Borehole Data Package for RCRA Well 299-W22-47 at Single-Shell Tank Waste Management Area S-SX, Hanford Site, Washington

D. G. Horton
M. A. Chamness

April 2006

Prepared for the U.S. Department of Energy under Contract DE-AC05-76RL01830
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Pacific Northwest National Laboratory
Richland, Washington 99352
Summary

One new Resource Conservation and Recovery Act (RCRA) groundwater assessment well was installed at single-shell tank Waste Management Area (WMA) S-SX in fiscal year (FY) 2005 to fulfill commitments for well installations proposed in Hanford Federal Facility Agreement and Consent Order, Milestone M-24-57 (2004). The need for the new well, well 299-W22-47, was identified during a data quality objectives process for establishing a RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Atomic Energy Act (AEA) integrated 200 West and 200 East Area Groundwater Monitoring Network.

This document provides a compilation of all available geologic data, spectral gamma ray logs, hydrogeologic data and well information obtained during drilling, well construction, well development, pump installation, aquifer testing, and sample collection/analysis activities. Appendix A contains the Well Summary Sheets, the Well Construction Summary Report, the geologist’s Borehole Log, well development and pump installation records, and well survey results. Appendix B contains analytical results from groundwater samples collected during drilling. Appendix C contains complete spectral gamma ray logs and borehole deviation surveys.

Additional well construction documentation is on file with Fluor Hanford, Inc. (FHI). Also, the Records Management Information System (RMIS) and the Hanford Well Information System (HWIS) [http://apweb02/cfroot/rapidweb/phmc/cp/hwisapp/] are two electronic databases that also contain drilling and construction records for these four wells.
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1.0 Introduction

One new Resource Conservation and Recovery Act (RCRA) groundwater assessment well was installed at single-shell tank Waste Management Area (WMA) S-SX in fiscal year 2005 to fulfill commitments for well installations proposed in Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement; Ecology et al. 1989), revised Milestone M-24-57 (2004). The need for the new well, well 299-W22-47, was identified during a data quality objectives process for establishing a RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Atomic Energy Act (AEA) integrated 200 West and 200 East Area Groundwater Monitoring Network (Byrnes and Williams 2003).

Well 299-W22-47 is located downgradient of WMA S-SX. The purpose of the well was to complete the groundwater detection and assessment network for the WMA and to bound the downgradient and lateral extent of the nitrate and technetium-99 contamination plume emanating from the WMA. This report provides the information obtained during drilling, characterization and installation of well 299-W22-47.

2.0 Well 299-W22-47

Well 299-W22-47 (well ID C4667) was installed between January 2005 and March 2005. The location for the well is shown on Figure 1. The new well was constructed to the specifications and requirements described in Washington Administrative Code (WAC) 173-160, the groundwater monitoring description of work for drilling and installation,¹ and specifications used by Fluor Hanford, Inc. (FHI), Richland, Washington. During drilling and construction of the well, sampling and analysis activities were conducted to support field screening for radiological and chemical contaminants, to collect sediment grab samples for geologic descriptions, and to characterize the vertical extent of contamination in the upper part of the unconfined aquifer.

This document provides a compilation of all available geologic data, spectral gamma ray logs, hydrogeologic data and well information obtained during drilling, well construction, well development, pump installation, aquifer testing, and sample collection/analysis activities. Appendix A contains the Well Summary Sheets, the Well Construction Summary Report, the geologist’s Borehole Log, well development and pump installation records, and well survey results. Appendix B contains analytical results from groundwater samples collected during drilling. Appendix C contains complete spectral gamma ray logs and borehole deviation surveys. The results of hydrologic testing will be published separately.²

---

Figure 1. Map of Single-Shell Tank Waste Management Area S-SX Showing the Location of New Well 299-W22-47 (noted as S1 on the map)

Additional well construction documentation is on file with FHI. Also, the Records Management Information System (RMIS) and the Hanford Well Information System (HWIS) [http://apweb02/cfroot/rapidweb/phmc/cp/hwisapp/] are two electronic databases that also contain drilling and construction records for these four wells.
English units are used in this report to describe drilling and well completion activities because that is the system of units used by drillers to measure and report depths and well construction measurements. Conversion to metric can be done by multiplying feet by 0.3048 to obtain meters or by multiplying inches by 2.54 to obtain centimeters.

2.1 Drilling and Sampling

Well 299-W22-47 (well ID C4667) was drilled with a dual-wall percussion (diesel hammer) drill rig from surface to a total depth of 348.6 ft below ground surface (bgs). The borehole was drilled through the uppermost 120 ft of the unconfined aquifer. Temporary 9-in. outside diameter (OD), dual-wall casing was used during drilling to total depth. Drilling began on January 4, 2005, and total depth was reached on January 21, 2005.

Grab samples of sediment for geologic description and archive were collected at approximately 5-ft intervals from ground surface to total depth. The samples were collected in 1-pint glass jars and transferred to the Hanford Geotechnical Sample Library, located in Building 3718A/B in the 300 Area. Also, three 2-ft-long split spoon samples were collected from 15 to 17 ft bgs, 20 to 22 ft bgs, and 25 to 27 ft bgs. These samples were transferred to Pacific Northwest National Laboratory (PNNL) for hydrologic testing.

Sediments encountered during drilling were predominantly unconsolidated sand with minor sandy gravel of the Hanford formation from approximately 5 to 133 ft bgs. Fine to medium sand with minor calcareous silty layers and gravelly sand and sandy gravel of the Cold Creek unit make up the sediments between about 133 and 158 ft bgs. The Taylor Flat member of the Ringold Formation occurs between about 158 and 182 ft bgs and consists of coarse sand. The Ringold Formation, member of Wooded Island unit E occurs between 182 ft bgs and total well depth at 348.6 ft bgs. The unit E in well 299-W22-47 is dominantly sandy gravel that is strongly cemented in places. The field geologist’s borehole log, along with the well construction summary report, as-built diagram, well development and pump installation records, and well survey results are included in Appendix A.

