

Borehole Summary Report for the Installation of Two Dual Purpose Wells in the 200-BP-5 Operable Unit, FY2019

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

CH2MHILL
Plateau Remediation Company

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Terms

bgs	below ground surface
Carpenter	Carpenter Drilling Company
CCU	Cold Creek unit
CCU _g	Cold Creek gravel unit
CCU _z	Cold Creek silt unit
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CHPRC	CH2M HILL Plateau Remediation Company
DOW	description of work
Ecology	Washington State Department of Ecology
HCl	hydrochloric acid
Hf1	gravel-dominated Hanford formation
Hf2	sand-dominated Hanford formation
Hf3	slack water and interflood-deposited Hanford formation
LEL	lower explosive limit
NAD83	<i>North American Datum of 1983</i>
NAVD88	<i>North American Vertical Datum of 1988</i>
NMLS	neutron moisture logging system
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
SAP	sampling and analysis plan
SGLS	spectral gamma logging system
TD	total depth
VOC	volatile organic compound

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1 Introduction

This borehole summary report provides an overview of the well drilling and construction activities performed during installation of two dual-purpose wells in the 200-BP-5 Groundwater Operable Unit (OU) along the River Corridor of the Hanford Site (Figure 1). SGW-62828, *Description of Work for the Installation of Two Dual Purpose Wells and Two Monitoring Wells in the 200-BP-5 Groundwater Operable Unit, FY 2019* (hereinafter referred to as the description of work [DOW]), is the controlling document for installation of the two new wells.

The two wells were drilled, constructed, and developed between February 26 and September 13, 2019, by Carpenter Drilling Company (Carpenter) for CH2M HILL Plateau Remediation Company (CHPRC). Well site geology, well drilling documentation, and construction documentation services were provided by GRAM Northwest, LLC. Geophysical logging services were provided by Bay West, LLC.

The new wells were installed to provide improved delineation of the target contaminant plumes in groundwater in addition to monitoring removal action performance. Installation of the new wells supports Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*. The wells were installed in compliance with the *Resource Conservation and Recovery Act of 1976* and the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).

Table 1 lists the well names, well identification numbers, Washington State Department of Ecology (Ecology) unique well tag numbers, and installation dates for the two new wells. Well summary sheets, borehole logs, geophysical log data reports, final civil survey reports, photo logs, and well development and testing data sheets are presented in Appendix A for well 299-E28-34 (C9752) and in Appendix B for well 299-E27-137B (C9753). Figure 2 shows the well locations.

1.1 Drilling, Sampling, and Well Construction Activities

This section summarizes the field activities associated with installation of dual-use wells 299-E28-34 (C9752) and 299-E27-137B (C9753).

1.2 General Information

The two new wells were constructed in accordance with the substantive requirements of WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells,” and the construction specifications identified in the DOW (SGW-62828). All well drilling and construction activities were documented in daily field activity reports, and borehole geology was logged. The sampling activities are outlined in DOE/RL-2017-69, *Sampling and Analysis Plan for Drilling Removal Action Wells in the 200-BP-5 Operable Unit*, (hereinafter referred to as the sampling and analysis plan [SAP]), which also includes the review comment record for the SAP.

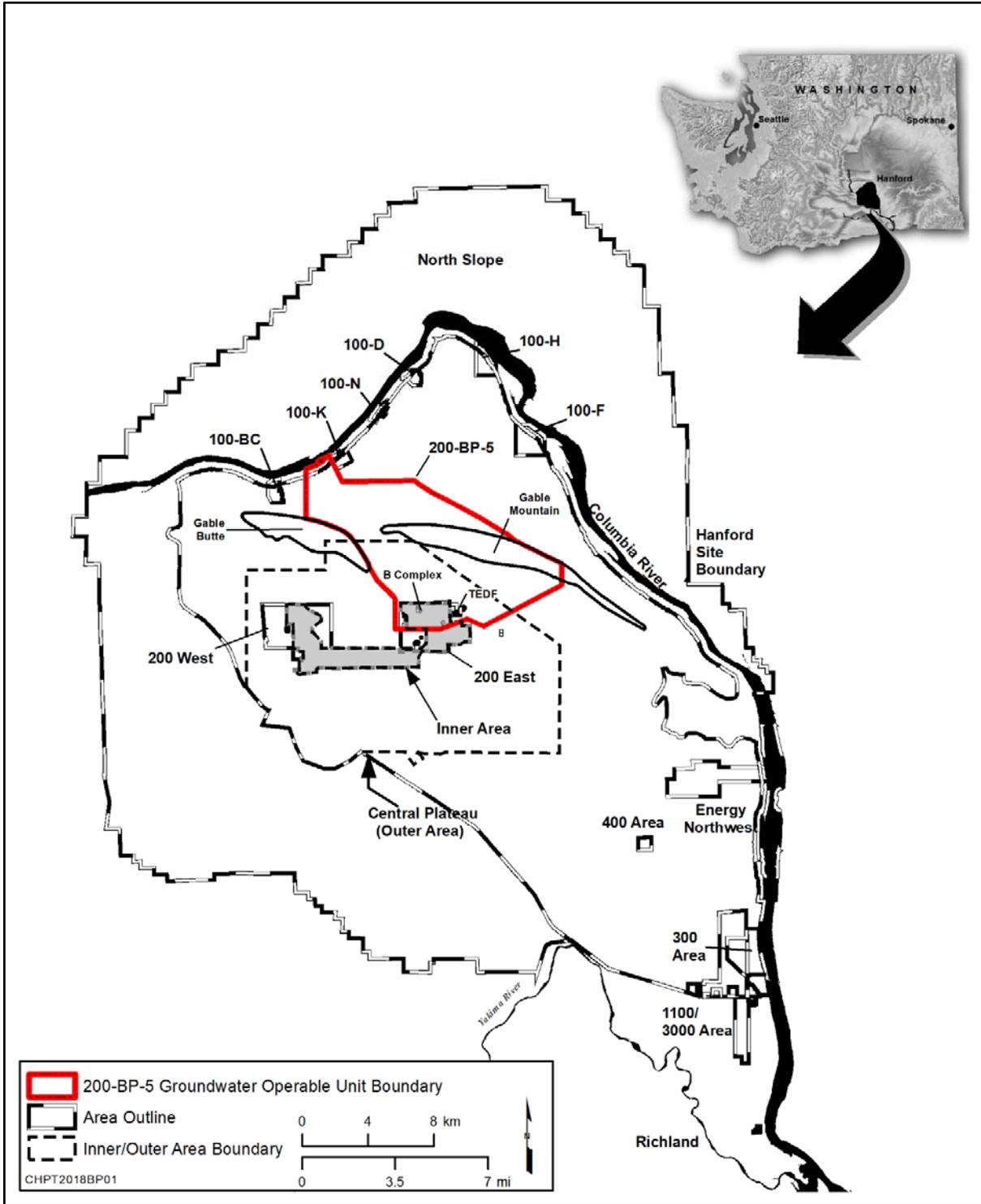


Figure 1. Hanford Site Map Showing the 200-BP-5 OU

Table 1. Well Identification and Drilling Date Summary

Well ID Number	Well Name	Well Installation Date		Ecology Well Tag Number
		Start	Finish	
C9752	299-E28-34	2/26/2019	7/18/2019	BLD034
C9753	299-E27-137B	5/28/2019	9/13/2019	BLD032

Ecology = Washington State Department of Ecology
 ID = identification

1.2.1 Drilling, Sampling, and Borehole Logging

The drilling, sampling, and borehole logging activities for installing the two new dual-purpose wells are summarized in the following sections.

1.2.1.1 Drilling

Boreholes C9752 and C9753 were drilled using a Wellmaster¹ 1500 cable tool rig operated by Carpenter. Borehole C9752 was drilled using a 16 in. outer-diameter (OD) carbon steel casing to a depth of 45.2 m (148.25 ft) below ground surface (bgs) and a 12 in. OD carbon steel casing to total depth (TD) at 87.0 m (285.53 ft) bgs. Borehole C9753 was drilled with a 16 in. OD carbon steel casing to a depth of 39.3 m (129.07 ft) bgs and a 12 in. OD carbon steel casing to a TD of 99.1 m (325.14 ft) bgs. The 16 in. casing was advanced using a 16 in. OD, 15 in. inner-diameter shoe. The 12 in. casing was advanced using a 12.75 in. OD, 12 in. inner-diameter shoe.

1.2.1.2 Sampling

Sampling was conducted in accordance with the DOW (SGW-62828) and the SAP (DOE/RL-2017-69). Geologic grab samples were collected and archived at 1.5 m (5 ft) intervals and at major lithologic changes during the drilling of each borehole. Archive grab samples were placed in labeled pint-size glass mason jars and in labeled plastic chip tray compartments for storage. Additional grab samples were collected every 1.5 m (5 ft) throughout the screened interval for particle size distribution analysis (sieve analysis). Sieve analyses of the collected samples were performed to determine the filter pack and well screen slot size for well construction.

The collection of split-spoon or grab samples varied by borehole:

- Borehole C9752: three split-spoon samples at depths estimated based on geology at nearby wells
- Borehole C9753: two split-spoon samples at depths estimated based on geology at nearby wells

During drilling, groundwater samples were collected at both of the new wells. Depth-discrete groundwater samples were collected within the unconfined aquifer for laboratory analysis to determine the vertical profile of groundwater contamination and for subsequent plume characterization. A post-development groundwater sample was also collected during final development of each well for laboratory analysis to confirm field test results and quantify other potential contaminants. All samples for chemical analysis were collected by CHPRC nuclear chemical operators. Section 2.2 provides additional well-specific sampling information.

¹ Wellmaster is a tradename of Wellmaster Pipe & Supply Inc., Tillsonburg, Ontario, Canada.



Figure 2. Locations of the Two New Wells in the 200-BP-5 OU

1.2.1.3 Geophysical Logging

The two new boreholes were logged using a spectral gamma logging system (SGLS) to detect natural and manmade gamma-emitting radionuclides and a neutron moisture logging system (NMLS) to detect the soil moisture in the vadose zone. Each borehole was drilled using multiple sizes of temporary casing (described in Section 1.1). Each borehole was logged prior to downsizing the casing, as well as after drilling to TD.

1.2.2 Health and Safety Screening

The health and safety screening included radiological field screening and air monitoring for volatile organic compounds (VOCs) and lower explosive limit (LEL), as discussed in the following sections.

1.2.2.1 Radiological Field Screening

A radiological control technician provided full-time support prior to drilling reaching 4.6 m (15 ft) bgs and then performed radiological surveys twice daily (once in the morning and once in the afternoon) during drilling, construction, and development activities. The radiological control technician conducted the surveys using standard radiological field screening instruments to detect any contaminants with alpha, beta, or gamma radiation on drill cuttings, geologic samples, temporary casings, and any other equipment that was used downhole. Radiological contamination was not detected above background levels during drilling activities at either borehole.

1.2.2.2 Air Monitoring for Volatile Chemicals

An industrial hygiene technician performed atmospheric monitoring twice daily (once in the morning and once in the afternoon) during drilling activities. The industrial hygiene technician used a photoionization detector and a multi-gas meter to confirm acceptable atmospheric conditions during drilling. Conditions monitored using the photoionization detector included total VOCs. Conditions monitored using the multi-gas meter included carbon monoxide, hydrogen sulfide, LELs, ammonia, and oxygen. The LEL wellhead monitoring was required prior to welding activities. Areas monitored for VOCs included the

driller's breathing zone near the wellhead, the wellhead or source, any fresh drill cuttings and/or geologic samples, and any other areas of potential concern. All readings recorded were below action levels.

1.2.3 Well Construction and Development

This section provides additional details on the well construction and development activities.

1.2.3.1 Screen and Casing Materials

Each well was constructed with permanent casing consisting of 8.63 in. OD, 8.38 in. inner-diameter stainless steel. Schedule 10S Type 304/304L stainless-steel blank casing, continuous wire-wrap well screen, and sumps with end caps. Screens used at both wells were continuous vee-wire wrap with a 50-slot (0.050 in.) aperture, and each well used a 1 m (3 ft) sump (i.e., 1 m [3 ft] of blank with a welded end cap) located below the screened interval. Well 299-E28-34 (C9752) was constructed using one 7.62 m (25.00 ft) section of screen (as described above). Well 299-E27-137B (C9753) was constructed using two 7.62 m (25.00 ft) sections of screen (as described above), separated by a 3 m (10.00 ft) stainless-steel blank. Section 2.2 provides further details on the construction materials used for each well.

1.2.3.2 Well Completion

A straightness test was conducted in each well with a tool that was 6.1 m (20 ft) in length with a 10 in. OD for both wells. The test was conducted prior to setting the permanent well in accordance with the substantive requirements of WAC 173-160.

The screen size and filter pack size used for construction were determined based on sieve analysis results, geologic borehole logs, geophysical logs, and intended well use. The two wells were constructed with a filter pack consisting of 8-16 mesh Colorado silica sand. The filter pack was settled using a dual-flange surging method. The top of the filter packs for wells 299-E28-34 (C9752) and 299-E27-137B (C9753) were set at 77.83 m (255.34 ft) bgs and 94.21 m (309.10 ft) bgs, respectively.

The annular seals for the two wells used 3/8 in. coated bentonite pellets immediately above the silica filter pack of the uppermost screened interval as an ~1 m (3 ft) seal, followed by granular #8 (8-20 mesh) bentonite crumbles. The top of the annular seals for wells 299-E28-34 (C9752) and 299-E27-137B (C9753) were set at 76.96 m (252.50 ft) bgs and 92.75 m (304.30 ft) bgs, respectively. The granular bentonite was placed from the top of the bentonite pellet seal to ~3 m (10 ft) bgs. Type I/II Portland neat cement was used for the surface seal and was placed from the top of the granular bentonite to the ground surface. Any remaining unfilled annular space was filled with high-strength concrete during well pad construction.

The surface completion consists of the permanent casing surrounded by a stainless-steel protective monument with a unique Ecology well tag number riveted to the monument. Each surface completion has a 1.2 m by 1.2 m by 15.2 cm (4 ft by 4 ft by 6 in.) concrete pad constructed around the wellhead protective monument. The wells are located within the center of the concrete pad with a brass surveyor's marker (stamped with the well name, identification number, and date of final construction) imbedded on the northern side of the pad. The monuments have a lockable cap, and the lock hasps were positioned to face northward. The surface completion also includes four steel bollards (1.8 m [6 ft] long and 7.6 cm [3 in.] diameter, one of which is removable) placed at the four corners of each concrete pad, with 0.9 m (3 ft) stickup for wellhead protection. The bollards were painted yellow in accordance with ANSI Z535.1-2017, *American National Standard for Safety Colors*, for increased visibility of physical hazards. Section 2.2 provides further details on well construction.

1.2.3.3 Final Well Development

Final well development for the two wells was conducted during construction activities, after the filter pack was added and settled and before the bentonite pellet seal was placed. Well 299-E28-34 (C9752) was developed in one interval within the 8 in. diameter stainless-steel casing near the bottom of the screened section, while well 299-E27-137B (C9753) was developed near the bottom of both screened sections using two intervals ~6.4 m (21.1 ft) apart. The groundwater was pumped while water quality parameters (turbidity, conductivity, dissolved oxygen, pH, and temperature) were monitored. Each development interval was completed when the turbidity read <5 nephelometric turbidity units (NTUs) and the remaining water quality parameters stabilized. A LevelTROLL[®] 700 datalogger was used to record the drawdown and recovery data during development activities. Table 2 provides the final water quality data for each well interval. Well development and testing data sheets are provided in Appendix A for well 299-E28-34 (C9752) and in Appendix B for well 299-E27-137B (C9753).

1.2.3.4 Washington State Department of Ecology Well Identification

Each well received a unique Ecology well identification number that was embossed onto a stainless-steel tag and riveted to the protective monument. When the monuments were set, all identification tags were set to face toward the north. Table 1 lists the Ecology tag numbers and the associated wells.

1.3 Well-Specific Information

This section summarizes the drilling, air monitoring, sampling, geophysical logging, construction, and development activities specific to each new well.

1.3.1 Well 299-E28-34 (C9752)

Well 299-E28-34 (C9752) was installed between February 27 and July 18, 2019. The borehole was drilled to a TD of 87.90 m (288.40 ft) bgs. Drilling began on February 27 using the cable tool drill rig. The first string of casing used during drilling was 16 in. OD carbon steel casing with threaded joints that was advanced to a depth of 45.19 m (148.25 ft) bgs. The second temporary string of casing used was 12.75 in. OD carbon steel with threaded joints and was advanced to a final depth of 87.03 m (285.53 ft) bgs. The borehole was advanced to a final depth of 87.90 m (288.40 ft) bgs on May 21. A final pre-development static water level was tagged at 80.08 m (262.72 ft) on May 20.

Sampling at well 299-E28-34 (C9752) included collecting soil samples for geologic archival purposes, composited soil sieve samples for sieve analysis, three split-spoon samples, and one grab sample, as well as two groundwater samples during drilling and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals and at lithology changes throughout the borehole. Samples for sieve analysis were collected as 3.0 m (10 ft) composites of each 1.5 m (5 ft) soil grab sample from the top of the water table to the top of the basalt. In addition, three split-spoon samples were collected for Pacific Northwest National Laboratory in the saturated zone: approximately one in the upper, one in the middle, and one in the lower saturated zone at ~81.0 m, 83.7 m, and 86.7 m (265.9 ft, 274.7 ft, and 284.3 ft) bgs, respectively. One waste characterization grab sample was collected at ~81.0 m (265.9 ft) bgs in the saturated zone. Two groundwater characterization samples were collected at ~83.78 and 86.45 m (274.86 and 283.64 ft) bgs during drilling to delineate the vertical extent of contamination. A single groundwater sample was also collected during well development at 78.05 m (256.06 ft) bgs. Table 3 provides summary information for the samples collected for chemical analysis.

LevelTROLL[®] is a registered trademark of In-Situ, Inc., Fort Collins, Colorado.

Table 2. Well Development Data Summary

Well ID Number	Well Name	Date Developed	Initial Water Level (ft bgs)	Pump Intake Depth (ft bgs)	Duration Pumped (minutes)	Average Flow Rate (gal/min)	Maximum Drawdown (ft)	Final Turbidity (NTU)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	pH	Temperature (°C)	Total Gallons Pumped
C9752	299-E28-34	7/2/2019	261.58	281.70	64	~75	0.06	0.56	469	7.69	7.95	18.38	~4,800
C9753	299-E27-137B	9/6/2019	282.98	318.90	25	~75	0.06	0.65	664	7.78	7.51	20.00	~2,100
		9/6/2019	283.05	297.80	131	~80 Adjusted ~60 (after 1,002 gal)	0.04	0.28	636	7.83	7.69	20.40	~10,200

bgs = below ground surface
 ID = identification
 NTU = nephelometric turbidity unit

Table 3. Sample Summary for Well 299-E28-34 (C9752)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
5/1/2019	I-001	265.90 – 268.40	Soil	Split spoon	B3NN65
5/1/2019	Waste 1	265.90 – 268.40	Soil	Grab	B3NNR9
5/8/2019	I-002	274.70 – 276.20	Soil	Split spoon	B3NN66
5/9/2019	I-003	284.30 – 286.80	Soil	Split spoon	B3NN67
5/7/2019	I-004	274.86	Water	Pumped	B3NN68 (filtered), B3NN69
5/14/2019	I-005	283.64	Water	Pumped	B3NN70, B3NN71, B3NN72
7/2/2019	Post-development	256.06	Water	Pumped	B3NN76

bgs = below ground surface

HEIS = Hanford Environmental Information System

Geophysical logging was performed through the 16 in. OD casing using NMLS from the surface to 45.11 m (148.01 ft) bgs and using SGLS from the surface to 44.81 m (147.01 ft) bgs on April 3. Geophysical logging was performed through the 12.75 in. OD casing using NMLS from 44.8 to 80.09 m (147.0 to 262.75 ft) bgs on April 28 and 29 and using SGLS from 44.5 to 87.48 m (146.0 to 287.01 ft) bgs on April 28. Manmade radionuclides were not detected in the borehole. Appendix A provides the geophysical logging report for well 299-E28-34 (C9752) (HGLP-LDR-1087).

Well completion activities began on June 18 with a straightness test. Carpenter performed a straightness test with a 6.1 m (20 ft) long, 10 in. OD tester, which passed through the 12 in. inner-diameter temporary casing without binding. Well installation continued on June 18 using 8 in. inner-diameter and 8-5/8 in. OD, Schedule 10S Type 304/304L stainless-steel blank casing, screen, and sump. A total of 7.62 m (24.99 ft) of continuous vee-wire wrap, stainless-steel screen with a 50-slot (0.050 in.) aperture was used. Stainless-steel centralizers were placed at the bottom and top of the screen interval and at every 12.2 m (40 ft) thereafter. Table 4 provides information on the well construction materials and associated depths for well 299-E28-34 (C9752), and Appendix A provides the well summary sheet.

Development at well 299-E28-34 (C9752) was performed during construction, prior to adding the final bentonite pellet seal. Development operations were conducted on July 2. One development interval was conducted to complete development using a 10-horsepower submersible pump. The average purge rate for the interval was ~284 L/min (75 gal/min). Before development is complete, the turbidity must decrease to <5 NTUs and the other key parameters (specific conductance, pH, and temperature) must stabilize. A total of ~25,200 L (6,300 gal) of water was purged to meet these development requirements. Table 2 presents the results for the development interval for this well, and Appendix A provides the well development and testing data sheet.

Table 4. Construction Summary for Well 299-E28-34 (C9752)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	8 in. Diameter Stainless-Steel Permanent Casing Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
288.40	262.72 (5/20/2019)	Stainless-steel monument	+3.00 – 2.00	N/A	Portland cement	0.0 – 9.08	Type I/II
		Stainless-steel blank casing	+1.96 – 259.99	N/A	Bentonite crumbles	9.08 – 252.50	8-20
		Stainless-steel screen	259.99 – 284.98	0.050	Bentonite pellets	252.50 – 255.34	N/A
		Stainless-steel sump	284.98 – 287.98	N/A	Filter pack sand	255.34 – 288.20	8-16
					Natural fill	288.20 – 288.40	N/A

bgs = below ground surface

N/A = not applicable

1.3.2 Well 299-E27-137B (C9753)

Well 299-E27-137B (C9753) was installed between May 28 and September 13, 2019. The borehole was drilled to a TD of 99.44 m (326.25 ft) bgs. Drilling began on May 28 using the cable tool drill rig. The first string of casing used during drilling was 16 in. OD carbon steel casing with threaded joints that was advanced to a depth of 39.30 m (130.39 ft) bgs. The second temporary string of casing was 12.75 in. OD carbon steel with threaded joints and was advanced to a final depth of 99.10 m (325.14 ft) bgs. The borehole was advanced to a final depth of 99.44 m (326.25 ft) bgs with an 8 in. OD core barrel on August 27. A final predevelopment static water level was tagged at 86.28 m (283.00 ft) on August 20.

Sampling at well 299-E27-137B (C9753) included collecting soil samples for geologic archival purposes, composited soil sieve samples for sieve analysis, two split-spoon samples, and two grab samples, as well as four groundwater samples during drilling and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals and at lithology changes throughout the borehole. Samples for sieve analysis were collected as 3.0 m (10 ft) composites of each 1.5 m (5 ft) soil grab sample from the top of the water table to the top of the basalt. In addition, two split-spoon samples were collected in the vadose zone for Pacific Northwest National Laboratory: one approximately in the upper vadose zone, and one in the lower vadose zone at ~54.8 and 82.4 m (179.7 and 270.3 ft) bgs. Two waste characterization grab samples were collected: one in the vadose zone at ~27.2 m (89.3 ft) bgs, and one in the saturated zone at ~93.3 m (306.0 ft) bgs. Four groundwater samples were collected at ~89.19 m, 92.05 m, 95.05 m, and 98.15 m (292.63 ft, 302.00 ft, 311.86 ft, and 322.0 ft) bgs during drilling for vertical delineation of contamination. A single groundwater sample was also collected during well development at 90.78 m (297.8 ft) bgs. Table 5 provides summary information for the samples collected for chemical analysis.

Table 5. Sample Summary for Well 299-E27-137B (C9753)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
6/6/2019	Waste 1	89.30 – 91.30	Soil	Grab	B3NNT0
6/24/2019	I-001	179.70 – 182.20	Soil	Split spoon	B3NN78
7/9/2019	I-002	270.30 – 272.80	Soil	Split spoon	B3NN79
7/12/2019	I-003	292.63	Water	Pumped	B3NN80, B3NN81 (field)
7/16/2019	I-004	302.00	Water	Pumped	B3NN82, B3NN83 (field), B3NN84 (DUP)
7/16/2019	Waste 2	306.00 – 307.50	Soil	Grab	B3NNT1
7/18/2019	I-005	311.86	Water	Pumped	B3NN86, B3NN87 (field)
7/23/2019	I-006	322.00	Water	Pumped	B3NN88, B3NN89 (field)
9/6/2019	Post-development	297.80	Water	Pumped	B3NN92, B3RW06, B3NN93 (field)

bgs = below ground surface

HEIS = Hanford Environmental Information System

Geophysical logging was performed through the 16 in. OD casing using NMLS from the surface to 39.47 m (129.51 ft) bgs on June 13 and using SGLS from the surface to 39.3 m (129.0 ft) bgs on June 12 and June 13. Geophysical logging was performed through the 12.75 in. OD casing using NMLS from 39.0 to 287.75 m (128.0 to 287.75 ft) bgs on July 26 and using SGLS from 39.0 to 99.1 m (128.0 to 325.0 ft) bgs on July 25 and July 26. Manmade radionuclides were not detected in the borehole. Appendix B provides the geophysical logging report for well 299-E27-137B (C9753) (HGLP-LDR-1096).

Well completion activities began on July 24 with a straightness test. Carpenter performed a straightness test with a 6.1 m (20 ft) long, 11-1/2 in. OD tester, which passed through the 12 in. inner-diameter temporary casing without binding. Well installation began on August 15 using 8 in. inner-diameter and 8-5/8 in. OD, Schedule 10S Type 304/304L stainless-steel blank casing, screen, and sump. A total of 10.67 m (35.00 ft) of continuous vee-wire wrap, stainless-steel screen with a 50-slot (0.050 in.) aperture was used. Stainless-steel centralizers were placed at the bottom and top of the screen interval and at every 12.2 m (40 ft) thereafter. Table 6 provides information on the well construction materials and associated depths for well 299-E27-137B (C9753), and Appendix B provides the well summary sheet.

Development at well 299-E27-137B (C9753) was performed during construction, prior to adding the final bentonite pellet seal. Development operations were conducted on September 6. Two development intervals at ~6.1 m (20 ft) increments were conducted to complete development using a 10-horsepower submersible pump. The maximum purge rate for the first interval was ~284 L/min (75 gal/min), and the maximum purge rate for the second interval was ~320 L/min (80 gal/min). For all development intervals, the requirement was to pump until the turbidity decreased to <5 NTUs and until other key parameters (specific conductance, pH, and temperature) stabilized. A total of ~46,560 L (12,300 gal) of water was purged during development. Table 2 presents the results for the two development intervals for this well, and Appendix B provides the well development and testing data sheet.

Table 6. Construction Summary for Well 299-E27-137B (C9753)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	8 in. Diameter Stainless-Steel Permanent Casing Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
326.25	283.06 (9/13/2019)	Stainless-steel monument	+3.00 – 2.00	N/A	Portland cement	0.0 – 10.2	Type I/II
		Stainless-steel blank casing	+2.00 – 277.14	N/A	Bentonite crumbles	10.2 – 266.7	#8
		Stainless-steel screen	277.14 – 302.14	0.050	Bentonite pellets	266.7 – 273.2	3/8 in.
		Stainless-steel blank casing	302.14 – 312.13	N/A	Filter pack sand	273.2 – 304.3	8-16
		Stainless-steel screen	312.13 – 322.13	0.050	Bentonite pellets	304.3 – 309.1	3/8 in.
		Stainless-steel sump	322.13 – 325.13	N/A	Filter pack sand	309.1 – 325.4	8-16
Natural fill	325.4 – 326.25				N/A		

bgs = below ground surface

N/A = not applicable

2 Geologic Observations

This chapter summarizes the general geology of the 200-BP-5 OU and the geology encountered at each of the well sites during drilling.

2.1 Geology of the 200-BP-5 Operable Unit

The 200-BP-5 OU is in the northern portion of the 200 East Area, which is on the eastern end of the Central Plateau, located ~32 km (20 mi) north-northwest of Richland, Washington (SGW-62828). The stratigraphy of this area is comprised of several different sedimentary deposits that lie above the Columbia River Basalt Group. The major units present in the 200-BP-5 OU include the following (from youngest to oldest):

- Holocene eolian deposits, disturbed sediments, and recent sand and gravel backfill
- Pleistocene gravel, sand and silt sediments of the Hanford formation
- Pliocene-Pleistocene coarse-grained sands and gravels with interbedded silts of the Cold Creek unit (CCU)
- Miocene-Pliocene Ringold Formation sediments:
 - Gravel and sand sediments of the Ringold Formation member of Wooded Island – unit A
- Miocene Elephant Mountain Member of the Saddle Mountains Basalt Formation of the Columbia River Basalt Group

In the northern portion of the 200 East Area, the unconfined aquifer is defined by semiconsolidated to consolidated ancestral Columbia River and lacustrine sediments of the Ringold Formation, which were incised later by unconsolidated Columbia River sediments of the CCU and high-energy glacial fluvial sediments of the Hanford formation. However, differentiating the Hanford sediments from the CCU sediments based on field observations is difficult in the 200 East Area (DOE/RL-2017-69; PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*). More recently, the ground surface of the 200-BP-5 OU has been extensively disturbed by grading, soil backfilling, construction, and demolition work. These disturbances generally range from 0.3 to 4.6 m (1 to 15 ft) bgs but can extend deeper (SGW-62828).

