SGW-59465
Revision 0

Borehole Summary Report for the Installation of Nine Injection Wells and Twenty-One Monitoring Wells in the 300-FF-5 Operable Unit, FY 2015

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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CH2M HILL Plateau Remediation Company

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Terms

bgs	below ground surface
BTR	Buyer's Technical Representative
CHPRC	CH2M HILL Plateau Remediation Company
DOE	U. S. Department of Energy
dpm	disintegration per minute
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
gpm	gallons per minute
HCl	hydrochloric acid
hp	horse power
I.D.	inner diameter
ID	Identification
IHT	Industrial Hygiene Technician
in	inch (inches)
N/A	Not applicable
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
PRZ	periodically rewetted zone
PVC	polyvinyl chloride
RCT	Radiological Control Technician
ROD	Record of Discussion
TD	total depth

Metric Conversion Chart

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces
tablespoons	15	milliliters	liters	2.113	pints
ounces	29.573	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts	0.946	liters	cubic meters	1.308	cubic yards
gallons	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

1 Introduction

The 300 Area encompasses approximately 105 km^2 (40 mi^2) along the Columbia River in the southeast portion of the Hanford Site in Benton County, Washington. The 300 Area included a core industrial complex comprised of the buildings, facilities, and process units used during research and development activities and the production of uranium fuel. Past liquid waste disposal to subsurface infiltration waste sites has resulted in contamination of the vadose zone and groundwater. The 300 Area contains three operable units (OUs): the 300-FF-1 and 300-FF-2 soil OUs and the 300-FF-5 groundwater OU.

Many of the 300 Area waste sites have been remediated, but deeper residual uranium is contributing to persistent uranium groundwater concentrations that exceed the cleanup level in the *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1* (EPA and DOE 2013) (hereafter referred to as the ROD/ROD Amendment). The selected remedy for uranium in the ROD/ROD Amendment (EPA and DOE 2013) is enhanced attenuation using sequestration. Sequestration will be carried out by infiltrating and injecting phosphate solutions into the vadose zone and the shallow aquifer to reduce the leachability of uranium in the soil. This will hinder or prevent further leaching of uranium to the aquifer.

The remedial actions selected in the ROD/ROD Amendment (EPA and DOE 2013) are implemented through DOE/RL-2014-13, *Integrated Remedial Design Report/Remedial Action Work Plan for the 300 Area (300-FF-1, 300-FF-2 & 300-FF-5 Operable Units).* A detailed discussion of uranium sequestration activities can be found in DOE/RL-2014-13-ADD2, *Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater* (referred to hereafter as the Groundwater Addendum).

The Groundwater Addendum (DOE/RL-2014-13-ADD2) calls for the enhanced attenuation area to target a 1 ha (3 ac) area containing a persistent source of uranium contamination to groundwater. In accordance with the Groundwater Addendum, uranium sequestration will be implemented using a staged approach. Stage A will consist of performing infiltration/injection in one quadrant of the Enhanced Attenuation Area (EAA), covering approximately 0.3 ha (0.75 ac). The Stage A results will be used to refine the Stage B approach for the remaining 3 quadrants (0.9 ha [2.25 ac]).

The Stage A enhanced attenuation area is near the inlet end of two liquid waste disposal sites (Figure 1-1). The northwest corner of the Stage A area is located at the southern end of 300 Area Process Trenches (waste site 316-5) which operated from 1975 to 1994 and received cooling water and low-level liquid waste from the 300 Area fuel fabrication facilities. Between 1991 and 1998, the trenches were excavated to a depth of 14 feet (ft) and backfilled with clean fill. The northeast corner of the Stage A area is located at the southeast end of the 300 Area North Process Pond (waste site 316-2) near the pond inlet. The pond was operated between 1948 and 1974 to dispose of cooling water and low-level waste from the 300 Area fuel fabrication facilities. Between 1998 and 1999, the pond was excavated to 25 ft and backfilled with clean fill.

The Stage A well field consists of 9 injection wells and a network of 13 deep monitoring wells and 13 shallow monitoring wells. Because the groundwater level in the 300 Area fluctuates in response to seasonal changes in river stage, the injection wells and monitoring wells are designed to treat and monitor uranium in the aquifer and in the periodically rewetted zone (PRZ) between the seasonal high and low water tables. The injection wells are designed with an upper screen set across the PRZ and a lower screen set within the aquifer below the historic low water table extending across the zone of highest contaminant concentration. During injection operations, the upper and lower screens are to be separated by an inflatable packer. The monitoring well network consist of 13 monitoring wells screened across the PRZ at depths coincident with upper injection well screens, and 13 deep monitoring wells with screens set below

the low water table at depths coincident with the lower injection well screens. Five existing wells will be used as monitoring wells. The document controlling the well drilling and construction of the remaining 30 wells was SGW-58553, *Description of Work for the Installation of Twenty Two Monitoring Wells and Nine Injection Wells in the 300-FF-5 Operable Unit, FY2015*.

The wells were installed between June 4, 2015 and August 6, 2015 by Holt Services Inc. using a sonic rig under the direction of CH2M HILL Plateau Remediation Company (CHPRC). Well-site geology services including contractor due diligence oversight was provided by TerraGraphics Environmental Engineering, Inc. and PBS Engineering and Environmental under direct management by CHPRC's Buyer's Technical Representative (BTR).

1.1 Purpose and Scope

This borehole summary report describes, in detail, field activities carried out during the installation and sampling of 30 wells as part of the Stage A uranium sequestration remedial action for the 300-FF-5 OU. The breadth of field activities and associated data included herein consists of drilling, sampling, well construction, and development. Also included in the scope of this report are borehole lithology descriptions, waste management information, well survey data, and final well acceptance dates.

The locations of the wells in the Stage A well field, including the 30 wells installed in accordance with SGW-58553, are shown in Figure 1-1. The 30 new wells shown in Figure 1-1 are listed by well type in Table 1-1. This document is organized by well type for ease of reference, and document navigation. The Well Summary Sheets, Borehole Logs, and Final Survey Reports for each well are located in the Appendices.

CHPRC procedures governing the drilling, geologic logging, well construction, and well development activities are listed in Section 7 of this document.

All wells are referred to by their C-series well identification (ID) numbers in the text of this report. All drilling data are reported in the original units recorded at the time of measurement.

Table 1-1. Stage A Enhanced Attenuation Well Drilling Summary

Well ID Number	Well Name	Drilling Dates		Washington State Department of Ecology Well Tag
		Start	Finish	
PRZ Monitoring Wells				
C8930	399-1-69	June 17, 2015	June 17, 2015	BJE 711
C8932	399-1-71	June 16, 2015	June 16, 2015	BJE 704
C8935	399-1-73	June 10, 2015	June 15, 2015	BJE 702
C8939	399-1-75	June 30, 2015	June 30, 2015	BJE 719
C8941	399-1-77	June 29, 2015	June 29, 2015	BJE 707
C9450	399-1-79	June 18, 2015	June 18, 2015	BJE 714
C9452	399-1-81	June 30, 2015	June 30, 2015	BJE 705
C9454	399-1-83	June 23, 2015	June 23, 2015	BJE 718
C9456	399-1-85	June 25, 2015	June 25, 2015	BJE 715
C9458	399-1-87	June 23, 2015	August 6, 2015	BJE 709

Table 1-1. Stage A Enhanced Attenuation Well Drilling Summary

Well ID Number	Well Name	Drilling Dates		Washington State Department of Ecology Well Tag
		Start	Finish	
Aquifer Wells				
C8931	399-1-70	June 15, 2015	June 16, 2015	BJE 703
C8934	399-1-72	June 9, 2015	June 10, 2015	BJE 701
C8937	399-1-74	June 29, 2015	June 29, 2015	BJE 706
C8940	399-1-76	July 7, 2015	July 13, 2015	BJE 720
C8942	399-1-78	June 22, 2015	June 22, 2015	BJE 713
C9408	399-1-65	June 18, 2015	June 18, 2015	BJE 712
C9409	399-1-66	June 17, 2015	June 17, 2015	BJE 710
C9451	399-1-80	July 14, 2015	July 14, 2015	BJE 721
C9453	399-1-82	June 24, 2015	June 24, 2015	BJE 717
C9455	339-1-84	June 25, 2015	June 25, 2015	BJE 716
C9457	399-1-86	June 22, 2015	June 23, 2015	BJE 708
Injection Wells				
C9460	399-1-89	June 8, 2015	August 4, 2015	BJE 725
C6461	399-1-90	June 16, 2015	August 4, 2015	BJE 726
C9462	399-1-91	July 22, 2015	August 5, 2015	BJE 727
C9463	399-1-92	July 20, 2015	August 4, 2015	BJE 730
C9464	399-1-93	June 8, 2015	August 5,2015	BJE 724
C9465	399-1-94	July 21, 2015	August 6, 2015	BJE 723
C9466	399-1-95	June 6, 2015	August 6, 2015	BJE 722
C9467	399-1-96	June 4, 2015	August 5, 2015	BJE 729
C9468	399-1-97	July 27, 2015	August 6, 2015	BJE 728

ID = Identification

PRZ = Periodically rewetted zone

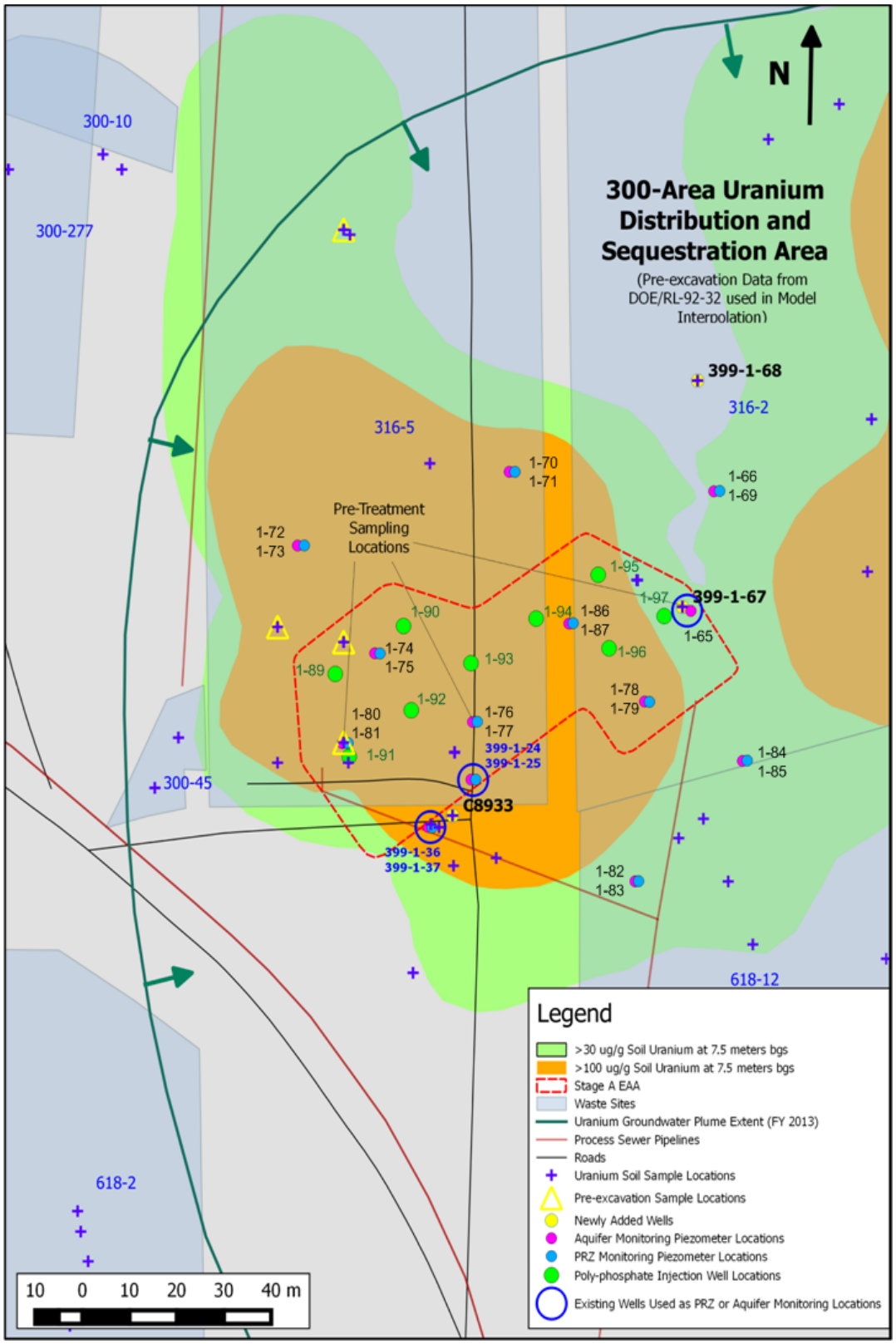

Figure 1-1 - Stage A Enhanced Attenuation Well Field.

(Note: The new wells installed in 2015 do not include the 399- prefix in the well name.)

1.2 Drilling Project Summary

This section summarizes the main elements of the drilling project and includes elements common to installation of all 30 wells.

1.2.1 Drilling

Drilling was conducted using a Terrasonic[1] 150 cc track-mounted sonic drill rig using unlined core barrels and temporary casing matched to the size of the core barrels with close tolerances. Aquifer and PRZ boreholes were drilled using a 4-in. inner diameter (I.D.), 4.875-in. outer diameter (OD) core barrel with 5-in. I.D., 6-in. OD threaded casing. Pilot holes for injection well were drilled using the same size core barrel and casing configuration as the aquifer and PRZ wells. Injection well boreholes were drilled following pilot holes using 7-in. I.D., 8-in. OD core barrel with 9.75-in. I.D., 10.75-in. OD threaded casing.

Injection wells were drilled to approximately 50 ft below ground suface (bgs). Aquifer monitoring wells were drilled to approximately 50 ft bgs, and PRZ monitoring wells were drilled to approximately 40 ft bgs. All measurements are as noted at the time of record.

1.2.2 Sampling

Soil samples for archive purposes were collected at 5 ft intervals and at lithology changes by the field site geologist per SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*. The samples were placed in pint–sized glass jars and chip trays. After the samples were collected and released by the radiological control technician (RCT), they were moved to CHPRC's soils library in the 400 Area.

Sieve samples were collected and analyzed per SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Soil- Wet Sieve Analysis* at the beginning of the project from four injection-well pilot boreholes to confirm anticipated sediment grain size distributions for well engineering. Sieve samples were collected by the field site geologist from split archive samples collected throughout the water table. The four wells sampled were C9460 (399-1-89), C9464 (399-1-93), C9466 (399-1-95), and C9467 (399-1-96).

Soil samples for analysis of uranium were collected from boreholes C8940 (399-1-76) and C9451 (399-1-80). Analytical soil samples were collected using a 4-in. by 2.5 ft long split spoon. Split spoon samplers were driven in continuous succession in these two boreholes from 10 ft to 32 ft and samples were collected from select portions of each split spoon to capture information necessary to satisfy data needs identified in SGW-56993, *Sampling Instruction for the 300-FF-5 Operable Unit Supplemental Post-ROD Field Investigation*, as amended by TPA-CN-656, TPA Change Notice Form, dated March 31, 2015, for SGW-56993, *Sampling Instruction for the 300-FF-5 Operable Unit Supplemental Post ROD Field Investigation.* One additional soil sample was collected from borehole C8935 (399-1-74) from a depth of 18 ft bgs where elevated levels of radioactive contamination was encountered. This sample was collected in accordance with provisions set forth in SGW-56993.

1.2.3 Well Construction

Well Materials – All of the aquifer and PRZ monitoring wells were constructed using threaded, 2-in. diameter, schedule 40 polyvinyl chloride (PVC) sumps and riser casing. The well screens were constructed using threaded, continuous wrap, 20-slot, 2-in. diameter, schedule 40 PVC. Screens for aquifer wells were placed below the seasonal low water level for the well field. Screens for PRZ wells were placed between the high and low seasonal water levels for the well field. Injection wells were

[1] Terrasonic is a copyright of Terra Sonic International, Marietta, Ohio.

constructed using threaded, 6-in. diameter, schedule 80 PVC for the sumps and riser casing. Injection wells were constructed with two 50-slot screens separated by a 5 ft blank casing section. Screens were constructed using 6-in. diameter, schedule 80 equivalent, continuous wrap PVC. Upper injection screens were placed in the PRZ and lower screens were placed below the low seasonal water level.

Annular Materials – All boreholes extending greater than 3 ft below the sump depths were decommissioned using bentonite. Aquifer and PRZ well annular fill materials included 10-20 mesh silica sand placed to within 5 ft of the top of the screens, 0.25-in. bentonite pellets placed 3 ft thick atop the filter pack, 0.375-in. bentonite chips placed to within 10 ft of ground surface, and neat cement-bentonite grout placed to within 2 ft of ground surface. Annular fill materials for all injection wells included: 8-16-mesh silica sand placed from just below the sumps to no greater than 5 ft above the top screen; 0.375-in. or 0.25-in. bentonite pellets placed 3 ft thick centered between screens; 0.25-in. bentonite pellets placed 3 ft. thick atop the upper interval filter pack; 0.375-in. bentonite chips placed to within 10 ft of ground surface; neat-cement-bentonite grout placed to within 2 ft of ground surface.

Well heads – Well heads were capped using a 12-in. diameter by 12-in. deep, weatherproof well vault placed in a 2 ft by 2 ft concrete pad set approximately 1-in. above ground surface. The well name, C-number and finish date were embossed on a bronze marker placed in the concrete pad on the north side of the well. Washington State Department of Ecology (Ecology) unique well identification tags were installed on the well casing inside the well vault.

1.2.4 Well Development

Well development for injection wells was conducted in accordance with SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*. Well development for aquifer monitoring wells and PRZ monitoring wells was conducted in accordance with SGRP-PRO-OP-50024, with special provisions made, as detailed in Section 2.

All of the wells were bailed, using a ball valve bailer, prior to development. The aquifer wells and PRZ wells were developed using a 12-volt submersible pump capable of pumping up to 2 gallons per minute (gpm). During pumping, the pump was raised and lowered by hand through the screened interval. Development continued until purge water “visibly cleared” per direction of the BTR and approval of CHPRC technical leads. Injection well lower screens were developed using a 2-horsepower (hp) submersible pump set in the center of the lower screen. Well C9468 (399-1-97) was developed using a 0.5-hp submersible pump approved by the BTR and CHPRC project management. Upper screens of injection wells were not developed since the upper screens were dry above the seasonal-low water level.

1.2.5 Environmental Monitoring

Radiological Field Screening – Screening was initially conducting during two daily checks in accordance with Revision 0 of GW-053, *Radiological Work Permit*. After encountering elevated radiological contamination in sediment during drilling at C8935 (399-1-73) (Section 2.1.5) on June 22, 2015, radiological field screening was conducted full time monitoring in accordance with Revision 2 of GW-053. Full time screening continued for the remainder of the project.

Air Quality Monitoring – Monitoring was provided twice daily by an Industrial Hygiene Technician (IHT) throughout the duration of the project, and during applicable split spoon soil sampling. No sustainable elevated readings for volatile organic compounds were reported during the project.

2 Well Specific Information

The following sections provide detailed information collected by the field geologists from TerraGraphics Environmental Engineering, Inc. and PBS Engineering and Environmental during the installation, sampling, and completion of the Stage A enhanced attenuation well field. This section is organized by well type to facilitate document navigation. Section 2.1 covers details specific to PRZ monitoring wells, Section 2.2 covers details specific to aquifer monitoring wells, and Section 2.3 covers details specific to injection wells. At the beginning of each section, construction summary tables and development tables are provided.

2.1 Ten PRZ Monitoring Wells: Drilling, Sampling, and Completion Activities

This section provides detailed information collected during drilling, sampling, construction, and development of the 10 PRZ monitoring wells. Well construction and development information for all 10 PRZ monitoring wells is summarized in Tables 2-1 and 2-2, respectively.

Drilling – Drilling was conducted using a Terrasonic 150 cc sonic drill rig. The temporary casing was threaded, carbon steel, 6-in. OD, 5-in. I.D., and 10 ft long. The core barrel was 4.875-in. outer diameter by 10 ft long. Drilling of all 10 wells took place between June 10, 2015 and June 30, 2015. All of the wells were drilled from ground surface to approximately 40 ft bgs.

Sampling – Sampling consisted of soil grab samples collected in 5 ft intervals, or at lithology changes, by the field site geologist for archive purposes. The samples were placed in pint jars and chip trays and were not collected if contamination was present. After the samples were surveyed and released by the RCT, they were moved to CHPRC's soils library in the 400 Area.

Well Construction – All of the PRZ wells were constructed using 2-in. diameter, schedule 40 PVC for the sumps and raisers. The well screens were 20-slot, 2-in. diameter, schedule 40 PVC. Table 2-1 and Appendix A provide the well construction details for each of the PRZ wells.

Well Development – The wells were bailed using a bailer with a ball valve. Bailing was done first in order to remove fines from the well. After the fines were removed, the well was pumped using a 2 gpm submersible pump. During the pumping process, the pump was raised and lowered by hand through the screened interval, to better develop the well. Development was concluded when the purgewater was determined to be "visibly clear" per direction of the BTR and CHPRC technical leads. Table 2-2 provides the well development details for each of the PRZ wells.

2.1.1 C8930 (399-1-69)

Drilling, sampling, and construction were performed at this site on June 17, 2015. The borehole was drilled from ground surface to a TD of 40 ft bgs. Static water level was measured at 29.3 ft bgs (June 17, 2015).

Well construction was conducted on June 17, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen, and riser casing. The permanent casing was placed from 0.4 ft bgs to 38.4 ft bgs. The sump with end cap was set at 38.4 ft bgs to 35.7 ft bgs. The screen was placed from 35.7 ft bgs to 30.7 ft bgs. Riser casing was placed from 30.70 ft bgs to 0.4 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40 ft bgs to 29.5 ft bgs. A bentonite pellet seal was placed from 29.5 ft bgs to 25.9 ft bgs. Bentonite chips were placed from 25.9 ft bgs to 9.7 ft bgs. Neat cement grout was used as a surface seal from 9.7 ft bgs to 0.84 ft bgs. Surface completion included the installation of a

12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag (BJE 711) was placed inside the protective monument on the grout surface seal.

Well development was performed on July 16, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.2 C8932 (399-1-71)

Drilling, sampling, and construction were performed at this site on June 16, 2015. The borehole was drilled from ground surface to a TD of 40 ft bgs. Static water level was measured at 31.2 ft bgs (June 16, 2015).

Well construction was conducted on June 16, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.45 ft bgs to 38.2 ft bgs. The sump with end cap was set at 38.2 ft bgs to 35.46 ft bgs. The screen was placed from 35.46 ft bgs to 30.43 ft bgs. Riser casing was placed from 30.43 ft bgs to 0.45 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40 ft bgs to 27.7 ft bgs. A bentonite pellet seal was placed from 27.7 ft bgs to 24.7 ft bgs. Bentonite chips were placed from 24.7 ft bgs to 10 ft bgs. Neat cement grout was used as a surface seal from 10 ft bgs to 1.3 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. The Ecology tag was placed inside the protective monument on the grout surface seal. An Ecology was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C8932 is BJE 704.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.3 C8935 (399-1-73)

Drilling, sampling, and construction were performed at this site from June 10, 2015 to June 17, 2015. The borehole was drilled from ground surface to a TD of 40.5 ft bgs. The maximum concentration of radiological contamination detected during drilling activities at C8935 was 18,000 disintegrations per minute (dpm) above background at 18 ft bgs. Static water level was measured at 31.1 ft bgs (June 11, 2015).

One soil sample was collected from a depth of 18 ft bgs where the highest level of radioactive contamination was encountered.

Well construction was conducted on June 15, 2015 using schedule 40, 2.375-in. OD and 2.125-in. ID PVC sump, screen and riser casing. The permanent casing was placed from 0.4 ft bgs to 35.9 ft bgs. The sump with end cap was set at 35.9 ft bgs to 33.27 ft bgs. The screen was placed from 33.27 ft bgs to 28.27 ft bgs. Riser casing was placed from 28.27 ft bgs to 0.4 ft bgs. A bentonite pellet seal was placed from 40 ft bgs to 35.9 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 35.9 ft bgs to 24.9 ft bgs. A bentonite pellet seal was placed from 24.9 ft bgs to 22.4 ft bgs. Bentonite chips were placed from 22.4 ft bgs to 10 ft bgs. Neat cement grout was used as a surface seal from 10 ft bgs to 0.75 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C8935 is BJE 702.

Well development was performed from July 15, 2015 to July 16, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.4 C8939 (399-1-75)

Drilling, sampling, and construction were performed at this site on June 29, 2015. The borehole was drilled from ground surface to a TD of 40.1 ft bgs. Static water level was measured at 31.8 ft bgs (June 29, 2015).

Well construction was conducted on June 29, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.36 ft bgs to 38.2 ft bgs. The sump with end cap was set at 38.2 ft bgs to 35.57 ft bgs. The screen was placed from 35.57 ft bgs to 30.57 ft bgs. Riser casing was placed from 30.57 ft bgs to 0.36 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.1 ft bgs to 28 ft bgs. A bentonite pellet seal was placed from 28 ft bgs to 25 ft bgs. Bentonite chips were placed from 25 ft bgs to 10 ft bgs. Neat cement grout was used as a surface seal from 10 ft bgs to 1.5 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag (BJE 707) was placed inside the protective monument on the grout surface seal.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.5 C8941 (399-1-77)

Drilling, sampling, and construction were performed at this site on June 30, 2015. The borehole was drilled from ground surface to a total depth (TD) of 40.17 ft bgs. Static water level was measured at 32.65 ft bgs on June 30, 2015.

Well construction was conducted on June 30, 2015. This well was constructed using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.55 ft bgs to 38 ft bgs. The sump with end cap was set at 38 ft bgs to 35.37 ft bgs. The screen was placed from 35.37 ft bgs to 30.37 ft bgs. Riser casing was placed from 30.37 ft bgs to 0.55 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.17 ft bgs to 27.75 ft bgs. A bentonite pellet seal was placed from 27.75 ft bgs to 25 ft bgs. Bentonite chips were placed from 25 ft bgs to 10.09 ft bgs. Neat cement grout was used as a surface seal from 10.09 ft bgs to 1.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag (BJE 719) was placed inside the protective monument on the grout surface seal.

Well development was performed on July 15, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.6 C9450 (399-1-79)

Drilling, sampling, and construction were performed at this site on June 18, 2015. The borehole was drilled from ground surface to a TD of 40.17 ft bgs. Static water level was measured at 31.6 ft bgs (June 18, 2015).

Well construction was conducted on June 18, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.8 ft bgs to 38.2 ft bgs. The sump with end cap was set at 38.2 ft bgs to 35.25 ft bgs. The screen was placed from 35.25 ft bgs to 30.25 ft bgs. Riser casing was placed from 30.25 ft bgs to 0.6 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.17 ft bgs to 28.09 ft bgs. A bentonite pellet seal was placed from 28.09 ft bgs to 25.13 ft bgs. Bentonite chips were placed from 25.13 ft bgs to 10.2 ft bgs. Neat cement grout was used as a surface seal from 10.2 ft bgs to 0.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft

surface concrete pad. An Ecology tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9450 is BJE 714.

Well development was performed on July 13, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.7 C9452 (399-1-81)

Drilling, sampling, and construction were performed at this site on June 30, 2015. The borehole was drilled from ground surface to a TD of 40.7 ft bgs. Static water level was measured at 34.8 ft bgs (June 30, 2015).

Well construction was conducted on June 30, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.25 to 38.25 ft bgs. The sump with end cap was set at 38.25 ft bgs to 35.61 ft bgs. The screen was placed from 35.61 to 30.61 ft bgs. Riser casing was placed from 30.61 to 0.25 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.7 to 28 ft bgs. A bentonite pellet seal was placed from 28 to 25.1 ft bgs. Bentonite chips were placed from 25.1 to 9.83 ft bgs. Neat cement grout was used as a surface seal from 9.83 to 1.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9452 is BJE 705.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.8 C9454 (399-1-83)

Drilling, sampling, and construction were performed at this site from June 23, 2015 to June 24, 2015. The borehole was drilled to a TD of 39.98 ft bgs. The temporary casing was advanced from ground surface to 39.98 ft bgs. Static water level was measured at 34.8 ft bgs (June 30, 2015).

Well construction was conducted on June 24, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.9 to 38.1 ft bgs. The sump with end cap was set at 38.1 to 35.35 ft bgs. The screen was placed from 35.35 to 30.35 ft bgs. Riser casing was placed from 30.35 to 0.9 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 39.98 to 28 ft bgs. A bentonite pellet seal was placed from 28 to 25 ft bgs. Bentonite chips were placed from 25 to 9.7 ft bgs. Neat cement grout was used as a surface seal from 9.7 to 0.7 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9454 is BJE 718.

Well development was performed on July 13, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.9 C9456 (399-1-85)

Drilling, sampling, and construction were performed at this site on June 25, 2015. The borehole was drilled from ground surface to a TD of 40.50 ft bgs. Static water level was measured at 31.8 ft bgs (July 14, 2015).

Well construction was conducted on June 25, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.64 to 38.21 ft bgs. The sump with end cap was set at 38.21 to 35.58 ft bgs. The screen was placed from 35.58 to 30.58 ft bgs.

Riser casing was placed from 30.58 to 0.64 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.5 to 27.3 ft bgs. A bentonite pellet seal was placed from 27.3 to 24.9 ft bgs. Bentonite chips were placed from 24.9 to 10 ft bgs. Neat cement grout was used as a surface seal from 10 to 0.7 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9456 is BJE 715.

Well development was performed on July 14, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.1.10 C9458 (399-1-87)

Drilling, sampling, and construction were performed at this site on June 23, 2015. The borehole was drilled from ground surface to a TD of 40.2 ft bgs. Static water level was measured at 31.6 ft bgs (July 20, 2015).

Well construction was conducted on June 23, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 38 ft bgs. The sump with end cap was set at 38 to 35.57 ft bgs. The screen was placed from 35.57 to 30.57 ft bgs. Riser casing was placed from 30.57 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.2 to 28.2 ft bgs. A bentonite pellet seal was placed from 28.2 to 25 ft bgs. Bentonite chips were placed from 25 to 9.5 ft bgs. Neat cement grout was used as a surface seal from 9.5 to 2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9458 is BJE 709.

Well development was performed on July 20, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

Table 2-1. PRZ Monitoring Well Construction Summary

Well ID/Well Name	TD (ft bgs)	Permanent Casing and Screen					Annular Materials				
		Well Riser Pipe[a] (ft bgs)	Screen[a] (ft bgs)	Screen Slot Size (inches)	Sump[a] (ft bgs)	Surface Seal[b] (ft bgs)	Surface Seal[c] (ft bgs)	Annular Seal[d] (ft bgs)	Annular Seal[e] (ft bgs)	Filter Pack[f] (ft bgs)	Annular Seal[g] (ft bgs)
C8930/ 399-1-69	40.00	0.40 – 30.70	30.70 – 35.70	0.020	35.70 – 38.40	0.80 – 0.84	0.84 – 9.70	9.70 – 25.90	25.90 – 29.50	29.50 – 40.00	N/A
C8932/ 399-1-71	40.00	0.45 – 30.43	30.43 – 35.46	0.020	35.46 – 38.20	0.60 – 1.30	1.30 – 10.80	10.80 – 24.70	24.70 – 27.70	27.70 – 40.00	N/A
C8935/ 399-1-73	40.00	0.40 – 28.27	28.27 – 33.27	0.020	33.27 – 35.90	0.00 – 0.75	0.75 – 10.00	10.00 – 22.40	22.40 – 24.90	24.90 – 35.90	35.90 – 40.00
C8939/ 399-1-75	40.10	0.36 – 30.57	30.57 – 35.57	0.020	35.57– 38.20	0.00 – 1.50	1.50 – 10.00	10.00 – 25.00	25.00 – 28.00	28.00 – 40.10	N/A
C8941/ 399-1-77	40.17	0.55 – 30.37	30.37 – 35.37	0.020	35.37 – 38.00	0.00 – 1.20	1.20 – 10.09	10.09 – 25.00	25.00 – 27.75	27.75 – 40.17	N/A
C9450/ 399-1-79	40.17	0.60 – 30.25	30.25 – 35.25	0.020	35.25 – 38.20	0.00 – 0.80	0.80 – 10.20	10.20 – 25.13	25.13 – 28.09	28.09 – 40.17	N/A
C9452/ 399-1-81	40.70	0.25 – 30.61	30.61 – 35.61	0.020	35.61 – 38.25	0.00 – 1.20	1.20 – 9.83	9.83 – 25.10	25.10 – 28.00	28.00 – 40.70	N/A
C9454/ 399-1-83	39.98	0.90 – 30.35	30.35 – 35.35	0.020	35.35 – 38.10	0.00 – 0.70	0.70 – 9.70	9.70 – 25.00	25.00 – 28.00	28.00 – 39.98	N/A
C9456/ 399-1-85	40.50	0.64 – 30.58	30.58 – 35.58	0.020	35.58 – 38.21	0.00 – 0.70	0.70 – 10.00	10.00 – 24.90	24.90 – 27.30	27.30 – 40.50	N/A
C9458/ 399-1-87	40.00	0.50 – 30.57	30.57 – 35.57	0.020	35.57 – 38.00	0.70 – 2.00	2.00 – 9.50	9.50 – 25.00	25.00 – 28.20	28.20 – 40.00	N/A

a. 2.375-in. OD and 2.125-in. I.D. schedule 40, PVC
b. Concrete
c. Type I-II Portland Cement grout
d. 3/8-in. bentonite crumbles
e. 3/8-in. bentonite pellets
f. 10-20 mesh Colorado Silica Sand
g. 3/8-in. bentonite pellets
ft bgs = feet below ground surface
N/A = not applicable

Table 2-2. PRZ Monitoring Well Development Summary

Well ID Number/Well Name	Date Developed	Initial Water Level (ft bgs)	Duration Pumped (minutes)	Total Gallons Pumped
C8930/ 399-1-69	7/16/2015	30.70	36	~36
C8932/ 399-1-71	7/09/2015	30.80	37	~37
C8935/ 399-1-73	7/16/2015	31.74	25	~25
C8939/ 399-1-75	7/09/2015	30.20	39	~39
C8941/ 399-1-77	7/15/2015	32.65	50	~50
C9450/ 399-1-79	7/13/2015	32.10	31	~31
C9452/ 399-1-81	7/09/2015	31.50	10	~10
C9454/ 399-1-83	7/13/2015	32.72	21	~21
C9456/ 399-1-85	7/14/2015	31.80	52	~52
C9458/ 399-1-87	7/20/2015	31.60	39	~39

~ = approximate
ft bgs = feet below ground surface

2.2 Eleven Aquifer Monitoring Wells: Drilling, Sampling, and Completion Activities

This section provides detailed information collected during drilling, sampling, construction, and development of the 11 aquifer monitoring wells. Well construction and development information for all 11 aquifer monitoring wells is summarized in Tables 2-5 and 2-6, respectively.

Drilling – Drilling was conducted using a Terrasonic 150 cc sonic drill rig using 6-in. OD, and 5-in. I.D. temporary, carbon steel, threaded casing. The core barrel used was 4.875-in. OD by 10-in. Drilling of all 11 wells took place between June 9, 2015 and July 13, 2015. All of the wells were drilled from ground surface to approximately 48 ft bgs.

Sampling – Sampling consisted of soil grab samples collected in 5 ft intervals, or at lithology changes, by the field site geologist for archive purposes. The samples were placed in pint jars and chip trays, and were not collected if contamination was present. After the samples were surveyed and released by the RCT, they were moved to CHPRC's soils library in the 400 Area. In addition to archive samples two of the boreholes had split spoon samples collected. Both C8940 (399-1-76) (Table 2-3) and C9451 (399-1-80) (Table 2-4) had split spoon samples collected continuously from approximately 10 to 32.5 ft bgs. Continuous IHT and RCT coverage was provided during the split spoon sampling process.

Well Construction – All of the aquifer monitoring wells were constructed using 2-in. schedule 40 PVC for the sumps and raisers. The well screens were 20-slot, 2-in. diameter, schedule 40 PVC. Table 2-5 and Appendix B provide the well construction details for each of the aquifer monitoring wells.

Well Development – The wells were bailed, using a ball bailer. Bailing was done first in order to remove fines from the well. After the fines were removed, the well was pumped using a 2 gpm submersible pump. During the pumping process the pump was raised and lowered, to better development the well. Development was concluded when the purgewater was determined to be "visibly clear" per direction of

the BTR and CHPRC technical leads. Table 2-6 provides the well development details for each of the aquifer monitoring wells.

2.2.1 C9408 (399-1-65)

Drilling, sampling, and construction were performed at this site on June 18, 2015. The borehole was drilled from ground surface to to a TD of 49.7 ft bgs. The maximum concentration of radiological contamination detected during drilling activities at this well was 3,000 dpm above background from 30 to 40 ft bgs. A radiological contamination reading of 1,000 dpm above background was also detected at 5 ft bgs. Static water level was measured at 30.33 ft bgs (June 30, 2015).

Well construction was conducted on July 18, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.35 to 48.6 ft bgs. The sump with end cap was set at 48.6 to 45.96 ft bgs. The screen was placed from 45.96 to 40.93 ft bgs. Riser casing was placed from 40.93 to 0.35 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 49.7 to 37.9 ft bgs. A bentonite pellet seal was placed from 37.9 to 34.7 ft bgs. Bentonite chips were placed from 34.7 to 10.86 ft bgs. Neat cement grout was used as a surface seal from 10.86 to 0.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9408 is BJE 712.

Well development was performed on June 30, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.2.2 C9409 (399-1-66)

Drilling, sampling, and construction were performed at borehole C9409 on June 17, 2015. The borehole was drilled from ground surface to a TD of 50.1 ft bgs. Static water level was measured at 31.15 ft bgs (July 20, 2015).

Well construction was conducted on July 17, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.4 to 47.1 ft bgs. The sump with cap was set at 47.1 to 44.47 ft bgs. The screen was placed from 44.47 to 39.48 ft bgs. Riser casing was placed from 39.48 to 0.4 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.1 to 37.95 ft bgs. A bentonite pellet seal was placed from 37.95 to 35.1 ft bgs. Bentonite chips were placed from 35.1 to 9.8 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.8 to 1.3 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C9409 is BJE 710.

Well development was performed on July 13, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.2.3 C8931 (399-1-70)

Drilling, sampling, and construction were performed at borehole C8931 from June 15, 2015 to June 16, 2015. The temporary casing was advanced from ground surface to 48.5 ft bgs. The borehole was further advanced uncased from 48.5 to 48.9 ft bgs using the down-hole drill bit. Static water level was measured at 33.8 ft bgs (June 15, 2015).

Well construction was conducted on June 16, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.3 to 48.98 ft bgs. The sump with cap was set at 48.98 to 46.25 ft bgs. The screen was placed from 46.25 to 41.25 ft bgs. Riser casing

was placed from 41.25 to 0.3 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 48.9 to 37.1 ft bgs. A bentonite pellet seal was placed from 37.1 to 34.9 ft bgs. Bentonite chips were placed from 34.9 to 10.1 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.1 to 1.5 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C8931 is BJE 703.

Well development was performed on August 6, 2015 using a 12-volt submersible pump capable of pumping up to 2gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.2.4 C8934 (399-1-72)

Drilling, sampling, and construction were performed at borehole C8934 from June 9, 2015 to June 10, 2015. The borehole was drilled from ground surface to a TD of 48.5 ft bgs. Static water level was measured at 31.69 ft bgs (July 16, 2015).

Well construction was conducted on June 10, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.35 to 47.4 ft bgs. The sump with cap was set at 47.4 to 44.67 ft bgs. The screen was placed from 44.67 to 39.67 ft bgs. Riser casing was placed from 39.67 to 0.35 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 48.5 to 39.9 ft bgs. A bentonite chips were placed from 39.9 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 1.30 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C8934 is BJE 701.

Well development was performed on July 16, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.2.5 C8937 (399-1-74)

Drilling, sampling, and construction were performed at borehole C8937 on June 29, 2015. The borehole was drilled from ground surface to a TD of 50.07 ft bgs. Static water level was measured at 30.2 ft bgs (July 9, 2015).

Well construction was conducted on June 29, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.3 to 47.8 ft bgs. The sump with cap was set at 47.8 to 45.17 ft bgs. The screen was placed from 45.17 to 40.17 ft bgs. Riser casing was placed from 40.17 to 0.3 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.07 to 37.2 ft bgs. A bentonite pellet seal was placed from 37.2 to 34.2 ft bgs. Bentonite chips were placed from 34.2 to 10.5 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.5 to 1.25 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C8937 is BJE 706.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.2.6 C8940 (399-1-76)

Drilling, sampling, and construction were performed at borehole C8940 from July 7, 2015 to July 13, 2015. The borehole was drilled from ground surface to a TD of 50.85 ft bgs. The maximum concentration of radiological contamination detected during drilling activities at C8940 was 10,000 dpm

above background at 38 ft bgs. A radiological contamination reading of 8,000 dpm above background was also detected at 22 ft bgs. Static water level was measured at 32.7 ft bgs (July 15, 2015). Continuous split spoon sampling was conducted from 10 to 32 ft bgs, and is presented in Table 2-3.

Well construction was conducted on July 13, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.45 to 47.85 ft bgs. The sump with cap was set at 47.85 to 45.23 ft bgs. The screen was placed from 45.23 to 40.22 ft bgs. Riser casing was placed from 40.22 to 0.45 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.85 to 37.92 ft bgs. A bentonite pellet seal was placed from 37.92 to 35 ft bgs. Bentonite chips were placed from 35 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 0.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C8940 is BJE 720.

Well development was performed on July 15, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

Table 2-3. Sample Summary: Well C8940 (399-1-76)

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
7/13/2015	10 – 12	Soil	Split Spoon	B31MY0, B31MY1, B31MY2, B31MY4
7/13/2015	12.5 – 14.5	Soil	Split Spoon	B31MY6, B31MY7, B31N00
7/13/2015	15 - 17	Soil	Split Spoon	B31N03, B31N05
7/13/2015	20 – 22	Soil	Split Spoon	B31N15 QC, B31N14, B31N13
7/13/2015	22.5 – 24.5	Soil	Split Spoon	B31N20, B31N19
7/13/2015	25 – 27	Soil	Split Spoon	B31N22, B31N23, B31N24, B31N25, B31N26
7/13/2015	27.5 – 29.5	Soil	Split Spoon	B31N27, B31N28, B31N29, B31N30, B31N31
7/13/2015	30 - 32	Soil	Split Spoon	B31N33, B31N34, B31N35, B31N36

ft bgs = feet below ground surface
HEIS = Hanford Environmental Information System

2.2.7 C8942 (399-1-78)

Drilling, sampling, and construction were performed at borehole C8942 on June 22, 2015. The borehole was drilled from ground surface to a TD of 50.3 ft bgsThe maximum concentration of radiological contamination detected during drilling activities at C8942 was 3,000 dpm above background from 22 to 30 ft bgs. Static water level was measured at 31.2 ft bgs (June 30, 2015).

Well construction was conducted on June 22, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 48.3 ft bgs. The sump with cap was set at 48.3 to 45.52 ft bgs. The screen was placed from 45.52 to 40.51 ft bgs. Riser casing was placed from 40.51 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.3 to 37.8 ft bgs. A bentonite pellet seal was placed from 37.8 to 35.1 ft bgs. Bentonite chips were placed from 35.1 to 9.8 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.8 to 1.4 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron

weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C8942 is BJE 713.

Well development was performed on June 30, 2015 and July 1, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer. During pumping, the pump was raised and lowered by hand through the screened interval. During this process the pump was separated from the drop pipe connecting it to the surface. There were several attempts to recover the pump. However, no attempts were successful and the pump remains in the sump. Development continued until purge water visibly cleared per direction of the BTR and approval of CHPRC technical leads.

2.2.8 C9451 (399-1-80)

Drilling, sampling, and construction were performed at borehole C9451 on July 14, 2015. The borehole was drilled from ground surface to a TD of 50.5 ft bgs. Static water level was measured at 32.8 ft bgs (July 14, 2015). Continuous split spoon sampling was conducted from 10 to 32 ft bgs, and is presented in Table 2-4.

Well construction was conducted on July 14, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen, and riser casing. The permanent casing was placed from 0.29 to 48.3 ft bgs. The sump with cap was set at 48.3 to 45.56 ft bgs. The screen was placed from 45.56 to 40.54 ft bgs. Riser casing was placed from 40.54 to 0.29 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.5 to 37.11 ft bgs. A bentonite pellet seal was placed from 37.11 to 35 ft bgs. Bentonite chips were placed from 35 to 9.5 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.5 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C9451 is BJE 721.

