

# Borehole Summary Report for the Installation of One Monitoring Well and One Borehole

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**

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**APPROVED**  
*By Janis Aardal at 9:46 am, Jul 18, 2016*

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Release Approval

Date

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## Contents

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
1.1	Purpose and Scope.....	1
<b>2</b>	<b>Drilling, Sampling, and Well Construction Activities.....</b>	<b>3</b>
2.1	General Information .....	3
2.1.1	Drilling, Sampling and Borehole Logging.....	3
2.1.2	Health and Safety Screening .....	3
2.1.3	Well Construction and Borehole Decommissioning.....	3
2.2	Well-Specific Information.....	4
2.2.1	C9516 (299-W22-118).....	4
2.2.2	C9520 (299-W22-122).....	5
<b>3</b>	<b>Geologic Observations .....</b>	<b>9</b>
3.1	Geology of the 200-WA-1.....	9
3.2	Borehole Geology.....	9
3.2.1	C9516 (299-W22-118).....	10
3.2.2	C9520 (299-W22-122).....	10
<b>4</b>	<b>Waste Management.....</b>	<b>11</b>
<b>5</b>	<b>Civil Survey .....</b>	<b>12</b>
<b>6</b>	<b>Well Acceptance .....</b>	<b>13</b>
<b>7</b>	<b>References .....</b>	<b>14</b>

## Tables

Table 1. Well Identification Tag and Drilling Dates.....	4
Table 2. C9516 Sample Data .....	5
Table 3. C9516 Borehole Decommissioning Details.....	5
Table 4. C9520 Sample Data .....	5
Table 5. Well Construction Material.....	7
Table 6. Civil Survey Summary.....	12

## Figure

Figure 1. Location Map for the 200-WA-1 OU Well .....	2
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## Appendices

<b>A</b> Well Documentation for 299-W22-118 (C9516) .....	<b>A-i</b>
<b>B</b> Well Documentation for 299-W22-122 (C9520) .....	<b>B-i</b>

## Terms

bgs	below ground surface
CCU	Cold Creek Unit
CHPRC	CH2M HILL Plateau Remediation Company
DOE	U. S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ft	foot/feet
HEIS	Hanford Environmental Information System
ID	identification
in	inch(es)
OD	outer diameter
OU	operable unit
PVC	polyvinyl chloride
RCT	radiological control technician
RWP	radiological work permit
SAP	sampling and analysis plan
TD	total depth

## Metric Conversion Chart

<b>Into Metric Units</b>			<b>Out of Metric Units</b>		
<i>If you know</i>	<i>Multiply by</i>	<i>To get</i>	<i>If you know</i>	<i>Multiply by</i>	<i>To get</i>
<b>Length</b>			<b>Length</b>		
inches	25.4	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.35	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.69	kilometers	kilometers	0.621	miles
<b>Area</b>			<b>Area</b>		
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	0.45	hectares	hectares	2.471	acres
<b>Mass (weight)</b>			<b>Mass (weight)</b>		
ounces (avoir)	28.349	grams	grams	0.0353	ounces
pounds	0.454	kilograms	kilograms	2.25	pounds
tons (short)	0.97	ton (metric)	ton (metric)	1.12	tons (short)
<b>Volume</b>			<b>Volume</b>		
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	1.38	cubic yards
gallons	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
<b>Radioactivity</b>			<b>Radioactivity</b>		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

# 1 Introduction

The report is to serve as an overview of the activities that took place during the drilling, sampling, and construction/decommissioning of one borehole and one monitoring well in the 200-WA-1 Operable Unit (OU). The installation of both the borehole and well supports Ecology et al., (1989), *Hanford Federal Facility Agreement and Consent Order*, and will be in compliance with requirements of the *Resource Conservation and Recovery Act of 1976* as well as the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*. The installation of the borehole and well included well drilling, soil sampling, and well-construction in accordance with DOE/RL-2010-88, *Sampling and Analysis Plan for the Uranium Sequestration Pilot Test (SAP)*.

Borehole 299-W22-118 (C9516) and well 299-W22-122 (C9520) were drilled, sampled, constructed, and decommissioned between August 18, 2015 and March 3, 2016. Drilling was conducted by Stillwater LLC, geologic support was provided by TerraGraphics Environmental Engineering and PBS Engineering and Environmental Services, and Stoller Newport News Nuclear conducted geophysical logging.

## 1.1 Purpose and Scope

The purpose of this document is to compile field records and summarize observations and measurements made during the drilling of two boreholes and construction of one well within the 200-WA-1 OU. This borehole summary report includes the field notes and forms prepared during the drilling and construction of the well, well construction details, and well development data. Additional information provided in the report includes descriptions of the subsurface geology encountered at the well, results of the well location and elevation civil survey, descriptions of the management and disposition of drilling-derived waste, and a summary of the well acceptance activity.

The location the C9516 and C9520 boreholes are in the 200 West Area of the Hanford Site (Figure 1). The 200 West Area is home to the S Plant, T Plant, U Plant, and the Plutonium Finishing Plant. The plants produced waste that was disposed to cribs, ditches, trenches and waste ponds. The disposal method allowed for contamination to enter the vadose zone and in some places the groundwater. One such disposal site was the 216-U-8 Crib. The crib is located just south of U Plant and has received waste from both the U Plant and S Plant. The 216-U-8 Crib was chosen for DOE/RL-2010-87, *Field Test Plan for the Uranium Sequestration Pilot Test*, based on previous characterization of the area. The primary purpose of DOE/RL-2010-87 is to decrease the mobility of uranium and other such constituents in the vadose zone around the 216-U-8 Crib waste site.

Appendices A (C9516) and B (C9520) contain the well summary sheet, borehole geologic log, photographic log, well survey report, and geophysical logs for each boring.

CHPRC procedures governing the drilling, geologic logging, well construction, and well development activities are listed in Section 7.0 of this document.

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

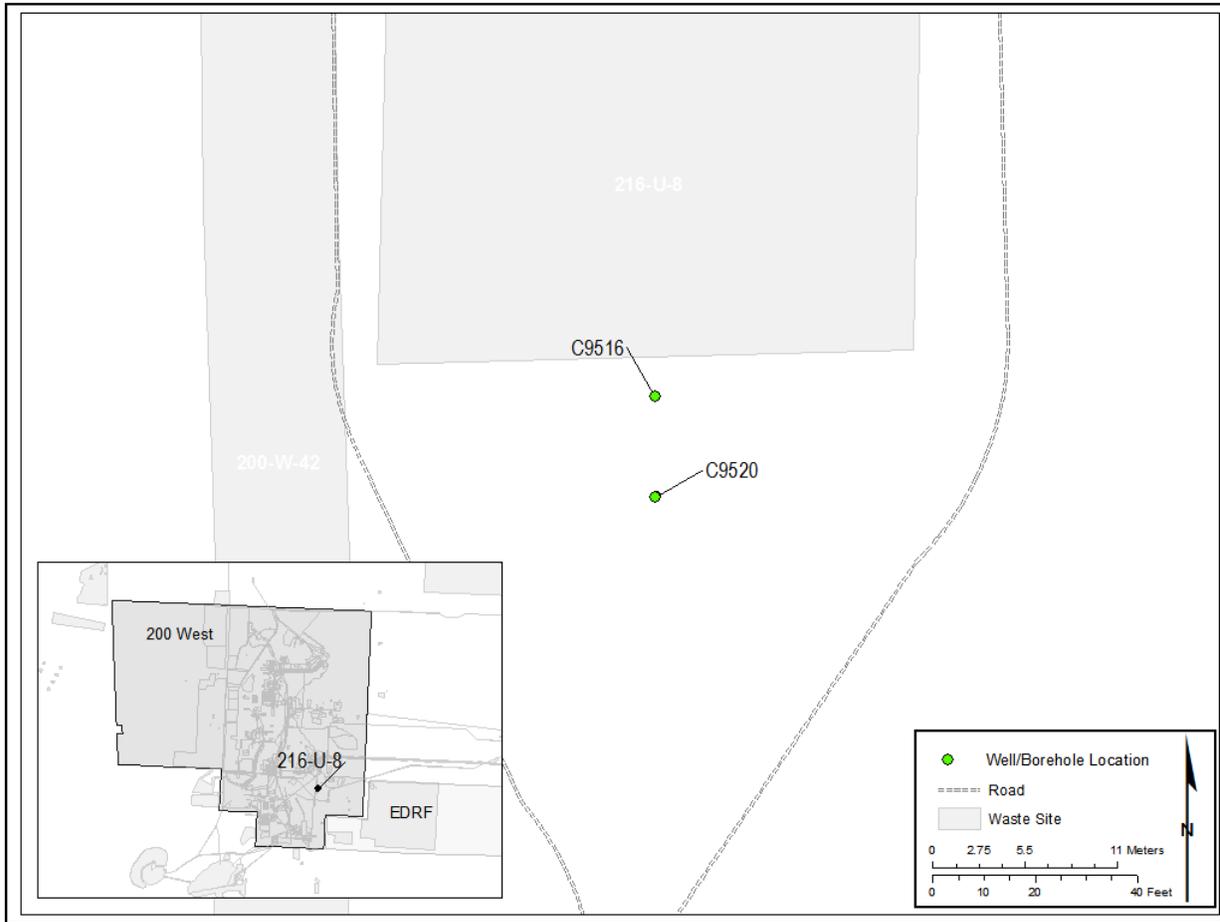


Figure 1. Location Map for the 200-WA-1 OU Well

## 2 Drilling, Sampling, and Well Construction Activities

This section summarizes of the field activities that took place on C9516 and C9520.

### 2.1 General Information

Stillwater LLC used a Bucyrus Erie 22W three series cable tool rig for the drilling, sampling, and construction/decommissioning of C9516 and C9520. The temporary casing used for the drilling of both boreholes was 8.625-inch (in) outer diameter and 7.625-in inner diameter carbon steel casing. Drilling was conducted with a 4-in drive barrel from ground surface to the total depth (TD) of each borehole.

#### 2.1.1 Drilling, Sampling and Borehole Logging

**Drilling** – Drilling planned in this stage included the drilling, soil characterization and installation of one vapor injection well. Due to a pair of complications that arose during the drilling process, one monitoring well was installed at a second location. The first complication was that the initial drilling location (C9516) encountered greater than anticipated radiological levels. This made sample collection and shipping unfeasible, and C9516 was decommissioned. After C9516 was decommissioned, the drill rig was moved approximately 20 feet (ft) south and C9520 was drilled. C9520 was planned to proceed as an injection well to replace C9516. However, due to the well parting during construction, it was deemed more suitable that C9520 would be used as a monitoring well.

**Sampling** – Sampling was conducted in accordance with the SAP (DOE/RL-2010-88). Sampling included continuous split spoon samples starting at approximately 30 ft below ground surface (bgs) for both boreholes as well as one grab sample for waste characterization. No archive samples were collected due to radiological reading of the drill cuttings.

**Geophysical Logging** – Geophysical logging was conducted by Stoller Newport News Nuclear. Logging included Spectral Gamma Logging System, High Rate Logging System and Neutron Moisture Logging System. More detailed information about geophysical logging can be found under well specific information in Appendix C.

#### 2.1.2 Health and Safety Screening

**Radiological Field Screening** – Radiological field screening was conducted under radiological work permit (RWP) GW-056, Rev. 5, which called for full time coverage. The full time radiological control technician (RCT) provided screening on all of the drill cuttings and samples collected during the project. In addition to checking drill cuttings, the RCT checked and labeled all of the casing that was used in the drilling, construction, and decommissioning processes. A secondary full time RCT was on-site to provide radiological support of all on-site personnel.

**Air Monitoring for Volatile Chemicals** – Air monitoring was performed twice daily. These twice daily checks were performed in the morning and afternoon. This type of check will be referred to as AM/ PM check. All check were below action levels for the duration on the project.

#### 2.1.3 Well Construction and Borehole Decommissioning

**Casing Materials** – C9520 was constructed using 2-in diameter, Schedule 40 polyvinyl chloride (PVC) blank risers. The well was provided by Pacific Northwest National Laboratory, and was pre-designed with gas samplers, thermistors, and electrodes attached to the outside of the well. In addition to the gas samplers, thermistors, and electrodes, there was a series of cables and tubes, which will act as sample

ports, at ground surface. The gas samplers, thermistors, electrodes, and cables were attached using stainless steel zip ties and PVC tape.

**Well Completion** – The well was set using alternating pours of fine grain, 100 mesh sand, and 200 mesh sand. The sand was preceded by cement surface seal, the seal was composed of Type I-II Portland cement. A flush mount vault was used to complete the well.

**Decommissioning** – C9516 was decommissioned from TD to ground surface. Bentonite chips were used from the TD of 35.5 ft bgs to 2.2 ft bgs. A surface seal of concrete was placed from 2.2 ft bgs to ground surface. A brass marker, noting the borehole name, well ID, and date, was placed on the surface seal.

**Washington State Department of Ecology Well Identification** – The Washington State Department of Ecology tag was placed in the concrete surrounding the well vault. A list of the identification numbers can be found in Table 1

Table 1. Well Identification Tag and Drilling Dates

Well Name	Well ID	Drilling / Construction Date		Ecology Tag ID
		Start	Finish	
299-W22-118	C9516	August 18, 2015	August 26, 2015	N/A
299-W22-122	C9520	August 27, 2015	March 3, 2016	BAC 453

Ecology = Washington State Department of Ecology

N/A = not applicable

## 2.2 Well-Specific Information

This section provides specific dates, depths, construction details, and sample information, by individual well.

### 2.2.1 C9516 (299-W22-118)

Drilling was initiated on August 18, 2015 and the borehole was decommissioned to ground surface on August 26, 2015. The borehole was drilled from ground surface to 29.96 ft bgs. Continuous split spoon sampling was conducted from 29.96 ft to 35.40 ft bgs, where drilling and sampling activities were concluded, due to elevated radiological levels. The higher-than-anticipated readings voided the limits of RWP GW-056, Rev. 5, which made drilling operations unfeasible at that location. It was determined that the best course of action would be to decommission the borehole and resume drilling in a new location. On August 26, 2015 the borehole was decommissioned.

Sampling was conducted between August 19 and August 20, 2015. The sample method used was split spoon. The 2.5-ft-long split spoons were lined with four 0.5-ft-long Lexan liners per split spoon. The sampling was conducted by CHPRC nuclear chemical operators in compliance with CHPRC procedures and training. Sample dates and Hanford Environmental Information System (HEIS) numbers can be found in Table 2.

Decommissioning of C9516 was conducted on August 26, 2015: bentonite chips were placed from 35.5 ft bgs to 2.2 ft bgs; a ground surface a concrete surface seal was poured from 2.2 ft bgs to 0.0 ft bgs. After the surface seal was poured, a brass maker with the well name, well ID, and date of decommissioning was placed in the concrete surface seal. See Table 3 for decommissioning details.

Table 2. C9516 Sample Data

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
8/19/2015	29.96-32.46	Sandy Gravel	Split Spoon	B32FV9, B32FW0, B32FW1
8/20/2015	32.90-35.40	Sand	Split Spoon	B32FW2, B32FW3, B32FW4, B32FW5

ft bgs = ft bgs

HEIS = Hanford Environmental Information System

Table 3. C9516 Borehole Decommissioning Details

Well Name	Well ID	Date	Bentonite Chips (ft bgs)	Concrete Surface Seal (ft bgs)
299-W22-118	C9516	August 26, 2015	35.5 to 2.2	2.2 to 0.0

ft bgs = ft bgs

### 2.2.2 C9520 (299-W22-122)

Drilling was initiated on August 27, 2015. The borehole was drilled from ground surface to a TD of 81.0 ft bgs. Continuous split spoon sampling was conducted from 29.7 ft bgs to 80.1 ft bgs. Upon the completion of the split spoon sampling, drilling activities were paused to allow for lab testing of the sampled material. Table 4 contains sampling details.