Water was encountered at a depth of 228 ft bgs. Two types of groundwater samples were collected from well 299-W22-47; air lifted samples and pumped samples. Air lifted samples of slurry and groundwater were collected every 5 ft throughout the drilled part of the aquifer. The samples were collected in new, labeled 1-gal jars and allowed to set at least over night so that most particulates could settle to the bottom. Samples were not kept cold during the settling period. Aliquots of the groundwater were then pumped through a filter into smaller sample containers for transport to the laboratory.

Pumped samples were collected from well 299-W22-47 at 20-ft intervals throughout the drilled part of the aquifer. The samples were collected after purging the well for at least one hour. The samples were put into pre-labeled, and preserved (for chromium) bottles and delivered to the laboratory.

All samples were analyzed for technetium-99 and chromium by inductively coupled plasma – mass spectrometry and for anions by ion chromatography. All analytical results are given in Appendix B and the analytical results are discussed in Section 2.4.

Four series of slug tests were performed in well 299-W22-47 as it was being drilled. The tests were done at depths of 235.4 to 241.7 ft bgs, 249.0 to 259.0 ft bgs, 285.5 to 293.4 ft bgs, and 338 to 348 ft bgs.
Two different stresses were used during each series of tests. Details of the tests and the test results will be published separately.3

The borehole and drill cuttings were monitored regularly for volatile organics and radionuclides. All volatile organic and radionuclide monitoring found less than detection values. A total gamma ray log was run on January 25, 2005, by Stoller Corporation. No manmade radionuclides were noted. The gamma log is provided in Appendix C.

### 2.2 Well Completion

The permanent casing and screen were installed in well 299-W22-47 in January 2005. A 35-ft-long, 4-in. inside diameter (ID), stainless steel, continuous wire-wrap 20 slot (0.02-in. slot) screen was set from 263.7 to 228.7 ft bgs. A 2-ft sump with end cap extends from the bottom of the screen to 265.7 ft bgs. The permanent well casing is 4-in. ID, stainless steel from 228.67 ft bgs to 1.47 ft above ground surface.

The borehole was backfilled with 10-20 mesh silica sand from 348.6 to 274.9 ft bgs and with 1/2 inch bentonite pellets from 274.9 to 269.9 ft bgs. The screen filter pack is composed of 10-20 mesh silica sand and placed from 269.9 to 218.1 ft bgs. The annular seal is composed of 1/4-in. bentonite pellets from 218.1 to 212.8 ft bgs and granular bentonite crumbles from 212.8 to 10 ft bgs. The surface seal is composed of Portland cement from 10 ft bgs to ground surface. A 4-ft by 4-ft by 6-in. concrete pad was placed around the well at the surface. A protective well head casing with locking cap, four protective steel posts, and a brass marker stamped with the well identification number and Hanford well number were set into the concrete pad. Appendix A contains the well construction and well summary reports.

A vertical borehole survey was conducted using a downhole gyroscope in the completed well to determine the bottom location relative to the vertical projection. The survey found that at a measured depth of 255.70 ft, the true vertical depth of the well is 255.25 ft, a difference of 0.45 ft. Gyroscope survey results are located in Appendix C.

The vertical and horizontal coordinates of the well were surveyed on April 26, 2005. The horizontal position of the well is referenced to Washington Coordinate System, South Zone, NAD83(91). The vertical datum is NAVD 1988. Survey data are included in Table 1 and Appendix A. The static water level was 231.52 ft bgs on March 10, 2005.

### 2.3 Well Development and Pump Installation

Well 299-W22-47 was developed on March 9, 2005 at three different intervals using a temporary, 5-horsepower submersible pump. The depth to water was measured at 231.80 ft below top of casing (btc) prior to development. (Protective casing stick-up is 2.47 ft.) A pressure transducer was installed above the pump and connected to a Hermit datalogger to monitor water level during development. A total of 2,282 gal of water were pumped. Final depth to water was measured at 231.90 ft btc after development. Table 2 contains the well development information.

| Table 1. Survey Data for Well 299-W22-47 at WMA S-SX |

---

### Table 2. Well Development Information for Well 299-W22-47

<table>
<thead>
<tr>
<th>Well Name (Well ID)</th>
<th>Easting (meters)</th>
<th>Northing (meters)</th>
<th>Elevation (meters)</th>
<th>Reference Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>299-W22-47 (C4667)</td>
<td>566908.74</td>
<td>134076.28</td>
<td>206.281</td>
<td>Center of casing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>206.275</td>
<td>Top of pump baseplate, N edge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>205.533</td>
<td>Top of Casing, N. Edge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>205.333</td>
<td>Brass Survey Marker</td>
</tr>
</tbody>
</table>

Pump Rate (gpm) | Pump Intake Depth (ft btc) | Pumping Run Time (min) | Drawdown (ft) | Final Turbidity Readings |
---|---|---|---|---|
21 | 260 | 34 | 1.31 | 2.02 NTU, 429 µS/cm, 19.2 C, 7.83 pH |
21 | 249 | 44 | 1.36 | 1.07 NTU, 425 µS/cm, 19.4 C, 7.81 pH |
23 | 239 | 28 | 1.46 | 1.67 NTU, 426 µS/cm, 19.7 C, 7.83 pH |

| ft btc = Feet below top of casing; protective casing stick-up is 2.47 ft. gpm = Gallons per minute. NTU = Nephelometric turbidity unit. µS/cm = micro Siemens per centimeter. |

A dedicated Redi-Flo-3, 0.5-horsepower Grundfos™ submersible sampling pump was installed in well 299-W22-47 on September 19, 2003. The sampling pump intake was set at 248.53 ft bgs or approximately 16.63 ft below the water table. The pump is connected to the surface with 1-in. diameter stainless steel riser pipe.