Additional information regarding the geology of the 200-BP-5 OU is presented in the following:

- BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*
- BHI-01648, *Late Pleistocene and Holocene-Age Columbia River Sediments and Bedforms: Hanford Reach Area, Washington, Part 1*
- DOE/RL-2014-33, *Sampling and Analysis Plan for the 200-BP-5 Groundwater Operable Unit*
- Lindsey, 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*
- WHC-SA-0740-FP, *Sedimentology and Stratigraphy of the Miocene-Pliocene Ringold Formation, Hanford Site, South-Central Washington*

Summaries of geologic units encountered throughout each borehole are presented in the following discussion.

2.2 Borehole Geology

This section describes the geologic characteristics and stratigraphic units that were observed from grab samples during drilling of the two new boreholes. Borehole logs are provided in Appendix A for well 299-E28-34 (C9752) and in Appendix B for well 299-E27-137B (C9753).

The interpretations included in this report regarding the stratigraphy of each drill site are based on field observations from drill cuttings collected every 1.5 m (5 ft) or where major lithologic changes occurred. Therefore, the depths of contacts included should be viewed as approximations. Final stratigraphic unit contacts will be determined based on field observations, borehole geophysical logging data, and regional stratigraphic interpretations.

Due to the drilling method used, geologic grab samples may appear more angular than the in situ formation. The samples collected may also appear more homogenous than the natural formation, as grab samples were collected in a 20 L (5 gal) bucket and transferred to a stainless-steel bowl prior to observation. Samples may also have a weakened reaction to 10% diluted hydrochloric acid (HCl) due to the presence of water added during the drilling process. The following sections discuss the determination of estimated stratigraphic unit contacts for each of the borehole summaries.

2.2.1 Well 299-E28-34 (C9752)

Interpretations described in this section have been determined by the author and may not align with the current regional geoframework model. Field observations described below are based on information recorded in the borehole log for this well. Appendix A provides the borehole log for C9752.

The major stratigraphic units encountered at well 299-E28-34 (C9752) after drilling past the gravel pad included the Hanford formation, the CCU, and the Elephant Mountain Member of the Saddle Mountains Basalt Formation.

The Hanford formation was observed beneath the gravel pad from a depth of ~0.2 to 68.6 m (0.5 to 225 ft) bgs, specifically as follows:

- The gravel-dominated Hanford formation (Hf1) was observed between ~0.2 and 9.1 m (0.5 to 30 ft) bgs based on the high concentrations of mafic gravels in a gray sand matrix. Geophysical logs (total gamma) also show a relative fining of sediments starting at ~6.0 m (20.0 ft) bgs. Sediments within this facies consisted of the following:
 - Gravelly sand, 0.2 to 1.5 m (0.5 to 5.0 ft) bgs: Light olive-brown silt and sands with a 25% overall gravel component. Gravels were 40 mm long on average, poorly sorted, and subangular to well-rounded in shape. Sediments reacted strongly with HCl.
 - Sandy gravel, 1.5 to 6.0 m (5.0 to 20.0 ft) bgs: Light olive-brown silt and sands with a 40% to 55% overall gravel component. Gravels were 25 mm on average, poorly sorted, and subangular to rounded in shape. Sediments reacted very strongly with HCl.
 - Gravelly sand, 6.0 to 9.1 m (20.0 to 30.0 ft) bgs: Light brownish-gray sands and silts with a 20% to 25% overall gravel component. Gravels were 5 mm on average, moderately sorted, and subangular to subrounded in shape. Sediments reacted very strongly with HCl.
 - Sand, 9.1 m (30 ft) bgs (contact with the sand-dominated Hanford formation [Hf2]).
- The Hf2 was observed between ~9.1 and 65.5 m (30.0 and 215.0 ft) bgs based on the relative lack of gravels and an increase in gray fine-grained sands and silts. Gray-brown sand with pockets of gravelly sands extended to the bottom of this facies at 65.5 m (215.0 ft) bgs. Sediments within this facies consisted of the following:
 - Sand, 9.1 to 30.5 m (30.0 to 100.0 ft) bgs: Light yellowish-brown, coarse-grained sands with a very small (<10%) gravel component. Sediments reacted strongly with HCl.
 - Gravelly sand, 30.5 to 33.5 m (100.0 to 110.0 ft) bgs: Light brownish-gray, coarse-grained sands with a 10% gravel component. Gravels were 2 to 11 mm on average, well sorted, and subangular to subrounded in shape. Sediments reacted strongly with HCl.
 - Sand, 33.5 to 50.0 m (110.0 to 164.0 ft) bgs: Light brownish-gray, coarse-grained sands with a very small gravel component. Sediments reacted strongly with HCl.
 - Gravelly sand, 50.0 to 50.6 m (164.0 to 166.0 ft) bgs: A 20% gravel component was observed in the sands. Gravels were 5 mm on average, poorly sorted, and subangular to subrounded in shape. Sediments reacted strongly with HCl.
 - Sand, 50.6 to 55.5 m (166.0 to 182.0 ft) bgs: Return to light brownish-gray, coarse-grained sands with a very small gravel component. Sediments reacted strongly with HCl.
 - Gravelly sand, 55.5 to 59.5 m (182.0 to 195.0 ft) bgs: A 10% gravel component returned to sands. Gravels were 2 to 25 mm on average, well sorted, and subangular to subrounded in shape. Sediments reacted strongly with HCl.

- Sand, 59.5 to 68.6 m (182.0 to 215.0 ft) bgs: Return to light brownish-gray, coarse-grained sands with a very small gravel component. Sediments reacted strongly with HCl.
- Sandy gravel, 68.6 m (215.0 ft) bgs (contact with the slack water and interflood-deposited Hanford formation [Hf3]).
- The Hf3 was observed between ~65.5 and 68.6 m (215 and 225.0 ft) bgs based on the reintroduction of mafic gravel-dominant sediments with a small silt component. Geophysical data at this location also indicated an increase in moisture content at 68.6 m (215.0 ft) bgs, suggesting an overall fining of sediments. Sediments within this facies consisted of the following:
 - Sandy gravel, 65.5 to 68.6 m (215 to 225.0 ft) bgs: Olive-brown, coarse-grained sands with a 70% overall gravel component. Gravels were 2 to 145 mm on average, poorly sorted, and subrounded to well-rounded in shape. Sediments reacted slightly to HCl.
 - Silty-sandy gravel, 68.6 m (215.0 ft) bgs (contact with the CCU).

The CCU was observed beneath the Hanford formation from a depth of ~68.6 to 86.9 m (225 to 285 ft), specifically as follows:

- The Cold Creek silt unit (CCU_z) was observed in the form of a small silt component within otherwise sandy gravels at 68.6 m (225.0 ft) bgs. As such, the CCU_z facies was determined to be nearly nonexistent at this location.
- The Cold Creek gravel unit (CCU_g) was observed from a depth of ~68.6 to 86.9 m (225 to 285.2 ft) bgs based on a shift from brown-gray sands and basaltic gravels of the Hanford formation to brown sands, with increased concentration of felsic gravel more typical of the CCU_g. Sediments within this facies consisted of the following:
 - Silty-sandy gravel, 68.8 to 74.7 m (225.0 to 245.0 ft) bgs: Light brownish-gray and grayish-brown, fine- to medium-grained sands and silts coarsening with depth. Sediments contained a 40% to 60% overall gravel component. Gravels were 2 to 50 mm on average, moderately sorted, and subrounded to rounded in shape. Sediments reacted very strongly to HCl.
 - Sandy gravel, 74.7 to 86.9 m (245.0 to 288.4 ft) bgs: Light brownish-gray, fine- to medium-grained sands with a 45% to 75% overall gravel component. Gravels were 2 to 135 mm on average, poorly sorted, and angular to well-rounded in shape. Sediments reacted strongly to HCl.

The contact between the CCU and the Elephant Mountain Member of the Saddle Mountains Basalt Formation was observed during drilling at 86.9 m (285.2 ft) bgs and continued to TD at 87.9 m (288.4 ft) bgs. The contact between the CCU and basalt was identified in the field based on an abrupt halt to drilling shortly after chips of black basalt were noted in the cuttings.

The water level was measured at 80.05 m (262.65 ft) bgs on May 1, 2019.

2.2.2 Well 299-E27-137B (C9753)

Interpretations described in this section have been determined by the author and may not align with the current regional geoframework model. Field observations described below are based on information recorded in the borehole log for this well. Appendix B provides the borehole log for C9753.

The major stratigraphic units encountered at well 299-E27-137B (C9753) after drilling past the gravel pad included the Hanford formation, the CCU, and the Elephant Mountain Member of the Saddle Mountains Basalt Formation.

The Hanford formation was observed beneath the gravel pad from a depth of ~0.3 to 74.7 m (1.0 to 245 ft) bgs, specifically as follows:

- The Hf1 was observed between ~0.3 and 9.1 m (1.0 to 30.0 ft) bgs. Although these sediments did not contain a dominant gravel component, this may represent a gradational or reworked contact between Hf1 and Hf2. Sediments were consistent with the mafic gravels and gray sand matrix of the Hf1. Geophysical logs (total gamma) also show a relative fining of sediments from ground surface until ~9.1 m (30.0 ft) bgs, where sediments changed from gravelly sand to sand. Sediments within this facies consisted of the following:
 - Slightly silty sand, 0.3 to 3.0 m (1.0 to 10.0 ft) bgs. Light olive-brown, fine- to medium-grained sands with a 20% silt component and a very small (<10%) gravel component. Sediments reacted very strongly with HCl.
 - Gravelly sand, 3.0 to 9.1 m (10.0 to 30.0 ft) bgs. Light grayish-brown and light brownish-gray sands and silts with a 10% to 25% overall gravel component. Gravels were 5 mm on average, well sorted, and subangular to rounded in shape. Sediments reacted moderately to strongly with HCl.
 - Sand, 9.1 m (30 ft) bgs (contact with the Hf2).
- The Hf2 was observed between ~9.1 and 74.4 m (30.0 and 244.0 ft) bgs based on the relative lack of gravels and an increase in gray fine-grained sands and silts. Geophysical logs (total gamma) confirm a relatively consistent grain size throughout the Hf2 sediments. Overall sediments resonated between sands, gravelly sands, and slightly silty sands. One anomalous decrease in total gamma was observed at 19.8 m (65.0 ft) bgs that did not correspond to field observation. However, the log run information contained in the geophysical report indicates that this was transition point between the end of run #1 and the start of run #2. Sediments within this facies consisted of the following:
 - Sand, 9.1 to 15.2 m (30.0 to 50.0 ft) bgs: Light brownish-gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments reacted moderately to strongly with HCl.
 - Gravelly sand, 15.2 to 16.8 m (50.0 to 55.0 ft) bgs: Light brownish-gray, medium- to coarse-grained sands with a 10% gravel component. Gravels were 6 mm on average, poorly sorted, and subangular to rounded in shape. Sediments reacted weakly with HCl.
 - Sand, 16.8 to 21.3 m (55.5 to 70.0 ft) bgs: Returned to light brownish-gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments reacted moderately to strongly with HCl.
 - Slightly silty sand, 21.3 to 27.4 m (70.0 to 90.0 ft) bgs: Light gray, medium- to coarse-grained sands and silts. Sediments contained a very small (<10%) overall gravel component. Sediments reacted strongly to HCl.
 - Sand, 27.4 to 29.0 m (90.0 to 95.0 ft) bgs: Light gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments reacted moderately with HCl.

- Slightly silty sand, 29.0 to 32.0 m (95.0 to 105.0 ft) bgs: Returned to light gray, medium- to coarse-grained sands and silts. Sediments contained a very small (<10%) overall gravel component. Sediments reacted strongly to HCl.
- Sand, 32.0 to 36.6 m (105.0 to 120.0 ft) bgs: Returned to light gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments reacted moderately with HCl.
- Slightly sandy silt, 36.6 to 42.7 m (120.0 to 140.0 ft) bgs: Returned to light brownish-gray, medium- to coarse-grained sands and silts. Sediments contained a very small (<10%) overall gravel component. Sediments reacted strongly to HCl.
- Gravelly sand, 42.7 to 44.2 m (140.0 to 145.0 ft) bgs: Returned to light brownish-gray, coarse-grained sands with a 10% gravel component. Gravels were 5 mm on average, well sorted, and subangular to subrounded in shape. Sediments reacted weakly with HCl.
- Sand, 44.2 to 47.2 m (145.0 to 155.0 ft) bgs: Returned to light brownish-gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments did not react with HCl.
- Gravelly sand, 47.2 to 51.8 m (155.0 to 170.0 ft) bgs: Returned to light brownish-gray, medium- to coarse-grained sands with a 10% to 25% gravel component. Gravels were 3 to 7 mm on average, poorly to moderately sorted, and angular to rounded in shape. Sediments reacted moderately with HCl.
- Sand, 51.8 to 56.4 m (170.0 to 185.0 ft) bgs: Returned to light brownish-gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments reacted moderately to strongly with HCl.
- Gravelly sand, 56.4 to 61.0 m (185.0 to 200.0 ft) bgs: Returned to light brownish-gray, medium- to coarse-grained sands with a 10% to 15% gravel component. Gravels were 4 to 5 mm on average, moderately sorted, and subangular to subrounded in shape. Sediments reacted moderately with HCl.
- Sand, 61.0 to 62.5 m (200.0 to 205.0 ft) bgs: Returned to light gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments reacted moderately with HCl.
- Slightly silty sand, 62.5 to 70.1 m (205.0 to 230.0 ft) bgs: Returned to light brownish-gray, fine- to coarse-grained sands and silts. Sediments contained a very small (<10%) overall gravel component. Sediments reacted strongly to HCl.
- Sand, 70.1 to 74.7 m (230.0 to 245.0 ft) bgs: Returned to light brownish-gray, medium- to coarse-grained sands and silts with a very small (<10%) gravel component. Sediments did not react with HCl.
- Gravelly sand, 74.7 to 75.0 m (245.0 to 246.0 ft) bgs: Returned to light brownish-gray, fine- to medium-grained sands with a 10% gravel component. Gravels were 2 to 44 mm on average, moderately sorted, and subrounded to rounded in shape. Sediments reacted moderately with HCl.
- Silt, 75.0 m (246.0 ft) (contact with the CCU).

- A small component of Hf3 may be represented by the increased overall gravel size present in sediments from 74.7 to 75.0 m (245.0 to 246.0 ft) bgs. However, the Hf3 was virtually indistinguishable from sediments of Hf2 based on field observations. As such, the Hf3 was determined to be nearly nonexistent at this location.

The CCU was observed beneath the Hanford formation from a depth of ~75.0 to 99.0 m (246.0 to 325.0 ft) bgs, specifically as follows:

- The CCU_z was observed from a depth of ~75.0 to 77.7 m (246.0 to 255.0 ft) bgs based on the appearance of a predominantly silt unit observed in cuttings. Geophysical logs show a significant decrease in total gamma and increase in moisture content starting at approximately 79.2 m (246 ft) bgs, suggesting an overall fining of sediments at that depth, indicative of the CCU_z. Sediments within this facies consisted of the following:
 - Silt, 75.0 to 77.7 m (246.0 to 255.0 ft) bgs: Moist grayish brown silts with a 15% overall fine-grained sand component. Sediments reacted very strongly with HCl.
- The CCU_g was observed from a depth of ~77.7 to 99.0 m (255.0 to 325.0 ft) bgs based on the appearance of sandy, gravel-dominant sediments and the absence of any substantial silt component in cuttings starting at ~77.7 m (255.0 ft) bgs. Sediments observed were consistent with gray-brown quartzo-feldspathic sands of the CCU, alternating between gravel and sandy gravel. Gravels at the top of this formation consisted of predominantly mafic material but increased in overall felsic composition with depth.
 - Slightly silty gravelly sand, 77.7 to 79.2 m (255 to 260 ft) bgs: Light olive-brown, fine- to medium-grained sands and silts. Sediments contained a 15% overall gravel component. Gravels were 2 to 60 mm on average, poorly sorted, and subangular to subrounded in shape. Sediments reacted very strongly to HCl.
 - Sandy gravel, 79.2 to 88.4 m (260 to 290 ft) bgs: Light brownish-gray, fine- to coarse-grained sands. Sediments contained a 45% to 75% overall gravel component. Gravels were 2 to 185 mm on average, poorly to moderately sorted, and subrounded to rounded in shape. Sediments reacted very strongly to HCl.
 - Gravel, 88.4 to 93.0 m (290 to 305 ft) bgs: Dark grayish-brown (wet), fine- to coarse-grained sands with an 80% overall gravel component. Gravels are 2 to 82 mm on average, poorly sorted, and subrounded to rounded in shape. Sediments did not react to HCl but were wet at the time of testing.
 - Sandy gravel, 93.0 to 96.0 m (305 to 315 ft) bgs: Returned to dark brownish-gray (wet), very fine- to medium-grained sands. Sediments contained a 75% overall gravel component. Gravels were 2 to 105 mm on average, poorly to moderately sorted, and subangular to subrounded in shape. Sediments did not react to HCl but were wet at the time of testing.
 - Gravel, 96.0 to 98.8 m (315 to 324 ft) bgs: Returned to dark grayish-brown (wet), coarse-grained sands with an 85% overall gravel component. Gravels were 2 to 75 mm on average, poorly sorted, and subangular to rounded in shape. Sediments did not react to HCl but were wet at the time of testing.

- Sandy gravel, 98.8 to 99.0 m (324 to 325 ft) bgs: Returned to very dark grayish-brown (wet), fine-grained sands. Sediments contained a 70% overall gravel component. Gravels were 10 to 120 mm on average, poorly sorted, and subangular to subrounded in shape. Sediments reacted slightly to HCl but were wet at the time of testing.

The contact between the CCU and the Elephant Mountain Member of the Saddle Mountains Basalt Formation was observed during drilling at 99.0 m (325.0 ft) bgs and continued until TD at 99.4 m (326.25 ft) bgs. The contact between the CCU and basalt was identified in the field based on the presence of weathered vesicular basalt in a dark silt/clay matrix (float).

The water level was encountered and measured at 86.18 m (282.75 ft) bgs on July 10, 2019. Appendix B provides the borehole log for C9753.

3 Waste Management

Waste generated during installation of the two dual-purpose wells included drill cuttings, purgewater, and miscellaneous solid waste. Waste was managed in accordance with CERCLA and DOE/RL-2017-64, *Post Remedial Investigation Waste Control Plan and Removal Action Waste Management Plan for the 200-BP-5 Groundwater Operable Unit*.

3.1 Drill Cuttings

All drill cuttings from boreholes C9752 and C9753 were collected in tip dumpsters, with water removed when necessary. The drill cuttings were then placed into designated Environmental Restoration Disposal Facility roll-off boxes. Miscellaneous solid waste associated with sampling activities was contained in clear plastic bags and was also disposed in the roll-off boxes. The roll-off boxes were then transported to the Environmental Restoration Disposal Facility for disposal at completion of the project.

3.2 Purgewater

Purgewater was generated during well drilling, sampling, and development activities. All purgewater was collected and contained at the wellhead until it was transported to the purgewater modular storage units using purge trucks in accordance with DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan*; and DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*.

4 Civil Survey

The locations for well 299-E28-34 (C9752) and well 299-E27-137B (C9753) were surveyed on November 7, 2019, using a Trimble® R8 RTK global positioning system and a Trimble DiNi 12 level to collect coordinates. Washington State Plane (south zone) *North American Datum of 1983* (NAD83) (with the 1991 adjustment) was used to record the horizontal coordinates; *North American Vertical Datum of 1988* (NAVD88) was used to record the vertical survey data. Table 7 identifies the locations of the surveyed wells. Survey reports for each well are presented in Appendix A for well 299-E28-34 (C9752) and in Appendix B for well 299-E27-137B (C9753).

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Table 7. Civil Survey Summary

Well ID Number	Well Name	Northing ^a (m)	Easting ^a (m)	Brass Survey Marker Elevation ^b (m)	Top of Casing ^{b,c} Elevation (m)
C9752	299-E28-34	137075.02	573971.50	201.717	202.444
C9753	299-E27-137B	136625.32	574332.45	208.029	208.798

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.

ID = identification

5 Well Acceptance

The final step of the installation process is well acceptance. Well acceptance represents confirmation that the wells meet the requirements outlined in the scope of work. Well acceptance also indicates the contractual completion of the finished wells.

After the wells were completed, representatives from CHPRC and Carpenter performed inspections for both wells. Work site assessments were conducted for wells 299-E28-34 (C9752) and 299-E27-137B (C9753) on September 23, 2019. Both wells were accepted by CHPRC.

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J.B. Geiger

J.M. Griffith

B.J. Howard,

J.L. Kaas

S.A. Lynch

J.R. Mallon

J.L. Richart

S.M. Sexton

J.L. Smoot

S.D. Springer

J.T. Stewart

K.K. Stiles

L.C. Sumner

G.S. Thomas

R.L. Wade

K.M. Whitley

T.J. Woffinden

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Appendix A

Well Documentation for 299-E28-34 (C9752)

- Well Summary Sheet for C9752
- Borehole Log for C9752
- Geophysical Log Data Report for C9752
- Final Survey Report for C9752
- Well Development and Testing Data Sheet C9752
- Photo Log for C9752

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WELL SUMMARY SHEET REV. 0

Well ID: C9752 Well Name: 299-E28-34 Start Date: 02/07/19
 Project: 200-BP-5 Location: 200-E Area End Date: 07/18/19

CONSTRUCTION DATA

GEOLOGIC/HYDROLOGIC DATA

Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
Surface Completion:				
4' x 4' x 6" Concrete Pad with brass survey marker and protective monument (3.00' ags - 2.00'bgs)		0		0 - 0.5: Gravel (sG)
Ecology Well # BLD-034				0.5 - 5.0 : Gravelly Sand (gS)
Well Completion Material:				
Type I/II Portland Cement		0 to 150		5.0 - 20.0: Sandy Gravel (sG)
0.00' bgs - 9.08' bgs				20.0 - 30.0 : Gravelly Sand (gS)
Bentonite Crumbles				30.0 - 100.0 : Sand (S)
9.08' bgs - 252.50' bgs				
Bentonite Pellet Seal				
252.50' bgs - 255.34' bgs				
8-16 mesh Primary Filterpack				
255.34' bgs - 288.2' bgs				
Natural Fill				
288.2' bgs - 288.4' bgs				
Permanent Well:				
8" ID Stainless Steel Blank		0 to 100		100.0 - 110.0 : Gravelly Sand (gS)
1.96' ags - 259.99' bgs				110.0 - 164.0: Sand (S)
8" ID Stainless Steel 0.050-in Screen				
259.99' bgs - 284.98' bgs				
8" ID Stainless Steel Sump				
284.98' bgs - 287.98' bgs				
Hole Dimensions:				
16" Temporary Casing: 148.25' bgs				
12" Temporary Casing: 285.53' bgs				
(all temporary casing removed)				
Total Depth : 288.40' bgs				
ags = above ground surface bgs = below ground surface				

Reported By: SJ Sexton Geologist [Signature] 1/2/19
 Print Name Title Signature Date

Reviewed By: Jennifer Richard Well Coordinator [Signature] 9/12/19
 Print Name Title Signature Date

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OR Doc Type: _____ WMU Code(s): _____

SGW 64056 REV 0
WELL SUMMARY CONTINUATION SHEET

Well ID: C9752

Well Name: 299-E28-34

Project: 200-BP-5

CONSTRUCTION DATA

GEOLOGIC/HYDROLOGIC DATA

Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
Surface Completion:				110.0 - 164.0: Sand (S)
4' x 4' x 6" Concrete Pad with brass survey marker and protective monument (3.00' ags - 2.00' bgs)				164.0-166.0: Gravelly Sand (gS)
Ecology Well # BLD-034				166.0-182.0: Sand (S)
Well Completion Material:				182.0-195.0: Gravelly Sand (gS)
Type I/II Portland Cement				195.0-215.0: Sand (S)
0.00' bgs - 9.08' bgs				215.0-225.0: Sandy Gravel (sG)
Bentonite Crumbles				225.0-245.0: Silty Sandy Gravel (msG)
9.08' bgs - 252.50' bgs				245.0-285.2: Sandy Gravel (sG)
Bentonite Pellet Seal				Depth to Water 262.65' (5/1/19)
252.50' bgs - 255.34' bgs				285.2-288.4: Basalt
8-16 mesh Primary Filterpack				
255.34' bgs - 288.2' bgs				
Permanent Well:				
8" ID Stainless Steel Blank				
1.96' ags - 259.99' bgs				
8" ID Stainless Steel 0.050-in Screen				
259.99' bgs - 284.98' bgs				
8" ID Stainless Steel Sump				
284.98' bgs - 287.98' bgs				
Natural Fill				
288.2' bgs - 288.4' bgs				
Hole Dimensions:				
16" Temporary Casing: 148.25' bgs				
12" Temporary Casing: 285.53' bgs (all temporary casing removed)				
Total Depth : 288.40' bgs				
ags = above ground surface				
bgs = below ground surface				

BOREHOLE LOG			Page <u>1</u> of <u>9</u>
		Date: <u>2/27/19</u>	
Well ID: <u>C9752</u>	Well Name: <u>299-E28-34</u>	Location: <u>~200m SE of B Tank Farms</u>	
Project: <u>Installation of Two Dual Purpose Wells and Two Monitoring in BR-5 Old</u>		Reference Measure Point: <u>Ground Surface</u>	
Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other
			Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0		0-0.5'	<u>Gravel Pod</u> ^{gs}
		0.5-5'	<u>Gravelly Silt & Sand (gs)</u>
		5-10'	<u>Sandy Gravel (SG)</u>
5	G.S. 2/27/19	5-10'	<u>Sandy Gravel (SG)</u>
10	G.S. 3/6/19	10-15'	<u>Sandy Gravel (SG)</u>
15	G.S. 3/7/19	15-20'	<u>Sandy Gravel (SG)</u>
20	G.S. 3/7/19	20-25'	<u>Gravelly Sand (GS)</u>
25	G.S. 3/13/19	25-30'	<u>Sand (S)</u>
30	G.S. 3/13/19	30-100'	<u>Sand (S)</u>

Reported By: <u>Brandon Thurnau</u> Geologist		Signature: <u>Brandon Thurnau</u> 3/13/19	
Reviewed By: <u>Sarah Springer</u> Sr. Geologist		Signature: <u>Sarah Springer</u> 5-22-19	

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OR Doc Type:	WMU Code(s):

BOREHOLE LOG (Cont.)

Date: 2/21/19

Well ID: C9752

Well Name: 299-~~E38~~-34
E28

Location: ~200m SE of B Tank Farms

Depth (ft)	Sample	Graphic Log	Sample Description:		Comments:
			Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other		Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35	G.S. 3/14/19	[Graphic Log: Dotted pattern]	30-100: Sand (S)		Cable tool w/ drive barrel; 16" temporary carbon steel as first string of casing; GS = grab sample; grab samples collected every 5' and @ major lithologic changes
			@ 35' - 5% Gravel: 30% M/30% F, 2mm-9mm, well sorted, subangular-rounded; 85% Sand: 65% F/35% M, u. fn. - u. crs. (crs. avg), med. sorted, subangular-subrounded; 10% silt: 2.54/6/2 light brownish gray; moist, u. string rxn w/ HCl (dry)		
			@ 37' - 45mm basalt pebble present; otherwise same characteristics as @ 35'		
40	G.S. 3/14/19		@ 40' - sands to 56% F/46% M; all other characteristics are same as above (95')		
			@ 45' - 3% Gravel: 75% M/25% F, 2mm-6mm, well sorted, subangular-subrounded; 87% Sand: 70% F/30% M, u. fn. - u. crs. (crs. avg), med. sorted, subangular-subrounded, 10% silt: 2.54/6/3 light yellowish brown (dry); med. rxn w/ HCl		
45	G.S. 3/18/19				
50	G.S. 3/18/19		@ 50' - gravels coarsen (one 37mm ^{basalt rounded pebble} present) and sands coarsen (crs. - u. crs. avg.) otherwise same characteristics as @ 45'		
			@ 55' - 3% Gravel: 75% M/25% F, 2mm-9mm, well sorted, subangular-subrounded; 92% Sand: 55% F/45% M, u. fn. - u. crs. (u. crs. avg), well sorted, subangular-subrounded; 5% silt: 2.54/6/3 light yellowish brown (dry); weak or no rxn w/ HCl		
55	G.S. 3/19/19				
		@ 60' - 3% Gravel: 70% M/30% F, 2mm-10mm, well sorted, subangular-subrounded; 87% Sand: 60% F/40% M, u. fn. - u. crs. (crs. avg), well sorted, subangular-subrounded, 10% silt: 2.54/5/2 grayish brown, med. rxn w/ HCl			
60	G.S. 3/19/19				
		@ 65' - 1% Gravel: 80% M/20% F, 2mm-12mm, well sorted, subangular-subrounded; 84% Sand: 65% F/35% M, u. fn. - u. crs. (med. - crs. avg), well sorted, subangular-subrounded; 10% silt: 2.54/6/2 light brownish gray, u. string rxn w/ HCl			
65	G.S. 3/19/19				
		@ 68'-68.5' - 100% Sand: med. - u. fn. sand layer, 70% F/30% M, u. well sorted, moist, strong rxn w/ HCl			
		@ 68.5' - 5% Gravel: 75% M/25% F, 2mm-8mm, well sorted, subangular-subrounded; 85% Sand: 65% F/35% M, u. fn. - u. crs. (med. - crs. avg), well sorted, subangular-subrounded; 10% silt: 2.54/6/2 light brownish gray, u. string rxn w/ HCl (dry)			
70	G.S. 3/20/19				
		@ 70' - 1% Gravel: 90% M/10% F, 2mm-14mm, well sorted, subrounded, 89% Sand: 35% M/65% F, u. fn. - u. crs. (med. - crs. avg), moderately sorted, subangular-subrounded; 10% silt: 2.54/6/3 light yellowish brown, u. string rxn w/ HCl			

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

3/21/19
Date

BOREHOLE LOG (Cont.)