Well development was performed on July 15, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

Table 2-4. Sample Summary: Well C9451 (399-1-80)

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
7/14/2015	10 – 12	Soil	Split Spoon	B31N62, B31N63, B31N65, B31N64, B31N66
7/14/2015	12.4 – 14.4	Soil	Split Spoon	B31N70, B31N69, B31N71
7/14/2015	15 - 17	Soil	Split Spoon	B31N72, B31N73, B31N75, B31N74, B31N76 (DUP)
7/14/2015	17.5 – 19.5	Soil	Split Spoon	B31N78, B31N79, B31N81, B31N80, B31N82
7/14/2015	20 – 22	Soil	Split Spoon	B31N84, B31N86, B31N85, B31N87
7/14/2015	22.5 – 24.5	Soil	Split Spoon	B31N91, B31N90
7/14/2015	25 – 27	Soil	Split Spoon	B31N97, B31N96
7/14/2015	27.5 – 29.5	Soil	Split Spoon	B31NB0, B31NB2, B31NB1, B31NB3
7/14/2015	30 - 32	Soil	Split Spoon	B31NB7, B31NB6

ft bgs = feet below ground surface
HEIS = Hanford Environmental Information System

2.2.9 C9453 (399-1-82)

Drilling, sampling, and construction were performed at borehole C9453 on June 24, 2015. The borehole was drilled from ground surface to a TD of 51.0 ft bgs. Static water level was measured at 31.4 ft bgs (June 30, 2015).

Well construction was conducted on June 24, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 48.3 ft bgs. The sump with cap was set at 48.3 to 45.55 ft bgs. The screen was placed from 45.55 to 40.5 ft bgs. Riser casing was placed from 40.5 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 51 to 35.6 ft bgs. A bentonite pellet seal was placed from 35.6 to 32.1 ft bgs. Bentonite chips were placed from 32.1 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 1.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C9453 is BJE 717.

Well development was performed on July 14, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.2.10 C9455 (399-1-84)

Drilling, sampling, and construction were performed at borehole C9455 on June 25, 2015. The borehole was drilled from ground surface to a TD of 60.0 ft bgs. Static water level was measured at 32 ft bgs (July 14, 2015).

Well construction was conducted on June 25, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.45 to 55.66 ft bgs. The sump with cap was set at 55.66 to 53.02 ft bgs. The screen was placed from 53.02 to 48.01 ft bgs. Riser casing was placed from 48.01 to 0.45 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 57 to 44.7 ft bgs. A bentonite pellet seal was placed from 44.7 to 42 ft bgs. Bentonite chips were placed from 42 to 10.2 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.2 to 1.6 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C9455 is BJE 716.

Well development was performed on July 14, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

2.2.11 C9457 (399-1-86)

Drilling, sampling, and construction were performed at borehole C9457 from June 22, 2015 to June 23, 2015. The borehole was drilled from ground surface to a TD of 50.1 ft bgs. Static water level was measured at 29.14 ft bgs (July 20, 2015).

Well construction was conducted on June 23, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 48.02 ft bgs. The sump with cap was set at 48.02 to 45.39 ft bgs. The screen was placed from 45.39 to 40.39 ft bgs. Riser casing was placed from 40.39 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.1 to 38 ft bgs. A bentonite pellet seal was placed from 38 to 35.1 ft bgs. Bentonite chips were placed from 35.1 to 10.5 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.5 to 2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather

proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology tag was placed inside the protective monument. The Ecology tag assigned to C9457 is BJE 708. Table 2-5 and Appendix B provide the well construction details.

Well development was performed on July 20, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

Table 2-5. Aquifer Monitoring Well Construction Summary

Well ID/Well Name	TD (ft bgs)	Permanent Casing and Screen					Annular Materials			
		Well Riser Pipe[a] (ft bgs)	Screen[a] (ft bgs)	Screen Slot Size (inches)	Sump[a] (ft bgs)	Surface Seal[b] (ft bgs)	Surface Seal[c] (ft bgs)	Annular Seal[d] (ft bgs)	Annular Seal[e] (ft bgs)	Filter Pack[f] (ft bgs)
C9408/ 399-1-65	49.70	0.35 – 40.93	40.93 – 45.96	0.020	45.96 – 48.60	0.00 – 0.80	0.80 – 10.86	10.86 – 34.70	34.70 – 37.90	37.90 – 49.70
C9409/ 399-1-66	50.10	0.40 – 39.48	39.48 – 44.47	0.020	44.47 – 47.10	0.00 – 1.30	1.30 – 9.80	9.80 – 35.10	35.10 – 37.95	37.95 – 50.10
C8931/ 399-1-70	48.90	0.30 – 41.25	41.25 – 46.25	0.020	46.25 – 48.98	0.00 – 1.50	1.50 – 10.10	10.10 – 34.90	34.90 – 37.10	37.10 – 48.90
C8934/ 399-1-72	48.50	0.35 – 39.67	39.67 – 44.67	0.020	44.67 – 47.40	0.00 – 1.30	1.30 – 10.00	10.00 – 39.90	N/A	39.90 – 48.50
C8937/ 399-1-74	50.07	0.30 – 40.17	40.17 – 45.17	0.020	45.17 – 47.80	0.00 – 1.25	1.25 – 10.50	10.50 – 34.20	34.20 – 37.20	37.20 – 50.07
C8940/ 399-1-76	50.85	0.45 – 40.22	40.22 – 45.23	0.020	45.23 – 47.85	0.00 – 0.80	0.80 – 10.00	10.00 – 35.00	35.00 – 37.92	37.92 – 50.85
C8942/ 399-1-78	50.30	0.50 – 40.51	40.51 – 45.52	0.020	45.52 – 48.30	0.00 – 1.40	1.40 – 9.80	9.80 – 35.10	35.10 – 37.80	37.80 – 50.30
C9451/ 399-1-80	50.50	0.29 – 40.54	40.54 – 45.56	0.020	45.56 – 48.30	0.00 – 1.00	1.00 – 9.50	9.50 – 35.00	35.00 – 37.11	37.11 – 50.50
C9453/ 399-1-82	51.00	0.50 – 40.50	40.50 – 45.55	0.020	45.55 – 48.30	0.00 – 1.80	1.80 – 10.00	10.00 – 32.10	32.10 – 35.60	35.60 – 51.00
C9455/ 399-1-84	60.00	0.45 – 48.01	48.01 – 53.02	0.020	53.02 – 55.66	0.00 – 1.60	1.60 – 10.20	10.20 – 42.00	42.00 – 44.70	44.70 – 57.00
C9457/ 399-1-86	50.10	0.50 – 40.39	40.39 – 45.39	0.020	45.39 – 48.02	0.00 – 2.00	2.00 – 10.50	10.50 – 35.10	35.10 – 38.00	38.00 – 50.10

a. 2.375 in. OD, 2.125 in. ID. schedule 40, PVC
b. Concrete
c. Type I-II Portland Cement grout
d. 3/8-in. bentonite crumbles
e. 3/8-in. bentonite pellets
f. 10-20 mesh Colorado Silica Sand
ft bgs = feet below ground surface
N/A = not applicable

Table 2-6. Aquifer Monitoring Well Development Summary

Well ID Number/Well Name	Date Developed	Initial Water Level (ft bgs)	Duration Pumped (minutes)	Total Gallons Pumped
C8931/399-1-70	6/29/2015	30.85	17	~17
C8934/399-1-72	7/16/2015	31.69	41	~41
C8937/399-1-74	7/9/2015	30.20	44	~44
C8940/399-1-76	7/15/2015	32.7	30	~30
C8942/399-1-78	7/11/2015	31.20	36	~36
C9408/399-1-65	6/30/2015	30.33	72	~72
C9409/399-1-66	7/13/2015	31.15	70	~70
C9451/399-1-80	7/15/2015	31.78	103	~103
C9453/399-1-82	7/14/2015	32.36	29	~29
C9455/399-1-84	7/14/2015	32.00	80	~80
C9457/399-1-86	7/20/2015	29.14	58	~58

~ = approximate
ft bgs = feet below ground surface

2.3 Nine Injection Wells: Drilling, Sampling, and Well Completion Activities

This section provides detailed information collected during drilling, sampling, construction, and development of the nine injection wells. Well construction and development information for all 9 injection wells is summarized in Tables 2-7 and 2-8, respectively.

Drilling – Drilling was conducted using a Terrasonic 150 cc sonic drill rig. The carbon steel, threaded, temporary casing used was 10.75-in. OD and 9.75-in. I.D. The core barrel was 8-in. OD by 10 ft long. Drilling of all nine wells took place between June 4, 2015 and August 6, 2015. All of the wells were drilled from ground surface to approximately 50 ft bgs. Four of the boreholes had 6-in. diameter pilot holes drilled initially, in order collect sieves samples to determine the screen aperture for well construction.

Sampling – Sampling consisted of soil grab samples collected in 5 ft intervals, and at lithology changes, by the field site geologist for archive purposes. The samples were placed in pint jars and chip trays, and were not collected if contamination was present. After the samples were surveyed and released by the RCT, they were moved to CHPRC's soils library in the 400 Area. Sieve samples were collected from wells C9460 (399-1-89), C9466 (399-1-95), C9467 (399-1-96), and C9468 (399-1-97) by compiling split portions of grab samples collected from below the water table over 10 ft long intervals into batches for the sieve analysis. The composited sieves samples were processed to determine particle size distribution for the selection of well screen slot size.

Well Construction – All of the injection wells were constructed using 6.75-in. OD, 6-in. I.D., schedule 80 PVC for the sumps and risers. The well screens were 50 slot, 6.75-in. OD, 6-in. I.D., schedule 80 PVC. Table 2-7 and Appendix C provide the well construction details for each of the injection wells.

Well Development – Well development of thelower screened intervals took place between August 4, 2015 and August 6, 2015. In accordance with CHPRC procedure GRP EE 01 6.3, Well Development and Testing. Drawdown and recovery tests were monitored using an In-Situ[2] Inc. Level TROLL 700 pressure transducer/data logger. Table 2-8 provides the well development details for the lower screened interval in each of the injection wells.

2.3.1 C9460 (399-1-89)

Well C9460 was drilled from ground surface to a TD of 50.5 ft bgs. The drilling was started on June 8, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. diameter by 10 ft long core barrel to 50.5 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen slot size. Water was tagged at 31.1 ft bgs. On June 9, 2015 the borehole was backfilled using 30-mesh silica sand. On July 15, 2015 the borehole was drilled in the same location using 10.75-in. OD casing from ground surface to 50.5 ft bgs, with an 8-in. diameter by 10 ft long core barrel. This process removed all of the 30-mesh silica sand.

Well construction was conducted on July 16, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.9 to 45.39 ft bgs. The first screen was placed from 45.39 to 35.39 ft bgs. The sump and first screen were surrounded by a 8-16 mesh sand from 50.9 to 34.92 ft bgs. A 5 ft blank riser was placed from 35.39 to 30.39 ft bgs. A bentonite pellet seal was placed from 34.92 to 31.99 ft bgs. A second screen was placed from 30.39 to 20.39 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.99 to 16.89 ft bgs. PVC riser was added from 20.39 to 0.7 ft bgs. Bentonite pellets were placed from 16.84 to 14.1 ft bgs to create a seal above the second screen. Bentonite chips were placed from14.1 to 10.2 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.2 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weatherproof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 725) was attached to the casing inside the vault.

Well development was conducted on August 4, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 3,077.4 gallons of water was pumped, at a purge rate of 44.6 gpm. Well development was deemed complete when the turbidity readings were less than 5 nephelometric turbidity units (NTU) and the remaining parameters were within 10% of the previous readings.

2.3.2 C9461 (399-1-90)

Well C9461 was drilled from ground surface to a TD of 51.05 ft bgs. The drilling was conducted on July 16, 2015. The borehole was cased using 10.75-in. OD and 9.75-in. I.D. from ground surface to 50.3 ft bgs.

Well construction was conducted in July 20, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.95 to 45.44 ft bgs. The first screen was placed from 45.44 to 35.43 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 51.05 to 34.9 ft bgs. A 5 ft blank riser was placed from 35.43 to 30.43 ft bgs. A bentonite pellet seal was placed from 34.9 to 31.95 ft bgs. A second screen was placed from 30.43 to 20.42 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.95 to 16.83 ft bgs. PVC riser was added from 20.42 to 0.7 ft bgs. Bentonite pellets were placed from 16.83 to

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14.1 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14.1 to 9.87 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.87 to 1.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 726) was attached to the casing inside the vault. A 1.88 ft by 1.9 ft well pad was poured around the protective monument.

Well development was conducted on August 4, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 2,044.16 gallons of water was pumped, at a purge rate of 63.88 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

2.3.3 C9462 (399-1-91)

Well C9462 was drilled from ground surface to a TD of 50.17 ft bgs. The drilling was conducted on July 20, 2015. The borehole was cased using 10.75-in. OD and 9.75-in. I.D. from ground surface to 50.03 ft bgs.

Well construction was conducted in July 21, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.54 to 44.97 ft bgs. The first screen was placed from 44.97 to 34.98 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 50.17 to 35.33 ft bgs. A 5 ft blank riser was placed from 34.98 to 29.98 ft bgs. A bentonite pellet seal was placed from 35.33 to 32 ft bgs. A second screen was placed from 29.98 to 19.98 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32 to 17.08 ft bgs. PVC riser was added from 19.98 to 0.35 ft bgs. Bentonite pellets were placed from 17.08 to 14.08 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14.08 to 9.15 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.15 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 727) was attached to the casing inside the vault.

Well development was conducted on August 4, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 2,945 gallons of water was pumped, at a purge rate of 54.76 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

2.3.4 C9463 (399-1-92)

Well C9463 was drilled and cased from ground surface to a TD of 49.55 ft bgs. The drilling was conducted on July 22, 2015.

Well construction took place between July 22, 2015 and July 23, 2015 using schedule 80, 6.75-in., OD and 6-in. I.D. PVC sump, screens, and riser. The sump with cap was set at 48.88 to 45.31 ft bgs. The first screen was placed from 45.31 to 35.31 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 49.55 to 35 ft bgs. A 5.01 ft blank riser was placed from 35.31 to 30.3 ft bgs. A bentonite pellet seal was placed from 35 to 32.17 ft bgs. A second screen was placed from 30.3 to 20.3 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32.17 to 16.92 ft bgs. PVC riser was added from 20.3 to 0.7 ft bgs. Bentonite pellets were placed from 16.92 to 14 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14 to 9.92 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.92 to 2.3 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault

set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE-730) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 4,104 gallons of water was pumped, at a purge rate of 76 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

2.3.5 C9464 (399-1-93)

Well C9464 was drilled from ground surface to a TD of 50.5 ft bgs. The drilling was started on June 8, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. by 10 ft core barrel to 50.5 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen size. Water was tagged at 31.6 ft bgs. On June 8, 2015 the borehole was backfilled using 30-mesh silica sand. On July 6, 2015 the borehole was drilled using 10.75-in. OD casing from ground surface to 50.5 ft bgs, with an 8-in. by 10 ft core barrel. This process removed all of the 30-mesh silica sand.

Well construction took place on July 15, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.05 to 44.54 ft bgs. The first screen was placed from 44.54 to 34.54 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 50.90 to 34.98 ft bgs. A 4.99 ft blank riser was placed from 34.54 to 29.55 ft bgs. A bentonite pellet seal was placed from 34.98 to 32.18 ft bgs. A second screen was placed from 29.55 to 19.55 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32.18 to 16.97 ft bgs. PVC riser was added from 19.55 to 0.2 ft bgs. Bentonite pellets were placed from 16.97 to 14.00 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14.00 to 10.00 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.00 to 3.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE-724) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 1,090 gallons of water was pumped, at a purge rate of 54.54 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

2.3.6 C9465 (399-1-94)

Well C9465 was drilled and cased from ground surface to a TD of 49.82 ft bgs on July 21, 2015.

Well construction took place on July 22, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.8 to 45.23 ft bgs. The first screen was placed from 45.23 to 35.24 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 49.82 to 35 ft bgs. A 5 ft blank riser was placed from 35.24 to 30.24 ft bgs. A bentonite pellet seal was placed from 35 to 31.82 ft bgs. A second screen was placed from 30.24 to 20.24 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.83 to 16.92 ft bgs. PVC riser was added from 20.24 to 0.55 ft bgs. Bentonite pellets were placed from 16.92 to 14 ft bgs to create a seal above the second screen. Bentonite chips were placed from14 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 1.05 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft

surface concrete pad. A Washington State Ecology well identification tag (BJE 723) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 3,002.36 gallons of water was pumped, at a purge rate of 63.88 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

2.3.7 C9466 (399-1-95)

Well C9466 was drilled from ground surface to a TD of 50.3 ft bgs. The drilling was started on June 6, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. by 10 ft core barrel to 50.3 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen size. The borehole was backfilled using 30-mesh silica sand. On July 23, 2015 the borehole was drilled using 10.75-in. OD casing from ground surface to 50.2 ft bgs, with an 8-in. by 10 ft core barrel. This process removed all of the 30-mesh silica sand.

Well construction was conducted in July 27, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 49.44 to 45.91 ft bgs. The first screen was placed from 45.91 to 35.92 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 50.3 to 35 ft bgs. A 5 ft blank riser was placed from 35.92 to 30.92 ft bgs. A bentonite pellet seal was placed from 35 to 31.96 ft bgs. A second screen was placed from 30.92 to 20.92 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.96 to 16.8 ft bgs. PVC riser was added from 20.92 to 0 ft bgs. Bentonite pellets were placed from 16.88 to 14.5 ft bgs to create a seal above the second screen. Bentonite chip were placed from14.5 to 10.16 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.16 to 2.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 722) was attached to the casing inside the vault.

Well development was conducted on August 6, 2015 using a 0.5-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 500 gallons of water was pumped, at a purge rate of 11 to 14 gpm. The pump would not successfully run for more than 10 minutes at a time, causing well development to be prematurely concluded (before turbidity dropped below 5 NTUs and field parameters stabilized).

2.3.8 C9467 (399-1-96)

Well C9467 was drilled from ground surface to a TD of 49.38 ft bgs. The drilling was started on June 4, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. by 10 ft core barrel to 49.38 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen size. Water was tagged at 31.45 ft bgs. On June 4, 2015 the borehole was backfilled using 30-mesh silica sand. On July 23, 2015 the borehole was drilled using 10.75-in. OD casing from ground surface to 50.5 ft bgs, with an 8-in. by 10 ft core barrel. This process removed all of the 30-mesh silica sand.

Well construction was conducted in July 23, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D. PVC sump, screens, and riser. The sump with cap was set at 48.38 to 44.87 ft bgs. The first screen was placed from 44.87 to 34.88 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 49.38 to 34.83 ft bgs. A 5 ft blank riser was placed from 34.88 to 29.88 ft bgs. A bentonite pellet seal was placed

from 34.83 to 32.18 ft bgs. A second screen was placed from 29.88 to 19.88 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32.18 to 14.1 ft bgs. PVC riser was added from 19.88 to 0.2 ft bgs. Bentonite pellets were placed from 16.84 to 14.1 ft bgs to create a seal above the second screen. Bentonite chips were placed from14.1 to 9.94 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.94 to 2.8 ft bgs.Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 729) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 3,570.68 gallons of water was pumped, at a purge rate of 60.5 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

2.3.9 C9468 (399-1-97)

Well C9468 was drilled and cased from ground surface to a TD of 50 ft bgs. The drilling was conducted between July 27, 2015 and July 28, 2015.

GWell construction took place on July 28, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.42 to 44.9 ft bgs. The first screen was placed from 44.9 to 34.9 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 50 to 34.92 ft bgs. A 5 ft blank riser was placed from 34.9 to 29.9 ft bgs. A bentonite pellet seal was placed from 34.92 to 32 ft bgs. A second screen was placed from 29.9 to 19.9 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32 to 16.9 ft bgs. PVC riser was added from 19.9 to 0.2 ft bgs. Bentonite pellets were placed from 16.9 to 13.87 ft bgs to create a seal above the second screen. Bentonite chips were placed from13.87 to 9.76 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.76 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 728) was attached to the casing inside the vault.

Well development was conducted on August 6, 2015 using a 0.5-hp submersible pump in the lower screen only. The upper screen was not developed since it was above the seasonal low water mark at the time. A total of 465.5 gallons of water was pumped, at a purge rate of 13.33 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

Table 2-7. Injection Well Construction Summary

Well ID/Well Name	TD (ft bgs)	Permanent Casing and Screen				Annular Materials						
		Well Riser Pipe[a] (ft bgs)	Upper Screen[a]/ Lower Screen (ft bgs)	Screen Slot Size (inches)	Sump[a] (ft bgs)	Surface Seal[b] (ft bgs)	Surface Seal[c] (ft bgs)	Annular Seal[d] (ft bgs)	Annular Seal[e] (ft bgs)	Filter Pack[f] (ft bgs)	Annular Seal[e] (ft bgs)	Filter Pack[f] (ft bgs)
C9460/ 399-1-89	50.90	0.70 – 20.39 / 30.39 – 35.39	20.39 – 30.39 / 35.39 – 45.39	0.050 / 0.050	45.39 – 48.90	0.00 – 1.00	1.00 – 10.20	10.20 – 14.10	14.10 – 16.89	16.89 – 31.99	31.99 – 34.92	34.92 – 50.90
C9461/ 399-1-90	51.03	0.70 – 20.42 / 30.43 – 35.43	20.42 – 30.43 / 35.43 – 45.44	0.050 / 0.050	45.44 – 48.95	0.00 – 1.20	1.20 – 9.87	9.87 – 14.10	14.10 – 16.83	16.83 – 31.95	31.95 – 34.90	34.90 – 51.03
C9462/ 399-1-91	50.17	0.35 – 19.98 / 29.98 – 34.98	19.98 – 29.98 / 34.98 – 44.97	0.050 / 0.050	44.97 – 48.54	0.00 – 1.00	1.00 – 9.15	9.15 – 14.08	14.08 – 17.08	17.08 – 32.00	32.00 – 35.33	35.33 – 50.17
C9463/ 399-1-92	49.55	0.70 – 20.30 / 30.30 – 35.31	20.30 – 30.30 / 35.31 – 45.31	0.050 / 0.050	45.31 – 48.88	0.00 – 2.30	2.30 – 9.92	9.92 – 14.00	14.00 – 16.92	16.92 – 32.17	32.17 – 35.00	35.00 – 49.55
C9464/ 399-1-93	50.90	0.20 – 19.95 / 29.95 – 34.94	19.95 – 29.95 / 34.94 – 44.94	0.050 / 0.050	44.94 – 48.45	0.00 – 2.05	2.05 – 10.20	10.20 – 14.00	14.00 – 16.97	16.97 – 32.18	32.18 – 34.98	34.98 – 50.90
C9465/ 399-1-94	49.82	0.55 – 20.24 / 30.24 – 35.24	20.24 – 30.24 / 35.24 – 45.23	0.050 / 0.050	45.23 – 48.80	0.00 – 1.05	1.05 – 10.00	10.00 – 14.00	14.00 – 16.92	16.92 – 31.83	31.83 – 35.00	35.00 – 49.82
C9466/ 399-1-95	50.30	0.00 – 20.92 / 30.92 – 35.92	20.92 – 30.92 / 35.92 – 45.91	0.050 / 0.050	45.91 – 49.44	0.00 – 2.80	2.80 – 10.16	10.16 – 14.50	14.50 – 16.80	16.80 – 31.96	31.96 – 35.00	35.00 – 50.30
C9467/ 399-1-96	49.38	0.20 – 19.88 / 29.88 – 34.88	19.88 – 29.88 / 34.88 – 44.87	0.050 / 0.050	44.87 – 48.38	0.00 – 2.80	2.80 – 9.94	9.94 – 14.10	14.10 – 16.70	16.70 – 32.18	32.18 – 34.83	34.83 – 49.38
C9468/ 399-1-97	50.00	0.20 – 19.90 / 29.90 – 34.90	19.90 – 29.90 / 34.90 – 44.90	0.050 / 0.050	44.90 – 48.42	0.00 – 1.00	1.00 – 9.76	9.76 – 13.87	13.87 – 16.90	16.90 – 32.00	32.00 – 34.92	34.92 – 50.00

a. 6-in. schedule 80, PVC
b. Concrete
c. Type I-II Portland Cement grout
d. 3/8-in. bentonite crumbles
e. 3/8-in. bentonite pellets
f. 8-16 mesh Colorado Silica Sand
ft bgs = feet below ground surface
NA = not applicable

Table 2-8. Injection Well Lower Screened Interval Development Summary

Well ID/Well Name	Date Developed	Initial Water Level (ft bgs)	Pump Intake Depth (ft bgs)	Duration Pumped (minutes)	Average Flow Rate (gpm)	Maximum Drawdown (ft)	Final Turbidity (NTU)	Specific Conductance (µS/cm)	pH	Temperature (C)	Total Gallons Pumped
C9460/399-1-89	8/04/2015	31.37	40.10	69	44.60	2.91	3.25	475	7.37	16.89	~3,077
C9461/399-1-90	8/04/2015	31.65	41.10	32	63.88	3.33	2.22	469	7.69	16.89	~2,044
C9462/399-1-91	8/04/2015	32.00	41.10	42	54.76	0.33	4.01	475	8.62	16.87	~2,945
C9463/399-1-92	8/05/2015	32.20	42.50	54	76.00	0.00	3.82	466	7.45	16.86	~4,101
C9464/399-1-93	8/05/2015	32.05	42.50	20	54.54	0.12	1.96	472	7.71	16.88	~1,090
C9465/399-1-94	8/05/2015	32.16	42.50	47	63.88	0.48	3.79	470	7.42	16.98	~3,002
C9466/399-1-95	8/06/2015	31.30	42.40	30	12.5	2.63	19.00	476	7.45	16.97	~500
C9467/399-1-96	8/05/2015	31.35	42.70	59	60.50	2.38	4.19	463	7.30	16.85	~3,570
C9468/399-1-97	8/06/2015	31.05	42.40	35	13	0.11	2.08	490	7.22	16.92	~465

ID = Identification
NTU = nephelometric turbidity unit
~ = approximately
ft bgs = feet below ground surface
gpm = gallons per minute

3 Geologic Observations

Section 3.1 summarizes the general stratigraphy and depositional setting of the Pasco Basin and Hanford Site, including the 300 Area. Section 3.2 provides detailed descriptions of geologic units encountered in the Stage A enhanced attenuation area. Sectionn 3.3 provides well-specific geologic details encountered during drilling of each borehole.

3.1 Geology of the 300 Area

The 300 Area is located along the southeastern margin of the Hanford Site within the Pasco Basin. The principal stratigraphy of the Hanford Site in ascending age is as follows:

- Holocene surficial deposits
- Pleistocene Hanford formation sediments
- Post-Ringold/Pre-Hanford deposits (Cold Creek Unit) (not present under well field)
- Miocene-Pliocene Ringold Formation sediments
- Miocene Columbia River Basalt Group and interbedded Miocene Ellensburg Formation sediments

Holocene surficial deposits in the 300 Area includes a thin veneer of surficial sediments consisting of unconsolidated Holocene aeolian sands and loess, generally less than 16 ft in thickness. Locally, these sediments have been removed from the well field during previous work to install, and later remediate, the north process ponds, trenches and adjacent grounds (PNNL-18340, *Borehole Completion and Conceptual Hydrogeologic Model for the IFRC Well Field, 300 Area, Hanford Site*).

The Hanford formation represents Pleistocene-age cataclysmic flood and inter-flood deposits and can be principally divided into three major facies each deposited in different portions of the Pasco basin (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*). These facies include a gravel-dominated facies, a sand-dominated facies and a fine-grained interbedded sand-and silt-facies. The gravel-dominated facies is deposited throughout the central portion of the Pasco basin roughly following the Columbia River forming several bars to the south of gable ridge across most of the Hanford Site. These gravels were deposited by the highest energy flow paths of the cataclysmic floods. The sand-dominated facies is principally deposited to the south of gable ridge extending across the bulk of the Hanford Site to the foot of rattle snake ridge and overlies much of the Hanford gravels, where present, in this area. The sand-dominated facies were deposited by intermediate- to low-flow floodwaters. The fine-grained interbedded sand- and silt-dominated facies is deposited on the margins of the Pasco basin and were deposited by slack water deposits at the peripheries of the cataclysmic flood channels (DOE/RL-2002-39). The 300 Area lies in the main channel of the flood waters, consequently, only the gravel-dominated facies of the Hanford formation are present in the 300 Area (PNNL-18340). The Hanford gravels in the 300 Area are up to 50 ft thick.

Calcareous sediments of the Cold Creek Unit separate the Hanford formation from the Ringold Formation, and represent mainstream alluvial, calcic paleosol, sidestream alluvial, colluvial, and overbank-aeolian environments marginal to the ancestral Columbia River. These sediments are not present at the 300-FF-5 OU, although gravels belonging to the Cold Creek Unit are found to the north and west of the OU (WHC-EP-0500, *Geology and Hydrology of the 300 Area and Vicinity, Hanford Site, South Central Washington*).

The Ringold Formation is primarily composed of fluvially-derived sand and gravel. The Ringold Formation, in descending order, consists of the Upper Ringold Unit (primarily gravelly sand), Unit "E" of

the Ringold Formation (primarily sandy gravel), the Ringold Lower Mud (primarily silt and fine sand) and Unit "A" of the Ringold Formation (primarily sandy gravel). Two discontinuous mud and silt intervals are reported (WHC-SD-EN-TI-052, *Phase I Hydrogeologic Summary of the 300-FF-5 Operable Unit, 300 Area*) within the Ringold Unit "E" gravels in the 300 Area. These units are potentially important because they may create semi-confined conditions in the 300 Area. Thickness of the Ringold Formation ranges from approximately 95 to 144 ft in the vicinity of the 300 Area (PNNL-18340).

Unit "E" of the Ringold Formation is dominated by clast-supported gravels. It is estimated that Unit "E" has a thickness of 50 to 65 ft. Based on two nearby wells (wells 399-1-16D and 399-1-17C), the contact between the Hanford formation and Unit "E" of the Ringold Formation is located at approximately 40 to 50 ft bgs (DOE/RL-2014-13).

The Ringold Lower Mud Unit sequence is composed of crudely laminated clay and silt and appears to be continuous across the operable unit. The lower mud sequence is approximately 30 to 40 ft thick. Based on two nearby wells (wells 399-1-16D and 399-1-17C), the Ringold Lower Mud Unit is located at approximately 115 to 120 ft bgs (DOE/RL-2014-13).

Gravels of the Ringold Formation Unit A are not present in the 300 Area (DOE/RL-2014-13).

The Ringold Formation is underlain by flood basalt flows of the Miocene Columbia River Basalt Group. The uppermost basalt unit encountered in the 300 Area is the Ice Harbor Member. The basalt surface dips towards the northwest (i.e., towards the axis of the Cold Creek syncline). Depth to basalt from surface ranges from approximately 193 ft at the western boundary of the 300 Area to approximately 175 ft adjacent to the river (DOE/RL-2014-13).

During this project, only the gravel-dominated unit of the Hanford formation and Ringold Unit E gravels were encountered. Ringold Unit E was not fully penetrated.

3.2 Geology of the Stage A Enhanced Attenuation Area

This section includes detailed lithologic descriptions of units encountered across the Stage A enhanced attenuation area.

Disturbed surface sediments and natural back fill of the 316-2 North Process Pond and 316-5 300 Area Process Trenches are comprised of Hanford formation sediments. This material is dark gray to very dark gray colored, matrix to clast supported, very poorly sorted sandy cobble gravel and clast supported gravel with no apparent fabric. Large boulders are often present throughout the fill material as well. Bedding and grading may be present in fill material as a relic of layering from the back-fill process. Fill in the 316-5 Process Trenches is present from ground surface to 16 to 18 ft bgs. Fill in the 316-2 North Process Pond extends from ground surface to no greater than 24 ft bgs, and disturbed surface sediments surrounding the trenches and ponds extend from ground surface to approximately 2 ft. The base of fill material often had very little resistance to drilling and produced very low- to no-recovery due to lack of moisture, and lack of cohesion.

The Hanford formation underlies the Stage A area between 2 ft and 50 ft bgs. It ranges in color from gray to dark grayish brown to black. The sediment is comprised principally of unconsolidated poorly-sorted, clast-supported slightly-silty, sandy pebble- to cobble-gravel. Grain size ranges widely from silt to boulders. Bedding, where present, ranges from 4-in. to several feet thick and typically exhibits normal grading with no apparent fabric in core. Beds less than 4 ft thick typically exhibit better overall sorting and better apparent grading than thicker beds. The formation contains abundant, sporadic, very-well-sorted, open-matrix beds and lenses of nearly 100% basalt. These matrix free beds and lenses range in thickness from a few inches up to 6 ft and are very discontinuous (often, not traceable between boreholes

placed as close as 3 to 4 ft apart). Lithology of the Hanford formation across the well field is prominently comprised of 70 to 99% sub-angular basalt, and 1% to 30% well rounded, intermediate composition porphyritic volcanics, quartzite, and gneiss. Sand composition typically range between 85% and 90% mafic medium to very-coarse granules, with 10% to 20% fine to medium quartz-felsdpar granules. Silt matrix in the Hanford formation typically does not exceed 15%.

Rip up clasts of silt and gravelly silt are present in abundance throughout the Hanford formation as encountered sporadically throughout the well field. Rip up clasts are typically composed of non- to very-well indurated massive to finely laminated silt, clayey silt and gravelly silt. The rip up clasts encountered throughout the well field range in size from a few inches up to 4 ft. Rip up clasts are typically colored olive brown to brown.

The base of the Hanford formation generally exhibits a relatively continuous bed of very well sorted, normal graded open framework gravel grading from very-fine pebbles to large-cobbles gravel. This open framework gravel generally is found resting atop a sharp contact with silt belonging to the Ringold Formation. Where Ringold silt is not present at the contact, gravels from both units are blended together over a 2 to 5 ft interval.

A silty sand and silt fine-grained Ringold subunit identified in (PNNL-18340) that overlays the Ringold E gravels in the vicinity of the South Process Ponds was not encountered throughout the phosphate injection well field. Though stratigraphically equivalent, discontinuous sand lenses were encountered in the top few feet of the Ringold Unit E gravles in some of the deep wells associated with this project.

The Ringold Formation Unit E gravel is present across the well field encountered in wells between 37 and 50.5 ft bgs. The Ringold Formation encountered under the phosphate injection well field typically consists of olive-yellow-brown colored, semi-consolidated- to well-consolidated, well-rounded ,matrix-supported, felsic-dominated, sandy gravels, silty sandy gravels, with 6-in. to 2 ft thick discontinuous beds of, gravelly-sand and sand. Gravels typically are moderately-well sorted, very well rounded, ranging in size from fine pebbles to large cobbles. Lithology of the Ringold Formation throughout the well field is composed of greater than 60% well rounded, iron stained, quartzite, intermediate composition porphyritic volcanics, gneiss, and granitiods and less than 40% basalt, andesite, and andesite lapilli tuff. Mafic clasts are typically less rounded and less altered. Sand fractions in gravels and in sand beds are very-fine to medium-grained, composed of 85% to 95% quartz feldspar with 5% to 15% mafic composition with up to 10% gold and silver muscovite mica. Silt fractions in gravels range from 0% to 20% of bulk composition and are typically olive yellow to tan colored and range from non-clayey to moderately clayey with no- to –moderate plasticity. Rindold Formation sediments throughout the well field generally have a low to moderate reaction to hydrochloric acid (HCl).

Of particular interest in this project is the intermittent presence of an oxidized zone and a reduced zone encountered below 44 ft bgs within the Ringold Formation under the well field. The oxidized zone ranges in color from faint brown to yellow to bright orange and does not appear to be associated with any particular strata type. The strongest oxidation appears in wells farthest to the east within and proximal to the former 316-2 North Process Pond and is fiant to absent in wells to the west of the former pond. The reduced zone is present immediately below the oxidized zone (where present) and ranges in color from faint blue gray to blue green, and also does not appear to be associated with a specific strata type. Furthermore, the boundary between the oxidized and reduced zone (where the oxidized zone is present) does not appear to be coincident with any particular sediment texture or type and does not appear to be controlled by any particular sediment type or boundaries between sediment types. The oxidized and reduced zones range in thickness from 4-in. to 6 ft or more with anoxic zones extending to the base of the deepest holes penetrated across the well field at 50 ft.

3.3 Well-Specific Geology

This section provides details of lithologic units encountered in each borehole drilled in the Stage A area. Wells are organized by type. For full lithologic descriptions of geology encountered in each borehole, please refer to the borehole logs included in the Appendices.

3.3.1 Ten PRZ Wells: Well Specific Geology

This section summarizes the geology encountered while drilling the 10 PRZ wells. The colors noted in this section were taken from a Munsell Color[3] chart. Borehole logs are provided in Appendix A.

3.3.1.1 C8930 (399-1-69)

Well C8930 was drilled to a TD of 40.5 ft bgs on June 17, 2015. Only Hanford formation was encountered in this well.

Disturbed Hanford formation, and possibly fill, was encountered from ground surface to 12 ft bgs comprised of 2.5Y3/2 very dark grayish brown, unconsolidated, poorly-sorted- to very-poorly-sorted, very fine pebbles to boulders up to 250mm with a sand matrix. Gravels grade from coarse pebbles to boulders from 8 to 12 ft towards the base of the interval.

Hanford formation was encountered in this well from 12 to 40 ft bgs. Sandy gravel was encountered from 12 to 21 ft bgs consisting of 2.5Y3/2 very dark grayish brown colored moderately-well sorted, very-fine- to medium-pebbles with sparse boulders up to 250 mm with fine to very coarse sand of 95% mafic composition. From 21 to 29 ft bgs slightly silty sandy gravel was encountered composed of poorly sorted fine- to coarse-pebbles of with very fine to medium sand and 10-15% non-plastic silt colored 2.5Y3/2 very dark grayish brown. From 29 to 30 ft, a one foot layer of slightly clayey coatings on open matrix clasts was encountered. Sandy gravel was encountered from 29 to 34 ft bgs composed of bimodal medium pebbles and small cobbles of 80% mafic composition with very fine to very coarse 90% mafic sand colored 5Y4/2 olive gray. From 34.2 to 39 ft bgs sandy gravel was encountered composed of moderately sorted very-fine- to coarse-pebbles of 90% mafic composition with poorly sorted 95% mafic sand. A slight downward fining sequence was noted through this interval. From 39 to 40.5 ft bgs, silty gravel consisting of poorly sorted very fine pebbles to small cobbles of 95% basalt, 5% felsics with a matrix of non plastic silt colored 2.5Y4/2 dark grayish brown.

Of particular interest in this well is the presence of a 2-in. thick black bed of moderately sorted clayey silty sandy gravel located from 34 to 34.2 ft bgs composed of medium- to very-coarse pebbles of 99% basalt with very fine to very coarse 99% mafic sand colored 2.5Y2.5/1 (black).

3.3.1.2 C8932 (399-1-71)

Well C8930 was drilled to a TD of 40 ft bgs on June 16, 2015. Only Hanford formation was encountered in this well.

Disturbed Hanford formation was encountered from ground surface to 3 ft bgs consisting of 5YR3/2 dark reddish brown, poorly sorted sandy gravel ranging in size from fine pebbles to large cobbles.

Hanford formation was encountered in this well from 3 ft to TD of 40 ft bgs. From 3 to 16 ft bgs, 2.5Y 4/3 reddish brown sandy gravel was encountered comprised of poorly sorted fine pebbles to small boulders up to 120mm with a matrix of slightly silty sand of 40% mafic/ 60% felsic composition. From 16 to 30 ft bgs, 7.5Y 3/1 very dark gray colored, poorly sorted, sandy gravel is present comprised of 60%

[3] Munsell Color 2013 is a copyright of X-Rite, Incorporated. All rights reserved.

very fine pebbles to small cobbles of 40% mafic, 60% felsic gravel with a matrix of 30% fine to coarse sand with up to 10% low plastic silt.

At 17 ft bgs, a 6-inch (in). gravelly clay rip up clast was encountered. From 26.5 to 28 ft bgs, a 1.5 ft diameter rip up clast of silty sandy gravel was encountered composed of 40% gravel, 30% fine to medium sand and 30% medium plastic silt. No color was recorded for these rip up clasts.

From 30 to 40 ft bgs, 7.5Y4/1 dark gray colored, sandy gravel was encountered comprised of poorly sorted very-fine pebbles to small-cobbles up to 120 mm of 60% mafic, 40% felsic gravel with a matrix of 20% fine to very coarse sand with up to 10% silt. Of particular note in this well was the lack of a discernible oxic and anoxic zone.

3.3.1.3 C8935 (399-1-73)

Well C8935 was drilled to a TD of 40.5 ft bgs between June 10, 2015 and June 11, 2015. Only Hanford formation was encountered in this well.

Disturbed Hanford formation was encountered from ground surface to 5 ft bgs. This material consisted of unconsolidated, 2.5Y4.1 dark gray colored, very poorly sorted, Hanford formation of 80% basalt gravel up to 120mm in size with 50/50 mafic:felsic sand.

Hanford formation was encountered from 5 ft to TD at 40.5 ft bgs. Poorly sorted, fine pebble- to small cobble, silty sandy gravel colored 2.5Y5/3 brown was encountered from 5 to 16 ft bgs. From 16 to 18.5 ft bgs, gravel of well-rounded, medium- coarse-pebbles of 99% basalt, colored 2.5Y5/1black was encountered. A 6-in. thick bed of very well sorted silty gravel containing medium- to coarse-pebbles colored 2.5 Y3/1 very dark gray was encountered. From 19 to 25 ft, poorly sorted clayey silty sandy gravel colored 2.5Y 4/2 dark grayish brown was encountered comprised of very fine to very coarse pebbles with sparse small cobbles. From 25 to 30 ft bgs, dark gray to dark grayish brown, sandy gravel to silty sandy gravel was encountered. From 30 to 31 ft bgs, gravelly silt was encountered containing up to 60% non-plastic 2.5Y2.5/1 black silt with 30% very-fine- to fine-pebbles of 90% basalt. From 31 to 34 ft bgs, moderately sorted fine-pebble to small-cobble silty sandy gravel was encountered. From 34 to 35 ft bgs, Gravel of fine to medium pebbles of 95% basalt was encountered. From 35 to 40 ft bgs, moderately sorted, silty sandy gravel containing very fine pebbles to small cobbles of 70% basalt, with medium to coarse sand of 85% basalt was encountered.

Of particular interest was the pervasive anoxic zone coloration of sediments from 31-40 ft bgs colored GLEY1 3/1 very dark greenish gray. Also of note was the notable lack of oxic yellowish orange coloration above the anoxic zone that was observed in other wells.

Another point of interest is that radiological contamination was encountered between 18.5 ft and 30 ft bgs with an 18,000 dpm beta, gamma spike at the 6-in. black clay coated open matrix gravel bed and drops off to 3,000 dpm beta gamma between 19 ft and 20 ft then continues do drop of towards background between 20 ft and 30 ft bgs. It may be possible that the contamination at 18.5 to 19.5 ft may have been confined to that bed and was drug downward by drilling. It should also be noted that the horizontal extent of the contamination may be localized to a few feet since contamination was not identified in the adjacent borehole 399-1-72 (C8924) located 4 ft to the east.

3.3.1.4 C8935 (399-1-75)

Well C8935 was drilled to TD on June 9, 2015. Only Hanford formation was encountered in this well.

Fill material of Hanford formation was encountered from ground surface to 14 ft bgs consisting of poorly sorted sandy gravel with clasts ranging from very-fine pebbles to small cobbles of 60% mafic, 40% felsic

composition with fine to medium sand matrix colored 2.5Y3/3 gray. The driller noted having to hold back pressure on the drill head to prevent it from nearly free falling through the sediments as a testament to how loose the sediments were through this sediment.

Hanford formation was encountered in this well from 14 ft to the TD of 40.5 ft bgs. From 14 to 35 ft bgs, sandy gravel was encountered composed of 2.5Y3/1 very dark gray, very poorly sorted, very fine pebbles to large cobbles of 60% mafic, 40% felsic composition with fine to coarse sand of 60% mafic, 40% felsic composition. From 35 to 40.5 ft bgs slightly silty sandy gravel was encountered composed of 2.5Y 3/1 very dark gray colored, poorly sorted very fine pebbles to large cobbles of composition similar to the above unit. No significant variation in lithology from the accepted description of the Hanford formation was noted at this borehole.