### 2.4 Results of Groundwater Analyses

Groundwater samples were collected in borehole 299-W22-47 as described in Section 2.1 above. All analytical data are given in Appendix B. Selected analytical results are shown in Figure 2 and Table 3.

The concentrations of technetium-99 and nitrate show very good correlation with each other throughout the sampled part of the aquifer. The maximum concentrations are between about 12 and 60 ft below the water table and there is a rapid concentration decrease at 70 to 75 ft below the water table. The maximum concentration of carbon tetrachloride is at 40 ft below the water table, although the concentration of carbon tetrachloride was only measured in pumped samples collected at 20-ft intervals.

The maximum concentration of chromium is about 40 ft below the water table. The chromium concentration decreases to near 1 µg/L between 60 and 80 ft below the water table. Only chromium concentrations from pumped samples are shown on Figure 2. Analysis of chromium values in all samples show a substantial difference between the air lifted and pumped results with the air lifted samples having lower concentrations. The groundwater associated with the air lifted samples was in contact with the drill cuttings for at least 12 hours before analysis. It is probable that the soluble Cr$^{6+}$ was reduced to insoluble Cr$^{3+}$ by being in contact with crushed basalt in the drill cuttings. Extensive purging of the well before collection of the pumped samples removed most or all of the groundwater affected by drilling so that the
resulting chromium concentrations were much less affected by reducing conditions created during drilling.

![Graph showing concentration of selected analytes in samples collected during drilling of Well 299-W22-47.](image)

**Figure 2.** Concentration of Selected Analytes in Samples Collected During Drilling of Well 299-W22-47

### 2.5 Aquifer Tests

Four slug tests were performed as the well was being drilled. Approximate depths of these tests are 235.4 to 241.7, 249 to 259, 285.5 to 293.4, and 339.3 to 349.3 ft bgs. In addition to the slug tests, a drift and pumpback tracer test was performed. A full description of the tests and results will be published separately.⁴

---

Table 3. Selected Analytical Results from Samples Collected During Drilling of Well 299-W22-47

<table>
<thead>
<tr>
<th>Sample Depth (ft bgs)</th>
<th>Depth Below Water Table (ft)&lt;sup&gt;(a)&lt;/sup&gt;</th>
<th>Sample Type</th>
<th>Tc-99 (pCi/L)</th>
<th>Cr (ug/L)</th>
<th>Nitrate (mg/L)</th>
<th>Carbon Tetrachloride (ug/L) Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>231</td>
<td>3</td>
<td>Air lift</td>
<td>306</td>
<td>1.15</td>
<td>39.67</td>
<td></td>
</tr>
<tr>
<td>235</td>
<td>7</td>
<td>Air lift</td>
<td>10455</td>
<td>0.98</td>
<td>103.13</td>
<td></td>
</tr>
<tr>
<td>240</td>
<td>12</td>
<td>Air lift</td>
<td>16575</td>
<td>0.755</td>
<td>106.24</td>
<td></td>
</tr>
<tr>
<td>243</td>
<td>15</td>
<td>Air lift</td>
<td>11135</td>
<td>0.733</td>
<td>121.18</td>
<td></td>
</tr>
<tr>
<td>248</td>
<td>20</td>
<td>Pump</td>
<td>19550</td>
<td>196</td>
<td>107.92</td>
<td></td>
</tr>
<tr>
<td>253</td>
<td>25</td>
<td>Air lift</td>
<td>20060</td>
<td>32.2</td>
<td>110.52</td>
<td></td>
</tr>
<tr>
<td>258</td>
<td>30</td>
<td>Air lift</td>
<td>20230</td>
<td>18.2</td>
<td>110.01</td>
<td></td>
</tr>
<tr>
<td>263</td>
<td>35</td>
<td>Air lift</td>
<td>20230</td>
<td>4.26</td>
<td>107.76</td>
<td></td>
</tr>
<tr>
<td>268</td>
<td>40</td>
<td>Pump</td>
<td>20740</td>
<td>232</td>
<td>108.81</td>
<td>145</td>
</tr>
<tr>
<td>273</td>
<td>45</td>
<td>Air lift</td>
<td>14042</td>
<td>49.6</td>
<td>73.79</td>
<td></td>
</tr>
<tr>
<td>278</td>
<td>50</td>
<td>Air lift</td>
<td>15011</td>
<td>74.3</td>
<td>79.56</td>
<td></td>
</tr>
<tr>
<td>283</td>
<td>55</td>
<td>Air lift</td>
<td>16490</td>
<td>48.8</td>
<td>90.26</td>
<td></td>
</tr>
<tr>
<td>288</td>
<td>60</td>
<td>Pump</td>
<td>15215</td>
<td>139</td>
<td>81.79</td>
<td>90</td>
</tr>
<tr>
<td>293</td>
<td>65</td>
<td>Air lift</td>
<td>11118</td>
<td>1.05</td>
<td>48.71</td>
<td></td>
</tr>
<tr>
<td>298</td>
<td>70</td>
<td>Air lift</td>
<td>12393</td>
<td>2.65</td>
<td>76.36</td>
<td></td>
</tr>
<tr>
<td>303</td>
<td>75</td>
<td>Air lift</td>
<td>1989</td>
<td>1.32</td>
<td>14.28</td>
<td></td>
</tr>
<tr>
<td>308</td>
<td>80</td>
<td>Pump</td>
<td>272</td>
<td>0.869</td>
<td>4.03</td>
<td>3.1</td>
</tr>
<tr>
<td>313</td>
<td>85</td>
<td>Air lift</td>
<td>629</td>
<td>1.09</td>
<td>6.67</td>
<td></td>
</tr>
<tr>
<td>318</td>
<td>90</td>
<td>Air lift</td>
<td>323</td>
<td>1.01</td>
<td>4.42</td>
<td></td>
</tr>
<tr>
<td>323</td>
<td>95</td>
<td>Air lift</td>
<td>85</td>
<td>1.04</td>
<td>2.42</td>
<td></td>
</tr>
<tr>
<td>328</td>
<td>100</td>
<td>Pump</td>
<td>340</td>
<td>0.764</td>
<td>8.33</td>
<td>5.2</td>
</tr>
<tr>
<td>333</td>
<td>105</td>
<td>Air lift</td>
<td>85</td>
<td>1.17</td>
<td>2.19</td>
<td></td>
</tr>
<tr>
<td>338</td>
<td>110</td>
<td>Air lift</td>
<td>(39)</td>
<td>0.951</td>
<td>1.75</td>
<td></td>
</tr>
<tr>
<td>343</td>
<td>115</td>
<td>Air lift</td>
<td>(17)</td>
<td>0.989</td>
<td>1.36</td>
<td></td>
</tr>
<tr>
<td>348</td>
<td>120</td>
<td>Pump</td>
<td>(15)</td>
<td>0.8</td>
<td>1.47</td>
<td>3.9</td>
</tr>
</tbody>
</table>