Table 4. C9520 Sample Data

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
9/01/2015	29.70-32.20	Sandy Gravel	Split Spoon	B32H48, B32H49, B32H50, B32H51
9/02/2015	32.40-34.90	Gravelly Sand	Split Spoon	B32H52, B32H53, B32H54, B32H55
9/03/2015	34.40-36.90	Gravelly Sand	Split spoon	B32H56, B32H57, B32H58, B32H59
9/03/2015	35.50-36.50	Gravelly Sand	Grab Sample for waste characterization	B32KB2, B32KB3, B32KB4
9/08/2015	36.50-39.00	Gravelly Sand	Split Spoon	B32H60, B32H61, B32H62, B32H63
9/08/2015	39.00-41.50	Gravelly Sand	Split Spoon	B32H64, B32H65
9/09/2015	41.40-43.90	Gravelly Sand	Split Spoon	B32H68, B32H69, B32H70, B32H71
9/09/2015	43.70-45.70	Gravelly Sand	Split Spoon	B32H72, B32H73, B32H74, B32H75
9/10/2015	45.70-48.20	Gravelly Sand	Split Spoon	B32H76, B32H77, B32H78, B32H79
9/10/2015	47.90-50.40	Gravelly Sand	Split Spoon	B32H80, B32H81, B32H82, B32H83
9/10/2015	50.70-53.20	Gravelly Sand	Split Spoon	B32H84, B32H85, B32H86, B32H87

Table 4. C9520 Sample Data

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
9/14/2015	53.00-55.50	Gravelly Sand	Split Spoon	B32H88, B32H89, B32H90, B32H91
9/15/2015	55.20-57.70	Gravelly Sand	Split Spoon	B32H92, B32H93, B32H94, B32H95
9/15/2015	57.40-59.90	Gravelly Sand	Split Spoon	B32H96, B32H97, B32H98, B32H99
9/15/2015	60.50-63.00	Gravelly Sand	Split Spoon	B32HB0, B32HB1, B32HB2, B32HB3
9/15/2015	62.60-65.10	Gravelly Sand	Split Spoon	B32HB4, B32HB5, B32HB6, B32HB7
9/16/2015	64.70-67.20	Gravelly Sand	Split Spoon	B32HB8, B32HB9, B32HC0, B32HC1
9/16/2015	68.10-70.60	Gravelly Sand	Split Spoon	B32HC2, B32HC3, B32HC4, B32HC5
9/16/2015	69.90-72.40	Gravelly Sand	Split Spoon	B32HC6, B32HC7, B32HC8, B32HC9
9/17/2015	72.70-75.20	Gravelly Sand	Split Spoon	B32HD0, B32HD1, B32HD2, B32HD3
9/17/2015	74.90-77.40	Gravelly Sand	Split Spoon	B32HD4, B32HD5, B32HD5, B32HD6
9/17/2015	77.60-80.10	Gravelly Sand	Split Spoon	B32HD0, B32HD0, B32HD0, B32HD0

ft bgs = ft bgs

HEIS = Hanford Environmental Information System

Sampling was conducted between September 1 and September 15, 2015. The sample method used was split spoon. The 2.5-ft-long split spoons were lined with four Lexan liners, each 0.5 ft in length. The sampling was conducted by CHPRC nuclear chemical operators in compliance with CHPRC procedures and training. Sample dates and HEIS numbers can be found in Table 4.

Well construction started on November 9, 2015. A 4-in outer diameter (OD) PVC well was set at 80.95 ft bgs. After the well was set, the well design called for neat grout as the annular material from 81 ft bgs to 54 ft bgs. During the placement of the neat grout, a bridge formed in the bottom of the temporary casing. As the bridge of neat grout dried, it hardened, causing the construction activities to pull apart the PVC well at approximately 65 ft bgs. Work was stopped in order to determine the best course of action for the project.

On January 13, 2016, the best course of action was determined to be the removal of the 4-in PVC well. The 4-in PVC well was drilled out using the cable tool rig. The borehole was drilled back down to a TD of 81.0 ft bgs, using 8.625 in outer diameter carbon steel temporary casing. No samples were collected in the re-drilling process. The drill cuttings were monitored to ensure that the majority of the 4-in PVC well was being retrieved as a part of the drilling process.

The 4-in planned injection well was replaced with a 2-in OD monitoring well. The 2-in monitoring well was constructed using a series of Schedule 40 PVC blank risers with gas samplers, thermistors, and electrodes attached to the outside. Well construction for the 2-in monitoring well started on February 24, 2016. The borehole was backfilled with 200 mesh sand from 81.0 ft bgs to 73.15 ft bgs. The well was set from 73.15 ft bgs to 0.6 ft bgs. The annular material consisted of alternating layers of 100 mesh sand and 200 mesh sand from 73.15 ft bgs to 10.4 ft bgs, and with a neat grout seal from 10.4 ft bgs to 2.0 ft bgs. A concrete surface seal was placed in a flush mount configuration. See Table 5 for well construction details.

Table 5. Well Construction Material

Annular Material	Lower Depth (ft bgs)	Upper Depth (ft bgs)	Gas Samplers	Thermistor	Electrode
200 Mesh Sand	81.00	70.65	--	--	72.35
100 Mesh Sand	70.65	69.95	--	--	--
200 Mesh Sand	69.65	66.90	--	67.85	69.35
100 Mesh Sand	66.90	65.15	--	--	66.35
200 Mesh Sand	65.15	64.15	--	--	--
100 Mesh Sand	64.15	62.75	--	--	63.35
200 Mesh Sand	62.75	61.15	61.85	61.85	
100 Mesh Sand	61.15	59.60	--	--	60.35
200 Mesh Sand	59.60	57.85	--	--	--
100 Mesh Sand	57.85	56.60	--	--	57.35
200 Mesh Sand	56.60	55.15	55.85	55.85	--
100 Mesh Sand	55.15	53.40	--	--	54.35
200 Mesh Sand	53.40	50.45	--	52.85	51.35
100 Mesh Sand	50.45	49.05	49.85	49.85	--
200 Mesh Sand	49.05	47.45	--	--	48.35
100 Mesh Sand	47.45	46.15	--	46.85	--
200 Mesh Sand	46.15	44.45	--	--	45.35
100 Mesh Sand	44.45	43.05	43.85	43.85	--
200 Mesh Sand	43.05	41.50	--	--	42.35
100 Mesh Sand	41.50	38.45	--	--	39.35
200 Mesh Sand	38.45	37.05	37.85	37.85	--
100 Mesh Sand	37.05	35.50	--	--	36.35
200 Mesh Sand	35.50	34.15	--	--	--
100 Mesh Sand	34.15	32.40	--	--	33.35
200 Mesh Sand	32.40	29.35	--	31.85	30.35

Table 5. Well Construction Material

<b>Annular Material</b>	<b>Lower Depth (ft bgs)</b>	<b>Upper Depth (ft bgs)</b>	<b>Gas Samplers</b>	<b>Thermistor</b>	<b>Electrode</b>
100 Mesh Sand	29.35	27.97	--	--	--
200 Mesh Sand	27.97	10.40	--	--	27.35
Neat Grout	10.40	2.00	--	--	--
Concrete	2.00	Ground Surface	--	--	--

ft bgs = ft bgs

### 3 Geologic Observations

This section summarizes the geology found in the 200-WA-1-OU.

#### 3.1 Geology of the 200-WA-1

The 200-WA-1 OU is located on the 200 West Area of the Hanford site, and includes most waste sites located in the 200 West Area. Surface elevations range between 600 ft to more than 700 ft above mean sea level. Columbia River Basalt Group and a sequence of overlying sediments comprise the local geology. The overlying sediments are approximately 564 ft thick and primarily consist of the Ringold Formation, Cold Creek Unit (CCU), and Hanford formation. These geologic formations are located above the basalt bedrock and consist of the following sedimentary units; not all of these may be present at any one location (in descending sequence):

- Sand and gravel backfill/disturbed surface sediments
- Sand and gravel of the Hanford formation
- Fine-grained silt and caliche of the CCU
- Sand and gravel of the Ringold Formation unit E (unit E)
- Fine-grained Ringold Formation lower mud unit
- Sand and gravel of Ringold Formation unit A (unit A)

Depending on proximity to former facilities and/or remediation sites, the ground surface of the 200 Areas has been extensively disturbed by grading, construction, and demolition work. Disturbed sediments can extend more deeply, but in general range from 1 to 15 ft bgs in disturbed areas. Underlying any Holocene deposits, the Hanford formation is a Pleistocene, cataclysmic flood and interflood deposit resulting from the Missoula Floods 15,000 to 12,000 years ago. The Hanford formation can be loosely divided into three facies associations: gravel-dominated, sand-dominated, and interbedded sand- and silt-grained lithofacies (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments within the Central Pasco Basin*). The gravel-dominated Hanford formation is highly basaltic, ranging from approximately 50% to 80% basalt (DOE/RL-2002-39). The sand-dominated facies of the Hanford formation consist of relatively thick, predominantly horizontally laminated, loose, basalt rich, fine- to coarse-grained sand, with an average of about 50% mafic and 50% quartz-feldspar composition. This gives the Hanford formation its characteristic “salt and pepper” appearance (DOE/RL-2002-39). The lower portion of the Hanford formation may contain several thin, fine-grained silty lenses.

Disconformably underlying the Hanford formation, the CCU includes the sedimentary sequence that also disconformably overlies the Ringold Formation. The CCU includes those deposits formerly referred to as the “Plio-Pleistocene unit” and “pre-Missoula Gravels,” as well as the “early Palouse soil” and “caliche” within the 200 West Area, and is not expected to be encountered during this project. The Ringold Formation comprises the deepest portion of the sedimentary sequence, disconformably underlies the CCU, overlies the basalt bedrock, and is not expected to be encountered during this project.

#### 3.2 Borehole Geology

This section serves as a summary of the geology noted at the time of drilling. The boreholes were logged in accordance with CHPRC procedure SGRP-PRO-EN-60025 (GRP-EE-01-7.0), *Geologic Logging*, by the field geologist. The boreholes can be found in the corresponding appendices.

### 3.2.1 C9516 (299-W22-118)

C9516 was drilled from ground surface to a TD of 35.5 ft bgs. The primary formation of this borehole was Hanford formation. The borehole log was created by field geologist observations of the sleeved drill cuttings and split spoon samples. Due to the nature of such observations, no hydrochloric acid was used in the logging of this borehole.

From ground surface to 8 ft bgs was silty sandy gravel of backfill/disturbed Hanford formation. Of note for this section was the slight moisture starting at approximately 3 ft bgs. From 8 ft bgs to 25.5 ft bgs was medium grain, well sorted sand with some natural moisture present. Starting at 25.5 ft bgs to 32.2 ft bgs there was sandy gravel. The sand was coarse grain and poorly sorted. The gravels ranged from small to large and were sub-rounded to rounded. At 32.2 ft bgs, the cuttings shifted back to well-sorted sand. The sand was found from 32 ft bgs to the TD of the borehole, at 35.5 ft bgs.

### 3.2.2 C9520 (299-W22-122)

C9520 was drilled from ground surface to a TD of 81 ft bgs. The primary formation of this borehole was Hanford formation. The borehole log was created by the field geologist observation of the sleeved drill cuttings and split spoon samples. Due to the nature of such observations, no hydrochloric acid was used in the logging of this borehole.

Backfill/ disturbed Hanford formation, encountered from ground surface to 6 ft bgs, was composed of sandy gravel. The lower contact grades over 3 ft to the sand-dominated Hanford formation below. The sand was encountered from 9 ft bgs to 24.5 ft bgs, medium- to coarse-grained, moderately sorted, and had natural moisture present. From 24.5 ft bgs to 31 ft bgs, sandy gravel was encountered: mafic dominated, sub-angular to rounded, and in a matrix of medium to coarse grain sand. At 31 ft bgs to the TD of the borehole, gravelly sand was encountered. The sand was fine to coarse grain and moderately sorted. There was natural moisture recorded at 70 ft bgs.

## 4 Waste Management

Waste generated during the drilling of the C9516 and C9520 was managed in accordance with DOE/RL-2015-46, *Waste Control Plan for the 200-WA-1 Uranium Sequestration Pilot Test*. This waste management plan establishes the requirements for the management and disposal of waste associated with boreholes C9516 and C9520. Investigation-derived waste generated throughout the scope of this project included vadose zone drill cuttings and miscellaneous solid waste such as sampling equipment, plastic, paper, and personal protective equipment.

All drilling cuttings were sleeved as they came out of the drive barrel and placed in drums. The drums were stored in an on-site radiological material area as well as the drilling tools that came in contact with the soil. This waste was disposed of at the Environmental Restoration Disposal Facility.

## 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*. 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 6 and the reports are located in the Appendices.

Table 6. Civil Survey Summary

Well ID Number	Well Name	Northing <sup>a</sup> (m)	Easting <sup>a</sup> (m)	Brass Survey Marker Elevation <sup>b</sup> (m)	Top of Casing <sup>b,c</sup> Elevation (m)
C9516	299-W22-118	134669.04	567616.16	212.47	N/A
C9520	299-W22-122	134663.00	567615.93	212.137	212.134

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.

c. Protective casing

m = meters

N/A = not applicable

## 6 Well Acceptance

Well acceptance is the last 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 Stillwater LLC (drilling contractor) participated in the acceptance inspection of C9520 on April 12, 2016. 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.

## 7 References

CH2M Hill Plateau Remediation Company Soil and Groundwater Remediation Project Procedures and Permits:

SGRP-PRO-EN-60025 (GRP-EE-01-7.0), *Geologic Logging*

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

GW-056, 2015, Rev. 5, *The Installation of One Borehole (C9516) with Six Optional Wells (C9515, C9517-C9520) in the 200-WA-1 Operable Unit, FY 2015*

Other References:

DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for Post Ringold-Formation Sediments within the Central Pasco Basin*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland Washington, available at:  
<http://pdw.hanford.gov/arpir/pdf.cfm?accession=0081471H>

DOE/RL-2009-39, 2009, *Investigation-Derived Waste Purgewater Management Action Memorandum*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, available at:  
<http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0096133>

DOE/RL-2010-87, 2015, *Field Test Plan for the Uranium Sequestration Pilot Test Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland Washington, available at:  
<http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=008164H>

DOE/RL-2010-88, 2015, *Sampling and Analysis Plan for the Uranium Sequestration Pilot Test*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:  
<http://pdw.hanford.gov/arpir/pdf.cfm?accession=0081163H>

DOE/RL-2015-46, 2015, *Waste Control Plan for the 200-WA-1 Uranium Sequestration Pilot Test*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:  
<http://pdw.hanford.gov/arpir/pdf.cfm?accession=0080207H>

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at:  
<http://www.hanford.gov/?page=91&parent=0>.

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

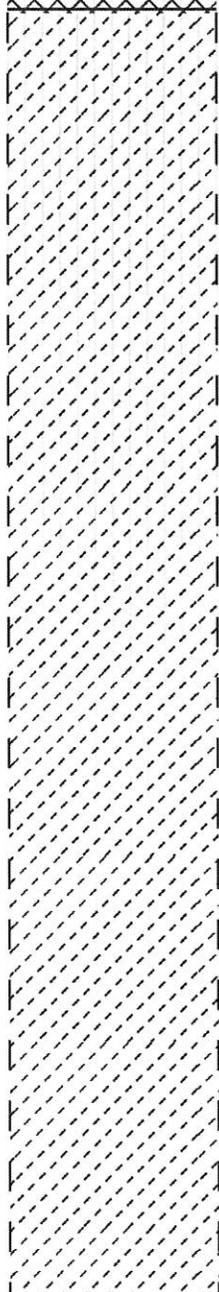
NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Springs, Maryland, as revised.

