

## EXHIBIT A

### Statement of Work for Lidar, 2006-2007 Portland Area Lidar Consortium, Modification 3.

The Portland Area Lidar Consortium proposes to contract with Kitsap County in 2007 to obtain Light Detection And Ranging (Lidar) data over portions of Clatsop, Tillamook, Washington, Clackams, Multnomah, Hood River Marion and Yamhill Counties in Northwestern Oregon. The proposed data collection is supported and funded by a loose consortium of state, Federal and local government agencies (see Table 1), and is being coordinated by the Oregon Department of Geology and Mineral Industries at the request of the U.S. Geological Survey.

**Table 1.**

Participant	Contribution	Contact	Phone	Email
USGS Urban Corridor	\$83,350	Ray Wells	650-329-4933	<a href="mailto:rwells@usgs.gov">rwells@usgs.gov</a>
USGS Landslide	\$74,000	Jeff Coe	303 273-8606	<a href="mailto:jcoe@usgs.gov">jcoe@usgs.gov</a>
USGS NEHRP	\$100,000	Craig Weaver	206-553-0627	<a href="mailto:craig@ess.washington.edu">craig@ess.washington.edu</a>
METRO	\$203,925	Richard Bolen	503-797-1582	<a href="mailto:bolend@metro.dst.or.us">bolend@metro.dst.or.us</a>
USFS Cloyd	\$5,700	Courtney Cloyd	503-808-2705	<a href="mailto:jcloyd@fs.fed.us">jcloyd@fs.fed.us</a>
USFS Golden	\$5,000	Michael Golden	503-808-2324	<a href="mailto:mdgolden@fs.fed.us">mdgolden@fs.fed.us</a>
City of Silverton	\$5,225	Sue DeVore	503-874-2211	<a href="mailto:sdevore@silverton.or.us">sdevore@silverton.or.us</a>
City of Hood River	\$2,090	Dave Bick	<a href="tel:541.387.5200">541.387.5200</a>	<a href="mailto:mailto:daveb@ci.hood-river.or.us">mailto:daveb@ci.hood-river.or.us</a>
Hood River County	\$36,053	Mike Schrankel	541-387-7104	<a href="mailto:mike.schrankel@co.hood-river.or.us">mike.schrankel@co.hood-river.or.us</a>
Oregon Department of Transportation	\$58,000	Paul Wirfs	(503) 986-3526	<a href="mailto:Paul.R.Wirfs@state.or.us">Paul.R.Wirfs@state.or.us</a>
US Bureau of Land Management	\$5,700	Susan Nelson	503.808.6139	<a href="mailto:Susan_Nelson@or.blm.gov">Susan_Nelson@or.blm.gov</a>
Oregon Department of Transportation Region 1	\$9,000	Thomas Picco	(503) 731-8230	<a href="mailto:thomas.j.picco@odot.state.or.us">thomas.j.picco@odot.state.or.us</a>
City of Canby	\$3,658	John R. Williams	503.266.7001	<a href="mailto:williamsj@ci.canby.or.us">williamsj@ci.canby.or.us</a>
USGS NGA	\$200,000	Nancy Tubbs	(503) 251-3210	<a href="mailto:ntubbs@usgs.gov">ntubbs@usgs.gov</a>
Port of Portland	\$3,800	Thomas Priebe	(503) 460-4547	<a href="mailto:Andy.Priebe@portofportland.com">Andy.Priebe@portofportland.com</a>
Oregon Department of Geology and Mineral Industries	Coordinator	Ian Madin	971 673 1542	<a href="mailto:ian.madin@dogami.state.or.us">ian.madin@dogami.state.or.us</a>
<b>Total</b>	<b>\$795,501</b>			

The Puget Sound Lidar Consortium (PSLC) has collected Lidar data in the Portland, Oregon urban areas in past years using USGS funding. In January 2006, the PSLC selected Watershed Sciences of Portland, Oregon, through competitive bid, for Lidar data acquisition

and preliminary analysis. Kitsap County will contract with Watershed Sciences to have Lidar flown for the Portland Area Lidar Consortium over the area described below for the data collection work of this program. All of the collected data will be available in the public domain.

