**COMPANY:** NORTHWEST NATURAL  
**WELL:** IW 23ach-3-65  
**FIELD:** Bruer Pool Inject/WD Storage  
**COUNTY:** Columbia, OR

**Location:** SE 1/4 Sec. 3, T6N-R5W; WB&M Coordinates: 2346.8’ N 86°26’ W and 1593.8’ N 3°33’ E from SE corner. Y: 874129.60 X:1292387.90 FIN

**API No.:** 36-009-00366  
**Spud Date:** 5/11/07  
**Total Depth:** 5/18/07  
**Elevation:** K.B. 1047.3’  
G.L. 1033.3’

**Company Geologist:** Jack Meyer  
**Company Engineer:** Clayton Roth  
**Company Pusher:** Ed Vader  
**Directional Engineer:** Scientific Drilling  
**Mud Company:** Beaver Drilling Fluids  
**Mud Engineer:** Ed Vader  
**Drilling Contractor:** TD Well Service  
**Rig Pusher:** Jerry Gann  
**Rig No.:** 101  
**Geolog Unit No.:** 19  
**Logging Geologists:** Jim Ferguson Matt Brown

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**LOG INTERVAL**

**DATES:** 5/11/07 TO 5/25/07  
**DEPTHS:** 50’ TO 3518’

**MUD TYPES**

- Gel Chem TO 3518’
- TO

**MUD PUMPS**

- **PUMP #1:** EMSCO DB 550 (16” x 5-1/2”)
- **PUMP #2:** OILWELL H 560 37 (8” x 5-1/2”)

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**TOTAL DEPTH**

**MEASURED:** 3518’  
**TRUE VERTICAL:** 2599.08’ Proj.

**HOLE SIZE**

- 17-1/2” TO 590’  
- 12-1/4” TO 626’
- 8-3/4” TO 3518’

**CASING DATA**

- 20” AT 20’
- 13-3/8” AT 563’

---

**CEMENT**

- **COAL & LIGNITE**
- **FINE SAND**
- **KAOLINITE**
- **VOLCANIC**

- **LIMESTONE**
- **CLAY**
- **MED. SAND**
- **TUFF**
- **IGNEOUS**

- **DOLOMITE**
- **SILEX**
- **COARSE SAND**
- **DIATOMITE**
- **METAMORPHIC**

- **GYPSUM**
- **SILTSTONE**
- **CONGLOMERATE**
- **PORCELANITE**

- **ANHYDRITE**
- **SANDY SILTSTONE**
- **SANDSTONE**
- **CHERT**

---

**DRILL RATE**  
ft/hr  
Backup Scale - x10

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>DRILL RATE</th>
<th>CUTTINGS</th>
<th>OIL</th>
<th>TOTAL GAS</th>
<th>CHROMATOGRAPH</th>
<th>LITHOLOGY DESCRIPTIONS &amp; REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
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<td>C1 C2 C3 C4 C5</td>
<td></td>
</tr>
</tbody>
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**LOG DESCRIPTIONS & REMARKS**

- **MUD COMPANY:**  
  - BG - Background Gas  
  - CB - Core Bit  
  - CG - Connection Gas  
  - CK - Filter Cake  
  - CKF - Check for Flow  
  - CL - Salinity, ppm Cl  
  - CR - Circulate Returns  
  - DB - Diamond Bit  
  - DC - Depth Correction  
  - DCB - Diamond Core Bit  
  - DF - Derrick Floor  
  - DG - Drilling Gas  
  - DS - Directional Survey  
  - DST - Drill Stem Test  
  - EL - Electric Log  
  - E.M.A. - Equivalent Methane in Air  
  - F - Filtrate, API cc’s  
  - F/T - Flowline Temperature  
  - GCM - Gas Cut Mud  
  - GCW - Gas Cut Water  
  - GL - Ground Level  
  - NCB - New Core Bit  
  - NR - No Returns  
  - PDC - Polycrystalline Diamond  
  - PR - Poor Returns  
  - PP - Pump Pressure  
  - PV - Plastic Viscosity  
  - PUMP #1: EMSCO DB 550  
  - PUMP #2: OILWELL H 560 37  
  - RMC - Mud Cake Resistivity, Ohm-Meter  
  - RM - Mud Resistivity, Ohm-Meter  
  - RMF - Mid-Filtrate Resistivity, Ohm-Meter  
  - RPM - Revolutions Per Minute  
  - RRB - Rerun Bit  
  - RT - Rotary Table  
  - SD - Sand %  
  - SLM - Solids %  
  - SPM - Strokes Per Minute  
  - STG - Short Trip Gas  
  - SWG - Swab Gas  
  - SVG - Survey Gas  
  - S/T - Suction Temperature  
  - T.D. - Total Depth  
  - T.E. - Temperature of Bit  
  - T.F. - Temperature of Fluids  
  - T.G. - Trip Gas  
  - T.G. - Trip Gas  
  - T.G. - Trip Gas  
  - TVD - True Vertical Depth  
  - V - Viscosity, API seconds  
  - WOB - Weight on Bit  
  - W - Weight of Mud, ppg/pcf  
  - X - Water %  
  - Y - Weight of Fluids, ppg/pcf  
  - Z - Zinc %