Date: 2/27/19

Well ID: C9762

Well Name: 299-E28-34

Location: ~200 m SE of B Tank Farms

Depth (ft)	Sample	Graphic Log	Sample Description:	Comments:
			Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75	G.S. 3/21/19		<u>30-100 : Sand (S)</u> @75'-3' Gravel: 70% M 30% F, 2mm-10mm, well sorted, subrounded-subangular; 87% Sand: 60% F 40% M, v. fn.-v. crs. (med.-crs. avg), mod. sorted, subangular-subrounded; 10% silt: 2.54 (1/2 light brownish gray, v. strong rxn w/ HCl)	Cable tool w/ drive barrel; 1 1/2" temporary carbon steel for 1st string of casing; GS=grab sample; grab samples collected every 5' and @ major lithologic changes
80	G.S. 3/21/19		@80'-90' Sand: 65% F 35% M, v. fn.-v. crs. (med.-crs. avg), mod. sorted, subangular-subrounded; 10% silt: 2.54 (1/2 light yellowish brown, strong rxn w/ HCl)	
85	G.S. 3/21/19		@85'-5' Gravel: 75% M 25% F, 2mm-5mm, well sorted, subround-subangular; 90% Sand: 60% F 40% M, v. fn.-v. crs. (crs. avg), well sorted, subangular-subrounded; 10% silt: 2.54 (1/2 light brownish gray, strong rxn w/ HCl)	
90	G.S. 3/25/19		@90'-max gravel size increase to 12mm, slight rxn w/ HCl (moist)	
95	G.S. 3/25/19		@95'-7' Gravel: 60% M 40% F, 2mm-4mm, well sorted, subangular-subround; 83% Sand: 55% F 45% M, v. fn.-v. crs. (crs.-v. crs. avg), well sorted, subangular-subround; 10% silt: 2.54 (1/2 grayish brown, light rxn w/ HCl)	
100	G.S. 3/25/19		<u>100-110 : Gravelly Sand (gS)</u> @100'-10% Gravel: 70% M 30% F, 2mm-11mm, well sorted, subangular-rounded; 80% Sand: 65% F 35% M, v. fn.-v. crs. (med.-v. crs. avg), mod. sorted, subangular-subrounded; 10% silt: 2.54 (1/2 light brownish gray), mod. rxn w/ HCl	
105	G.S. 3/26/19		@105'-10% Gravel: 80% M 20% F, 2mm-10mm, well sorted, subangular-rounded; 80% Sand: 70% F 30% M, v. fn.-v. crs. (med.-crs. avg), well sorted, subangular-subrounded; 10% silt: 2.54 (1/2 grayish brown (dry), strong rxn w/ HCl)	
110	G.S. 3/26/19		<u>110-164 : Sand (S)</u> @110'-7' Gravel: 75% M 25% F, 2mm-13mm, well sorted, subangular-subrounded; 83% Sand: 65% F 35% M, v. fn.-v. crs. (med.-v. crs. avg), mod. sorted, subrounded-subangular; 10% silt: 2.54 (1/2 light brownish gray, v. strong rxn w/ HCl)	

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

4/8/19
Date

BOREHOLE LOG (Cont.)

Date: 2/27/19

Well ID: C9752

Well Name: 299-E2B-34

Location: ~200m SE of B Tank Farms

Depth (ft)	Sample	Graphic Log	Sample Description:	Comments:
			Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
115	G.S. 3/27/19		110 - 104: Sand (S)	
			@ 115', 4% gravel, 80% M, 20% F, 2-7mm, well sorted, sub-angular to sub-rounded,	
			86% sand, 65% F, 35% M, very fine - very coarse (medium - very coarse avg), mod. sorting, mostly	
120	G.S. 3/27/19		sub-angular, some sub-rounded, slightly damp moist	
			Silt: 10%, 2.5Y 5/2 greyish brown, strong rxn w/ HCl	
			@ 120' gravel changes to 6%, sand to 84%, all else remains same	
			@ 125' 90% sand, 70% F, 30% M, very fine - very coarse (medium - very coarse avg), mod. sorting, sub-angular - sub-rounded, slightly moist, 10% silt; 2.5Y	
130	G.S. 3/28/19		5/2, greyish brown, strong rxn w/ HCl	
			@ 130': 5% gravel; 75% M; 25% F, 2mm-5mm, well sorted, angular-subround	
			85% sand: 65% F; 35% M, v. fn. - v. ccs. (med. - ccs. avg), mod. sorted, subround-subangular; 10% silt: 2.5Y 6/2 light brownish gray, strong rxn w/ HCl	
135	G.S. 4/1/19			
		@ 135': 2% gravel; ^{874M} 75% M; 25% F, 2mm-7mm, well sorted, subangular-subround		
		88% sand: 70% F; 30% M, v. fn. - v. ccs. (ccs. avg), well sorted, subround-subangular; 10% silt: 2.5Y 6/2 light brownish gray, strong rxn w/ HCl		
140	G.S. 4/1/19			
		@ 140': 3% Gravel: 70% M; 30% F, 2mm-10mm, well sorted, subangular-subround,		
		@ 7' sand: 70% F; 30% M, v. fn. - v. ccs. (moderate ccs. avg), mod. sorted, subround-subangular; 10% silt: 2.5Y 6/2 light brownish gray, strong rxn w/ HCl		
145	G.S. 4/2/19			
		@ 145': 1% Gravel: 75% M; 25% F, 2mm-7mm, well sorted, subangular-subround;		
		89% sand: 65% F; 35% M, v. fn. - v. ccs. (cls. avg), well sorted, subround-subangular;		
		10% silt: 2.5Y 6/2 light brownish gray, moderate rxn w/ HCl		
150	G.S. 4/2/19			
		@ 150' - Sands slightly finer (med.-ccs. avg); max gravel size = 5mm		

Bottom of 16" temporary casing advanced to 148.25' prior to logging; down 5' to 12" temporary casing B3/4 DD core barrel w/ 3' length used for 2nd string of casing

Reported By: Brandon Thurman / Dan Chamberlain Geologist / Geologist [Signature] 3/27/19
 Print Name Title Signature Date

BOREHOLE LOG (Cont.)

Page 6 of 9

Date: 4/8/19

Well ID: C9752

Well Name: 299-E2B-34

Location: ~200 m SE of B Tank Farm S

Depth (ft)	Sample	Graphic Log	Sample Description:		Comments:
			Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other		Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
155 150 BT 4/8/19	G.S. 4/8/19	[Graphic Log: Dotted pattern]	110-164 : Sand (S)		Cable tool w/ drive barrel; 12" temporary carbon steel casing as 2nd string; G.S. = Grab Sample; G.S.'s collected every 5' and @ major lithologic changes
			@155' - 1% Gravel: 2mm-4mm, well sorted, subround-subangular; 89% Sand: 65% F/35% M, v. fn.-v. crs. (med.-crs. avg.), moderately sorted, subround-subangular; 10% Silt: 2.54 5/13 light olive brown (wet), slight rxn w/ HCl		
160	G.S. 4/9/19		@160' - Same characteristics @155' except sample is slightly moist w/ color 2.54 5/13 light olive brown and has a very strong rxn when tested w/ HCl		G.S. collected on 4/8/19 were collected w/ rainy conditions and moisture content may decrease
165	G.S. 4/9/19	[Graphic Log: Dotted pattern]	164-166 : Sandy gravel (SGr) Gravelly Sand (GS)		observed rxn w/ HCl
			@164' - 30% Gravel: 2mm-58mm (25mm avg.), poorly sorted, subangular-rounded, 70% M, 30% F; 67% Sand: v. fn.-v. crs. (avg. med.-crs.), moderately sorted, 60% F/40% M, subround-subangular; 5% Silt: 2.54 6/2 light brownish gray, strong rxn w/ HCl		
170	G.S. 4/9/19		@165 moisture content ↑ 166-182 : Sand (S)		
			@166 - 7% Gravel: 75% M/25% F, 2mm-5mm, well sorted, subangular-subround; 88% Sand: 66% F/35% M, subround-subangular, v. fn.-v. crs. (crs.-v. crs. avg), med. sorted; 5% Silt: 2.54 6/2 light brownish gray, strong rxn w/ HCl		
175	G.S. 4/9/19	[Graphic Log: Dotted pattern]	@175 - max gravel size increase to 15mm		
			@180 - 3% Gravel / 92% Sand / 5% Silt; other characteristics same as @166'		
180	G.S. 4/9/19		182-195 : (gravelly Sand (GS))		
			@182 - 15% Gravel: 80% M/20% F, 2mm-30mm, med sorted, subangular-subround, 75% Sand: 65% F/35% M, subround-subangular, v. fn.-v. crs. (crs. avg), med. sorted; 10% Silt: 2.54 6/2 light brownish gray; strong rxn w/ HCl (dry)		
185	G.S. 4/10/19	[Graphic Log: Dotted pattern]	@184.5' - ~30mm 2.54 6/2 light brownish gray silt layer present		
			@185' - same characteristics as sample from 182'		
			@187' - ↓ to 10% gravel, ↑80% Sand, 10% Silt; otherwise characteristics same as above		
190	G.S. 4/11/19		@190' - 20% Gravel: 80% M/20% F, 2mm-24mm, well sorted, rounded-subangular; 75% Sand: 40% F/60% M, subround-subangular, v. fn.-v. crs. (med.-crs. avg) med sorted; 5% Silt: 2.54 5/2 grayish brown, dry, strong rxn w/ HCl		

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

4/11/19
Date

BOREHOLE LOG (Cont.)

Date: 4/11/19

Well ID: C9762

Well Name: 299-E20-34

Location: ~200 m SE of B Tank Forms

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
195	G.S. 4/11/19		192-195 : <u>Gravelly Sand (GS)</u> @191'-10' Gravel: 2mm-2.5mm, 80% M/20% F, well sorted, rounded-subround, 80% Sand: 60% F/40% M, subround-subangular, v. fn.-v. cfs. (med. avg.), mod. sorted; 10% silt, 2.5% 5/2 grayish brown, dry, string rxn w/ HCl	Cable tool w/ drive barrel, 12" temporary casing, as second string of casing; GS=grab sample; G.S.'S collected every 5' and @ major lithologic changes
200	G.S. 4/11/19		@195'-1' Gravel: 2-3mm, well sorted, subround-subangular, 89% Sand: (65% F/34% M), subround-subangular, v. fn.-v. cfs. (med. avg.), mod. sorted; 10% silt: 2.5% 6/2 light brownish gray, string rxn w/ HCl @200'- same characteristics as @195' G.S.	
205	G.S. 4/15/19		@205'-95% Sand: 60% F/40% M, subround-subangular, v. fn.-v. cfs. (med. cfs. avg.), mod. sorted; 5% silt: 2.5% 5/3 light olive brown, v. string rxn w/ HCl	
210	G.S. 4/16/19		@210'- sands appear more fine (~med. avg) and are well sorted; silt composition increase to ~10% 215-225 : <u>Sandy Gravel (SG)</u> @225'- 70% Gravel-2mm-14.5mm, well rounded-subrounded, poorly sorted, 75% M/25% F; 25% Sand: (60% F/40% M, v. fn.-v. cfs. (v. cfs. avg.), rounded-subangular, mod. sorted; 5% silt-2.5% 4/3 olive brown (moist), slight rxn w/ HCl (moist)	
215	G.S. 4/15/19		@217'- 45% Gravel, 40% Sand, 10% silt @218'- 43% Gravel, 55% Sand, 10% silt 40	
220	G.S. 4/16/19		@220'- 40% Gravel: 55% M/45% F, 2mm-74mm, rounded-subrounded, poorly sorted; 60% Sand: v. fn.-v. cfs. (55% F/45% M, (medium grain avg.), subround-subangular, moderately sorted; 10% silt: 2.5% 6/2 light brown gray, v. string rxn w/ HCl	
225	G.S. 4/17/19		225-230 : <u>Silty Sandy Gravel (MSG)</u> @225'- 40% Gravel: 60% M/40% F, 2mm-51mm, rounded-subrounded, poorly sorted; 40% Sand: 60% F/40% M, subround-subangular, v. fn.-v. cfs. (fn.-med. avg.), mod. sorted; 20% silt: 2.5% 6/2 light brownish gray, v. string rxn w/ HCl (dry)	
230	G.S. 4/17/19		230-245 : <u>Silty Sandy Gravel (MSG)</u> @230'- 50% Gravel: 60% M/40% F, 2-45mm, mod. sorted, rounded-subangular; 35% Sand: 55% F/45% M, subround-subangular, v. fn.-v. cfs. (vs. avg.), poorly sorted; 15% silt: 2.5% 5/2 grayish brown, mod. rxn w/ HCl	

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

4/18/19
Date

BOREHOLE LOG (Cont.)

Date: 4/18/19

Well ID: C9752

Well Name: 299-E29-34

Location: ~200m SE of B Tank Farms

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
235	G.S. 4/18/19		235-245 : Silty Sandy Gravel (msG) @235'-45% Gravel: 65% M/35% F, 2-24mm, poorly sorted, rounded; 40% Sand: 60% F/40% M, v. fn.-v. crs. (fn.-med. avg.), moderately sorted; 15% silt: 2.54 1/2 light brownish gray, string rxn w/ HCl	Cable tool w/ drive barrel; 12" temporary carbon steel casing for 2nd string; G.S. = grab sample; G.S.'s collected every 5' and @ major lithologic changes; S.S. = Split Spoon; W.S. =
240	G.S. 4/22/19		@240'-45% Gravel: 60% M/40% F, 2mm-5mm, moderately sorted, rounded; 40% Sand: 60% F/40% M, v. fn.-v. crs. (fn. avg.), well sorted; 15% silt: 2.54 5/2 grayish brown, mod. rxn w/ HCl @242' - max gravel size equals 90mm 245-285 : Sandy Gravel (SG)	water sample; BOC = bottom of casing
245	G.S. 4/22/19		@245'-55% Gravel: 70% M/30% F, 2-125mm, poorly sorted, rounded-subround; 40% Sand: 55% F/45% M, v. fn.-v. crs. (med.-crs. avg.), moderately sorted, subround-subangular; 5% silt: 2.54 6/2 light brownish gray, string rxn w/ HCl @248' - moisture content ↑; return appears damp	
250	G.S. 4/29/19		@250'-45% Gravel: 60% M/40% F, 2-82mm (crs. pebble avg.), rounded-angular, poorly sorted; 20% Sand: 65% F/35% M, v. fn.-v. crs. (med.-crs. avg.), mod. sorted, subround-subangular; 5% silt: 2.54 4/2 dark grayish brown (moist), slight rxn w/ HCl (moist)	angularity ↑ @ 250' likely due to focus fragmented from core barrel
255	G.S. 4/30/19		@255'-70% Gravel: 65% M/35% F, 2-12mm (medium pebble avg.), rounded-subangular, poorly sorted; 25% Sand: 60% M/40% F, v. fn.-v. crs. (med.-crs. avg.), mod. sorted, subround-subangular; 5% silt: 2.54 5/2 grayish brown (dried), no rxn w/ HCl (moist)	
260	G.S. 4/30/19		@260' - max gravel size = 165mm @260' - wet sample - 75% Gravel: 65% M/35% F, 2-80mm (medium pebble avg.), rounded-subrounded, poorly sorted; 20% Sand: 50% M/50% F, v. fn.-v. crs. (med.-crs. avg.), mod. sorted, subround-subangular; 5% silt: 2.54 4/2 dark grayish brown (wet), no rxn w/ HCl (wet)	@260' core barrel swapped for smaller 8.56" OD core barrel due to not getting any returns likely from the presence of H2O
265	G.S. 5/1/19		@265' - max gravel size = 92mm otherwise characteristics remain the same as @ 260'	water encountered on 4/30/19 in grab sample; H2O tagged first on 5/1/19 @ 262.65' bags
270	G.S. 5/1/19		@270'-75% Gravel: 60% M/40% F, 2-114mm (med. pebble avg.), rounded-subangular, poorly sorted; 20% Sand: 55% F/45% M, v. fn.-v. crs. (med.-crs. avg.), mod. sorted, subround-subangular; 5% silt: 2.54 4/2 dark grayish brown and no rxn w/ HCl (wet)	S.S. I-001 collected on 5/1/19 @ 2745, Actual Depth: 265.9-268.4' bags; BOC = 266.30' bags; 100% recovery sandy gravel; H2O's # B3NN65; music sample taken from S.S. # E5H B3NNR9

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

5/2/19
Date

BOREHOLE LOG (Cont.)				Page 8 of 9
Well ID: C9752		Well Name: 299-E28-34		Date: 5/21/19
Location: ~200m SE of B Tank Farms				
Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
275	W.S. I-001 5/18/19 S.S. I-002		245-285 ^{BT 5/21/19} Sandy Gravel (SG) @275' (taken from I-002 split spoon) - 70% Gravel - 60% M/40% F, 2-70mm (min avg), subrounded-rounded, poorly sorted; 20% Sand - 60% F/40% M, u.f.n. - v.crs., fn. - med. avg., mod. sorted, subround-subangular; 10% silt; 2.54 5/2 grayish brown, no rxn w/ HCl (wet sample)	Cable tool w/ drive barrel; 12" temporary carbon steel casing for 2 nd string; G.S. = grab sample; G.S.'s collected every 5' and @ major lithologic changes; S.S. = split spoon; W.S. = water sample; BOC = bottom of casing; BBH = bottom of borehole; TD = Total Depth
280	G.S. 5/19/19		@280' - 75% Gravel - 60% M/40% F, 2-135mm (15mm avg), poorly sorted, rounded-subangular, poorly sorted; 20% Sand; 55% F/45% M, u.f.n. - v.crs. (med. - crs. avg.) mod. sorted, subround-subangular; 6% silt; 2.54 4/2 dark grayish brown, no rxn w/ HCl (wet sample)	W.S. I-004: Bottom of casing and actual depth @ 274.86'; borehole @ 274.65'; @ 3.5 gpm, 171 min time logged; sample time @ 1340 on 5/17/19; HEI SH B3NN68 (filtered), B3NN69
285	W.S. I-005 G.S. 5/19/19 G.S. 5/22/19		282.5' @284' - ↑25% Sand, ↑10% silt (med) @284.3' - ↑15% silt; 284.3-285.2: silty sandy gravel 285.2-288.4: B2S26 Basalt fragments found from split spoon; no HCl rxn, 2.54 2.5/1 Black (wet)	S.S. I-002: Actual depth: 274.7-276.2' bgs; Bottom of casing @ 274.86'; sample time 0755 on 5/18/19; 50% sandy gravel recovery HEI SH B3NN66
290				Difficulty getting returns starting @ ~280'; drillers switch to sand pump; sample may appear more coarse due to removing water before collecting sample and may wash fines away
295				BT 5/19/19 @ 280' drilling slows; hard to advance @ 283' time driving casing and core barrel; returns appear compacted and slightly cemented (wet)
300				S.S. I-003: Actual depth: 284.3-286.8' bgs; bottom of casing @ 284.24' bgs; sample time 1425 on 5/21/19; 100% recovery silty sandy gravel; HEI SH B3NN67; Split spoon was 100% full, but only drove 0.9'; Result contact estimated @ 285.2' bgs
305				W.S. I-005: Bottom of casing and actual depth @ 287.64'; BBH @ 286.8'; ~3.7 gpm, 93 min
310				avg'd; sample time @ 1017 on 5/19/19; HEI SH B3NN70, B3NN71, B3NN72 Drillers switch to hard tool after encountering basalt in split spoon; uses sand pump to clean out hole

Reported By: Brandon Thurnell Geologist Brandon Thurnell 5/21/19
 Print Name Title Signature Date

BOREHOLE LOG (Cont.)

Page 9 of 9

Date: 5/15/19

Well ID: C9752

Well Name: 299-E28-34

Location: ~200m SE of B Tank Farms

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
<p><i>NOT USED BT 5/12/19</i></p>				
				<p>Driller is having a hard time advancing both the hole and casing @ 285.2'; hole appears to keep casing in w/ above formation; ~80% sands are ^{BRISIS/} BRISIS/ removed while cleaning out the w/ sand pump and after hard tooling (more fines may be present due to returns being heavily crushed from the hard tooling process); driller thinks there is a layer of sand above the basalt that is getting compacted and not allowing the casing to seal off, resulting in cave in; switch to 1 1/4" OD hard tool w/ "blade" down the middle to cut through the sand collecting above the basalt; samples are not representative after 285' due to sand pump and hard tool processes (basalt is heavily crushed and mixed w/ H₂O from sand pump); final depth for 12" casing @ 285.5' bgs</p> <p>Total Depth = 288.4' bgs</p>

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

5/21/19
Date

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299-E28-34 (C9752)

Log Data Report

Borehole Information

Log Date	2019-05-29	Filename	C9752_HG-NM_2019-05-29	Site	200-BP-5
DTW¹ (ft)		DTW Date		DTW Source	
262.72		05/20/19		Gram NW	
		Drill Date	05/21/19	Total Depth (ft)	288.4
				Depth Datum	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
			Outer	Inside			
Welded Steel	Cable Tool	TC ²	16	15.3	0.35	1.25 AGS ³	148.24
Welded Steel	Cable Tool	TC	12.75	12.05	0.35	4.5 AGS	285.5

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing stick-up using a steel tape measure, casing outside diameter using a steel circumference tape, and thickness using a precision wall-thickness gauge. Maximum logging depth achieved was 287 ft, approximately 1.5 ft below the reported casing depth. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 1LD	Type	60% Coaxial HPGe (SGLS) ⁴
Effective Calibration Date	12/04/2018	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-175, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5TB	Type	60% Coaxial HPGe (SGLS)
Effective Calibration Date	12/12/2018	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-180, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 1HD	Type	He-3 (CPN 503DR) NMLS ⁵
Effective Calibration Date	12/04/2018	Serial No.	H310700352
Calibration Reference	HGLP-CC-176, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

Logging System	Gamma 5PB	Type	He-3 (CPN 503DR) NMLS
Effective Calibration Date	12/12/2018	Serial No.	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

¹ depth to water inside casing

² Temporary casing

³ Above ground surface

⁴ Spectral Gamma Logging System

⁵ Neutron Moisture Logging System

SGLS Log Run Information

Log Run	3	4	5 Repeat	6
HEIS Number	1021096	1021097	1021098	1021099
Date	04/03/19	04/03/19	04/03/19	05/28/19
Logging Engineer	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0.0	67.0	60.0	146.0
Finish Depth (ft)	66.0	147.01	75.0	287.01
Count Time (sec)	100	100	100	100
Live/Real	R	R	R	R
Shield (Y/N)	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0
Log Speed (ft/min)	NA	NA	NA	NA
Pre-Verification	C9752FTB20190 403AV00CAB1	C9752FTB20190 403AV00CAB1	C9752FTB201904 03AV00CAB1	C9752ALD20190 528AV00CAB1
Start File	AD000000	BD006700	CD006000	AD014600
Finish File	AD006600	BD014701	CD007500	AD028701
Post-Verification	C9752FTB20190 403CV00CAA1	C9752FTB20190 403CV00CAA1	C9752FTB201904 03CV00CAA1	C9752ALD20190 528BV00CAA1
Depth Return Error (in.)	N/A	1.0 high	1.0 high	N/A
Comments	None	Reestablished zero reference	None	None

Log Run	7 Repeat			
HEIS Number	1021100			
Date	05/28/19			
Logging Engineer	Spatz			
Start Depth (ft)	255.0			
Finish Depth (ft)	269.01			
Count Time (sec)	100			
Live/Real	R			
Shield (Y/N)	N			
MSA Interval (ft)	1.0			
Log Speed (ft/min)	NA			
Pre-Verification	C9752ALD2019 0528AV00CAB1			
Start File	BD025500			
Finish File	BD026901			
Post-Verification	C9752ALD2019 0528BV00CAA1			
Depth Return Error (in.)	2.5 low			
Comments	None			

NMLS Log Run Information

Log Run	1	2 Repeat	8	9
HEIS Number	1021101	1021102	1021103	1021104
Date	04/02/19	04/02/19	05/28/19	05/29/19
Logging Engineer	Meisner/Spatz	Meisner	Spatz	Spatz
Start Depth (ft)	0.0	120.0	147.0	176.0
Finish Depth (ft)	148.01	135.01	177.0	262.75
Count Time (sec)	15	15	15	15
Live/Real	R	R	R	R
Shield (Y/N)	N	N	N	N
MSA Interval (ft)	0.25	0.25	0.25	0.25
Log Speed (ft/min)	NA	NA	NA	NA
Pre-Verification	C9752FPB20190 402AV00CAB1	C9752FPB2019040 2AV00CAB1	C9752AHD2019 0528AV00CAB1	C9752AHD201 90529BV00CA B1
Start File	AD000000	BD012000	AD014700	BD017600
Finish File	AD014801	BD013501	AD017700	BD026275
Post-Verification	C9752FPB20190 402BV00CAA1	C9752FPB2019040 2BV00CAA1	C9752AHD2019 0528AV00CAA1	C9752AHD201 90529CV00CA A1
Depth Return Error (in.)	N/A	1.0 high	0.5 low	N/A
Comments	None	None	None	None

Log Run	10 Repeat			
HEIS Number	1021105			
Date	05/29/19			
Logging Engineer	Spatz			
Start Depth (ft)	250.0			
Finish Depth (ft)	262.5			
Count Time (sec)	15			
Live/Real	R			
Shield (Y/N)	N			
MSA Interval (ft)	0.25			
Log Speed (ft/min)	NA			
Pre-Verification	C9752AHD2019 0529BV00CAB1			
Start File	CD025000			
Finish File	CD026250			
Post-Verification	C9752AHD2019 0529CV00CAA1			
Depth Return Error (in.)	2.5 low			
Comments	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	06/17/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.35-in. thick casing was applied to the SGLS log data.

For the SGLS, a water correction was applied below 262.72 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in EXCEL templates identified as ALD20181204 and FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are not reported in vol% moisture as the 16 and 12.75-in. OD casings size exceeds the calibration condition.

HGU⁶ 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

No manmade radionuclides were detected in this borehole.

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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

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

List of Log Plots

Depth Reference is ground surface.