3.3.1.5 C8941 (399-1-77)

Well C8941 was drilled to a TD of 40.17 ft bgs on June 30, 2015. Only Hanford formation was encountered in this well.

Fill or disturbed Hanford formation was encountered from ground surface to 4 ft bgs composed of 2/5Y3/3 dark olive brown colored sandy gravel consisting of poorly sorted very fine pebbles to large cobbles of 60% mafic, 40% felsic composition with medium sand of 60%mafic, 40% felsic composition. Back fill may extend to 16 ft bgs at this location exhibited by the presence of boulders, and the presence of rip up clasts below 16 ft bgs in this well.

Hanford formation was encountered from 4 to TD of 40 ft bgs in this well. From 4 to 16 ft bgs, sandy gravel colored 2.5Y3/3 dark olive brown was encountered composed of very poorly sorted very fine pebbles to large cobbles of 60% mafic, 40% felsic composition with 25% and 30% fine to very coarse sand of 60% mafic, 40% felsic composition. From 16 to 21 ft the same gravels coarsen down ward with maximum clasts ranging up to 250mm diameter boulders. From 21 to 40 ft, 2.5Y3/1 very dark gray colored very-poorly sorted sandy gravel was encountered composed of very fine pebbles to boulders ranging up to 250 mm in diameter with up to 30% poorly sorted mafic dominated sand forming the matrix. At 38 ft bgs, a 1.25 ft lens or bed of near open matrix, very well sorted well rounded gravel of small cobbles was noted with up to 15% clayey silt coating clasts. Color was not noted for this sub-unit.

Of particular notice in this well is the presence of abundant rip up clasts. At 25 ft bgs, a 9-in. diameter rip up clast of 80% silt, 20% find sand colored 2.5Y4/3 olive brown was encountered. At 28 ft bgs, a 6-in. rip up clast colored 2.5Y5/2 grayish brown was encountered composed of 60% fine sand, 30% sub-round gravel.

3.3.1.6 C9450 (399-1-79)

Well C9450 was drilled to a TD of 40 ft bgs on June 18, 2015. Only Hanford formation was encountered in this well.

Natural fill or disturbed Hanford formation was encountered from ground surface to 17.5 ft bgs composed of 2.5Y 6/1 gray to 2.5Y4/2 dark grayish brown colored sandy gravel consisting of moderately sorted very fine pebbles to small cobbles of 60% felsic, 40% mafic composition with very fine coarse sand of 80% felsic, 20% mafic composition.

Hanford formation was encountered from 17.5 ft to the TD of 40 ft bgs. From 17.5 to 23 ft bgs, sandy gravel was encountered comprised of 65% moderate sorted, rounded- to sub-rounded, very-fine-pebbles to small-cobbles with very fine to coarse sand colored 2.5Y4/2 dark grayish brown. From 23 to 30 ft bgs, gravels of the same makeup fine considerably with improved sorting ranging from very fine- to coarse-pebbles with poorly sorted sand colored 2.5Y4/1 dark gray. From 30 to 40 ft bgs, moderately sorted sandy

gravel was encountered composed of very fine- to very-coarse-pebbles with poorly sorted sand colored 2.5Y4/1 dark gray. No unique sub-units were noted in this well.

3.3.1.7 C9452 (399-1-81)

Well C9452 was drilled to a TD of 40.7 ft bgs on June 30, 2015. Only Hanford formation was encountered in this well.

Natural fill and disturbed Hanford formation was encountered from ground surface to 3 ft bgs, composed of 2.5Y3/3 very dark olive brown sandy gravel consisting of moderately sorted, very fine pebbles to very coarse pebbles of 60% mafic, 40% felsic composition with poorly sorted sand matrix.

Hanford formation was encountered from 3 ft to TD of 40.7 ft bgs. From 3 to 9 ft bgs, poorly sorted sandy gravel was encountered consisting of very vine pebbles to small boulders of 60% mafic, 40% felsic composition with poorly sorted sand of 60% mafic, 40% felsic composition. From 9 to 21 ft bgs, 2.5Y3/1 very dark gray colored, poorly sorted sandy gravel was encountered composed of similar composition to the above interval, but the with maximum gravel size decreasing to large cobbles. From 21 to 40.7 ft bgs, sandy gravel continued from the above intervals but the modal abundance of gravel ranged from very fine to very coarse pebbles, with 20% large cobbles up to 200 mm in diameter. This interval was noted as 2.5Y3/2 dark grayish brown.

Of interest in this unit, at 28 ft bgs, a 1 ft thick bed or lens of nearly open matrix, well sorted, silty gravel was encountered consisting of 85% gravel and 15% silt. No further details were recorded.

3.3.1.8 C9454 (399-1-83)

Well C9454 was drilled to a TD of 39.98 ft bgs on June 24, 2015. Only Hanford formation was encountered in this well.

From ground surface to 3.2 ft bgs, silty sand colored 2.5Y3/2 very dark grayish brown was encountered composed of fine to coarse silty sand of 40% mafic, 60% felsic composition with 5% fine pebbles to small cobbles of 70% mafic, 30% felsic composition. Slightly silty sandy gravel was encountered from 3.2 to 17 ft bgs composed of 54% poorly sorted fine pebbles to large cobbles of 50% mafic, 50% felsic composition with 40% fine to coarse sand colored 2.5Y4/1 dark gray. Sand was encountered from 17 to 28 ft bgs consisting of 2.5Y4/3 dark grayish brown colored, 95% fine to medium sand of 60% mafic, 40% felsic composition with trace silt and up to 3% gravel. From 28 to 39.7 ft bgs, poorly sorted sandy gravel was encountered composed of very fine pebbles to large cobbles of 70% mafic, 40% felsic composition with poorly sorted sand of 60% mafic, 40% felsic composition. This unit was noted as 7.5 YR 2.5/1 black in color.

An agglomerated rip up clast of 2.5Y5/1 gray colored micaceous, low plastic silt with 30% moderately sorted angular very fine pebbles to small cobbles of 60% mafic, 40% felsic composition and 10% coarse sand of 60% mafic, 40% felsic composition with no reaction to HCl.

Of particular interest is a 1-in. thick pervasively colored oxic band colored 2.5YR3.4 dark reddish brown noted at 36 ft within the sandy gravel unit.

3.3.1.9 C9456 (399-1-85)

Well C9456 was drilled to a TD of 40.5 ft bgs on June 25, 2015. Only Hanford formation was encountered in this well.

From ground surface to 2.7 ft bgs, slightly silty sandy gravel was encountered composed of 35% moderately sorted medium pebbles to small cobbles of 70% mafic, 30% felsic composition with fine to

coarse sand of 60% mafic, 40% felsic composition with up to 15% 2.5Y3/3 dark olive brown colored silt. Sandy gravel was encountered from 2.7 to 17 ft bgs composed of 50% poorly sorted very fine pebble to large cobbles of 65% mafic, 35% felsic composition with poorly sorted sand of 60% mafic, 40% felsic composition colored 2.5Y 4/1 dark gray. From 17 to 40 ft bgs, slightly silty sandy gravel was encountered consisting of 45% poorly sorted fine pebbles to very coarse pebbles with 2% large cobbles of 60% mafic, 40% felsic composition with well sorted coarse to very coarse of 60% mafic, 40% felsic composition colored 2.5Y 3/1 very dark gray. From 34 ft bgs, and 39 ft bgs, two lenses of very well sorted, almost matrix free well- to sub-rounded gravels of coarse to very coarse pebbles was encountered.

Within the above units, at 18 ft bgs is a 2-in. thick horizon of clayey gravel colored 2.5Y6/4 light yellowish brown with a strong reaction to HCl. No other notes were made on this bed. A 6-in. thick lens of silty sandy gravel was encountered composed of 40% gravel, 40% non plastic silt colored 2.5Y6/4 light yellowish brown with 20% very fine sand.

3.3.1.10 C9458 (399-1-87)

Well C9458 was drilled to ground surface to 40 ft bgs on June 23, 2015. Only Hanford formation was encountered in this well.

Gravelly sand was encountered from ground surface to 2.8 ft bgs composed of 70% fine to coarse sand of 40% mafic, 60% felsic composition with 20% moderately sorted very fine pebbles to very coarse pebbles of 70% mafic, 30% felsic composition with up to 10% silt colored 2.5Y3/2 very dark grayish brown. from 2.8 to 23 ft bgs, sandy gravel was encountered composed of very poorly sorted very fine pebbles to boulders of 60% mafic, 40% felsic composition with very fine to coarse sand of 40% mafic, 60% felsic composition with 10% silt colored 2.5Y 4/1 dark gray. A one ft thick Silty gravel lens was encountered from 23 to 24 ft composed of 70% moderately sorted medium pebble to small cobble with coarse sand of 80% mafic, 20% felsic composition colored 2.5Y 4/1 dark gray. From 24 to 37 ft bgs, sandy gravel was encountered composed of 45% moderately sorted very fine- to coarse-pebbles of 60% mafic, 40% felsic composition with fine to very coarse sand of 50% mafic, 50% felsic composition with 10% silt colored 2.5Y 3/1 very dark gray. Silty gravel was encountered from 37 to 40 ft bgs composed of 75% poorly sorted, well rounded, fine pebbles to small cobbles of 70% mafic, 30% felsic composition with 10% coarse sand of 80% mafic, 20% felsic composition with up to 15% silt.

3.3.2 Eleven Aquifer Monitoring Wells: Well Specific Geology

This section summarizes the geology encountered during the drilling of 11 aquifer monitoring wells. The borehole logs are provided in Appendix B.

3.3.2.1 C9408 (399-1-65)

Stratigraphic units identified during the drilling of well C9408 include the Hanford formation and Ringold formation.

Well C9408 was drilled from ground surface to a TD of 49.7 ft bgs. The gravel pad at this site extends from ground surface to 0.4 ft bgs. Hanford formation sediments were encountered from 0.4 to 40 ft bgs. Sub-rounded, fine pebble to cobble, sandy gravel colored 2.5Y 4/1 dark gray was encountered from 0.4 to 30 ft bgs. From 30 to 38 ft bgs, silty sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y 4/1 very dark gray was encountered. From 38 to 40 ft bgs, sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y 4/1 very dark gray was encountered. Ringold Formation sediments were encountered from 40 to 49.7 ft bgs. Sub-rounded, fine pebble to cobble, sandy gravel colored 10YR 6/6 brownish yellow was encountered from 40 to 44.5 ft bgs. From 44.5 to 49.7 ft bgs, medium to very coarse micaceous sand colored 10YR 5/3 to 10YR 3/2 brown to very dark grayish brown was encountered.

3.3.2.2 C9409 (399-1-66)

Stratigraphic units identified during the drilling of well C9409 include the Hanford formation and Ringold Formation.

Well C9409 was drilled from ground surface to a TD of 50.1 ft bgs. The gravel pad at this site extends from ground surface to 0.8 ft bgs. Hanford formation sediments were encountered from 0.8 to 37.5 ft bgs poorly sorted, well rounded, fine pebble to small cobble, sandy gravel colored 2.5Y 4/2 dark grayish brown was encountered from 0.8 to 13 ft bgs. From 13 to 19 ft bgs, sandy gravel of moderate to poorly sorted, fine pebbles to coarse pebbles colored 2.5Y 2.5/1 black was encountered. From 19 to 23 ft bgs, silty sandy gravel of moderately sorted, well rounded, fine pebbles to coarse pebbles colored 2.5Y 3/2 very dark grayish brown was encountered. From 23 to 26 ft bgs, silty gravel of well rounded, medium pebbles to small cobbles colored 2.5Y 4/3 very dark grayish brown was encountered. From 26 to 29 ft bgs, sandy gravel of moderate to poorly sorted, fine pebbles to large cobbles colored 2.5Y 3/2 very dark grayish brown was encountered. Sub-rounded, fine pebble to cobble, sandy gravel colored 10YR 6/6 brownish yellow was encountered from 40 to 44.5 ft bgs. Yellowish brown coloration was most intense at the first upper most occurrence of oxidation and gradually became less pronounce with depth. The strongest oxidation in this instance appears to have been coincident with a transition from very porous sediments to less porous fine grained sediments. Ringold Formation sediments were encountered from 44.5 to 49.7 ft bgs, composed of medium to very coarse micaceous sand colored 10YR 5/3 to 10YR 3/2 brown to very dark grayish brown.

3.3.2.3 C8931 (399-1-70)

Stratigraphic units identified during the drilling of well C8931 include the Hanford formation.

Well C8931 was drilled from ground surface to a TD of 48.9 ft bgs. The gravel pad at this site extends from ground surface to 0.75 ft bgs. Hanford formation sediments were encountered from 0.75 to 48.9 ft bgs. Poorly sorted, sub-rounded to sub-angular, fine pebble to cobble, silty sandy gravel colored 5YR 3/2 dark reddish brown was encountered from 0.75 to 3 ft bgs. From 3 to 14 ft bgs, silty sandy gravel of poorly sorted, angular to sub-rounded, fine pebbles to cobbles colored 2.5YR 4/3 reddish brown was encountered. From 14 to 32 ft bgs, silty sandy gravel of poorly sorted, angular to round, fine pebbles to cobbles colored 7.5YR 3/1 very dark gray was encountered. Possible Ringold Formation rip up clast observed at 17 ft bgs. Rip up clasts consist of micaceous fine grain sand/silt approximately 80% felsic. From 32 to 45 ft bgs, silty sandy gravel of poorly sorted, sub-rounded to well rounded, pebbles to cobbles colored 7.5YR 4/1 dark gray was encountered. From 45 to 48.9 ft bgs, silty sandy gravel of sub-angular to sub-rounded, fine pebbles to cobbles colored 7.5YR 3/1 very dark gray was encountered. Silt present from 45 to 48.9 ft bgs shows very low plasticity.

3.3.2.4 C8934 (399-1-72)

Well C8934 was drilled from ground surface to 48.1 ft bgs. Only Hanford formation was encountered in this borehole.

Poorly sorted sandy gravel was encountered from ground surface to 4 ft bgs comprised of 60% to 70% sub-rounded fine pebbles to small cobbles and 30% to 40% very fine to coarse sand colored 2.5Y4/2 dark grayish brown. From 5 to 15 ft bgs, mafic dominated poorly sorted sandy gravel was encountered composed of 60% very fine pebbles to small cobbles with 30% poorly sorted sand with 10% silt colored 10YR4/3 brown. From 15 to 19 ft bgs a very well sorted, open framework unit of sandy gravel coarsening downward coarsening to gravel was encountered comprised of 75% to 85% sub-rounded very fine pebbles gradually grading to coarse pebbles of 95% basalt with 25% to 15% coarse mafic sand. The bottom 6-in. of this coarsening unit has up to 25% clayey silt matrix colored 2.5Y3/4 light olive brown

which would make it a silty gravel bed. This 6-in. unit is laterally equivalent to the silty gravel bed that expressed radiological contamination as high as 18,000 dpm beta/gamma. Radiological contaminant levels in this bed in this borehole were not detectable. From 19 to 30 ft bgs a well sorted sandy gravel unit was encountered consisting of well rounded very fine pebbles to coarse pebbles grading to fine-to coarse-pebbles of 95% basalt with medium to coarse mafic sand matrix colored 2.5Y4/2 dark grayish brown. From 30 to 40 ft bgs, very poorly sorted sandy gravel was encountered composed of very well rounded very fine pebbles to small cobbles of 80% basalt with medium to very coarse mafic sand matrix colored 2.5Y2.5/1 black. From 40 to 48 ft bgs, well sorted mafic dominated sandy gravel was encountered comprised of 57% to 80% very fine pebbles to coarse pebbles with coarse to very coarse mafic sand matrix. From 44 to 48.1 ft bgs, sediments are stained to a pervasive GLEY2 4/1 dark greenish gray coloration.

3.3.2.5 C8937 (399-1-74)

Stratigraphic units identified during the drilling of well C8937 include the Hanford formation and Ringold Formation.

Well C8937 was drilled from ground surface to a TD of 50.07 ft bgs. The gravel pad at this site extends from ground surface to 0.15 ft bgs. Hanford formation sediments were encountered from 0.15 to 46 ft bgs. Poorly sorted, sub-angular to sub-rounded, fine pebble to cobble, silty sandy gravel colored 2.5Y 3/3 dark olive brown was encountered from 0.15 to 14 ft bgs. From 14 to 34 ft bgs, silty sandy gravel of poorly sorted, sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. At 18 ft bgs a small carbonate lens about 0.05 ft in thickness and of 2.5Y 8/1 white color was identified. At 25 ft bgs a gravel lens about 0.9 ft in thickness consisting of sub-rounded to well rounded small cobbles was identified. From 34 to 46 ft bgs, silty sandy gravel of moderate sorted, sub-angular, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. Ringold Formation sediments were encountered from 46 to 50.07 ft bgs. Sub-rounded to well rounded, fine pebble to cobble, silty sandy gravel colored 2.5Y 2.5/1 black was encountered from 46 to 50.07 ft bgs. Silt present from 46 to 50.07 ft bgs shows low plasticity.

3.3.2.6 C8940 (399-1-76)

Stratigraphic units identified during the drilling of well C8940 include the Hanford formation and Ringold Formation.

Well C8940 was drilled from ground surface to a TD of 50.85 ft bgs. The gravel pad at this site extends from ground surface to 0.25 ft bgs. Hanford formation sediments were encountered from 0.25 to 47 ft bgs. Poorly sorted, sub-rounded, fine pebble to cobble, sandy gravel colored 2.5Y 3/3 dark olive brown was encountered from 0.25 to 8.5 ft bgs. From 8.5 to 21 ft bgs, silty sandy gravel of moderate sorted, sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. From 21 to 47 ft bgs, silty sandy gravel of very poorly sorted, angular to rounded, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. At 38 ft bgs a silt/sand lens about 2 ft in thickness colored 2.5Y 5/4 light olive brown was identified. Ringold Formation sediments were encountered from 47 to 50.85 ft bgs. Moderate sorted, sub-rounded, cobble, silty sandy gravel colored 2.5Y 4/3 to 2.5Y 2.5/1 olive brown to black was encountered from 47 to 50.85 ft bgs. Color gradient present from 47 to 50.85 ft bgs appears to be second graded contact between the oxidizing/reducing zones.

3.3.2.7 C8942 (399-1-78)

Stratigraphic units identified during the drilling of well C8942 include the Hanford formation and Ringold Formation.

Well C8942 was drilled from ground surface to a TD of 50.3 ft bgs. The gravel pad at this site extends from ground surface to 0.5 ft bgs. Hanford formation sediments were encountered from 0.5 to 41 ft bgs. Sub-rounded, pebble to cobble, sandy gravel colored 2.5Y 4/2 dark grayish brown was encountered from 0.5 to 18 ft bgs. From 18 to 21 ft bgs, sandy gravel of sub-rounded, pebbles to small cobbles colored 2.5Y 4/3 brown was encountered. From 21 to 31 ft bgs, silty gravel of sub-rounded, fine pebbles to coarse pebbles colored 2.5Y 4/2 dark grayish brown was encountered. From 31 to 41 ft bgs, sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y 4/1 dark gray was encountered. Ringold Formation sediments were encountered from 41 to 50.3 ft bgs low plasticity mud of color 2.5Y 3/1 very dark gray was encountered from 41 to 46 ft bgs. From 46 to 50.3 ft bgs, sandy gravel of sub-rounded to rounded, fine pebbles to coarse pebbles colored 2.5Y 2.5/1 black was encountered.

3.3.2.8 C9451 (399-1-80)

Stratigraphic units identified during the drilling of well C9451 include the Hanford formation and Ringold Formation.

Well C9451 was drilled from ground surface to a TD of 50.5 ft bgs. The gravel pad at this site extends from ground surface to 0.5 ft bgs. Hanford formation sediments were encountered from 0.5 to 50.5 ft bgs. Poor to moderate sorted, sub-angular to sub-rounded, pebble to cobble, sandy gravel colored 2.5Y 3/3 dark olive brown was encountered from 0.5 to 9.8 ft bgs. From 9.8 to 29 ft bgs, silty sandy gravel of poorly sorted, sub-angular to sub-rounded, fine pebbles to coarse cobbles colored 2.5Y 3/1 very dark gray was encountered. From 29 to 50.5 ft bgs, silty gravel of angular to rounded, fine pebbles to coarse cobbles colored 2.5Y 3/2 brownish black was encountered. Ringold Formation rip up sediments were encountered from 41 to 49 ft bgs. Rip up sediments consists of poorly sorted, sub-angular, pebbles to cobbles colored 2.5Y 5/6 light olive brown. At 48.5 ft bgs the sediment changes color from 2.5Y 5/6 light olive brown to 2.5Y 2.5/1 black.

3.3.2.9 C9453 (399-1-82)

Stratigraphic units identified during the drilling of well C9453 include the Hanford formation and Ringold Formation.

Well C9453 was drilled from ground surface to a TD of 51 ft bgs. The gravel pad at this site extends from ground surface to 0.2 ft bgs. Hanford formation sediments were encountered from 0.2 to 40.5 ft bgs. Moderately sorted, rounded, pebble, silty sand colored 10YR 4/3 brown was encountered from 0.2 to 3 ft bgs. From 3 to 18.2 ft bgs, sandy gravel of moderately sorted, sub-rounded to rounded, cobbles colored 5Y 6/1 gray was encountered. From 18.2 to 19.8 ft bgs, well sorted, medium grain sand colored 2.5Y 6/1 gray was encountered. From 19.8 to 28.5 ft bgs, sandy gravel of moderately sorted, sub-rounded to well rounded, cobbles colored 2.5Y 6/1 gray was encountered. From 28.5 to 40.5 ft bgs, sandy gravel of poorly sorted, sub-rounded to well rounded, cobbles colored 2.5Y 5/1 gray was encountered. Ringold Formation sediments were encountered from 40.5 to 51 ft bgs. Moderately sorted, sub-rounded to well rounded, coarse pebble, gravelly silty sand colored 2.5Y 6/6 olive yellow was encountered from 40.5 to 41.7 ft bgs. From 41.7 to 51 ft bgs, sandy gravel of well sorted, sub-rounded to well rounded, fine cobbles colored GLEY 2 4/1 dark bluish gray was encountered. Organic material was identified at 44.5 ft bgs. A sand lens was also present from 47 to 49 ft bgs.

3.3.2.10 C9455 (399-1-84)

Stratigraphic units identified during the drilling of well C9455 include the Hanford formation and Ringold Formation.

Well C9455 was drilled from ground surface to a TD of 60 ft bgs. The gravel pad at this site extends from ground surface to 0.9 ft bgs. Hanford formation sediments were encountered from 0.9 to 40 ft bgs.

Sub-angular to sub-rounded, pebble to cobble, silty sandy gravel colored 2.5Y 3/3 dark olive brown was encountered from 0.9 to 4 ft bgs. From 4 to 16 ft bgs, silty sandy gravel of poorly sorted, sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. From 16 to 39 ft bgs, silty sandy gravel of angular to sub-rounded, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. At 18 ft bgs a carbonate lens about 0.1 ft in thickness colored 2.5Y 8/1 white was identified. Light yellowish brown 2.5Y 6/3 clay surrounds gravel clasts from 29 to 29.5 ft bgs. From 39 to 40 ft bgs, gravel of sub-rounded, pebbles colored 2.5Y 3/1 very dark gray was encountered. Ringold Formation sediments were encountered from 40 to 60 ft bgs. Sub-angular, coarse pebble, silty gravel was encountered from 40 to 41 ft bgs. From 41 to 46 ft bgs, 2.5Y 2.5/1 black mud was encountered. Organic material was identified at 43 ft and 45 ft bgs. From 46 to 53 ft bgs, silty sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y 2.5/1 black was encountered. From 53 to 58 ft bgs, silty sand of well sorted, sub-rounded, very fine to fine grains colored GLEY 1 3/1 very dark gray was encountered. Sub-angular to sub-rounded, poorly sorted, fine pebble to cobble, silty sandy gravel colored 2.5Y 2.5/1 black was encountered from 58 to 60 ft bgs.

3.3.2.11 C9457 (399-1-86)

Stratigraphic units identified during the drilling of well C9457 include the Hanford formation and Ringold Formation.

Well C9457 was drilled from ground surface to a TD of 50.1 ft bgs. The gravel pad at this site extends from ground surface to 0.25 ft bgs. Hanford formation sediments were encountered from 0.25 to 41 ft bgs. Sub-angular to sub-rounded, fine pebble to coarse pebble, silty sandy gravel colored 2.5Y 3/2 very dark grayish brown was encountered from 0.25 to 3.3 ft bgs. From 3.3 to 22 ft bgs, silty sandy gravel of poorly sorted, angular to sub-rounded, fine pebbles to small boulder colored 2.5Y 3/1 very dark gray was encountered. Ringold Formation rip up sediments were encountered from 22 to 25 ft bgs. Rip up sediments consists of mud with low to no plasticity. From 25 to 32 ft bgs, silty sandy gravel of sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. From 32 to 41 ft bgs, silty sandy gravel of sub-rounded to well rounded, fine pebbles to cobbles colored 2.5Y 3/1 very dark gray was encountered. Ringold Formation sediments were encountered from 41 to 50.1 ft bgs. Poorly sorted, sub-rounded to well rounded, fine pebbles to cobbles colored 2.5Y 4/3 olive brown was encountered from 41 to 49 ft bgs. From 49 to 50.1 ft bgs, silty sandy gravel of sub-rounded to well rounded, fine pebbles to cobbles colored 2.5Y 5/1 black was encountered.

3.3.3 Nine Injection Wells: Well Specific Geology

This section summarizes the geology encountered while drilling the nine injection wells as part of the phosphate injection well field. The colors noted in this section were taken from a Munsell Color chart. Appendix C contains the borehole logs.

3.3.3.1 C9460 (399-1-89)

Well C9460 was drilled from ground surface to at TD of 50.5 ft bgs. Hanford formation and Ringold Formation were encountered in this borehole.

From ground surface to 2 ft bgs, disturbed Hanford formation gravels and poorly developed slightly humasy gravely soil was encountered colored very dark grayish brown 2.5Y 3/2.

The Hanford formation was encountered from 2 to 42ft bgs characterized by the presents of mafic dominated sandy gravels and slightly sandy gravels. From 2 to 21 ft bgs, poorly sorted sandy gravel was encountered composed of 60% grading to 55% very fine pebbles to large cobbles with 30% to 40% poorly sorted sand matrix colored very dark gray 2.3Y3/1. From 21 to 38 ft bgs, moderately poor sorted slightly silty sandy gravel was encountered composed of 65% very fine pebbles to small cobbles with

20% poorly sorted sand with up to 15% low plastic silt. A lense of silt matrix colored 10YR6/3 pale brown appeared infill the gravel from 21 to 21.8 ft bgs.

Ringold Formation was encountered between 42 ft bgs to this borehole TD at 50.5 ft bgs characterized by felsic dominated silty sandy gravel. From 38 to 42 ft bgs, slightly silty gravelly sand was encountered composed of 60% mafic dominated coarse sand with 25% well sorted small cobbles with silt colored 5YR3/1 very dark gray. At 42 ft bgs a sharp contact was encountered. From 42 to 50.5 ft bgs, moderately well sorted silty sandy gravel was encountered composed of 50% to 60% well rounded felsic dominated very fine pebbles to small cobbles with 20% to 30% felsic dominated fine to medium grained silty sand of moderate plasticity.

An oxic zone pervasively colored 5 YR 4/2 dark reddish gray was encountered from 42 to 48 ft bgs with a sharp change in color at 48 ft to a pervasive GLEY1 3 /1 very dark grey extending to TD.

3.3.3.2 C9461 (399-1-90)

Well C9461 was drilled from ground surface to 51.03 ft bgs. In this borehole, Hanford formation was encountered from ground surface to 44 ft bgs. Ringold may extend from 44 ft bgs in this borehole.

Disturbed Hanford formation was encountered from ground surface to 4 ft bgs composed of poorly sorted gravelly sand composed of 80% mafic dominated medium to coarse sand with 20% poorly sorted mafic dominated very fine pebbles to small cobbles. This interval appeared to gradually grade to the underlay strata.

Hanford formation was encountered from 4 to 44 ft bgs. From 4 to 44 ft bgs, very poorly sorted mafic dominated slightly silty sandy gravel was encountered composed of 45% to 50% very fine pebbles to large cobbles up to 200 mm with 35% to 40% mafic dominated poorly sorted silty sand matrix colored 2.5Y3/1 gray to 2.5Y3/1 very dark gray. Within this unit at 22 ft a one ft thick lense or bed of well sorted silty gravel with small cobbles was encountered. At 26 ft and at 28 ft bgs 1-in. thick silt lenses were encountered colored olive brown 2.5Y 5/6

From 44 ft to the TD of 51.03 ft there was a notable change shift from mafic dominated material to felsic dominated material. The silty sandy gravel in the lower portion of the borehole was composed of fine to medium grain sand and poorly sorted, sub rounded gravels.

An anoxic zone pervasively colored GLEY1 3/2 very dark grayish green was encountered from 44 ft to TD of 51.03 ft bgs with patchy colorations of 2.5Y5.1 black.

3.3.3.3 C9462 (399-1-91)

Well C9462 was drilled to a TD of 50.17 ft bgs. Only Hanford formation was encountered in this borehole.

Disturbed Hanford formation was encountered from ground surface to 4 ft consisting of sandy gravel composed of 80% moderately well sorted mafic, medium pebbles to very coarse pebbles with 20% mafic dominated poorly sortred sand colored 2.5Y3/2 dark olive brown.

From 4 ft to 31 ft bgs, very poorly sorted sandy gravel was encountered composed of mafic dominated 60% fine pebbles to boulders up to 260 mm with 30% mafic dominated poorly sorted sand colored 2.5 Y3/1 very dark gray. From 31 to 50 ft bgs, moderately poor sorted slightly silty sandy gravel was encountered composed of mafic dominated very fine pebbles to large cobbles with very poorly sorted mafic dominated silty sand colored very dark grayish brown similar to above. Angularity in this unit appeared to express an increase in roundness with size. From 33 to 35 ft bgs, a large rip up clast of 80%

mica rich 2.5Y5/4 light olive brown silt with 20% very fine sand was encountered. No oxic or anoxic zone colorations were identified in this borehole.

3.3.3.4 C9463 (399-1-92)

Well C9463 was drilled to a TD of 49.55 ft bgs. Only Hanford formation was encountered in this borehole.

From ground surface to 3.2 ft bgs well sorted aeolian sand was encountered colored 2.5 Y 3/3 dark olive brown. From 3.2 to 49.55 ft bgs the borehole was characterized by Hanford formation, and was composed of mafic dominated silts, sands, and gravels colored 2.5Y3/1 very dark gray. There were three silty gravel lenses encountered in this borehole located at 28 ft bgs, 38 ft bgs, and 44 ft. The lenses were composed of well rounded gravels and silt.

3.3.3.5 C9464 (399-1-93)

Well C9464 was drilled from ground surface to a TD of 50.5 ft bgs. Only Hanford formation was encountered in this borehole.

From ground surface to 3.5 ft bgs, well sorted micaceous, aeoliand sand was encountered colored brown 10YR4/3. From 3.5 to 16 ft bgs downward coarsening moderately to very poorly sorted silty sandy gravel was encountered composed of mostly mafic 60% very fine pebbles to large cobbles grading to boulders with a matrix of silty non-plastic mafic dominated, poorly sorted sand colored 2.5Y3/2 very dark grayish brown. From 16 to 35 ft bgs, moderately sorted sandy gravel was encountetered composed of mafic dominated 70% very fine pebbles to small cobbles with 20% poorly sorted mafic sand colored similar to above. A very large rip up clast was encountered from 29.5 to 36 ft bgs composed of 100% moderately plastic silt mottled light yellowish brown and dark grayish borwn 2.5Y6/3 and 2.5Y3/2 respectively. A bed of silty gravel was encountered below the rip up clast from 36 to 38 ft bgs composed of 78% poorly sorted fine pebbles to small cobbles of 30% basalt, 70% felsic quartz and interediat volcanics with 20% very clayey matrix colored 2.5Y4/1 dark gray. From 38 to 47 ft bgs moderately slightly silty sandy gravel was encountered composed of 75% mafic dominated very fine to very coarse pebbles with 15% poorly sorted mafic sand and 15% very plastic silt colored 3.5Y4/1 dark grayish brown.

A second clay lens or rip up clast was encountered in this borehole from 47 ft to the TD of 50.5 ft bgs colored 2.5 Y 5/3 light olive brown.

3.3.3.6 C9465 (399-1-94)

Well C9465 was drilled to a TD of 50.17 ft bgs. Aeolian sand, Hanford formation and Ringold Formation were encountered in this boerehole. Well sorted, medium grained aeolian sand 2.5 Y3/3 dark olive brown was encountered from ground surface to 3.6 ft bgs. At 3.6 ft bgs the sand graded into the underlying Hanford formation

Hanford formation was encountered from ground surface to 43 ft bgs. From 3.6 to 14 ft, moderately poor sorted mafic dominated sandy gravel was encountered composed of 60% fine pebbles to large cobbles with 30% poorly sorted silty sand matrix colored 2.5Y3/1 dark gray. From 14 to 43 ft bgs, moderately poor sorted mafic dominated slightly silty sandy gravel was encountered composed of 55% very fine pebbles to large cobbles with 30% poorly sorted silty sand and 15% silt colored 2.5 Y3/1 very dark gray. The Hanford formation has a sharp contact with underlying Ringold Formation

Ringold Formation was encountered from 43 ft to TD of 51.17 ft bgs in this borehole. This unit was easily differentiated from overlying Hanford formation by its high felsic sand and drastic color change. This unit is composed of moderately poor sorted slightly silty sandy gravel consisting of 55% well rounded very

fine pebbles to small cobbles of 50% mafic, 50% felsic composition with 30% felsic dominated fine to medium sand with low plastic silt. At 57 ft bgs, a 1-in. thick well sorted medium grained sand lens was encountered colored 5YR4/6 yellowish red. This bed exhibits strong oxidation with a gradual transition below 47 ft bgs to an anoxic zone pervasively colored GLEY12.5/10Y greenish black.

3.3.3.7 C9466 (399-1-95)

Well C9466 was drilled to 50.5 ft bgs. Hanford formation and Ringold Formation was encountered in this borehole.

Hanford formation was characterized by predominately mafic silts, sands and gravels. The Hanford formation was observed from 3 to 39 ft bgs. Points of interest in this section of the borehole were at 18 ft bgs and at 38 ft bgs. At 18 ft bgs a 1 ft thick rip up clast composed of 2.5Y6/2 yellowish brown colored silty sandy gravels with a very strong reaction to HCl. At 18 ft bgs, a 1 ft thick bed of well sorted, sandy gravel of well rounded mafic fine- to very coarse-pebbles was encountered. At 38 ft bgs, a 1 ft thick lens or bed of well sorted open matrix mafic pebble gravel was encountered. This bed was encountered resting atop a sharp contact with underlying Rindold Formation gravels.

Ringold Formation was encountered from 39 to TD of 50.5 ft bgs. This unit was easily differentiated from Hanford formation by its greater felsic composition, lighter olive yellow color and inproved rounded gravels. From 39 to 44 ft bgs, moderately well sorted sandy gravel was encountered composed of 75% very well rounded medium to coarse pebbles of 70% felsic composition with 30% fine to medium felsic sand matrix colored 2.5YR5/1 gray. From 44 to TD of 50.5 ft bgs, moderately sorted slightly silty sandy gravel was encountered composed of 70% very well rounded medium pebbles to small cobbles of 70% felsic composition with 15% very fine to medium felsic sand and 15% clayey silt colored 10 YR 6/3 light yellowish brown.

Of particular interest in this borehole was an oxic zone of pervasive 10 YR 6/8 brownish yellow coloration with decreasing color intensity with depth from 46 to 49 ft bgs with a sharp transition to an anoxic zone at 49 ft with a pervasive coloration of GLEY 2 5/1 bluish gray extending to the base fo the borehole.

3.3.3.8 C9467 (399-1-96)

Well C9467 was drilled to 50 ft bgs. Hanford formation and Ringold Formation were encountered in this borehole.

Disturbed Hanford formation and reworked poorly developed soil was encountered from ground surface to 3 ft bgs composed of very poorly sorted silty sandy gravel comprised of 40% mafic dominated fine pebbles to small cobbles with poorly sorted silty sand matrix colored 2.5Y5/1 light olive brown. From 13 to 22 ft bgs, moderately poor sorted mafic dominated silty sandy gravel was encountered composed of 50% very fine pebbles to small cobbles with poorly sorted sand matrix colored similar to above. From 22 to 31 ft bgs mafic dominated gravelly sand was encountered composed of 60% poorly sorted sand with 30% very fine pebbles to large cobbles. From 31 to 35 ft bgs, gravelly sand was encountered composed of 60% mafic dominated poorly sorted sand with very fine to fine pebbles colored 2.5Y4/1 dark gray. From 35 to 40 ft bgs, a very well sorted gravel unit of small cobbles was encountered. From 40 to 42 ft bgs, sandy gravel was encountered composed of well sorted normal graded sandy gravel composed of 60% fine- to medium to medium pebbles with 5 % clayey silt coating clasts. This bed rests atop a sharp contact with underlying sandy gravel. From 42 to 44.5 ft, poorly sorted mafic gravelly sand similar, to above units, was encountered.

A rip up clast of very fine felsic sandy silt was encountered from 28 to 30.5 ft bgs.

Ringold Formation was encountered in this borehole from 42 ft to the TD of 50 ft bgs. From 44.5 to 48 ft bgs, moderately poor sorted quartz felsic dominated silty sandy gravel was encountered composed of very fine pebbles to small cobbles with 30% micaceous fine sand with 30% slightly clayey silt. From 48 ft to TD of 50 ft bgs, 100% sand was encountered composed of 80% medium felsic sand colored 2.5Y5/4 light olive brown.

An anoxic zone of pervasive GLEY2 3/1 very dark bluish gray coloration was encountered from 44.5 to 48 ft bgs. No orange oxic zone was discernible above the anoxic zone in this borehole.

3.3.3.9 C9468 (399-1-97)

Well C9468 was drilled to 50 ft bgs. Hanford formation and Ringold Formation were encountered in this borehole.

Hanford formation was encountered from ground surface to 39.5 ft bgs. From ground surface to 16 ft bgs, unconsolidated , poorly sorted sandy gravel of the typical of Hanford formation was encountered composed of 50% gravel and 40% sand with up to 10% colored 2.5Y3/2 very dark grayish brown. This unit grades to lower units. From 16 to 39.5 ft bgs, very poorly sorted, mafic dominated slightly silty sandy gravel was encountered composed of 50% very fine pebbles to large cobbles with 35% poorly sorted sand and up to 15% silt colored 2l.5Y3/2 very dark grayish brown. Within this unit at 25 ft bgs, 3-in. thick very well sorted open matrix gravel lens or bed of coarse pebbles was encountered.

Ringold Formation was encountered from 39.5 ft to the borehole TD of 50 ft bgs. From 39.5 to 44.8 ft bgs, felsic dominated moderately well sorted gravelly sand was encountered composed of 60% well sorted medium sand of 80% quartz-feldspar with 30% very fine- to coarse-pebble gravel with 10% silt colored 10YR6/3 pale brown. From 44.8 to 50 ft bgs, well sorted slightly silty gravelly sand was encountered composed of 60%felsic dominated well sorted, micaceous medium sand with 25% very-fine- to very coarse pebbles with 15% silt.

A zone of pervasive 2.5 Y 2.5/1 black coloration was encountered from 48 ft to the TD of 50 ft bgs in this borehole. Carbonized wood chips about 100 mm long by 50mm wide were encountered in the anoxic zone in the lower two ft of this borehole. The color changed from 10YR 6/3 pale brown to 2.5 Y 2.5/1 black. In addition to the color change at 44.8 ft bgs, there was wood in the sediments at approximately 48 ft bgs.

4 Waste Management

Waste created during the drilling of the 30 boreholes was managed in accordance with DOE/RL-2000-56, *Waste Management Plan for the 300-FF-5 Operable Unit*, and was characterized to the extent necessary to meet the requirements of DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*. Investigation derived waste generated throughout the scope of this project included cuttings from both the vadose zone and groundwater saturated zone, purgewater and miscellaneous solid waste such as sampling equipment, plastic, paper, and personal protective equipment.

4.1 Drill Cuttings

All drilling cuttings from both the vadose zone and groundwater saturated zone was collect in a tip dumpster and transferred to a ROLL-OFF bin located on site. Two ROLL-OFF bins were used over the course of this project. In addition to drill cuttings, miscellaneous solid waste was also disposed of in the ROLL-OFF bins. This waste was disposed of at the Environmental Repository and Disposal Facility.

4.2 Purgewater

Purgewater was collected during well development in accordance with DOE/RL-2009-39, *Investigation-Derived Waste Purgewater Management Action Memorandum,* and DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan.* Purge water was transferred directly from the wells to purgewater trucks. Purge water trucks transported and disposed all purge water generated throughout the scope of this project to the Modular tanks facility on Site.

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5 Civil Survey

The well locations were surveyed in accordance with CHPRC procedure SGRP-PRO-SMP-52857 (GRP-EE-01-1.6), *Survey Requirements and Techniques*, on August 10, 2015. Vertical survey data were recorded using *North American Vertical Datum of 1988* (NAVD88) and the horizontal coordinates were recorded using the Washington State Plane (South Zone) *North American Datum of 1983* (NAD83), with the 1991 adjustment for horizontal coordinates. Surveyed locations of the boreholes are presented in Table 5-1 and the reports are located in the Appendices.

Table 5-1. Civil Survey Summary

Well ID Number	Well Name	Northing[a] (m)	Easting[a] (m)	Top of Well Vault Elevation[b] (m)
PRZ Monitoring Wells				
C8930	399-1-69	116505.03	594169.73	114.54
C8932	399-1-71	116508.84	594126.33	114.738
C8935	399-1-73	116494.22	594081.69	114.781
C8939	399-1-75	116475.62	594098.69	114.819
C8941	399-1-77	116460.56	594118.72	115.071
C9450	399-1-79	116463.09	594154.88	114.778
C9452	399-1-81	116454.92	594090.9	114.887
C9454	399-1-83	116427.4	594152.48	114.939
C9456	399-1-85	116451.42	594175.5	114.799
C9458	399-1-87	116478.8	594138.62	114.85
Aquifer Monitoring Wells				
C8931	399-1-70	116508.83	594125.04	114.743
C8934	399-1-72	116494.16	594080.16	114.824
C8937	399-1-74	116475.26	594097.65	114.822
C8940	399-1-76	116460.62	594117.79	115.106
C8942	399-1-78	116463.17	594153.7	114.763
C9408	399-1-65	116481.19	594164.48	114.617
C9409	399-1-66	116504.97	594168.41	114.514
C9451	399-1-80	116454.78	594089.52	114.881
C9453	399-1-82	116427.47	594151.78	114.943
C9455	399-1-84	116451.41	594174.47	114.836
C9457	399-1-86	116478.66	594137.74	114.865

Table 5-1. Civil Survey Summary

Well ID Number	Well Name	Northing[a] (m)	Easting[a] (m)	Top of Well Vault Elevation[b] (m)
Injection Wells				
C9460	399-1-89	116467.59	594087.17	114.698
C9461	399-1-90	116478.21	594102.77	114.812
C9462	399-1-91	116489.07	594118.24	114.874
C9463	399-1-92	116466.66	594132.82	114.943
C9464	399-1-93	116470.77	594116.97	114.911
C9465	399-1-94	116479.65	594130.8	114.882
C9466	399-1-95	116488.32	594143.85	114.707
C9467	399-1-96	116473.85	594146.2	114.673
C9468	399-1-97	116480.09	594157.77	114.546

a Northing and easting coordinates are based on Washington State Plane Coordinates *North American Datum of 1983* (NAD83).
b *North American Vertical Datum of 1988* (NAVD88) values rounded to 0.001 m.
m = meters
PRZ = partially rewetted zone

6 Well Acceptance

Well acceptance is the final step in the well construction process and represents confirmation of meeting requirements of the work scope. Well acceptance also serves as the contractual completion of the finished product.

Representatives from CHPRC and Holt Services Inc. (drilling contractor) participated in the acceptance inspection of all thirty wells on August 12, 2015. Final well acceptance was documented by completion of a checklist and signatures from representatives of the drilling contractor and CHPRC. A Quality Assurance Work Site Assessment will be prepared to document well acceptance.