## Appendix A

### Well Documentation for C9516

- Well Summary Sheet
- Borehole Log
- Log Data Report
- Final Survey Report

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WELL SUMMARY SHEET			Start Date: 8/18/2015		Page <u>1</u> of <u>2</u>	
Well ID: C9516			Well Name: 299-W22-118			
Location: South of U Plant			Project: Uranium Sequestration Pilot Test			
Prepared By: C. Kildall/J. Russell		Date:	Reviewed By:		Date:	
Signature: 		5/9/16	Signature:			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
Borehole was decommissioned on 8/26/2015.		0		0.0 - 8.0: Silty Sandy Gravel - msG		
Concrete circular flush mount with brass marker indicating well name, ID#, and date		5				
<b>Materials used in construction:</b>		10	8.0 - 24.0: Sand - S			
Concrete surface seal		15				
Type I/II Portland Cement		20				
0.0' bgs - 2.2' bgs		25	24.0 - 25.0: Gravel lens			
3/8" Bentonite Chips			25.5 - 32.2: Sandy Gravel - sG			
2.2' bgs - 35.5' bgs						



**BOREHOLE LOG**

Page 1 of 2

Date: August 18, 2015

Well ID: 09516

Well Name: 299-W22-118

Location: S of U plant

Project: WA-1

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0			0-0	Ground surface to 8.00 ft bgs.	Drilling is being conducted w/ a cable tool rig
			0-0	Formation <u>Hanford/backfill</u> <u>msG</u>	
			0-0	15% silt 40% sand 45% Gravel	22W
			0-0	Sand: med grain, well sorted	8 5/8" casing
5			0-0	sub round. ~40% matric 60% felsic	6" core barrel
			0-0	Gravel: 2mm to ~70mm. poorly sorted	
			0-0	sub to well round.	No grab sample
			0-0	Dry for the first ~3 ft the slight damp.	are being collected for the part of the project.
10			0-0	10YR 7/2 dark grayish brown.	
			0-0	HCL No Used.	
			0-0	8.00 ft bgs - 25.50 ft bgs	
			0-0	Formation <u>Hanford</u> <u>S</u>	Drilling improves
15			0-0	0% silt 95% sand 5% Gravel	
			0-0	Sand. Medium grain well sorted	
			0-0	Sub round ~40% matric 60% felsic.	@ ~26 ft bgs
			0-0	Damp	Driller start sieving the cuttings
20			0-0	10YR 4/1 dark grayish brown.	
			0-0	Gravel: 2mm to 70mm sub ang.	
			0-0	poorly sorted some sub-to rounded	s.s. = split spoon
			0-0	Sand appears to become more coarse @ ~17.50 ft bgs.	
25			0-0	Gravel lens @ 24.00 ft	
			0-0	2.2' thick composed of mixed	TD 35.50
			0-0	(70% matric 50% felsic) cobbles.	
			0-0	sub round.	Borehole decommissioned 8/26/15
30			0-0	@ 25 ft bgs. sand returns to medium grain.	
			0-0	25.50 ft to 32.00 ft	
			0-0	Formation <u>Hanford</u> <u>SG</u>	
35			0-0	10% silt 30% sand 60% Gravel	
			0-0	Sand: fine to coarse grain poorly sorted ~35% matric 65% felsic	
			0-0	Gravel 2mm to ~70mm sub ang.	

Reported By: Candice Burnette Kildall

Reviewed By: Jarah Springer

Title: Geologist

Title: geologist

Signature: Candice Kildall

Date: 8/18/15

Signature: Jarah Springer

Date: 05-04-16





## 299-W22-118 (C9516) Log Data Report

### Borehole Information:

<b>Log Date:</b>	2015-08-25	<b>Filename:</b>	C9516_HG-NM_2015-08-25	<b>Site:</b>	U-8 Crib
<b>Coordinates (WA St Plane)</b>		<b>DTW<sup>1</sup> (ft) :</b>	Dry	<b>DTW Date:</b>	08/24/15
<b>North (m)</b>	<b>East (m)</b>	<b>Drill Date</b>	<b>TOC<sup>2</sup> Elevation</b>	<b>Total Depth (ft)</b>	<b>Type</b>
N/A	N/A	08/24/15	N/A	34	Cable Tool

### Casing Information:

Casing Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
		Outer	Inside			
Threaded Steel	1.0	8 5/8	7 3/8	0.75	1.0	34.0

### Borehole Notes:

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing stick-up and casing diameter (rounded to the nearest 1/16-in.). Logging was terminated at 33 ft to prevent the sonde from touching potentially contaminated material at the bottom of the borehole.

Zero reference is ground surface.

### Logging Equipment Information:

<b>Logging System:</b>	Gamma 5T	<b>Type:</b>	60% HPGe SGLS <sup>3</sup>
<b>Effective Calibration Date:</b>	03/19/15	<b>Serial No.:</b>	54-TP13441B
<b>Calibration Reference:</b>	HGLP-CC-115, Rev. 0	<b>Logging Procedure:</b>	SGRP-PRO-OP-53023, Rev. 0

<b>Logging System:</b>	Gamma 5C	<b>Type:</b>	planar HPGe HRLS <sup>4</sup>
<b>Effective Calibration Date:</b>	07/30/15	<b>Serial No.:</b>	39A314
<b>Calibration Reference:</b>	HGLP-CC-123, Rev. 0	<b>Logging Procedure:</b>	HGLP-MAN-002, Rev. 2a

<b>Logging System:</b>	Gamma 5P	<b>Type:</b>	NMLS <sup>5</sup>
<b>Effective Calibration Date:</b>	04/15/15	<b>Serial No.:</b>	H34055445
<b>Calibration Reference:</b>	HGLP-CC-116, Rev. 0	<b>Logging Procedure:</b>	SGRP-PRO-OP-53024, Rev. 0

### SGLS Log Run Information:

Log Run	1	2 Repeat			
HEIS Number	1017382	1017383			
Date	08/25/15	08/25/15			
Logging Engineer	Felt/Meisner	Felt/Meisner			
Start Depth (ft)	0.0	28.0			
Finish Depth (ft)	33.0	31.0			

<sup>1</sup> depth to water inside casing

<sup>2</sup> top of casing

<sup>3</sup> Spectral Gamma Logging System

<sup>4</sup> High Rate Logging System

<sup>5</sup> Neutron Moisture Logging System



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Log Run	1	2 Repeat			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9516FTB2015 0825AV00CAB 1	C9516FTB2015 0825AV00CAB 1			
Start File	AD000000	AD002800			
Finish File	AD003300	AD003100			
Post-Verification	BV00CAA1	BV00CAA1			
Depth Return Error (in.)	N/A	2.0 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

**HRLS Log Run Information:**

Log Run	5	6 Repeat			
HEIS Number	1017384	1017385			
Date	08/25/15	08/25/15			
Logging Engineer	McClellan/Felt/ Meisner	McClellan/Felt/ Meisner			
Start Depth (ft)	29.0	32.0			
Finish Depth (ft)	33.0	33.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9516FCB2015 0825AV00CAB 1	C9516FCB2015 0825AV00CAB 1			
Start File	AD002900	AD003200			
Finish File	AD003100	AD003300			
Post-Verification	BV00CAA1	BV00CAA1			
Depth Return Error (in.)	N/A	1.0 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

**NMLS Log Run Information:**

Log Run	3	4 Repeat			
HEIS Number	1017386	1017387			
Date	08/25/15	08/25/15			
Logging Engineer	McClellan/Felt/ Meisner	McClellan/Felt/ Meisner			
Start Depth (ft)	0.0	28.0			



**Stoller Newport News Nuclear**

Log Run	3	4 Repeat			
Finish Depth (ft)	33.25	31.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9516FPB20150 825AV00CAB1	C9516FPB20150 825AV00CAB1			
Start File	AD000000	AD002800			
Finish File	AD003325	AD003101			
Post-Verification	BV00CAA1	BV00CAA1			
Depth Return Error (in.)	N/A	N/A			
Comments	None	None			

**Logging Operation Notes:**

A centralizer was not installed on the sondes because plastic was wrapped around the sondes to prevent potential contamination.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

**Analysis Notes:**

<b>Analyst:</b>	P.D. Henwood	<b>Date:</b>	10/29/15	<b>Reference:</b>	HGLP-MAN-003, Rev. 1a
-----------------	--------------	--------------	----------	-------------------	-----------------------

A casing correction for a 3/4-in. thick casing was applied to the log data.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as FTb20150319\_cc115, using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

NMLS data are reported in counts per second as there is no calibration for conversion to volumetric moisture for borehole diameters greater than 8 in.

The HGU<sup>6</sup> is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Calibration Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

**Results and Interpretations:**

Cs-137 was detected from the ground surface to 33 ft. A relatively high activity zone was encountered at approximately 30 ft. Concentrations were increasing with depth when the logging terminated at 33 ft, approximately one ft above the bottom of the borehole. The highest concentration measured by the HRLS was approximately 39,500 pCi/g at 33 ft in depth, and likely would be much higher if the borehole were extended.

No other manmade radionuclides were detected above MDLs. MDLs for Pa-234m (U-238) and U-235 are included as they were possible contaminants in the crib.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. Based on the moisture measurements, it appears the borehole intersected the excavation for the crib. The relatively elevated moisture content from approximately 21 to 23 ft lies in sediments

<sup>6</sup> Hanford Gamma Unit



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above a relatively low moisture content zone that is likely a gravel layer that was placed during construction. This gravel layer exists from 23 to approximately 31 ft. Below the gravel, the high gamma activity zone begins. These depths interpreted from log data are consistent with Hanford Drawing H-2-43028 construction details.

The manmade, KUT, and moisture repeat plots indicate that the respective systems were working properly.

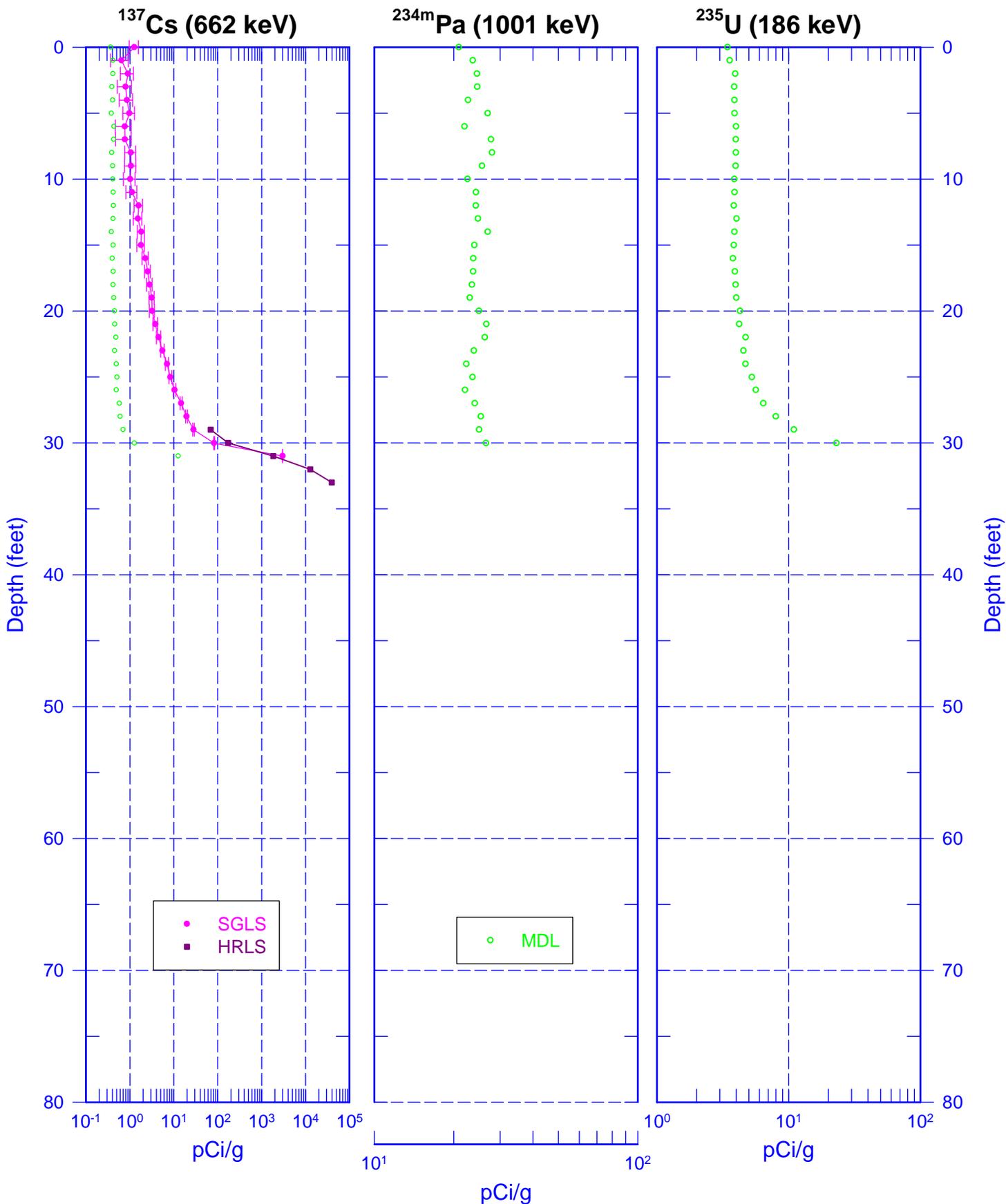
### **List of Log Plots:**

Depth Reference is ground surface.