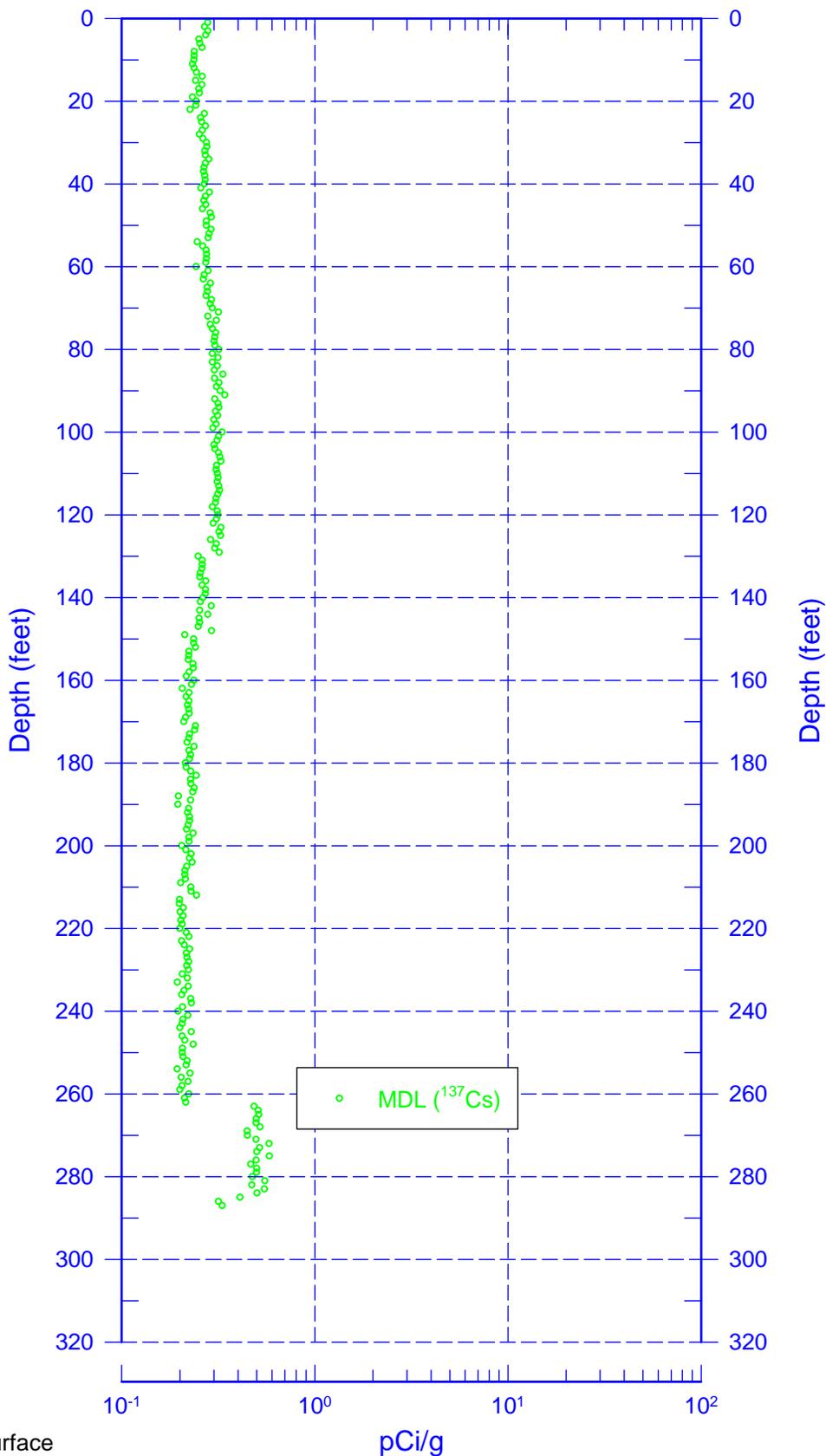
- Manmade Radionuclides (0-320 ft)
- Natural Gamma Logs (0-160 ft)
- Natural Gamma Logs (150-310 ft)
- Combination Plot (0-120 ft)
- Combination Plot (110-230 ft)
- Combination Plot (220-340 ft)
- Combination Plot (0-300 ft)
- Total Gamma & Moisture (0-160 ft)
- Total Gamma & Moisture (150-310 ft)
- Total Gamma & Hanford Gamma Unit (0-300 ft)
- Repeat Section of Natural Gamma Logs (60-75 ft)
- Repeat Section of Natural Gamma Logs (255-269 ft)

⁶ Hanford Gamma Unit

Moisture Repeat Section (120-135 ft)
Moisture Repeat Section (250-263 ft)



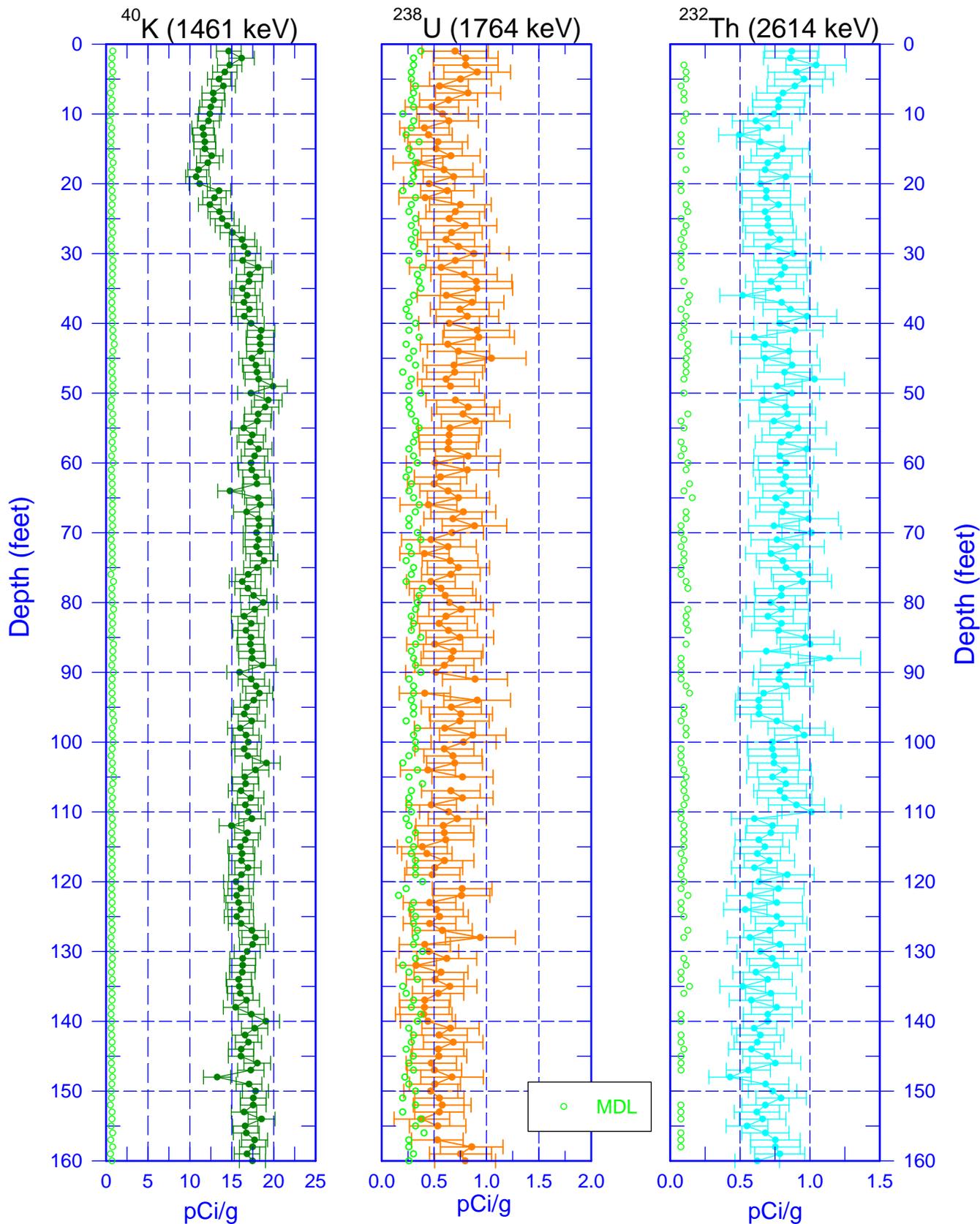
299-E28-34 (C9752) Manmade Radionuclides



Zero Reference - ground surface



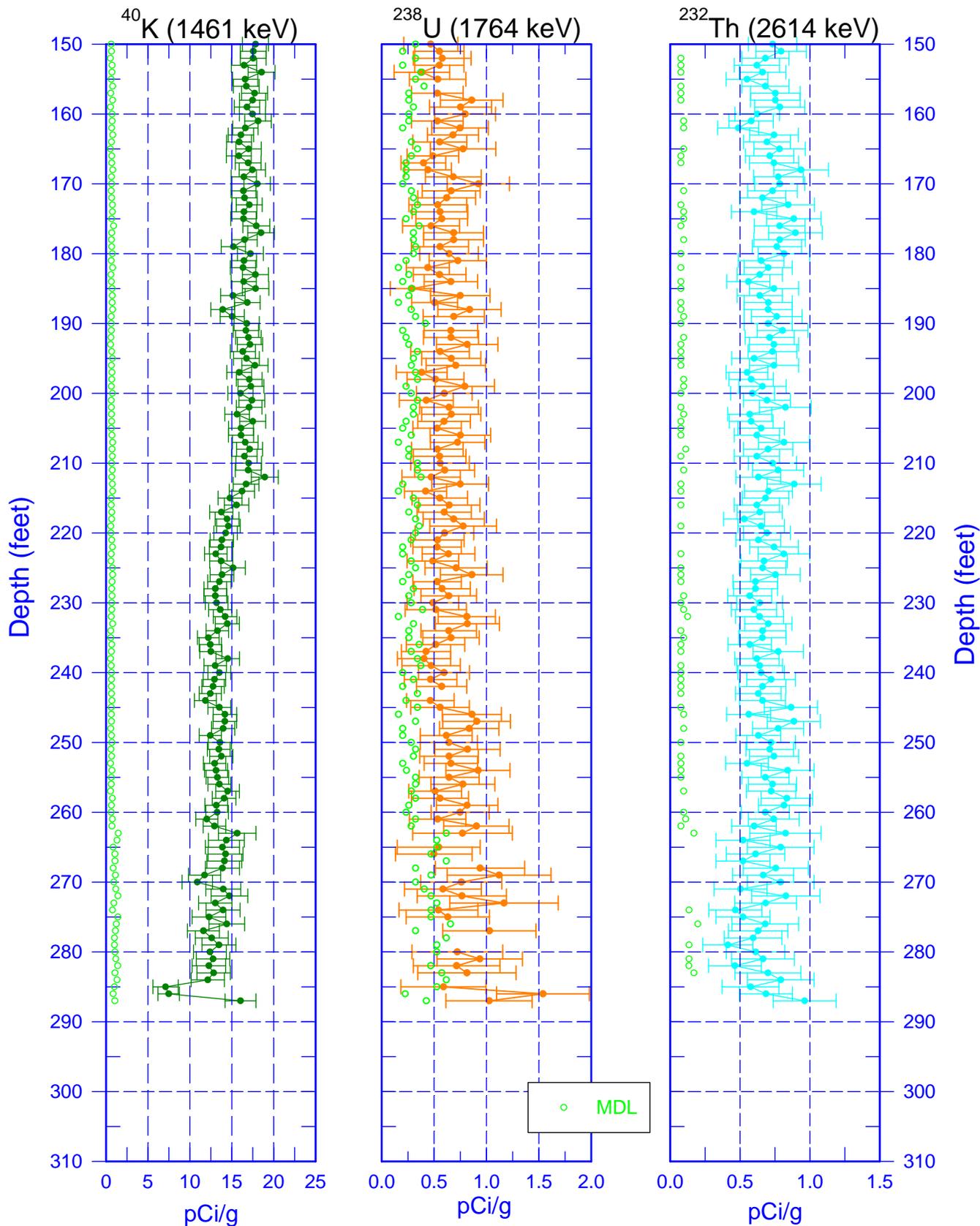
299-E28-34 (C9752) Natural Gamma Logs



Zero Reference - ground surface



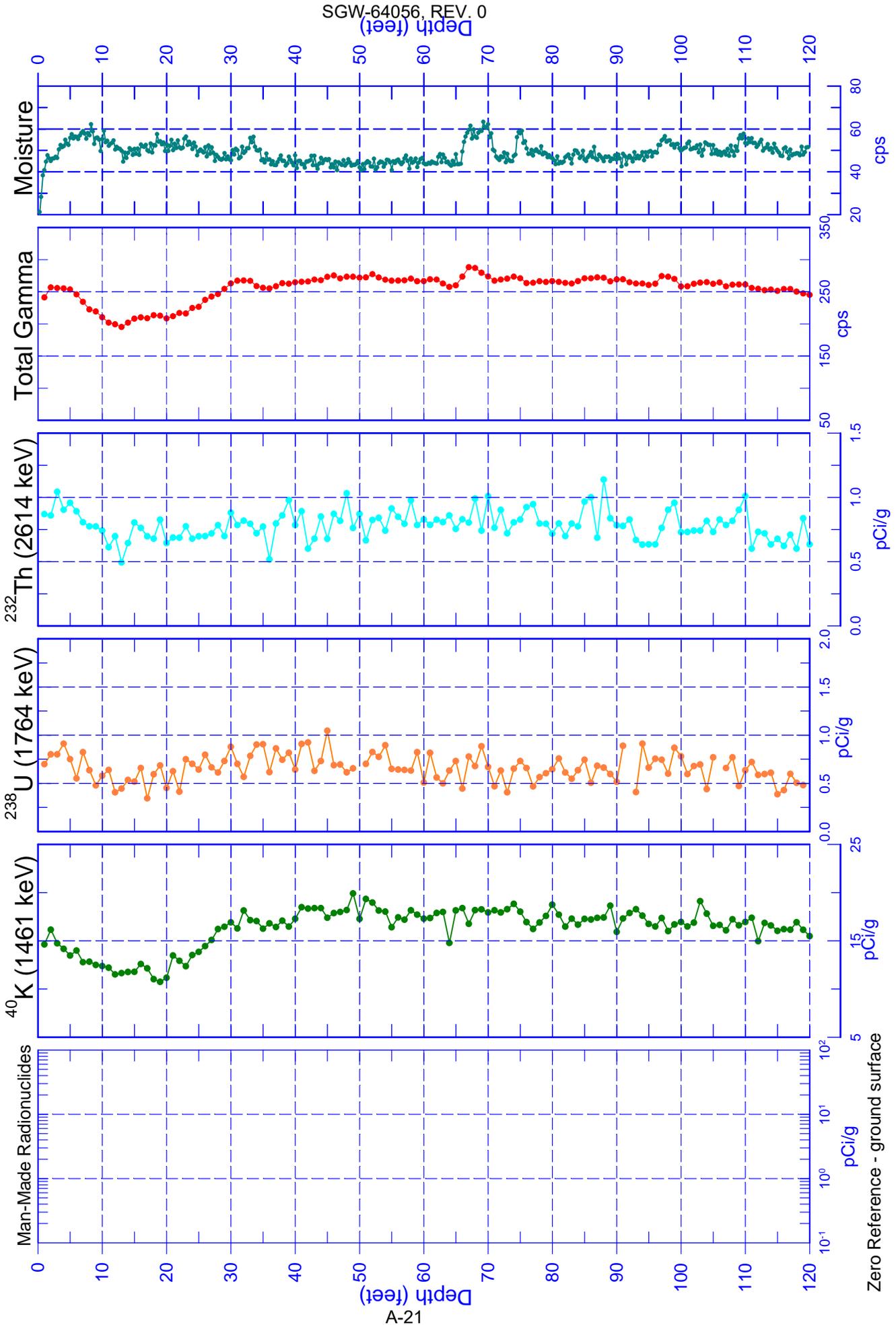
299-E28-34 (C9752) Natural Gamma Logs



Zero Reference - ground surface

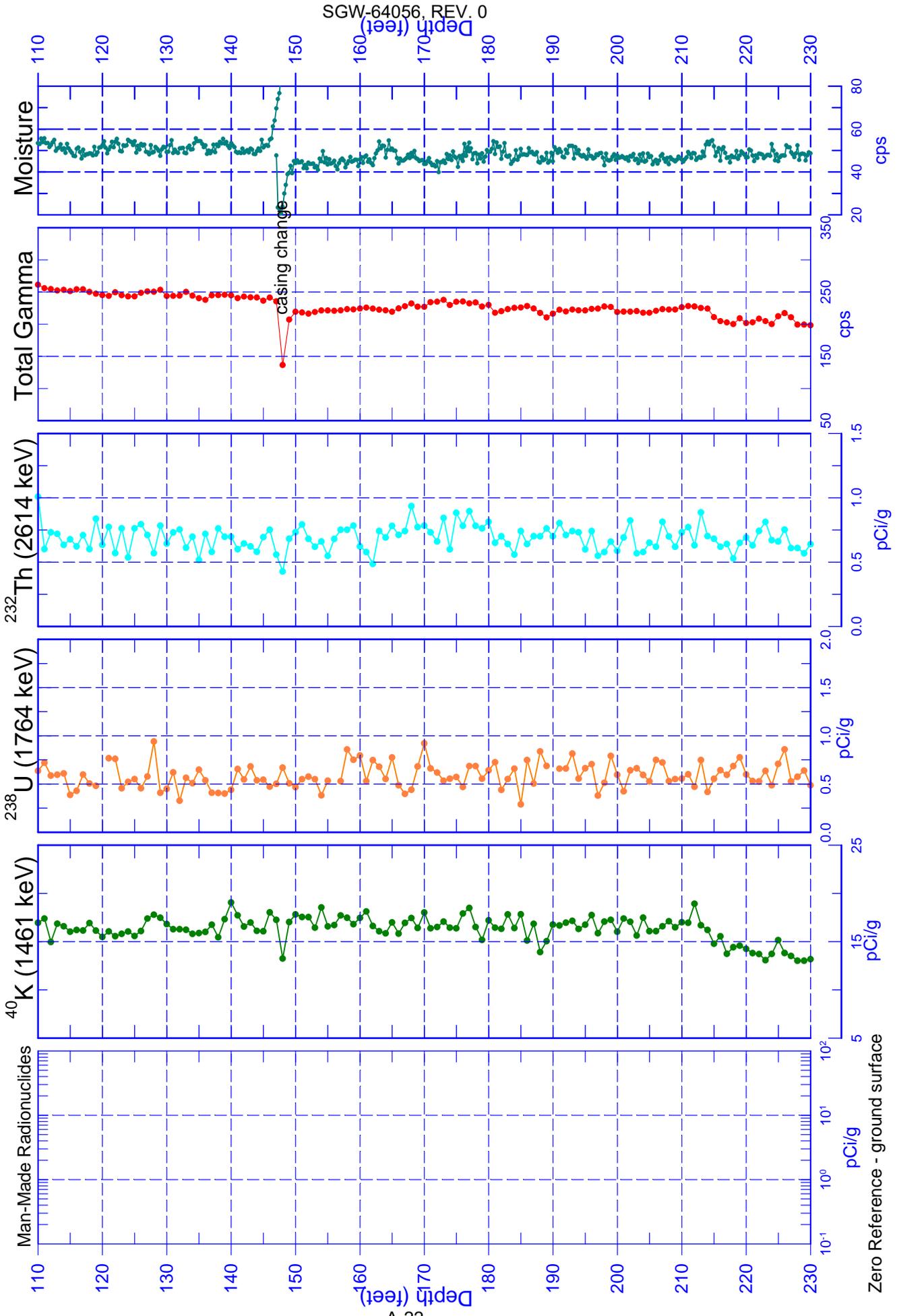


299-E28-34 (C9752) Combination Plot



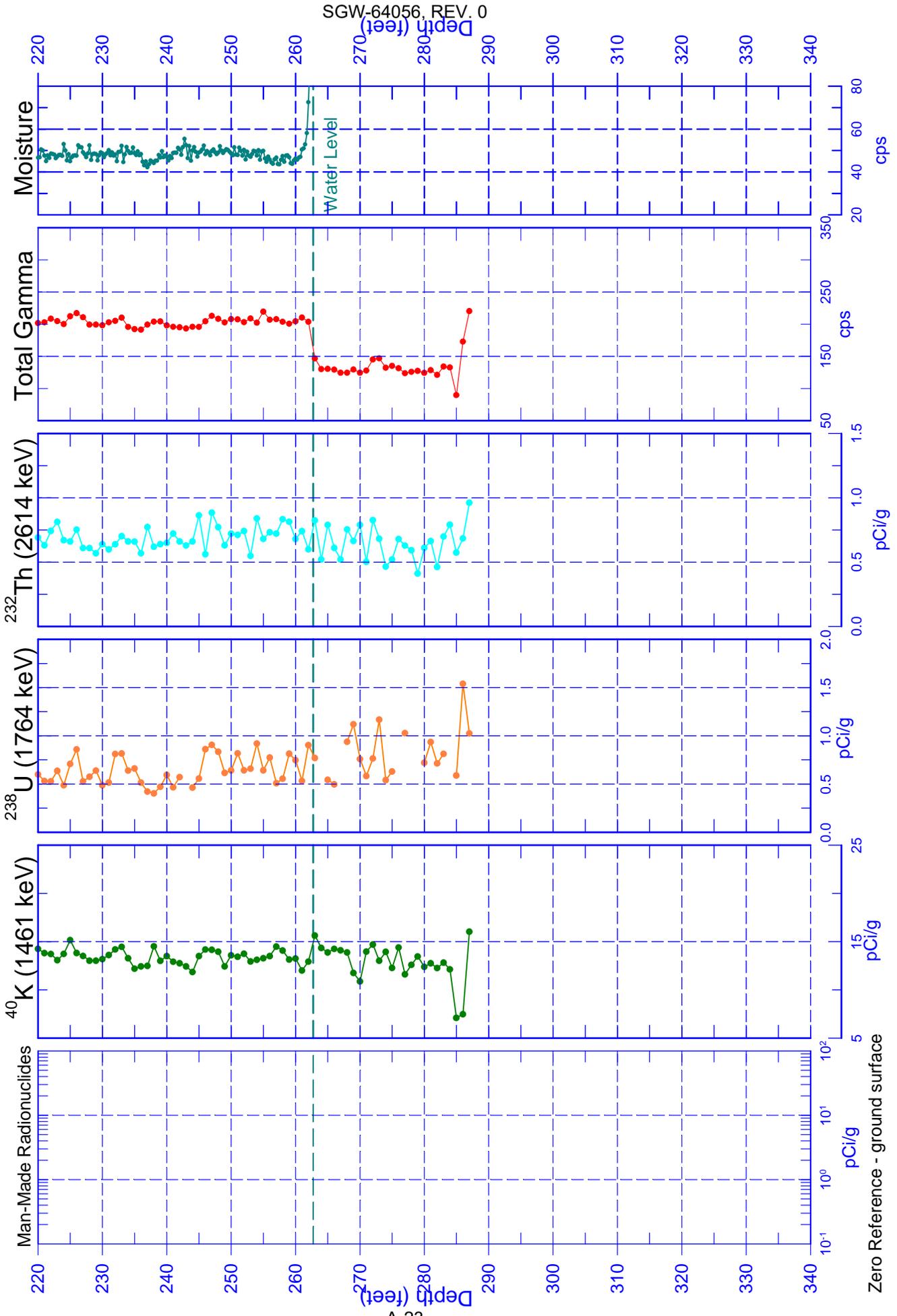


299-E28-34 (C9752) Combination Plot



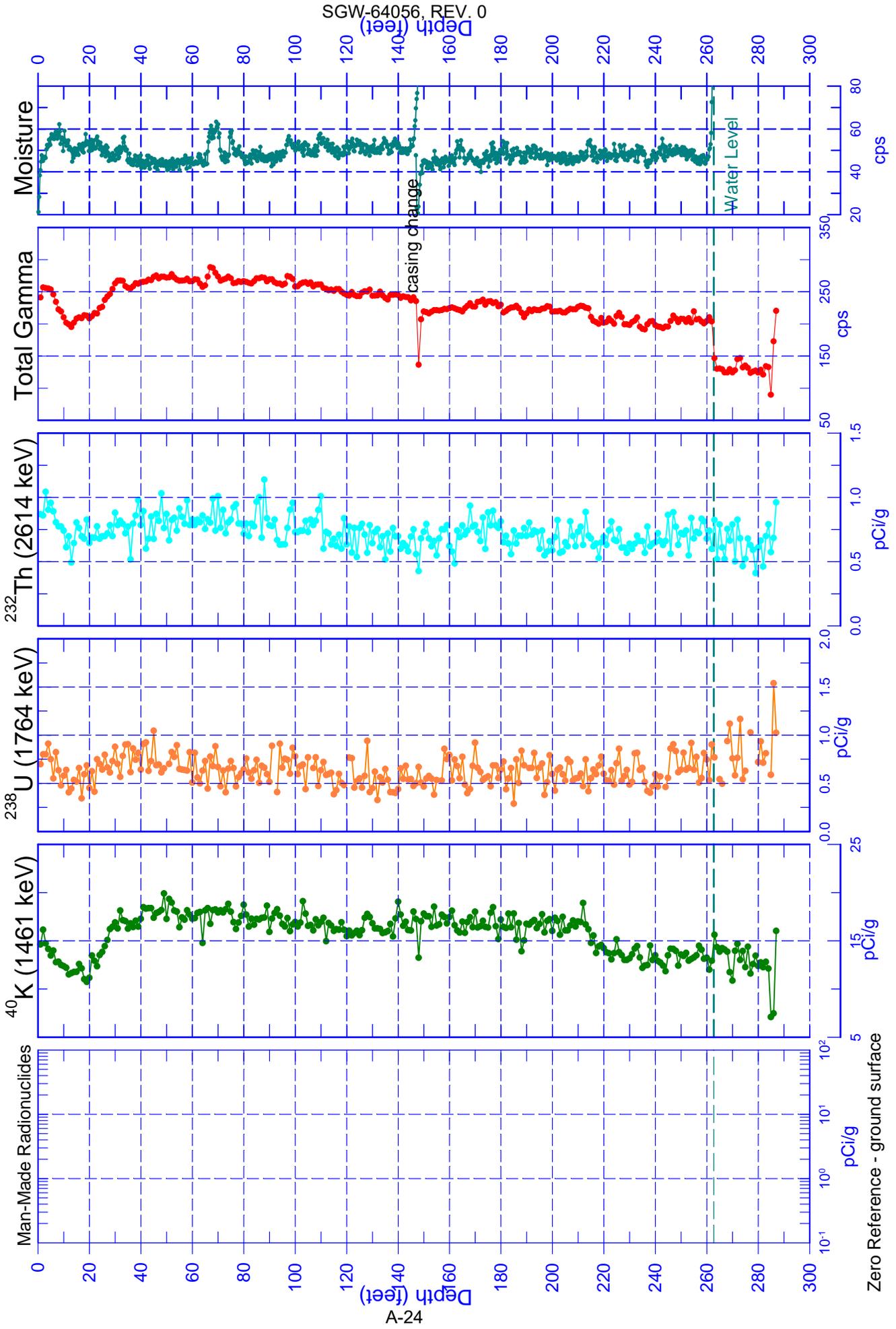


299-E28-34 (C9752) Combination Plot





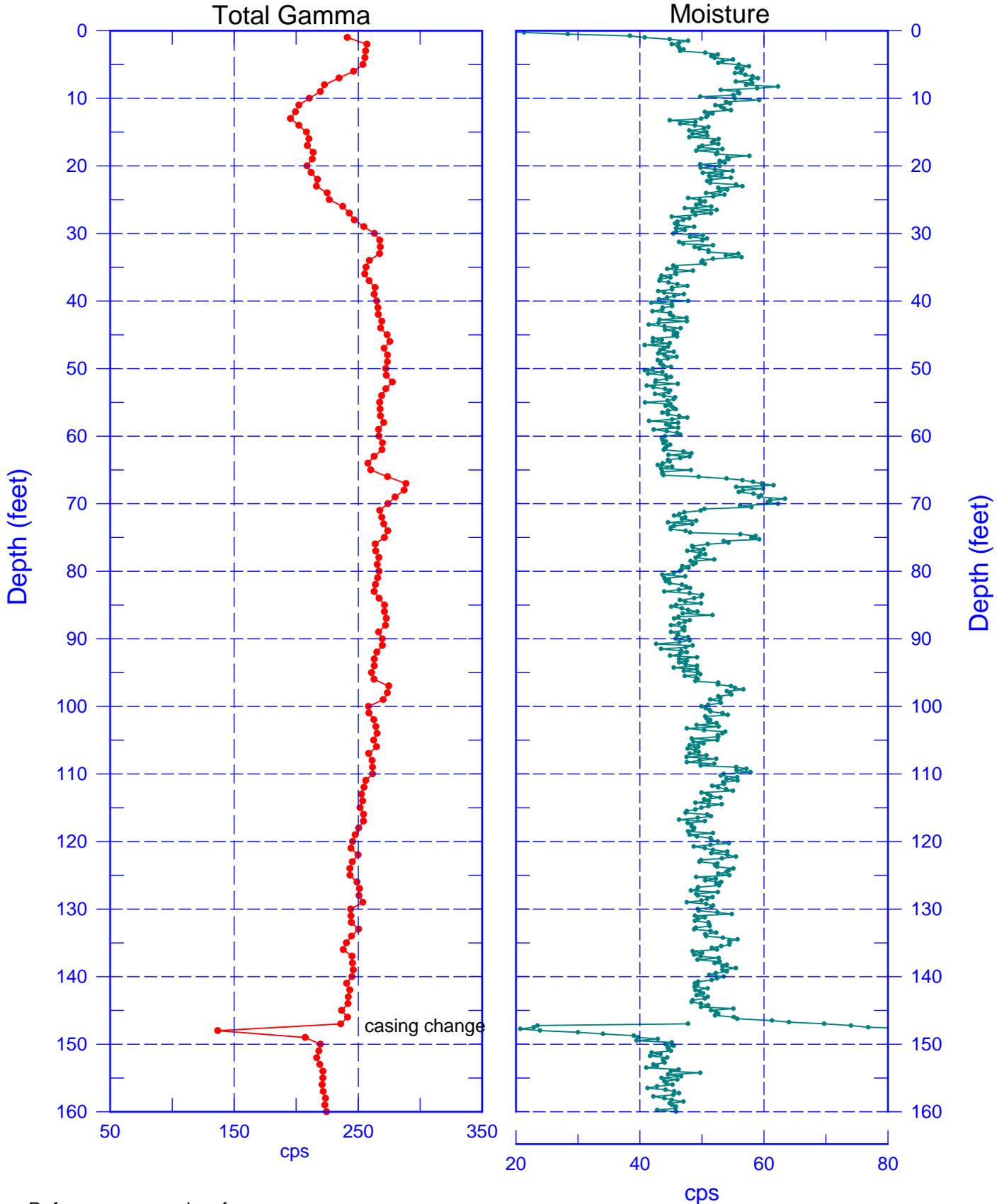
299-E28-34 (C9752) Combination Plot





299-E28-34 (C9752)

Total Gamma & Moisture

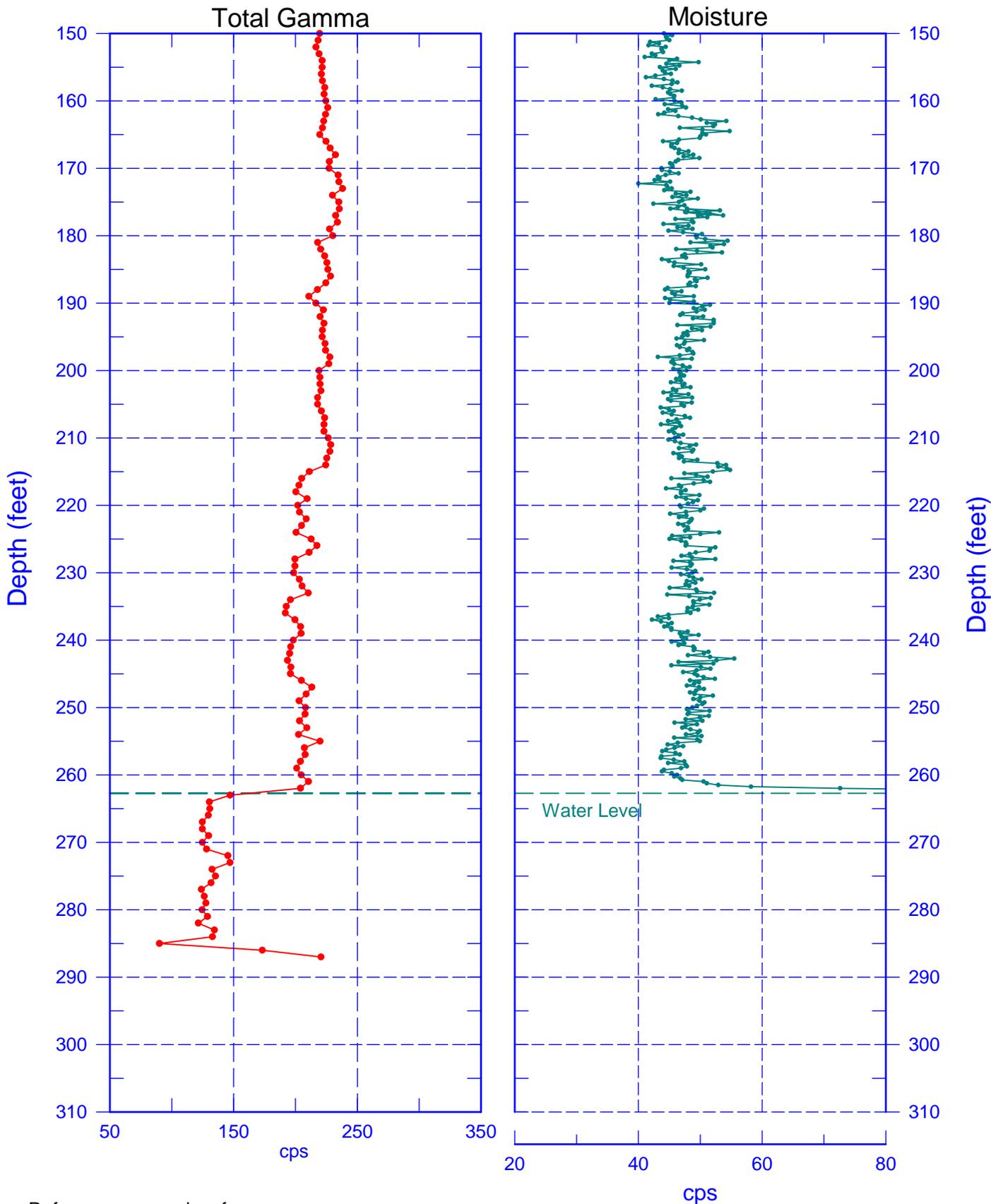


Zero Reference - ground surface



299-E28-34 (C9752)