(a) Water table is 228 feet below ground surface

ND = Not determined.

(*) = less than sample quantitation limit of 51 pCi/L for technetium-99
3.0 References


Appendix A

Geologic Logs, Well Construction, and Completion Documentation, Well 299-W22-47
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Blown Recovery</th>
<th>Graphic Log</th>
<th>Sample Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0-9'</td>
<td>No recovery</td>
<td></td>
<td>0-9' pebbles</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>From top</td>
<td></td>
<td>10-19' pebbles</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>From top</td>
<td></td>
<td>20-29' pebbles</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>From top</td>
<td></td>
<td>30-39' pebbles</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>From top</td>
<td></td>
<td>40-49' pebbles</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>From top</td>
<td></td>
<td>50-59' pebbles</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>From top</td>
<td></td>
<td>60-69' pebbles</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
<td>From top</td>
<td></td>
<td>70-79' pebbles</td>
<td></td>
</tr>
</tbody>
</table>

Reported By: Michael E. Conom
Reviewed By: L.D. Walker

Title: Senior Geologist
Title: Geologist
### BOREHOLE LOG

**Project:** RCRA Monitoring Well  
**Location:** WMA S-SX  
**Reference Measuring Point:** ground surface  
**Date:** 1-5-05

<table>
<thead>
<tr>
<th>Depth (FT)</th>
<th>Sample Type No.</th>
<th>Blows</th>
<th>Recovery</th>
<th>Graphic Log</th>
<th>Sample Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td>77-81': gravelly sand (G S) medium</td>
<td>Beckert Hammer, 10-20% gravel, 2-cm mostly matrix (heal) with 9&quot; x 6&quot; dual well casing</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td>115-7: fine-medium sand, well sorted, subangular, clasts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td>116-3: fine sand, 5% mafic clasts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>130</td>
<td></td>
<td></td>
<td></td>
<td>132-3: fine sand and mafic clasts, minor calcses, very silt layers and sparse angular boulder, cobble to gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140</td>
<td></td>
<td></td>
<td></td>
<td>139-97: gravelly sand (G S) coarse mafic sand, 15-20% mafic pebbles to 9 cm - subrounded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td>146-156: sandy gravel (G S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90-90% coarse sand; very clean</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reported By:** Michael E. Cunn  
**Reviewed By:** L.D. Walter

**Title:** Senior Geologist  
**Title:** Geologist

**Signature:**  
**Date:** 1-5-05  
**Signature:**  
**Date:** 3/10/05

---

A.2
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Blows Recovery</th>
<th>Graphic Log</th>
<th>Sample Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td>150-180: coarse sand, well-sorted</td>
<td>Becker Hammer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10-15% matrix clay, clay dominated</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Sub-rounded to well-rounded clasts</td>
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<td></td>
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<td></td>
<td></td>
<td>Gravel/cobble layer with</td>
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<td></td>
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<td></td>
<td></td>
<td>breccia cobbles to 2-3&quot;, well-rounded</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>177-179: medium sand, poorly sorted</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1% silt, 99% sand</td>
<td></td>
</tr>
<tr>
<td>190</td>
<td></td>
<td></td>
<td></td>
<td>102-107: clayey gravel, 80% &lt; 3&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25% silt, 75% gravel</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sub-rounded, breccia 4&quot;-6&quot;</td>
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<td></td>
<td>Breccia/Viscous 4&quot;-6&quot;</td>
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<td>Volcanic Ashes</td>
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<td></td>
<td></td>
<td>Rasch 107-108: medium sand, poorly sorted</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td>25% silt, 75% sand</td>
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<td></td>
<td>Sub-rounded, well-rounded</td>
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<td></td>
<td></td>
<td>207-210: medium sand, generally</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15% gravel, 85% sand</td>
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<tr>
<td>220</td>
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<td>Rasch 217-218: coarse sand</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td>228-230: gravel, well-rounded</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Breccia/Viscous, 4&quot;-6&quot;</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Rasch 230: medium sand, 207-210</td>
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<td></td>
<td></td>
<td></td>
<td>Rasch 228-230: gravel, well-rounded</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rasch 228-230: gravel, well-rounded</td>
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<td></td>
<td></td>
<td></td>
<td>Rasch 228-230: gravel, well-rounded</td>
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<td></td>
<td></td>
<td>Rasch 228-230: gravel, well-rounded</td>
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<td></td>
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<td></td>
<td>Rasch 228-230: gravel, well-rounded</td>
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<td></td>
<td></td>
<td>Rasch 228-230: gravel, well-rounded</td>
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<td></td>
<td></td>
<td></td>
<td>Rasch 228-230: gravel, well-rounded</td>
<td></td>
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</tbody>
</table>