- Manmade Radionuclides (0-80 ft)
- Natural Gamma Logs (0-80 ft)
- Combination Plot (0-60 ft)
- Total Gamma & Moisture (0-80 ft)
- Total Gamma & Hanford Gamma Unit (0-80 ft)
- Manmade Radionuclides Repeat (SGLS) (28-31 ft)
- Manmade Radionuclides Repeat (HRLS) (31-34 ft)
- Repeat Section of Natural Gamma Logs (28-31 ft)
- Moisture Repeat Section (28-31 ft)



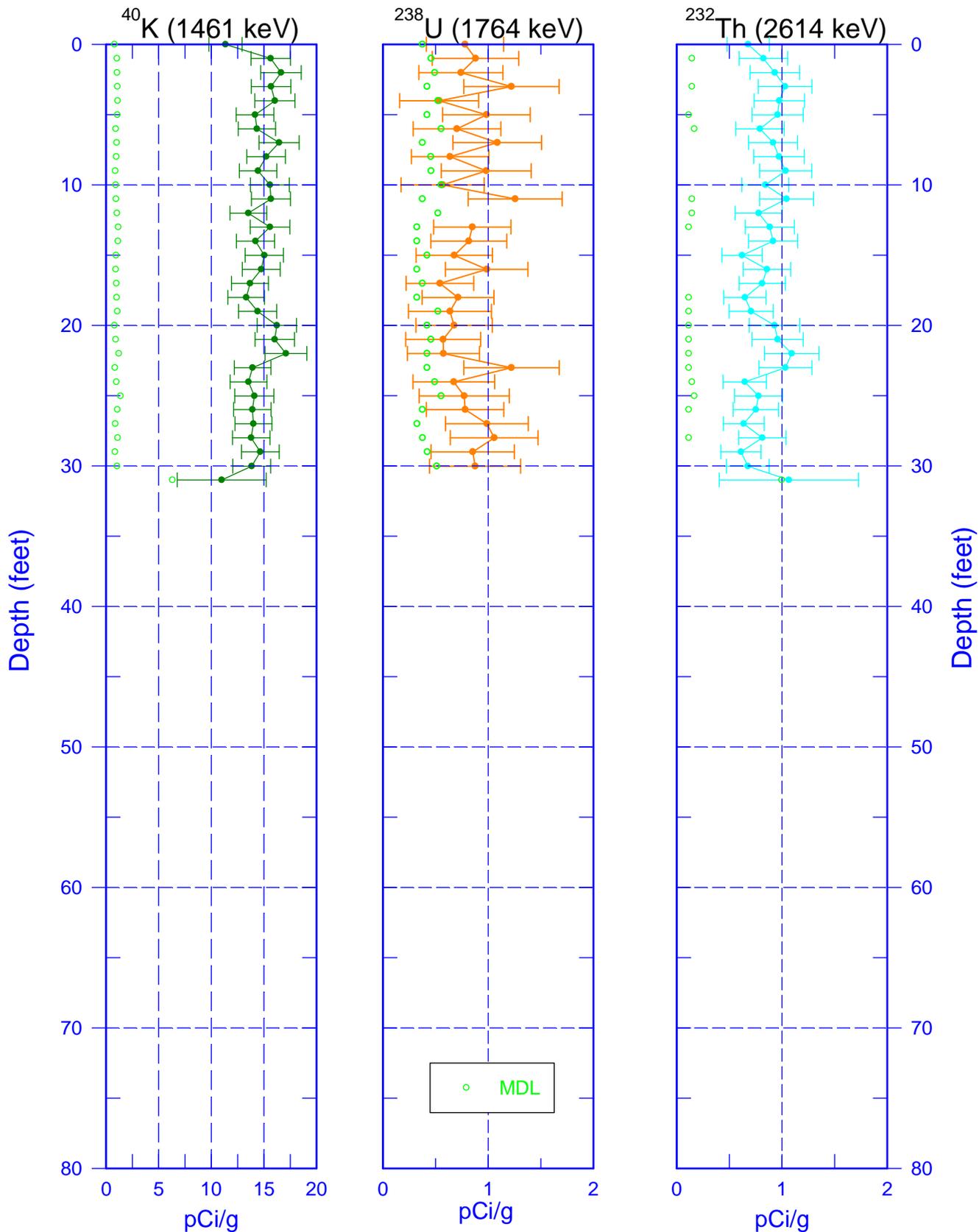
# 299-W22-118 (C9516) Manmade Radionuclides



Zero Reference - Ground Surface



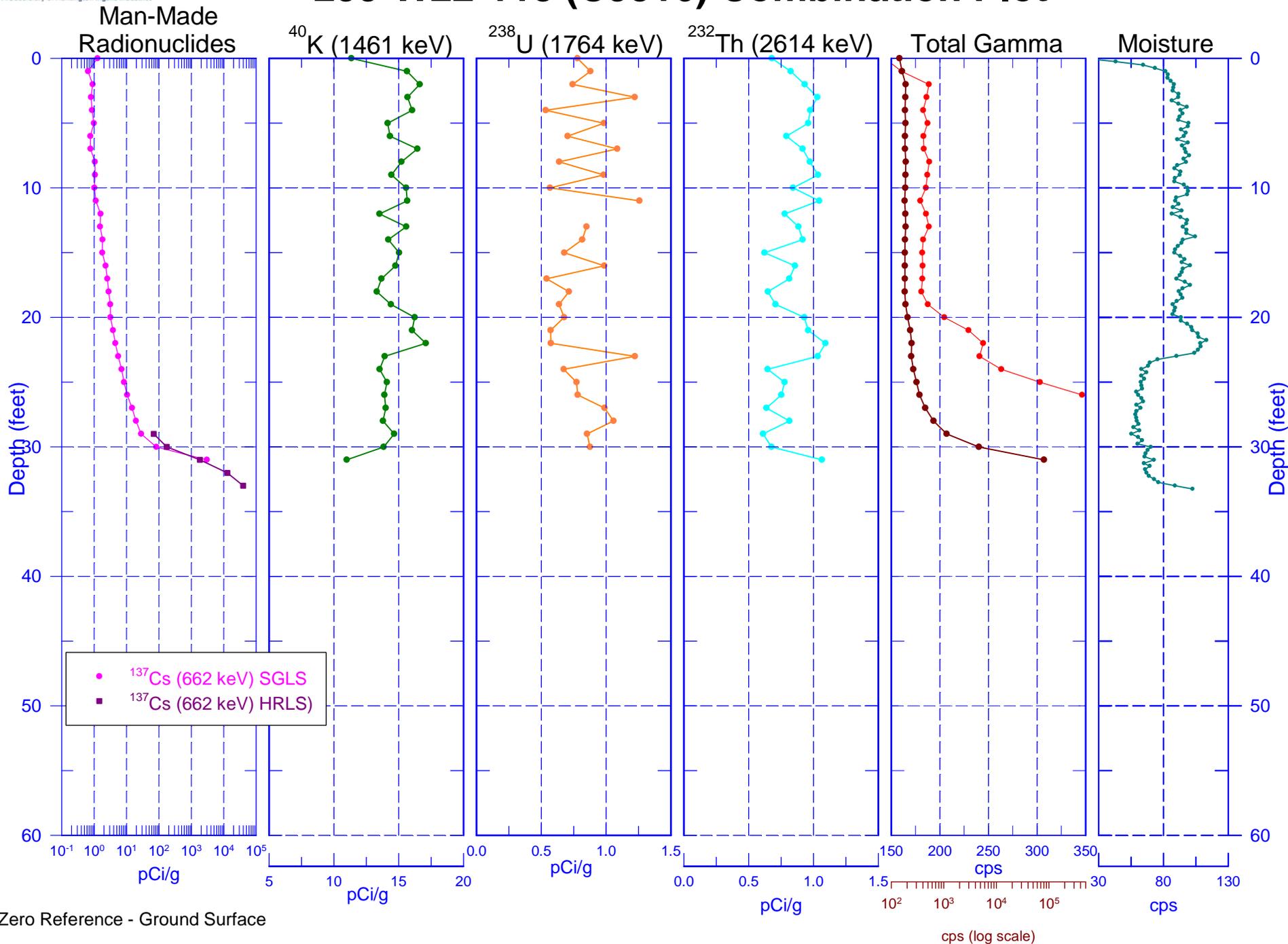
# 299-W22-118 (C9516) Natural Gamma Logs