Total Gamma & Moisture

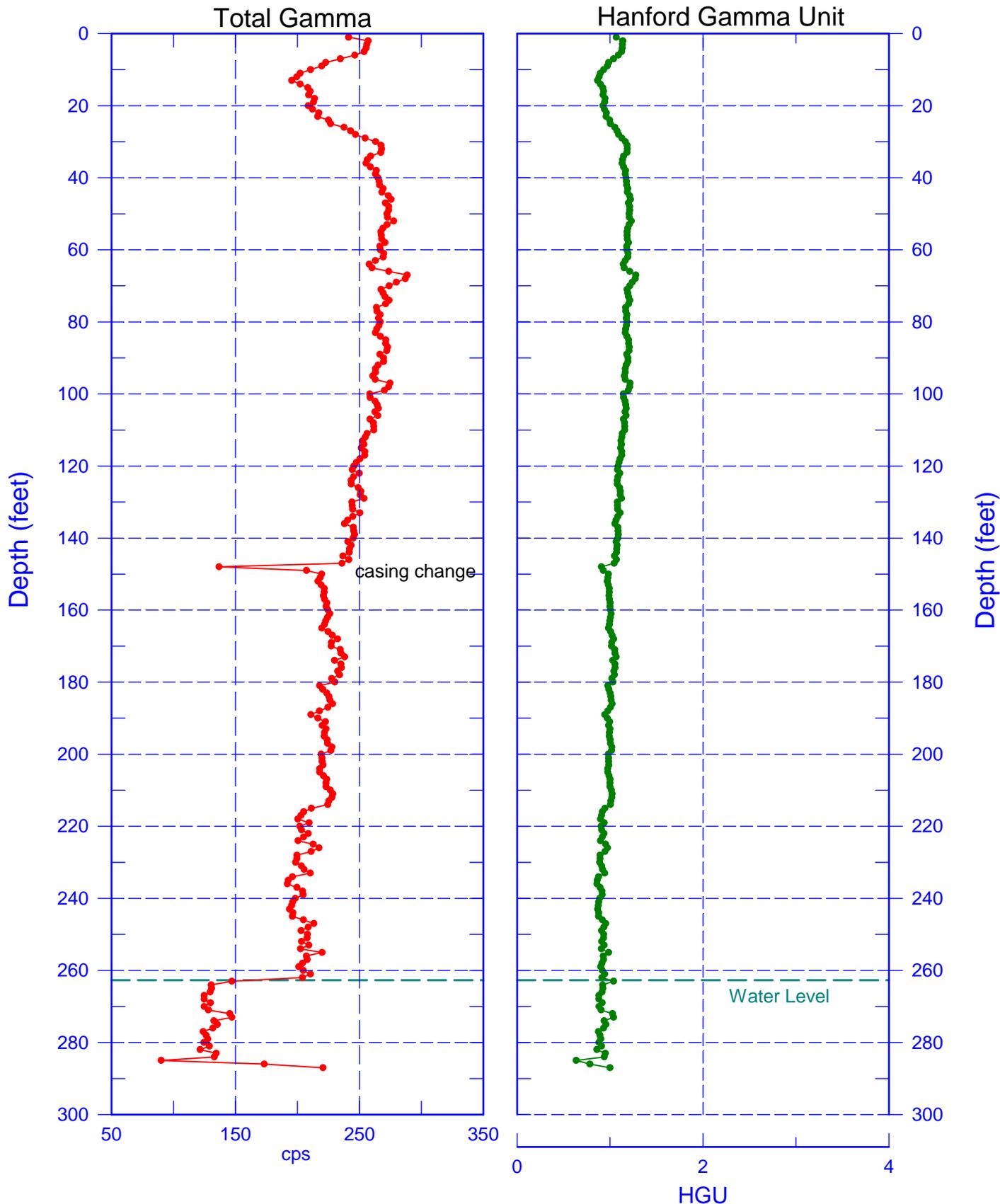


Zero Reference - ground surface



299-E28-34 (C9752)

Total Gamma & Hanford Gamma Unit

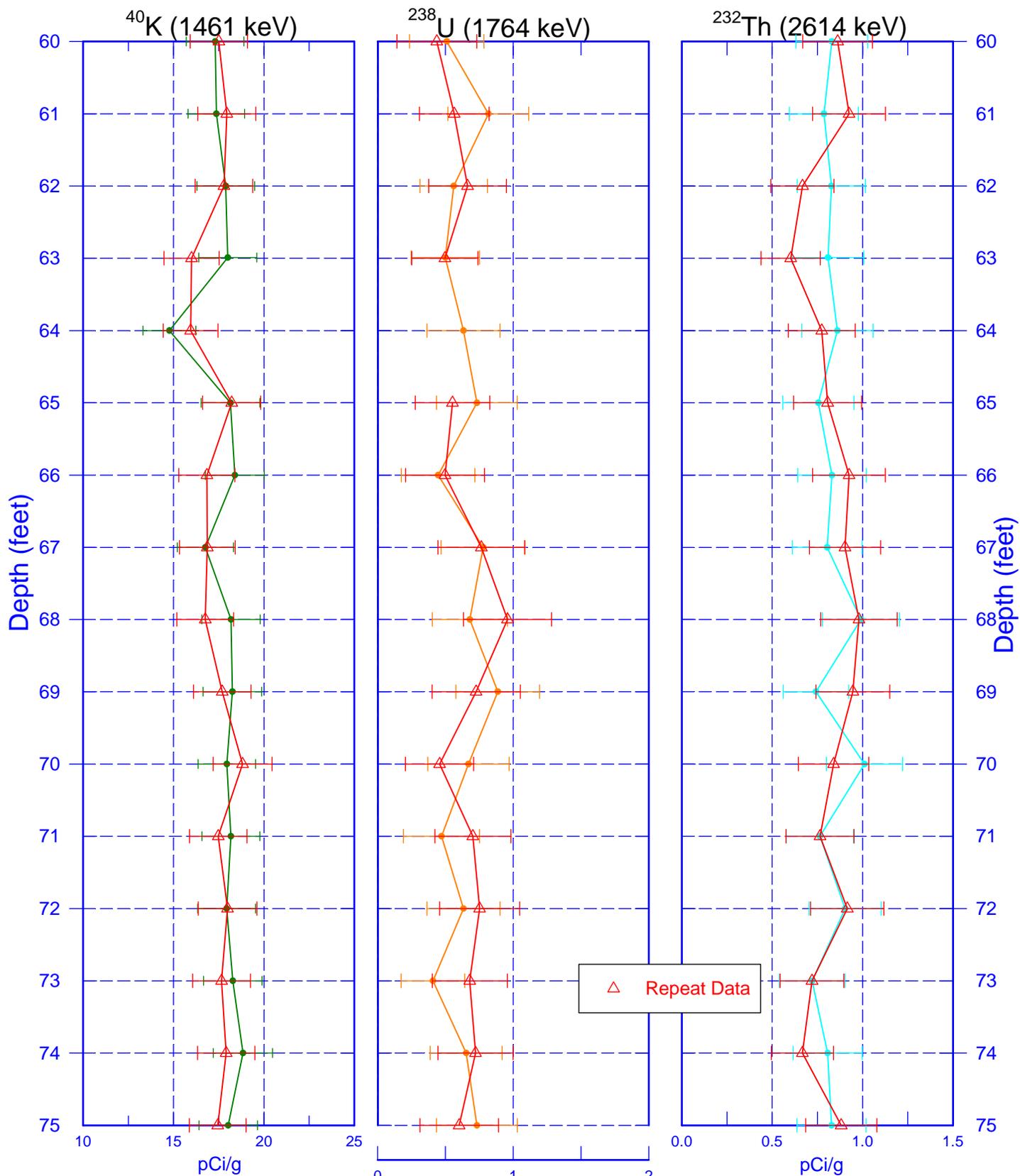


Zero Reference - ground surface



299-E28-34 (C9752)

Repeat Section of Natural Gamma Logs

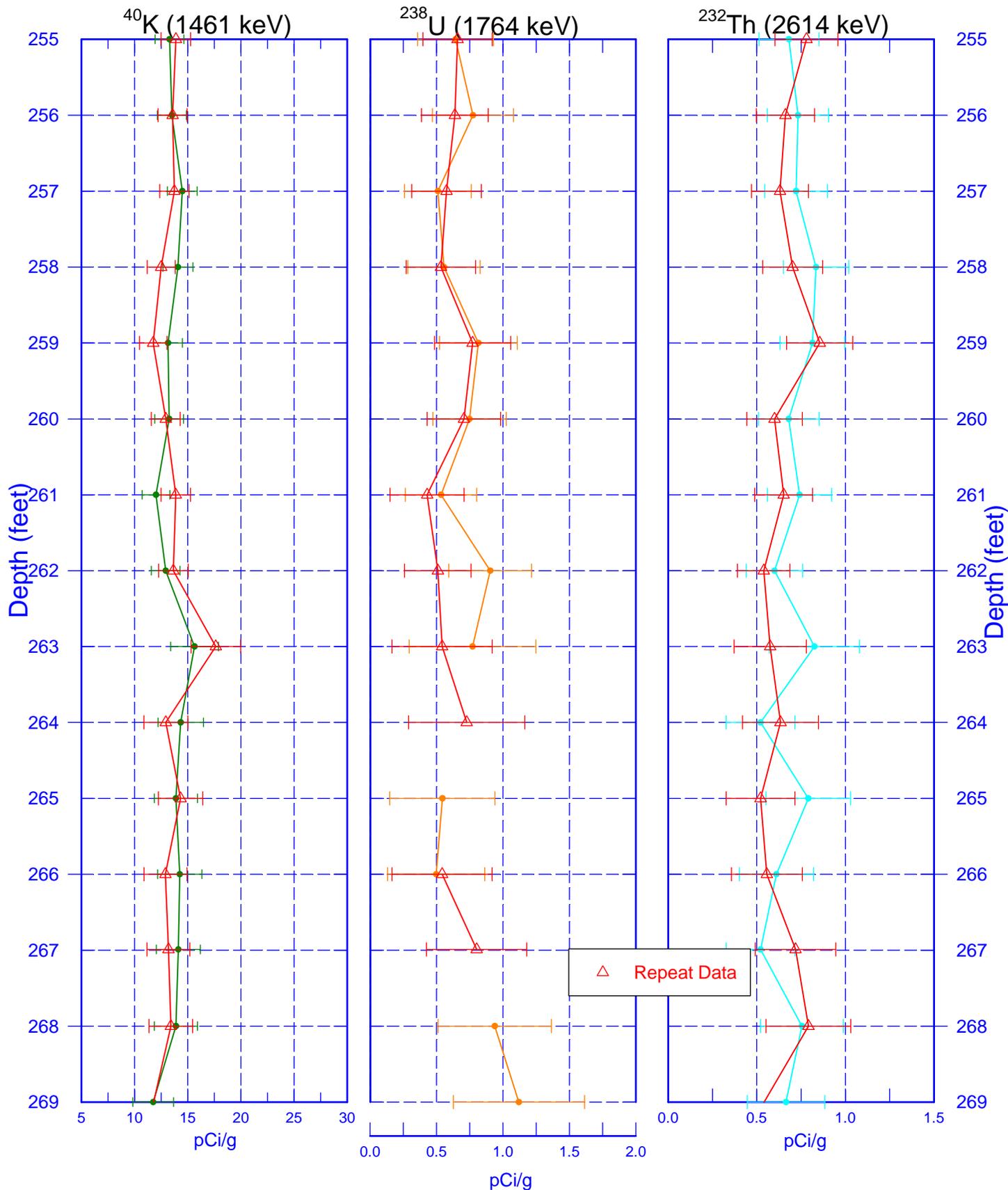


Zero Reference - ground surface



299-E28-34 (C9752)

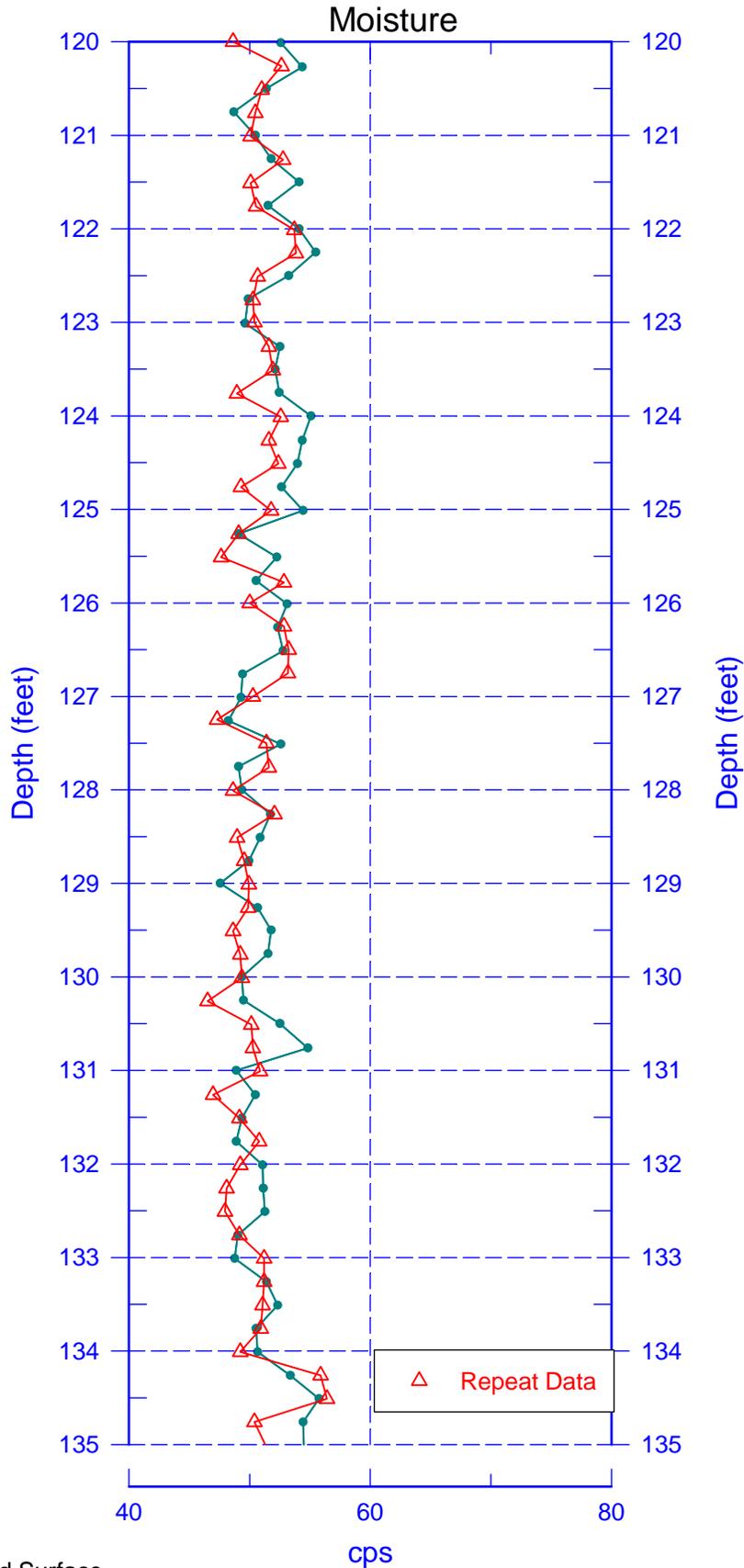
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

299-E28-34 (C9752)

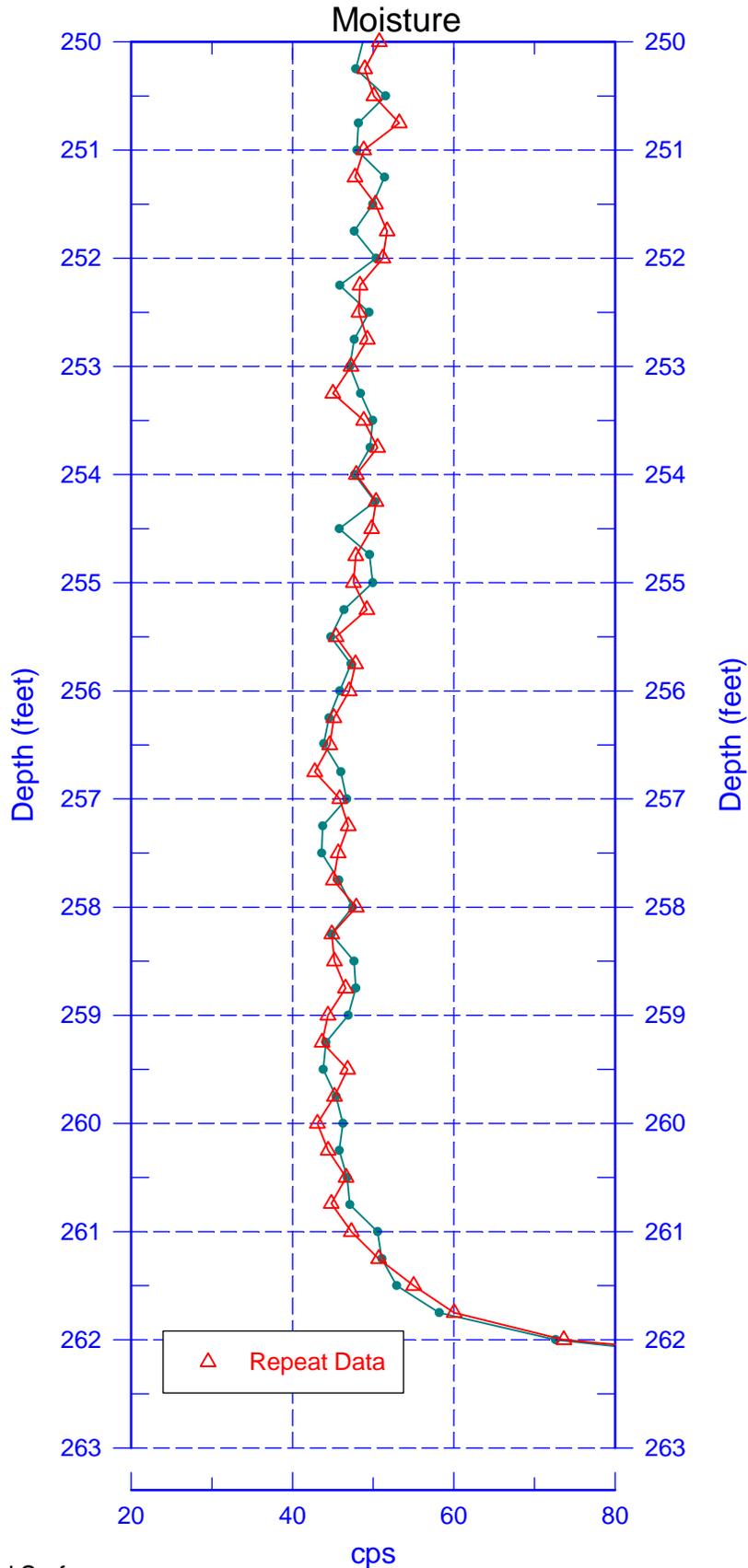
Moisture Repeat Section



Zero Reference - Ground Surface

299-E28-34 (C9752)

Moisture Repeat Section



Zero Reference - Ground Surface

cps

A-31

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WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend
	Company: CHPRC
Date Requested: 09/30/19	Requestor: Matthan G. Wilson (CHPRC)
Date of Survey: 11/07/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of BP-5 Well C9752 (299-E28-34) located southeast of B-Farm in 200E Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2E-140 (CHPRC) and 2E-49 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9752	299-E28-34	573971.50	137075.02		Center of Casing
				202.137	Top Pump Baseplate, N. Edge Inner Casing
				202.444	Top Outer Casing, N. Edge Stamped "X"
				201.717	Brass Survey Marker

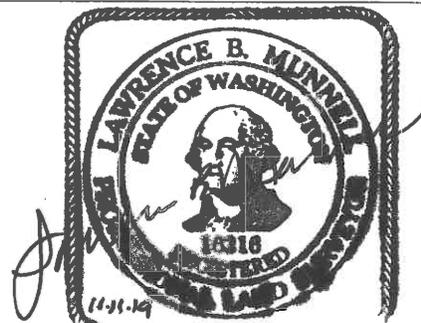
Notes:

Brass Survey Marker elevation was taken on top of domed brass cap in concrete.

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.



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WELL DEVELOPMENT AND TESTING DATA

Well ID: CG752 Well Name: 299-E28-34 Date: 7/12/19

Location: ~200m SE of B Farms

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

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

Initial Conditions

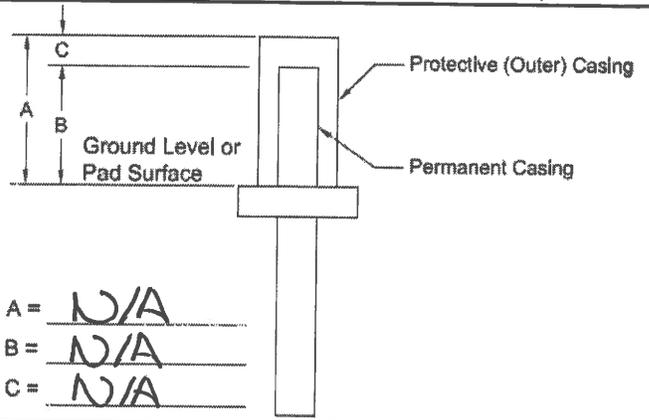
Start of Job: _____ End of Job: _____

STATIC WATER LEVEL:

Date: 7/12/19 262.50' bgs (7/13/19)
262.60' bgs
 Date: _____

DEPTH TO BOTTOM:

Date: 7/12/19 287.48' bgs (7/13/19)
287.48' bgs
 Date: _____



Intake Depth (ft bgs)	Specific Capacity (gpm/ft)	Troll Depth (ft bwt)	Turbidity (NTU)		Pump Start	Pump Stop	Pumping Rate (gpm)	Maximum Drawdown (ft)
			Initial	Final				
<u>281.7' bgs</u>	<u>1250</u>	<u>20.11</u>	<u>783</u>	<u>0.56</u>	<u>10:04</u>	<u>10:08</u>	<u>~75</u>	<u>0.06</u>
<i>JLK 9/12/19</i>								

Total Pumped: 1500 gal prior to test + ⁴⁸⁰⁰4800 gal during test = 6,300 gal

Pump Model: Grundfos GF85S100-7.6 ^{7/12/19}

Troll Serial Number and Pressure Range (PSI and depth): LevelTROLL 700 (r: 70m/231', man: 2017-10

Comments: S/N: 553218)

*"End of Job" measurements taken 7/13/19 due to the occurrence of lightning prior to collection on 7/12/19

Prepared By: SJ Sexton [Signature] 7/13/19
 Print Name Signature Date

Reviewed By: Jennifer Richardt [Signature] 9/12/19
 Print Name Signature Date

For Office Use Only

OR Doc Type: _____ WMU Code(s): _____

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C9752 Photo Log



0-5 ft bgs



5-10 ft bgs



10-15 ft bgs



15-20 ft bgs



20-25 ft bgs



25-30 ft bgs



30-35 ft bgs



35-40 ft bgs



40-45 ft bgs



45-50 ft bgs



50-55 ft bgs



55-60 ft bgs



60-65 ft bgs



65-70 ft bgs



70-75 ft bgs



75-80 ft bgs



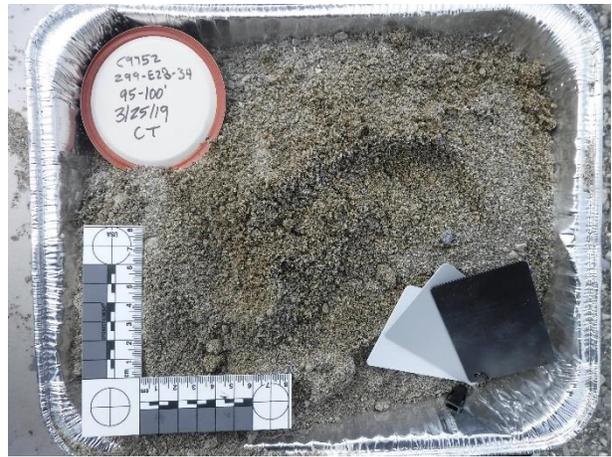
80-85 ft bgs



85-90 ft bgs



90-95 ft bgs



95-100 ft bgs



100-105 ft bgs



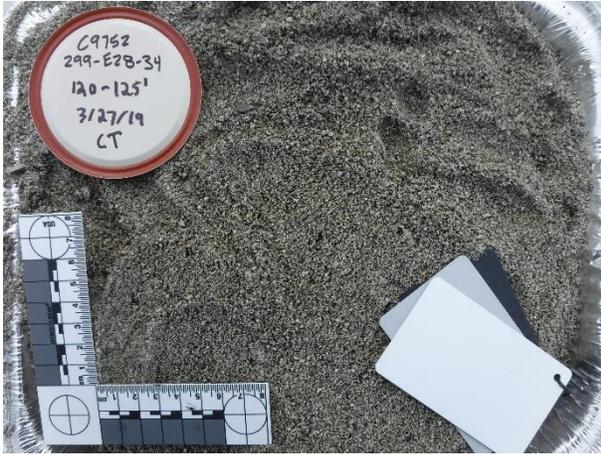
105-110 ft bgs



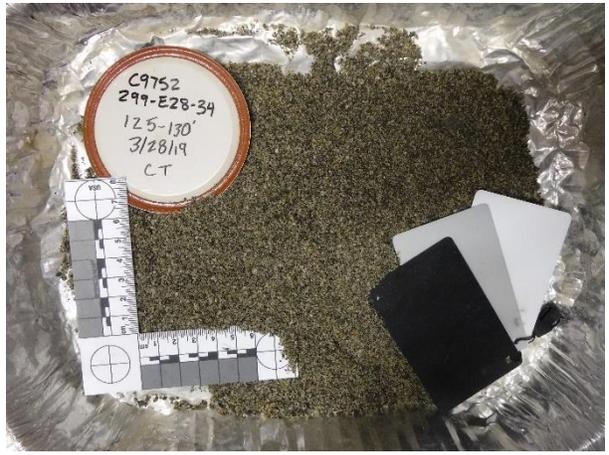
110-115 ft bgs



115-120 ft bgs



120-125 ft bgs



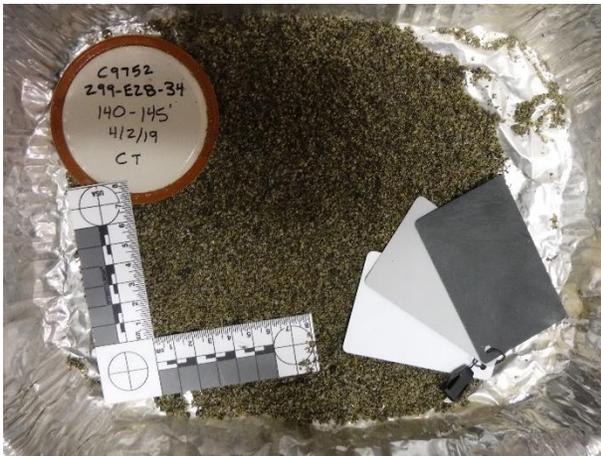
125-130 ft bgs



130-135 ft bgs



135-140 ft bgs



140-145 ft bgs



145-150 ft bgs



150-155 ft bgs



155-160 ft bgs



160-165 ft bgs



165-170 ft bgs



170-175 ft bgs



175-180 ft bgs



180-185 ft bgs



185-190 ft bgs



190-195 ft bgs



195-200 ft bgs



200-205 ft bgs



205-210 ft bgs



210-215 ft bgs



215-220 ft bgs



220-225 ft bgs



225-230 ft bgs



230-235 ft bgs



235-240 ft bgs



240-245 ft bgs



245-250 ft bgs



250-255 ft bgs



255-260 ft bgs



260-265 ft bgs



265-270 ft bgs



270-275 ft bgs



275-280 ft bgs



280-285 ft bgs



285.2-286.5 ft bgs

Appendix B

Well Documentation for 299-E27-137B (C9753)

- Well Summary Sheet for C9753
- Borehole Log for C9753
- Geophysical Log Data Report for C9753
- Final Survey Report for C9753
- Well Development and Testing Data Sheet C9753
- Photo Log for C9753

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WELL SUMMARY SHEET			Page 1 of 3	
Well ID: C9753		Well Name: 299-E27-137B		Start Date: 5/28/19
Project: 4 Wells in the 200-BP-5 GW OU		Location: ~0.5 km SE of C9752		End Date: 9/13/19
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
<p>Surface Completion: 4' x 4' x 6" Concrete Pad with brass survey marker and protective monument (3.00' ags - 2.00' bgs) Ecology Well # BLD-032 Well Completion Material: Type I/II Portland Cement 0.0' bgs - 10.2' bgs Bentonite Crumbles 10.2' bgs - 266.7' bgs Bentonite Pellet Seal 266.7' bgs - 273.2' bgs 8-16 mesh Primary Filterpack 273.2' bgs - 304.3' bgs Bentonite Pellet Seal 304.3' bgs - 309.1' bgs 8-16 mesh Primary Filterpack 309.1' bgs - 325.4' bgs Permanent Well: 8" ID Stainless Steel Blank 2.00' ags - 277.14' bgs 8" ID Stainless Steel 0.050-in Screen 277.14' bgs - 302.14' bgs 8" ID Stainless Steel Blank 302.14' bgs - 312.13' bgs 8" ID Stainless Steel 0.050-in Screen 312.13' bgs - 322.13' bgs 8" ID Stainless Steel Sump 322.13' bgs - 325.13' bgs Hole Dimensions: 16" Temporary Casing: 129.07' bgs 12" Temporary Casing: 325.14' bgs Total Depth : 326.25' bgs ags = above ground surface bgs = below ground surface</p>				
				<p>0 - 1: Gravel Pad 1 - 10: Slightly Silty Sand [(m)S] 10 - 30: Gravelly Sand (gS) 30 - 50: Sand (S) 50 - 55: Gravelly Sand (gS) 55 - 70: Sand (S) 70 - 90: Slightly Silty Sand [(m)S] 90 - 95: Sand (S) 95 - 105: Slightly Silty Sand [(m)S] 105 - 120: Sand (S)</p>
<p>Reported By: <u>Brandon Thurnau</u> Geologist <u>Brandon Thurnau</u> Signature <u>9/6/19</u> Date</p> <p>Reviewed By: <u>Jennifer Richardt</u> Well coordinator <u>J Richardt</u> Signature <u>9/23/19</u> Date</p>				
For Office Use Only				
OR Doc Type:		WMU Code(s):		