The Puget Sound Lidar Consortium (PSLC) consists of a core group of agencies – Kitsap County, Kitsap County Public Utilities District Number 1 (PUD), City of Seattle, Puget Sound Regional Council, the United States Geological Survey (USGS), and the National Aeronautics and Space Administration (NASA). The core group is responsible for data quality, overall survey design, and coordination with the contractor, Watershed Sciences. The core group determines if data delivered meets the contract specifications and authorizes payment. Kitsap County Department of Emergency Management is the fiscal agent of the program and is responsible for contract monitoring and for the administrative services necessary to collect, evaluate the quality, and distribute the Lidar data. This Statement of Work involves only that portion of the Lidar data to be collected over portions northwestern Oregon. The overall Lidar survey design will be established by the PSLC.

### **2006-2007 Portland Area Lidar Consortium Project**

The original 2006-2007 Portland Area Lidar Consortium Project proposed to obtain approximately 1,221 square miles of aerial digital Lidar DEM and DTM images and data for a swath of Northwestern Oregon stretching from Hood River County in the East into Clatsop County to the west, and covering all of the Portland METRO region (Figure 1). The first modification expanded the coverage within that area to a total of 1680 square miles (Figure 1). This modification increases the coverage to a total of 1688 square miles. The exact area of coverage required is defined by an ESRI shape format GIS file supplied with this exhibit (2007 Portland Survey Modification 2 area\_region), and is shown on the accompanying high resolution PDF format map (Plate 1). In addition, 2 ft contours will be prepared for portions of the Survey covering Hood River County, the City of Hood River, the City of Canby and the City of Silverton. The exact extents of the contour coverage are specified in the attached shapefiles (Hood River Contours, Silverton Flyover Area, Canby Contours) and are shown on Figure 1 and Plate 1 as hatched areas. The collected data will meet the specifications listed below, except that the 8 square miles added in this study are to be flown during leaf-on conditions. The data will be delivered to DOGAMI on portable hard drives. The coordinate system for the data will be:

System: Oregon State Plane, North (FIPS 3601)

Horizontal Datum: North American Datum of 1983 with 1991 Adjustments (HARN)

Vertical Datum /North American Vertical Datum of 1988 (Geoid03)

Units: International Feet (Horizontal), Feet (Vertical)

The approximate total budget is \$795,501, which includes Lidar DEM, DTM data, contours as specified, and Kitsap County PSLC/Lidar administrative fees.

Cost is based on a per square mile rate of \$428 (for contract work greater than 250 square miles), (plus 10% for optional 2-foot contour maps) and a 10% Puget Sound Lidar Consortium fee.