Zero Reference - Ground Surface

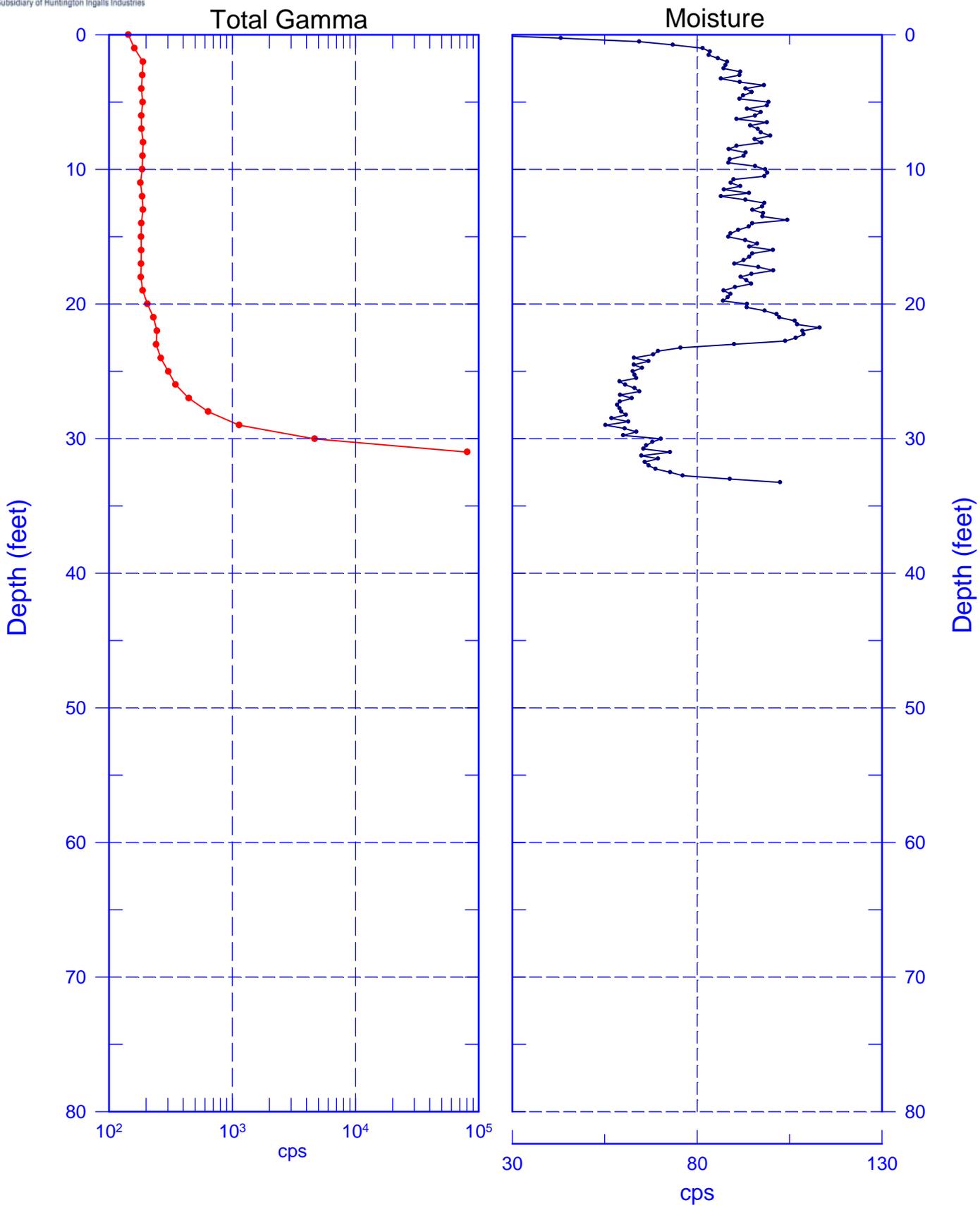


# 299-W22-118 (C9516) Combination Plot





# 299-W22-118 (C9516) Total Gamma & Moisture

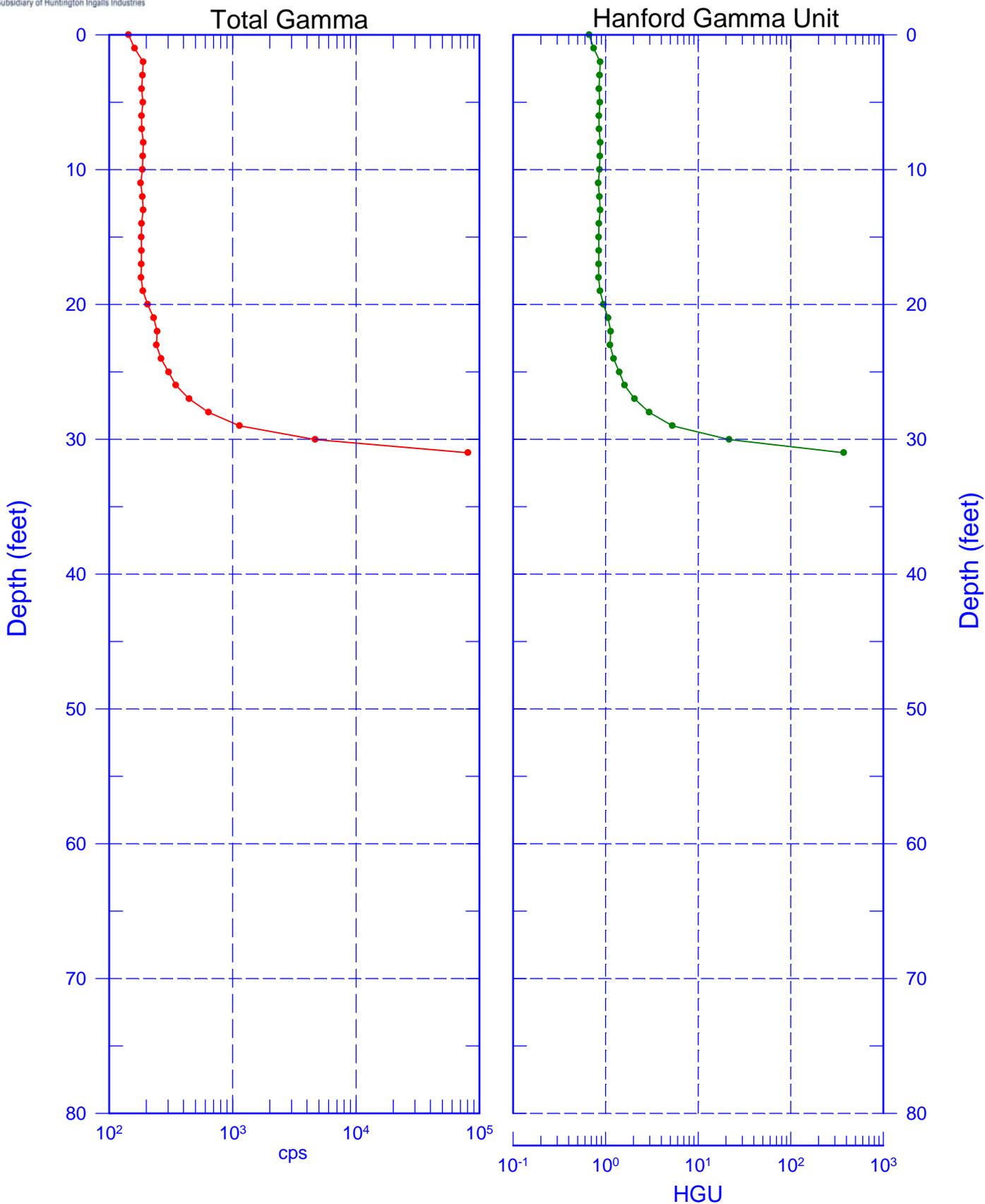


Zero Reference - Ground Surface



# 299-W22-118 (C9516)

## Total Gamma & Hanford Gamma Unit

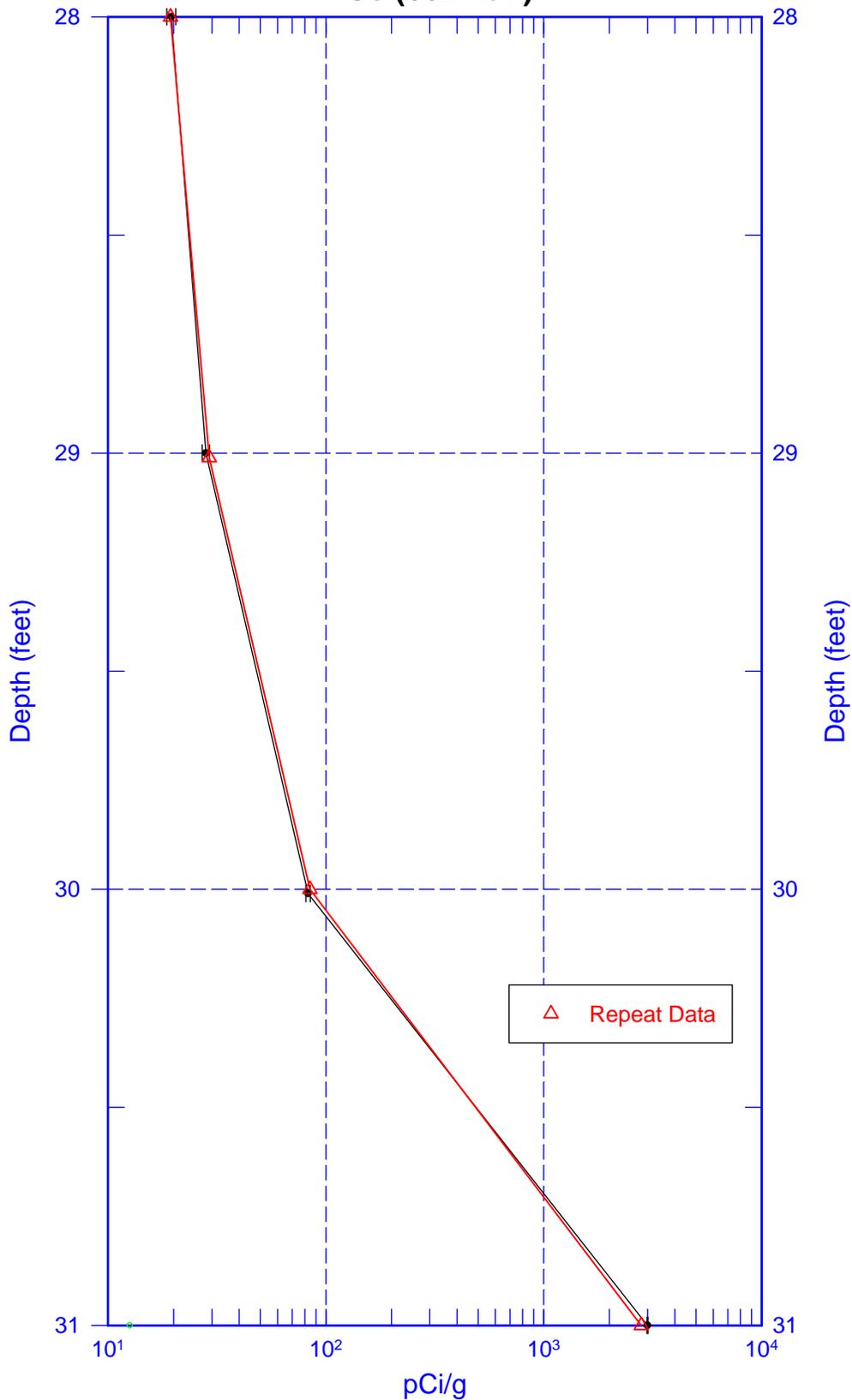


Zero Reference - Ground Surface



# 299-W22-118 (C9516) Manmade Radionuclides Repeat (SGLS)

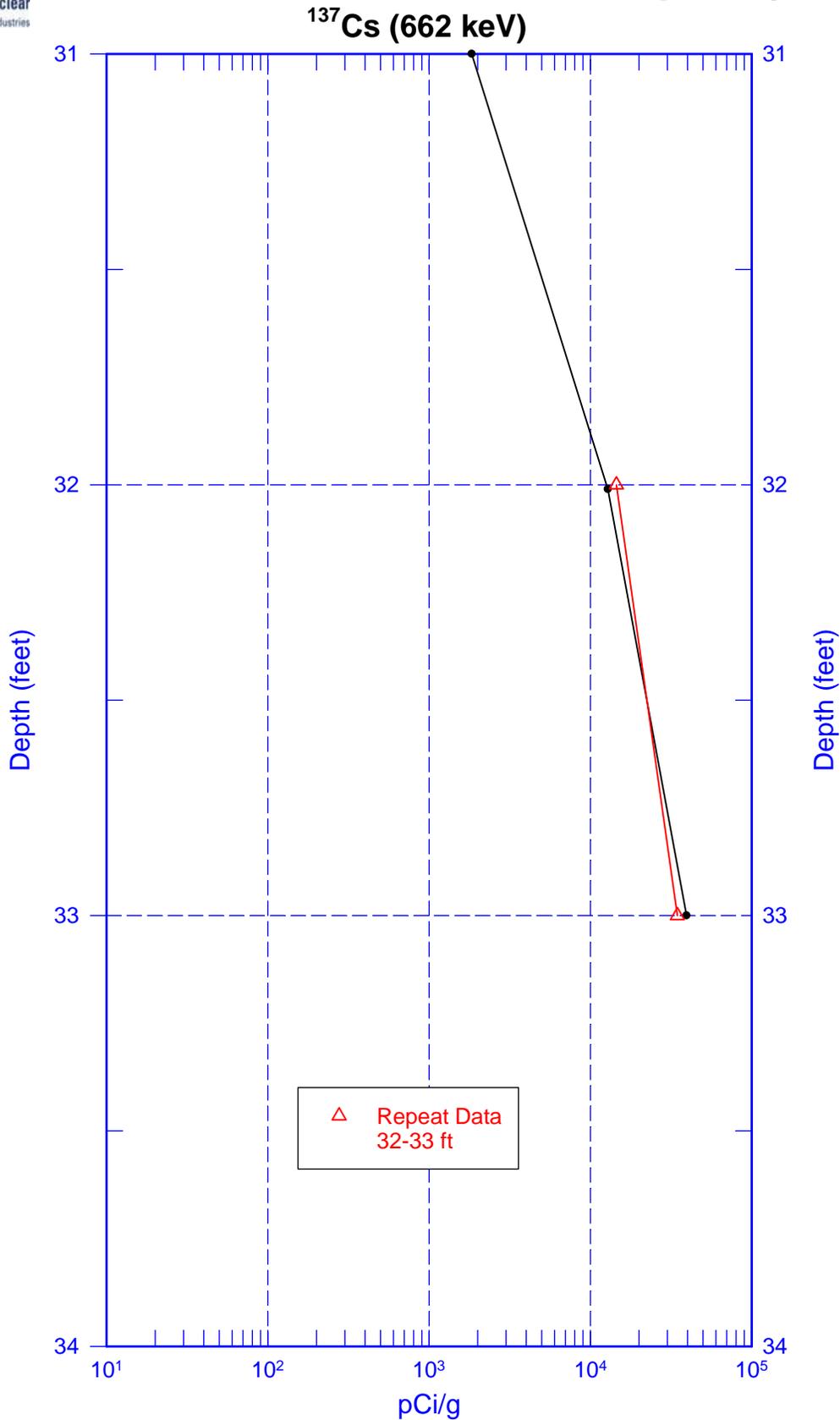
<sup>137</sup>Cs (662 keV)



Zero Reference - Ground Surface



# 299-W22-118 (C9516) Manmade Radionuclides Repeat (HRLS)

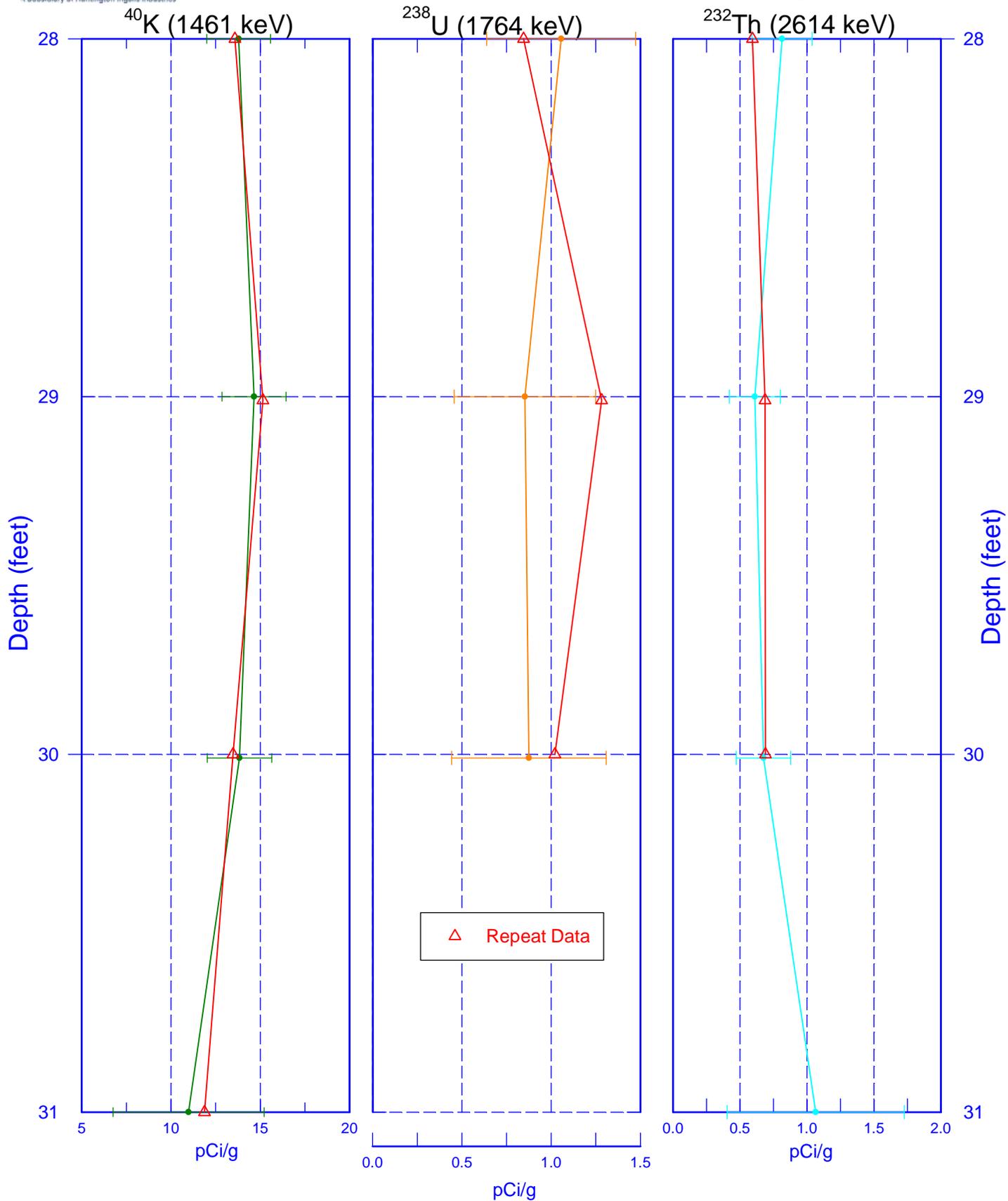


Zero Reference - Ground Surface



# 299-W22-118 (C9516)

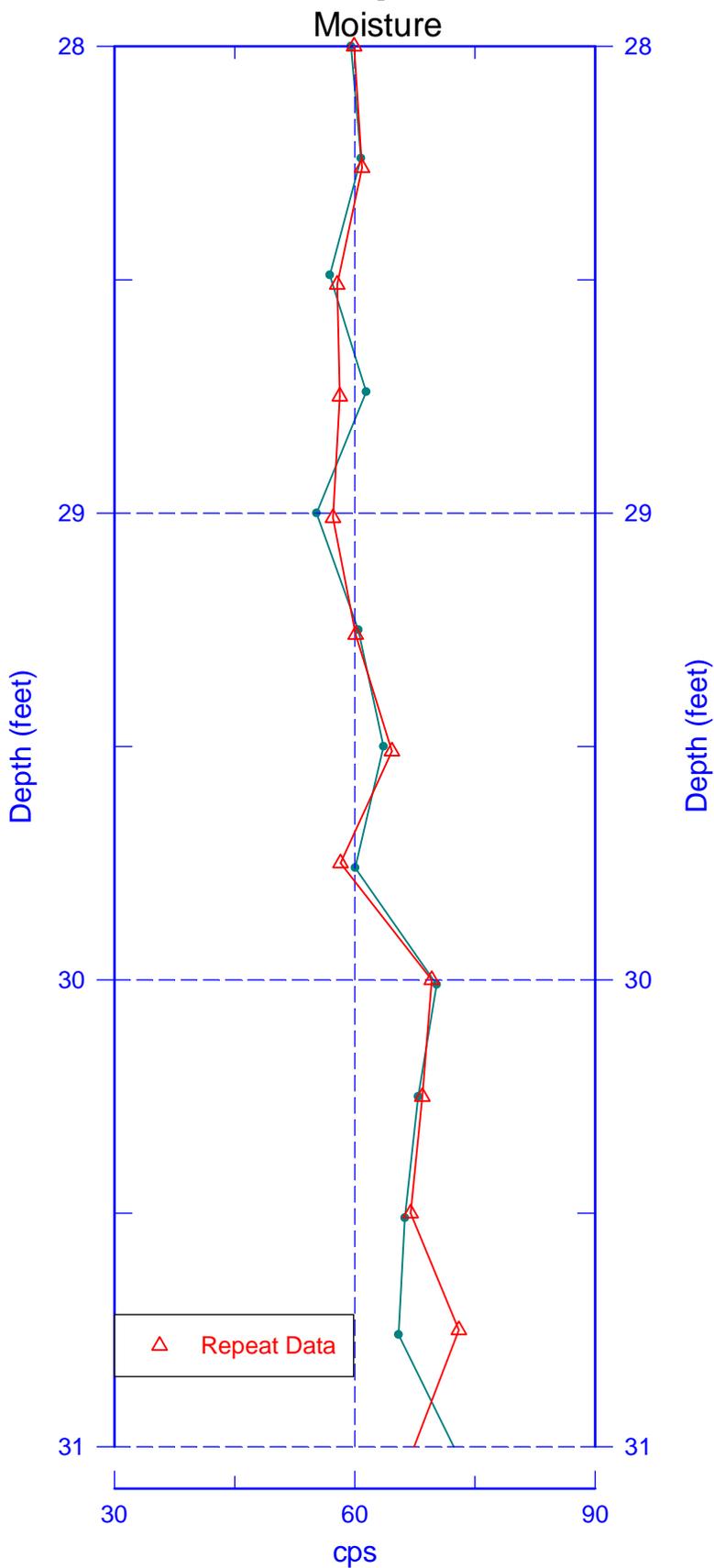
## Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



# 299-W22-118 (C9516) Moisture Repeat Section



Zero Reference - Ground Surface

<b>SURVEY DATA REPORT</b>				Page 1 of 3	
				Request No. 163-081	
Project No.		Title 200W Wells C9516 and C9520 Final Surveys		File No. 2WT12R26	
Job No. CACN: 303602-JPRC		Prepared By N.P. Fastabend	Date 5/5/16	Reviewer <i>UBM</i>	
<b>DESCRIPTION OF WORK</b>			<b>DISTRIBUTION</b>	<b>SDR</b>	<b>PLOT</b>
Obtained final coordinates and elevation of brass cap marker for decommissioned Well C9516 (299-W22-118) and final coordinates and elevations of completed Well C9520 (299-W22-122) in 200W Area.  Horizontal Datum: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR	
			J.E. Fritts	1	
			K.M. Whitley	1	
			J.L. Smoot	1	
			J.B. Geiger	1	
			B.J. Howard	1	
			A.J. Green	1	
<b>SURVEY RESULTS AND COMMENTS</b>					
See Attached Well Survey Data Report Sheets					
<b>FOR OFFICE USE ONLY</b>					
OR Doc Type:			WMU Code(S):		



## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 05/03/16	<b>Requestor:</b> Kelly M. Whitley (CHPRC)
<b>Date of Survey:</b> 05/05/16	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9520 (299-W22-122) located in 200W Area.	<b>Horizontal Datum:</b> NAD83(91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 200W

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
2W-53 (CHPRC) and 2W-57 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9520	299-W22-122	567615.93	134663.00		Center of Casing
				212.134	"X" on Rim
				212.137	Brass Survey Marker