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7 References

CH2M Hill Plateau Remediation Company Soil and Groundwater Remediation Project Procedure:

SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*

SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*

SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Soil- Wet Sieve Analysis*

SGRP-PRO-SMP-52857 (GRP-EE-01-1.6), *Survey Requirements and Techniques*

Other References:

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NAD83, 1991, *North American Datum of 1983*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Springs, Maryland, as revised.

NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Springs, Maryland.

PNNL-18340, 2009, *Borehole Completion and Conceptual Hydrogeologic Model for the IFRC Well Field, 300 Area, Hanford Site*. Pacific Northwest National Laboratory, Richland, Washington.

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SGW-58553, 2015, *Description of Work for the Installation of Twenty Two Monitoring Wells and Nine Injectin Wells in the 300-FF-5 Operable Unit, FY2015*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

TPA-CN-656, TPA Change Notice Form, dated March 31, 2015, for SGW-56993, *Sampling Instruction for the 300-FF-5 Operable Unit Supplemental Post ROD Field Investigation*, Rev.0, CH2M HILL Plateau Remediation Company, Richland, Washington

WHC-EP-0500, 1991, *Geology and Hydrology of the 300 Area and Vicinity, Hanford Site, South Central Washington*, Westinghouse Hanford Company, Richland, Washington

WHC-SD-EN-TI-052, 1992, *Phase I Hydrogeologic Summary of the 300-FF-5 Operable Unit, 300 Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington

Appendix A

Well Documentation for PRZ Monitoring Wells

- Well Summary Sheet
- Borehole Log
- Final Survey Report

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WELL SUMMARY SHEET

Start Date:	6/17/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C8930	Well Name:	399-1-69
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER Environmental Scientist
Date:	9-28-15	Date:	10/28/15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.8' bgs

Permanent Well:

2.375" OD PVC Blank: 0.7' - 30.7' bgs

2.375" OD PVC 0.020-slot Screen: 30.7' - 35.7'bgs

2.375" OD PVC Blank Casing: 35.7' - 38.4'

Construction Materials:

Concrete: 0.80' - 0.84' bgs

Suface Seal: 0.84' - 9.70' bgs

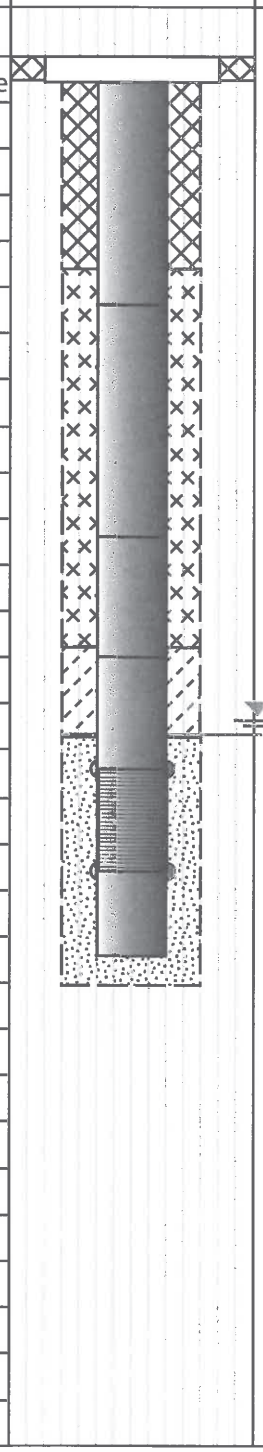
Bentonite Chips: 9.70 - 25.90'

Bentonite Pellets: 25.90' - 29.50'

8/16 Mesh Filter Pack Sand: 29.5- 40.00' bgs

All temporary 6" OD casing removed 6/17/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.4: Gravel Drill Pad, G

0.4 - 12.0: Sandy Gravel, sG

12.0 - 29.0: Silty Sandy Gravel, msG

Depth to Water: 29.30' bgs (6/17/15)

29.0 - 39.0: Sandy Gravel, sG

39.0 - 40.0: Silty Gravel, mG

Total Depth = 40.00'bgs (6/17/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2
Date: 6.17.15

Well ID: C8930 | Well Name: 399-1-69 | Location: 300 Area. N. Process Ponds

Project: 300 Area U Sequestration Remedial Action | Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0.0-0.4 : Gravel Pad.	Sonic w/ 5" core barrel (cb.)
				0.4-12 : Sandy Gravel sG. (75-70%G, 25-30%S <5%m)	
				mod-pr. srtd. v.f. pbl. to v.c.pbl. grading to v. pr.srtd. c.pbl.-bldr.	
				of 95%bslt./5%Mafic Meta.>int. Volc. max: 20mm grading to 250mm	▨ -no Recovery
				w/ v.f.-v.c.sub-ang. S. of 98%Mafic/2%felsic. comp. v.unconsolidated.	
5	9.S.	80%		Prob. Fill. 2.5Y 3/2 v.drk. ~~grayish~~ AS 6/17/15 grayish brown. slightly moist.	5': g.s.
				wk. rxn. w/ HCl.	
				• 8': gravels coarsen. srtd: v.pr.srtd. sub-rndd.-v.w.rndd.	
				~~10~~ AS 6/17/15 of 95%bslt./5% felsic. Meta>int. Volc.; matrix of v.f.-v.c.	
10				sub-ang. S. trace. m. 2.5Y 3/2 v.drk. grayish brown.	
	9.S.			12.0-21 : slightly silty sandy Gravel (m)SG (70%G-20%S, 5-10%m)	
				mod.-w. srtd. v.f.-m. pbl. w/ ~20% c.pbl. max: 64mm. of 80%bslt/	13': g.s.
15		80%		20%felsic int. Volc.>Meta. w/ w.rndd. f.-v.c. S. of 95%Mafic/5%	
				felsic. v. unconsolidated. wk.-mod. rxn. w/HCl. 2.5Y 3/2 v.drk.	
				grayish. brn.	
	9.S.			• 15': mod. srtd. w.rndd. v.f.-m. pbl. w/20% c.pbl. matrix	18': g.s.
				similar to above.	
20				• 20': similar to above. w/ sprs. sm.cbl. of int. Volc.-v.w.rndd.	18.5-30': Redrill.
				• 21': sprs. v.w.rndd. bldr. max 250 mm. cored by Drill.	22-23': g.s. 0% recovery.
				21-23': silty sandy Gravel msG (60%G, 20-30%S, 20%m-)	
	9.S.			v.pr.srtd. (reworked by drill.) v.w.rndd. m.pbl.-sm.cbl. of	
				70%-80%bslt/30-20%felsic Meta>int. Volc. w/ clayey matrix. of	25-29': g.s.
25	9.S. AS 6/17/15	0% Redrill		v.f.-v.c. sub-rndd. S. w clayey silt matrix. mod. plastic. low dilatency.	
				2.5Y 3/2 v.drk. grayish. brown. v.wk. rxn. w/HCl.	
				23-29 : silty sandy Gravel msG (60%G, 30%S, 10-15%m)	
	9.S.			v.pr.srtd. v.w.rndd. f.pbl.-v.c.pbl. of 80%bslt/20%felsic meta>	WT @ 29.30 6/17/15
				int. Volc. max: 60mm. w/ v.f.-m. sub-rndd. S. 90%Mafic, 10%felsic.	
30			AS 6/17/15	w/ non plastic silt. 2.5Y 3/2 v.drk. grayish brown. prob. normal grading. v.wk. rxn w/HCl.	
				• 29-30: wet. slightly clayey v.low plastic. coating clasts.	
	9.S.			29-34': AS 6/17/15 ~~silty~~ sandy Gravel ~~msG~~ AS 6/17/15 msG (75%G, 20%S, 5%m)	slightly silty sandy Gravel (m)SG
				v.pr.srtd. sub-ang.-sub-rndd. m.pbl. w/ C.pbl. (bimodal size)	
	9.S.			of 80%bslt/20% int. Volc.>Meta. w/ v.f.-v.c. sub-ang. S. 90%Mafic	30-33': g.s.
35				10%felsic. v. low plastic silt.-low plastic. ~~5~~ AS 6/17/15 5Y 4/2 olive gray. wet.	34': g.s. of black clayey Gravel
				no rxn w/HCl.	
				34~34.2': ~~Black silty sandy Gravel msG (15%G, 20%~~ AS 6/17/15	clayey silty Gravel
				move nxt. pg.	

Move Down | Move | 70% Down | Move Down

Reported By: A. Lantau		Reviewed By: Kevin Bergstrom	
Title: Geo. Tech.		Title: Sr. Geologist	
Signature: A. Lanto	Date: 6.17.15	Signature: K. Bergstrom	Date: 8/10/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: 6-17-15

Well ID: C8930 | Well Name: 399-1-69 | Location: 300 Area N. Process Ponds

Project: 300 Area U Sequestration RA. | Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30				29-34': Sandy Gravel sG. (75%G, 20%S, 5%m)	Sonic w/ 5" x 10' core barrel.
30.5				v.pr.srtd. sub-ang-sub-rndd. bimodal size gravel of m. pbl.	
31.0				+ sm. cbl. of 80% int. volc. bslt./20% int. volc. > meta. w/ v.f.-	30-33': g.s.
31.5				v.c.s. sub-ang. S. 90% mafic/10% felsic v. low plastic - low	
32.0				plastic silt 5Y 4/2 olive gray. wet. no rxn. w/HCl.	
32.5					
33					
.5					
34				34-34.2': bgs: silty Gravel (clayey) mG (60%G, 20%S, 20%m)	
.5				Black (2.5Y 2.5/1). Pr. srtd. m. pbl.-v.c. pbl. w. rndd. of 99% bslt.	34-34.2': g.s. - no Rod. -
35		70 ft		1% felsic. w/ v.f.-v.c. sub-ang. S. 95% Mafic/5% felsic w/ v. plastic	
.5				clayey silt. mod. rxn w/HCl. wet.	35-39': g.s.
36					
.5				34.2-39': sandy Gravel sG (75%G, 25%S)	
37				Pr.-mod. srtd. v.w.rndd. v.f. pbl.-c. pbl. w/ s/rs. v.c. pbl. max: 40mm	
37.5				avg: 10-20mm. Downward fining. 40mm-10mm.	
38				matrix: f.-v.c. sub-ang. S. of 99% Mafic/1% felsic. comp.	
.5				2.5Y 2.5/1 Black. none-trace m.	
39					
.5				39-40.5': silty Gravel (mG) (75-80%G, 25-20%m)	39-40.5': g.s.
40				v.Pr.srtd. v.w.rndd. sm. cbl. to v.f. pbl. of 95% bslt, 5% felsic	
.5				Meta. trace f.n.-m. S. of 90% felsic comp. non plastic silt color	
				2.5Y 4/2 dark. grayish brown. Prob. downward fining. wet.	
				no rxn w/HCl 5Y 4/2	

Reported By: A. Lantow		Reviewed By: Kevin Bergstrom	
Title: Geo. Tech.		Title: Sr. Geologist	
Signature: A. Lantow	Date: 6-17-15	Signature: Kevin Bergstrom	Date: 8/10/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/16/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C8932	Well Name:	399-1-71
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10/28/15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.6' bgs

Permanent Well:

2.375" OD PVC Blank: 0.45' - 30.43' bgs

2.375" OD PVC 0.020-slot Screen: 30.43' - 35.46'bgs

2.375" OD PVC Blank Casing: 35.46' - 38.20'

Construction Materials:

Concrete: 0.60'- 1.30' bgs

Suface Seal: 1.30'- 10.00' bgs

Bentonite Chips: 10.00'- 24.70' bgs'

Bentonite Pellets: 24.70' - 27.70' bgs

10/20 Mesh Filter Pack Sand: 27.70'- 40.00' bgs

All temporary 6" OD casing removed 6/16/15.

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 1.0: Gravel Drill Pad, G

1.0 - 40.0: Silty Sandy Gravel, msG

Depth to Water: 31.20' bgs (6/16/15)

Total Depth = 40.00'bgs (6/16/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: June 16, 2015

Well ID: C8932	Well Name: 399-1-71	Location: 300 Area N of PNNL
Project: PRR monitoring well		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		100% Recovery		0.0 to 1.0 ft	Drilling is being
				Formation Backfill / Drilling pad MSG	conducted w/ Sonic
					6" Casing
	g.s			1.00 to 3.00 ft bgs MSG	4" core barrel
				Formation: Hanford	
5				10% silt 40% sand 50% Gravel	g.s = Grab Sample
				Sand: medium grain, mod sorted	
				sub angular 30% mafic 70% felsic	0-10 ft drilled
	g.s			Gravel 2mm to ~100mm poorly	Slow due to poor
				sorted sub angular to rounded.	soil ~~compaction~~ CK 6/16/15
10		50% recovery		60% mafic 40% felsic: Damp	compaction.
				weak reaction to HCL (dry	
				5YR 3/2 dark reddish brown (damp)	
	g.s			3.00 ft 16.00 ft bgs ~~(dry)~~ CK 6/16/15 MSG	Grab Sample
				Formation: Hanford	0'-5'
15				10% Silt 35% sand 55% Gravel	5-10'
				Sand: Fine to coarse poorly sorted	10'-15'
	g.s			sub angular 40% mafic 60% felsic	15-20'
				Gravel: 2mm to small boulders	20'-25'
				Boulder (quartzite) @ 13 to 15 ft bgs	26.5'-28.00' "Litho"
				causing poor recovery.	25'-30'
20		80% recovery		overall gravels are poorly sorted	30-35'
	g.s			angular to sub round 60% mafic	35-40'
				40% felsic.	
				slight reaction to HCL (dry)	
				2.5YR 4/3 reddish brown (damp)	
25					
	g.s				
				16.00 ft to 30.00 ft MSG	
				Formation Hanford	
30		0% recovery		10% silt 3% Sand 60% Gravel	Recovery
	g.s			Sand: fine to coarse poorly sorted	0'-10' 100%
				sub angular 40% mafic 60% felsic	10.00-20.00' 50%
				Gravel: 2mm to 160 mm very poorly	20.00-30.00 80%
35				Sorted. Angular to sub round.	30.00-40.00 0%
	g.s			when saturated silt has low plasticity	
				@ 17.00 ft ~~Hanf~~ Ringold rip	
				up clast in the form of clay around	
				larger gravels.	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/16/15	Signature: [signature]	Date: 8/4/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: June 16, 15

Well ID: C8932	Well Name: 399-1-71	Location: 300 Area N of PNNL
Project: PRZ monitoring well		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				16.00' to 30.00 ft bgs Continued.	Drilling is being
				At 26.50 ft to 28.00 ft bgs	Conducted w/ a
				there is a large Ringold	Terrasonic 150 cc
				rip up clast.	6" casing
				Clast is composed of:	4" core barrel
				30% silt 30% Sand (fine to med.)	
				40% gravel.	
				The clast has medium plasticity	
				Overall unit color	
				7.5 YR 3/1 very dark gray	
				lower section moist ~25'	
				Slight to no reaction to HCL	
				30.00' to 40.00' bgs	
				Formation: Hanford MSG	
				10% silt 20% Sand 70% Gravel	
				There was zero recovery on the	
				first run description and archive	
				samples were collected from the	
				clean out.	
				Sand: fine to very coarse, poorly	
				sorted. Angular: 60% mafic 40% felsic	
				Gravel: 2mm to 160 mm, poorly	
				sorted sub angular to well	
				rounded - rounding increase w/ size.	
				7.5 YR 4/1 dark gray (damp)	
				weak reaction to HCL (damp)	
				Wet	
				TD 40.00 ft bgs 6/16/15	
				DTW 30.80 ft bgs	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/16/15	Signature: [signature]	Date: 8/4/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/10/15
Finish Date: 8/6/15
Page 1 of 1

Well ID: C8935	Well Name: 399-1-73
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Tessa Clark	Reviewed By: J.D. MEHRER
Signature:	Signature:
Date: 9-28-15	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.6' bgs

Permanent Well:

2.375" OD PVC Blank: 0.40' - 28.27' bgs

2.375" OD PVC 0.020-slot Screen: 28.27' - 33.27'bgs

2.375" OD PVC Blank Casing: 33.27' - 35.90'

Construction Materials:

Suface Seal: 0.75'- 10.00' bgs

Bentonite Chips: 10.00'- 22.40 bgs'

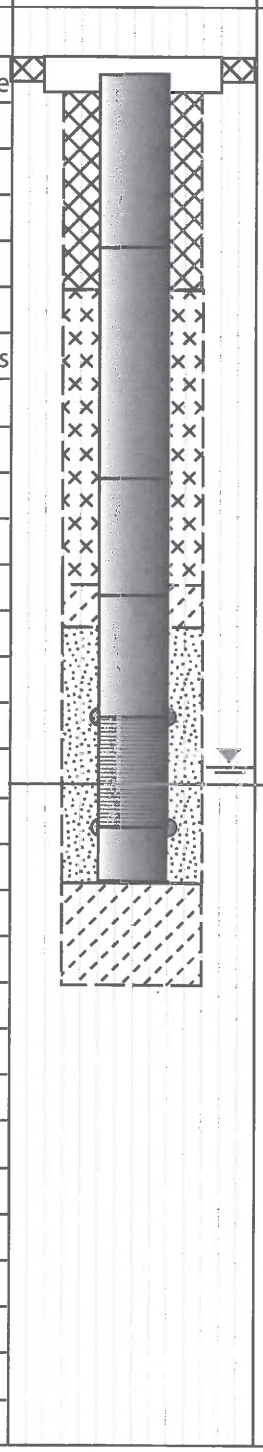
Bentonite Pellets: 22.40- 24.90' bgs

10/20 Mesh Filter Pack Sand: 24.90'- 35.90' bgs

Bentonite Pellets: 35.90-40.00' bgs

All temporary 6" OD casing removed 6/15/15.

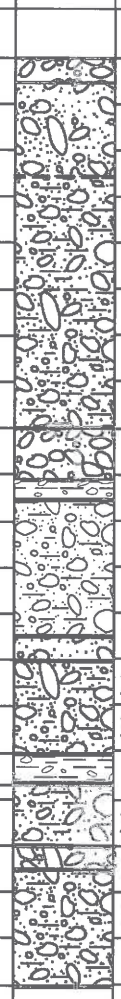
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log



Lithologic Description

- 0.0 - 1.0: Gravel Drill Pad, G
- 1.0 - 5.0: Sandy Gravel, sG
- 5.0 - 16.0: Silty Sandy Gravel, msG
- 16.0 - 18.5: Gravel, G
- 18.5 - 19.0 : Silty Gravel, mG
- 19.0 - 25.0: Silty Sandy Gravel, msG
- 25.0-26.0: Sandy Gravel, sG
- 26.0-30.0: Silty Sandy Gravel, msG
- 30.0 - 31.0: Gravelly Silt, gM
- Depth to Water: 31.10' bgs (6/11/15)
- 31.0 - 34.0: Silty Sandy Gravel, msG
- 34.0 - 35.0: Gravel, G
- 35.0 - 40.0: Silty Sandy Gravel, msG
- **Total Depth** = 40.0'bgs (6/16/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

KAB 6-10-15

BOREHOLE LOG

Page 1 of 2
Date: 6·10·15

Well ID: ~~C9955~~ C8935	Well Name: 399-1-73	Location: 300 Area N. Process Pond	
Project: 300 Area U Sequestration RA		Reference Measuring Point: Ground Surface.	

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0				~~0.5-10': Gravel Pad.~~ 0-10': Gravel Pad	Sonic w/10'x5" core barrel (cb)
				1.0-5': Sandy Gravel sG (75%G, 20%S, 5%m)	
				v.pr.srtd. sub-rndd. m.pbl.-sm.cbl. of 80%bslt./20%felsics	0.5-5': grab sample (g.s.)
				meta.>int.volc. max clast: 120mm. w/v.f.-m. sub.ang.S.	▨ = no Returns.
				50/50% Mafic/felsic S. w/low cohesion 2.5Y 4/1 drk.gray.	0.5-5': bys. g.s. to RMA
5				wk. rxn w/HCl.	
				5-16': silty sandy Gravel msG (60-70%G, 30-20%S, 10%m)	5-16': g.s. to RMA
				• 5-10': v.pr.srtd. m.pbl.-sm.cbl. of 60-70%bslt/40-30%felsic	
				int.v.>meta. max: 70mm w/v.f.-m. sub-ang. S. of 70%felsic/	
				30%mafic meta>int. volc. fine muscovite 2.5Y 3/1 v.drk.gray	
10				no rxn w/HCl.	10-16': g.s. + Bulk sample to RMA
				• 10-16': silty sandy Gravel cont. (60%G, 30%S, 10%m)	
				pr.srtd. v.f.pbl.-sm.cbl. max: 90mm of 60-70%bslt/40-30%felsic.	
				sub.-w.rndd. clasts. matrix of: m.-v.c. ang. S.	
				2.5Y 5/3 brown no rxn w/HCl.	
15					16-20': bulk sample to RMA
				16-18.5' bys.: Gravel (99%G) ~1%S. v.w.srtd.	
				v.w.graded ~~matrix~~ Clast suprtd. m.-crs.pbl. v.w.rndd. of.	
				99%bslt. 1%felsic. max clast: 20mm. ~~Fining downward.~~	
				Coarsening downward. w/c.ang.S. of 99%bslt.	
20				2.5Y 2.5/1 black. slightly moist. no rxn w/HCl.	20': grab sample. to RMA.
				18.5'-19.0': silty Gravel sG. (80-90%G, 10-20%m)	18.5-19.0': 18,000 dpm β/γ
				v.w.srtd., v.w.rndd. m.-crs.pbl. of 95%bslt./5%felsic	150 dpm α.
				w/clayey silt 2.5Y 3/1 v.drk gray. no rxn w/HCl. max clast: 20mm.	Suspect α. Uranium.
				19-25': silty sandy gravel msG (70%G, 20%S, 10-15%m)	
25				Pe-mod. srtd. w.rndd. v.f.pbl.-v.c.pbl. sprs. sm.cbl.	19-20': 3,000 dpm β/γ; 0 α
				max: 130mm. avg: m.pbl. grading to v.c.pbl. of 70%bslt./	non removable
				30%felsic meta.>int. volc. w/matrix of v.c.S. grading to	
				v.f.S. clayey. slightly. 2.5Y 4/2 drk grysh brown no rxn HCl	20-30': 1500 dpm β/γ, 0 α
				25-26': sandy Gravel sG (75%G, 25%S.) mod.srtd.-w.srtd.	non removable.
30				v.f.-f. w.rndd. pbl. of 100%bslt. w/c.-v.c. sub-ang. mafic S.	
				2.5Y 3/1 v.drk.gray. no rxn w/HCl.	
				26-30': silty Sandy Gravel msG (75%G, 15%S, 10-15%m)	
				pr.srtd. v.w.rndd. v.f.pbl.-sm.cbl. max: 120mm. avg.: 20mm.	
				of 60%bslt/40%felsic meta.>int. volc. w/v.f.-v.crs. sub-ang. S.	
				sprs. mica. ~1%. low plastic. 2.5Y 4/2 drk grysh. brown. wk. rxn w/HCl.	
					20-40': no grab samples collected due to Rad.
40					

Sample Type No.: 0.5, 2.5, 9.5 Bulk; 19.5 Bulk
Blows Recovery: 100%, 30%, 60%, 90%, Shift
Graphic Log: move down

Reported By: A. Lantau		Reviewed By: Kevin Bergstrom	
Title: Geo. Tech.		Title: Sr. Geologist	
Signature: A. Lantau	Date: 6·11·15	Signature: Kevin Bergstrom	Date: 8/6/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: 6·11·15

Well ID: ~~C8934~~ ~~C8933~~ C8935 (AZ 9.1.15)
Well Name: 399-1-72
Location: 300 Area N. Process Ponds.
Project: 300 Area U Sequestration RA.
Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
30				30-31': Gravelly Silt gM ~~(70%m, 30%G, 5%S)~~ (AZ 9.1.15) (60%m, 30%G 5-10%S)	Sonic w/10'x5" core barrel.
30.5		sluff			
31				m.srtd. v.f.-f.pbl. of-sub-ang. of 90%bslt./10%felsic Qtz.	▨ = no recovery.
31.5				w/v.f. ang. Qtz-felds. S. in silt matrix. mod. plastic. no rxn	
32				w/HCl. wet. 2.5Y 2.5/1 black.	30-40': 1,000ppm Bw. 0α
32.5					
33				31-34': silty sandy Gravel msG (60%G, 20%S, 20%M)	
				v.pr.srtd. v.f.pbl.-sm.cbl. well rndd. max: 120mm	
34				of 60%felsic Meta.>int. Volc./40%bslt. w/matrix.	30-40': 50% recovery.
				of v.f.-m. sub-ang. S. of 70%Qtz-felds/30%mafics.	~~35~~ (AZ 9.1.15) 40': no recovery.
35				clayey, mod. plastic silt GLEY1 3/1 v.drk. greenish gray	
		0.5		- Reducing? zone. potential. mod. rxn. w/HCl.	
36					
				34'-35': Gravel (G)(95%G, 5%S) v.w.srtd.	
37				m.-f.pbl. v.w.rndd. of 95%bslt./5%felsic open matrix.	
37.5				w/v.c. ang.-sub.ang. S. of 95%mafics/5%felsic.	
38				GLEY1 3/1 v.drk. greenish gray.	
				35': Layer of lrg.cbl. max 200mm. sub.rndd. of bslt.	
39				35-40': Silty sandy Gravel msG (75%G, 20%S, 10%M)	35-40': Soils observed from
				mod.-pr.srtd. v.w.rndd. v.f.pbl.-sm.cbl. of 70%bslt./30%felsic	casing cleanout.
40				w/m.-v.c. ang. S. of 85%bslt./15%Qtz-felds. non-plastic	~~TD: 40.5'~~ 40.50' bgs.: TD
			TD: 40.5	silt. 2.5Y 2.5/1 black to GLEY1 3/1 v. drk. greenish	
				gray.	

Reported By: A. Lardner
Title: Geo. Tech.
Signature: A. Lardner
Date: 6·11·15

Reviewed By: Kevin Bergstrom
Title: Sr. Geologist
Signature: Kevin Bergstrom
Date: 8/6/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/29/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C8939	Well Name:	399-1-75
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER Environmental Scientist
Date:	9-28-15	Date:	10/28/15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.85' bgs

Permanent Well:

2.375" OD PVC Blank: 0.36'- 30.57' bgs

2.375" OD PVC 0.020-slot Screen: 30.57' - 35.57'bgs

2.375" OD PVC Blank Casing: 35.57' - 38.20'

Construction Materials:

Suface Seal: 0.70'- 10.00' bgs

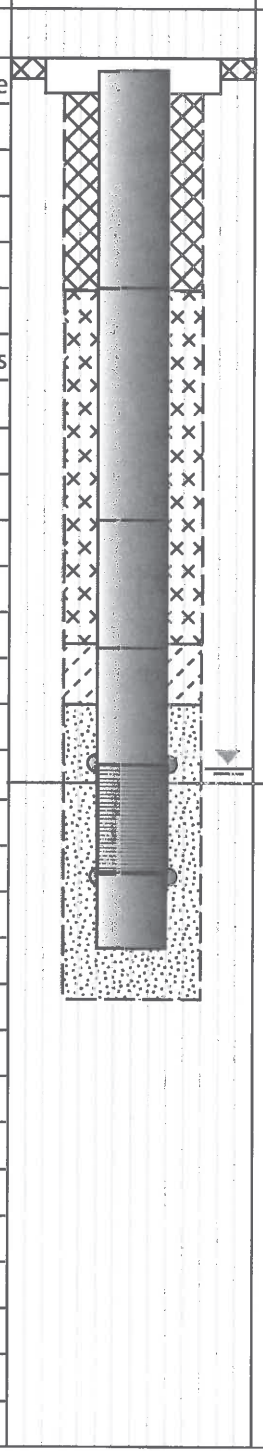
Bentonite Chips: 10.00'- 25.00' bgs

Bentonite Pellets: 25.00- 28.00' bgs

10/20 Mesh Filter Pack Sand: 28.00'- 40.17' bgs

All temporary 6" OD casing removed 6/29/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.15: Gravel Drill Pad, G

0.15 - 14.0: Sandy Gravel, sG

14.0 - 35.0: Silty Sandy Gravel, msG

Depth to Water: 31.80' bgs (6/29/15)

35.0-40.5: Silty Sandy Gravel, msG

Total Depth = 40.17'bgs (6/16/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 1

Date: June 29, 2015

Well ID: C8939 | Well Name: 399-1-75 | Location: 300 Area N of PNNL

Project: 30 well 300-FF-5 FY15 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		50% recovery		0 ft to 0.15 ft bgs Drill Pad / Backfill	PR2 well
	gs				Drilling is being conducted with a Terrasonic 15-0.c.c 6" casing 4"x10' core barrel
				0.15 to 14.00 ft bgs msg Formation 5% silt 45% sand 50% Gravel Sand: fine to med. grain mod/poor sorted Angular 60% matic 40% felsic Gravel: 2mm to 100mm poorly sorted sub round 60% matic 40% felsic Mod to strong reaction to HCL 2.5Y 3/3 Dry	
5					
	gs				
10		60% recovery			g.s. = Grab sample
	gs				
15					
	gs			14.00 ft bgs to 35.00 ft bgs msg 10% silt 40% Sand 50% Gravel Sand fine to coarse, very poorly sorted. Angular 60% matic 40% felsic Gravel: 2mm to 150 mm, poorly sorted sub round to sub angular 60% matic 40% felsic weak to strong reaction to HCL 2.5Y 3/1 very dark gray moist @ ~ 28 ft bgs. Hanford	recovery 0-10' ~50% 10-20 ~60% 20-30 ~70% 30-40 ~50% 40-40.50 ~100%
20		70% recovery			
	gs				
25					
	gs				
30		100% recovery		35.00 ft bgs to 40.50 ft bgs. TD msg Formation Hanford 15% silt 30% sand 55% gravel Sand very coarse to fine. very poorly sorted. 60% matic 40% felsic Gravel: 2mm to 175 mm, very poorly sorted, Angular to round 60% matic 40% felsic. weak to no Reaction to HCL 2.5Y 3/1 very dark gray Wet	TD 40.50 ft DTW 30.20 ft
	gs				
35					
	gs				

Reported By: Candice Burnette Kirkall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 6/29/15 | Signature: [signature] | Date: 8/4/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/30/15
Finish Date: 8/6/15
Page 1 of 1

Well ID: C8941	Well Name: 399-1-77
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Tessa Clark	Reviewed By: J.D. MEHRER
Date: 9-28-15	Date: 10/28/15
Signature:	Signature:

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.85' bgs

Permanent Well:

2.375" OD PVC Blank: 0.55' - 30.37' bgs

2.375" OD PVC 0.020-slot Screen: 30.37' - 35.37'bgs

2.375" OD PVC Blank Casing: 35.37' - 38.00'

Construction Materials:

Suface Seal: 0.85'- 10.09' bgs

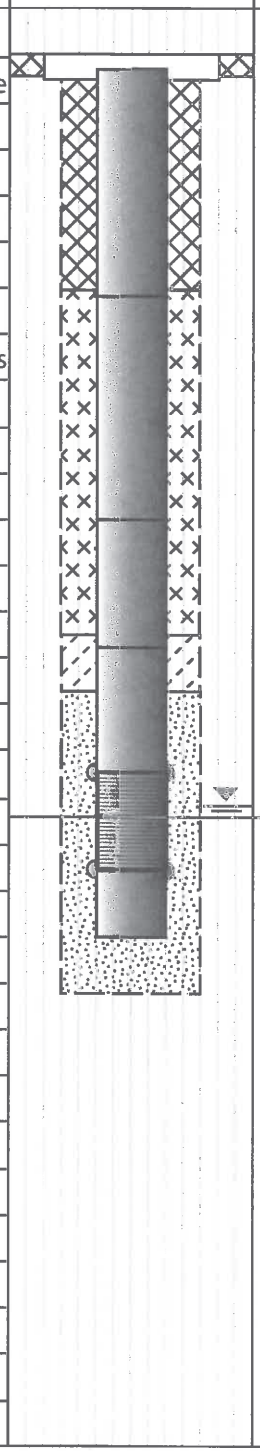
Bentonite Chips: 10.09'- 25.00' bgs

Bentonite Pellets: 25.00' - 27.75' bgs

10/20 Mesh Filter Pack Sand: 27.75'- 40.17' bgs

All temporary 6" OD casing removed 6/30/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.1: Gravel Drill Pad, G

0.1 - 4.0: Sandy Gravel, sG

4.0 - 40.17: Silty Sandy Gravel, msG

Depth to Water: 32.65' bgs (6/30/15)

Total Depth = 40.17'bgs (6/30/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: June 30, 2015

Well ID: C8941	Well Name: 399-1-77	Location: 300 Area W. of PNNL
Project: 30 Wells 300-FF-5 FY15		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground surface to 0.1 ft bgs	PRZ well
				Backfill/drill pad	
					Drilling is being
	g.s				conducted with a
				0.10 ft bgs to 4.00 ft bgs SG	Terrasonic 150CC
				Formation	6" Casing
5				5% silt 45% sand 50% gravel	4"x10' core barrel
	g.s			Sand: medium grain well sorted	
				Sub round. 60% matic 40% felsic	
		100% recovery		Gravel: 2mm to 150 mm poorly sorted	g.s = grab sample
				sub angular 60% matic 40% felsic	
10				2.5 Y 3/3 dark olive brown	
	g.s			Strong reaction to HCl (100° day HCL	
				was not)	
				Dry	
15					
	g.s			4.00 ft bgs to 21.00 ft bgs MSG	
				Formation: Hanford	
		75% recovery		10% silt 35% sand 55% gravel	
				Sand: fine to coarse very poorly	
20				sorted sub angular ~60% matic	
	g.s			40% felsic	
				Gravel: 2mm to small boulders	Recovery
				one @ ~16 ft bgs.	0-10 ~100%
				Angular to sub rounded poorly	10-20 ~75%
25				sorted. 60% matic 40% felsic	20-30 ~80%
				2.5 Y 3/1	30-40 ~50%
	g.s			Strong reaction to HCL	
		80% recovery		Dry	
					TD 40.17 ft
30					
				21.00 ft to 40.17 ft bgs MSG	DTW 32.65 ft
	g.s			Formation: Hanford	
				15% silt 25% sand 60% gravel	
				Sand: fine to very coarse. very	
35				poorly sorted. Angular	
	g.s			60% matic 40% felsic	
		50% recovery		Gravel: 2mm to ~175 mm	
				Angular to well rounded	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/30/15	Signature: [signature]	Date: 8/4/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: June 30 2015

Well ID: C8941	Well Name: 399-1-77	Location: 300 Area N of PNNL
Project: 30 well 300-FF-5 FY 15		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				21.00 ft to 40.17 ft Continued	
				rounding increases with size	
				~70% of the gravels are less	
				than 50mm. 60% mafic	
				40% felsic	
				2.5Y 3/1	
				weak to no reaction to HCL	
				wet	
				@ 25 ft there is a	
				0.9' thick ringold rip up	
				clast made of 80% silt	
				20% fine grain sand	
				2.5Y 4/3 ~~light olive~~ brown	
				no reaction to HCL	
				Dry	
				@ 28.00 ft there	
				is a ringold rip up clast	
				made up of 60% silt 10%	
				sand (fine grain) and 30% gravel	
				sub round ~30 mm average	
				2.5Y 5/2 grayish brown.	
				no reaction to HCL	
				Dry	
				the rip up clast is 0.5 ft	
				in thickness.	
				@38 ft Gravel / Silt	
				lens. 1.25' in thickness	
				well rounded average size ~70 mm	
				85% gravel 15% silt	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: Candice Kildall	Date: 6/30/15	Signature: Kevin Bergstrom	Date: 8/6/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/18/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C9450	Well Name:	399-1-79
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Signature:		Signature:	
Date:	9-28-15	Date:	10/28/15

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.85' bgs

Permanent Well:

2.375" OD PVC Blank: 0.60'- 30.25' bgs

2.375" OD PVC 0.020-slot Screen: 30.25' - 35.25'bgs

2.375" OD PVC Blank Casing: 35.25' - 38.20'

Construction Materials:

Suface Seal: 0.70'- 10.20' bgs

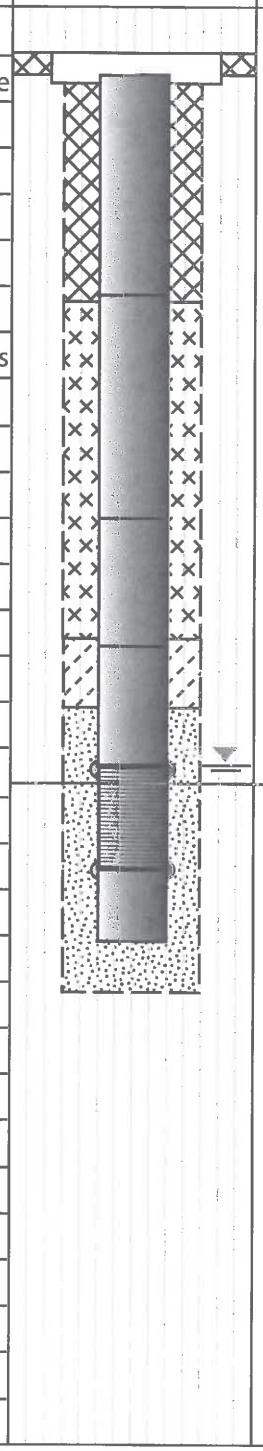
Bentonite Chips: 10.20'- 25.13' bgs

Bentonite Pellets: 25.13'- 28.09' bgs

10/20 Mesh Filter Pack Sand: 28.09'- 40.17' bgs

All temporary 6" OD casing removed 6/18/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.5: Gravel Drill Pad, G

0.5-30.0: Sandy Gravel, sG

30.0-40.0: Silty Gravel, mG

Depth to Water: 31.6 bgs (6/18/15)

Total Depth = 40.17'bgs (6/30/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: 6/18/15

Well ID: C9450	Well Name: 399-1-79	Location: 300 Area (300-FF-5OU) N of PNNL	
Project: 31 Wells in 300-FF-5 OU FY2015		Reference Measuring Point: Ground Surface	

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-0.5 Gravel Drill Pad	Terra Sonic
				0.5-17.5 60% Gravel, 30% Sand, 10% Silt	6" casing
				Sandy Gravel (SG); Gravel: SR, 60% Felsic	4" Core barrel
				40% Mafic, 2mm-10cm; Sand: vf-c, 80%	
				Felsic, 20% Mafic, SR-SA; poorly sorted, 2.5Y 4/1 -	
5	GS	45%		2.5Y 4/2 gray to dark grayish brn, dry to	
				moist, mod rxn w/ HCl	
10	GS				
15	GS	30%			
				17.5'-23' 65% Gravel, 30% Sand, 5% Silt	
				Sandy Gravel (SG); Gravel: R-SR, 2cm-12cm	
				max, avg 2cm, 60% Felsic, 40% Mafic; Sand:	
20	GS			SR-SA, 80% Felsic, 20% Mafic, vf-vc; 2.5Y 4/2	
				dark grayish brn, moist, slight rxn w/ HCl.	
				23.0'-30.0' 70% Gravel, 20% Sand, 10% Silt	
				Sandy Gravel (SG); Gravel: SR-SA, 60%	
25	GS			Felsic, 40% Mafic, 2cm-8cm, 4cm avg.	
		65%		Sand: vf-vc, SR-SA, 80% Felsic, 20% Mafic;	
				2.5Y 4/1 dk gray; moist, no rxn w/ HCl.	
30	GS			30'-40' 70% Gravel, 10% Sand, 20% Silt	
				Silty Gravel (mG); Gravel: R-SR, 80% Felsic,	
				20% Mafic, 2cm-4cm; Sand: 60% Felsic, 40%	
				Mafic, SR-SA, f-vc; 2.5Y 4/1 dark gray,	
35	GS	60%		poorly sorted, dry to wet; no rxn w/ HCl.	

Reported By: Jennifer Russell		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: Jennifer Russell	Date: 6/18/15	Signature: [signature]	Date: 8/3/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: 6/18/15

Well ID: C9450 | Well Name: 399-1-79 | Location: 300 Area N of PNNL

Project: 31 Wells 300-FF-5 OU | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	GS	60%		(cont.) 30' - 40' 70% Gravel, 10% Sand, 20% Silt; Silty Gravel (mG); Gravel: R-SR, 80% Felsic, 20% Mafic, 2cm-4cm; Sand: 60% Felsic, 40% Mafic, SR-SA, f-vc; 2.5Y 4/1 dark gray, dry to wet, poorly sorted, no rxn w/ HCL.	Terra Sonic 4" core barrel 6" casing
					GW = 31.6' bgs
					TD = 40.0' bgs

Reported By: Jennifer Russell | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: Jennifer Russell | Date: 6/18/15 | Signature: [illegible] | Date: 8/3/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/30/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C9452	Well Name:	399-1-81
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Signature:	[signature]	Signature:	[signature]
Date:	9-28-15	Date:	10/28/15

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.85' bgs

Permanent Well:

2.375" OD PVC Blank: 0.25' - 30.61' bgs

2.375" OD PVC 0.020-slot Screen: 30.61' - 35.61'bgs

2.375" OD PVC Blank Casing: 35.61' - 38.25'

Construction Materials:

Suface Seal: 0.50'- 9.83' bgs

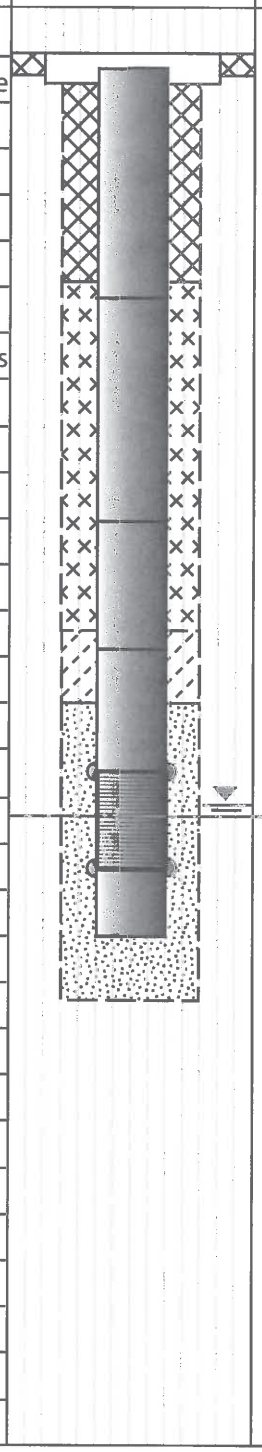
Bentonite Chips: 9.83'- 25.10' bgs

Bentonite Pellets: 25.10' - 28.00' bgs

10/20 Mesh Filter Pack Sand: 28.00'- 40.70' bgs

All temporary 6" OD casing removed 6/30/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 1.5: Gravel Drill Pad, G

1.5 - 9.0: Sandy Gravel, sG

9.0 - 40.7: Silty Sandy Gravel, msG

Depth to Water: 31.5' bgs (6/30/15)

Total Depth = 40.7'bgs (6/30/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page ~~2~~ 1 of ~~2~~ 1 CE 4/30/15
Date: June 30, 2015

Well ID: C9452 | Well Name: 399-1-81 | Location: 300 Area N of PNNL

Project: 30 Wells 300-FF-5 FY15 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0		60% recovery		Ground Surface to 1.50 ft bgs	PRZ well
				Drill pad / Backfill	
					Drilling is being
	g.s.			1.50 ft to 9.00 ft bgs SG	conducted w/ a
				Formation	Terrasonic 150CC rig
5				5% silt 45% sand 50% gravel	6" casing
				Sand: medium to fine grain	4" X 10' core barrel
				mod. sorted, sub round to	
	g.s			angular. 60% mafic 40% felsic	
				Gravel: 2mm to small boulder	g.s. = grab sample
10		90% recovery		Small boulder @ ~3ft bgs	Grab samples
				sub angular poorly sorted	were collected
				60% mafic	every 5ft ~~and~~ CE 7/1/15 in
	g.s			weak reaction to HCL	pint jars and
				2.5Y 3/3 very dark olive brown	Chip trays
15				Dry	
	g.s.				
				9.00 ft bgs to 21.00 ft bgs MSG	
				Formation: Hanford	
20				Silt 10% Sand 40% Gravel 50%	
				Sand: fine to coarse, poorly sorted	
		60% recovery		Angular 60% mafic 40% felsic	Recovery
	g.s			Gravel: 2mm to ~175mm poorly	0'-10' ~60%
				sorted sub round 60% mafic	10-20' ~90%
25				40% felsic.	20'-30' ~60%
				weak to mod. reaction to HCL	30'-40' ~100%
	g.s			2.5Y 3/1 very dark gray	
				Dry	
30					TD 40.70 ft
	g.s	100% recovery		21.00 ft to 40.70 ft bgs MSG	DTW 31.50 ft
				Formation: Hanford	
				15% silt 30% sand 55% Gravel	
				Sand: Coarse to fine very poorly	
35				sorted. Angular. 60% mafic 40% felsic	
	g.s			Gravel: 2mm to ~200mm (~80%	
				of the gravels are under 50mm)	
				Angular to rounded, rounding	
				increases w/ size	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] Date: 7/29/15 | Signature: [signature] Date: 8/3/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: June 30, 2015

Well ID: C9452	Well Name: 399-1-81	Location: 300 Area W of PNNL
Project: 30 wells 300-FF-5 FY15		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				60% matic 40% felsic	
				weak to no reaction to HCL	
				2.5Y 3/2 Dark grayish brown	
				wet	
				@ ~ 28 ft bgs	
				Gravel / silt lens	
				~1 ft thick average gravel	
				size ~80mm sub round	
				15% silt 85% Gravel	

Reported By: Candice Bainette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/30/15	Signature: [signature]	Date: 8/3/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/24/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C9454	Well Name:	399-1-83
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEUPER
Date:	9-28-15	Date:	10/28/15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.85' bgs

Permanent Well:

2.375" OD PVC Blank: 0.90' - 30.35' bgs

2.375" OD PVC 0.020-slot Screen: 30.35' - 35.35'bgs

2.375" OD PVC Blank Casing: 35.35' - 38.10'

Construction Materials:

Suface Seal: 0.90'- 9.70' bgs

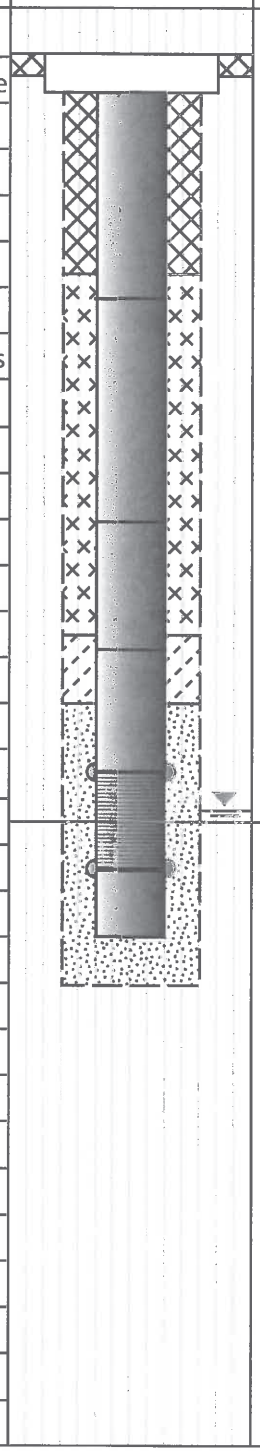
Bentonite Chips: 9.70'- 25.00' bgs

Bentonite Pellets: 25.00' - 28.00' bgs

10/20 Mesh Filter Pack Sand: 28.00'- 39.98' bgs

All temporary 6" OD casing removed 6/23/15.