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**LEGEND**

- **COMPANY PUSHER:** Jack Meyer  
  - Clayton Roth  
  - Ed Vader  
  - Jerry Gann  
  - Matt Brown  

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**MUD PUMPS**

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---

**TOTAL DEPTH**

- Measured: 3518’
- True Vertical: 2599.08’ Proj.

---

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  - DG - Drilling Gas  
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  - DST - Drill Stem Test  
  - EL - Electric Log  
  - E.M.A. - Equivalent Methane in Air, 1% = 50 Units  
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  - GCW - Gas Cut Water  
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  - WOB - Weight on Bit  
  - W - Weight of Mud, ppg/pcf  
  - X - Water %  
  - Y - Weight of Fluids, ppg/pcf  
  - Z - Zinc %
Ran 20" conductor pipe; set at 20'. Drill out with 8-3/4" bit.

Mw 8.7+  Vis 34

Siltst: Medium gray moderately firm, occasionally grading to very fine grain sandst, poorly cemented mostly with clay matrix, some carbonaceous with traces fossil fragments

Sandst: light gray moderately firm friable, very fine to fine with rare medium mostly subangular clear, white qtz with predom clay matrix
Sandy siltst: medium to dark gray, friable soft, with common very fine grain sandst of clear, white and transul quartz occasionally very clayey, argillaceous

Siltst: Medium gray moderately firm, occasionally grading to very fine grain sandst, poorly cemented mostly with clay matrix, some carbonaceous with traces fossil fragments

Siltst: It-med gry, fn-med grain, subang-subrnd, firm-friable, argillaceous siltstone. It gray, fn grain subang-subrnd, claystone, clear-milky, fn grain, subrnd, quartz sand
Drill 8-3/4" hole 617', open 17-1/2" to 590'. Run and cement 13-3/8" casing with shoe at 590'. Rig up BOP Drill ahead.

Siltst: lt-med gry, fn-med grain, subang-subrnd, firm-friable, argillaceous siltstone, lt gry, fn grain subang-subrnd, claystone, clear-milky, fn grain, subrnd, quartz sand, occ blk, volcanic fragments
Clay-st medium gray-brown, moderately soft, occasionally very sandy and silty with some fossil fragments, argillaceous, soluble in part, sticky soft.
Survey at 1403'        Incl 16.40°
Az 335.60°          TVD 1397.54'
N 45.63'                       W 33.65'

Survey at 1509'        Incl 19.30°
Az 339.07°          TVD 1498.49'
N 75.77'                       W 45.10'

Siltst: lt-med gry, fn grain, subang-subrnd, moderately firm-firm, siltstone, lt gry, fn grain, friable clay stone, lt-med gry-tan, slou-subsolu, occ sticky, silty clay, occ volcanic fragments
WOB 10 K
PP 1200
RPM 6-45 (w/MM)
SPM 60/120

Survey at 1668'        Incl 25.06°
Az 329.02°          TVD 1646.00'
N 128.34'                     W 17.13'

Survey at 1759'        Incl 28.03°
Az 331.21°          TVD 1727.13'
N 163.88'                     W 92.94'

Siltst: lt-med gry, fn grain, subang-subrnd, moderately firm-firm, siltstone, lt gry, fn grain, friable clay stone, lt-med gry-tan, slou-subsolu, occ sticky, silty clay, poss tuff, occ volcanic fragments

Mw 8.7     Vis 37

Survey at 1759°     Incl 28.03°
Az 331.21°          TVD 1727.13'
N 163.88'                     W 92.94'
Survey at 1966’        Incl 27.50°
Az 332.45°          TVD 1910.27’
N 234.86’   W137.70’

Siltst: lt-med gry, fn grain,
subangular-subrounded, moderately firm-
friable clay stone, lt gry-tan,
subsolu, sticky, gummy, silty
clay, poss tuff fragments