**Notes:**

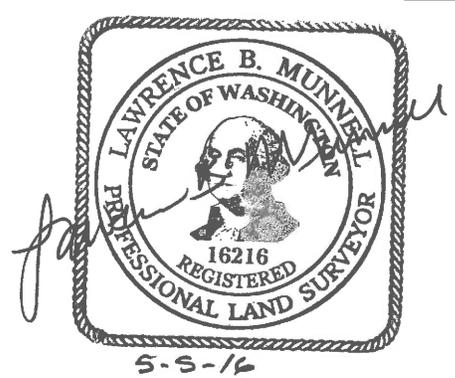
211.966 Top Inner 2" PVC Casing, N.Edge

"X" on Rim is stamped "X" on top of Outer 18" Protective Casing, North Edge

**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.



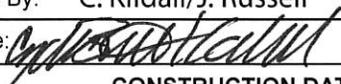
5-5-16

## Appendix B

### Well Documentation for 299-W22-122 (C9520)

- Well Summary Sheet
- Borehole Log
- Log Data Report
- Final Survey Report

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WELL SUMMARY SHEET			Start Date: 8/27/2015	Page <u>1</u> of <u>2</u>
Well ID: C9520		Well Name: 299-W22-122		
Location: South of U Plant		Project: Uranium Sequestration Pilot Test		
Prepared By: C. Kildall/J. Russell	Date:	Reviewed By:		Date:
Signature: 	5/4/16	Signature:		
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Graphic Log	Lithologic Description	
<b>Borehole Completion:</b>		0		
Concrete circular flush mount with brass marker indicating well name, ID#, and date		10	0.0 - 6.0: Sandy Gravel - sG	
Ecology Tag ID: BCA 453			6.0 - 9.0: Gravelly Sand - gS	
<b>Materials used in construction:</b>		20	9.0 - 24.5: Sand - S	
Concrete surface seal		30		
0.0' bgs - 2.0' bgs			24.5 - 31.0: Sandy Gravel - sG	
Type I/II Portland Cement		40		
2.0' bgs - 10.4' bgs			31.0 - 47.5: Gravelly Sand - gS	
200 Mesh Sand		50		
10.4 bgs - 27.75' bgs			47.5 - 48.5: Silt - M	
100/200 Mesh Sand			48.5 - 81.0: Gravelly Sand - gS	
27.75' bgs - 70.65 bgs				
200 Mesh Sand				
70.65' bgs - 80.8' bgs				
<b>Permanent Well Materials:</b>				
18" Diameter Vault				
0.0' bgs - 1.0' bgs				
2" Schedule 40 PVC				
0.6' bgs - 73.15' bgs				



**BOREHOLE LOG**

Page 1 of 3

Date: 8/27/15

Well ID: C9520 Well Name: 299-W22-122 Location: South of U Plant

Project: Uranium sequestration Pilot test Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0.0 ft bgs to 6.00 ft bgs Formation <u>Hanford / Backfill (SG)</u> 10% silt 35% Sand 55% Gravel sand fine to coarse grain - sub rounded poorly sorted. ~40% matric 60% felsic Gravel: 2mm to ~70mm. poorly sorted sub angular to sub round ~70% matric 30% felsic 7.5 YR 7/2 brown Dry. Acid not used.	Drilling is being conducted w/ a Bucyrus Erie 22 Cable tool rig. 8 5/8" casing 4" Drive barrel g.s = grab sample s.s = Split Spoon
5				6.00 ft bgs 9.00 ft bgs (gs) 1% silt 84% sand 15% Gravel Sand: med to very coarse mod. sorted Sub ang to round. 40% matric 60% felsic Gravel: 2mm to ~10mm.	I-001 29.7 - 32.2 100% I-002 32.4 - 34.9 100% I-004 34.4 - 36.9 100% I-003 Grab sample
10				Angular 70% matric 30% felsic No Acid Used 7.5 YR 7/2 brown. (best via sleeving)	I-005 36.5 - 39.0 100% I-006 39.0 - 41.5 35% I-007 41.4 - 43.9 100% I-008 43.7 - 46.2 100%
15				9.00 ft to 24.50 ft bgs. Formation <u>Hanford (S)</u> Sand 95% Gravel 5% Sand: Med to coarse grain mod sorting sub round 30% matric 70% Gravel: 2mm to ~18mm Sub angular ~70% matric 30% felsic poorly sort. 7.5 3/4 dark brown No Acid (Due to sleeving) damp	I-009 45.7 - 47.9 100% I-010 47.9 - 50.4 100% I-011 50.7 - 53.2 100% I-012 53.0 - 55.5 100% I-013 55.2 - 57.7 100% I-014 57.4 - 59.9 100% I-015 60.5 - 63.0 100% I-016 62.6 - 65.10 100%
20					
25					
30					
35					

Reported By: Candice Bernette Kildall

Reviewed By: Sarah Springer

Title: Geologist

Title: Geologist

Signature: [Handwritten Signature]

Date: 8/27/15

Signature: [Handwritten Signature]

Date: 05-04-16

BOREHOLE LOG					Page <u>2</u> of <u>3</u>
Well ID: <u>299-WZZ-122</u>			Well Name: <u>C9520</u>		Location: <u>s. of U. Plant</u>
Project: <u>Uranium Sequestration Pilot test</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	1-005			24.50-31.00 ft bgs Continued Gravel: 2mm to ~80mm poorly sorted sub round to sub angular 60% mafic 40% felsic 2.5 YR 4/1 dark gray, No HCL	Drilling is being conducted w/ a 22 w cable tool rig 8 5/8" casing 4" core barrel
45	1-006			31.00 ft to 48.50 ft bgs (gs) Formation: <u>Hanford</u> Sand 85% Gravel 15% Sand: med to coarse grain mod. to well sorted sub angular to sub-round 60% mafic 40% felsic Gravel: 2mm to ~60mm Sub round ~70% mafic 50% felsic 2.5 YR 4/1 dark gray No HCL damp @ 47.5 to 48.50 Silt lens. (composed of silt ~90% 10% fine grain sand.)	
50	1-007			48.50 ft to 80.96 ft bgs Formation: <u>Hanford</u> (gs) 10% silt 80% Sand 10% Gravel Sand: fine to med grain mod. sorting Sub angular to sub round Possible large pebble/small boulder that is being pushed by casing. damp to dry, graded upper contact 10 YR 5/2 grayish brown @ 70 ft bgs NCO said sample was super dry ("fluffy") Gravel: 5mm to 25mm Sub round poorly sorted ~80% mafic 20% felsic	
55	1-008				
60	1-009				
	1-010				
	1-11				
	1-12				
	1-13				
	1-14				
	1-15				
	1-16				
65					
70					
75					

Reported By: <u>Candice Burnette Kiddall</u>	Reviewed By: <u>Sarah Springer</u>
Title: <u>Geologist</u>	Title: <u>Geologist</u>
Signature: <u>[Signature]</u>	Signature: <u>[Signature]</u>
Date: <u>8/27/15</u>	Date: <u>05-04-16</u>





## 299-W22-122 (C9520) Log Data Report

### Borehole Information:

<b>Log Date:</b>	2015-09-22	<b>Filename:</b>	C9520_HG-NM_2015-09-22	<b>Site:</b>	U-8 Crib
<b>Coordinates (WA St Plane)</b>		<b>DTW<sup>1</sup> (ft) :</b>	Dry	<b>DTW Date:</b>	09/21/15
<b>North (m)</b>	<b>East (m)</b>	<b>Drill Date</b>	<b>TOC<sup>2</sup> Elevation</b>	<b>Total Depth (ft)</b>	<b>Type</b>
N/A	N/A	09/17/15	N/A	34	Cable Tool

### Casing Information:

Casing Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
		Outer	Inside			
Threaded Steel	0.4	8 3/4	7 1/2	5/8	0.4	80.1

### Borehole Notes:

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing stick-up and casing diameter (rounded to the nearest 1/16-in.). Logging was terminated at 78 ft to prevent the sonde from touching potentially contaminated material at the bottom of the borehole.

Zero reference is ground surface.

### Logging Equipment Information:

<b>Logging System:</b>	Gamma 5T	<b>Type:</b>	60% HPGe SGLS <sup>3</sup>
<b>Effective Calibration Date:</b>	03/19/15	<b>Serial No.:</b>	54-TP13441B
<b>Calibration Reference:</b>	HGLP-CC-115, Rev. 0	<b>Logging Procedure:</b>	SGRP-PRO-OP-53023, Rev. 0

<b>Logging System:</b>	Gamma 5C	<b>Type:</b>	planar HPGe HRLS <sup>4</sup>
<b>Effective Calibration Date:</b>	07/30/15	<b>Serial No.:</b>	39A314
<b>Calibration Reference:</b>	HGLP-CC-123, Rev. 0	<b>Logging Procedure:</b>	HGLP-MAN-002, Rev. 2a

<b>Logging System:</b>	Gamma 5P	<b>Type:</b>	NMLS <sup>5</sup>
<b>Effective Calibration Date:</b>	04/15/15	<b>Serial No.:</b>	H34055445
<b>Calibration Reference:</b>	HGLP-CC-116, Rev. 0	<b>Logging Procedure:</b>	SGRP-PRO-OP-53024, Rev. 0

<sup>1</sup> depth to water inside casing

<sup>2</sup> top of casing

<sup>3</sup> Spectral Gamma Logging System

<sup>4</sup> High Rate Logging System

<sup>5</sup> Neutron Moisture Logging System



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**SGLS Log Run Information:**

Log Run	1	2	3	4 Repeat	5 Repeat
HEIS Number	1017396	1017397	1017398	1017399	1017400
Date	09/21/15	09/21/15	09/21/15	09/21/15	09/21/15
Logging Engineer	Felt/Meisner	Felt/Meisner	Felt/Meisner	Felt/Meisner	Felt/Meisner
Start Depth (ft)	0.0	40.0	48.0	49.0	48.0
Finish Depth (ft)	39.01	48.01	78.01	49.0	48.0
Count Time (sec)	100	20	100	1000	1000
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0	1.0
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A
Pre-Verification	C9520FTB2015 0925AV00CAB 1	C9520FTB2015 0925AV00CAB 1	C9520FTB2015 0925AV00CAB 1	C9520FTB2015 0925AV00CAB 1	C9520FTB2015 0925AV00CAB 1
Start File	AD000000	BD004000	CD004800	DD004900	ED004800
Finish File	AD003901	BD004801	CD007801	DD004900	ED004800
Post-Verification	GV00CAA1	GV00CAA1	GV00CAA1	GV00CAA1	GV00CAA1
Depth Return Error (in.)	N/A	N/A	N/A	N/A	N/A
Comments	No fine gain adjustments made				

**SGLS Log Run Information:**

Log Run	6 Repeat				
HEIS Number	1017401				
Date	09/21/15				
Logging Engineer	Felt/Meisner				
Start Depth (ft)	50.0				
Finish Depth (ft)	55.0				
Count Time (sec)	500				
Live/Real	R				
Shield (Y/N)	N				
MSA Interval (ft)	1.0				
Log Speed (ft/min)	N/A				
Pre-Verification	C9520FTB2015 0925AV00CAB 1				
Start File	GD005000				
Finish File	GD005500				
Post-Verification	GV00CAA1				
Depth Return Error (in.)	2.0 high				
Comments	No fine gain adjustments made				



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**HRLS Log Run Information:**

Log Run	7	8 Repeat			
HEIS Number	1017402	1017403			
Date	09/21/15	09/21/15			
Logging Engineer	Felt/Meisner	Felt/Meisner			
Start Depth (ft)	32.0	37.0			
Finish Depth (ft)	47.0	38.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9520FCB2015 0925AV00CAB 1	C9520FCB2015 0925AV00CAB 1			
Start File	AD003200	BD003700			
Finish File	AD004700	BD003800			
Post-Verification	BV00CAA1	BV00CAA1			
Depth Return Error (in.)	N/A	3.0 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

**NMLS Log Run Information:**

Log Run	9	10 Repeat			
HEIS Number	1017404	1017405			
Date	09/22/15	09/22/15			
Logging Engineer	Felt	Felt			
Start Depth (ft)	0.0	19.0			
Finish Depth (ft)	78.0	27.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9520FPB20150 922AV00CAB1	C9520FPB20150 922AV00CAB1			
Start File	AD000000	RD001900			
Finish File	AD007800	RD002700			
Post-Verification	RV00CAA1	RV00CAA1			
Depth Return Error (in.)	N/A	2.0 high			
Comments	None	None			

**Logging Operation Notes:**

A centralizer was installed on the sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.



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**Analysis Notes:**

<b>Analyst:</b>	P.D. Henwood	<b>Date:</b>	11/13/15	<b>Reference:</b>	HGLP-MAN-003, Rev. 1a
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A casing correction for a 5/8-in. thick casing was applied to the log data.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as FTb20150319\_cc115, using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

The HGU<sup>6</sup> is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Calibration Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

**Results and Interpretations:**

Cs-137 was detected from the ground surface to 7 ft, at a few locations from 8 to 28 ft, and the remainder of the borehole. A relatively high activity zone was encountered from approximately 32 to 47 ft where the HRLS was deployed. The highest concentration measured by the HRLS was approximately 16,900 pCi/g at 37 ft in depth.

Pa-234m (manmade U-238) was detected at the upper and lower margins of the high activity zone. The maximum concentration measured was approximately 347 pCi/g at 33 ft. Based on the existence of U-238 at the margins of the high activity zone, it is likely significant manmade uranium exists in the entire high activity interval and at higher concentrations. One detection of U-235 occurred at 48 ft where a 1000 second counting time was used to lower the MDL. The concentration was measured at 13 pCi/g.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. Based on the moisture measurements, it appears the borehole intersected the excavation for the crib. The relatively elevated moisture content from approximately 21 to 23 ft lies in sediments above a relatively low moisture content zone that is likely a gravel layer that was placed during construction. This gravel layer exists from 23 to approximately 30 ft. Below the gravel, the high gamma activity zone begins. These depths interpreted from log data are consistent with Hanford Drawing H-2-43028 construction details.

The manmade, KUT, and moisture repeat plots indicate that the respective systems were working properly. Concentrations measured with longer counting times at selected depths are consistent with the normal 100 second counting times.

**List of Log Plots:**

Depth Reference is ground surface.

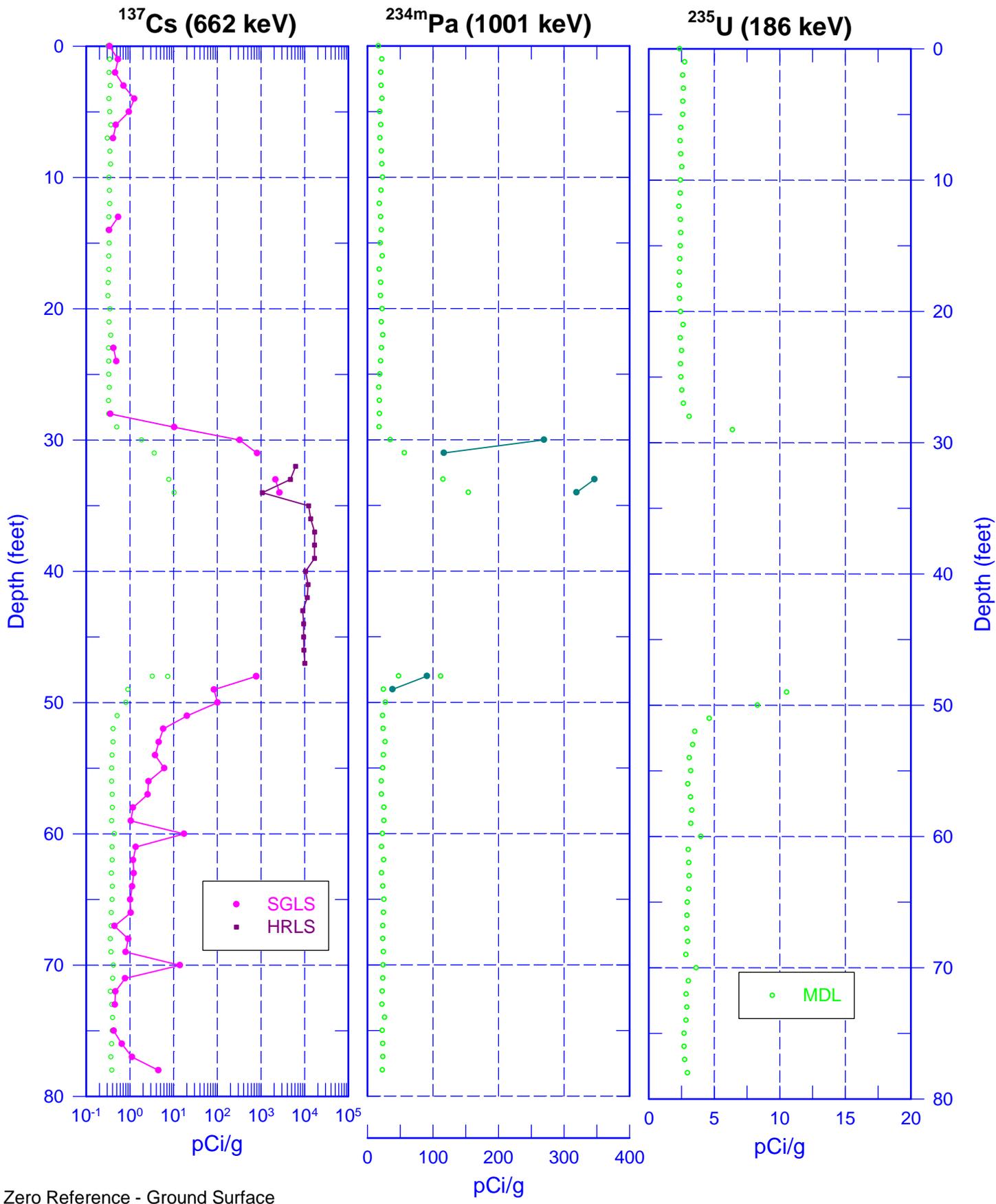
- Manmade Radionuclides (0-80 ft)
- Natural Gamma Logs (0-80 ft)
- Combination Plot (0-80 ft)
- Total Gamma & Moisture (0-80 ft)
- Total Gamma & Hanford Gamma Unit (0-80 ft)
- Manmade Radionuclides Repeat (HRLS) (35-55 ft)
- Repeat Section of Natural Gamma Logs (50-56 ft)
- Moisture Repeat Section (19-27 ft)