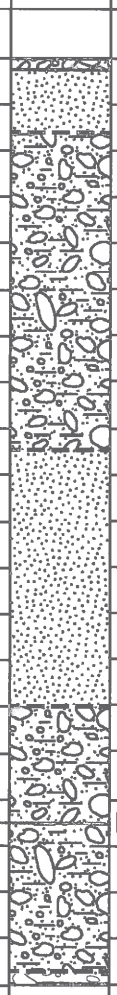
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log



Lithologic Description

0.0 - 0.5: Gravel Drill Pad, G

0.5 - 3.2: Sand, S

3.2 - 17.0: Silty Sandy Gravel, msG

17.0 - 28.0: Sand, S

28.0 - 39.7: Silty Sandy Gravel, msG

Depth to Water: 33.15' bgs (6/24/15)

39.7 - 39.98: Gravelly Silt, gM

Total Depth = 39.98' bgs (6/24/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: June 24, 2015

Well ID: C9454	Well Name: 399-1-83	Location: 300 Area N of PNNL
Project: 31 well 300-FF-5 FY15 (PR2 well)		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		100% Recovery		Ground surface to 0.50 ft bgs Backfill/drilling pad.	Drilling is being conducted with ~~an~~ Sonic rig Terra Sonic 150 CC
	g.s.			0.5 ft bgs to 3.20 ft bgs Formation (S)	6" casing 4"X10' core barrel
5				5% Silt 90% Sand 5% Gravel. Sand: fine to coarse, poorly sorted	g.s. = grab sample
	g.s			sub angular ~40% mafic 60% felsic Gravel ~4mm to 100mm sub angular	grab samples collected for archive in 5' intervals
				70% mafic 30% felsic Weak reaction to HCL	
10	g.s	100% recovery		2.5Y 3/2 very dark grayish brown Dry	H2O Tag @ 33.15 ft bgs TD - 39.98 ft bgs.
15	g.s			3.20 fbgs to 17.00 ft bgs Formation: Hanford (MSG) 15% Silt 40% Sand 45% Grave	
				Sand: fine to coarse, poorly sorte Sub angular 50% mafic 50% felsic	
20	g.s	75% recovery		Gravel: 2mm to ~150mm poorly sorted Angular to sub round Weak to mod reaction to HCL reaction decreases down unit. 2.5Y 4/1 dark gray	
25	g.s			17.00 ft bgs to 28.00 ft bgs Formation: Hanford (S) 2% Silt 95% sand 3% Gravel	
30	g.s	50% recovery		Sand: Fine to medium grain, mod sorted Angular 60% mafic 40% felsic No reaction to HCL 2.5Y 4/2 dark grayish brown Dry	
35	gs			28.00 ft to 39.70' bgs Formation: MSG 15% Silt 30% sand 55% gravel	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: Candice Kildall	Date: 6/24/15	Signature: Kevin Bergstrom	Date: 8/3/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: June 24, 2015

Well ID: C9454	Well Name: 399-1-83	Location: 300 Area W of PNNL
Project: 31 Wells 300ff-5 FY15 (PRZ wells)		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				28.00 ft to 39.70' continued	drilling is being
				Sand: Coarse grain, poorly sorted	conducted
				Angular, 70% mafic 30% felsic	with a Terra sonic 150cc
				Gravels: 2mm to ~150mm	6" casing
				Angular to sub round, poorly	4"X10' core barrel
				sorted. 60% mafic 40% felsic	
				@ ~36 ft bgs there is	
				a 0.10 ft color change of 2.5YR 3/4	
				Dark reddish brown.	
				Overall sample color is	
				2.5YR 2.5/1 black	
				No reaction to HCL	
				wet	
				39.70 ft bgs to 39.98' bgs	
				Formation: gM	
				60% silt 10% ~~Gravel~~ CK 6/24/15 Sand 30% gravel	
				Sand: coarse grain, mod sort	
				Angular ~60% mafic 40% felsic	
				Gravel: 2mm to ~10mm sub round	
				~60% mafic 40% felsic	
				silt - contain mica low plasticity	
				2.5Y 5/1 gray	
				no reaction to HCL	
				wet.	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: Candice Kildall	Date: 6/24/15	Signature: Kevin Bergstrom	Date: 8/3/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/25/15
Finish Date:	6/8/15
Page	1 of 1

Well ID:	C9456	Well Name:	399-1-85
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10/28/15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument:
0.0' - 0.85' bgs

Permanent Well:

2.375" OD PVC Blank: 0.64' - 30.58' bgs

2.375" OD PVC 0.020-slot Screen:
30.58' - 35.58' bgs

2.375" OD PVC Blank Casing:
35.58' - 38.21' bgs

Construction Materials:

Concrete: 0.0'- 0.7' bgs

Suface Seal: 0.7'- 10.0' bgs

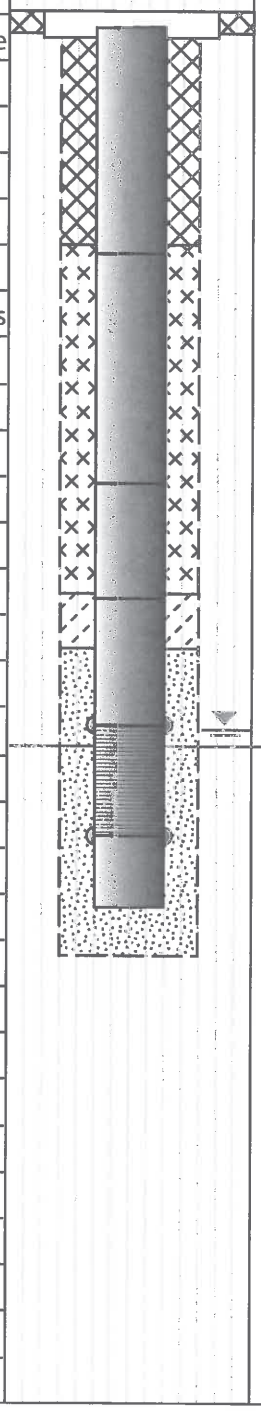
Bentonite Chips: 10.0'- 24.9' bgs

Bentonite Pellets: 24.9- 27.3' bgs

10/20 Mesh Filter Pack Sand:
27.3'- 40.5' bgs

All temporary 6" OD casing removed 6/25/15.

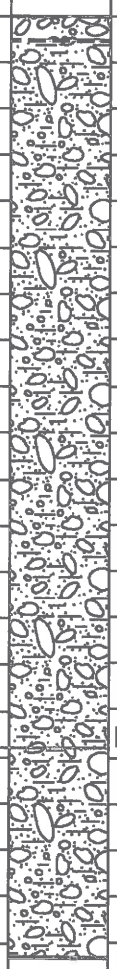
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log



Lithologic Description

0.0 - 1.0: Gravel Drill Pad, G

1.0 - 40.5: Silty Sandy Gravel, msG

Depth to Water: 31.80' bgs (6/25/15)

Total Depth = 40.5'bgs (6/24/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: June 25, 2015

Well ID: C9456 | Well Name: 399-1-85 | Location: 300 Area W of PNNL

Project: 31 well installation 300 FF-5 FY15 | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		80% Recovery		Ground surface (0) to 1.00 ft bgs G Drill pad / Backfill	PRZ well
	g.s.			1.00 ft to 2.70 ft bgs MSG Formation	Drilling is being conducted with a Terrasonic 150cc 6" casing 4"x10' core barrel
5				15% silt 50% sand 35% Gravel Sand: fine to coarse grain, poorly sorted, Angular 40% mafic 60% felsic Gravel: ~10mm to ~120 mm, poorly sorted, subround. ~70% mafic 30% felsic	
	g.s			weak reaction to HCL 2.5Y 3/3 dark olive brown Dry	g.s = grab sample Grab sample are collected in 5 ft intervals.
10		70% recovery			
	g.s				
15				2.70 ft to 17.00 ft bgs MSG Formation: Hanford 10% silt 40% Sand 50% Gravel Sand: fine to coarse grain very poorly sorted Angular to Subangular ~60% mafic 40% felsic Gravel: 2mm to ~175 mm, sub-angular to sub rounded 65% mafic 35% felsic weak to no reaction to HCL (Dry) 2.5Y 4/1 dark gray Dry	Recovery 0'-10' = ~80% 10'-20' = ~70% 20'-30' = ~100% 30'-40' = ~60% TD 40.50 ft bgs DTW 31.80 ft bgs
	g.s				
20		100 Recovery			
	g.s				
25				17.00 ft to 40.45 MSG Formation: Hanford 15% silt 40% sand 45% Gravel Sand: fine to very coarse. Higher % of sand is coarse to very coarse. Angular very poorly sorted ~60% mafic 40% felsic Gravel: 2mm to 150mm (gravels run small ~2% are over 100mm) Sub angular to well rounded 60% mafic 40% felsic	
	g.s				
30		60% recovery			
	g.s				
35					
	g.s				

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 6/25/15 | Signature: [signature] | Date: 8/3/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: June 25, 2015

Well ID: C9456	Well Name: 399-1-85	Location: 300 Area N of PNNL
Project: 31 well installation 300-FF-5 FY15		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				17.00 ft to Continued	PRZ well
				No reaction to HCL (damp)	
			TD 40.50'	2.5 Y 3/1 very dark gray	Drilling was conducted
				moist.	with a
					Terrasonic 150cc rig
				@ ~18.00 ft to 18.20 ft bgs	6" casing
				small clay / gravel lens	4"x10' core barrel
				2.5 Y 6/4 light yellowish brown	
				6/25/15 reaction to HCL = mod-strong (Dry)	
				Dampish	
				@ 25.50 ft to 26.00 ft bgs	
				Small lens ~40% silt 30% ver fine	
				grain sand 40% gravel	
				mica noted is Clay.	
				low plasticity	
				2.5Y 6/4 Light yellowish brown	
				No reaction to HCL	
				@ 32 ft bgs bedding appears	
				gravels consentrate in to	
				two lens:	
				@ ~34 ft bgs (0.90 ft)	
				@ ~39 ft bgs	
				Average size of gravels is ~35 mm	
				sub round to well round	
				no reaction to HCL	
				No color chang	
				Water tagged 6/25/15 @ 33.60 ft bgs	
				TD = 40.50 ft bgs	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/25/15	Signature: [signature]	Date: 8/3/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/23/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C9458	Well Name:	399-1-87
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10-28-15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.7' bgs

Permanent Well:

2.375" OD PVC Blank: 0.50' - 30.57' bgs

2.375" OD PVC 0.020-slot Screen: 30.57' - 35.57' bgs

2.375" OD PVC Blank Casing: 35.57' - 38.00' bgs

Construction Materials:

Concrete: 0.7'- 2.0' bgs

Suface Seal: 2.0'- 9.5' bgs

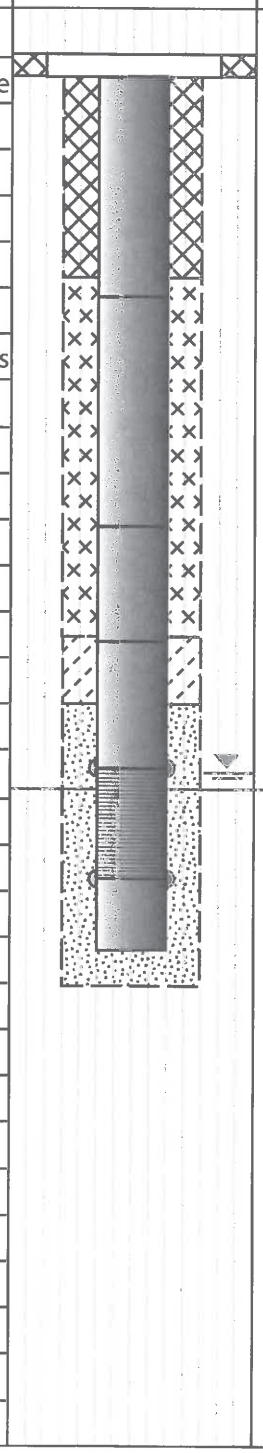
Bentonite Chips: 9.5'- 25.0' bgs

Bentonite Pellets: 25.0- 28.2' bgs

10/20 Mesh Filter Pack Sand: 28.2'- 40.0' bgs

All temporary 6" OD casing removed 6/23/15.

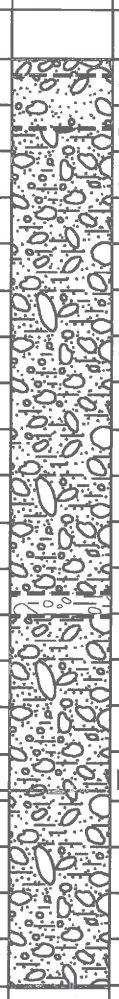
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log



Lithologic Description

0.0 - 0.3: Gravel Drill Pad, G

0.3 - 2.8: Gravelly Sand, gS

2.8 - 23.0: Silty Sandy Gravel, msG

23.0 - 24.0: Silty Gravel, mG

24.0 - 40.0: Silty Sandy Gravel, msG

Depth to Water: 31.60' bgs (7/20/15)

Total Depth = 40.0' bgs (6/24/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: June 23, 2015

Well ID: C9458	Well Name: 399-1-87	Location: 300 Area N of PNNL
Project: 31 Well 300-FF-5 FY15 PRT		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0.0 to 0.30 ft bgs	Drilling is being
				Drilling pad / Backfill	conducted w/ a
					Terrasonic 150 cc
					6" casing
	gs	100% recovery		0.30 to 2.80 ft bgs	4"X10' core barrel
				Formation (g)S	
5				10% Silt Sand 70% Gravel 20%	G.S. = grab sample
	g.s.			Sand: fine to coarse, poorly sorted	grab samples collected
				sub angular 40% mafic 60% felsic	in five foot intervals
				Gravel 2mm to ~40 mm poorly	for Archive.
10				sorted angular 70% mafic 30% felsic	
	g.s.	50% recovery		weak to no reaction to HCL (Dry)	
				2.5Y 3/2 ver dark grayish brown	
				Dry	
					Tag H2O @32.8' bgs
					6/23/15
15				2.80 ft to 23.00 ft	
	g.s			Formation: Hanford MSG	TD 40.00 ft bgs
				10% Silt 40% ~~Gro~~ Sand 50% Gravel ck 6/23/15	
				Sand: very fine to coarse, poorly sorted	
20				sub angular to angular	
		80% recovery		40% mafic 60% felsic	
	g.s			Gravel: 2mm to small Boulder.	
				poorly sort Angular to sub round	
				60% mafic 40 felsic (boulder @ 6')	
				weak reaction to HCL (Dry)	
25				2.5Y 4/1 dark gray	
	g.s			Dry	
				23.00'-24.00' ft bgs Hanford	
				20% Silt 10% Sand 70% gravel	
30				Sand: Coarse grained angular	
	g.s	40% recovery		80% mafic 20% felsic	
				Gravel: ~15mm to 100mm poorly sorted	
				sub round.	
35				No reaction to HCL	
	g.s			2.5Y 4/1 dark gray	
				moist	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/23/15	Signature: [signature]	Date: 8/3/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: June 23, 2015

Well ID: C9458	Well Name: 399-1-87	Location: 300 Area N of PNNL
Project: 31 well 300-FF-5 FY 15 PR2 well		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				24.00 ft 37.00 ft bgs MSG	Drilling is being
				10% silt 45% sand 45% Gravel	conducted w/ a
				Sand: fine to very coarse poorly	TerraSonic 150CC
				sorted Angular. 50% mafic 50% felsic	6" Casing
				Gravel: 2mm to 50mm poorly sorted	4"X10' Core barrel
				sub rounded to well rounded.	
				60% mafic 40% felsic	g.s = grab sample.
				2.5Y 3/1 very dark gray	
				No reaction to HCL	
				Moist	
				37.00 ft to 40.00 ft bgs	
				Formation: Hanford	
				15% M 10% S 75% G	
				Sand: coarse grain, Angular	
				80% mafic 20% felsic	
				Gravel: 2mm to 130mm sub to	
				well rounded. 70% mafic 30% felsic	

Reported By: Candice Burnette Kuldell		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date:	Signature: [signature]	Date: 8/3/15

A-6003-642 (03/03)

SURVEY DATA REPORT

Request No. 154-161			
Project No.	Title: 300-FF-5 Wells Final Surveys		File No. 3AT10R28
Job. No. CACN: 303500-JPRC	Prepared By: N.P. Fastabend	Date: 8/11/15	Reviewer: LBM

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casings) and elevations of 30 completed 300-FF-5 flush mount wells located on north side of 300 Area.	Survey File	OR		
	E.C. Rafuse	1		
	S.J. Trent	1		
	K.M. Whitley	1		
	J.B. Geiger	1		
Horizontal Coordinate System: WCS83S/91 (Meters)	B.J. Howard	1		
Vertical Datum: NAVD88 (Meters)	A.J. Green	1		

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheets

A-6006-495 (REV 0)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8930 (399-1-69) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8930	399-1-69	594169.73'	116505.03'		Center of Casing
				114.635'	"X" on Rim
				114.632'	Brass Survey Marker

Notes:

114.540' Top Inner 2in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8932 (399-1-71) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8932	399-1-71	594126.33	116508.84		Center of Casing
				114.838	"X" on Rim
				114.838	Brass Survey Marker

Notes:

114.738 Top Inner 2in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8935 (399-1-73) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8935	399-1-73	594081.69	116494.22		Center of Casing
				114.917	"X" on Rim
				114.920	Brass Survey Marker

Notes:

114.781 Top Inner 2in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8939 (399-1-75) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8939	399-1-75	594098.69	116475.62		Center of Casing
				114.922	"X" on Rim
				114.918	Brass Survey Marker

Notes:

114.819 Top Inner 2in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8941 (399-1-77) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8941	399-1-77	594118.72	116460.56		Center of Casing
				115.254	"X" on Rim
				115.253	Brass Survey Marker

Notes:

115.071 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9450 (399-1-79) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9450	399-1-79	594154.88	116463.09		Center of Casing
				114.912	"X" on Rim
				114.911	Brass Survey Marker

Notes:

114.778 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9452 (399-1-81) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9452	399-1-81	594090.90	116454.92		Center of Casing
				114.984	"X" on Rim
				114.984	Brass Survey Marker

Notes:

114.887 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9454 (399-1-83) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9454	399-1-83	594152.48	116427.40		Center of Casing
				115.066	"X" on Rim
				115.062	Brass Survey Marker

Notes:

114.939 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9456 (399-1-85) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9456	399-1-85	594175.50	116451.42		Center of Casing
				114.932	"X" on Rim
				114.931	Brass Survey Marker

Notes:

114.799 Top Inner 2in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

Appendix B

Well Documentation for Aquifer Monitoring Wells

- Well Summary Sheet
- Borehole Log
- Final Survey Report

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WELL SUMMARY SHEET

Start Date: 6/15/2015
Finish Date: 8/6/2015
Page 1 of 1

Well ID: C8931	Well Name: 399-1-70
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/24/15
Signature: MMiller	Reviewed By: J.D. MEHRER
	Signature: [signature]
	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

2'x2' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.60' bgs

Permanent Well:

2.37" OD PVC Blank: 0.30' - 41.25' bgs

2.37" OD PVC 0.020-slot Screen: 41.25' - 46.25' bgs

2.37" OD PVC Blank: 46.25' - 48.98' bgs

Construction Materials:

Concrete: 0.0' - 1.50' bgs

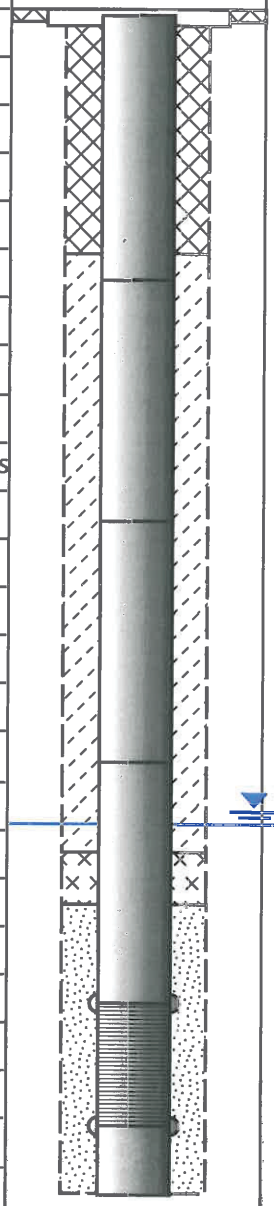
Neat Grout: 1.50' - 10.10' bgs

Bentonite Chips: 10.10' - 34.90' bgs

Bentonite Seal: 34.90' - 37.10' bgs

10/20 Mesh Filter Pack Sand: 37.10' - 48.90' bgs

All temporary 6" OD casing removed 6/16/15.



GEOLOGIC/HYDROLOGIC DATA

0.0' - 0.75': Gravel Drill Pad, G

0.75' - 48.90': Silty Sandy Gravel, msG

Depth to Water: 33.8' bgs (6/15/15)

Total Depth = 48.90' bgs (6/15/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: June 16, 2015

Well ID: C8931 | Well Name: 399-1-70 | Location: 300 Area N of PNNL

Project: Aquifer monitoring well | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0	Litho g.s	100% recovery		0-0.75 ft Formation: Backfill / drilling pad	Drilling is being conducted w/a Terrasonic 150 cc Drill rig 4" core barrel 6" casing.
5	g.s			0.75 ft to 3.00 ft Formation: Hanford MSG 10% Silt 40% Sand 50% Gravel Sand: Medium grain, mod. sorted Subangular to angular 30% mafic to ~70% felsic Gravel: 2mm to 100mm poorly sorted subrounded to sub angular 60% mafic 40% felsic 5YR 3/2 dark reddish brown (damp) Naturally damp. Slight reaction to HCL.	g.s = Grab sample Litho = sample collected at a change in Lithology. Grab samples collected @ 0'-5' 5-10' 10-15' 15-20' 20-25' 25-30' 30'-35' 35-40' 40'-45' 45-48.90'
10	g.s.	60% recover			
15	g.s.			3.00 ft to 14 ft Formation: Hanford MSG 10%m 30%s 60%g Sand: fine to coarse very poorly sorted sub angular Gravel: 2mm to 110mm, poorly sorted Angular to sub round. 60% mafic 40% felsic 2.5YR 4/3 reddish Brown (damp) Slight reaction to HCL Dry	
20	g.s	70% recovery			
25	g.s.				Litho samples collected @ 3' 32'
30	Litho g.s	50% recovery		14.00 ft 32.00 ft Formation Hanford MSG 10% silt 35% Sand 50% Gravel Sand: fine to very coarse, poorly sorted sub ~~angular~~ angular 40% mafic 60% felsic Gravel: 2mm to ~140mm poorly sorted, Angular to round. 60% mafic 40% felsic	Recovery 0-10' 100% 10'-20' 60% 20'-30' 70% 30'-40' 50% 40'-48.90' 100% TD 48.90' bgs DTW 33.8' bgs
35					

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] Date: 6/15/15 | Signature: [signature] Date: 9/8/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: June 16, 2015

Well ID: C8931	Well Name: 399-1-70	Location: 300 Area N of PNNL
Project: Aquifer monitoring well		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40		100% recovery		14.00 to 32.00 ft Continued:	Drilling is being
				@ ~ 17 ft bgs small compact	conducted w/ a
	g.s.			chips of fine grain sand/silt	Terrasonic 150C
				high in felsic (80%) material to	6" casing
				include mica. Possible ringold	4" Core barrel
45				rip up clast.	
				7.5YR 3/1 very dark gray (damp)	
				slight to no reaction to HCl (Dry)	g.s = grab sample
	g.s.			Damp	
				32.00 ft 45.00 ft bgs	
50			TD 48.90 6/15/15 Drilled	Formation Hanford MSG	
				10% silt 30% sand 60% Gravel.	
				Sand: sand is located at the	2" monitoring
				lower end of the sample and	well installed
				is well graded. This is most	6/16/15
				likely because the vibrations, and	
				from drilling in the water.	Borehole drilled
				~~So~~ Sand is fine to coarse sub-	6/15/15
				angular 50% mafic 50% felsic	
				Gravels: 4mm to 130 mm poorly	
				sorted. sub round to well round.	
				60% mafic 40% felsic	
				7.5YR 4/1 dark gray (damp	
				weak reaction to HCl	
				wet	
				45.00 ft to 48.90 ft bgs	
				Formation:	
				15% silt Sand 35% 50% gravel	
				Sand is very fine to coarse, mica	
				sub round poorly sorted	
				40% mafic 60% felsic	
				Gravel: 2mm to ~100 mm	
				sub angular to sub rounded	
				40% mafic 60% felsic	
				silt has some (very low) plasticity.	
				7.5YR 3/1 very dark gray (damp)	
				no reaction to HCl.	
				Wet	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/16/15	Signature: [signature]	Date: 9/8/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/9/2015
Finish Date: 8/6/2015
Page 1 of 1

Well ID: C8934	Well Name: 399-1-72
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Reviewed By: J.D. MEHRER
Date: 9/24/15	Date: 10-28-15
Signature:	Signature:

CONSTRUCTION DATA

Surface Completion:

1.90'x1.90' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.90' bgs

Permanent Well:

2.37" OD PVC Blank: 0.35' - 39.67' bgs

2.37" OD PVC 0.020-slot Screen: 39.67' - 44.67' bgs

2.37" OD PVC Blank: 44.67' - 47.40' bgs

Construction Materials:

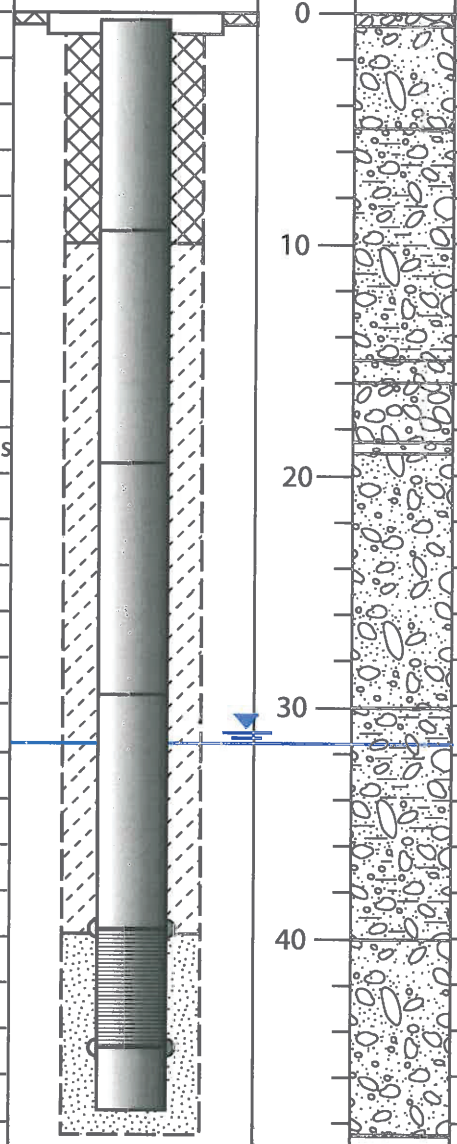
Concrete: 0.0' - 1.30' bgs

Neat Grout: 1.30' - 10.0' bgs

Bentonite Chips: 10.0' - 39.90' bgs

10/20 Mesh Filter Pack Sand: 39.90' - 48.50' bgs

All temporary 6" OD casing removed 6/10/15.



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0' - 0.5': Gravel Drill Pad, G

0.5' - 5.0': Sandy Gravel, sG

5.0' - 15.0': Silty Sandy Gravel, msG

15.0' - 16.0': Sandy Gravel, sG

16.0' - 18.50': Gravel, G

18.50' - 19.0': Silty Gravel, mG

19.0' - 30.0': Sandy Gravel, sG

30.0' - 40.0': Silty Sandy Gravel, msG

Depth to Water: 31.69' bgs (7/16/15)

40.0' - 48.50': Sandy Gravel, sG

Total Depth = 48.50' bgs (6/10/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2
Date: 6·9·15

Well ID: C8934
Well Name: 399-1-72
Location: 300 Area N. of PNNL. N. Process Ponds.
Project: 300 Area U. Sequestration
Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-0.5': Gravel Pad.	Sonic w/10.5' x 5" core barrel
				0.5'-4.0': Sandy Gravel. sG (65-70%G, 30-45%S, <2%m)	
				v.f.pbl.-sm.cbl. sub rndd. of 60%bslt/40%felsic Meta.>int.Volc.	
	g.s.			w/ v.f.-v.c. sub-ang. S. of 50%mafic/50%felsic. no mica.	3': grab sample (g.s.)
				2.5Y 4/2 drk grysh. brown. wk. rxn w/HCl. Prob. mixed w/	▨ = no recovery if known.
5		40%		non-loess soil. Poor recovery.	
				5-15': silty sandy Gravel msG(60%G,30%S,10%m)	5-10': no recovery - Rock blocked
				Poor srtd. v.f.pbl.-sm.cbl. of 60%-bslt./40%felsic Meta>int.V.>	shoe @ 5'
				sub-v.w.rndd. clasts max: 100mm. w/matrix of v.f.-c. sub-ang. S.	
				S. is 70%-50% Qtz felds. sprs. mica. no cohesion. 10YR 4/3 brown.	
			no Recovery.	moist. mod. rxn. w/HCl.	
10		6-9.5ft			10-20': 80% recovery: uncertain on origination of matl.
	g.s.				13': g.s.
				15- : 6"-2' normal graded bedding. Prob. Agthmite.	
				15-16': Sandy Gravel sG(60%G,40%S) v.w.srtd. v.f.-f.pbl. of	
15		60%		bslt. w/m.-v.c. S. 10YR 3/1 blk.	
	g.s.			•16-18.5': sandy gravel grading to Gravel. (85%G, 15%S)	17': g.s. of sG.
				v.f.pbl. grading to c.pbl. w.rndd. of 95%bslt. 5%felsic. w/sand matrix	
	g.s.			of m-v.c. sub-ang. S. of bslt. 10YR 3/1 blk. wk rxn w/HCl.	
20	g.s.	M.B.9.9ft PRZ		•18.5-19': Silty Gravel bed. mG(75%G,25%m) gravels similar	18.5': g.s. of silty Gravel
				to above w/fine matrix of 2.5Y 3/4 lt. olv. brown.	20': g.s. of msG
				•19-20': sG. Sandy Gravel sG(70-75%G,30-25%S) mod-w. srtd.	
				v.f.-crs.pbl. v.w.rndd. of 95%bslt./5%felsic. w/matrix grading	
				from m-c. ang. S to v.f.-c. S. silt content increases w/depth.	
				2.5Y 4/2 drk. grysh. brown no rxn w/HCl. max clast: 25mm	
				20'-30': ~~silty~~ Sandy Gravel msG(75%G,15%S,10%m)	
				w. Srtd. KNO v.w.rndd. m.pbl.-v.crs.KNO pbl. of 85%bslt.15%felsic	
				meta.>int.V. w/matrix of v.f.-crs. ang. S. of 80%Mafic, 20%felsic.	
				2.5Y 4/2 drk grysh brown. no rxn w/HCl. max clast: 35mm	
20		M.6.9ft PRZ		moist.	20-30': ~100% recovery. 10% sluff.
		PRZ			
25	g.s.			•25': msG Grant. (60-70%G, ~~40-20~~ 30-20%S, 15%m) pr.srtd.	25': g.s.
				v.f.pbl.-v.c.pbl. v.w.rndd. of 90%bslt./10%felsic Meta. w/	-25-55': 2500 cpm By/0α.
		100%		v.f.-~~v.c.~~ m. ang. S. 2.5Y 4/2 drk grysh brown. no rxn w/HCl. moist	

Reported By: A. Lantow
Title: Geo. Tech.
Signature: A. Lantow
Date: 6-9-15

Reviewed By: Kevin Bergstrom
Title: Sr. Geologist
Signature: K. Bergstrom
Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: 6.10.15

Well ID: C8934 | Well Name: 399-1-72 | Location: 300 Area N. Process Ponds.

Project: 300 Area U Sequestration RA. | Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30				30-35 : silty sandy Gravel msG (75% G, 20% S, 5-10% M)	Sonic w/ 5"x10' core barrel.
				v. Pr. srtd. v.w.rndd. v.f. pbl. to lrg. cbl. of 80% bslt/20% felsic	-25-35': 2500 dpm Bgr/0α
				int. V.> Meta. w/ v.f.-v.c. sub-ang. S. of 95% Mafic/5% Qtz-felds.	▨ = no recovery.
				v. low plastic silt. 2.5Y 2.5/1 black.	-
				· Prob. downward coarsening.	30-35': g.s.
35				35 · max clast: sprs. lrg cbl. 250 mm. blocked core barrel.	35-40': no recovery bit blocked by rock.
				35-40': silty Sandy Gravel msG. (75% G, 20% S, 10% M)	
				mod-pr. srtd. v.w.rndd. v.f. pbl.-sm. cbl. of 75% bslt/25% int V.>	
				Meta. w/ vr-v.c. ang. S. of 85% bslt. 15% Qtz-felds. non plastic	
				2.5Y 2.5/1 black. no rxn w/ HCl. v.w.rndd clasts	
40				40-48': silty Sandy Gravel sG (75-80% G, 20% S, 5% M)	40-48': 50 % recovery.
				mod. srtd. v.f. pbl.-v.crs. pbl. v.w.rndd. of 60% bslt/40% Meta.>	no recovery on 1st try.
				int. V. w/ crs. to v.crs. ang. S. 90% bslt./10% Qtz. felds.	slough from 40-44' bgs.
				slightly plastic. clayey silt. ~~2.5Y 4/1~~ (GLEY) 2 4/1 drk. greenish	
				gray. wet. max clast: 64 mm. "Reducing prob."	40-48': g.s.
45					
			TD: 48.1'		TD: 48.1' bgs.
50					DTW: 31.69' bgs

Reported By: A. Lantow | Reviewed By: Kevin Bergstrom

Title: Geo. Tech. | Title: Sr. Geologist

Signature: A. Lantow | Date: 6.10.15 | Signature: K. Bergstrom | Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/29/2015	Page 1 of 1
Finish Date: 8/6/2015	

Well ID: C8937		Well Name: 399-1-74	
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU	
Prepared By: Tessa Clark	Date: 9/25/15	Reviewed By: J.D. MEHRER	Date: 10-28-15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.60' bgs

Permanent Well:

2.375" OD PVC Blank: 0.30' - 40.17' bgs

2.375" OD PVC 0.020-slot Screen: 40.17' - 45.17' bgs

2.375" OD PVC Blank: 45.17' - 47.80' bgs

Construction Materials:

Concrete: 0.0' - 1.25'bgs

Neat Grout: 1.25' - 10.50' bgs

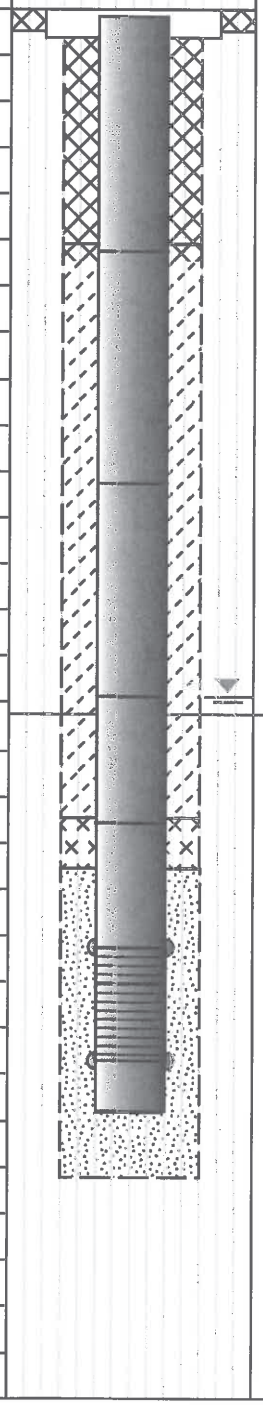
Bentonite Chips: 10.50' - 34.20' bgs

Bentonite Seal: 34.20'- 37.20' bgs

10/20 Mesh Filter Pack Sand: 37.20' - 50.07' bgs

All temporary 6" OD casing removed 6/16/15.