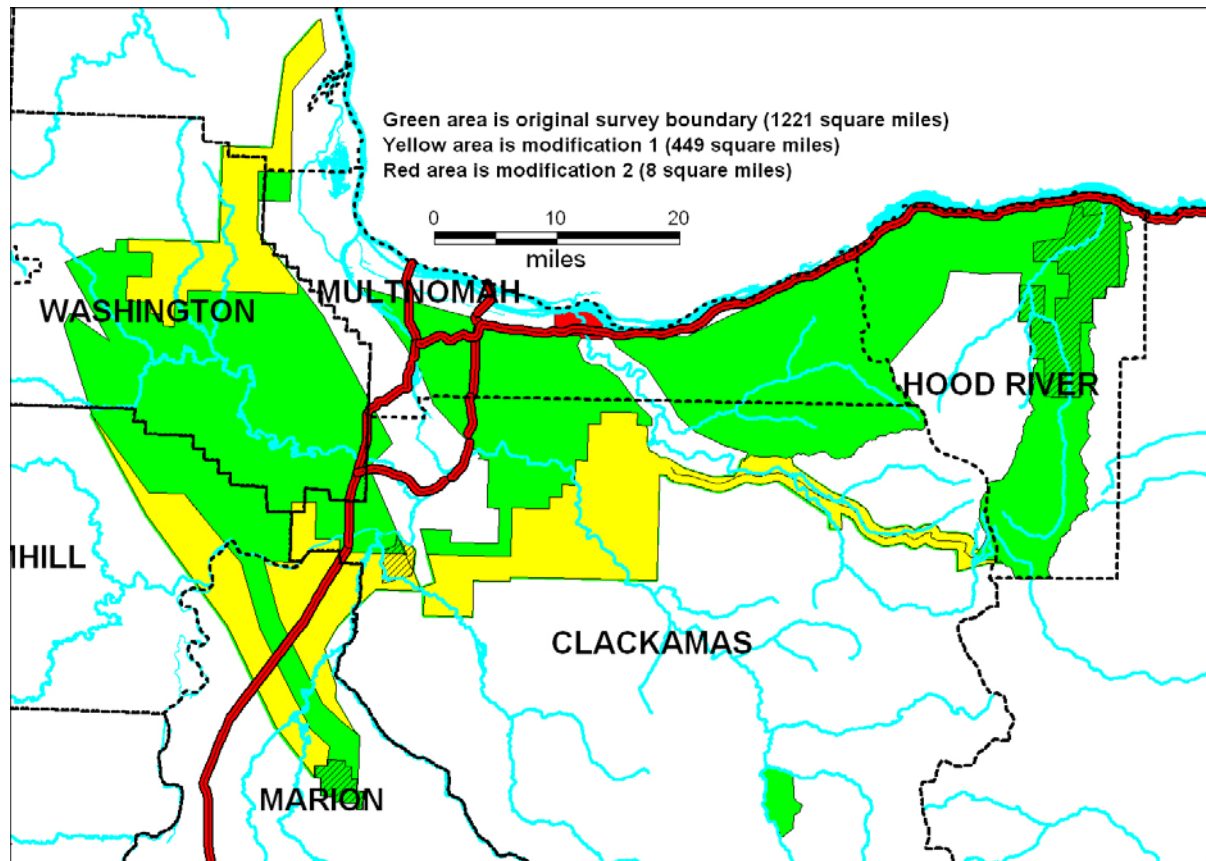


Figure 1. Original proposed Lidar survey area shown in green, modification 1 shown in yellow, this modification in shown in red. Areas for optional contours in diagonal hatch.

## Watershed Sciences – Puget Sound Lidar Consortium Lidar Survey Specifications

<b>Data acquisition</b>	<i>Survey Design</i>	<i>Minimum requirements<sup>1</sup></i>
Laser pulse rate	Up to 116,000 pulses per second	
Returns per pulse	Up to 4	First and last (up to 2)
On-ground laser beam diameter	approx 25 cm	Between 10 cm and 100 cm
Scan angle	±13 degrees	≤ ±20 degrees
Aircraft altitude	800 m above ground	
Aircraft speed	105 knots	
Ground swath width	<500 meters	
Swath overlap	50% sidelap (100% overlap)	No voids between swaths. No voids because of cloud cover or instrument failure. <20% no-overlap area per project. No arbitrary 1 km x 1 km square with >50% no-overlap area
Aggregate pulse density	>8/m <sup>2</sup>	Barring non-reflective areas (e.g., open water, wet asphalt): <ul style="list-style-type: none"> <li>• ≥85% design pulse density for entire project area.</li> <li>• Within areas of swath overlap, no 30m x 30m area with &lt;50% design pulse density</li> </ul>
Flight line direction	Opposing	
GPS base-line length	≤24 km	
GPS PDOP	≤3.0, ≥6 satellites in view	≤3.5, ≥6 satellites in view
Survey conditions		Leaf-off and no significant snow cover at discretion of Puget Sound Lidar Consortium
<b>Accuracy</b>	<i>Survey Design</i>	<i>Minimum requirements</i>
Absolute accuracy	<13 cm vertical, <10 cm horizontal (RMSE) <sup>2</sup>	≤20 cm vertical (RMSE) <sup>3</sup>