Reported By: Michael E. Caron
Reviewed By: L.D. Walker
Title: Senior Geologist
Reviewed By: L.D. Walker
Title: Geologist
Signature: Date: 1-5-05
Signature: Date: 3-1-65

A-6003-642 (03/03)
## BOREHOLE LOG

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Blown Recovery</th>
<th>Graphic Log</th>
<th>Sample Description</th>
<th>Sample Name</th>
<th>Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>240</td>
<td>Under</td>
<td>3-8</td>
<td>Hg. 3-5</td>
<td>248-258: sandgravel (SG)</td>
<td><strong>Ragel</strong>'s</td>
<td>U3: undisturbed sample</td>
<td>258: <strong>Ragel</strong>'s</td>
</tr>
<tr>
<td>230</td>
<td>Under</td>
<td>2-4</td>
<td>Hg. 3-5</td>
<td>238-248: sandgravel (SG)</td>
<td><strong>Ragel</strong>'s</td>
<td>U3: undisturbed sample</td>
<td>248: <strong>Ragel</strong>'s</td>
</tr>
<tr>
<td>230</td>
<td>Under</td>
<td>2-4</td>
<td>Hg. 3-5</td>
<td>238-248: sandgravel (SG)</td>
<td><strong>Ragel</strong>'s</td>
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<td><strong>Ragel</strong>'s</td>
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<td>Hg. 3-5</td>
<td>238-248: sandgravel (SG)</td>
<td><strong>Ragel</strong>'s</td>
<td>U3: undisturbed sample</td>
<td>248: <strong>Ragel</strong>'s</td>
</tr>
</tbody>
</table>

---

**Reported By:** Michael E. Carson  
**Reviewed By:** L.D. Walker  
**Title:** Senior Geologist  
**Date:** 4/2/05  
**Signature:** [Signature]

**Title:** Geologist  
**Date:** 3/1/05  
**Signature:** [Signature]
## Borehole Log

**Well ID:** C4667  
**Well Name:** 259-12247  
**Location:** WMA 5-54  
**Project:** ECRA Monitoring Well  
**Reference Measuring Point:** ground surface  
**Date:** 1-19-05

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Blows Recovery</th>
<th>Graphic Log</th>
<th>Sample Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>350</td>
<td>3B1-8L</td>
<td></td>
<td></td>
<td>34-346: Sandy gravel Chopped &amp; well-packed with gravel, 4'x6' well wall</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>350</td>
<td>3B1-174</td>
<td>Dic 125, 158</td>
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<td>340</td>
<td>3B1-8L</td>
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<td>330</td>
<td>3B1-8L</td>
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<td>320</td>
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<tr>
<td>320</td>
<td>3B1-8L</td>
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<td>300</td>
<td>3B1-8L</td>
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<tr>
<td>290</td>
<td>3B1-8L</td>
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<tr>
<td>280</td>
<td>3B1-8L</td>
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<td>270</td>
<td>3B1-8L</td>
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<tr>
<td>260</td>
<td>3B1-8L</td>
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<tr>
<td>250</td>
<td>3B1-8L</td>
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</tr>
</tbody>
</table>

**Comments:**

- Medium sand, gravel, well-rounded and well-sorted.
- Cobble to gravel, 2" to 5", max = 4'.
- Sub-rounded to well-rounded.
- Water slurry sample (Fluor.

**Depth of Casing, Drilling Method:**

- Depth from 0 to 250 feet.

**Signed:**

- **Reported By:** Michael E. Carson  
- **Reviewed By:** Li D. Walker  
- **Date:** 1-21-05

---

A.5
WELL SUMMARY SHEET

Well ID: C4 647
Well Name: 244 - W22 - 47
Location: WMA S-5X

Prepared By: Michael E. Caven Date: 3-14-05
Reviewed By: L.D. Walker Date: 3-16-05

CONSTRUCTION DATA

<table>
<thead>
<tr>
<th>Description</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot; PP - 204 / 304 Schluse</td>
<td></td>
</tr>
<tr>
<td>+1.47' -&gt; 228.67'</td>
<td></td>
</tr>
<tr>
<td>4&quot; PP - 204 / 304 Schluse</td>
<td></td>
</tr>
<tr>
<td>228.67' -&gt; 263.68'</td>
<td></td>
</tr>
<tr>
<td>263.68' -&gt; 265.68'</td>
<td></td>
</tr>
<tr>
<td>Type II SE Sealed Cement</td>
<td></td>
</tr>
<tr>
<td>0' -&gt; 100'</td>
<td></td>
</tr>
</tbody>
</table>