Diagram



Depth in Feet: 0, 10, 20, 30, 40, 50

GEOLOGIC/HYDROLOGIC DATA

Graphic Log

Lithologic Description

0.0' - 0.15': Gravel Drill Pad, G

0.15' - 14.0': Silty Sandy Gravel, msG

14.0' - 34.0': Silty Sandy Gravel, msG

Depth to Water: 30.2' bgs (7/9/15)

34.0' - 46.0': Silty Sandy Gravel, msG

46.0' - 50.50': Silty Sandy Gravel, msG

Total Depth = 50.50' bgs (6/29/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: June 29, 2015

Well ID: C8937	Well Name: 399-1-74	Location: 300 Area N of PNNL
Project: 30 well 300-FF-5 FY15		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground surface to 0.15 ft bgs	Aquifer well
				Drill pad / Backfill	
					Drilling is being
	g.s				conducted w/ a
				0.15 to 14.00 ft bgs msg	Terra sonic 150CC
				Formation	6" casing
5				5% silt 45% sand 50% gravel	4'X10' core barrel
	g.s			Sand: med to coarse grain. mod	
				sorted, sub-angular 40% matic	
				60% felsic	
		Recovery 60%		Gravel: 2 mm to ~120 mm poorly	
10				sorted sub angular to sub round.	g.s = grab sample
	g.s			60% matic 40% felsic	
				Mod. reaction to HCl	
				2.5Y 3/3 dark olive brown.	
15				Dry	
	g.s			14.00 - 34.00 ft bgs msg	
				10% silt 35% sand 55% Gravel	
		Recovery 45%		Sand: fine to coarse grain, poorly	Recovery
20				sorted sub-angular 60% matic	0-10 60%
	g.s			40% felsic	10-20 45%
				Gravel 2mm to 175mm poorly	20-30 75%
				sorted sub round to sub angular	30-40 50%
				60% matic 40% felsic	40-50 50%
25				weak to mod reaction to HCl	
	g.s			2.5Y 3/1 very dark gray	
		75% recovery		D	
30				@ ~48 ft bgs carbonate lens	
	g.s			~0.05 ft. very strong reaction	
				to HCL 2.5Y 8/1 white.	
35				@ ~25 ft bgs gravel lens	
	g.s			0.90 ft of sub to well rounded	
				gravels average size 50mm. silt/clay	
		50% recovery		surrounding gravels low plasticity.	
				Moist	

Reported By: Candice Burnette Kildall	Reviewed By: Kevin Bergstrom
Title: Geologist	Title: Sr. Geologist
Signature: Candice Burnette Kildall Date: 6-29-15	Signature: Kevin Bergstrom Date: 9/9/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: June 29, 2015

Well ID: C8937	Well Name: 399-1-74	Location: 300 Area N of PNNL
Project: 30 well 300-FF-5 FY 15		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				24.00 ft bgs to 46.00 ft bgs	Aquifer well
				15% silt 40% Sand 45% Gravel	
				Formation: MSG	Drilling is being
	g.s			Sand: med to very coarse grain sand	conducted w/ a
				Angular poorly sorted 60% matic	Terrasonic 150 cc
45				40% felsic	6" casing
				Gravel: 2mm to 130 mm mod. sorted	4" x 10' core barrel
				round to subangular, rounding	
	g.s	50% recovery		increases with size. 60% matic 40% felsic	g.s. = grab sample
				No reaction to HCL	
50				2.5Y 3/1 very dark gray	
				wet	
				46.00 to 50.50 ft bgs MSG	
				Formation:	
				10% silt 40% sand 50% gravel	
				Sand: very fine to med. grain	
				mod. sorting. sub round.	
				40% matic 60% felsic	
				Gravel: 2mm to 100mm	
				sub round to well round.	
				mod. sort.	
				40% matic 60% felsic	
				Clay/silt low plasticity	
				2.5Y 2.5/1 Black	
				wet	
				No reaction to HCL.	
				TD 50.50	
				Water 42.87 bgs 6-29-15	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstron	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6-29-15	Signature: [signature]	Date: 9/9/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	7/7/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C8940	Well Name:	399-1-76
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10-28-15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.7' bgs

Permanent Well:

2.375" OD PVC Blank: 0.45 - 40.22' bgs

2.375" OD PVC 0.020-slot Screen: 40.22' - 45.23' bgs

2.375" OD PVC Blank Casing: 45.23' - 47.85' bgs

Construction Materials:

Suface Seal: 0.8'- 10.0' bgs

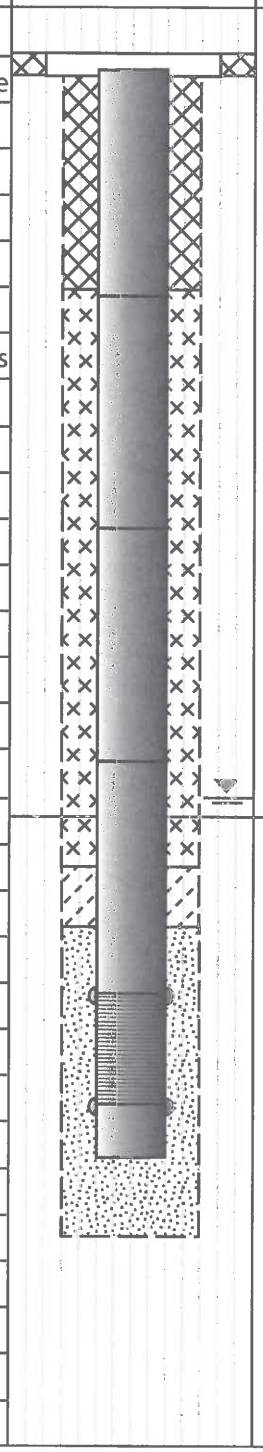
Bentonite Chips: 10.0'- 35.0' bgs

Bentonite Pellets: 35.0- 37.92' bgs

10/20 Mesh Filter Pack Sand: 37.92'- 50.85' bgs

All temporary 6" OD casing removed 7/13/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.25: Gravel Drill Pad, G

0.25 - 8.5: Sandy Gravel, sG

8.5 - 21.0: Silty Sandy Gravel, msG

21.0 - 47.0: Silty Sandy Gravel, msG

Depth to Water: 32.7' bgs (7/15/15)

47.0 - 50.85 Silty Sandy Gravel, msG

Total Depth = 50.85' bgs (7/7/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: July 7, 2015

Well ID: C8940 | Well Name: 399-1-76 | Location: 300 Area N of PNNL

Project: 30 well 300FF-5 FY15 | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0				Ground surface to 0.25 ft bgs	Aquifer well
				Drill pad / Backfill	
					Drilling is being
	gs			0.25 ft bgs to 8.5 ft bgs.	conducted w a
				Formation:	Terrasonic 150cc
				60% Sand 40% Gravel SG	6" Casing
5				Sand: medium grain well sorted	4" x 10' Core barrel
	gs			sub round 60% matic 40% felsic	
				Gravel: 2mm to ~70 mm sub round	g.s = grab sample
				Poorly sorted 60% matic 40% felsic	Grab samples are
				weak to no reaction to HCL	collected every
10	S.S 10-12	I-001D S-I001C I001B I-001A		2.5Y 3/3 Dark olive brown	5 ft in pint jars
	gs			Dry	and chip trays.
		100%			
	S.S 12.5-15	I-002E I-002B I002A			
		recovery		8.50 ft bgs to 21.00 ft bgs	
15	S.S 15-17.5			Formation: Hanford. MSG	Recovery
				10% silt 40% sand 50% Gravel	0'-10' ~90%
				Sand: fine to coarse poorly sorted	10'-20' ~100%
	SS I-006	gs		sub angular 60% matic 40% felsic	20'-30' ~50%
				Gravel: 2mm to ~105 mm mod. sorted	30'-40' ~40%
20	S.S I-005	g.s		sub round to sub angular.	40'-50 ~80%
				~60% matic 40% felsic.	
	I-006			2.5Y 3/1 very dark gray	Split Spoon Samples
				weak to mod reaction to HCL	SS = split spoon
25	I-007	g.s		Dry	B31MY4 I-001 ~~10'-10.5'~~ 11.5'-12
					B31MY2 I-001 ~~10.5'-11'~~ 11.0-11.5
					B31MX3 I-001 ~~11'-11.50'~~ 10.5'-11'
	I-008			21.00 ft bgs to 47.00 ft bgs	B31MX0 I-001 ~~11.5'-12.0'~~ 10.'10.5
				Formation MSG	Sample time 100%
30	I-009	g.s		15% silt 40% Sand 45% Gravel	Recovery 0805
				Sand fine to very coarse.	sample spoon #2
				Very poorly sorted Angular to	B31N00 I-002A 14'-14.5'
				Sub angular ~60% matic 40%	B31MY7 I-002B 13.5'-14'
				felsic.	B31MY6 I-002C 13.00-13.50
35		g.s		Gravel: 2mm to ~175 mm. very	No recovery for I-008
				poorly sorted ~75% of the	Sample time 0830
				gravel is 50 mm or less.	70% recovery
				Angular to rounded.	
				rounding increase with size.	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] Date: 7-7-15 | Signature: [signature] Date: 9/9/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: July 7, 2015

Well ID: C8940 | Well Name: 399-1-76 | Location: 300 Area N of PNNL

Project: 300-FF-5 FY15 30 wells. | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				21.00 ft bgs to 47.00 ft bgs con	Aquifer well
				~60% mafic 40% felsic	
	gs			2.5Y 3/1 very dark gray	g.s = grab sample
				wet	S.S. = split spoon
45					Split Spoon Sample # 3
					B31N05 I-008A 16.5-17.00
	gs			@ ~38 ft bgs there is a	B31N03 I-008B 16.0-16.5
				fine grain sand / silt lens.	Sample time 0908
				the len is ~2 ft thi.	40% recovery
50				No Plasticity.	
				20% mafic 80% felsic	B31N05 I-008A 16.5'-17'
			TD	2.5Y 5/4 light olive brown	B31N03 I-008B 16.' 16.5'
	gs 7/13/15		50.85	no reaction to HCL	B31N13 I-005B 21.5'-22'
				Damp	B31N14 B31N15 (Dup)
55					B31N19 I-006B 24-24.5
				47.00 ft bgs to	B31N20 "
				Formation.	B31N26 I-007A 26.5-27.0
				20% silt 40% Sand 40% Gravel	B31N25 B31N24 I-007B 26-26.5
				Sand medium grain well sorted	B31N23 I-007C 25.5-26
				sub round. ~~30% fels mafic~~	B31N22 I-007D 25-25.5
				~~70% felsic~~ ~30% Mafic 70%	B31N31 I-008A 29-29.5
				felsic.	B31N30 I-008B 28.5-29
				Gravel: sub round average	B31N29 "
				size ~50mm. mod sorting	B31N28 I-008C 28-28.5
				The ~3ft section appears to be	B31N27 I-008D 27.5-28
				a grade contact between	B31N36 I-009A 31.5-32
				an oxidizing / reducing zone.	B31N35 I-009B 31-31.5
				NO reaction to HCL	B31N34 " "
				2.5Y 4/3 olive brown	B31N33 I-009C 30.5-31
				2.5Y 2.5/1 Black	
					TD 7/13/15 50.85
					Raw H_2O 7/13/15 45.6'

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 7-7-15 | Signature: [signature] | Date: 9/9/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/22/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C8942	Well Name:	399-1-78
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10-28-15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.7' bgs

Permanent Well:

2.375" OD PVC Blank: 0.5 - 40.51' bgs

2.375" OD PVC 0.020-slot Screen: 40.51' - 45.52' bgs

2.375" OD PVC Blank Casing: 45.52' - 48.30' bgs

Construction Materials:

Concrete: 0.0'- 1.4' bgs

Suface Seal: 1.4'- 9.8' bgs

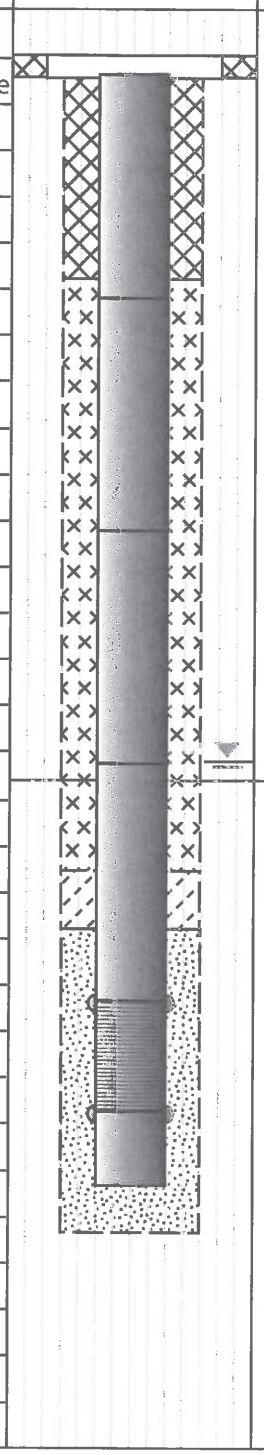
Bentonite Chips: 9.8'- 35.1' bgs

Bentonite Pellets: 35.1- 37.8' bgs

10/20 Mesh Filter Pack Sand: 37.8'- 50.3' bgs

All temporary 6" OD casing removed 7/13/15.

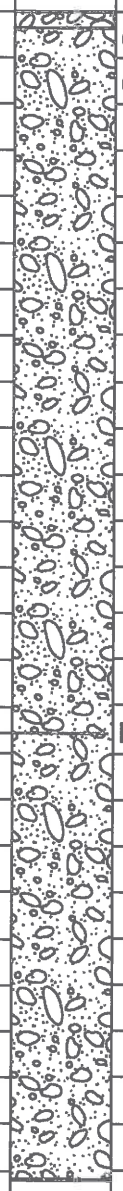
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log



Lithologic Description

0.0 - 0.5: Gravel Drill Pad, G

0.5 - 50.3: Sandy Gravel, sG

Depth to Water: 31.2' bgs (6/30/15)

Total Depth = 50.3' bgs (6/22/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: 6/22/15

Well ID: C8942	Well Name: 399-1-78	Location: 300 Area N of PNNL
Project: 31 Wells 300-FF-5 (FY2015)		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		–		0-0.5 Gravel Drill Pad	Terra Sonic
				0.5'-18' 70% Gravel, 20% Sand, 10% Silt	4" core barrel
				Sandy Gravel (SG); Gravel: SR, 60% Felsic,	6" casing
				40% Mafic, 2cm-10cm; Sand: vf-c, SR-SA, 85%	
				Felsic, 15% Mafic; moist; 2.5Y 4/2 dk grayish brn,	
5	GS	40%		mod rxn w/ HCL; poorly sorted.	
10	GS	–			
15	GS	25%			
				35% 60% 5%	
				18'-21' 60% Gravel, 30% Sand, 10% Silt	
				Sandy Gravel (SG); Gravel: SR, 2cm-6cm, 75%	
20	GS	–		Felsic, 25% Mafic; Sand: f-c, SR-SA, 80% Felsic, 20%	
				Mafic; 2.5Y 4/3 brn; moist; mod rxn w/ HCL	
				21'-31' 70% Gravel, 10% Sand, 20% Silt	
				Silty Gravel (mG) Gravel: 60% Felsic, 40% Mafic,	
				SR, 8mm-4cm, 2cm avg.; Sand: 60% Mafic, 40% Felsic,	
25	GS	75%		SA-SR, f-c; 2.5Y 4/2 dk grayish brown; moist;	Drillers note drilling
				slight rxn w/ HCL, poorly sorted.	more difficult @ ~25' bgs
30	GS	–		31'- 70% Gravel, 25% Sand, 5% Silt	
				Sandy Gravel (SG); Gravel: 8mm-8cm, SR,	
				70% Felsic, 30% Mafic; Sand: m-vc, SA-SR, 70%	
				Mafic, 30% Felsic; poorly sorted, wet, 2.5Y 4/1 dk	
35	GS	50%		gray; no rxn w/ HCL.	

Reported By: Ken Russell		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: Ken Russell	Date: 6/22/15	Signature: [signature]	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: 6/22/15

Well ID: C8942	Well Name: 399-1-78	Location: 300 Area N of PNNL
Project: 31 Wells in 300-FF-5 OU FY2015		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	GS	–		(cont.) 31' – 41' 70% Gravel, 25% Sand, 5% Silt, Sandy Gravel (SG); Gravel: 8mm – 8cm, SR, 70% Felsic, 30% Mafic; Sand: m-vc, SA-SR, 70% Mafic, 30% Felsic; poorly sorted, wet, 2.5Y 4/1 Dark gray; no rxn w/ HCl,	Terra Sonic Drill rig 4" core barrel 6" casing
45	GS	100%		41' – 46' Mud (80% Silt / 20% Clay), low plasticity 2.5Y 3/1 very dark gray, moist, no rxn w/ HCl. 46' – 50' 70% Gravel, 20% Sand, 10% Silt Sandy Gravel (SG); Gravel: R-SR, 8mm – 4cm, 2cm avg, 70% Mafic, 30% Felsic; Sand: f-m, micaceous, 80% Felsic, 20% Mafic, SA-SR; 2.5/1 Black, wet, poorly sorted. no rxn w/ HCl.	GW: 41.3' bgs TD: 50.1' bgs
50	GS	–			

Reported By: Jen Russell		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: Jen Russell	Date: 6/22/15	Signature: [signature]	Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/18/2015
Finish Date: 8/6/2015
Page 1 of 1

Well ID: C9408	Well Name: 399-1-65
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller — Date: 9/24/15	Reviewed By: J.D. MEHRER — Date: 10-28-15
Signature: MAMiller	Signature:

CONSTRUCTION DATA

Surface Completion:

2'x2' Flush mount concrete pad w/brass survey marker.
13 1/2" OD Protective Monument: 0.0' - 0.70' bgs

Permanent Well:

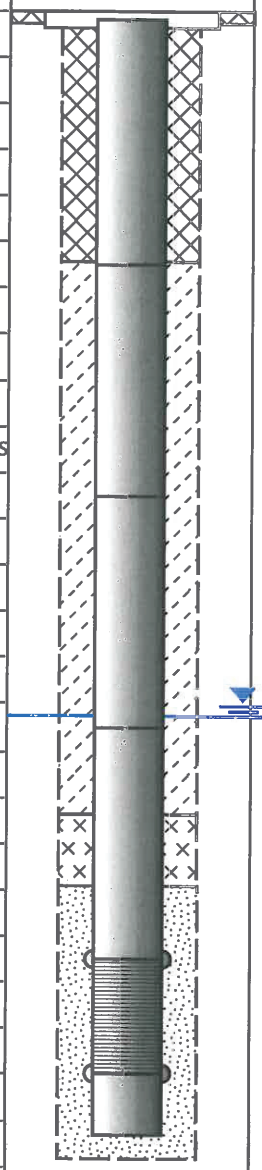
2.37" OD PVC Blank: 0.35' - 40.93' bgs
2.37" OD PVC 0.020-slot Screen: 40.93' - 45.96' bgs
2.37" OD PVC Blank: 45.96' - 48.60' bgs

Construction Materials:

Concrete: 0.0' - 0.80' bgs
Neat Grout: 0.80' - 10.86' bgs
Bentonite Chips: 10.86' - 34.70' bgs
Bentonite Seal: 34.70' - 37.90' bgs
10/20 Mesh Filter Pack Sand: 37.90' - 49.70' bgs

All temporary 6" OD casing removed 6/18/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0' - 0.4': Gravel Drill Pad, G
0.4' - 30.0': Sandy Gravel, sG
30.0' - 38.0': Silty Sandy Gravel, msG
Depth to Water: 30.33' bgs (6/30/15)
38.0' - 44.50': Sandy Gravel, sG
44.50' - 49.70': Sand, S
Total Depth = 49.70' bgs (6/18/15)

OD = outside diameter
bgs = below ground surface
Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: 6·18·15

Well ID: ~~C8108~~ C9408 CK 9/22/15

Well Name: 399-1-65

Location: 300 Area N of PNNL

Project: Aquifer Monitoring Well 300-FF-5

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		–		0'-0.4' Gravel drill pad / FILL	Terrasonic 150 cc
				0.4-11.4 Sandy Gravel (SG):	Drill rig
				60% Gravel, 40% Sand; Gravel: SR, 20% Felsic	
				80% Mafic, 10 cm max; Sand: 40% Felsic 60% Mafic,	4" core barrel
				f-c, SR-SA; poorly sorted; Dark gray 2.5Y4/1;	6" casing
5	GS	70%		mod rxn w/ HCL; dry.	
10	GS	–		11.4-18' Sandy Silty Gravel (mSG): 70% Gravel,	
				10% Sand, 20% Silt; Gravel: SR, 70% ~~Felsic~~ Mafic JR 6/18/15	
				30% ~~Mafic~~ Felsic JR 6/18/15, 2mm-8cm; Sand: vf-c, 70% Felsic,	
				30% Mafic, SA-SR; poorly sorted; Dark gray	
15	GS	80%		2.5Y4/1; no rxn w/ HCL, moist.	
				18'-30' Sandy Silty Gravel (mSG): 65% Gravel,	Increased sand
				15% Sand; 20% Silt; Gravel: SR, sm pebbles	content
20	GS	–		8cm max, 4mm avg., 60% Mafic, 40% Felsic;	
				Sand: vf-vc, SR-SA, 60% Mafic, 40% Felsic;	
				2.5Y4/1 Dark gray; sl rxn w/ HCL, poorly	
				sorted; moist.	
25	GS	60%			
30	GS	–		30'-38' 60% Gravel, 20% Sand, 20% Silt;	
				Silty sandy gravel (msG); Gravel: SR,	
				2mm-8cm max, 4cm avg.; 70% ~~Mafic~~ Felsic, 30%	JR 6/18/15
				~~Felsic~~ Mafic; Sand: SA-SR, f-c, 70% Felsic, 30% Mafic;	
				no rxn w/ HCL; moist; 2.5Y4/1, very dk gray.	
35		100%		JR 6/18/15	No GS @ 35' due to elevated rad levels
				38'-40' 70% Gravel, 20% Sand, 10% Silt; Sandy Gravel (SG)	

Reported By: Jen Russell		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: Jen Russell	Date: 6/18/15	Signature: K Bergstrom	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: 6.18.15

Well ID: C8408 | Well Name: 399-1-65 | Location: 300 Area N of PNNL

Project: Aquifer Monitoring well 300-FF-5 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40		–		38'-40' (cont.) Sandy Gravel (SG); 70% Gravel, 20% Sand; 10% Silt; Gravel: SR, 70% Felsic, 30% Mafic, vc pebbles-cobbles, 2mm-8cm, 4mm avg; Sand: SA-SR, vf-c, 70% Felsic, 30% Mafic; 2.5Y4/1 very dk gray; wet; no rxn w HCl	Terrasonic/4" CB/6" casing NO GS collected @ 40 ft bgs due to elevated rad levels
45		100%		40'-44.5' 65% Gravel, 30% Sand, 5% Silt Sandy Gravel (SG); Gravel: 95% Felsic, 5% Mafic, SR, 3mm-6cm max, 2cm avg. Sand: 95% Felsic 5% Mafic, SR-SA, m-vc; no rxn w/HCl; moist, 10YR6/6 brownish yellow	No GS - elevated rad
50		–		44.5'-50' 10% Gravel, 80% Sand, 10% Silt Sand (S); Gravel: 90% Felsic, 10% Mafic, SR, 3cm-5cm; Sand: m-vc, 90% Felsic, 10% Mafic, micaceous; 10YR5/3-10YR3/2 brn-vdk grayish brn; moist; no rxn w/ HCl	No GS - elevated rad TD = 49.7' bgs GW = 32.8' bgs

Reported By: Jen Russell | Reviewed By: Kevin Bergstron

Title: Geologist | Title: Sr. Geologist

Signature: Jen Russell | Date: 6/18/15 | Signature: [illegible] | Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/17/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C9409	Well Name:	399-1-66
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10-28-15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.85'bgs

Permanent Well:

2.375" OD PVC Blank: 0.4 - 39.48' bgs

2.375" OD PVC 0.020-slot Screen: 39.48' - 44.47' bgs

2.375" OD PVC Blank Casing: 44.47' - 47.10' bgs

Construction Materials:

Concrete: 0.0'- 1.30' bgs

Suface Seal: 1.30'- 9.80' bgs

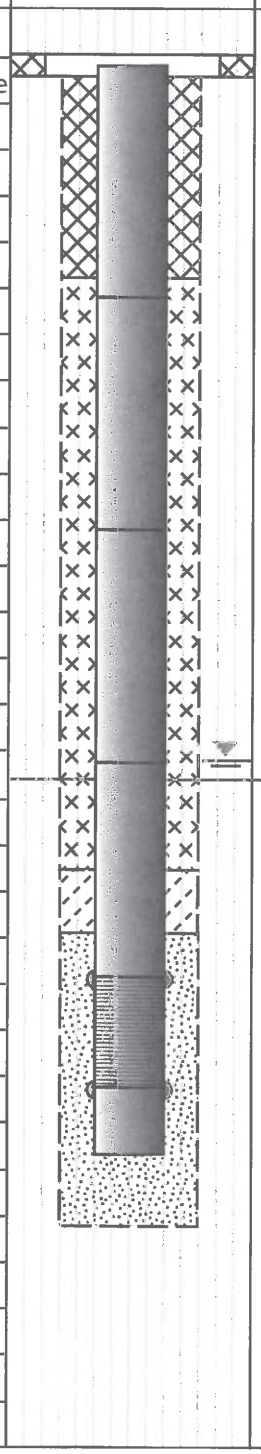
Bentonite Chips: 9.80'- 35.10' bgs

Bentonite Pellets: 35.10- 37.95' bgs

10/20 Mesh Filter Pack Sand: 37.95'- 50.10' bgs

All temporary 6" OD casing removed 6/17/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.8: Gravel Drill Pad, G

0.8 - 13.0: Silty Sandy Gravel, msG

13.0 - 19.0: Sandy Gravel, sG

19.0-23.0: Silty Sandy Gravel, msG

23.0-26.0: Silty Gravel, mG

26.0 - 29.0: Silty Sandy Gravel, msG

29.0 - 34.0: slightly Silty Sandy Gravel, (m)sG

Depth to Water: 31.15' bgs (7/13/15)

34.0 - 43.5: Sandy Gravel, sG

43.5 - 44.0: Silty Sandy Gravel, msG

44.0 - 50.5: Sandy Gravel, sG

Total Depth = 50.1' bgs (6/17/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: 6·17·15

Well ID: C9409	Well Name: 399-1-66	Location: 300 Area N. Process Ponds
Project: 300 Area U sequestration Remedial Action.		Reference Measuring Point: Ground surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0.0-0.8': Gravel Pad.	Sonic w/ 5"x11' core barrel.
				0.8-13': ~~silty~~ sandy Gravel msG (70%G, 20%S, 10%m)	
				v.pr.srtd. v.w.rnd. v.f.pbl.-sm.cbl. of 80-75% bslt./20-25% felsic	
				Meta>int.Volc. w/ fn.-v.c. sub-ang. S. 70% mafic, 30% felsic. moist.	
				2.5Y 4/2 drk grysh. brown. mod. rxn w/HCl. unconsolidated.	5': g.s. (grab sample)
5	g.s.			·5': v.pr.srtd. similar to above. max clast: 90mm.	
				non plastic. matrx. silts continue. moist	
		60%			
10					
	g.s.			·11-13': Normal grading prob. msG. cont. (70%G, 20%S, 10%m)	11': g.s.
				v.f.pbl.-sm.cbl. v.w.rnd. of 80% bslt./20% felsics. w/ v.f.-v.c. sub-ang.	
				S. 2.5Y 4/2 drk grayish brown. non plastic. noncohesive. moist.	
				max clast: 120mm. no rxn w/HCl.	
15	g.s.	80%		13-19': sandy Gravel sG (75%G, 25%S) trace-5%m	15': g.s.
				mod.-pr.srtd. bimodal size: v.f.-m.pbl. w/~20% v.c.pbl. of	
				95% bslt./5% felsic. Meta.>int.Volc. w/ m-v.c. sub-ang. S. of 99%	
				mafic./1% felsic. 2.5Y 2.5/1 black. no rxn w/HCl.	
				·13-18': bimodal fractions: 80% fn.-m.pbl./20% v.c.pbl.	
20	g.s.			·18-19': bimodal fractions: 80% v.f.pbl. / 20% v.c.pbl.	20': g.s.
				19'-23': silty sandy Gravel msG (60%G, 20%S, 20%m)	
				v.f.-c.pbl. v.w.rnd.-mod. srtd: of 80% bslt./20% felsics w/ v.f.-m.ang.	
	g.s.			S. 2.5Y 3/2 v.drk. grayish brown. non plastic. mod. consolidated.	
				·19.5': 3cm silt lense w/ 80% 2.5Y 3/2 v.drk. gray mottled w/	23': g.s.
25		90%		20% 7.5YR 5/6 strong brown. faint stringers of strong brown	
				apparent non-plastic. - most of unit ground to dry powder. -	
				23'-26': silty Gravel mG (80%G, 20%m, trace S)	
	g.s.			v.w.graded. m.pbl.-sm.cbl. of v.w.rnd. of ~~80% bslt. 20% mafic~~	28': g.s.
				80% bslt./20% mafic. w/ v.f. S. + 2.5Y 4/3 v.drk grayish brown	
30				silt. - ~~non~~ mod. plastic	
				·23': 2" layer w/ silt colored matrx of 7.5Y 5/6 strong	
				brown. ~~·base of unit~~ AK 6.29.15	
				26-29': ~~silty~~ sandy Gravel msG (70%G, 20%S, 10%m)	
				mod. srtd. grading to v.pr.srtd. w. graded bed. of v.f.-m. pbl.	
				grading to v.f.-lrg. cbl. max range: from 4mm to 150 mm.	
				w/ v.f.-v.crs. S. of 95% bslt/5% felsic int. Volc. > Meta.	
				2.5Y 3/2 v.drk. grayish brown. moist. mod. rxn w/HCl.	

Mature Brown

Reported By: A. Lontan		Reviewed By: BA WILLIAMS	
Title: Geo. Tech.		Title: SR. GEOLOGIST	
Signature: Aaron Tate	Date: 6·17·15	Signature: [signature]	Date: 9/22/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 1 of 2

Date: 6·17·15

Well ID: C9409 | Well Name: 399-1-66 | Location: 300 Area N. Process Ponds

Project: 300 Area U Sequestration Remedial Action. | Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30				29-34': ~~slightly silty~~ sandy Gravel ~~w/~~ sG (75%G, 15%-20%S,	Sonic w/ 5"x4' core barrel.
				10%m). v. pr. srtd. sub-w. rndd. v.f. pbl.-sm. cbl. max: 120mm	
				of 75%-80% bslt/25-20% felsic int. Volc.>Meta. w/ v.f.-v.c. sub-rndd.	
	S.S.			S. of 95% mafic comp. pr. consolidated. nonplastic matrix. silt.	33': g.S.
				2.5Y 4/2 drk.-drk. grayish brown. - no black silty gravel bed @34'. like in adjacent well.	
35	35			@34'-37.5': sandy Gravel sG (78%G, 12%S) trace m.	
		100 %		pr. srtd. v.f. pbl.- sm. cbl. sub-w. rndd. of 75% bslt./25% felsic	35': g.S.
				Meta.>int. v. trace S.S.; w/ c.-v.c. sub-rndd S. of 95% bslt/5% felsic.	
				5Y 3/2 drk olive gray. wet. wk. rxn w/ HCl when dry. no visible	
				bed-forms. (grns. crs. mica.) AZ 6.18.15	
40				37.5-43.5': sandy Gravel sG (60%G 35%S, 5%m)	
				v. pr. srtd. m. pbl.- sm. cbl. of 95% bslt>And./5% felsic-Qtzite.	
	S.S.			max: 120mm w/ s/rs. bldr of bslt. 400mm+. avg: c. pbl. v.w.	
	S.S.			rndd. 20-30mm. matrix of v.f.-m. felsic Qtz-felds. S.-sub-ang.	42': g.S.
				7.5Y 5/6 strong brown. abnt. fn. mica. non plastic.	
45				• 37.5-39': v. deep orange brown rust colored matrix.	44.5': g.S.
				darker orange seems to be associated w/ slight increase	
				in silt content ~10-5% no rxn w/ HCl.	
	S.S.	100 %		43.5-44': ~~silty~~ sandy Gravel ~~w/~~ sG (60%G, 30%g, 10%m)	48': g.S.
				Black 10YR 2/1 black silty sand matrix supported pebble gravel bed.- or	
50				siltysand conglomerate. ; v.w. rndd. fn.-m. pbl. of bslt. w/ v.f.-m. S.	
			T.D.	no rxn. w/ HCl. non plastic.	TD@50.0'
				44-47': sandy Gravel sG (78%G 12%S)-(75%G, 25%S)	DTW: 31.15' bgs
				mod. srtd. v.w. rndd. m. pbl.-v.c. pbl. of 99% bslt.>And./1% Qtzite.	
				w/ m.-c. ang. felsic S. abnt. mica. 95% Qtz-felds.	
				10YR 5/8 yellowish brown. clasts Fe-oxidized-stained.	
				no rxn w/ HCl wet. unconsolidated. trace m.	
				no visible bed-forms.	
				47-50.5': sandy Gravel sG (75%G, 25%S) mod. srtd.	
				v.w. rndd. m.-v.crs. pbl. of 95% bslt.>And./5% Qtz. w/ m.-c.	
				ang. felsic S. 95% Qtz.-felds. 2.5Y 5/4 lt. olv. brn. no rxn. w/ HCl.	
				unconsolidated. same as unit above, but no oxide.	

Reported By: A. Lanton | Reviewed By: BA WILLIAMS

Title: Geo. Tech. | Title: SR. GEOLOGIST

Signature: A. Lanton | Date: 6·17·15 | Signature: [illegible] | Date: 9/22/15

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	7/14/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C9451	Well Name:	399-1-80
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10-28-15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.7' bgs

Permanent Well:

2.375" OD PVC Blank: 0.29 - 40.54' bgs

2.375" OD PVC 0.020-slot Screen: 40.54' - 45.56' bgs

2.375" OD PVC Blank Casing: 45.56' - 48.30' bgs

Construction Materials:

Concrete: 0.0'- 1.00' bgs

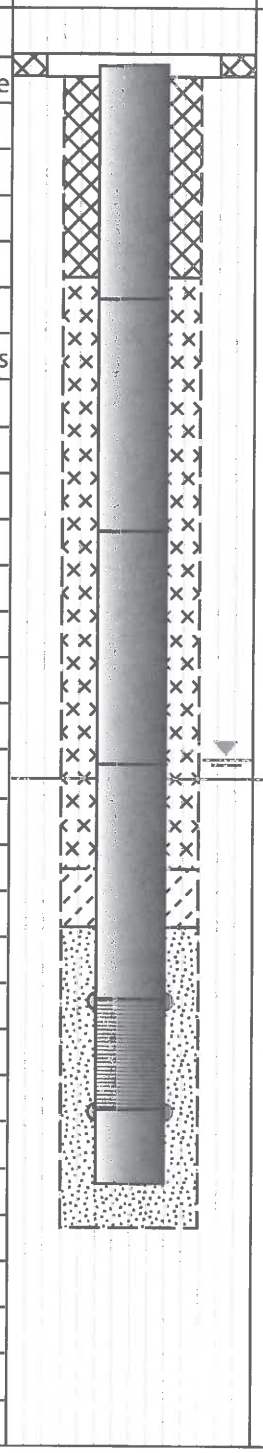
Suface Seal: 1.00'- 9.50' bgs

Bentonite Chips: 9.50'- 35.00' bgs

Bentonite Pellets: 35.00'- 37.11' bgs

10/20 Mesh Filter Pack Sand: 37.11'- 50.00' bgs

All temporary 6" OD casing removed 7/14/15.



GEOLOGIC/HYDROLOGIC DATA

0.0 - 0.5: Gravel Drill Pad, G

0.5 - 9.8: Sandy Gravel, sG

9.8 - 50.5: Silty Sandy Gravel, msG

Depth to Water: 32.8' bgs (7/14/15)

Total Depth = 50.5' bgs (7/14/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: July 14, 2015

Well ID: C9451	Well Name: 399-1-80	Location: 300 Area N of PNNL	
Project: 300FF5 30 Well installation FY15		Reference Measuring Point: Ground surface	

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground surface to 0.50 ft bgs	Aquifer
				Drill pad / Backfill	
					Drilling is being
	9.5				conducted w/ a
				0.5 ft bgs to 9.80 ft bgs. SG	Terrasonic 150CC
				Formation	7" Casing
5				45% Sand 55% Gravel	4" Core
	9.5			Sand: med. to coarse grain, mod	S.S = Split Spoon
				sorted ~ 60% matic 40% felsic	
				sub Angular.	Grab samples
10				Gravel: 10mm to 150mm sub angular	are collected in
	I-001 9.5			to sub round. ~~to~~ mod to poorly	5 ft intervals.
				Sorted 60% matic 40% felsic	
	I-002 S.S			2.5 Y 3/3 Dark olive brown	Split Spoons
				weak reaction to HCL	I-001D B31N62
15				Dry	I-001C B31N63
	I-003 S.S.				I-001B B31N65, B31N64
					I-001A ~~to S~~ B31N66
				9.80 to 29.00 ft bgs. mSG	I-002D No Recovery
	I-004 S.S			Formation	I-002C No Recovery
20				10% silt 45% Sand 45% Gravel	I-002B B31N70 B31N69
	I-005 9.5			Sand fine to very coarse. mod	I-002A B31N71
				Sort. sub angular to Angular	I-003D B31N72
	I-006 S.S.			60% matic 40% felsic	I-003C B31N73
				Gravel: 2mm to 200mm sub	I-003B B31N74 B31N75
25				angular to Sub round. poorly	I-003B B31N76 (DUP
	I-007 9.5			Sorted. 60% matic 40% felsic	I-003A B31N77
				weak to mod reaction to HCL	I-004D B31N78
	I-008 S.S			2.5 Y 3/1 very dark gray	I-004C B31N79
				damp / Dry	I-004B B31N80 B31N81
30					I-004A B31N82
	I-009 9.5			50.50 mSG	I-005D No Recovery
				29.00 ft bgs to ~~49.80~~ ft bgs CK 7/14/15	I-005C B31N84
				Formation	I-005B B31N85 B31N86
				10% Silt 20% Sand 70% gravel	I-005A B31N87
35				Sand: fine to Coarse, Angular	I-006A B31N90 B31N91
				Poorly sorted 60% matic	I-007A B31N96 B31N97
	9.5			40% felsic	I-008D No recovery
					I-008C B31N80
					I-008B B31N81 B31N82

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date:	Signature: [signature]	Date: 9/9/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: July 14, 2015

Well ID: C9451 | Well Name: 399-1-80 | Location: 300 Area North of PNNL

Project: 300-FF-5 30 well installation FY15 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				29.00 ft to 51 ft Conti	Aquifer well
				Gravel: 2mm to 200mm ~80%	
	9.5			of the gravels are between	Drilling is
				2mm and 10mm. Angular to	being conducted
				round. Rounding increase with	with a terrasonic
45				size. 60% mafic 40% felsic	150 cc rig
				2.5Y 3/2	7" casing
				wet	4"x10' core barrel
	9.5			No reaction to HCL	
					Split Spoon Sample Con:
50				41.00 ft to 49 (rip up?)	I-009A B3/N57 B3/N56
				Formation	I-009B No recovery
				15% Silt 40% Sand 45% Gravel	I-009C No recovery
				Sand: med. grain well to mod	I-009D No recovery
				sorted sub angular ~40% mafic	
				60% felsic	
				Gravel: ~10mm to 150mm sub	
				angular poorly sorted	
				35% mafic 65% felsic	
				No reaction to HCL	
				Wet. 2.5Y 5/6 Light olive brown	
				Silt has low plasticity	
				@ 48.5 ft bgs the is	
				a color change 2.5Y 2.5/1 Black	
				most likely a reducing zone.	
				TD 50.50' (7-14-15) ft bgs	
				DWT 31.78 ft bgs	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstron

Title: Geologist | Title: Sr. Geologist

Signature: [signature] Date: 7/14/15 | Signature: [signature] Date: 9/9/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/24/2015
Finish Date: 8/6/2015
Page 1 of 1

Well ID: C9453	Well Name: 399-1-82
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller — Date: 9/24/15	Reviewed By: J.D. MEHRER — Date: 10-28-15
Signature: MMiller	Signature:

CONSTRUCTION DATA

Surface Completion:

2'x1.95' Flush mount concrete pad w/brass survey marker.
13 1/2" OD Protective Monument: 0.0' - 0.85' bgs

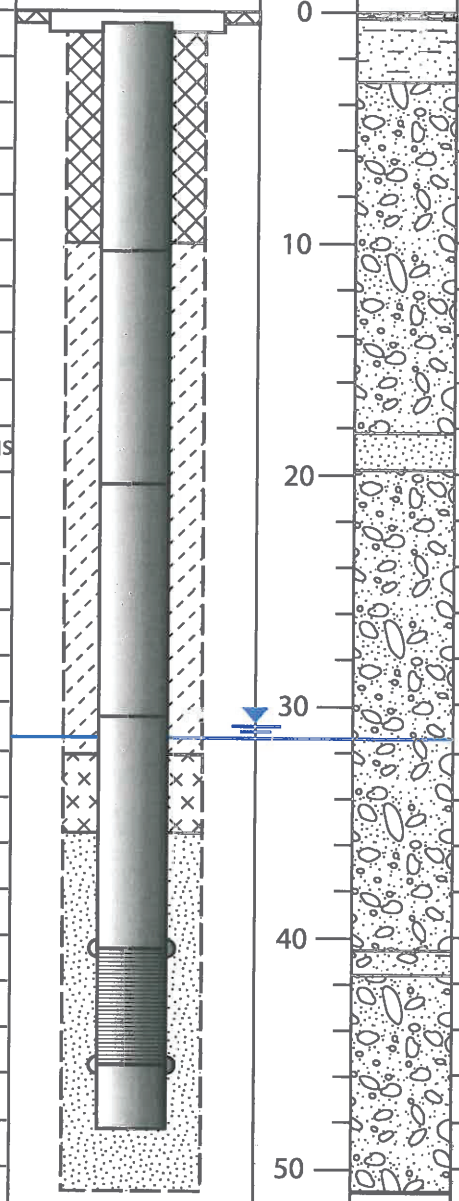
Permanent Well:

2.37" OD PVC Blank: 0.50' - 40.50' bgs
2.37" OD PVC 0.020-slot Screen: 40.50' - 45.55' bgs
2.37" OD PVC Blank: 45.55' - 48.30' bgs

Construction Materials:

Concrete: 0.0' - 1.80' bgs
Neat Grout: 1.80' - 10.0' bgs
Bentonite Chips: 10.0' - 32.10' bgs
Bentonite Seal: 32.10' - 35.60' bgs
10/20 Mesh Filter Pack Sand: 35.60' - 51.0' bgs

All temporary 6" OD casing removed 6/24/15.



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description:

0.0' - 0.2': Gravel Drill Pad, G
0.2' - 3.0': Silty Sand, mS
3.0' - 18.20': Sandy Gravel, sG
18.20' - 19.80': Sand, S
19.80' - 40.50': Sandy Gravel, sG
Depth to Water: 31.40' bgs (6/30/15)
40.50' - 41.70': Gravelly Silty Sand, gmS
41.70' - 51.0': Sandy Gravel, sG

Total Depth = 51.0' bgs (6/24/15)
OD = outside diameter
bgs = below ground surface
Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: 6.24.15

Well ID: C9453	Well Name: 399-1-82	Location: N of PNNL 300 Area	
Project: 30 well 300-FF-5 FY15		Reference Measuring Point: Ground Surface	

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0'-0.2' bgs well pad gravel	Aquifer well
	g.s			0.2'-3' bgs Silty Sand (mG): 40% m, 60% S, 5% G. Sand: med grain, mod sorted, sub ang, 30% mafic, 70% felsic. Gravel: max 80 mm 6.24.15 clast, rounded, mod sorted, 70% mafic, 30% fel sic. 10YR 4/3 dry. Weak RXN HCl.	Drilling was Conducted with a Terrasonic 150 CC 6" Casing 4"X10' Core barrel
5	g.s			3'-18.2' bgs Sandy Gravel (sG): 50-60% S, 40-50% G, 5-10% M. Sand: med-coarse, mod sorted, ang-sub ang, 70-80% Mafic, 20-30% felsic. Gravel: max 100mm clast, rounded-sub rndd, mod sorted, 50-60% mafic, 40-50% felsic. 5Y 6/1 Dry. Mod RXN HCl @ 8.7' bgs. No RXN otherwise.	g.s = grab sample grab samples well collected in 5' intervals and @ lithology changes.
10	g.s				
15	g.s			18.2'-19.8' bgs Sand (S): med grain, ang-sub ang, well sorted, 30-40% mafic 60-70% felsic. 2.5Y 6/1 Dry. Weak RXN HCl.	
20	g.s	80% Recovery		19.8'-28.5' bgs ~~Gravelly Sand (gS)~~ Sandy Gravel (sG): 70% S, 30% G, 5-10% M. Sand: med-coarse grain, mod sorted, ang-sub ang, 70% mafic, 30% felsic. Gravel: 140 mm max clast, well rndd-sub rndd, mod sorted, 50-60% mafic, 40-50% felsic. 2.5Y 6/1 Dry. No RXN HCl.	TD 50.50 DTW 32.30
25	g.s				
30	g.s	40% Recovery		28.5'-40.5' bgs Sandy Gravel (sG): 40% S, 60% G, 5% M. Sand: med-coarse grain, mod sorted, ang-sub ang, 60-70% mafic, 30-40% felsic. Gravel: Max 130 mm clasts, well rndd-sub rndd, poor sorted, 60-65% mafic, 40-35% felsic, 2.5Y 5/1. No RXN HCl. Wet starting @ 39' bgs.	
35	g.s				

Reported By: MARQUES MILLER Candice Kidall		Reviewed By: Kevin Bergstrom	
Title: Geologist / Geologist		Title: Sr. Geologist	
Signature:	Date: 6.24.15	Signature:	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: 6·24·15

Well ID: C9453	Well Name: 399-1-82	Location: N of PNNL 300 Area
Project: 30 well, 300-FF-5 FY 2015		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				Gravelly Silty Sand (gmS)	Aquifer well
				40.5' – 41.7' bgs ~~Silty Sandy Gravel~~ (GM): 30% M, 50% S, 20% G, Sand: fine-med grain, mod sorted, ang-sub ang, 40% mafic, 60% fel sic. Gravel: max 50mm clast, well rndd-sub rndd, mod sorted, 50-60% felsic, 40-50% mafic, 2.5Y 6/6 wet. No RXN HCl wet.	Drilling was conducted with a Terra Sonic 150CC 6" Casing 4"X10' Core barrel
	gS			41.7' – 50' bgs Sandy Gravel (sG): 60% S, 40% G. Sand: med-grain well sorted, sub ang, 20-25% mafic, 75-80% felsic. Gravel: max 70mm clast, well rndd-sub rndd, well sorted, 30-40% mafic, 60-70% felsic. Clay 2.4/5b wet. No RXN HCl wet. Organics @ 44.5' bgs. 47' – 49' bgs sand lens.	gS = grab sample
45					
50					

Reported By: MARQUES MILLER / Candice Kildal	Reviewed By: Kevin Bergstrom
Title: Geologist / Geologist	Title: Sr. Geologist
Signature: MAMM / [illegible] Date: 6-30-15 24 mm 6·24·15	Signature: [illegible] Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date:	6/25/15
Finish Date:	8/6/15
Page	1 of 1

Well ID:	C9455	Well Name:	399-1-84
Location:	300 Area N of PNNL	Project:	30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By:	Tessa Clark	Reviewed By:	J.D. MEHRER
Date:	9-28-15	Date:	10-28-15
Signature:		Signature:	

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.75' bgs

Permanent Well:

2.375" OD PVC Blank: 0.40 - 48.01' bgs

2.375" OD PVC 0.020-slot Screen: 48.01' - 53.02' bgs

2.375" OD PVC Blank Casing: 53.02' - 55.66' bgs

Construction Materials:

Concrete: 0.0'- 1.6' bgs

Suface Seal: 1.6'- 10.2' bgs

Bentonite Chips: 10.2'- 42.0' bgs

Bentonite Pellets: 42.0'- 44.7' bgs

10/20 Mesh Filter Pack Sand: 44.7'- 57.0' bgs

Bentonite Pellets: 47.0'- 60.0' bgs

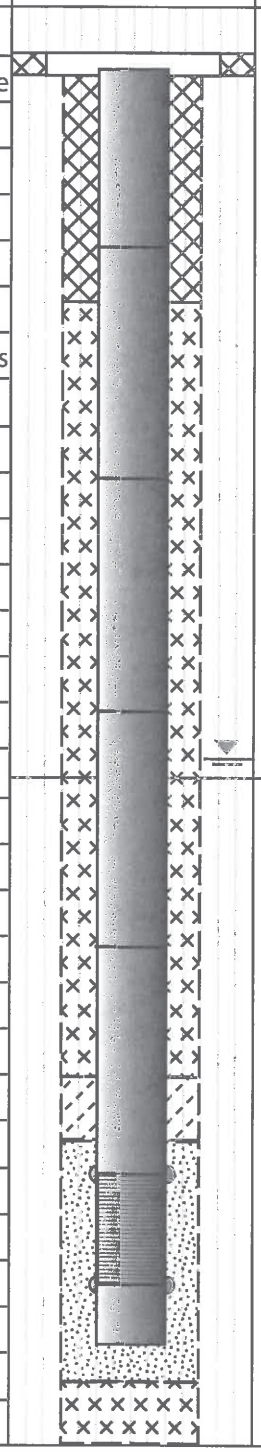
All temporary 6" OD casing removed 6/25/15.