1 Local relief, turbulence, inability to maintain an exact flying height, and aircraft and instrument availability routinely lead to departures from the survey design. *Minimum requirements* listed here are the minimum acceptable under this contract. PSLC routinely evaluates delivered data to ensure compliance with minimum swath overlap and aggregate pulse density.

2 Watershed Sciences survey practices are optimized to achieve this absolute accuracy. Performance is verified by vendor-established ground control using hundreds of points per project.

3 Routinely evaluated by PSLC using available ground control points (GCPs). Number of available GCPs in a survey area is commonly small thus required RMSE is calculated using the formula

$$RMSE \leq 20 \text{ cm} * ((n-1) - 2.326 * (n-1)^{1/2}) / n)^{1/2}$$

where **n** is the number of GCPs.

Between-swath reproducibility <sup>4</sup>	≤15 cm vertical on horizontal surfaces (RMSE)
Reproducibility of range measurements <sup>5</sup>	≤5 cm (RMSE)
<b>Spatial reference framework</b>	
Vertical Datum	NAVD88, Geoid03 (unless otherwise specified)
Horizontal Datum	NAD83
Projection	UTM, State Plane, Oregon Lambert (as requested)
Units	Meters (UTM) or survey/international feet (State Plane, Oregon Lambert)
<b>Deliverables</b>	
Report of Survey	Text report that describes survey methods; results; vendor's accuracy assessments, including internal consistency and absolute accuracy; and metadata <i>.pdf, .doc, or .odt format</i>
Aircraft trajectories (SBET files)	Aircraft position (easting, northing, elevation) and attitude (heading, pitch, roll) and GPS time recorded at regular intervals of 1 second or less. May include additional attributes. <i>ASCII text or shapefile format</i>
All-return point cloud	List of all valid returns. For each return: GPS week, GPS second, easting, northing, elevation, intensity, return#, return classification. May include additional attributes. No duplicate entries. <i>ASCII text and LAS version 1.1 format</i> <i>1/64<sup>th</sup> USGS 7.5-minute quadrangle (0.9375 minute by 0.9375 minute) tiles</i>
Ground point list	List of X,Y,Z coordinates of all identified ground points. <i>ASCII text.</i> <i>1/4<sup>th</sup> USGS 7.5-minute quadrangle (0.375 minute by 0.375 minute) tiles</i>
Ground surface model	Raster of ground surface, interpolated via triangulated irregular network from identified ground points. No unavoidable point misclassification <sup>6</sup> <i>ESRI floating point grid, 6 ft or 3 ft (2m or 1m) cell size, snapped to (0,0), 1/4<sup>th</sup> USGS 7.5-minute quadrangle (0.375 minute by 0.375 minute) tiles</i>

4 Extensive swath overlap allows for robust estimation of intra-survey reproducibility. Intra-survey measurement errors on flat ground are commonly 4-6 cm RMSE<sub>Z</sub>, with an increase in Z errors as local slope increases. PSLC routinely analyzes samples of delivered data for conformance with this specification.

Because errors related to dense forest cover are outside the vendor's control, this contract includes no specification for the accuracy of bare-earth DEMs. The error of a bare-earth DEM includes errors in classifying points as ground and errors introduced by interpolation from scattered ground points to a continuous surface, as well as measurement errors. Analyses of swath-to-swath reproducibility suggest that, barring wholesale vertical shifts, errors of bare-earth DEMs produced by Watershed Sciences surveys of western Washington and northwest Oregon are circa 15 cm (RMSE<sub>Z</sub>) or less.