<sup>6</sup> Hanford Gamma Unit



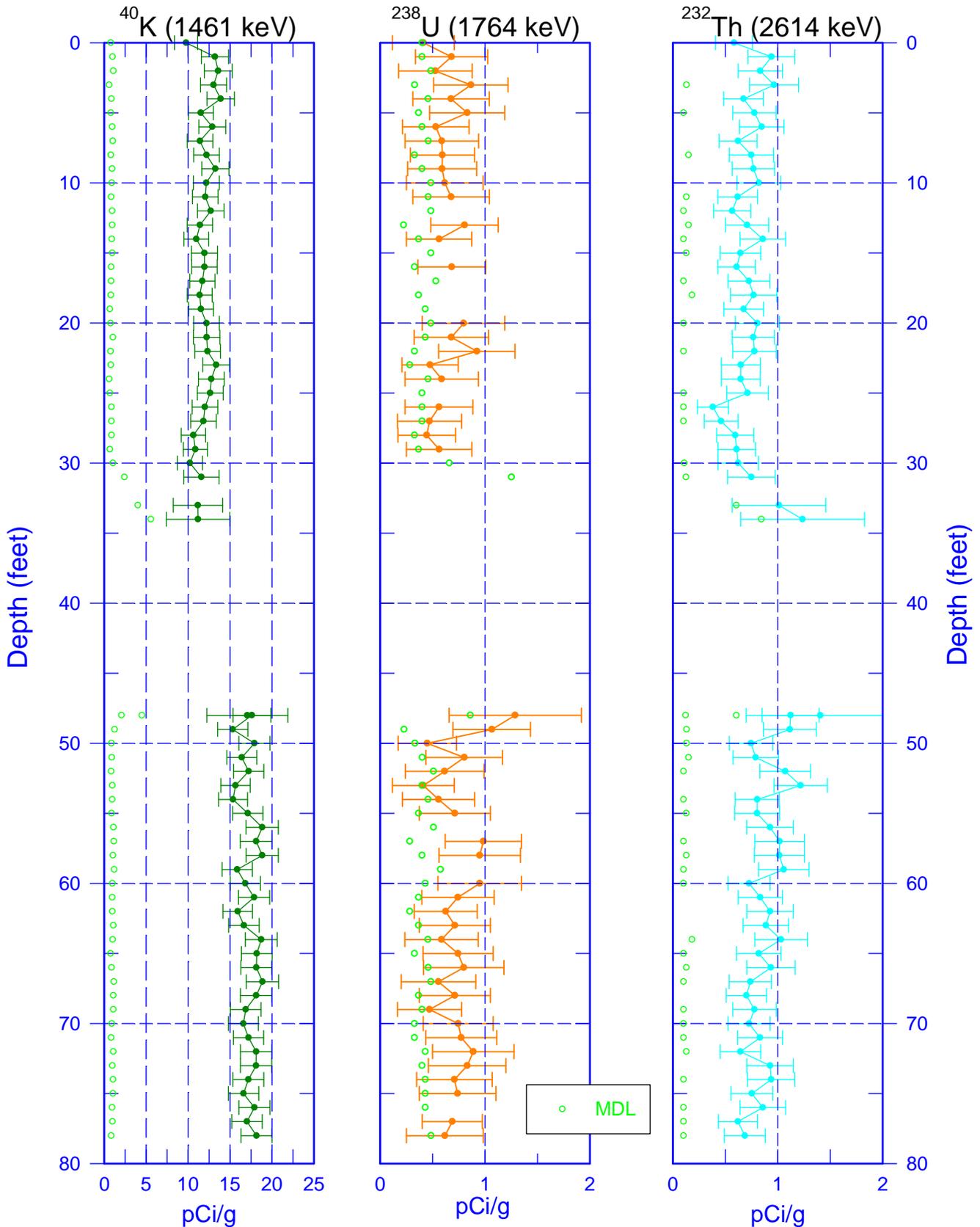
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# 299-W22-122 (C9520) Manmade Radionuclides





# 299-W22-122 (C9520) Natural Gamma Logs



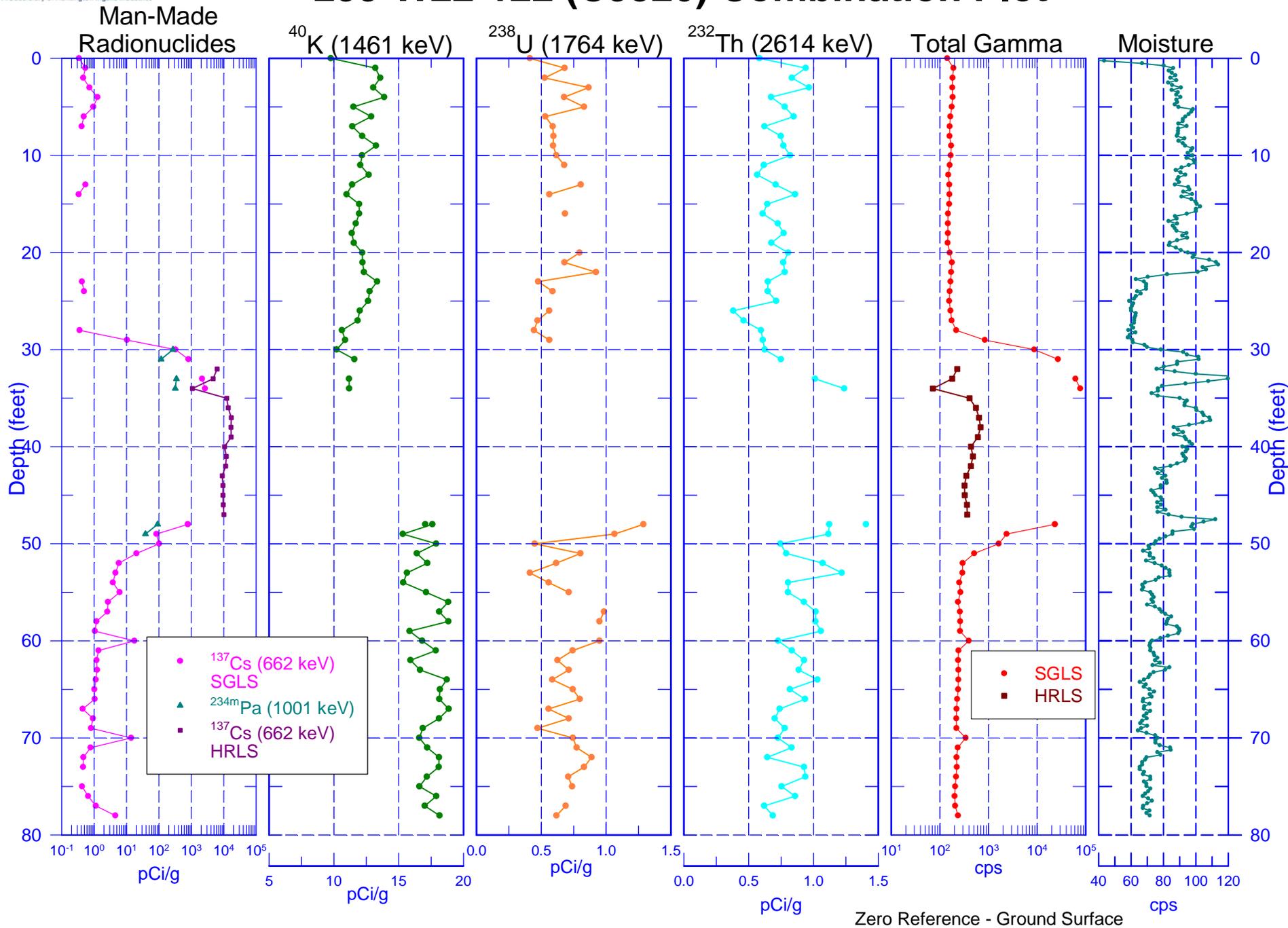
Zero Reference - Ground Surface



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JUNE 2016

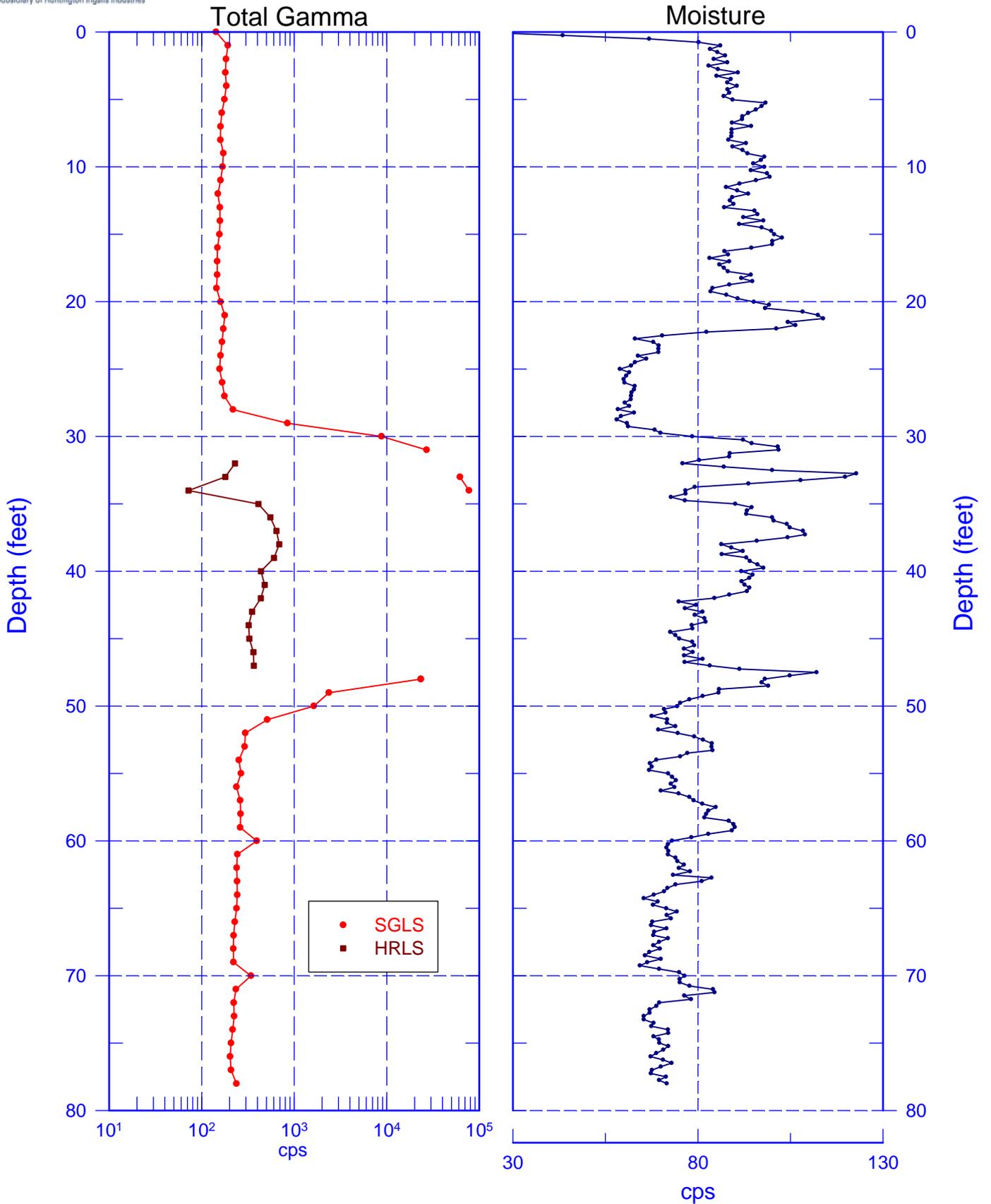
# 299-W22-122 (C9520) Combination Plot





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# 299-W22-122 (C9520) Total Gamma & Moisture