OD = outside diameter

bgs = Below Ground Surface

Centralizers: top of sump & bottom of last blank riser.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.9: Gravel Drill Pad, G

0.9 - 39.0: Silty Sandy Gravel, msG

Depth to Water: 32.8' bgs (7/14/15)

39.0 - 40.0: Gravel, G

40.0 - 41.0: Silty Gravel, mG

41.0 - 46.0: Silt, M

46.0 - 53.0: Silty Sandy Gravel, msG

53.0 - 58.0: Silty Gravel, mG

58.0 - 60.0: Silty Sandy Gravel, msG

Total Depth = 60.00' bgs (7/14/15)

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 3

Date: June 25, 2015

Well ID: C9455	Well Name: 399-1-84	Location: 300 Area N of PNNL
Project: 30 Wells 300-FF-5 FY 15		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground Surface to 0.9'	Aquifer
				Back fill / Drill Pad	
					Drilling is being
					conducted with a
	gs			0.90 ft to 4.00 ft bgs MSG	Sonic rig
				15% silt 40% Sand 45% Gravel	6" Casing
5				Formation:	4" x 10' Core barrel
	gs	100% recovery		Sand: fine to coarse. poorly sorted	
				sub-angular 60% mafic 40%	
				felsic	
				Gravel: 10mm to 100mm sub angular	
10				to sub-round 60% mafic 40% felsic	
	gs			weak to moderate reaction to HCL	
				2.5Y 3/3 dark olive brown	
				Dry	
				4.00 ft to 16.00 ft bgs MSG	
15				Formation: Hanford	Recovery
	gs	60% recovery		10% silt 35% Sand 55% Gravel	0'-10' = 100%
				Sand: fine to coarse poorly sorted	10'-20' = 60%
				Angular 60% mafic 40% felsic	20'-30' = 90%
				Gravel: 2mm to 150mm, poorly	30'-40' = 60%
20				sorted sub angular to sub-round	40'-50' = 100%
	gs			60% mafic 40% felsic	50'-60' = 100%
				weak to mod reaction to HCL	
				2.5Y 3/1 very dark gray	
25				Dry	
	gs	90% Recovery		16.00 ft to 39 ft bgs MSG	TD: 60.00 ft bgs
				Formation: Hanford	DTW: 32.00 ft bgs
30				10% silt 50% Sand 40% Gravel	
	gs			Sand: fine to very coarse, poorly	
				sorted Angular 60% mafic 40% felsic	
				~~Gravel~~ CR 6/25/15	
				Gravel: 2mm to 170mm (~90% of	
35				the gravels are under 50mm)	
				Angular to sub round, rounding	
	gs	100% recovery		increase w/ size.	
				60% mafic 40% felsic	
				Weak reaction to HCL (dAMP	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/25/15	Signature: [signature]	Date: 9/9/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3

Date: June 25, 2015

Well ID: C9455	Well Name: 399-1-84	Location: 300 Area N of PNNL
Project: 30Wells 300-FF-5 FY15		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				16.00ft to 39.00 Continued	Aquifer well
				2.5Y 3/1 very dark gray.	
					Drilling is being
	gs			@ ~18.00 ft bgs is 0.10' of	conducted with a
				carbonate chunks - strong reaction	Terrasonic 150 cc
45				to HCL Dry. 2.5Y 8/1 white.	6" Casing
					4" x 10' Core barrel
	gs	100% Recovery			
				@ 29.00 ft to 29.50 ft bgs	
				there is 2.5Y 6/3 light yellowish	
50				brown clay surround the gravels.	
	gs			@ 39 ft to 40 ft	
				Gravel bed/Lens average size	
				of the gravel = 35 mm.	
55				sub round no color change.	
	gs.	100% Recovery		40ft to 41.00 ft bgs mG	
				Formation:	
				40% silt 10% sand 50% Gravel	
60				Sand: very fine grain rounded	
				mica, 20% mafic 80% felsic	
				Gravels: Average 50mm sub angular	
				40% mafic 60% felsic.	
				41ft to 46.00 ft bgs ~~CK S~~ (M)	
				Formation:	
				100% silt	
				small wood flecks found @	
				~43' and 45' moist to	
				Dry - (hard compact possibly from	
				drilling method) 2.5Y 2.5/1 Black	
				No reaction to HCL	
				46.00ft to 53.00 ft bgs MSG	
				Formation	
				40% silt 25% sand 30% Gravel	
				Sand: fine to med grain; poorly	
				sorted sub angular (mica)	
				40% mafic 60% felsic	
				Gravel: 2mm to ~100mm	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/25/15	Signature: [signature]	Date: 9/9/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 3

Date: June 25, 2015

Well ID: C9455 | Well Name: 399-1-84 | Location: 300 Area N of P

Project: 30 well 300FF-5 FY15 | Reference Measuring Point:

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				46.00 ft to 53.00 ft Continued	Aquifer well
				Gravels: sub-round 60% mafic	
				40% felsic	Drilling is being
				2.5Y 2.5/1 Black	conducted with a
				no reaction to HCl	Terra sonic 150cc
					6" Casing
					4"X10' Core barrel
				53.00 ft to 58.00 ft mS	
				Formation	
				30% silt 70% sand	
				Sand: very fine to fine grain	
				sub round well sorted.	
				30% mafic 70% felsic	
				silt has low plasticity	
				GLEY1 3/1 very dark gray	
				cle 6/25/15	
				~~58.00 to 60.00 ft bgs~~	
				58.00 ft to 60.00 ft bgs msG	
				40% silt 25% sand 30% Gravel	
				Sand: fine to medium grain, poorly	
				sorted sub angular to sub	
				round, (mica) ~ 40% mafic	
				60% felsic	
				Gravel ~2mm to ~100mm poorly	
				sorted sub round to sub angular	
				40% mafic 60% felsic	
				2.5Y 2.5/1 Black	
				No reaction to HCL	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 6/25/15 | Signature: [signature] | Date: 9/9/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/22/15
Finish Date: 8/6/15
Page 1 of 1

Well ID: C9457	Well Name: 399-1-86
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Tessa Clark	Date: 9-28-15
Signature:	Reviewed By: J.D. MEHRER
	Signature:
	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.75' bgs

Permanent Well:

2.375" OD PVC Blank: 0.50- 40.39 bgs

2.375" OD PVC 0.020-slot Screen: 40.39' - 45.39' bgs

2.375" OD PVC Blank Casing: 45.39' - 48.02 bgs

Construction Materials:

Concrete: 0.0'- 2.0' bgs

Grout Suface Seal: 2.0'- 10.5' bgs

Bentonite Chips: 10.5'- 35.1' bgs

Bentonite Pellets: 35.1- 38.0' bgs

10/20 Mesh Filter Pack Sand: 38.0'- 50.1 bgs

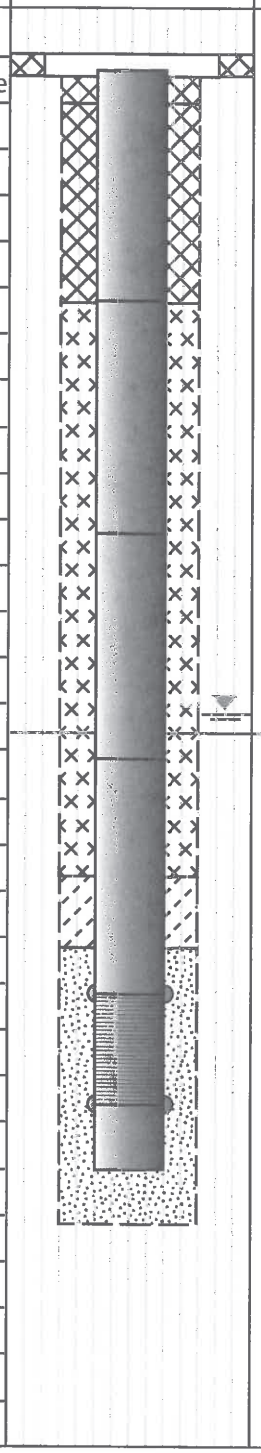
All temporary 6" OD casing removed 6/22/15.

OD = outside diameter

bgs = Below Ground Surface

Centralizers: top of sump & bottom of last blank riser.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0 - 0.25: Gravel Drill Pad, G

0.25 - 3.3: Silty Sandy Gravel, msG

3.3 - 22.0: Silty Sandy Gravel, msG

22.0 - 25.0: Silt, M

25.0 - 32.0: Silty Sandy Gravel, msG

Depth to Water: 29.14' bgs (7/20/15)

32.0 - 41.0: Silty Sandy Gravel, msG

41.0 - 49.0: Silty Sandy Gravel, msG

49.0 - 50.1: Silty Sandy Gravel, msG

Total Depth = 50.10' bgs (6/23/15)

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 3
Date: 6/22/15

Well ID: C9457 | Well Name: 399-1-86 | Location: 300 Area N of PNNL

Project: 31 Wells in 300-FF-5OU FY2015 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0		100% Recovery		Ground Surface to 0.25'	Drilling was
				Backfill / Drilling pad.	conducted
					w/ Terra Sonic 150CC
				0.25' to 3.30'	6" casing
	g.s			Formation (MSG)	4" core barrel
				10% m 40% s 50% G	
5				Sand: fine to course, very poorly sorted	g.s = grab sample
				sub angular ~40% mafic 60% felsic	
	g.s.			Gravel: 2mm to ~40mm, Sub	Grab sampler and
				angular to sub round.	chip trays samples
				60% mafic to 40% felsic	were collected
10		60% recovery		Weak reaction to HCl	every 5' for
	g.s			2.5 Y 3/2 very dark grayish brown.	archive.
				Dry	
15				3.30' to 22.00 ft bgs	
	g.s.			Formation: Hanford (MSG)	
				10% silt 35% Sand 55% Gravel	
				Sand: fine to course very poorly	
				sorted sub angular 40% mafic	
20		100% recovery		60% felsic	
	g.s			Gravel: 2mm to small boulder	
				poorly sorted; Angular to sub round	
				70% mafic ~30% felsic	
				@ ~11 ft 0.5 ft of mod.	
25				sorted sub round gravel lens	
	g.s.			average size ~15mm (possible	
				artifact of drilling method.)	
				weak to no reaction to HCl	
				2.5Y 3/1 very dark gray	
30		70% recovery		Dry	
	g.s				
				22.00 ft to 25.00 ft (m)	
				ringold rip up clast	
				90% silt 0% Sand 10% Gravel	
35				Low plasticity to no plasticity.	
	g.s.			Gravels are poorly sorted subangular	
				~80% mafic and located @ the	
				margins of the clast	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 6/23/15 | Signature: [signature] | Date: 9/9/2015

A-6003-642 (03/03)

BOREHOLE LOG

Date: June 23, 2015

Well ID: C9457	Well Name: 399-1-86	Location: 300 Area N of PNNL
Project: 31 well 300-FF-5 FY 15		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40		100% recovery		25.00 ft bgs to 32 ft bgs (MSG)	Drilling is being
				10% 45% S 45% G (Hanford)	conducted w/ a
				Sand fine to very coarse, very poorly	TerraSonic 150cc rig
	g5			sorted Angular ~~70~~ 50% mafic	6" casing
				50% felsic	4" x 10' Core barrel
				Gravels: 2mm to ~100 mm	
45				Sub angular to sub rounded	g.s = grab sample
				size increases down unit	collected is 5 ft
	g.s.			~70% mafic 30% felsic	intervals for
				No reaction to HCL	Archive.
				2.5Y 3/1 very dark gray	
50	TD 49.8 ft bgs			moist	Water tagged:
					42.00 ft bgs 6/23/15
				32.00 - 41.00'	
				Formation: Hanford (MSG)	
				15% silt 10% sand 75% gravel	
				Sand: fine to coarse poorly sorted	
				angular ~40% mafic 60% Felsic	
				Gravel ~2mm to 100 mm	
				sub round to well round	
				70% mafic 30% felsic	
				No reaction to HCL	
				2.5Y 3/1 very dark gray	
				moist	
				41' to 49'	
				Formation (MSG)	
				15% silt 40% Sand 45% Gravel	
				Sand: fine to coarse, poorly sorted	
				sub angular 30% mafic 70% felsic	
				large mica flakes	
				Gravel 2mm to 130mm sub round	
				to well round. poorly sorted	
				lots (20% chert) overall 30% mafic	
				70% felsic	
				2.5Y 4/3 olive brown	
				No reaction to HCL	
				wet	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/23/15	Signature: [signature]	Date: 9/9/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 3

Date: June 23, 2015

Well ID: 399-1-86	Well Name: C9457	Location: 300 Area N of PNNL
Project: 31 well 300-FF-5 FY15		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				49.00'–49.8' TD (MSG)	Drilling is being
				Formation	Conducted with
				15% silt 40% sand 45% Gravel	a terrasonic 150cc
				Sand: fine to coarse poorly sorted	10" casing
				sub angular 30% mafic 70% felsic	4"x10' Core barrel
				large flexs of mica	
				Gravel 2mm to ~130mm	T.D. Total depth
				sub round to well round	Tagged 49.8 6/23/15
				Lots of Chert	
				30% mafic 70% felsic	
				No reaction to HCL	
				2.5Y 5/1 Black	
				wet	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 6/23/15	Signature: [signature]	Date: 9/9/2015

A-6003-642 (03/03)

SURVEY DATA REPORT				Request No. 154-161
Project No.	Title 300-FF-5 Wells Final Surveys			File No. 3AT10R28
Job. No. CACN: 303500-JPRC	Prepared By N.P. Fastabend	Date 8/11/15	Reviewer LBM	

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casings) and elevations of 30 completed 300-FF-5 flush mount wells located on north side of 300 Area.	Survey File	OR		
	E.C. Rafuse	1		
	S.J. Trent	1		
	K.M. Whitley	1		
	J.B. Geiger	1		
Horizontal Coordinate System: WCS83S/91 (Meters)	B.J. Howard	1		
Vertical Datum: NAVD88 (Meters)	A.J. Green	1		

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheets

A-6006-495 (REV 0)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8931 (399-1-70) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8931	399-1-70	594125.04	116508.83		Center of Casing
				114.822	"X" on Rim
				114.822	Brass Survey Marker

Notes:

114.743 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8934 (399-1-72) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8934	399-1-72	594080.16'	116494.16'		Center of Casing
				114.912'	"X" on Rim
				114.915'	Brass Survey Marker

Notes:

114.824' Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8937 (399-1-74) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8937	399-1-74	594097.65'	116475.26'		Center of Casing
				114.917'	"X" on Rim
				114.923'	Brass Survey Marker

Notes:

114.822' Top Inner 2in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8940 (399-1-76) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8940	399-1-76	594117.79	116460.62		Center of Casing
				115.231	"X" on Rim
				115.233	Brass Survey Marker

Notes:

115.106 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8942 (399-1-78) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8942	399-1-78	594153.70	116463.17		Center of Casing
				114.895	"X" on Rim
				114.900	Brass Survey Marker

Notes:

114.763 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9408 (399-1-65) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9408	399-1-65	594164.48	116481.19		Center of Casing
				114.692	"X" on Rim
				114.689	Brass Survey Marker

Notes:

114.617 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9409 (399-1-66) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9409	399-1-66	594168.41	116504.97		Center of Casing
				114.629	"X" on Rim
				114.632	Brass Survey Marker

Notes:

114.514 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9451 (399-1-80) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9451	399-1-80	594089.52	116454.78		Center of Casing
				114.977	"X" on Rim
				114.979	Brass Survey Marker

Notes:

114.881' Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9453 (399-1-82) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9453	399-1-82	594151.78	116427.47		Center of Casing
				115.064	"X" on Rim
				115.067	Brass Survey Marker

Notes:

114.943 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9455 (399-1-84) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9455	399-1-84	594174.47	116451.41		Center of Casing
				114.943	"X" on Rim
				114.951	Brass Survey Marker

Notes:

114.836 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9457 (399-1-86) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9457	399-1-86	594137.74	116478.66		Center of Casing
				114.970	"X" on Rim
				114.974	Brass Survey Marker

Notes:

114.865 Top Inner 2in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

Appendix C

Well Documentation for Injection Wells

- Well Summary Sheet
- Borehole Log
- Final Survey Report

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WELL SUMMARY SHEET

Start Date: 6/8/2015
Finish Date: 8/4/2015
Page 1 of 1

Well ID: C9460	Well Name: 399-1-89
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/17/15
Signature: Marques Miller	Reviewed By: J.D. MEHRER
	Signature: [signature]
	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

2'x2' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.78' bgs

Permanent Well:

6.75" OD PVC Blank: 0.70' - 20.39' bgs

6.75" OD PVC 0.050-slot Screen: 20.39' - 30.39' bgs

6.75" OD PVC Blank: 30.39' - 35.39' bgs

6.75" OD PVC 0.050-slot Screen: 35.39' - 45.39' bgs

6.75" OD PVC Blank: 45.39' - 48.90' bgs

Construction Materials:

Concrete: 0.0' - 1.0' bgs

Neat Grout: 1.0' - 10.20' bgs

Bentonite Chips: 10.20' - 14.10' bgs

Bentonite Seal: 14.10' - 16.89' bgs

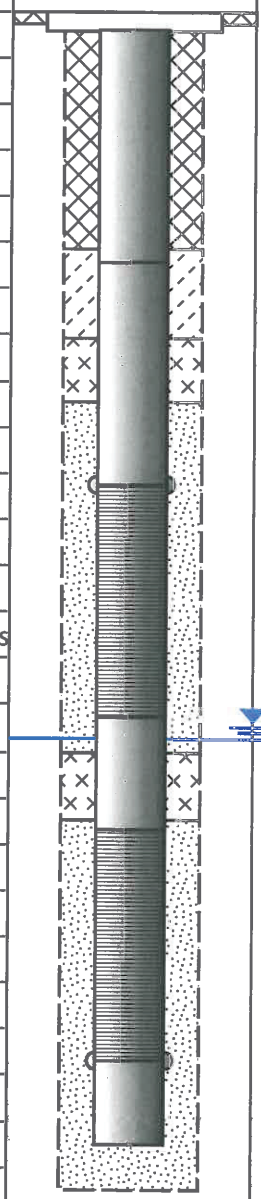
8/16 Mesh Filter Pack Sand: 16.89' - 31.99' bgs

Bentonite Seal: 31.99' - 34.92' bgs

8/16 Mesh Filter Pack Sand: 34.92' - 50.90' bgs

All temporary 10 3/4" OD casing removed 7/16/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0' - 0.25': Gravel Drill Pad, G

0.25' - 2.0': Silty Sandy Gravel, msG

2.0' - 21.0': Sandy Gravel, sG

21.0' - 38.0': Silty Sandy Gravel, msG

Depth to Water: 31.37' bgs (8/4/15)

38.0' - 42.0': Slightly Silty Gravelly Sand, (m)gs

42.0' - 50.90': Silty Sandy Gravel, msG

Total Depth = 50.90' bgs (7/16/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

C9460 399-1-89

Page 1 of 3

Date: 6/8/15

Well ID: ~~399-1-89~~ KAB | Well Name: ~~C9460~~ KAB | Location: 300 Area N of PNNL

Project: 30 well expantion | Reference Measuring Point: ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0	Litho 2'	100% recovery		0' to 0.25' backfill (drill pad)	Terrasonic 150cc
					4"x10' core barrel
				0.25' to 2.00 ft bgs	16" Casing
				Formation:	
				15% silt 30% sand 55% gravel	
5				Sand: fine to coarse, sub rounded	g.s = grab sample
				40% mafic 60% felsic Poorly sorted	
				Gravel: 2 mm to ~125 mm sub round	Litho = change
				to sub angular 7% mafic 30% felsic	in lithology
				2.5Y 3/2 very dark grayish brown (damp)	
10	Litho 9'	90% recovery		Strong reaction to HCL (dry)	
					Grab samples
					were collected
					over 5' interval
				2.00' to 9.00 ft bgs	
15				Formation:	Litho samples
				10% silt 30% sand 60% Gravel	were collected
				Sand: fine to coarse, poorly sorted	@ the contacts
				sub angular 30% mafic 70% felsic	
				Gravel: 2 mm to +200 mm (small cobbles)	Sieve samples
20	Litho 21	100% recovery		Poorly sorted, Angular to sub round	were collected
				rounding increases w/ size	in 10' intervals
				60% mafic 40% felsic	started @ 25' bgs
				2.5Y 3/1 very dark gray (damp	
				mod. reaction to HCL (dry	
25	Sieve #1 25' to 35'	100% recovery			
					TD 50.50' (7/15/15)
				9.00' ft to 21.00' bgs	DTW 30.76' (7/16/15)
				Formation	
30		60% recovery		5% silt 40% sand 55% Gravel	
				Sand: very coarse to coarse grain	
				mod to well sorted, sub round	
				40% mafic 60% felsic	
				Gravel: 2 mm to 140 mm poorly sorted	
35	Sieve #2			sub to well rounded. 60% mafic	
				40% felsic	
				2.5Y 3/1 very dark gray (damp)	
	Litho 36			mod to weak reaction to HCL (dry)	

Reported By: Candice Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] Date: 6/10/15 | Signature: [signature] Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3
Date: 6/9/15

Well ID: 399-1-89 | Well Name: C 9460 | Location: 300 Area N of PNNL

Project: 30 well expansion | Reference Measuring Point: ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	35 to 45, GS, Sample #3 45 to 50, GS	100% recovery		21.00' to 38.00 ft bgs	
				Formation	
				15% Silt 20% sand 65% Gravel	
				Sand: very fine to course grain, poorly	
				sorted, sub angular 60% mafic 40%	
45				felsic	
				Gravel: 2mm to ~100 mm sub round	
				to round poorly sorted 60% mafic	
				40% felsic	
				Silt/clay w/Low plasticity	
				Silty/~~gr~~ gravely lens at 21.50 to	
50				21.75' bgs (tan color 10YR 6/3 pale brown)	
				Sample color 2.5Y 3/2 very dark grayish	
				brown (damp)	
				weak reaction to HCL (dry)	
55				wet	
				38.00' to 42.00 ft bgs	
				Formation:	
				15% silt 60% sand 25% Gravel	
				Sand: course grain, mod sorted	
				sub round 40% mafic 60% felsic	
				Gravels: Larger ~100mm to small	
				cobbles sub angular to sub rounded	
				40% mafic 60% felsic	
				5YR 3/1 very dark gray (damp)	
				weak to no reaction to HCL (dry)	
				Wet	
				Sharp contact.	
				42.00 to 48.00 ft bgs	
				Formation	
				20% silt 20% sand 60% gravel	
				Sand fine grain, well sorted	
				sub rounded 35% mafic 65% felsic	
				notable mica present.	
				Gravel: 2mm to 160 mm sub round	
				to well round. 40% mafic	
				60% felsic (continued on pg 3)	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: Cindi Burnette Kildall | Date: 6/10/15 | Signature: [signature] | Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 3
Date: 6/9/15

Well ID: 399+89
Well Name: C9460
Location: 300 Area N of PNNL
Project: 300 Area 30 well expantion
Reference Measuring Point: ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				42.00' to 48.00' bgs Continued	
				5YR 4/2 dark reddish gray (damp)	
				silt/clay low to mod. plasticity	
				sharp contact ~~to HCl~~ CK 6/9/15	
				slight reaction to HCL	
				48.00' to 50.50 ft bgs	
				20% silt 30% sand 50% gravel	
				Sand: fine, sub round mod to well	
				sorted 40% mafic 60% felsic	
				Gravel: ~4mm to 80 mm poorly	
				sorted sub angular to sub rounded	
				40% mafic to 60% felsic	
				Silt ~~/clay~~ CK 6/9/15 very low to low plasticity	
				GLEY1 3/1 very dark gray (damp)	
				slight reaction to HCL (dry)	
				wet	
				50.50 TD	

Reported By: Candice Burnette Kildall
Title: Geologist
Signature: by CK Kildall
Date: 6/10/15

Reviewed By: Kevin Bergstrom
Title: Sr. Geologist
Signature: [signature]
Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 7/16/2015
Finish Date: 8/4/2015
Page 1 of 1

Well ID: C9461	Well Name: 399-1-90
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/17/15
Signature:	Reviewed By: J.D. MEHRER
	Signature:
	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

1.88'x1.90' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.85' bgs

Permanent Well:

6.75" OD PVC Blank: 0.70' - 20.42' bgs

6.75" OD PVC 0.050-slot Screen: 20.42' - 30.43' bgs

6.75" OD PVC Blank: 30.43' - 35.43' bgs

6.75" OD PVC 0.050-slot Screen: 35.43' - 45.44' bgs

6.75" OD PVC Blank: 45.44' - 48.95' bgs

Construction Materials:

Concrete: 0.0' - 1.20' bgs

Neat Grout: 1.20' - 9.87' bgs

Bentonite Chips: 9.87' - 14.10' bgs

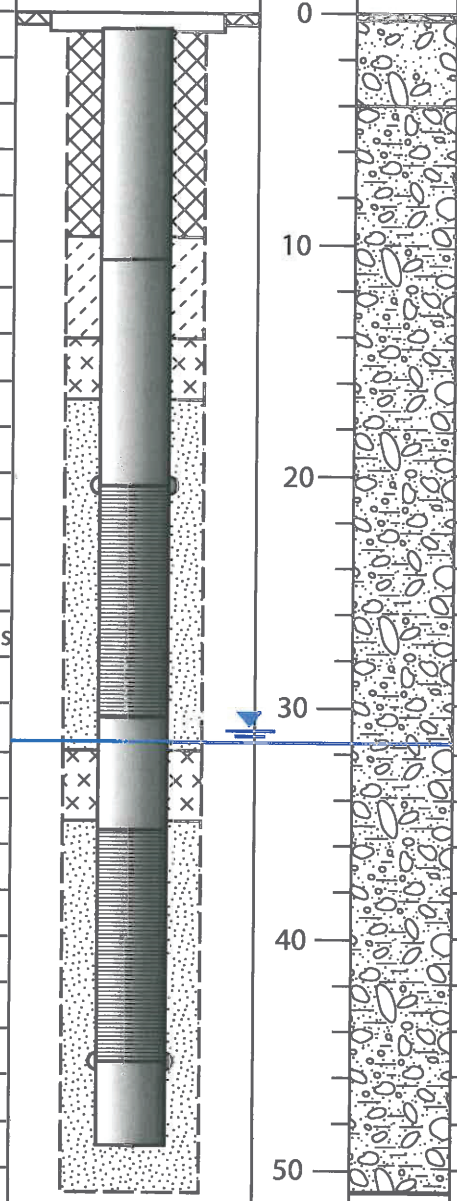
Bentonite Seal: 14.10' - 16.83' bgs

8/16 Mesh Filter Pack Sand: 16.83' - 31.95' bgs

Bentonite Seal: 31.95' - 34.90' bgs

8/16 Mesh Filter Pack Sand: 34.90' - 51.03' bgs

All temporary 10 3/4" OD casing removed 7/20/15.



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0' - 0.25': Gravel Drill Pad, G

0.25' - 4.0': Sandy Gravel, sG

4.0' - 51.03': Silty Sandy Gravel, mSG

Depth to Water: 31.65' bgs (8/4/15)

Total Depth = 51.03' bgs (7/20/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: July 16, 2015

Well ID: C9461	Well Name: 399-1-90	Location: 300 Area W of DNNL
Project: 300-FF-5 Borwell FY15		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground Surface to 0.25 ft	Injection well
				Backfill / drill pad	
					Drilling is being
	gs			0.25 ft to 4.00 ft bgs SG	Conducted with
				Formation	a Terrasonic 150 cc
				80% sand 20% Gravel	8"x10' Core barrel
5				Sand: medium grain ~~pr~~ mod sort.	10" Casing
				sub angular 60% matic 40% felsic	
	gs			Gravel: 2mm to ~75mm, sub	g.s = grab sample
				to well rounded poorly sorted	
				mod reaction to HCL	Drilling is slow from
10				70% matic 30% felsic	~8' bgs to
				2.5Y3/3 dark olive	
	gs			Dry	
					recovery
					0-10' 100%
15				4.00 ft to ~~2~~ 14.00 ft bgs MSG (7-16-15)	10'-20' 60%
				Formation	20'-30' 100%
	gs			15% silt 40% sand 45% gravel	
				Sand: fine to coarse very poorly	grab sample
				sorted Angular to sub Angular	are taken in 5 ft
20				60% matic 40% felsic	intervals. The samples
				Gravel 2mm to 200mm, very	are collected in
	gs			poorly sorted sub round to	pint jars and
				round. ~60% matic 40% felsic	chip trays.
25				Graded ~~taper~~ upper contact	
				sharp lower contact	
	gs			mod-to-weak reaction to	
				HCL going down unit.	
				2.5Y3/1 Gray (dry)	
30				Dry	
	gs				
				14.00 ft to 44.00 ft MSG	
				Formation	
35				15% silt 35% Sand 50% Gravel	
				Sand fine to very coarse mod	
	gs			sorted Angular 70% matic	
				30% felsic	
				Gravel: see pg 2	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 7/20/15	Signature: [signature]	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: July 16, 2015

Well ID: C9461 | Well Name: 399-1-90 | Location: 300 Area W of PNNL

Project: 30 well installation 300-FF-5 FY15 | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				14.00 ft to 44.00 Continued	Injection well
				Gravel: 2mm to ~150 mm very poorly	
				sorted ~ 75% of gravels are	Drilling is being
	95			under 75 mm. sub round to	conducted with
				well round. 60% mafic 40% felsic	a terrasonic 150 CC
45				2.5 Y 3/1 very dark gray.	8" X 10' core barrel
				No reaction to HCL	10" casing.
				moist (water was added as part of	
				drilling).	final tag 51.03' bgs
	85				DWT 32.60' bgs
50				@ 21.00 to 22.00 there	
				is a silty Gravel lens.	
				Gravel is ~100mm sub round	
				low plasticity in silt surrounding	
				gravel.	
				@ 26.00 to 26.08 silt ~~th~~ lens	
				@ 28.00 to 28.05 silt lens	
				2.5 Y 5/6 Light olive brown	
				@ 35.00 ft to 36 ft	
				Gravel lens: well to sub round	
				~ 75 mm to 100 mm	
				44.00 ft to	
				Formation	
				20% silt 40% sand 40% Gravel	
				Sand: fine to medium grain sub	
				round mod. sorted. 45% mafic	
				55% felsic sand has a	
				greenish color (GLEY 1 3/2 very dark	
				grayish green.	
				Gravel: 2mm to 175 mm poorly	
				sorted sub round 55% mafic	
				45% felsic	
				2.5 Y 2.5/1 Black	
				no reaction to HCL	
				wet.	
				Sharp upper contact	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 7/20/15	Signature: [signature]	Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 7/20/2015
Finish Date: 8/4/2015
Page 1 of 1

Well ID: C9462	Well Name: 399-1-91
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Reviewed By: J.D. MEHRER
Signature:	Signature:
Date: 9/16/15	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

1.88'x1.84' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.74' bgs

Permanent Well:

6.75" OD PVC Blank: 0.35' - 19.98' bgs

6.75" OD PVC 0.050-slot Screen: 19.98' - 29.98' bgs

6.75" OD PVC Blank: 29.98' - 34.98' bgs

6.75" OD PVC 0.050-slot Screen: 34.98' - 44.97' bgs

6.75" OD PVC Blank: 44.97' - 48.54' bgs

Construction Materials:

Concrete: 0.0' - 1.0' bgs

Neat Grout: 1.0' - 9.15' bgs

Bentonite Chips: 9.15' - 14.08' bgs

Bentonite Seal: 14.08' - 17.08' bgs

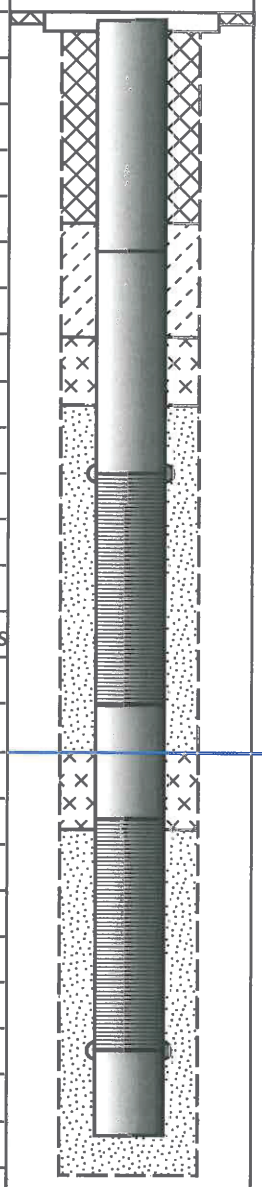
8/16 Mesh Filter Pack Sand: 17.08' - 32.0' bgs

Bentonite Seal: 32.0' - 35.33' bgs

8/16 Mesh Filter Pack Sand: 35.33' - 50.17' bgs

All temporary 10 3/4" OD casing removed 7/21/15.

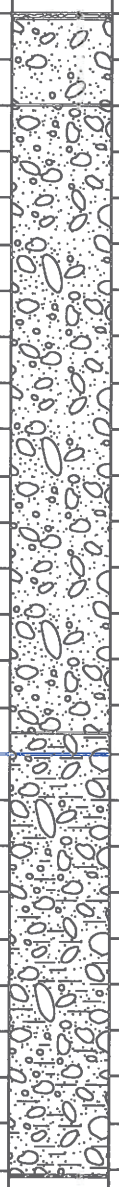
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log



Lithologic Description

0.0' - 0.2': Gravel Drill Pad, G

0.2' - 4.0': Gravelly Sand, gS

4.0' - 31.0': Sandy Gravel, sG

31.0' - 50.17': Silty Sandy Gravel, msG

Depth to Water: 32' bgs (8/4/15)

Total Depth = 50.17' bgs (7/21/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: July 20, 2015

Well ID: C9462 | Well Name: 399-1-91 | Location: 300 Area N of PNNL

Project: 30well installation 300-FF-5 FY15 | Reference Measuring Point: Groend Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground Surface to 0.20 ft bgs	Injection Well
				Drill pad / Backfill	
					Drilling is being
	g.s			0.20 ft to 4.00 ft bgs	conducted with
				Formation	a Terrasonic CC150
5				silt 0% Sand 8% Gravel 20%	8"x10' Core barrel
				Sand: medium grain mod to well	10" Casing.
	g.s			sorted sub round. 60% mafic	
				40% felsic	g.s = grab sample
		~70% recovery		Gravel: 10mm to 70mm mod sorting	Grab samples are
10				Sub round to well rorend 8% mafic	collected in 5' intervals
				20% felsic	
	g.s			weak to no reaction to HCl	
				Graded contacts top & bottom	
				2.5 Y3/3 dark olive brown	
15					
	g.s			4.00 ft bgs to 31.00 ft bgs SG	
				Formation:	Recovery
		~60% recovery		10% silt 30% sand 60% Gravel	0-10 ~70%
20				Sand fine to coarse, poorly sorted	10-20 ~60%
				sub angular to angular 70% mafic	20-30 ~100%
				30% felsic	30-40 ~80%
	gs			Gravel: 2mm to small boulders	40- ~100%
				very poorly sorted angular	
25				to well rounded, rounding increases	
				with size.	
	gs			mod reaction going to weak	
		~100% recovery		reaction down unit.	
				graded contacts upper and	
30				lower	
	g.s.			2.5 Y 3/1 very dark gray	
	litho			31.00 ft bgs to 50.17' bgs MSG	
35				Formation	
		~80% recovery		15% silt 25% Sand 60% Gravel	TD = 50.17' bgs
	gs			Sand fine to very coarse, very	~~DWT EK 7-21-15~~
				poorly sorted, Angular 70% mafic	DTW = 40.90' bgs
				30% felsic	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 7/20/15	Signature: [signature]	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: July 20, 15

Well ID: C9462 | Well Name: 399-1-91 | Location: 300 Area N of PNNL

Project: 300 Well Installation 300-FF-5 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40		—		31.00 ft bgs to 50.17' bgs MSG	Injection well
				Continued	
	g.s			Gravel: 2mm to ~200mm	Drilling is being
				Poorly sorted ~80% of the	Conducted with a
		~100% recovery		gravels are less than 100mm	Terrasonic 150CC
45				the smaller gravels tend to	8"x10' Core barrel
				be angular with round	10" Casing
				increasing with size	
	g.s			60% mafic 40% felsic	g.s = grab sample
				Silt: tends to concentrate	
50				around the larger gravels	
				No reaction to HCL	
			TD 50.17'	2.5 Y 3/2 very dark grayish brown	
				@ 33.00 ft Bgs to 35 ft bgs	
				There is a ~~Ringto~~ Ringold	
				Rip up clast. The clast	
				is composed of 80% Silt	
				20% felsic (very mica rich)	
				Very fine grain sand.	
				Very low plasticity.	
				No reaction to HCL	
				2.5 Y 5/4 light olive brown	

Reported By: Candice Burnette Kiblall
Title: Geologist
Signature: [signature] Date: 7-21-15

Reviewed By: Kevin Bergstrom
Title: Sr. Geologist
Signature: [signature] Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 7/23/2015
Finish Date: 5/13/2015
Page 1 of 1

Well ID: C9463	Well Name: 300-1-92
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/16/15
Signature: MMiller	Reviewed By: J.D. MEHRER
	Signature:
	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

1.85'x1.90' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.75' bgs

Permanent Well:

6.75" OD PVC Blank: 0.7' - 20.3' bgs

6.75" OD PVC 0.050-slot Screen: 20.3' - 30.3' bgs

6.75" OD PVC Blank: 30.3' - 35.3'

6.75" OD PVC 0.050-slot Screen: 35.3' - 45.3' bgs

6.75" OD PVC Blank: 45.3' - 48.8' bgs

Construction Materials:

Concrete: 0.0' - 2.3' bgs

Neat Grout: 2.3' - 9.92' bgs

Bentonite Chips: 9.92' - 14.0' bgs

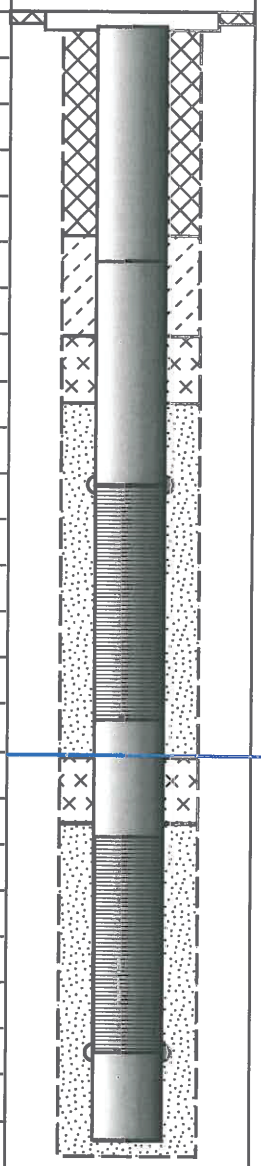
Bentonite Seal: 14.0' - 16.92' bgs

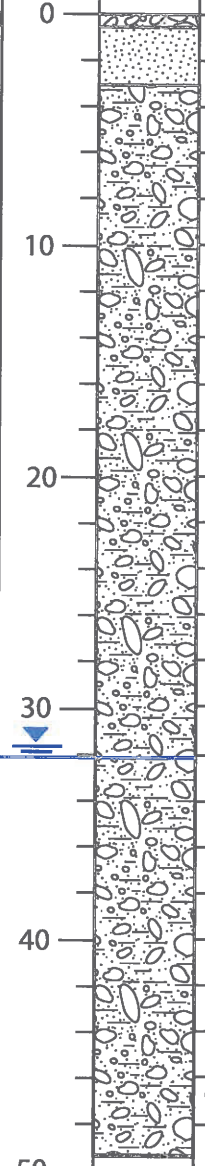
8/16 Mesh Filter Pack Sand: 16.92' - 32.1' bgs

Bentonite Seal: 32.17' - 35.0' bgs

8/16 Mesh Filter Pack Sand: 35.0' - 49.5' bgs

All temporary 10 3/4" OD casing removed 7/23/15.





