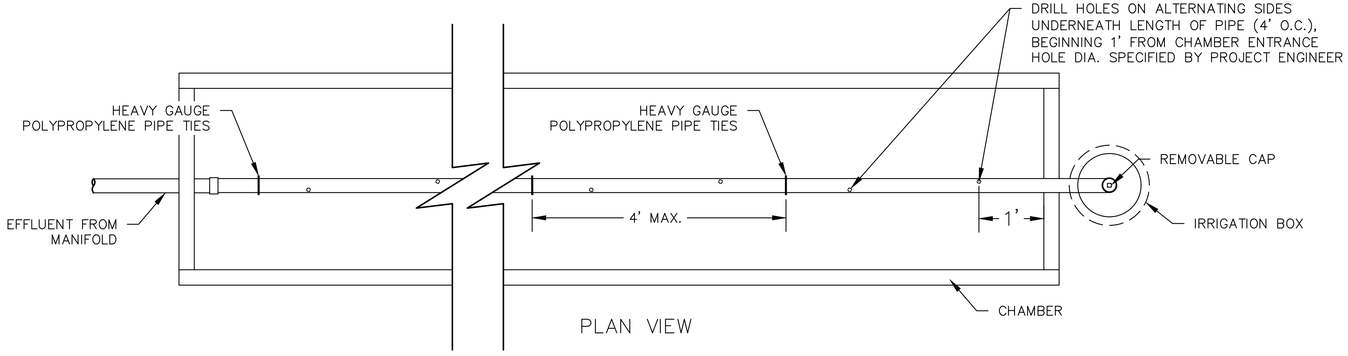


PROFILE VIEW

NOTE: ALTERNATE DIRECTION OF PERFORATION EVERY 4-FT



PERFORATIONS ALONG 2" SCH. 40 PVC PIPE



PLAN VIEW

3 — PRESSURE DOSED DRAINFIELD CHAMBER DETAIL
NOT TO SCALE

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

GRASSY MOUNTAIN GOLD MINE WATER & SEWER
CALICO RESOURCES USA CORP.
ABSORPTION TRENCH AND CHAMBER DETAILS

REGISTERED PROFESSIONAL ENGINEER
20170??
8/22/2019
OREGON
MAR 13, 2019
MATTHEW W. RASMUSSON
RENEWS: 12/31/2020

ITEM	DESCRIPTION	DATE
0	FINAL PERMIT SET	8/22/19

REVISIONS

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	1294.0050
DESIGNED:	EH/SM/JL
DRAWN:	JL/SM/KN
CHECKED:	JT

C509

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Xref Filename: | X-TITLE | X-TITLE (2) |