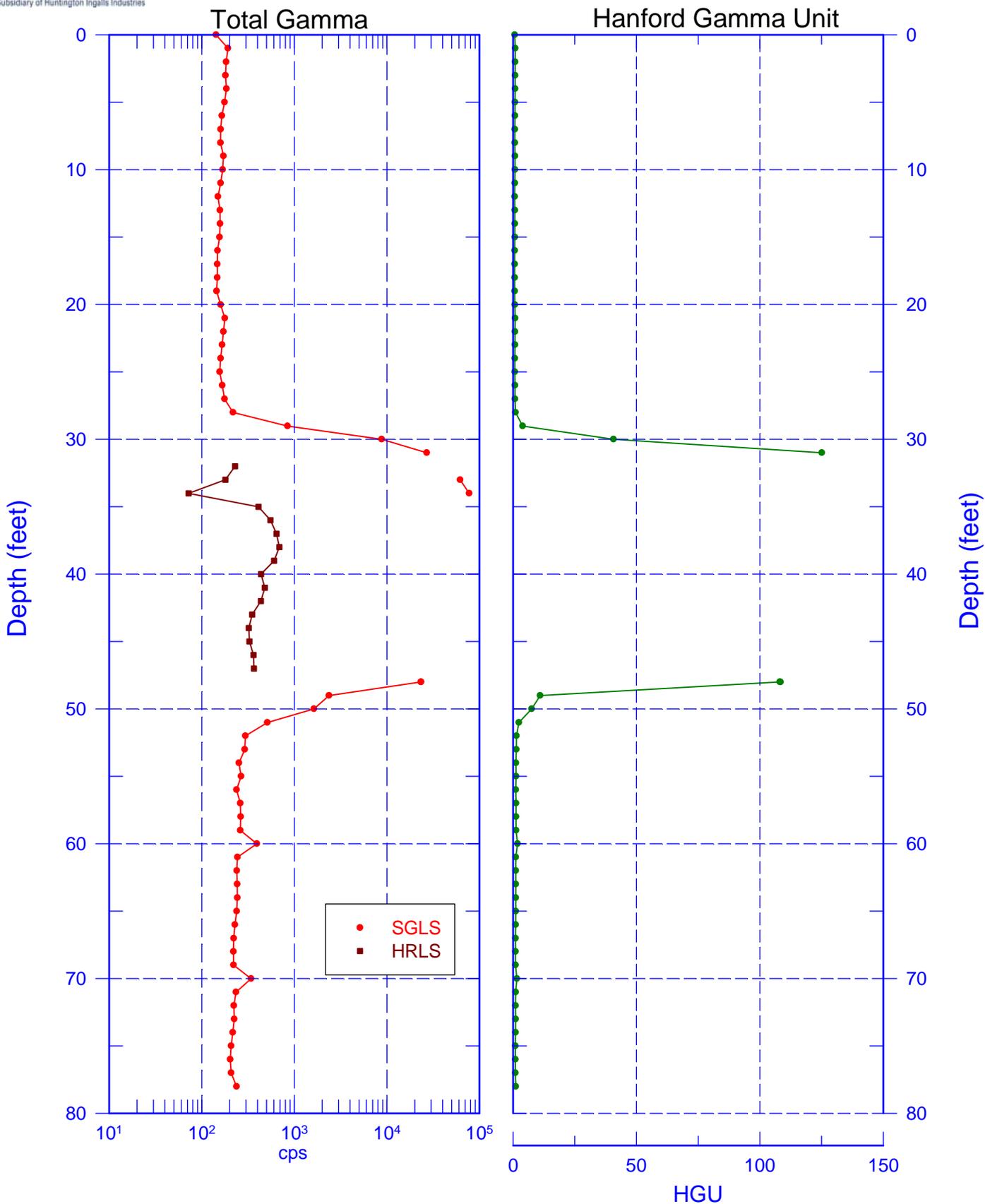


Zero Reference - Ground Surface



# 299-W22-122 (C9520)

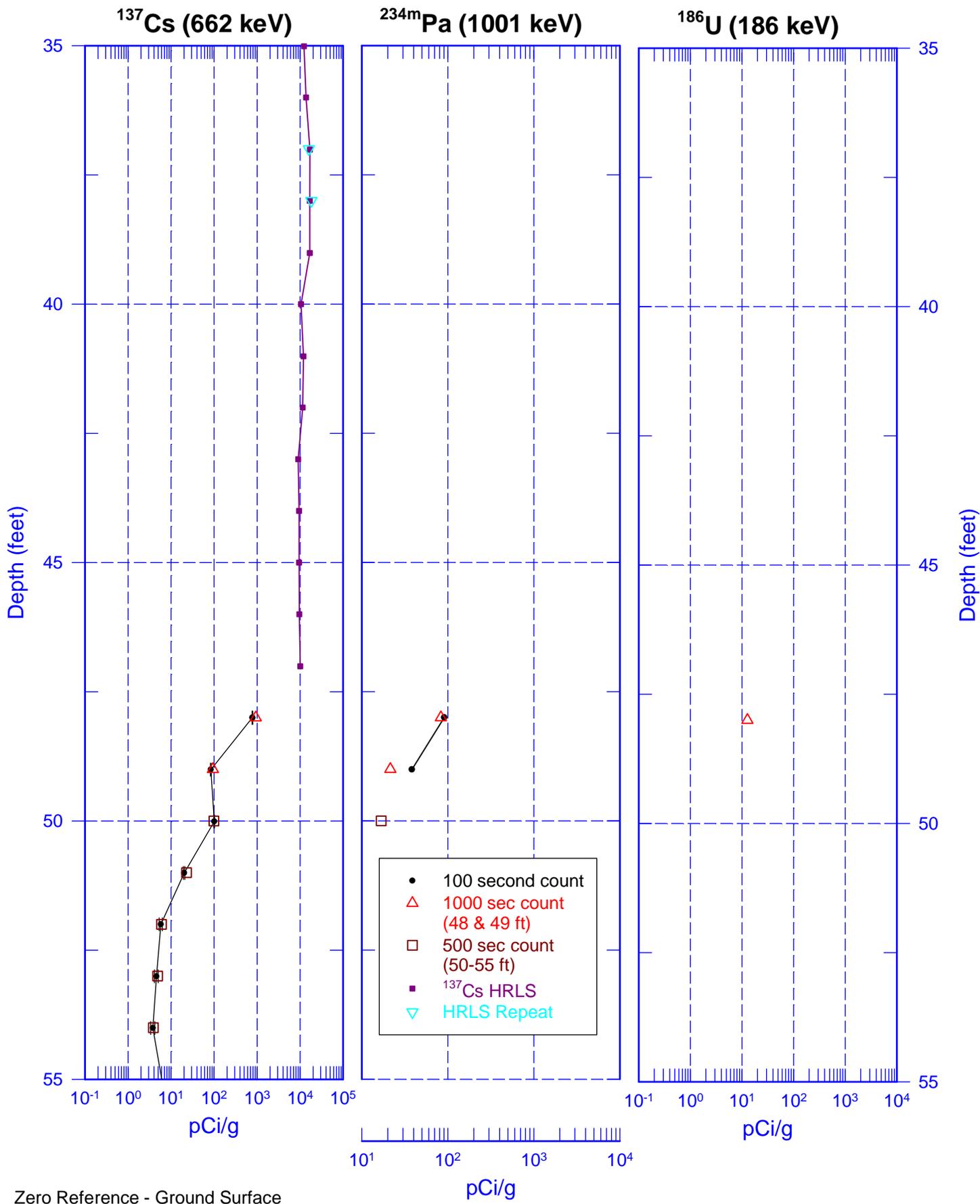
## Total Gamma & Hanford Gamma Unit



Zero Reference - Ground Surface



# 299-W22-122 (C9520) Manmade Radionuclides Repeat Data

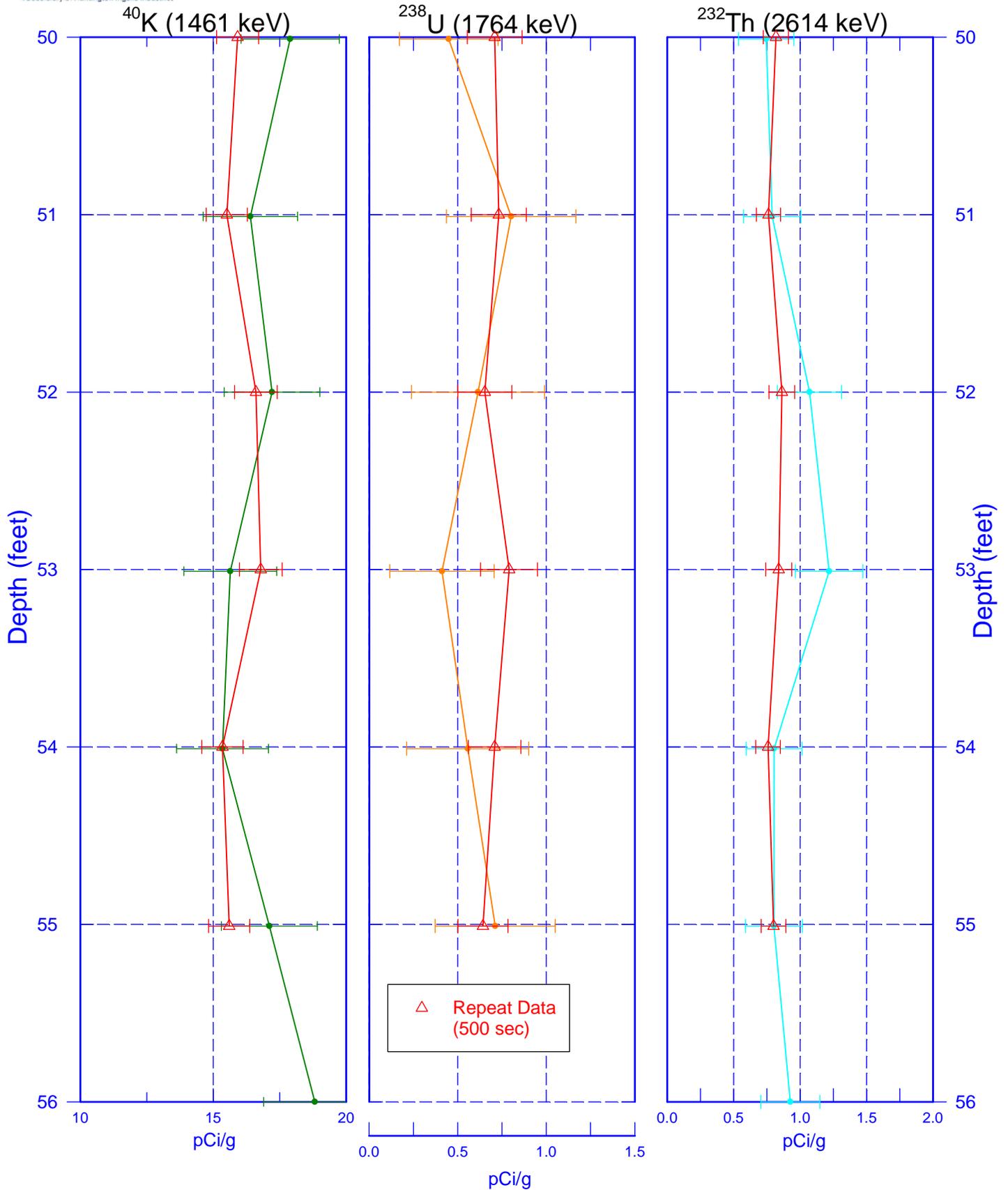


Zero Reference - Ground Surface



# 299-W22-122 (C9520)

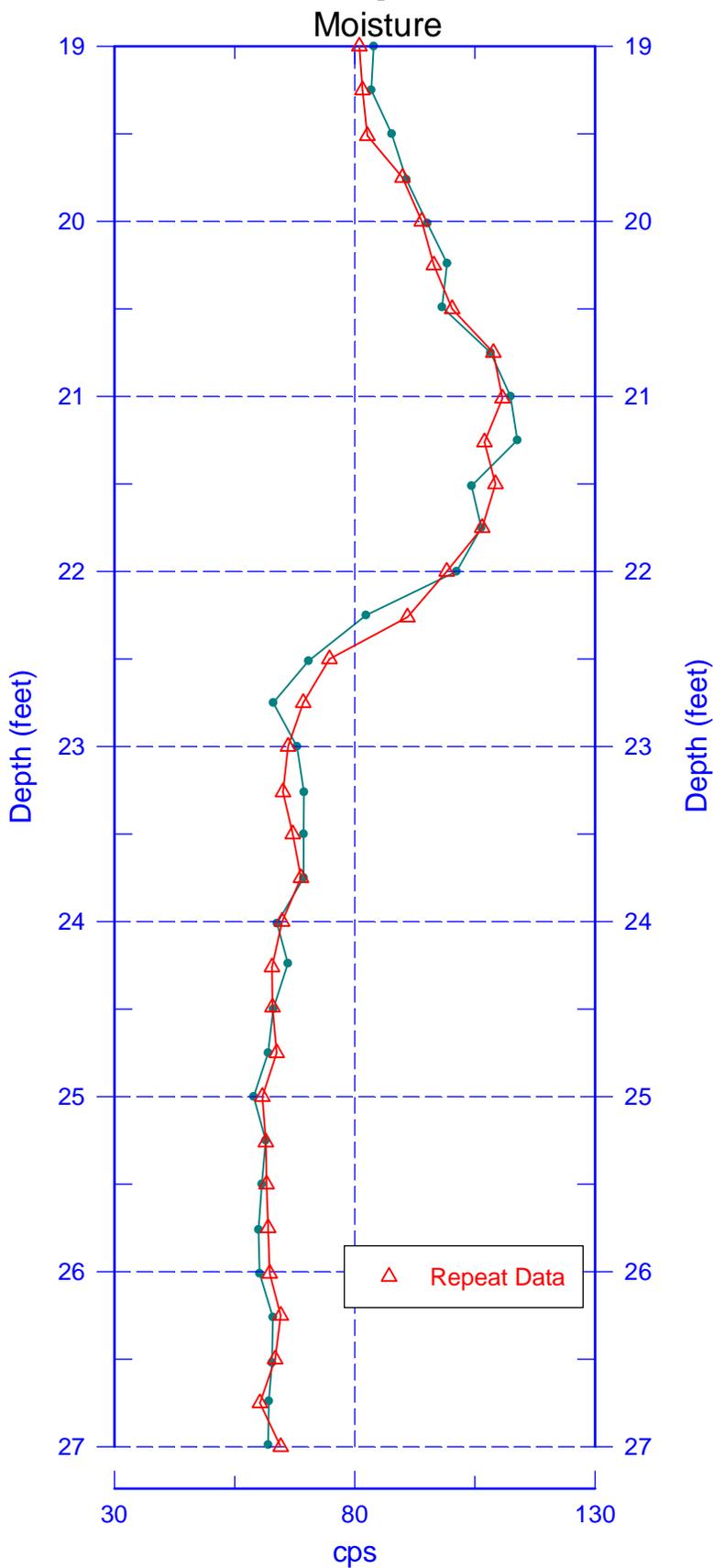
## Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



# 299-W22-122 (C9520) Moisture Repeat Section



Zero Reference - Ground Surface

<b>SURVEY DATA REPORT</b>				Page 1 of 3		
				Request No. 163-081		
Project No.		Title 200W Wells C9516 and C9520 Final Surveys		File No. 2WT12R26		
Job No. CACN: 303602-JPRC		Prepared By N.P. Fastabend		Date 5/5/16	Reviewer <i>UBM</i>	
<b>DESCRIPTION OF WORK</b>				<b>DISTRIBUTION</b>	<b>SDR</b>	<b>PLOT</b>
Obtained final coordinates and elevation of brass cap marker for decommissioned Well C9516 (299-W22-118) and final coordinates and elevations of completed Well C9520 (299-W22-122) in 200W Area.  Horizontal Datum: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)				Survey File	OR	
				J.E. Fritts	1	
				K.M. Whitley	1	
				J.L. Smoot	1	
				J.B. Geiger	1	
				B.J. Howard	1	
				A.J. Green	1	
<b>SURVEY RESULTS AND COMMENTS</b>						
See Attached Well Survey Data Report Sheets						
<b>FOR OFFICE USE ONLY</b>						
OR Doc Type:			WMU Code(S):			

## WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 05/03/16	Requestor: Kelly M. Whitley (CHPRC)
Date of Survey: 05/05/16	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtained final survey coordinates and elevation of Brass Cap Marker in concrete for Decommissioned Well C9516 (299-W22-118) located in 200W Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 200W

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
Washington State Reference Network

Well ID	Well Name	Easting	Northing	Elevation	
					Center of Casing
					"X" on Rim
C9516	299-W22-118	567616.16	134669.04	212.47	Brass Survey Marker

**Notes:**

Equipment Used: Trimble R8 RTK GPS

**Surveyor Statement:**

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 05/03/16	<b>Requestor:</b> Kelly M. Whitley (CHPRC)
<b>Date of Survey:</b> 05/05/16	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9520 (299-W22-122) located in 200W Area.	<b>Horizontal Datum:</b> NAD83(91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 200W

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
2W-53 (CHPRC) and 2W-57 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9520	299-W22-122	567615.93	134663.00		Center of Casing
				212.134	"X" on Rim
				212.137	Brass Survey Marker

**Notes:**

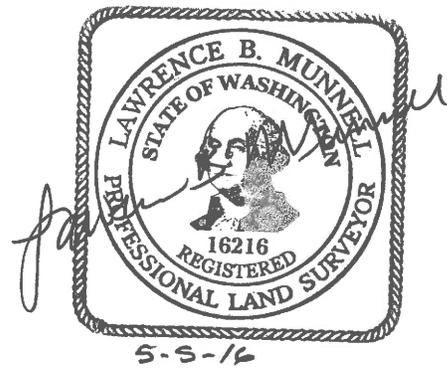
211.966 Top Inner 2" PVC Casing, N.Edge

"X" on Rim is stamped "X" on top of Outer 18" Protective Casing, North Edge

**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.



5-5-16