Sandst: light to medium gray, firm
predominately subrounded clear,
white and translucent quartz,
common mafics with some vari-
colored volcanics grains with well
 cemented calcareous matrix

Mw 8.8     Vis 43
Clayst: medium to light gray with some mottled gray brown, occasionally very silty to sandy, mostly sticky soft, soluable in part, with rare lignite and fossil fragments, amorphous

Siltst: medium gray moderately firm slightly calcareous, occasionally grading to very fine grain sandst, argillaceous

Survey at 2126° Incl 33.30°
Az 319.70° TVD 2053.16'
N 307.07° W179.03°

Mw 8.8+ Vis 52
Sandy Siltst: medium to light gray brown, moderately firm calcareous, occasionally grading to very fine grain sandstone, some argillaceous with rare fossil fragments.

Siltst: medium gray to gray brown with some green olive tint, occasionally grading to very fine grain sand with abundant clay with some clay matrix, argillaceous, poor fissility with rare fossil fragments.
Survey at 2462'        Incl 45.00°
Az 296.50°      TVD 2314.67'
N 428.55'        W 349.01'

Survey at 2670'        Incl 59.40°
Az 286.90°      TVD 2442.39'
N 488.74'        W 500.78'

Siltst: medium gray to gray brown with some green olive tint, occasionaly grading to very fine grain sandst with abundant clay with some clay matrix, argillaceous, poor fissility with rare fossil fragments

Sand: clear-milky, vfn-fn grain, subang-submd, quartz sand, lt gry, fn-med grain, subang-submd, hard calc sandstone, lt-med gry, subsolu, gummy, sticky, sandy clay, med gry, subang, argillaceous siltstone, occ fossil fragments & pyrite
Clay: lt-med gry, subsolu, gummy, sticky, sandy clay, med gry, subang, argillaceous siltstone, clear-milky, vfn-fn grain, subang-subrnd, quartz sand, occ fossil fragments & pyrite

Clay: lt-med gry, subsolu, gummy, sticky, sandy clay, med gry, subang, argillaceous siltstone, clear-milky, vfn-fn grain, subang-subrnd, quartz sand, occ fossil fragments, tuff & pyrite

Survey at 2826'  Incl 65.78°
Az 280.56°  TVD 2513.40'
N 520.98'  W 653.71'

Clay: lt-med gry, subsolu, gummy, sticky, sandy clay, med gry, subang, argillaceous siltstone, clear-milky, vfn-fn grain, subang-subrnd, quartz sand, occ fossil fragments, tuff & pyrite
Sand: clear-milky, vfn-fn grain, subang-subrnd, quartz sand, lt-med gry, subsolu, gummy, sticky, sandy clay, lt gry, fn-med grain, subang-subrnd, hard calc sandstone, occ muscovite & pyrite

Survey at 3023'  Incl 78.86°
Az 280.17°  TVD 2577.35'
N 553.58'  W 817.40'

--CR, POOH
--max gas 285 u
--TVD 2600'
--5/18/07

Sand: clear-milky, vfn-fn grain, subang-subrnd, quartz sand, lt-med gry, subsolu, gummy, sticky, sandy clay, lt gry, fn-med grain, subang-subrnd, hard calc sandstone, med brn-gry, fn grain, subang, firm siltstone, muscovite, pyrite & occ chlorite
Survey at 3180'  Incl 85.79°  
Az 282.08°  TVD 2600.33'  
N 582.88'  W 969.84'

Survey at 3277'  Incl 89.30°  
Az 283.00°  TVD 2604.97'  
N 603.61'  W 1064.47'

Sand: clear-milky, vfn-fn grain, 
subang-subrnd, quartz sand, lt-
med gry, subsolu, gummy, sticky, 
sandy clay, lt gry, fn-med grain, 
subang-subrnd, hard calc 
sandstone, med brn-gry, fn grain, 
subang, firm siltstone, abundant 
mica & pyrite, occ chlorite & tuff
Sand: clear-milky, vfn-fn grain, subang-subrnd, quartz sand, lt gry, fn-med grain, subang-subrnd, hard calc sandstone, med brn-gry, fn grain, subang, firm siltstone, abundant mica & pyrite, occ lignite

Sand: Light gray, unconsolidated very fine to fine with common medium grain predominately clear, white and transul quartz, very micaceous with muscovite, occasionly with lignite, and welded tuff

Survey at 3469' Incl 92.00°
Az 281.70° TVD 2600.83'
N 641.55' W 1252.67'

Mw 9.0+ Vis 47