5 Evaluated by measuring departures from planarity of returns from planar surfaces (e.g., building roofs)

6 PSLC evaluates conformance by visual inspection of large-scale shaded-relief images. Tiling artifacts and measurement errors may also be identified during this inspection

First-return (highest-hit) surface model	Raster of first-return surface, cell heights are highest recorded value within that cell, voids may be filled with ground surface model <i>ESRI floating point grid, 6 ft or 3 ft (2m or 1m) cell size, snapped to (0,0), 1/4<sup>th</sup> USGS 7.5-minute quadrangle (0.375 minute by 0.375 minute) tiles</i>
Surface models shall have no tiling artifacts and no gaps at tile boundaries. Areas outside survey boundary shall be coded as NoData. Internal voids (e.g., open water areas, shadowed areas in first-return surface) may be coded as NoData.	
Intensity image	<i>GeoTIFF, 3 ft (1m) pixel size, 1/4<sup>th</sup> USGS 7.5-minute quadrangle (0.375 minute by 0.375 minute) tiles</i>
Contours <b>*OPTIONAL*</b> (add 10% to total cost)	2-ft contours <i>AutoCAD .dxf or ESRI shapefile format 1/64<sup>th</sup> USGS 7.5-minute quadrangle (0.9375 minute by 0.9375 minute) tiles</i>
<b>Files shall conform to a consistent naming scheme. Files shall have consistent internal formats.</b>	

1. 1 Local relief, turbulence, inability to maintain an exact flying height, and aircraft and instrument availability routinely lead to departures from the survey design. Minimum requirements listed here are the minimum acceptable under this contract. PSLC routinely evaluates delivered data to ensure compliance with minimum swath overlap and aggregate pulse density.
2. 1 Watershed Sciences survey practices are optimized to achieve this absolute accuracy. Performance is verified by vendor-established ground control using hundreds of points per project.
3. 1 Routinely evaluated by PSLC using available ground control points (GCPs). Number of available GCPs in a survey area is commonly small thus required RMSE is calculated using the formula

$$RMSE \leq 20 \text{ cm} * ((n-1) - 2.326 * (n-1)^{1/2}) / n)^{1/2}$$

where n is the number of GCPs.

4. 1 Extensive swath overlap allows for robust estimation of intra-survey reproducibility. Intra-survey measurement errors on flat ground are commonly 4-6 cm RMSE<sub>Z</sub>, with an increase in Z errors as local slope increases. PSLC routinely analyzes samples of delivered data for conformance with this specification.

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5. 1 Evaluated by measuring departures from planarity of returns from planar surfaces (e.g., building roofs)
6. 1 PSLC evaluates conformance by visual inspection of large-scale shaded-relief images. Tiling artifacts and measurement errors may also be identified during this inspection

**EXHIBIT B**  
**COMPENSATION**

Fixed Cost: \$791,701.00

For the services performed hereunder, the CONTRACTOR shall be paid as per the fee scheduled outlined below based upon contiguous survey area size. Included in the fee schedule are all mobilizations cost, all phases of acquisition and processing and delivery of the data in digital form. Data Specifications are listed in Exhibit A. Fee schedule as follows:

<b>Survey Area Distributions</b>	<b>Cost per Acre</b>
50mi <sup>2</sup> - 32,000 acres	\$1.34
>100 mi <sup>2</sup> - 64,000 acres	\$1.00
>150 mi <sup>2</sup> - 96,000 acres	\$0.84
>200 mi <sup>2</sup> - 128,000 acres	\$0.74
>250 mi <sup>2</sup> - 160,000 acres	\$0.67

Note: 640 acres in a square mile

The CONTRACTOR may bill as follows: Exhibit B Compensation: 40% of the fees charged may be billed upon collection of data, 30% upon delivery of the data and the remaining 20% upon acceptance by the County.

Included in all cost shall be a 10% Administration fee to be paid to Kitsap County Department of Emergency Management. 5% of the fee shall be for contract administration and 5% of the fee shall be for quality control monitoring.