WELL SUMMARY CONTINUATION SHEET

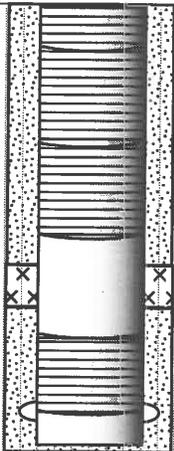
Well ID: C9753

Well Name: 299-E27-137B

Project: 4 Wells in the 200-BP-5 OU

CONSTRUCTION DATA

GEOLOGIC/HYDROLOGIC DATA

Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)		
Well Completion Material:						
Type I/II Portland Cement		280		260 - 290: Sandy Gravel (sG)		
0.0' bgs - 10.2' bgs						
Bentonite Crumbles						
10.2' bgs - 266.7' bgs						290 - 305: Gravel (G)
Bentonite Pellet Seal				300		
266.7' bgs - 273.2' bgs						
8-16 mesh Primary Filterpack						305 - 315: Sandy Gravel (sG)
273.2' bgs - 304.3' bgs						
Bentonite Pellet Seal						315 - 324: Gravel (G)
304.3' bgs - 309.1' bgs				320		
8-16 mesh Primary Filterpack						
309.1' bgs - 325.4' bgs						324 - 325: Sandy Gravel (sG)
Natural Fill						325 - 325.25: Basalt
325.4' bgs - 326.25' bgs						
Permanent Well:						
8" ID Stainless Steel Blank		340				
2.00' ags - 277.14' bgs						
8" ID Stainless Steel 0.050-in Screen						
277.14' bgs - 302.14' bgs		360				
8" ID Stainless Steel Blank						
302.14' bgs - 312.13' bgs						
8" ID Stainless Steel 0.050-in Screen						
312.13' bgs - 322.13' bgs		380				
8" ID Stainless Steel Sump						
322.13' bgs - 325.13' bgs						
Hole Dimensions:						
16" Temporary Casing: 129.07' bgs		400				
12" Temporary Casing: 325.14' bgs						
Total Depth : 326.25' bgs						
ags = above ground surface						
bgs = below ground surface						
		420				
		440				

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BOREHOLE LOG				Page <u>1</u> of <u>9</u>
Well ID: <u>C9753</u>		Well Name: <u>299-E29-137B</u>		Date: <u>5/28/19</u>
Project: <u>Two Dual Purpose and Two Monitoring Wells in the 200-BU-5 GWU</u>			Location: <u>~0.5 km SE of C9752</u>	
Reference Measure Point: <u>Ground Surface</u>				
Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0		280.00 285.00	0-1': Gravel Pzd 1-10': Slightly silty sand [m] S	Cable tool - 24" auger bit used for the first ~8' starter
5	G.S. 5/28/19	-	25'-57' Gravel: 75% M 25% F, 2mm-30mm, rounded-subrounded, mod. sorted; 75% Sand: 55% / 15% M, v. fn. - v. crs. (fn. - med. aug.), mod. sorted; 20% silt: 2.54 5/13 light olive brown (dry), v. strong rxn w/ HCl	hole for 16" temporary casing then switch to dual barrel w/ 1 1/2" OD and 2.00' length; G.S. = Grab Sample at 5/28/19 G.S. 25' not heavily disturbed due to auger method
10	G.S. 5/29/19	o	10-30: Gravelly Sand (G.S.) 10'-15% Gravel: 70% M 30% F, 2-14mm (5mm avg.), rounded-subangular, well sorted; 75% Sand: 10% F 40% M, v. fn. - v. crs (med. - crs. avg.), mod. sorted; 10% silt: 2.54 (1/2 light yellowish brown, strong rxn w/ HCl (dry))	
15	G.S. 5/29/19	o	215-20% Gravel: 75% M 25% F, 2-7mm (4mm avg.), round-subangular, well sorted; 70% Sand: 55% F 45% M, v. fn. - v. crs. (med. - crs. avg.) mod. sorted; 10% silt: 2.54 1/2 light brown, strong rxn w/ HCl	
20	G.S. 5/29/19	o	220'-25% Gravel: 70% M 30% F, 2-22mm (4mm avg.), rounded-subangular, well sorted; 70% Sand: 45% F 15% M 5% F, v. fn. - v. crs. (crs. avg.), well sorted; 5% silt: 2.54 1/2 light brownish gray; mod rxn w/ HCl	
25	G.S. 5/30/19	o	225'-10% Gravel: 75% M 25% F, 2-12mm (3mm avg.), rounded-subangular, well sorted; 85% Sand: 50% M 50% F, v. fn. - v. crs. (crs. avg.), well sorted; 5% silt: 2.54 (1/2 light brownish gray; mod. rxn w/ HCl	
30	G.S. 5/30/19	o	30-50: Sand (S) 30'-5% Gravel: 80% M 20% F, 2-18mm (4mm avg.), rounded-subround, well sorted; 90% Sand: 55% M 45% F, v. fn. - v. crs. (med. - crs. avg.), mod. sorted; 5% silt: 2.54 (1/2 light brownish gray; mod. rxn w/ HCl	

Reported By: Brandon Thurnen Geologist Brandon Thurnen 5/28/19
Print Name Title Signature Date

Reviewed By: Sarah Springer Sr Geologist Sarah Springer 07-30-19
Print Name Title Signature Date

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OR Doc Type: _____ WMU Ccode(s): _____

BOREHOLE LOG (Cont.)

Date: 5/30/19

Well ID: C9753

Well Name: 299-EZ7-137B

Location: ~0.5 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description:	Comments:
			Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35	Gr.S. 5/30/19		<u>30-50: Sand (S)</u> @35'-5% Gravel: 80% M/20% F, 2-10mm (3mm avg.), rounded-subangular, well sorted; 90% Sand: 50% M/50% F, v. fn. - v. crs. (med. - crs. avg.), med. sorted; 5% Silt: 2.54 (1/2) light brownish gray, med - strong rxn w/ HCl	Cank tool w/ 2,00' and 1 1/2" OD drive barrel; Gr.S. = Grab sample.
40	Gr.S. 6/3/19		@40'-max gravel size is 4mm (4mm avg.), slight - mod. rxn w/ HCl; other characteristics similar or the same as grab sample from 35'	
45	Gr.S. 6/3/19		@45'-5% Gravel: 70% M/30% F, 2-9mm (3mm avg.), rounded-subangular, well sorted; 90% Sand: 45% M/45% F, v. fn. - v. crs. (crs. avg.), well sorted; 5% Silt: 2.54 (1/2) light brownish gray, weak rxn w/ HCl	
50	Gr.S. 6/3/19		<u>50-55: Gravelly Sand (gS)</u> @50'-10% Gravel: 75% M/25% F, 2-7mm (avg. 6mm), rounded-subangular, poorly sorted; 85% Sand: 45% M/55% F, v. fn. - v. crs. (med. - crs. avg.), med sorted; 5% Silt: 2.54 (1/2) light brownish gray (dry), weak rxn w/ HCl	
55	Gr.S. 6/4/19		<u>55-70: Sand (S)</u> @55'-3% Gravel: 70% M/30% F, 2-10mm (3mm avg.), rounded-subangular, well sorted; 90% Sand: 50% M/50% F, v. fn. - v. crs. (crs. avg.), well sorted; 7% Silt: 2.54 (1/2) light brownish gray (dry), weak - mod. rxn w/ HCl	
60	Gr.S. 6/4/19	@60'-5% Gravel: 75% M/25% F, 2-12mm (4mm avg.), rounded-subrounded, well sorted; 90% Sand: 50% M/50% F, v. fn. - v. crs. (med. - crs. avg.), well sorted; 5% Silt: 2.54 (1/2) light brownish gray (dry); weak rxn w/ HCl		
65	Gr.S. 6/4/19	@65'-3% Gravel: 80% M/20% F, 2-19mm (4mm avg.), rounded-subrounded, well sorted; 87% Sand: 45% M/55% F, v. fn. - v. crs. (med. - crs.), med sorted; 10% Silt: 2.54 (1/2) light brownish gray (dry), med. - strong rxn w/ HCl		
70	Gr.S. 6/5/19	<u>70-90: Silty Sand (mS)</u> @70'-5% Gravel: 90% M/10% F, 2-13mm (4mm avg.), rounded-subround, well sorted; 75% Sand: 50% M/50% F, v. fn. - v. crs. (fn. - crs. avg.), med. sorted; 20% Silt: 2.54 (1/2) light gray (dry), strong rxn w/ HCl		
			@74.5' - one 131mm well rounded large cobble present	

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

5/30/19
Date

BOREHOLE LOG (Cont.)

Date: 6/5/19

Well ID: C9753

Well Name: 299-E27-137B

Location: ~0.5 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description:	
			Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75	G.S. 6/5/19		70-90 : Slightly Silty Sand [(m)S]	Cable tool w/ 200' and 1 1/2" OD
			@75'-5' : 1/6 Gravel: 75% M / 25% F, 2-8mm (4mm avg.), rounded-sub-rounded, well sorted; 75% Sand: 45% F / 55% M, v.f.n. - v.c.s. (med. - c.s. avg.), mod. sorted; 20% Silt: 2.54 7/2 light gray, string rxn w/ HCl	drive barrel; G.S. = grab sample
80	G.S. 6/5/19		@80'-3' : 1/6 Gravel: 80% M / 20% F, 2-10mm (4mm avg.), rounded-subangular, well sorted; 82% Sand: 50% M / 50% F, v.f.n. - v.c.s. (med. - c.s. avg.), mod. sorted; 15% Silt: 2.54 6/2 light brownish gray, string rxn w/ HCl	
85	G.S. 6/6/19		@85'-3' : 1/6 Gravel: 90% M / 10% F, 2-5mm (3mm avg.), rounded-subangular, well sorted; 82% Sand: 45% M / 55% F, v.f.n. - v.c.s. (med. - c.s. avg.), mod. sorted; subround-subangular; 15% Silt: 2.54 6/2 light brownish gray, mod. - string rxn w/ HCl	
90	G.S. 6/6/19		90-95 : Sand (S)	Waste 1 soil grab sample info -
			@90'-1' : 1/6 Gravel: 80% M / 20% F, 2-8mm (3mm avg.), subrounded-angular, well sorted; 89% Sand: 50% M / 50% F, v.f.n. - v.c.s. (med. - c.s. avg.), mod. sorted; subround-subangular; 10% Silt: 2.54 7/2 light gray, mod. rxn w/ HCl	borehole @ 89.3' bgs, casing @ 88.15', actual depth: 89.3-91.3' bgs, 100% recovery, sample time @ 1020 on 6/6/19
				HEIS # B3NNT0
95	G.S. 6/6/19		95-105: Slightly Silty Sand [(m)S]	
			@95'-1' : 1/6 Gravel: 90% M / 10% F, 2-5mm (3mm avg.), subround-subangular, well sorted; 84% Sand: 50% M / 50% F, v.f.n. - v.c.s. (fn. - med. avg.), mod. sorted; subrounded-subangular; 15% Silt: 2.54 7/2 light gray	
100	G.S. 6/10/19			@100' - characteristic similar / same as G.S. from 95'
				105-120: Sand (S)
105	G.S. 6/10/19			@105'-2' : 1/6 Gravel: 90% M / 10% F, 2-9mm (8mm avg.), subround-subangular, well sorted; 88% Sand: 55% M / 45% F, v.f.n. - v.c.s. (med. avg.), well sorted, subround-subangular; 10% Silt: 2.54 7/2 light gray, mod. rxn w/ HCl
110	G.S. 6/10/19		@110'-5' : 1/6 Gravel: 85% M / 15% F, 2-7mm (4mm avg.), round-subangular, well sorted; 85% Sand: 1/6 M / 5/6 F, v.f.n. - v.c.s. (med. avg.), well sorted, subround-subangular; 10% Silt: 2.54 6/2 light brownish gray, mod. - string rxn w/ HCl	

Reported By:

Brandon Thurnell
Print Name

Geologist
Title

Brandon Thurnell
Signature

6/5/19
Date

BOREHOLE LOG (Cont.)

Date: 6/10/19

Well ID: C9753

Well Name: 299-E27-137B

Location: ~0.5 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description:	Comments:
			Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
115	G.S. 6/11/19		105-120 : Sand (S) @115' - 7% Gravel: 80% M / 20% F, 2-8 mm (5 mm avg), subround-subangular, well sorted; 83% Sand: 50% M / 50% F, v. fn. - v. ccs. (fn. - ccs. avg.) mod. sorted, subround-subangular; 10% Silt: 2.54 (1/2 light brownish gray, mod. - strong rxn w/ HCl)	Cable tool w/ 2.00' length and 1 1/2" OD drive barrel; G.S. = grab sample
120	G.S. 6/11/19		120-140 : Silty Sand (mS) @120' - 7% Gravel: 90% M / 10% F, 2-11 mm (4 mm avg), subround-subangular, well sorted; 78% Sand: 45% M / 55% F, v. fn. - v. ccs. (fn. - ccs. avg.), mod. sorted, subround-subangular; 15% Silt: 2.54 (1/2 light brownish gray, mod. rxn w/ HCl)	
125	G.S. 6/11/19		@125' - 5% Gravel: 90% M / 10% F, 2-5 mm (3 mm avg), subround-subangular, well sorted; 75% Sand: 50% M / 50% F, v. fn. - v. ccs. (fn. - med. avg.), well sorted, subround-subangular; 20% Silt: 2.54 (1/2 light brownish gray, mod. - strong rxn w/ HCl)	
130	G.S. 6/12/19		@130' - 5% Gravel: 85% M / 15% F, 2-8 mm (3 mm avg), subround-subangular, well sorted; 80% Sand: 55% M / 45% F, v. fn. - v. ccs. (med. avg.), subround-subangular; 15% Silt: 2.54 (1/2 light brownish gray, strong rxn w/ HCl)	
135	G.S. 6/18/19		@135' - 5% Gravel: 90% M / 10% F, 2-6 mm (3 mm avg), subround-subangular, well sorted; 75% Sand: 50% M / 50% F, v. fn. - v. ccs. (med. avg.), subround-subangular; 20% Silt: 2.54 (1/2 light brownish gray, mod. rxn w/ HCl)	
140	G.S. 6/18/19		140-145 : Gravelly Sand (gS) @140' - 15% Gravel: 95% M / 5% F, 2-11 mm (5 mm avg), subround-subangular, well sorted; 75% Sand: 55% M / 45% F, v. fn. - v. ccs. (ccs. avg.), subround-subangular; 10% Silt: 2.54 (1/2 light brownish gray, weak rxn w/ HCl)	
145	G.S. 6/18/19		145-150 : Sand (S) @145' - 5% Gravel: 80% M / 20% F, 2-5 mm (3 mm avg), subround-subangular, well sorted; 85% Sand: 50% M / 50% F, v. fn. - v. ccs. (med. - ccs. avg.), mod. sorted, subround-subangular; 10% Silt: 2.54 (1/2 light brownish gray, mod. - weak rxn w/ HCl)	
150	G.S. 6/19/19		@150' - Characteristic same/similar to the grab sample collected @ 145' except max gravel size = 6mm	

Reported By:

Brandon Thurnam
Print Name

Geologist
Title

Brandon Thurnam
Signature

6/19/19
Date

BOREHOLE LOG (Cont.)

Page 5 of 9

Date: 6/19/19

Well ID: C9753

Well Name: 299-E27-137B

Location: 0.6 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
155	G.S. 6/19/19		155-170': Gravelly Sand (GS) @155'-25% Gravel: 95% M / 5% F, 2-24 mm (7 mm avg.), subround-angular, mod. sorted; 65% Sand: 55% M / 45% F, v. fn - v. ccs. (med. - ccs. avg.), mod. sorted, SR-SA; 10% Silt: 2.54 7/2 light gray, mod. rxn w/ HCl	White tool w/ 2.00' length and 1 1/2" OD drive barrel; G.S. = grab sample; S.S. = Split Spoon
160	G.S. 6/20/19		@160'-20% Gravel: 80% M / 20% F, 2-17 mm (5 mm avg.), round-subangular, mod. sorted; 70% Sand: 45% M / 55% F, v. fn - v. ccs. (fn - ccs. avg.), poorly sorted, subround-subangular; 10% Silt: 2.54 6/2 light brownish gray, mod. rxn w/ HCl	
165	G.S. 6/20/19		@165'-10% Gravel: 90% M / 10% F, 2-10 mm (3 mm avg.), subround-subangular, mod. sorted; 80% Sand: 45% M / 55% F, v. fn - v. ccs. (med. - ccs. avg.), mod. sorted, subround-subangular; 10% Silt: 2.54 6/2 light brownish gray, mod. rxn w/ HCl	
170	G.S. 6/20/19		170-185': Sand (S) @170'-7% Gravel: 80% M / 20% F, 2-13 mm (3 mm avg.), round-subangular, mod. sorted; 80% Sand: 50% M / 50% F, v. fn - v. ccs. (ccs. avg.), well sorted, subround-subangular; 5% Silt: 2.54 6/2 light brownish gray, mod. - strong rxn w/ HCl	
175	G.S. 6/24/19		@175'-5% Gravel: 85% M / 15% F, 2-11 mm (3 mm avg.), subround-subangular, well sorted; 85% Sand: 45% M / 55% F, v. fn - v. ccs. (med. - ccs. avg.), mod. sorted, subround-subangular; 10% Silt: 2.54 7/2 light gray, moderate rxn w/ HCl	
180	G.S. 6/24/19		@180'-7% Gravel: 80% M / 20% F, 2-9 mm (3 mm avg.), round-subangular, well sorted; 80% Sand: 50% M / 50% F, v. fn - v. ccs. (med. - ccs. avg.), mod. sorted, subround-subangular; 7% Silt: 2.54 7/2 light gray, mod. - strong rxn w/ HCl	180 G.S. collected from I-001 Split spoon
185	G.S. 6/25/19		185-200': Gravelly Sand (GS) @185'-10% Gravel: 80% M / 20% F, 2-19 mm (4 mm avg.), subround-subangular, well sorted; 85% Sand: 45% M / 55% F, v. fn - v. ccs. (med. - v. ccs. avg.), mod. sorted, subround-subangular; 5% Silt: 2.54 6/2 light brownish gray, mod. rxn w/ HCl	I-001 Split Spoon details: Actual Depth: 179.7' - 182.2' bgs; borehole @ 179.7'; casing @ 180.16' bgs; sample time 1330 on 6/24/19; 100% Recovery of Sand; HEIS # B3NN78
190	G.S. 6/25/19		@190' - max gravel size = 11mm; other characteristics similar/same as description from 185' G.S.	

Reported By:

Brandon Thurnau
Print Name

Geologist
Title

Brandon Thurnau
Signature

6/25/19
Date

BOREHOLE LOG (Cont.)

Date: 6/25/19

Well ID: C9753

Well Name: 299-E27-137B

Location: ~0.5 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
195	G.S. 6/25/19		195-200: Gravelly Sand (GS) @195'-15% Gravel: 90% M / 10% F, 2-25mm (5 mm avg.), rounded-subangular, mod. sorted; 15% Sand: 50% M / 50% F, v.f. v. c.r.s. (med.-c.r.s. ang.), subround-subang, med. sorted; 10% Silt: 2.5% 1/2 light brownish gray, mod. rxn w/ HCl	Cable tool w/ 200' length and 1 1/2" OD Drive barrel; G.S. = grab sample
200	G.S. 6/25/19		200-205: Sand (S) @200'-3% Gravel: 90% M / 10% F, 2-5mm (2 mm avg.), subround-subang, well sorted; 87% Sand: 45% M / 55% F, v.f. v. c.r.s. (med.-c.r.s. ang.), mod. sorted; 10% Silt: 2.5% 1/2 light gray, moderate rxn w/ HCl	
205	G.S. 6/26/19		205-210: slightly silty Sand [Lm]S @205'-2% Gravel: 95% M / 5% F, 2-4mm (2 mm avg.), subround-subang, well sorted; 78% Sand: 50% M / 50% F, v.f. v. c.r.s. (fn.-c.r.s.), mod. sorted; 20% Silt: 2.5% 1/2 light brownish gray; strong rxn w/ HCl	
210	G.S. 6/27/19		@210 - Composition for gravel ↓ 1%, sand ↑ to 94%, silt ↓ to 15%; other characteristics similar/same as 205' G.S.	Driller was having difficulties getting returns w/ core barrel @ 212' and casing @ ~214.5'; driller add ~3 gal of H ₂ O
215	G.S. 6/27/19		@215'-2% Gravel: 90% M / 10% F, 2-5 mm (2 mm avg.), round-subangular, well sorted; 83% Sand: 45% M / 55% F, v.f. v. c.r.s. (fn.-c.r.s. ang.), mod. sorted; 15% Silt: 2.5% 1/2 light brownish gray, mod.-strong rxn w/ HCl	
220	G.S. 6/28/19		@ 220' (85% S, 15% M); Sand: v.f. 40%, f 40%, med. 15%, cse 5%, mod. sort, dry, 2.5% 1/2 lt. brownish gray, 100% f / 40% ang. - sub. ang.; 95% quartz: feldspathic / 10% basaltic; Silt: loose, dry, v. well sort, same color as sand; mod. rxn to HCl.	
225	G.S. 6/28/19		@ 227' (80% S, 20% M); Sand: v.f. 40%, f 40%, med. 10%, cse 10%, mod sort, dry w/ moisture clump of silt, 2.5% 1/2 lt. brownish gray, ang. - sub. ang., 70% f / 30% m; Silt: loose, some clumps, v. well sort, slt. damp-dry, same color as sand, mod rxn to HCl.	
230	G.S. 6/28/19			

Reported By:

Brandon Thurman/Jess Hocking
Print Name

Geologist/Sr. Geologist
Title

Brandon Thurman
Signature

6/28/19
Date

BOREHOLE LOG (Cont.)

Date: 6/28/2019

Well ID: C9753

Well Name: 299-E27-137B

Location: ~0.5 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
235	G.S. <u>6/28/19</u>		<u>230 - 245 Sand (S):</u> <u>(90% S, 10% M); Sand: 5% v.f., 10% f, 75% med, 10% crse, mod sort, dry - slt. damp,</u> <u>ang. - sub ang., 80% f / 20% m, 2.54 1/2 lt</u> <u>brownish gray; Silt: % decrease, loose, dry;</u> <u>no rxn to HCl.</u>	<u>Cable Tool</u> <u>11 1/2" OD DRIVE BARREL</u> <u>12" Temp. casing.</u> <u>G.S. = grab sample</u> <u>S.S. = Split spoon</u> <u>@ 235' RCT reads</u> <u>~ 300 - 350 cpm (~100 - 150 counts above bkgnd.)</u> <u>@ 240' bkgnd + 100 counts</u> <u>@ 242' RCT reads</u> <u>5 dpm α; still ~ 300 - 350 cpm β/γ.</u>
240	G.S. <u>6/28/19</u>		<u>@ 235' (95% S, 5% M); Sand: 5% v.f., 40% f, 50% med., 5% crse, mod-well sort, dry - slt. damp, ang. - sub. ang., 70% f / 30% m, 2.54 1/2 lt. brownish gray; Silt: % dec, loose, dry; no rxn to HCl; flakes of mica present.</u>	
245	G.S. <u>7/1/19</u>		<u>@ 240' (95% S, 5% M); Sand: 50% v.f., 50% f, v. well sort, dry - v. slt. damp, ang. - sub. ang., 60% f / 40% m, 2.54 1/2 lt. brownish gray; Silt: % same, loose, dry; no rxn to HCl; flakes of mica still present.</u>	
250	G.S. <u>7/1/19</u>		<u>245 - 246: Gravely Sand (GS)</u>	
255	G.S. <u>7/13/19</u>		<u>@ 245' - 10% Gravel; 80% M / 20% F, 2-44mm, rounded-subround, mod. sorted;</u> <u>85% Sand; 40% M / 60% F, v. fn. - crs. (fn. - med. ang.), subangular, well sorted;</u> <u>5% Silt; 2.54 1/2 light brownish gray; weak mod. rxn w/ HCl</u>	
260	G.S. <u>7/13/19</u>		<u>246 - 255: Mud/Silt (M) well sorted</u> <u>@ 246' - 15% Sand; 70% F - 30% M, v. fn. - crs. (fn. ang.), SA-SB; 85% Silt; 2.54 1/2 grayish brown, moist, v. strong rxn w/ HCl, no plasticity, clay formation less than 1%; gravels: well rounded</u> <u>@ 250' - 10% Sand; 45% F / 35% M, v. fn. - v. crs. (fn. ang.), round-subround, well sorted; 90% Silt; 2.54 1/2 light brownish gray, no plasticity, v. strong rxn w/ HCl</u>	<u>Difficulties emptying core barrel starting @ 246' due to formation</u>
265	G.S. <u>7/13/19</u>		<u>255 - 260: Slightly Silty Gravely Sand (M/GS)</u> <u>@ 255' - 15% Gravel; 80% M / 20% F, v. fn. 2-60mm, round-subround, partly sorted; 65% Sand; 40% M / 60% F, v. fn. - v. crs. (fn. - med. ang.), well sorted, subround-subangular; 20% Silt; 2.54 1/2 light olive brown, v. strong rxn w/ HCl</u>	
270	G.S. <u>7/19/19</u>		<u>260 - 265: Sandy Gravel (SG)</u> <u>@ 260' - 45% Gravel; 90% M / 10% F, 2-180mm, partly sorted, round-subround; 45% Sand; 30% M / 70% F, v. fn. - v. crs. (crs. ang.), well sorted, round-subangular; 10% Silt; 2.54 1/2 light brownish gray, strong rxn w/ HCl</u>	<u>I-002 Split spoon details:</u> <u>Actual depth 270.3 - 272.8' bgs</u> <u>borehole @ 270.3'; casing @ 269.96'; sample time 0942</u> <u>on 07/09/19 100% recovery</u>
			<u>@ 265' - Characteristics similar/same as 260' as except max gravel size = 185mm</u> <u>Sandy gravel HES: CSNH 79</u>	

Reported By: Brandon Trueman / Jess Holding Geologist / Sr. Geologist Brandon Trueman 7/13/19
 Print Name Title Signature Date

BOREHOLE LOG (Cont.)

Page 8 of 9
Date: 7/3/19

Well ID: C9753 Well Name: 299-E27-137B Location: ~0.5 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
275	G.S. 7/9/19		<u>265.5 - 290' : Sandy Gravel</u> <u>G.S. 265.5 65% Gravel 85% M/15% F</u> <u>2mm - 70mm, rounded to sub angular, poorly sorted. 25% Sand, very fine to very coarse sand, avg fine sand.</u>	Cable tool w/ 200' length and 1 1/2" OD drive barrel; G.S. = grab sample; W.S. = water sample
280	G.S. 7/10/19		<u>Moderately sorted, 60% F/40% M, subrounded to sub angular. 10% Silt</u> <u>Strong reaction to HCl, color light brownish gray 2.54, 6/2</u>	Water encountered and tugged @ 282.75' bgs on 7/10/19
285	G.S. 7/11/19		<u>@ 270 70% Gravel 55% M/45% F</u> <u>2mm - 48mm, rounded to sub angular, poorly sorted. 25% Sand very fine to very coarse sand, avg medium sand. Moderately sorted, 65% F/35% M, subrounded to angular.</u>	Swap to 1.75' core barrel (3.1' total length) w/ 7 5/8" ID / 8 5/8" OD once H2O was encountered
290	G.S. 7/11/19		<u>5% Silt, strong reaction to HCl, color light brownish gray. 2.54, 6/2</u>	H2O tugged @ 283.00' bgs on 7/11/19 once casing and hole was @ ~293' bgs
295	W.S. I-003 7/12/19		<u>@ 275' - 70% Gravel: 60% M/40% F, 2mm - 75 mm, rounded - subround, poorly sorted; 20% Sand: 30% M/70% F, v.f.n. - v.c.s., (fin. avg.), mod. sorted, subround</u>	around the 16" casing; the 16" casing also dropped ~1.5' to 130.39' bgs while driving the
300	G.S. 7/15/19		<u>Angularly; 10% Silt: 2.54 (6/2 light brownish gray; strong rxn w/ HCl</u>	12" casing; drills the reinforced 16" casing to rest on 4x4s,
300	G.S. 7/15/19		<u>@ 280' - 75% Gravel: 60% M/40% F, 2-12mm, rounded - subangular, poorly sorted; 20% Sand: 40% M/60% F, v.f.n. - v.c.s., (mod. avg), mod. sorted, round - subangular, 5% Silt: 2.54 light brownish gray; v. strong rxn w/ HCl</u>	Filled in the hole and continued drilling
305	G.S. 7/15/19		<u>@ 285' - 70% Gravel: 60% M/40% F, 2-87mm, poorly sorted, round - subangular; 25% Sand: 30% M/70% F, v.f.n. - v.c.s., poorly sorted, subround - subangular; 5% Silt: 2.54 4/2 dark grayish brown and no rxn w/ HCl (wet sample)</u>	I-003 W.S.: Actual depth - 292.63', ~12.5 gpm, purge vol. = (47.292) (pump on 0936, pump off 1054, H2O surfaced 0937, sample time @ 1045 on 7/12/19, HEIS #5 B3NN80, B3LN81 (field)
305	G.S. 7/17/19		<u>290 - 305 : Gravel (G)</u>	Drillers use sandpump to clean out stuff after driving casing to ~298.5' and to advance the borehole to ~294'; core barrel used again to collect 295' G.S.;
310	G.S. 7/17/19		<u>@ 290' - 80% Gravel: 70% M/40% F, 2-82 mm, poorly sorted, round - subangular; 15% Sand: 15% M/85% F, v.f.n. - v.c.s., poorly sorted, subround - subangular; 5% Silt: 2.54 4/2 dark grayish brown and no rxn w/ HCl (wet sample)</u>	some fines may wash out of core barrel due to being in the 50/100' zone; Drillers not getting returns @ 296' and drill w/ sandpump
310	G.S. 7/18/19		<u>@ 300' - max gravel size is 157mm and 50% M/50% F; sand is 25% M/75% F, other characteristics similar (same as @ 295' G.S.)</u>	
310	G.S. 7/18/19		<u>305 - : Sand Gravel (S(G))</u>	

Reported By: Brandon Turnard Ellen Whaley Geologist + / Geologist
Print Name Title
Brandon Turnard Signature
Date: 07/09/19

BOREHOLE LOG (Cont.)