GEOLOGIC/HYDROLOGIC DATA

Depth in Feet | Graphic Log

Lithologic Description

0.0 - 0.5: Gravel Drill Pad, G

0.5 - 3.2: Sand, S

3.2 - 49.5: Silty Sandy Gravel, mSG

Depth to Water: 32.15' bgs (8/5/15)

Total Depth = 49.5' bgs (7/23/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: July 23, 2015

Well ID: C9463	Well Name: 399-1-92	Location: 300 Area N of BNNL	
Project: 30 Well 300-FF-5 FY15		Reference Measuring Point: Ground Surface	

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		—		0.0' to 0.5' Backfill / Drill pad.	Injection Well
	g.s				Drilling is being conducted with a
		~100%		0.5' to 3.20 ft bgs (S) Formation 100% Sand Mod to well sorted medium grain sub round. ~40% mafic 60% felsic 2.5Y 3/3 dark olive brown No reaction to HCL Dry, Graded contact upper/Lower	Terosonic 150 cc 10" Casing 8"x10' Core barrel
5	g.s				g.s = grab sample grab samples are collected every 5' and placed in pint jars and chip trays
10	g.s	—			
		~80%		3.20' to 18.00 ft bgs (MSG) Formation 10% Silt 40% Sand 50% Gravel Sand: fine to coarse poorly sorted sub angular 60% mafic 40% felsic Gravel: 2mm to 250mm. Angular to sub round. very poorly sorted 2.5Y 3/1 Very dark gray Dry, Graded contacts upper/Lower Strong reaction to HCL @ top of unit weak to no at bottom of unit.	Recovery 0'-10' ~100% 10'-20' ~80% 20'-30' ~75% 30'-40' ~70% 40'-50' ~50%
15	g.s				
20	g.s	—			
25	g.s	~75%			
				18.00' to 49.55' bgs (MSG) Formation 15% silt 25% Sand 60% Gravel Sand: med. to very coarse, very poorly sorted Angular 60% mafic 40% felsic Gravel: 2mm to ~100 mm Gravels tend to be less the 50mm very poorly sorted. Angular with rounding increasing with size	
30	g.s	—			
		~70%			
35	g.s				TD 49.55 ft DTW 34.65 ft

Reported By: Candice Burnette Kiddall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date:	Signature: [signature]	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: July 23, 2015

Well ID: C9463 | Well Name: 399-1-92 | Location: 300 Area W of PNNL

Project: 30 Wells 300-FF-5 & FY15 | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40				18.00' to 49.55 Continued	Injection well
				2.5Y 3/1 Very dark gray	
				Wet	Drilled w/ a
	gs			No reaction to HCl	Terrasonic 150 CC
		~50%			10" Casing
45				@ 28.00 ft to 28.50 80%G 20%m	8" core barrel
				there is a Gravel lens./Silt	
				Gravel 35mm to 60mm well round	
	gs				
50				@ 38.00 to 40.00' 80%G 20%m	
				silty gravel lens	
				gravel ~35mm to 60mm well	
				rounded	
				@ 44.00 ft to 44.50 ft	
				silty gravel lens 80%G 20% m	
				gravel ~40mm to 80mm well rounded	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: | Signature: [signature] | Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/8/2015
Finish Date: 8/5/2015
Page 1 of 1

Well ID: C9464	Well Name: 399-1-93
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/17/15
Signature:	Reviewed By: J.D. MEPPER
	Signature:
	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

1.95'x2' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.75' bgs

Permanent Well:

6.75" OD PVC Blank: 0.20' - 19.95' bgs

6.75" OD PVC 0.050-slot Screen: 19.95' - 29.95' bgs

6.75" OD PVC Blank: 29.95' - 34.94' bgs

6.75" OD PVC 0.050-slot Screen: 34.94' - 44.94' bgs

6.75" OD PVC Blank: 44.94' - 48.45' bgs

Construction Materials:

Concrete: 0.0' - 3.20' bgs

Neat Grout: 3.20' - 10.20' bgs

Bentonite Chips: 10.20' - 14.0' bgs

Bentonite Seal: 14.0' - 16.97' bgs

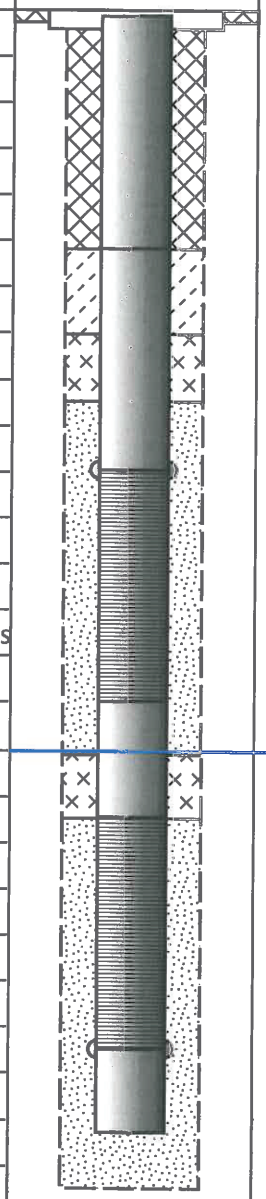
8/16 Mesh Filter Pack Sand: 16.97' - 32.18' bgs

Bentonite Seal: 32.18' - 34.98' bgs

8/16 Mesh Filter Pack Sand: 34.98' - 50.90' bgs

All temporary 10 3/4" OD casing removed 7/15/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0' - 0.5': Gravel Drill Pad, G

0.5' - 3.5': Sand, S

3.5' - 4.0': Silty Gravel, mG

4.0' - 16.0': Sandy Gravel, sG

20.0' - 29.5': Silty Sandy Gravel, msG

29.5' - 36.0': Silt, M

Depth to Water: 32.05' bgs (8/5/15)

36.0' - 38.0': Silty Sandy Gravel, msG

38.0' - 39.5': Sandy Gravel, sG

39.5' - 47.0': Silty Sandy Gravel, msG

47.0' - 50.90': Silt, M

Total Depth = 50.90' bgs (7/6/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: 6·8·15

Well ID: C9464	Well Name: 399-1-93	Location: 300-Area N. of PNNL
Project: 300 Area U Sequestration		Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-0.5 : Gravel Pad. KAB	Sonic w/ 10.5" & 5" core barrel.
				0.5-3.5' f-m silty Sand. mS. (90%S, 10%m <2%g.)	
	g.s.			v.f.-c. sub-rndd.-rndd. micaceous S. w/ low plastic-no plastic	2.0': g.s. (grab sample)
	g.s.			silty clay. Dry. 10YR 4/3 brown. no rxn w/HCl	
				3.5-4.0': Moist interbed - silty Gravel mG (60%G 20%S, 20%m)	
5				mod. srtd. f.-c. pbl. of bslt. (sub-rndd.) w/ matrix: v.f.-c. sub-ang.	3.8': g.s.
	g.s.	100%		S. w/ 2.5Y 4/2 dk grayish brown low-mod. plastic silt. Moist. ← mod. rxn w/HCl.	
				4.0-20' : Sandy Gravel sG (75-80%G, 25-20%S, <5%m)	6.0': g.s.
				v.pr. srtd. v.f. pbl.-lrg. cbl. max: 150mm sub-rndd. of 70% felsic meta. 30% bslt. lrg. clasts of bslt.	
				matrix: v.f.-c. sub-ang. S. 80% mafic, 20% felsic. Qtz. felds. w/ trc.	
10				non-plastic M. 2.5Y 4/3/2 v. dark grayish brown. moist. mod. rxn w/HCl.	
				·10-16': SG. cont. Downward coarsening.	
	g.s.			v.p. srtd. clasts. v.f. pbl.-bldr. of 30-50% bslt, 70-50% felsic	12': g.s.
				Meta. > int. volc. > green schists w/ v.f.-v.c. sub ang. S.	
		60%		color same as above 2.5Y 3/2. wk. rxn w/HCl. max: >256mm	
15				16-20': No Returns.	16-20': boulder blocked core barrel.
20				20-29.5': silty Sandy Gravel msG (70%G, 20%S, 10%m)	
				mod. srtd. v.f. pbl.-sm. cbl. of 60% felsic, 40% bslt. (Qtz > meta >	
				int. volc.): sub. rndd. w/ matrix: v.f.-v.c. ang-sub ang. S. of	
	g.s.			80% mafic/20% felsic. w/ non low plastic M. 2.5Y 4/2 dk. grayish	23': g.s.
		PRZ		brown. moist. no rxn w/HCl.	23-33': Sieve #1 (minus 29-36') (Silt)
25		100%			
	g.s.				28': g.s.
				29.5-36' : Silt. (100%m) mod-st. clayey/sticky/plastic.	
30				mod. plastic. low dilatency. 50%/50% blocky mottling. 2.5Y 6/3	
				lt. yellowish brown + 2.5Y 3/2 v. drk. grayish brown. moist.	31.6': water (6·8·15)
	g.s.			no rxn w/HCl.	
				sandy	33': g.s.
		100%		& sharp contact.	33-
35				36-38': silty Gravel (mSG) (70%G, 20%m, 2%S)	
	g.s.			Pr. srtd. f. pbl.-sm. cbl. w. rndd. of 30% bslt./70% (Qtz > int. volc.)	37': g.s.
				w/ v.f.-m. ang. S. in v. clayey. v. low dilatency silt. 2.5Y	
	g.s.			4/1 dark grey. wet.	39': g.s.

Reported By: A. Lockton		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: A. Lockton	Date: 6·8·15	Signature: Kevin Bergstrom	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: 6·8·15

Well ID: C9464 | Well Name: 399-1-93 | Location: 300 Area N. of PNNL

Project: 300 Area U. Sequestration | Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40		100%		38-39.5': Sandy Gravel sG (~~20%G~~ 60%G, 40%S)	Sonic w/ 10.5'x5" core barrel.
				v.w. srtd. intvl. v.w. graded. normal graded bed.	39': g.s.
				•38-39': Sandy Gravel sG (v.w. srtd. m-v.crs. S. w/	
				v.f.-m. sub-rnd-w.rnd. pbl. of 85% bslt/5% felsic Qtz.	33-47': Sieve #2.
				Coarsening downward: max: 12mm	(minus silt 33-36')
				•39-39.5': 6" bed base of ~~sal mod.~~ well srtd. v.f. pbl.-m. pbl.	
				max: 16mm. of 85% bslt/15% felsics w/ v.crs. ang. S.	
				2.5Y 3/1 black. wet. no rxn w/HCl. - no mica.	
				39.5'-47.0': Silty Sandy Gravel msG (75%G 15%S, 15%M)	
40				mod. srtd. v.f.-v.crs. pbl. v.w. rnd. discoidal of	
				75-80% bslt/25-20% felsic Qtz > int. volc. > granoblastic meta.	
				matrix of v.f.-v.crs. sub-ang. S. w/ v. plastic M. v. low dilatency.	
				2.5Y 4/2 drk. grayish. brown. - no mica.	
45	Sieve #2	60%	Refusal		45': g.s.
				47.0-50.5': Clayey silt. (98% M, 2% G)	
		90%	Silt	v. plastic w/ v. low dilatency. v. soft. w/ indurated	50.5': g.s.
50			TD: 50.5	fn.-m. blocky structure ~30-40%. max block ~10mm.	50.5': TD.
				2.5Y 5/3 lt. olv. brn. sprs. ~~sa. plate~~ fn.-m. pbl. of felsics.	

Reported By: A. Lantan | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: A. Lat | Date: 6·8·15 | Signature: [signature] | Date: 9/18/2018

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 7/21/2015
Finish Date: 8/6/2015
Page 1 of 1

Well ID: C9465	Well Name: 399-1-94
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller — Date: 9/16/15	Reviewed By: J.D. MEHRER — Date: 10-28-15
Signature: MMiller	Signature:

CONSTRUCTION DATA

Surface Completion:

2'x2' Flush mount concrete pad w/brass survey marker.
13 1/2" OD Protective Monument: 0.0' - 0.80' bgs

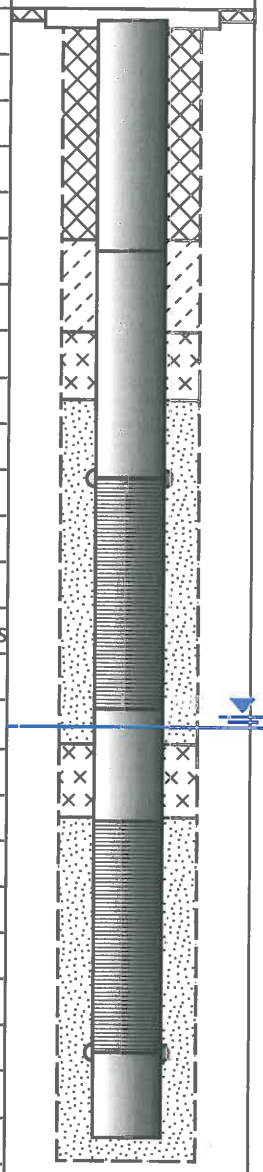
Permanent Well:

6.75" OD PVC Blank: 0.55' - 20.24' bgs
6.75" OD PVC 0.050-slot Screen: 20.24' - 30.24' bgs
6.75" OD PVC Blank: 30.24' - 35.24' bgs
6.75" OD PVC 0.050-slot Screen: 35.24' - 45.23' bgs
6.75" OD PVC Blank: 45.23' - 48.80' bgs

Construction Materials:

Concrete: 0.0' - 1.05' bgs
Neat Grout: 1.05' - 10.0' bgs
Bentonite Chips: 10.0' - 14.0' bgs
Bentonite Seal: 14.0' - 16.92' bgs
8/16 Mesh Filter Pack Sand: 16.92' - 31.83' bgs
Bentonite Seal: 31.83' - 35.0' bgs
8/16 Mesh Filter Pack Sand: 35.0' - 49.82' bgs

All temporary 10 3/4" OD casing removed 7/22/15.



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet — Graphic Log

Lithologic Description:

0.0' - 0.1': Gravel Drill Pad, G
0.1' - 3.6': Sand, S
3.6' - 14.0': Sandy Gravel, sG
14.0' - 49.82': Silty Sandy Gravel, msG
Depth to Water: 31.16' bgs (8/5/15)

Total Depth = 49.82' bgs (7/21/15)
OD = outside diameter
bgs = below ground surface
Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: July 21, 2015

Well ID: C9465 | Well Name: 399-1-94 | Location: 300 Area N of PNNL

Project: 30 Well 300 FF 5 FY15 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		1		Ground surface to 0.10 ft bgs	Injection well
				Back fill / drill pad	
		2			Drilled by a
	gs				Terrasonic 150 cc
		100%		0.10 ft to 3.60 ft bgs (S)	
				Formation	g-s = grab sample
5				Sand 98% gravel 2%	
				Sand: med grain; well sorted	
	g.s			Sub round ~40% mafic 60% felsic	
				Gravel ~15mm to 30mm angular	Recovery
				90% mafic 10% felsic	0-10 ~100%
10		1		Dry	10-20 60%
	g.s	2		Weak to no reaction to HCl	20-30 50%
		60%		2.5Y 3/3 dark olive brown	30-40 75%
				Graded upper/Lower contact	40- 100%
15					
				3.60 ft to 14.00 ft bgs	
	g.s			Formation	
				Silt 10% Sand 30% Gravel 60%	
				Sand: fine to coarse poorly sorted	
20		1		Sub round. 60% mafic 40% felsic	
	g.s	2		Gravel: 2mm to Large Cobble, angular	
		50%		to sub round. poorly sorted	
				~60% mafic 40% felsic	
				Dry	
25				2.5Y 3/1 Dark gray	
				Strong to mod reaction to HCl	
	gs			graded contact upper/Lower.	
30		1		14.00 ft to 43.00 ft bgs	
	g.s	2		Formation	
		75%		15% Silt 30% Sand 55% Gravel	TD = 50.17
				Sand: fine to very coarse, very poorly	DTW = 35.65'
				sorted. Angular. (~70% of the sand	
35				is coarse to very coarse) 60% mafic	
	g.s			40% Felsic.	
				Gravel: 2mm to large cobble, poorly	
				sorted. Angular to round.	

Reported By: Candice Burnette Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: [signature]	Date: 7-21-15	Signature: [signature]	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: July 21, 2015

Well ID: C9465 | Well Name: 399-1-94 | Location: 300 Area N of PNNL

Project: 30 wells 300-FF-5 FY15 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
40				14.00 ft to 43.00 ft Continued	
				rounding increases with size	
	9.5	2 100%		Wet, No reaction to HCl	
				2.5Y 3/1 very dark gray	
				graded upper/sharp lower contact.	
45					
	9S			43.00 ft to 50.17 ft bgs	
				Formation	
				15% silt 30% sand 55% Gravel.	
				Sand: fine to med. grain well sorted	
50				sub to well rounded 20% mafic 80% felsic	
				Gravel: 2mm to 100mm mod. sorting	
				Sub round. 50% mafic 50% felsic	
				Wet, No reaction to HCl	
				Silt has low Plasticity	
				GLEY1 2.5/10Y greenish black	
				@47ft there is a 1' sand lens.	
				lens in med grain well sorted,	
				round ~100% felsic.	
				5YR 4/6 yellowish red.	

Reported By: Candice Burnette Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 7-21-15 | Signature: [signature] | Date: 9/12/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/4/2015
Finish Date: 8/6/2015
Page 1 of 1

Well ID: C9466	Well Name: 399-1-95
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/17/15
Signature: MAMiller	Reviewed By: J.D. MEHRER
	Date: 10-28-15
	Signature: JDM

CONSTRUCTION DATA

Surface Completion:

2'x2' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.80' bgs

Permanent Well:

6.75" OD PVC Blank: 0.0' - 20.92' bgs

6.75" OD PVC 0.050-slot Screen: 20.92' - 30.92' bgs

6.75" OD PVC Blank: 30.92' - 35.92' bgs

6.75" OD PVC 0.050-slot Screen: 35.92' - 45.91' bgs

6.75" OD PVC Blank: 45.91' - 49.44' bgs

Construction Materials:

Concrete: 0.0' - 2.80' bgs

Neat Grout: 2.80' - 10.16' bgs

Bentonite Chips: 10.16' - 14.50' bgs

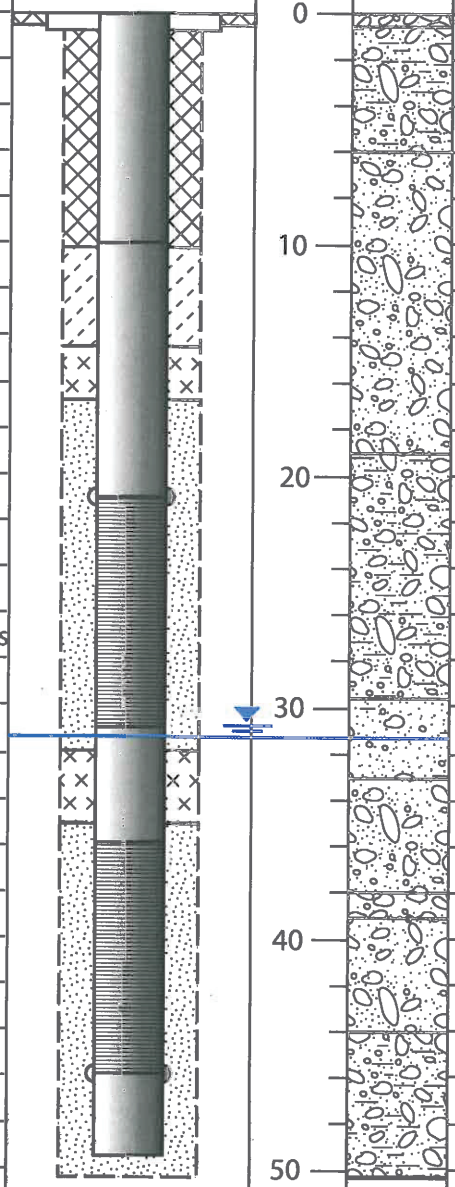
Bentonite Seal: 14.50' - 16.80' bgs

8/16 Mesh Filter Pack Sand: 16.80' - 31.96' bgs

Bentonite Seal: 31.96' - 35.0' bgs

8/16 Mesh Filter Pack Sand: 35.0' - 50.30' bgs

All temporary 10 3/4" OD casing removed 7/27/15.



GEOLOGIC/HYDROLOGIC DATA

Lithologic Description

0.0' - 0.5': Gravel Drill Pad, G

0.5' - 6.0': Silty Sandy Gravel, msG

6.0' - 19.0': Sandy Gravel, sG

19.0' - 29.5': Silty Sandy Gravel, msG

29.5' - 33.0': Gravelly Silty Sand, gmS

Depth to Water: 31.30' bgs (8/6/15)

33.0' - 38.0': Sandy Gravel, sG

38.0' - 39.0': Gravel, G

39.0' - 44.0': Sandy Gravel, sG

44.0' - 50.30': Silty Sandy Gravel, msG

Total Depth = 50.30' bgs (7/27/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: 6-4-15

Well ID: C9466	Well Name: 399-1-95	Location: 300 Area N of PNNL	
Project: 300-FF-5		Reference Measuring Point: Ground Surface	

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-0.5': Gravel Pad. Crushed aggregat.	Sonic Corebarrel: 4 7/8" - 5-inch.
				0.5-3.0': Silty Sandy Gravel msG (60%G, 25%S, 15%m)	10' core barrel (c.b.)
	g.s.			Poor srtd. v.f.pbl.-sm.cbl. sub-ang-w.rndd. max 75mm. w/	Grab. Sample (g.s.) @ 2'
				v.f.-v.c. sub-rndd. S. 95% mafic/5% felsic. silt: 10YR 6/2 lt. brownish	
				gray. Dry. unconsolidated. wk. rxn w/HCl.	
5	g.s.			3.0-6.0': Silty Sandy Gravel msG (40%G, 40%S, 20%m)	5.0': g.s.
				v.Pr.srtd. sub-rndd.-w.rndd. m.-v.c.pbl. abnt. lrg.cbl. of bslt.	
				w/v.f.-c. sub-rndd. S. silt color 2.5Y 4/2 Drk grayish brown.	
				low delatency. low plastic. Comp: 80% bslt./20% felsic Meta > Volc.	
	g.s.			wk rxn w/HCl. KMB KMB	9.0': g.s.
10				6.0-17.0': Silty Sandy Gravel (msG) (60%G, 30%S, 10%m)	
				mod.-pr.srtd. w.-sub-rndd. v.f.pbl.-sm.cbl. max: 70mm. avg: 40mm.	
				of 60% bslt./40% felsic meta. > int. Volc. w/ v.f.-m. sub.-rndd. S.	
				silt: 10YR 4/1 drk gray. moist. no plastic. wk. rxn w/HCl.	
15	g.s.			-16': prob. coarsening downward. from 11-17': avg. clast from 40mm	15': g.s.
				to 70mm.	
				17.0'-18.0': Rip up clast of silty gravel (sG) (80%G, 20%m, 10%S)	10%S.
				2.5Y 4/2 lt. yllowsh. brown matrix of cemented sandy silt w/gravel	
	g.s.			mod. plastic. v. weathered basalt w/clay rinds. v.st. rxn w/HCl.	18.5': g.s.
20	g.s.			19-19': Sandy Gravel sG (70%G, 30%S, 5%m)	
				mod.w.srtd. v.f.-v.c.pbl. w-v.w.rndd. of 80% bslt/20% meta.	20': g.s.
				pr. consolidated. wk rxn w/HCl. w/m-v.c. ang. S. 10YR 4/2 v.drk. brown.	
				19-23.0': Silty Sandy Gravel msG (70%G, 15%S, 15%m)	22': Top of Periodically rewetted zone (PRZ)
				mod. srtd. v.w.rndd. v.f.-v.c.pbl. of 80% bslt./20% meta. > int. V.	(PRZ)
AK 2020 6-4-15				w/v.f.-v.c. sub-ang. S. Silt is slight clayey mod. plastic. low delatent.	
				10YR 4/2 v.drk. brown. no rxn w/HCl - wk. rxn w/HCl	
				23-24': Silty Sandy Gravel msG (70%G, 20%m, 15%S)	
	g.s.			v.poor srtd. v.f.pbl.-v.c.pbl. max: 64mm v.w.-sub-rndd. of	23.5': g.s.
25				85% bslt/15% int. Volc. tuff. w/v.f.-m. sub-ang. S. + plastic, slight. clayey	
				silt. color 10YR 3/2 v.drk. grayish brown w/1% mottle 10YR 5/4 yllowsh brown.	
				mod. imbrication.	
	g.s.			24.0-29.5': Silty Sandy Gravel msG (60%G, 20%S, 20%m)	27': g.s. 26-36': Sieve #1
				mod. srtd. grading to poor srtd. v.f.-m.pbl. -> v.f.pbl.-sm.cbl. of	
				85% bslt/15% felsic meta. w/mod. clayey, mod. plastic silt. +	
30				v.f.-v.c. sub-ang. S. 10YR 3/2 v.drk. grayish brown. no rxn w/HCl.	
	g.s.			29.5-33.0': Gravelly Silty Sand gmS (15%G, 15%m-20%m, 70%S)	
				v.pr.srtd. unconsolidated. sub-w.rndd. v.f.-v.c. S. w/2.5Y 5/1 gray	31': g.s.
				nonplastic M. w/v.f.pbl.-sm.cbl. of 95% bslt/5% qtz > meta.	31.29: Water Table (7.23.15)
				no rxn w/HCl. slightly moist.-moist.	

Sieve #1

Reported By: A. Lanteau		Reviewed By: Kevin Bergstrom	
Title: Geo. Tech.		Title: Sr. Geologist	
Signature: A. Lanteau	Date: 7-30-15	Signature: Kevin Bergstrom	Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: 6·4·15

Well ID: C9466	Well Name: 399-1-95	Location: 300 Area N of PNNL
Project: 300-FF-5		Reference Measuring Point: Ground surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
35				33-38.0': Silty sandy Gravel | KMG sG (70-75%G 20-30%S, 5-10%m)	Sonit w/5' core barrel | x 10' long.
	g.s.			mod. srtd. v.w.rndd. v.f.-v.c. pbl. of 98% bslt. ~2% Meta. w/	36': g.s.
				v.f.-v.c. sub-ang-subrndd. S. mod. plastic, mod delatent. clayey silt.	36-46': Sieve #2
				2.5Y 5/1 Gray. Grades to fine gravels below.	
				38-39': Gravel | G (90%G, 10-5%S) trace m.	
40				v.w.srtd. v.f.-m.pbl. v.w.rndd. of 98% bslt. 2% Meta. w/f.-v.c.	
	g.s.			sub-rndd. mafic S. 2.5Y 5/1 Gray. sharp contact below.	
	sieve #2			~~39-44': AL 6.4.15~~	
				39-44': Sandy Gravel | sG (75%G 20%-30%S, 0-5%m)	42': g.s.
				mod. srtd. v.w.rndd. m.-v.c.pbl. of 70% felsic Meta > Qtz	
45				int. V. tuff / 30-20% bslt. + And. in matrix. of m-crs. sub-ang	
	g.s.			S. of Qtz-felds. w/abnt. muscovite mica, 2.5Y 5/3 H. yelwsh. brown.	
				no rxn w/HCl. grades to gravelly silt: 53-54'	46': g.s. Sieve #3: 46-50.5'
	g.s. sieve			~~44-50.5': gravelly Silt. aM / AL 6.4.15~~	48': sieve grab. (s.a).
	sieve #3			44-50.5': silty sandy Gravel | m sG (70%G, 10-15%S, 15%m)	
50	g.s.			44-49': Poorly srtd. m.pbl.-sm.cbl. max: 70mm. v.w.-	
			50.5' TD.	sub.rndd g. of 70% felsic Meta. > int. volcanics > Qtz / 30%	50.5': g.s. @ TD.
				bslt. in matrix: v.f.-m. sub-ang. S. w/intercalated layers 2-4"	
				of m-c. S. of 90% felds. Qtz. w/abnt. mica. Ox. staining	
				from 44-46. color 10YR 6/8 brownish yellow. Silt of	
				v. plastic-clayey-sticky. mod. delatency. no rxn w HCl	
				• 46-49' color: 2.5Y 5/6 yellowish brown. no rxn w/HCl	
				• 46-49': sorting improves to mod-w. srtd. f.-m-c. pbl	
				49-50.5': Color change to GLEY2 5/1 bluish	
				gray. "Anoxic zone" no rxn w/HCl.	

Reported By: A. Lontan		Reviewed By: Kevin Bergstrom	
Title: Geo. Tech.		Title: Sr. Geologist	
Signature: A. Lont	Date: 7·30·15	Signature: K. Rg	Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 6/4/2015
Finish Date: 8/5/2015
Page 1 of 1

Well ID: C9467	Well Name: 399-1-96
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/17/15
Signature: Marques Miller	Reviewed By: J.D. MEHRER
	Signature:
	Date: 10-28-15

CONSTRUCTION DATA

Surface Completion:

1.95'x1.88' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 0.95' bgs

Permanent Well:

6.75" OD PVC Blank: 0.20' - 19.88' bgs

6.75" OD PVC 0.050-slot Screen: 19.88' - 29.88' bgs

6.75" OD PVC Blank: 29.88' - 34.88' bgs

6.75" OD PVC 0.050-slot Screen: 34.88' - 44.87' bgs

6.75" OD PVC Blank: 44.87' - 48.38' bgs

Construction Materials:

Concrete: 0.0' - 2.80' bgs

Neat Grout: 2.80' - 9.94' bgs

Bentonite Chips: 9.94' - 14.10' bgs

Bentonite Seal: 14.10' - 16.70' bgs

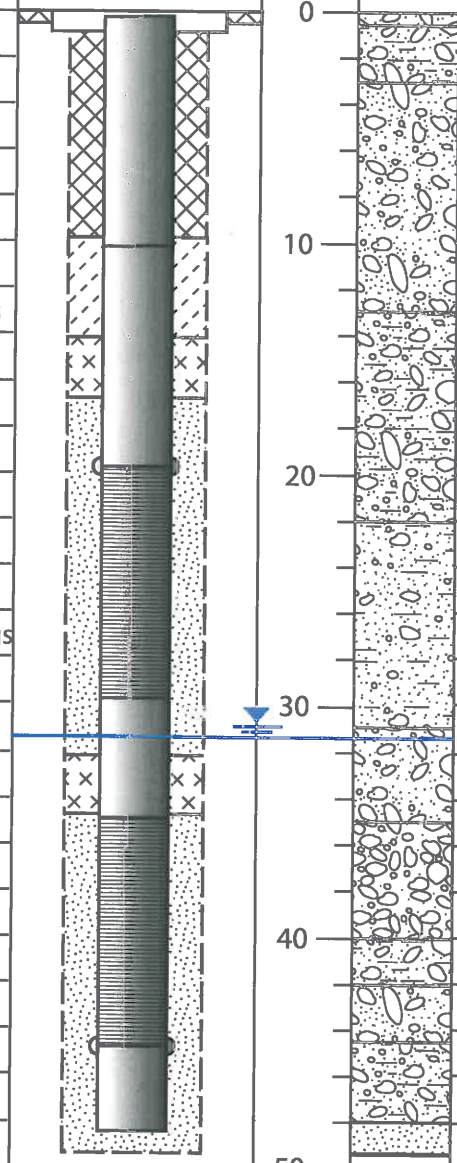
8/16 Mesh Filter Pack Sand: 16.70' - 32.18' bgs

Bentonite Seal: 32.18' - 34.83' bgs

8/16 Mesh Filter Pack Sand: 34.83' - 49.38' bgs

All temporary 10 3/4" OD casing removed 7/23/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0' - 0.5': Sandy Gravel, sG

0.5' - 3.0': Silty Sandy Gravel, msG

3.0' - 13.0': Sandy Gravel, sG

13.0' - 22.0': Silty Sandy Gravel, msG

22.0' - 31.0': Slightly Silty Gravelly Sand, (m)gs

Depth to Water: 31.35' bgs (8/5/15)

31.0' - 35.0': Sandy Gravel, sG

35.0' - 40.0': Gravel, G

40.0' - 42.0': Silty Sandy Gravel, msG

42.0' - 44.5': Sandy Gravel, sG

44.5' - 48.0': Silty Sandy Gravel, msG

48.0' - 49.38': Sand, S

Total Depth = 49.38' bgs (7/23/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 4

Date: June 4, 2015

Well ID: C9467 | Well Name: 399-1-96 | Location: N of PNNL 200 EF -5

Project: 300 EF -5 FY15 | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				0.0 (Ground surface) to 0.50 ft bgs	Drilling is being
				Formation: Unknown Backfill SG	Conducted w/ a Sonic
				5% silt 20% Sand 75% Gravel	rig
	95			Sand: fin to course 80% Mafic sub round	6" borehole
				Gravel: Angular, 70% mafic 30% felsic	
5					Borehole was
					drilled and sampled
				0.50 ft bgs to 3.00 ft bgs	then backfill w/
				Formation: Hanford (mSG)	sand. (6/4/15)
				20% silt 40% Sand 40% Gravel	
10				Sand: fine to course. Angular to sub	
				ang. Poorly sorted 40% mafic 60% felsic	5'-10'
	95			Larger grains tend to be more mafic	Low recovery
				Gravel: 2mm to ~120mm, sub round	~60 of the core
				to round. Rounding increase in relation	barrel. Driller
15				to size. ~70% mafic 30% felsic	notes low down/up
				Strong reaction to HCL	Pressure.
				2.5Y 5/1 light olive brown (damp for odor)	
					10'-20'
20				3.00 ft bgs to 13.00 ft bgs	Low recovery
	95			Formation: Hanford (SG)	~70%
				5% silt 40% Sand 55% Gravel	Low/up/down
				Sand: Medium to course grain	pressure
				sub round. Mod sort 60% Mafic	
30				Gravel: 2mm to ~8mm sub angular	20'-30'
				to sub round. Poorly sorted 60% mafic	100% recovery
				40% felsic.	
	95			Natural moisture present	30'-40'
				Mod to strong reaction to HCL (dry)	~50% recovery
35				2.5Y 4/2 Dark grayish brown (damp)	drilling/clean out
	95				was slow.
				13.00 ft to 22.00 ft	40'-50'
				Formation: Hanford (mSG)	100% recovery
40				20% Silt 30% Sand 50% Gravel	
	95			Sand: course to fine, mod to poorly	g.s = grab sample
				sorted sub angular 60% mafic	
	95			40% felsic	TD 49.38 (7-23/15)
				Gravels: 2mm to 140 mm	DTW 34.26 (7/23/15)

Reported By: Candia Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 6/4/15 | Signature: [signature] | Date: 9/16/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 4

Date: June 4 2015

Well ID: C9467 | Well Name: 399-1-96 | Location: N of PNNL

Project: 300-FF-5 | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
45	gs			sub round poorly sorted, gravels	Borehole was
				tend to be larger in the lower	driller + cased
				segment. 60% mafic 40% felsic	7-23-15 w/
	gs			Some clay present and surrounding	10" casing
				the ~~grave~~ gravels in the unit	8" core barrel
				weak plasticity.	
50			50 TD 6/4/15	strong (very) reaction to HCL (dry)	
				2.5 Y 3/2 dark grayish brown (damp)	
				Natural moisture present	
				22.00 ft bgs to 31 ft bgs (mrgs	
				Formation: (~~MSG~~) CK 6/4/15	
				10% silt 60% Sand 30% Gravel	
				Sand: very fine to course grain	
				sub angular, med sorted. 70% mafic	
				to 30% felsic	
				Gravel: 2mm to 180mm, sub angular	
				to round. 65% mafic 35% felsic	
				2.5 Y 3/1 very dark gray (damp)	
				weak to no reaction to HCL (dry)	
				The bottom .5 ft is mostly silt	
				this section of the sample was dry	
				most likely an artifact of drilling	
				not a lens.	
				* Possible rip up clast between	
				28 and 30.50 ft bgs. Clast are composed	
				of very fine grain felsic sand and	
				light colored silt. Clasts collected in	
				grab sample.	
				Segment contained natural moisture	
				31.00 ft to 35 ft bgs	
				Formation (SG)	
				5% silt 60% sand 35% Gravel	
				Sand: Coarse to fine grain, sub rounded	
				Well sorted 70% mafic 30% felsic	

Reported By: Candice Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] Date: 6/4/15 | Signature: [signature] Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 4
Date: June 4, 2015

Well ID: C9467 | Well Name: 399-1-69 | Location: N of PNNL

Project: 300-FF-5 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				31 ft to 35 ft Continued.	
				Gravel: 2mm to 40mm	
				some small cobbles (2) Poorly sorted	
				sub round to round.	
				weak to No reaction to HCL (Dry)	
				2.5 Y 4/1 dark gray (damp)	
				Moist/Wet	
				Sharp contact	
				35ft to 40 ft bgs	
				Formation: G	
				5% silt 95% Gravel	
				Gravel: Average size ~80mm	
				sub round to rounded, well sorted	
				70% mafic 30% felsic	
				2.5 Y 4/1 dark gray (damp)	
				Slight reaction to HCL (dry)	
				Wet	
				Sharp contact	
				40 ft bgs to 42 ft bgs	
				Formation: msG	
				10% silt 30% Sand 60% Gravel	
				Sand: fine to course, sub angular	
				mod. sort 60% mafic 40% felsic	
				Gravel: 20mm to 40mm sub round	
				to round. 60% mafic 40% felsic	
				weak to No reaction to HCL (dry)	
				2.5 Y 4/1 dark gray (damp)	
				Damp/Wet	
				42.00 ft to 44.50 ft bgs	
				Formation sG	
				5% silt 60% Sand 35% Gravel	
				Sand: medium grain, well sorted	
				sub round 20% mafic 80% felsic	
				~10% mica	

Reported By: Candice Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 6/4/15 | Signature: [signature] | Date: 9/10/2015

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 4
Date:

Well ID: C9467 | Well Name: 399-1-69 | Location: N of PNNL

Project: 300-FF-5 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				42.00 ft to 44.5 ft Continued	
				Gravel: 2mm to 140mm sub round	
				40% mafic 60% felsic	
				weak reaction to HCL (dry)	
				2.5Y 5/4 light olive brown (damp)	
				Wet	
				Sharp contact	
				44.50 ft to 48.00 ft bgs (MSC)	
				30% silt 30% sand 40% gravel	
				Sand: fine grain, well sorted	
				rounded, large flakes of mica	
				20% mafic 80% felsic	
				Gravel: 2mm to 100mm sub angular	
				to sub round. 40% mafic to 60%	
				felsic	
				Slight reaction to HCL (dry)	
				GLEY 2 3/1 very dark bluish gray	
				Wet.	
				Silt has Low Plasticity.	
				Sharp contact	
				48.00 to 50.00 ft bgs	
				Formation (S)	
				100% Sand	
				Sand: medium grain well sorted	
				well rounded. High mica content	
				20% mafic 80% felsic	
				No reaction to ~~Brett~~ CKBWAS HCL (dry)	
				2.5Y 5/4 light olive brown (damp)	
				Wet	
				(sorting may be caused by drilling	
				method).	

Reported By: Candice Kildall | Reviewed By: Kevin Bergstrom

Title: Geologist | Title: Sr. Geologist

Signature: [signature] Date: 7/4/15 | Signature: [signature] Date: 9/10/2015

A-6003-642 (03/03)

WELL SUMMARY SHEET

Start Date: 7/27/2015
Finish Date: 8/6/2015
Page 1 of 1

Well ID: C9468	Well Name: 399-1-97
Location: 300 Area N of PNNL	Project: 30 Monitoring/Injection Wells in 300-FF-5 OU
Prepared By: Marques Miller	Date: 9/17/15
Signature: Marques Miller	Reviewed By: J.D. MEHRER
	Date: 10-28-15
	Signature:

CONSTRUCTION DATA

Surface Completion:

1.88'x1.90' Flush mount concrete pad w/brass survey marker.

13 1/2" OD Protective Monument: 0.0' - 1.0' bgs

Permanent Well:

6.75" OD PVC Blank: 0.20' - 19.90' bgs

6.75" OD PVC 0.050-slot Screen: 19.90' - 29.90' bgs

6.75" OD PVC Blank: 29.90' - 34.90' bgs

6.75" OD PVC 0.050-slot Screen: 34.90' - 44.90' bgs

6.75" OD PVC Blank: 44.90' - 48.42' bgs

Construction Materials:

Concrete: 0.0' - 1.0' bgs

Neat Grout: 1.0' - 9.76' bgs

Bentonite Chips: 9.76' - 13.87' bgs

Bentonite Seal: 13.87' - 16.90' bgs

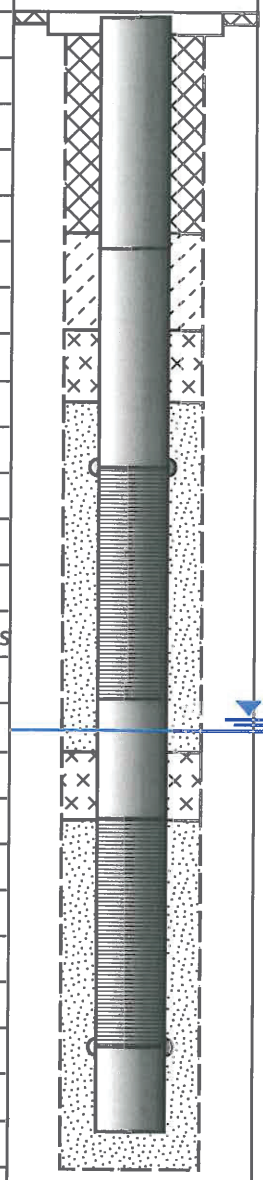
8/16 Mesh Filter Pack Sand: 16.90' - 32.0' bgs

Bentonite Seal: 32.0' - 34.92' bgs

8/16 Mesh Filter Pack Sand: 34.92' - 50.0' bgs

All temporary 10 3/4" OD casing removed 7/28/15.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0.0' - 0.5': Gravel Drill Pad, G

0.5' - 16.0': Sandy Gravel, sG

16.0' - 39.5': Silty Sandy Gravel, msG

Depth to Water: 31.05' bgs (8/6/15)

39.5' - 44.80': Sandy Gravel, sG

44.80' - 50.0': Gravelly Silty Sand, gmS

Total Depth = 50.0' bgs (7/28/15)

OD = outside diameter

bgs = below ground surface

Centralizers: top of sump & bottom of last blank riser.

A-6003-643 (REV 1)

BOREHOLE LOG

Page 1 of 2

Date: July 27, 2015

Well ID: C9468 ~~C9468~~ CE 9/22/15

Well Name: 399-1-97

Location: 300 Area N of PNNL

Project: 30 wells 300-FF-5 CE 7-27-15 FY15

Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0				0.00 ft (ground surface) to 0.50 ft Drill pad / backfill	Injection well
	g.s	50% recovery		0.50 ft to 16.00 ft bgs SG ~~mSG~~ Formation: 10% silt 40% Sand 50% Gravel Sand: fine to medium grain. mod. sorting, sub angular ~60% mafic 40% felsic Gravel: 2mm to ~200 mm Angular to round. very poorly sorted. ~60% mafic 40% felsic very weak reaction to HCl 2.5Y 3/2 very dark grayish brown Dry graded contacts upper/lower	Drilling is being conducted with an a 7-27-15 Sonic 150 CC
5	g.s				g.s = grab sample. Grab samples are collected every 5 ft and place in Pint jars and Chip trays.
10	g.s	70% recovery			
15	g.s			16.00 ft to 39.50 ft bgs (m)SG Formation: 15% silt 35% Sand 50% Gravel Sand: fine to very coarse, very poorly sorted. Angular. the majority ~60% of the sand is coarse to very coarse. ~60% mafic 40% felsic Gravel: 2mm to ~150 mm. Some larger cobble (less than 1%) sub round to well round for gravel over ~50mm. Gravels are very poorly sorted w/the majority >50 mm smaller gravels tend to be more angular. Wet reaction to HCl moist to wet 2.5Y 3/2 very dark grayish brown	
20	g.s	90% recovery			
25	g.s				Recovery: 0-10 50%; 10-20 70%; 20-30 90%; 30-40 75%; 40-50% 100%
30	g.s	75% recovery			
35 ~~30~~ KAB	g.s			@ 25.00 ft to 25.30 ft there is a gravel lens average size ~50mm well rounded	TD 50.00 ft bgs DWT 36.85 ft bgs.
				@ 28.00 ft to 28.70 ft there is →	

Reported By: Candice Burnette Kildall

Title: Geologist

Signature: [signature] Date: 7/28/15

Reviewed By: B.A. WILLIAMS

Title: SR. GEOLOGIST

Signature: [signature] Date: 9/22/15

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2

Date: July 28, 2015

Well ID: C9468 | Well Name: 399-1-97 | Location: 300 Area N of PNNL

Project: 30 wells 300FF-5 FY15 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40		~100% recovery		a silty (~20) gravel lens	Injection well
				gravels a ~50mm well rounded	
	g.s			~~(m) silt~~ silt has low to med. plasticity	Drilling is being
				~~FOTS 5-28-15~~	conducted with a
				~~@ 38.00 to~~ 38.00 to 38.50 ft	Terrasonic 150 CC
45				there is a gravel lens ~75mm	10" casing
				gravels, well rounded.	8" X 10' core barrel
	g.s wood				
					g.s = grab sample
				39.50 ft to 44.80 ft bgs SG	
50				Formation ~~Ringold~~ Ringold	
				10%m 60%s 30% gravel	
				Sand: med grain, well sorted	
				rounded. ~20% mafic 80% felsic	
				Gravel: 2mm to 30mm, mod/poor	
				sorting sub round to well round	
				40% mafic 60% felsic	
				No reaction to HCL	
				10YR 6/3 Pale brown	
				wet: graded upper/sharp lower contact	
				44.80 to 50.00 ft bgs (g)mS	
				15% silt 60% Sand 25% gravel	Wood found @
				Sand: well sorted med grain	~48 ft bgs. Some
				rounded. Large flakes of mica	of the chunk were
				20% mafic 80% felsic	collected and placed
				Gravel: 2mm to 20mm sub-round	in a pint jar with
				~40% mafic to 60% felsic	the Archive samples.
				Wood found in the last ~~two~~ CS 7-20-15	
				two feet: chunks are ~100mm X 50mm	
				No reaction to HCL	
				2.5Y 2.5/1 black	
				wet	

Reported By: Candice Burnette Kildall | Reviewed By: R.D. Williams

Title: Geologist | Title: Sr. Geologist

Signature: [signature] | Date: 7/28/15 | Signature: [signature] | Date: 9/22/15

A-6003-642 (03/03)

SURVEY DATA REPORT

Request No. 154-161			
Project No.	Title: 300-FF-5 Wells Final Surveys		File No. 3AT10R28
Job. No. CACN: 303500-JPRC	Prepared By: N.P. Fastabend	Date: 8/11/15	Reviewer: LBM

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casings) and elevations of 30 completed 300-FF-5 flush mount wells located on north side of 300 Area.	Survey File	OR		
	E.C. Rafuse	1		
	S.J. Trent	1		
	K.M. Whitley	1		
	J.B. Geiger	1		
Horizontal Coordinate System: WCS83S/91 (Meters)	B.J. Howard	1		
Vertical Datum: NAVD88 (Meters)	A.J. Green	1		

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheets

A-6006-495 (REV 0)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9460 (399-1-89) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9460	399-1-89	594087.17	116467.59		Center of Casing
				114.842	"X" on Rim
				114.839	Brass Survey Marker

Notes:

114.698 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9461 (399-1-90) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9461	399-1-90	594102.77	116478.21		Center of Casing
				114.942	"X" on Rim
				114.949	Brass Survey Marker

Notes:

114.812 Top Inner 6in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9462 (399-1-91) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9462	399-1-91	594118.24	116489.07		Center of Casing
				115.012	"X" on Rim
				115.014	Brass Survey Marker

Notes:

114.874 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9463 (399-1-92) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9463	399-1-92	594132.82	116466.66		Center of Casing
				115.070	"X" on Rim
				115.071	Brass Survey Marker

Notes:

114.943 Top Inner 6in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9464 (399-1-93) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9464	399-1-93	594116.97'	116470.77'		Center of Casing
				115.047'	"X" on Rim
				115.050' *	Brass Survey Marker

Notes:

114.911' Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

* BRASS MARKER LOOSE - LBM

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9465 (399-1-94) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9465	399-1-94	594130.80	116479.65		Center of Casing
				115.033	"X" on Rim
				115.032	Brass Survey Marker

Notes:

114.882 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9466 (399-1-95) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9466	399-1-95	594143.85	116488.32		Center of Casing
				114.833	"X" on Rim
				114.834	Brass Survey Marker

Notes:

114.707 Top Inner 6in PVC Casing,North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9467 (399-1-96) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9467	399-1-96	594146.20	116473.85		Center of Casing
				114.836	"X" on Rim
				114.838	Brass Survey Marker

Notes:

114.673 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 08/04/15	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 08/10/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C9468 (399-1-97) located on north side of 300 Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 300A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9468	399-1-97	594157.77	116480.09		Center of Casing
				114.759	"X" on Rim
				114.762	Brass Survey Marker

Notes:

114.546 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

8-11-15

A-6003-659 (04/03)