GEOLOGIC/HYDROLOGIC DATA

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Graphic Log</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5': no recovery</td>
<td>0-5': no recovery</td>
<td>0-5': no recovery</td>
</tr>
<tr>
<td>5-16': medium to coarse sand, Hanford Fm.</td>
<td>5-16': medium to coarse sand, Hanford Fm.</td>
<td>5-16': medium to coarse sand, Hanford Fm.</td>
</tr>
<tr>
<td>16-76': sandy gravel, Hanford Fm.</td>
<td>16-76': sandy gravel, Hanford Fm.</td>
<td>16-76': sandy gravel, Hanford Fm.</td>
</tr>
<tr>
<td>76-86': gravelly sand, Hanford Fm.</td>
<td>76-86': gravelly sand, Hanford Fm.</td>
<td>76-86': gravelly sand, Hanford Fm.</td>
</tr>
<tr>
<td>86-137': fine to medium sand. Hanford Fm.</td>
<td>86-137': fine to medium sand. Hanford Fm.</td>
<td>86-137': fine to medium sand. Hanford Fm.</td>
</tr>
</tbody>
</table>

Note: All temporary casing has been removed from the ground. All depths recorded in ft below ground surface.
### WELL SUMMARY SHEET

**Well ID:** C4667  
**Location:** WMA S-Sx  
**Well Name:** 299-W22-47  
**Project:** FY05 BEEA Monitoring Well

**Prepared By:** Michael E. Caven  
**Date:** 3-14-05  
**Reviewed By:** C.D. Walker  
**Date:** 3/16/05

### CONSTRUCTION DATA

<table>
<thead>
<tr>
<th>Description</th>
<th>Diagram</th>
<th>Depth in Feet</th>
<th>Graphic Log</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot; SS protective casing set 10' above the well casing</td>
<td></td>
<td>120</td>
<td></td>
<td>81-137': fine to medium sand, Hanford Cn.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>140</td>
<td></td>
<td>137-138': fine to medium sand with minor calcite - Cold Creek Unit?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>145</td>
<td></td>
<td>139-147': gravelly sand, Hanford Cn.</td>
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<tr>
<td></td>
<td></td>
<td>160</td>
<td></td>
<td>147-150': sandy gravel, Hanford Cn.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>155</td>
<td></td>
<td>151-152': coarse sand, Hanford Cn.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>180</td>
<td></td>
<td>158-182': sandy gravel, Ringedale E'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200</td>
<td></td>
<td>182-207': medium sand, Ringedale E'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>220</td>
<td></td>
<td>207-210': medium sand, Ringedale E'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240</td>
<td></td>
<td>210-246': sandy gravel, Ringedale E'</td>
</tr>
</tbody>
</table>

**Water table:** 228.3' BGS

---

A.7
## WELL SUMMARY SHEET

<table>
<thead>
<tr>
<th>Description</th>
<th>Diagram</th>
<th>Graphic Log</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentomite Pellets, 1/2&quot;</td>
<td>![Diagram]</td>
<td>![Graphic Log]</td>
<td>262.9&quot; to 274.9&quot;</td>
</tr>
<tr>
<td>Colorado Silica Sand</td>
<td>![Diagram]</td>
<td>![Graphic Log]</td>
<td>274.9&quot; to 348.6&quot;</td>
</tr>
<tr>
<td><strong>TD = 348.6' bgs</strong></td>
<td>![Diagram]</td>
<td>![Graphic Log]</td>
<td>210 - 348.6' sandy gravel, Rhyolite'</td>
</tr>
</tbody>
</table>

Start Date: 1-3-05  
Finish Date: 3-10-05  
Page 3 of 2
# WELL CONSTRUCTION SUMMARY REPORT

**Well ID:** C4667  
**Well Name:** 289-W22-47  
**Approximate Location:** WAA 5-SX

**Project:** FY05 RCCA Monitoring WELL  
**Company:** Lavee Christensen  
**Geologist(s):** Michael Lavae, Brian Helgeson, Jeff Weil, Ian Carpen, Les Walker

**Drillers License #:**

### TEMPORARY CASING AND DRILL DEPTH

<table>
<thead>
<tr>
<th>Size/Grade &amp; lbs. per</th>
<th>Interval</th>
<th>Shoe OD &amp; Dia</th>
<th>Auger Diameter</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>9&quot; x 6&quot; Dual Liners</td>
<td>0' - 348.6'</td>
<td>10'/6.5&quot;5/8&quot;</td>
<td>Diameter From 10&quot; to 10.5&quot;</td>
<td>From 0&quot;</td>
<td>To 348.6&quot;</td>
</tr>
</tbody>
</table>

### DRILLING METHOD

<table>
<thead>
<tr>
<th>HOLE DIAMETER (IN) / INTERVAL (R)</th>
</tr>
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<tbody>
<tr>
<td>Diameter From 10&quot; to 10.5&quot;</td>
</tr>
</tbody>
</table>

### DÉSEL HAMER

| Diameter From 10" to 348.6" |

### Indicate Welded (W) Flush Joint (FJ) Coupled (C) & Thread Design

### Drilling Fluid

- N/A

**Total Drilled Depth:** 348.6'  
**Dowel Dia. @ TD:** 10"  
**Total Amt. Of Water Added During Drilling:** N/A  
**Well Straightness Test Results:** Placed

### GEOPHYSICAL LOGGING

<table>
<thead>
<tr>
<th>Sondes (type)</th>
<th>Interval</th>
<th>Date</th>
<th>Sondes (type)</th>
<th>Interval</th>
<th>Date</th>
</tr>
</thead>
</table>

### COMPLETED WELL

<table>
<thead>
<tr>
<th>Size/WT/Material</th>
<th>Depth</th>
<th>Thread</th>
<th>Slot Size</th>
<th>Type</th>
<th>Annual Sandite Pcs</th>
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### OTHER ACTIVITIES