Date: 7/15/19

Well ID: C9753

Well Name: 299-627-137B

Location: ~0.5 km SE of C9752

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
315	GS 7/11/19		305-315 : Sandy gravel (SG) @205'-75% Gravel (0.75M/40%F, 2-105mm, round-subround, poorly sorted; 20% Sand; 25%M/15%F, v. fn. - v. c.s. (c.s. 2mg), subround-subangular, poorly sorted; 5% Silt; 2.54/12 dark grayish brown, no rxn w/ HCl (wet sample)	Cable tool w/ 7.00' length and 1 1/2" OD drive barrel; GS = grab sample; WS = water sample
320	GS 7/22/19		@308'- Silt content ↑ to 10% @310' - Sample collected from sandpump and not representative; heavily crushed gravel in return due to multiple attempts to collect g.s. w/ core barrel	1-004 w.s.: Actual depth - 302.00' has ~14gpm, purge vol. 152gal, pump on 0818, pump off 0924, H ₂ O surfaced @ 0814, sample time @ 0912 on 7/16/19, HGTS #B3NNB2, B3NNB3 (field), B3NNB4 (Dup)
325	GS 7/23/19		315-324: Gravel @315-85% Gravel (0.75M/35%F, 2-75mm, round-subangular, poorly sorted; 10% Sand; 40%M/40%F, v. fn. - v. c.s. (c.s. 2mg), med. silt @; 5% Silt; 2.54/12 dark grayish brown, no rxn w/ HCl (wet sample)	Drilling occurs w/ sand pump between G.S.'s collected every 5' w/ drive barrel once
330			324.0 - 325.0 : Sandy Gravel (SG) 70%G/20%S/10%M Grnd/sub med.; 40%M/60%F; <1cm-12cm poorly sorted; some basalt chips ↑ w/ depth S: 20% C/30% M/30% F/30% v.f.; slight rxn C: grains mostly qtz & feldspar, 10YR3/2 (v. dk greyish bn) (wet) m: silty nodules 10YR4/1 (dk. grey)	ground water was encountered and drillers plan to use this method until borehole reaches TD waste 2 g.s. info: Actual depth: 306.0-307.5' bgs; casing @ 308.0' bgs; barrel @ 306.0' bgs; sample time 0755 on 7/16/19
335			325.0 - 326.25 : Basalt 2.54 2.51 weathered vesicular basalt w/ areas of oxidation present in a 54 714 pale yellow mottled alteration silt/clay matrix that reacts very strongly when tested w/ HCl	GSs collected @ 310' collected w/ sand pump and not representative; representative sample would likely be similar to g.s. collected @ 305'
340				1-005 w.s.: Actual depth - 311.80' bgs, ~15gpm, purge vol. 234gal, pump on 0712, H ₂ O to surface @ 0713, sample time 0800 on 7/18/19, pump off 0805, HGTS #B3NNB6, B3NNB7 (f.c. id)
345				GSs collected @ 315' collected w/ 6" diameter sand pump; fines may have been washed out from sand pump process
350				1006 LWS - actual depth 322.0' bgs, ~14gpm, purge vol: 208.88 gal, pump on: 0744, 208.88 gal, pump off: 0840 Sample time: 0820; pump off: 0840 HGTS: B3NNB8 & B3NNB9 (f)
				TP=326.25' bgs; Bottom of 12" casing @ 325.14' bgs

Reported By:

Brandon Thurman/SJ Sexton
Print Name

Geologist/Geologist
Title

Brandon Thurman/SJ
Signature

7/24/19
Date

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299-E27-137B (C9753)

Log Data Report

Borehole Information

Log Date	2019-07-26	Filename	C9753_HG-NM_2019-07-26	Site	200-BP-5
DTW¹ (ft)		DTW Date		DTW Source	
287.6		07/26/19		Bay West	
		Drill Date	07/23/19	Total Depth (ft)	326.25
				Depth Datum	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
			Outer	Inside			
Welded Steel	Cable Tool	TC ²	16.05	15.35	0.35	1.43 AGS ³	130.39
Welded Steel	Cable Tool	TC	13.03	12.73	0.35	4.0 AGS	325.14

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing dimensions using a circumference tape and dial thickness gauge and calculating the inside diameter. Maximum logging depth achieved was 325 ft, approximately even with the reported casing depth that is near the top of basalt. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 1LD	Type	60% Coaxial HPGe (SGLS) ⁴
Effective Calibration Date	12/04/2018	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-175, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 1HD	Type	He-3 (CPN 503DR) NMLS ⁵
Effective Calibration Date	12/04/2018	Serial No.	H310700352
Calibration Reference	HGLP-CC-176, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

Logging System	Gamma 5TB	Type	60% Coaxial HPGe (SGLS)
Effective Calibration Date	12/12/2018	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-180, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	Type	He-3 (CPN 503DR) NMLS
Effective Calibration Date	12/12/2018	Serial No.	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

¹ depth to water inside casing

² Temporary casing

³ Above ground surface

⁴ Spectral Gamma Logging System

⁵ Neutron Moisture Logging System

SGLS Log Run Information

Log Run	1	2	3 Repeat	6
HEIS Number	1021162	1021163	1021164	1021165
Date	06/12/19	06/13/19	06/13/19	07/25/19
Logging Engineer	Patterson	Spatz	Spatz	Spatz
Start Depth (ft)	0.01	64.0	97.0	128.0
Finish Depth (ft)	65.0	129.0	110.0	288.0
Count Time (sec)	100	100	100	100
Live/Real	R	R	R	R
Shield (Y/N)	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0
Log Speed (ft/min)	NA	NA	NA	NA
Pre-Verification	C9753FTB20190 612AV00CAB1	C9753FTB2019061 3BV00CAB1	C9753FTB20190 613BV00CAB1	C9753ALD20190 725AV00CAB1
Start File	AD000001	BD006400	CD009700	AD012800
Finish File	AD006500	BD012900	CD011000	AD028800
Post-Verification	C9753FTB20190 612AV00CAA1	C9753FTB2019061 3CV00CAA1	C9753FTB20190 613CV00CAA1	C9753ALD20190 725AV00CAA1
Depth Return Error (in.)	0.0	N/A	0.5 high	0.5 low
Comments	None	None	None	None

SGLS Log Run Information

Log Run	7	8 Repeat		
HEIS Number	1021166	1021167		
Date	07/26/19	07/26/19		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	287.0	240.0		
Finish Depth (ft)	325.0	260.0		
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)	NA	NA		
Pre-Verification	C9753ALD2019 0726BV00CAB1	C9753ALD2019072 6BV00CAB1		
Start File	BD028700	CD024000		
Finish File	BD032500	CD026000		
Post-Verification	C9753ALD2019 0726CV00CAA1	C9753ALD2019072 6CV00CAA1		
Depth Return Error (in.)	N/A	1.5 low		
Comments	None	None		

NMLS Log Run Information

Log Run	4	5 Repeat	9	10 Repeat
HEIS Number	1021168	1021169	1021170	1021171
Date	06/13/19	06/13/19	07/26/19	07/26/19
Logging Engineer	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0.0	73.0	128.0	240.0
Finish Depth (ft)	129.51	87.0	287.75	256.01
Count Time (sec)	15	15	15	15
Live/Real	R	R	R	R
Shield (Y/N)	N	N	N	N
MSA Interval (ft)	0.25	0.25	0.25	0.25
Log Speed (ft/min)	NA	NA	NA	NA
Pre-Verification	C9753FPB20190 613AV00CAB1	C9753FPB2019061 3AV00CAB1	C9753AHD2019 0726AV00CAB1	C9753AHD20190 726AV00CAB1
Start File	AD000000	BD007300	AD012800	BD024000
Finish File	AD012951	BD008700	AD028775	BD025601
Post-Verification	C9753FPB20190 613BV00CAA1	C9753FPB2019061 3BV00CAA1	C9753AHD2019 0726BV00CAA1	C9753AHD20190 726BV00CAA1
Depth Return Error (in.)	N/A	0.5 high	N/A	0.5 low
Comments	None	None	None	None

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	08/13/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

Casing corrections for a 0.35-in. thick casing was applied to the first and second casing for the SGLS log data.

For the SGLS, a water correction was applied below 287.6 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in EXCEL templates identified as ALD20181204 and FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

NMLS data are reported in counts per second for the entire length of the borehole. Conversions from count rate to vol% moisture were not performed because of the excessive outside diameters of the casing.

HGU⁶ 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).

⁶ Hanford Gamma Unit

Results and Interpretations

No manmade radionuclides were detected in this borehole.

Based on the divergence of the 609 and 1764 keV gamma rays, radon is evident in the first two log runs from 0 to 65 ft on June 12 and from 65 to 129 ft on June 13.

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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence. The relatively high moisture from 242 to 252 ft appears to be associated with a fine-grain interval based on the elevated Th-232 concentration.

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

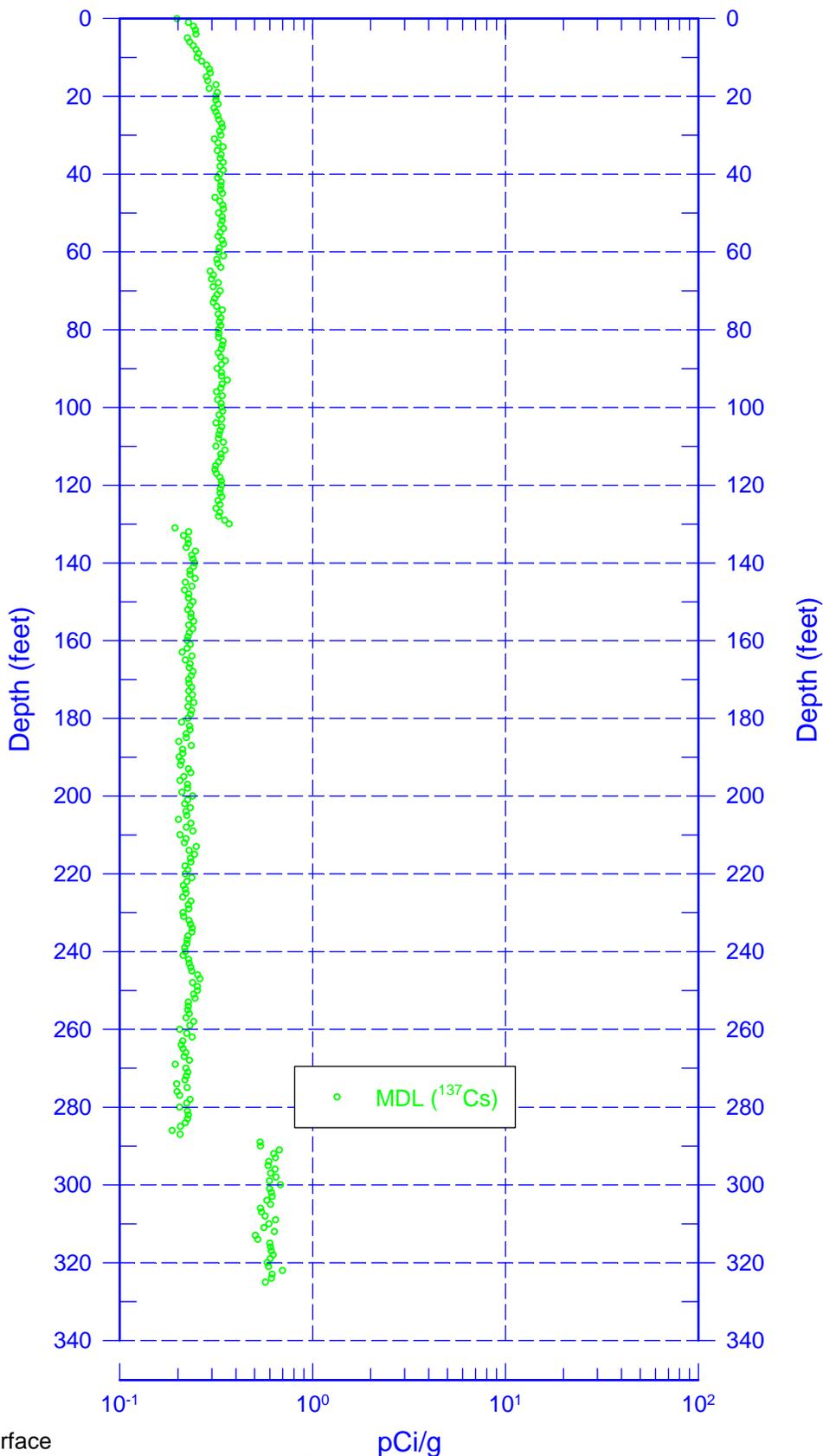
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-340 ft)
Natural Gamma Logs (0-160 ft)
Natural Gamma Logs (150-310 ft)
Natural Gamma Logs (300-460 ft)
Combination Plot (0-120 ft)
Combination Plot (110-230 ft)
Combination Plot (220-340 ft)
Combination Plot (0-340 ft)
Total Gamma & Moisture (0-160 ft)
Total Gamma & Moisture (150-310 ft)
Total Gamma & Hanford Gamma Unit (0-340 ft)
Repeat Section of Natural Gamma Logs (97-110 ft)
Repeat Section of Natural Gamma Logs (240-260 ft)
Moisture Repeat Section (73-87 ft)
Moisture Repeat Section (240-256 ft)



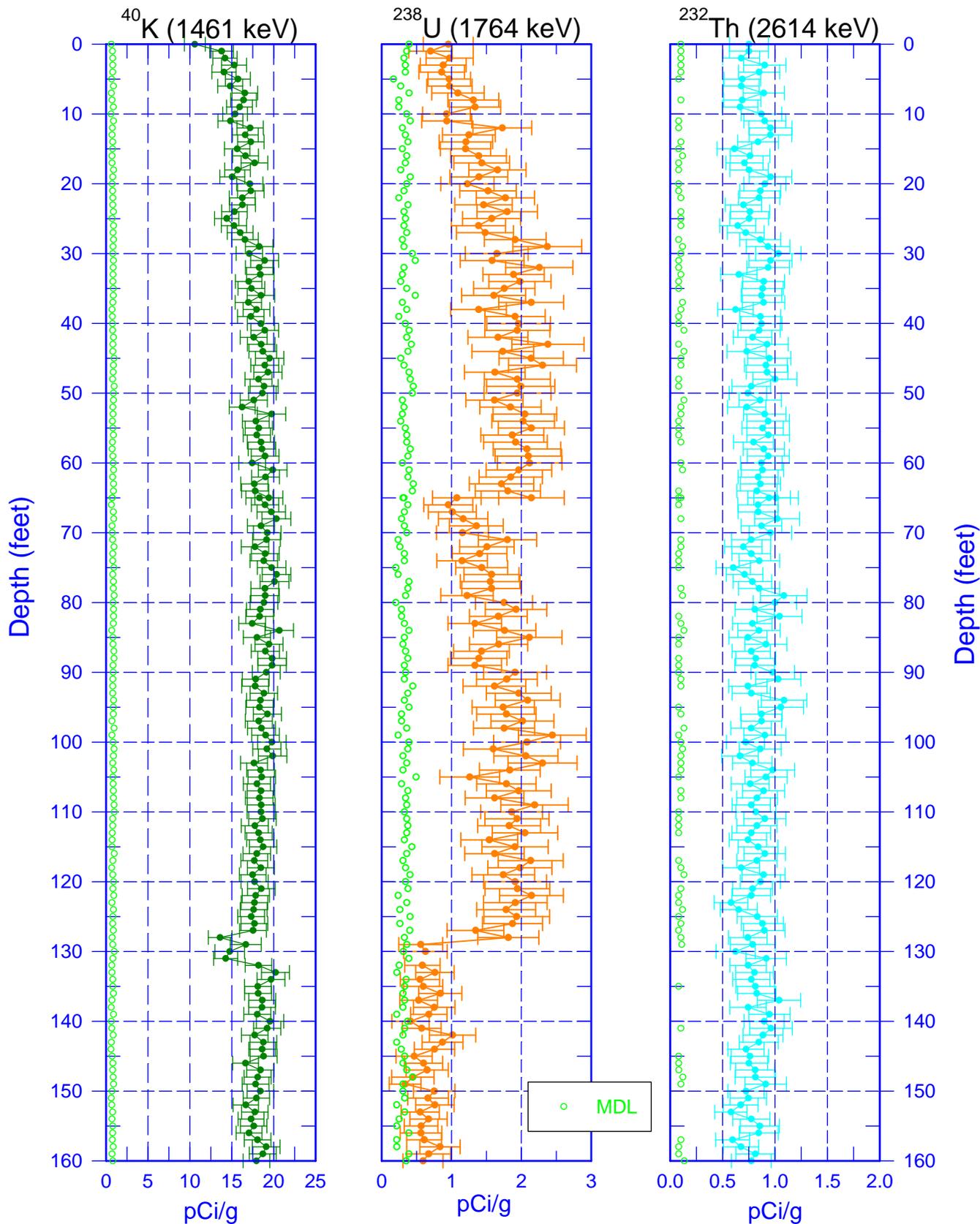
299-E27-137B (C9753) Manmade Radionuclides