**Silica Sand:** 248.1' - 248.6' 101 lbs | 10.5" |

**Aquifer Test:** WELL DEVELOPMENT

**Description:** 5 HP Fundam Sub Pump, Intake 28.5' (2.0 cm), Intake Raised to 28.5' (2.0 cm), Intake Level 28.5' (2.0 cm), Discharge 288.6' (2.0 cm), Discharge Level 288.6' (2.0 cm), Discharge 10.5" (1/4")

### WELL SURVEY DATA (If applicable)

### COMMENTS / REMARKS

**Yield, Cuts:** P (C = 2)  
**b = 1.285**  
**c = 59.9%**  
**f = 59.9%**  
**g = 82 lbs x 0.71 HPA = 67.32 ft**  
**N = 10.5" Pellets**

**t = 2 lbs x 0.71 HPA = 1.24 ft**  
**t = 82 lbs x 0.71 HPA = 58.32 ft**  
**N = 10.5" Pellets**

**t = 3 lbs x 0.71 HPA = 1.06 ft**

** Reported By:** Brian Helgeson  
**Title:** Geologist  
**Signature:** [Signature]

**Date:** 03-10-05

---

A.9
WELL DEVELOPMENT AND TESTING DATA

Well Name: 799-W21-47  Well ID: C4667  Well Location: WMA S-SX (200-West)  Date: 3-9-05

Reference Measuring Point (unless otherwise noted): TOP OF OUTER CASING (TOC)

Has the well been surveyed?  □ Yes  □ No  Does the well have a cement pad?  □ Yes  □ No

PART 1

STATIC WATER LEVEL:

Start of Job 231.80' (TOC)
End of Job 231.90' (TOC)

DEPTH TO BOTTOM:

Start of Job 265.7' (TOC)
End of Job 268.03' (TOC)

PART 2

WELL DEVELOPMENT DATA

Pump Model 5 HP electric submersible
Intake Depth 260'
Starting Turbidity >100 NTU

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Total Pumped ~ 2292 gal

Final Turbidity 1.67 NTU

XD SN/Range (PSI) 2743D5/20 psi

PART 3

INSTANTANEOUS SLUG TEST

Static Water Level (TOC)
Transducer Depth
Baseline Start
Injection Start
Baseline Start
Withdrawal Start
Slug Volume

XD SN/Range (PSI)

Prepared by (print name): Brian Helgeson  Signature:  Date: 3/09/05
Reviewed by (print name): L. D. Walker  Signature:  Date: 3/16/05

Comments:

Test 1: Start pump with intake at 260' (TOC)
Test 2: Start pump with intake at 260' (TOC)
Test 3: Start pump with intake at 2.47' (TOC)
Test 4: Start pump with intake at 1.14' (TOC)
Test 5: Start pump with intake at 2.47' (TOC)

ADDITIONAL DATA RECORDED ON DAILY FAP (3-9-05)
# WELL SURVEY DATA REPORT

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**Surveyor Statement:**

I, Grant F. Brazil, a Professional Land Surveyor registered in the State of Washington (Registration No. 22326), hereby certify that this report is based on a field survey performed in April, 2005 under my direct supervision, and that the data contained here is true and correct.

Original to
Distribution by DIS
Appendix B

Analytical Results from Groundwater Samples Collected During Drilling
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<th>Sample Depth (ft bgs)</th>
<th>Depth Below Water Table (ft)</th>
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<th>Cr (ug/L)</th>
<th>Fluoride (mg/L)</th>
<th>Chloride (mg/L)</th>
<th>Nitrate (mg/L)</th>
<th>Carbonate (mg/L)</th>
<th>Sulfate (mg/L)</th>
<th>Carbon Tetrachloride (ug/L) Field</th>
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(a) Water table is 228 feet below ground surface
ND = Not determined.
( ) = less than sample quantitation limit of 51 pCi/L for technetium-99
Appendix C

Spectral Gamma Ray Logs and Gyroscope Survey Data
Survey File: C:\DSE\C4667.RAW
Date:  Sep 27,2005
Time:  8:37
Description:  Borehole Deviation Survey
LOCATION:  299-W22-47
CUSTOMER:  PNNL
OPERATOR:  Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4   #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel. Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 30.07 min

Sight Reference Description: Corresponding Magnetic Compass Reading
Water run-off T-post
Local Magnetic Declination: 19 deg.

REFERENCE SUMMARY
Survey Reference Point: 199 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

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<th>Course from Vert.</th>
<th>Course Direction (deg)</th>
<th>True Vertical Depth (feet)</th>
<th>Rectangular Coordinates +N/-S</th>
<th>Rectangular Coordinates +E/-W</th>
<th>Dogleg Severity °/100 f</th>
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Bottom:
True Vertical Depth  255.25 feet
Closure Distance     12.3 feet
Closure Direction    347.7 deg.
Course Direction     333.2 deg.
DEFINITIONS:
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.
Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.
Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.
ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.
ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).
299-W22-47 (C4667)
Log Data Report

Borehole Information:

<table>
<thead>
<tr>
<th>Borehole:</th>
<th>299 W22 47 (C4667)</th>
<th>Site: 216-S-1 Crib</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinates (WA State Plane)</td>
<td>GWL (ft): 228.35</td>
<td>GWL Date: 01/25/05</td>
</tr>
<tr>
<td>North</td>
<td>Drill Date: 01/05</td>
<td>TOC Elevation Not available</td>
</tr>
<tr>
<td>East</td>
<td>Total Depth (ft): 349</td>
<td>Type: Becker</td>
</tr>
</tbody>
</table>

Casing Information:

<table>
<thead>
<tr>
<th>Casing Type</th>
<th>Stickup (ft)</th>
<th>Outer Diameter (in.)</th>
<th>Inside Diameter (in.)</th>
<th>Thickness (in.)</th>
<th>Top (ft)</th>
<th>Bottom (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threaded Steel</td>
<td>0</td>
<td>6 5/8</td>
<td>5 3/8</td>
<td>5/8</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Becker dual wall - inner</td>
<td>2.9</td>
<td>6 1/4</td>
<td>6</td>
<td>0.12</td>
<td>0</td>
<td>349</td>
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<tr>
<td>Becker dual wall - outer</td>
<td>2.3</td>
<td>9</td>
<td>8</td>
<td>1/2</td>
<td>0</td>
<td>349</td>
</tr>
</tbody>
</table>

The logging engineer measured the casing using a steel tape for the casing from 0-10 ft. The casing thicknesses for both the 6- and 8-in. casings are from published data for Becker dual wall casing.

Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drill pipe.

The Becker drilling system uses a dual-wall casing. Air flows down the annulus and cuttings are returned inside the inner casing. Total wall thickness is 0.620 in., increasing to 1.115 in. at the casing joints that occur at 10-ft intervals.

Logging Equipment Information:

<table>
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<tr>
<th>Logging System:</th>
<th>Gamma 4E</th>
<th>Type: 70% HPGe (34TP40587A)</th>
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<tr>
<td>Effective Calibration Date:</td>
<td>12/21/04</td>
<td>Calibration Reference: DOE-EM/GJ854-2005</td>
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<td>Logging Procedure:</td>
<td>MAC-HGLP 1.6.5, Rev. 0</td>
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Spectral Gamma Logging System (SGLS) Log Run Information:

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<th>Log Run</th>
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<th>2 Repeat</th>
<th>3</th>
<th>4</th>
<th>5 Repeat</th>
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</thead>
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<tr>
<td>Date</td>
<td>12/27/04</td>
<td>12/27/04</td>
<td>01/26/05</td>
<td>01/26/05</td>
<td>01/25/05</td>
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<tr>
<td>Logging Engineer</td>
<td>Spatz</td>
<td>Spatz</td>
<td>Spatz</td>
<td>Spatz</td>
<td>Spatz</td>
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<tr>
<td>Start Depth (ft)</td>
<td>8.0</td>
<td>8.0</td>
<td>348.0</td>
<td>142.5</td>
<td>50.0</td>
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<tr>
<td>Finish Depth (ft)</td>
<td>0.0</td>
<td>3.0</td>
<td>143.0</td>
<td>7.0</td>
<td>18.0</td>
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<td>Count Time (sec)</td>
<td>100</td>
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<td>Live/Real</td>
<td>R</td>
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<td>Shield (Y/N)</td>
<td>N</td>
<td>N</td>
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<tr>
<td>Sample Interval</td>
<td>N/A¹</td>
<td>N/A</td>
<td>0.5 ft</td>
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<td>MSA Interval (ft)</td>
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<td>N/A</td>
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Page 1

C.3
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<tr>
<th>Log Run</th>
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<th>5 Repeat</th>
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<tr>
<td>Log speed (ft/min)</td>
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<td>DE591000</td>
<td>DE591411</td>
<td>DE591683</td>
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<td>Finish File</td>
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<td>DE541014</td>
<td>DE591410</td>
<td>DE591682</td>
<td>DE591751</td>
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<td>Post-Verification</td>
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<tr>
<td>Depth Return Error (in.)</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>-3</td>
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</table>
| Comments     | No fine-gain adjustment. | No fine-gain adjustment. | No fine-gain adjustment. | No fine-gain adjustment. | No fine-gain adjustment. |}

**Logging Operation Notes:**

The borehole was initially drilled to 10 ft in depth and logged December 27, 2004. After completion of drilling in January 2005 to a depth of approximately 349 ft, logging was performed January 25 inside the Becker dual walled casing.

Gamma attenuation changes significantly as the sonde passes through the Becker dual walled pipe joints; therefore, it is not possible to provide accurate casing correction factors. The log is run in continuous mode with a logging speed of 1 ft/min. and a count time equivalent to a depth increment of 0.5 ft. A total gamma log is produced for correlation purposes. Gamma energy spectra are available but counting statistics are relatively poor for most individual peaks.

Total gamma data were collected using Gamma 4E. Pre- and post-survey verification measurements employed the Amersham KUT (40K, 238U, and 232Th) verifier with serial number 115. Logging was performed with a centralizer installed on the sonde. Zero reference was the ground surface. Maximum logging depth achieved was 348 ft.

**Analysis Notes:**

<table>
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<th>Analyst:</th>
<th>Henwood</th>
<th>Date:</th>
<th>06/13/05</th>
<th>Reference:</th>
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Pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the acceptance criteria. All of the verification spectra were within the acceptance criteria.

Log spectra were processed in batch mode using APTEC SUPERVISOR to determine gross counts, and count rates were calculated in EXCEL. Water and dead time corrections were not applied to the data. The influence of the thick joints is apparent on the total gamma where reduced count rates are exhibited at approximately 10-ft depth intervals.

**Log Plot Notes:**

Log plots are provided for total gamma counts per second. A plot of the repeat log versus the original log is included.

**Results and Interpretations:**

A decrease in gamma activity occurs at each casing joint, where the increase in wall thickness results in greater attenuation of gamma activity. No anomalous gamma activity was observed. This observation suggests no significant concentrations of man-made radionuclides.

A plot of the repeat log demonstrates reasonable repeatability of the total gamma log.
1 GWL – groundwater level
2 TOC – top of casing
3 N/A – not applicable
299-W22-47 (C4667)
Repeat of Total Gamma Log (16-50 ft)
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