Zero Reference - ground surface



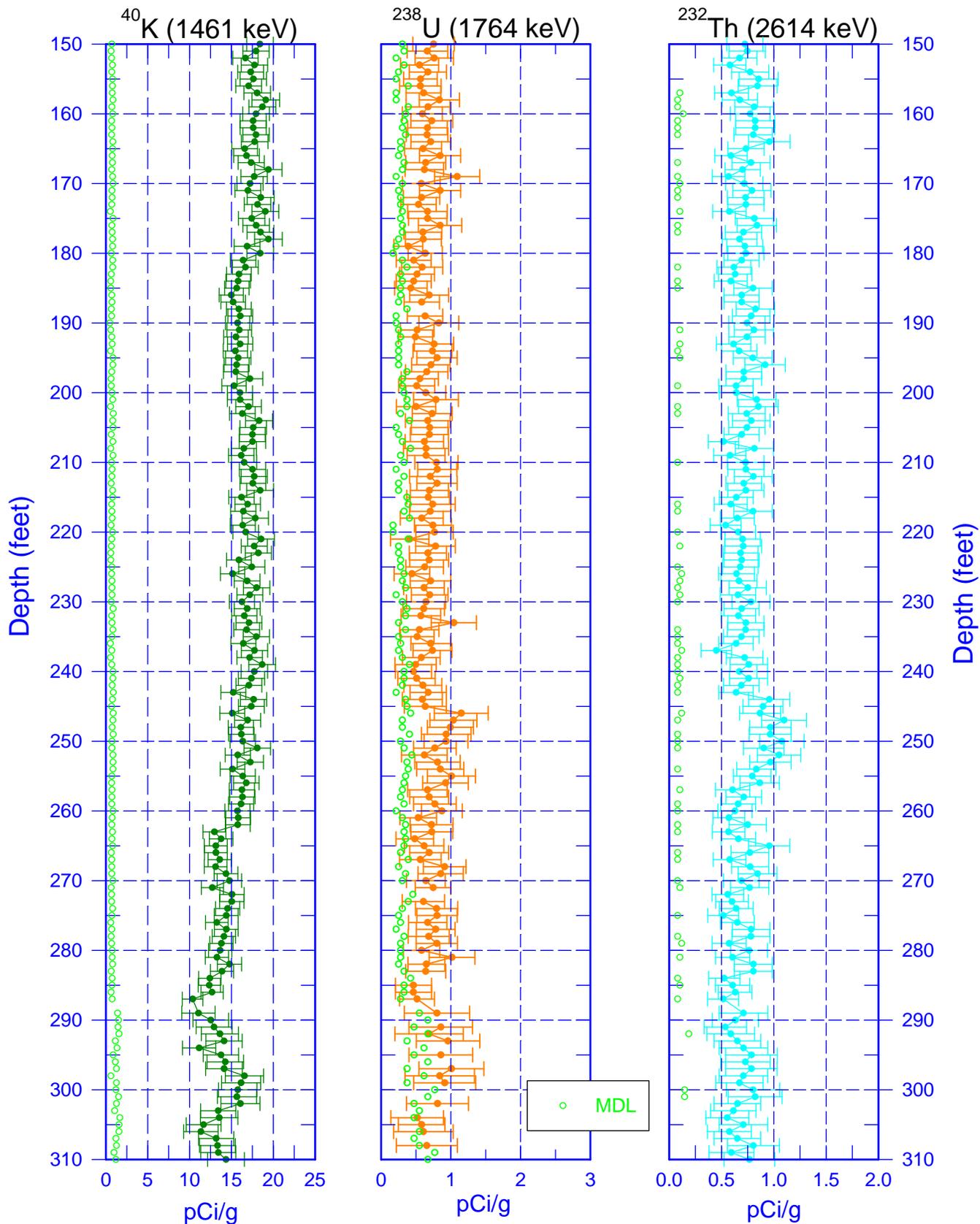
299-E27-137B (C9753) Natural Gamma Logs



Zero Reference - ground surface



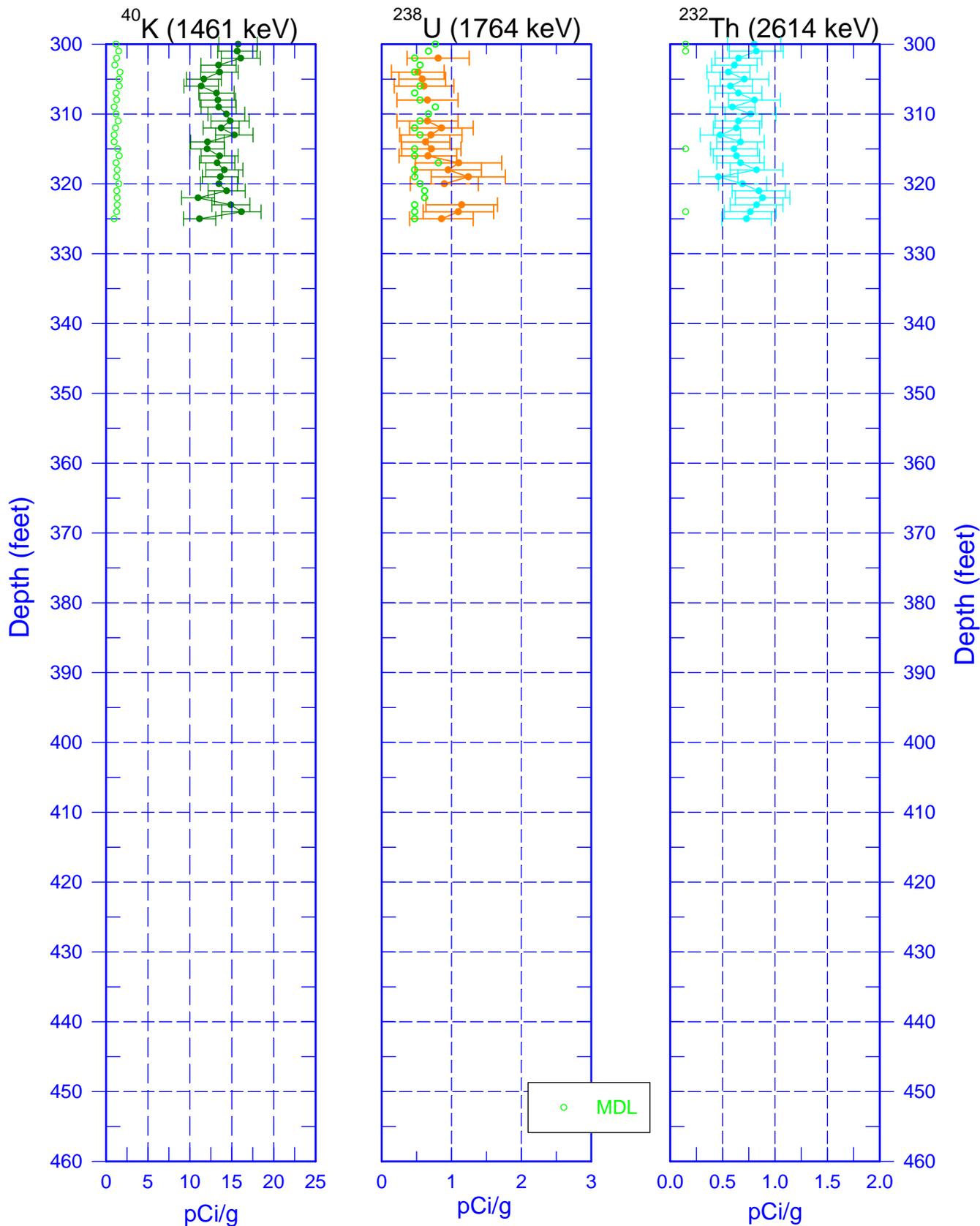
299-E27-137B (C9753) Natural Gamma Logs



Zero Reference - ground surface



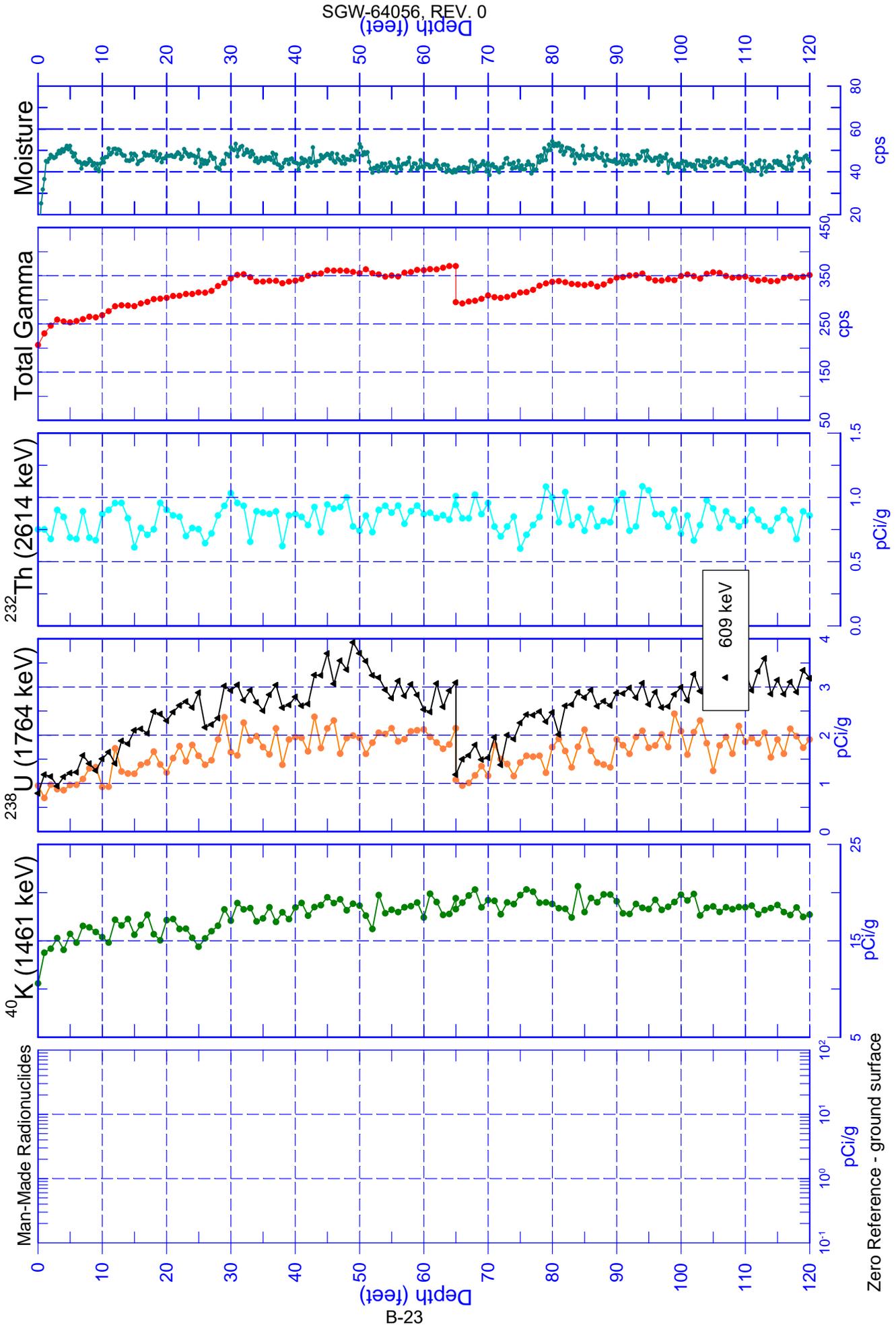
299-E27-137B (C9753) Natural Gamma Logs



Zero Reference - ground surface

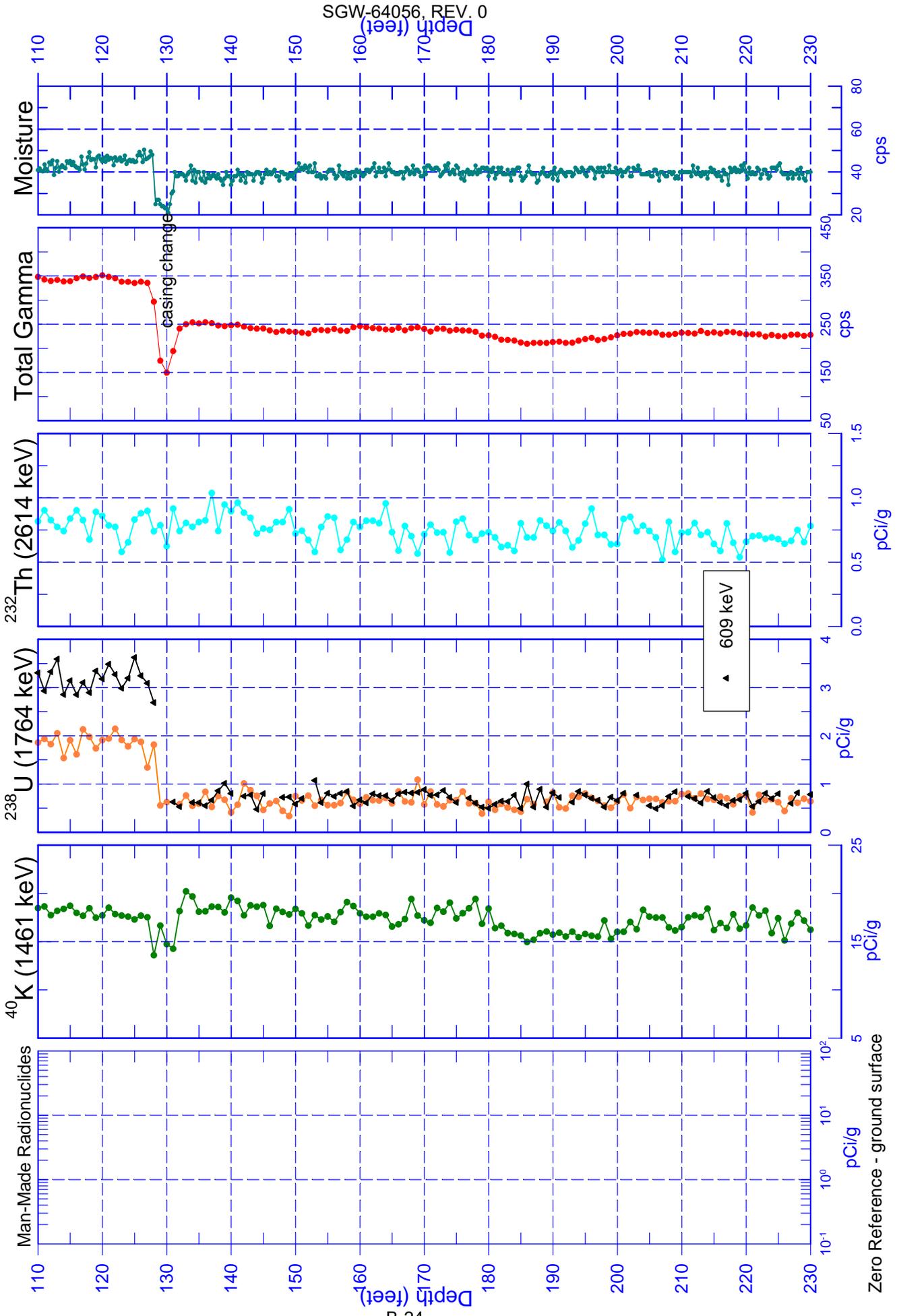


299-E27-137B (C9753) Combination Plot



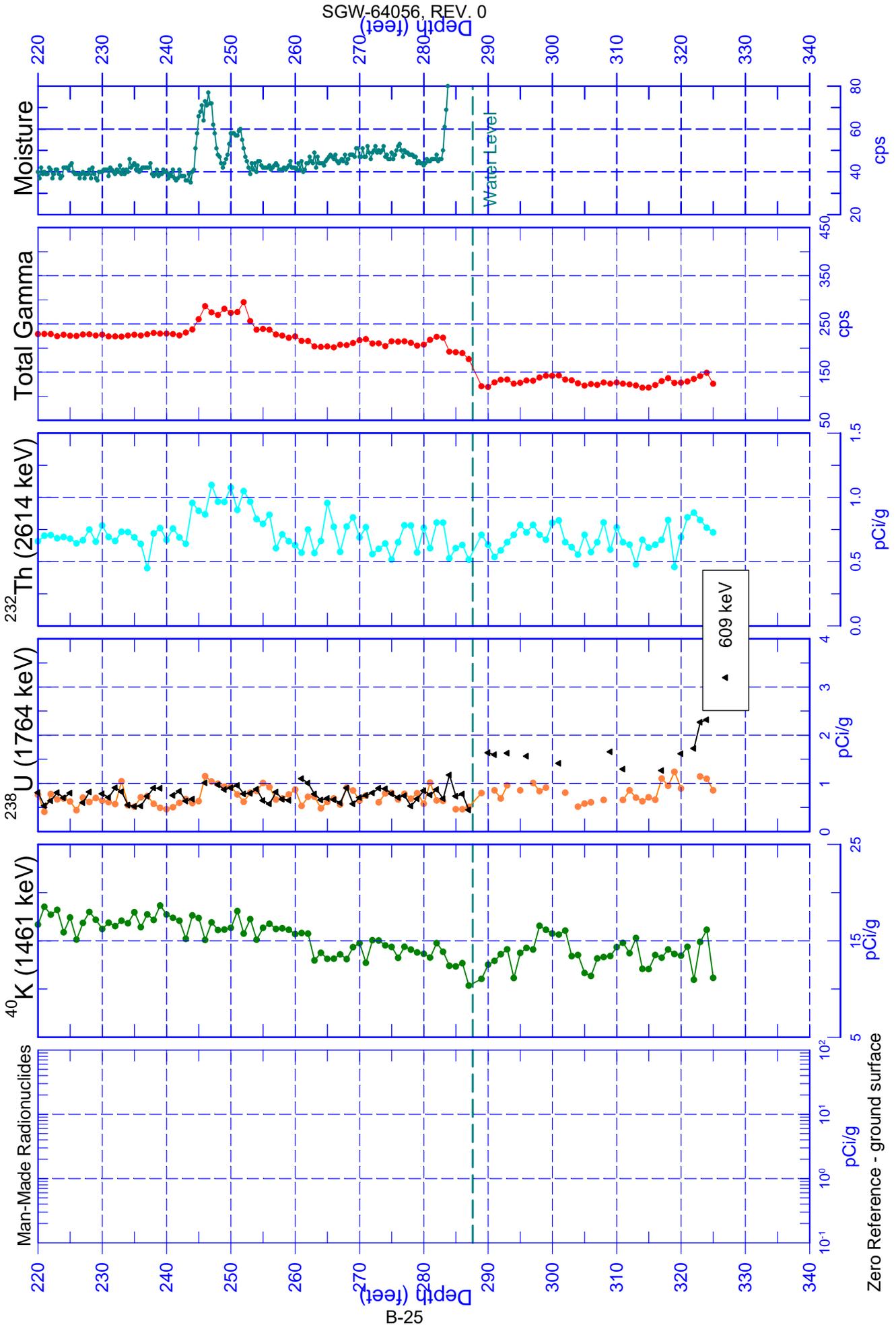


299-E27-137B (C9753) Combination Plot



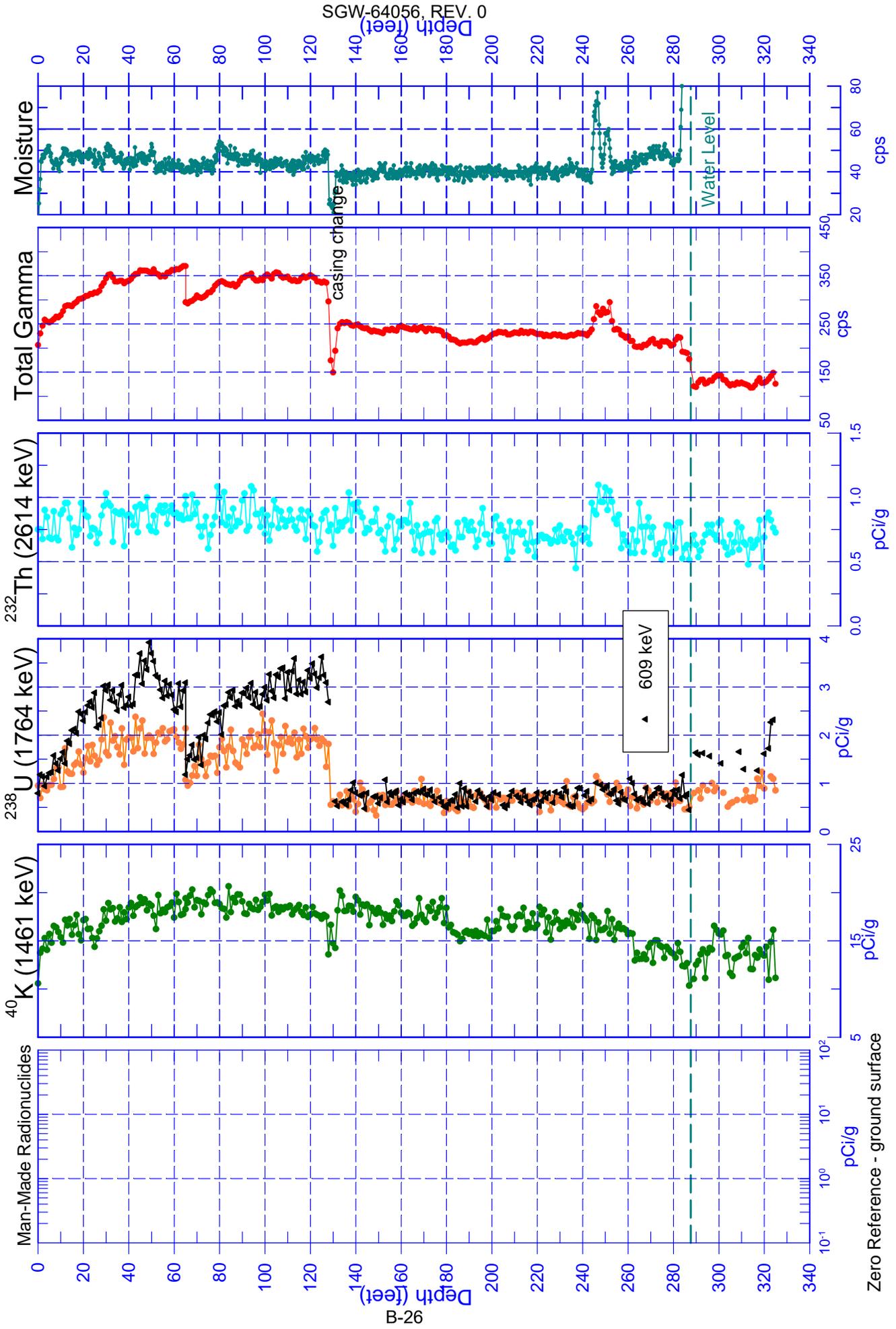


299-E27-137B (C9753) Combination Plot





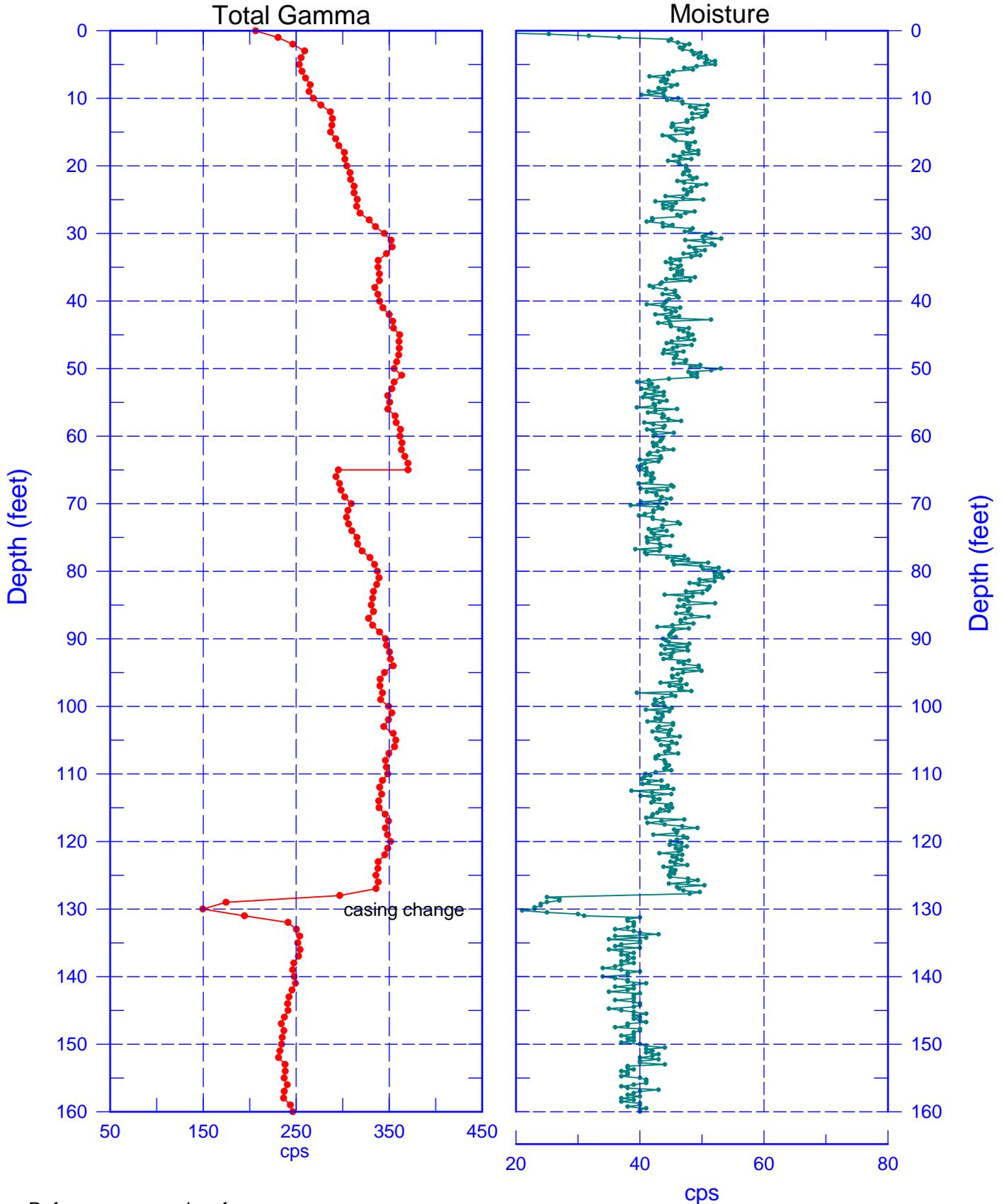
299-E27-137B (C9753) Combination Plot





299-E27-137B (C9753)

Total Gamma & Moisture

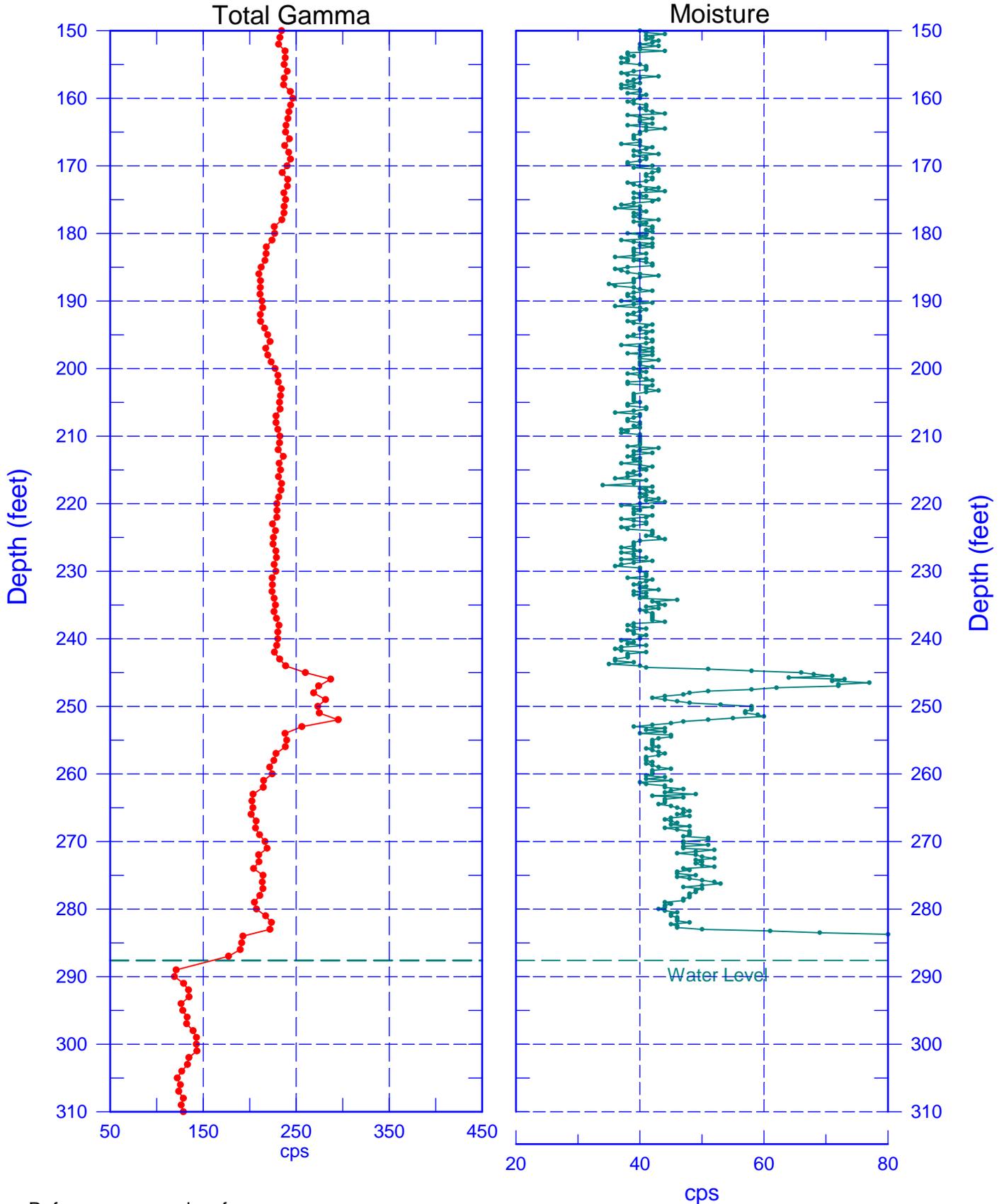


Zero Reference - ground surface



299-E27-137B (C9753)

Total Gamma & Moisture

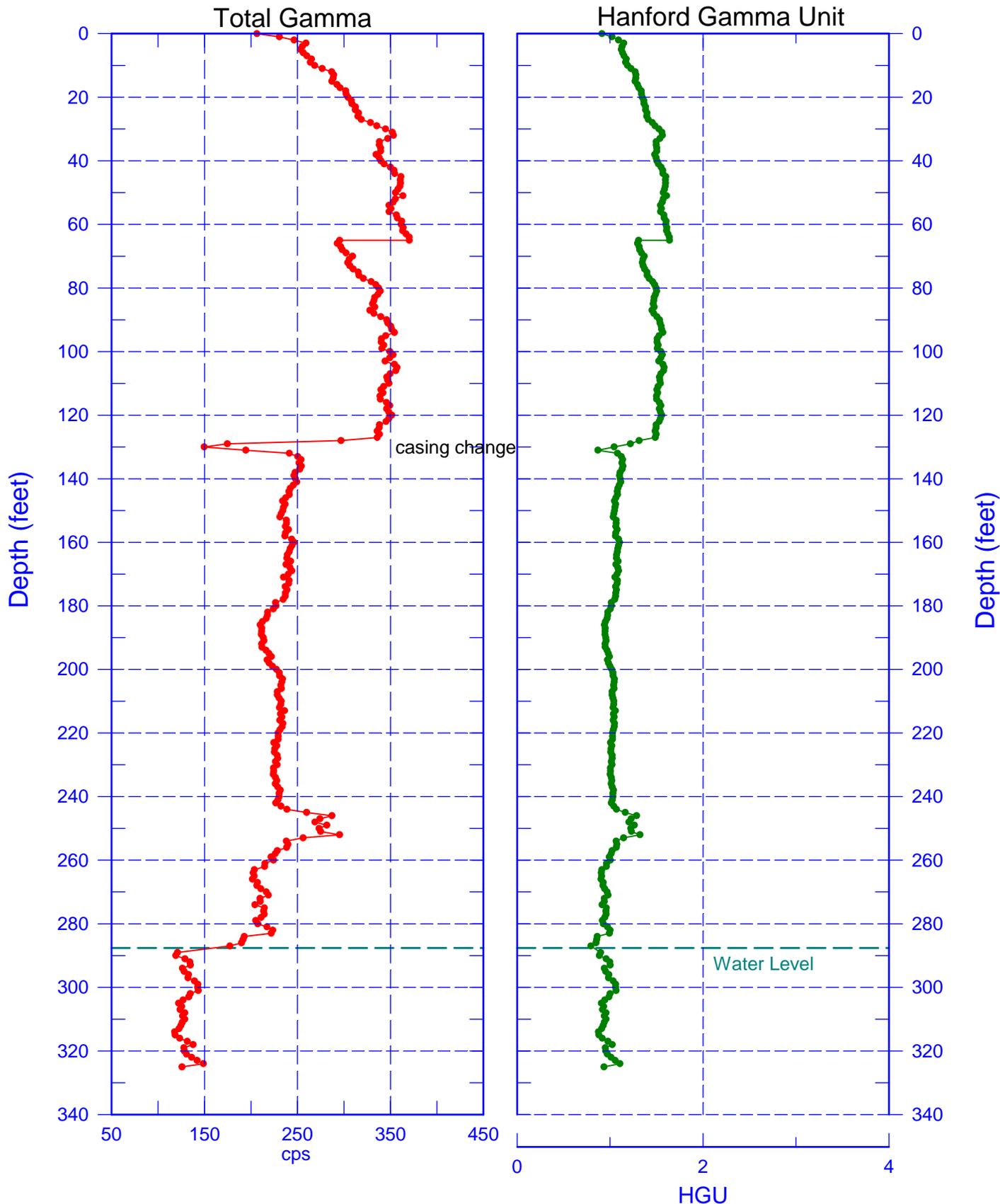


Zero Reference - ground surface



299-E27-137B (C9753)

Total Gamma & Hanford Gamma Unit

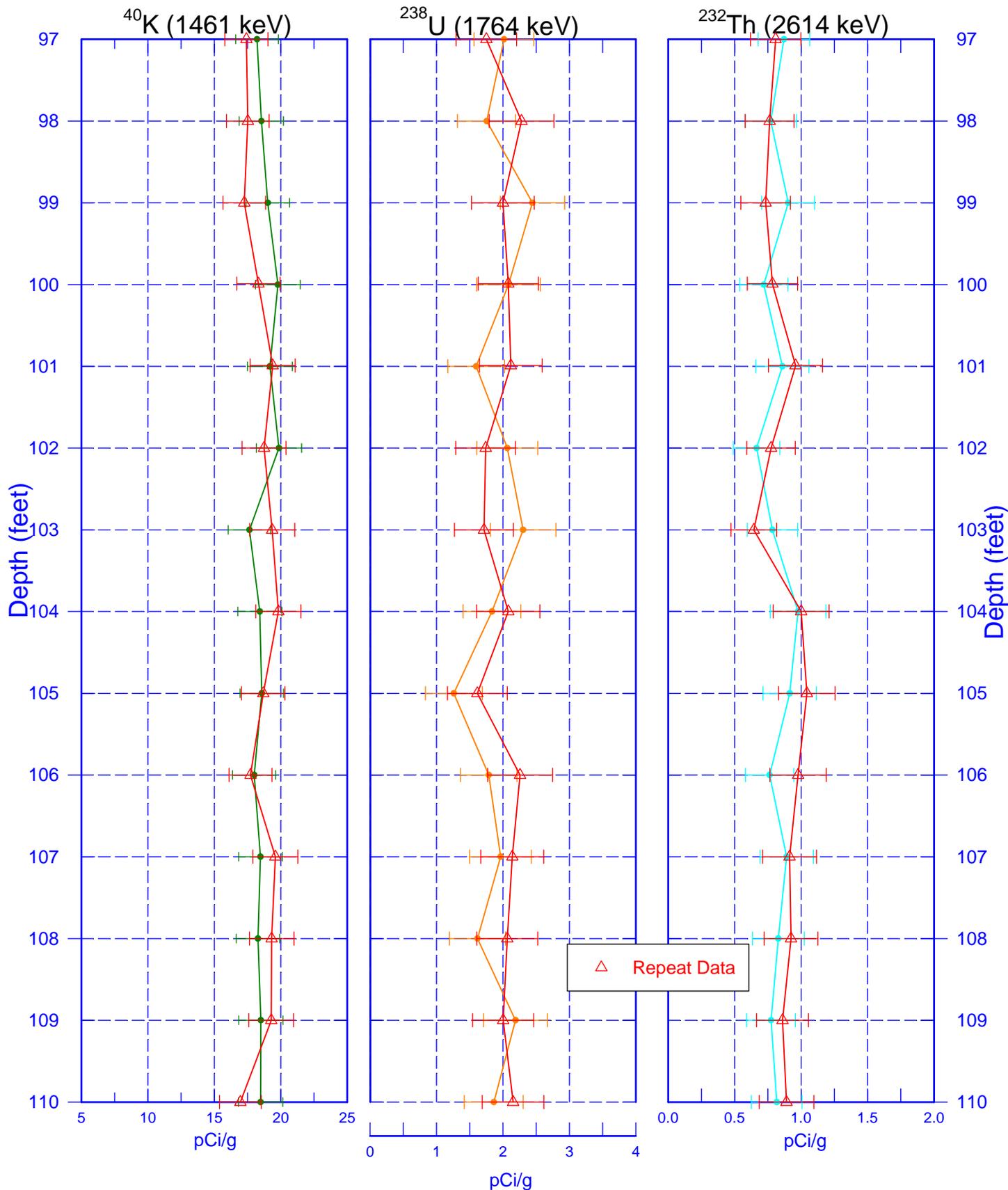


Zero Reference - ground surface



299-E27-137B (C9753)

Repeat Section of Natural Gamma Logs

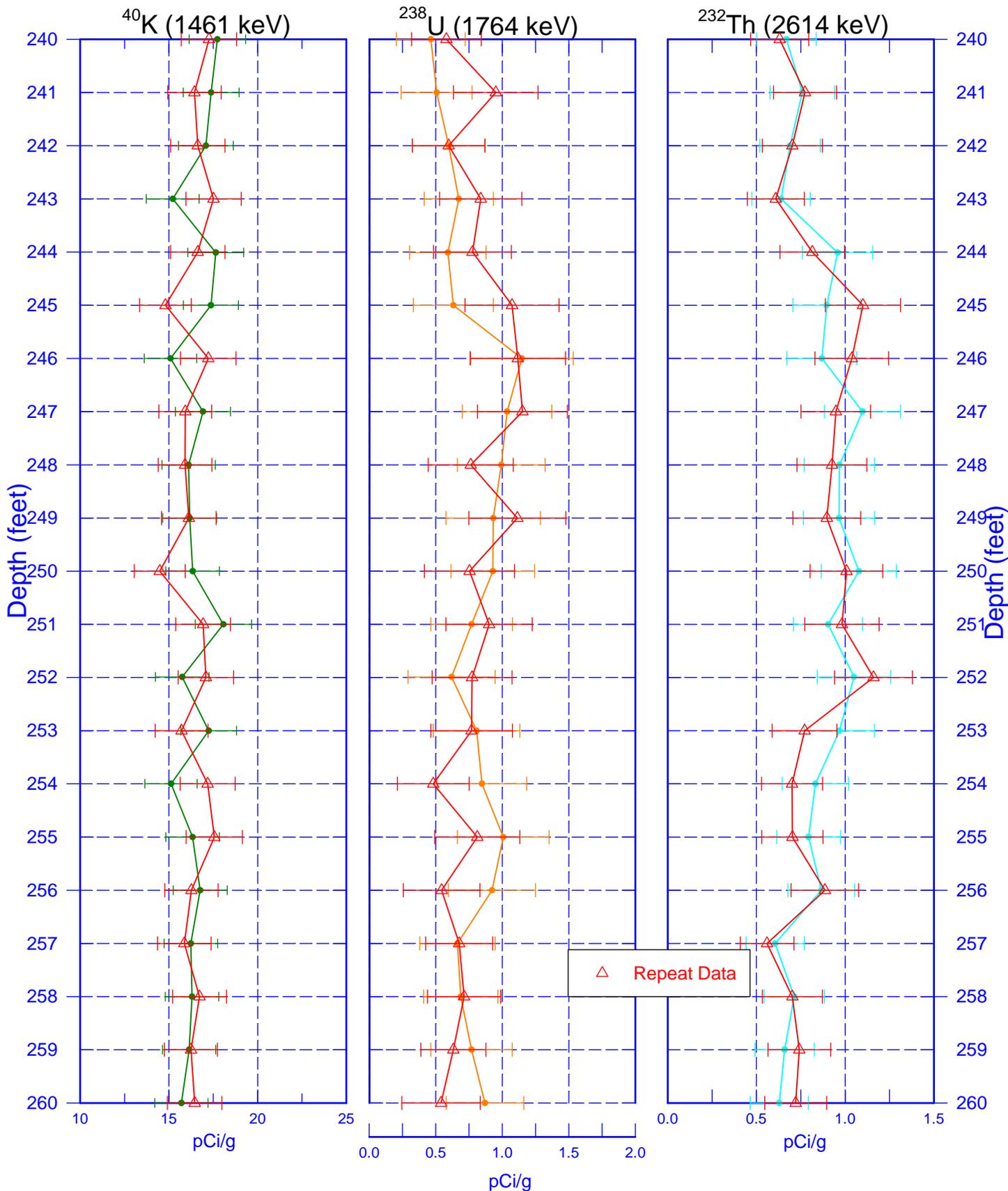


Zero Reference - ground surface



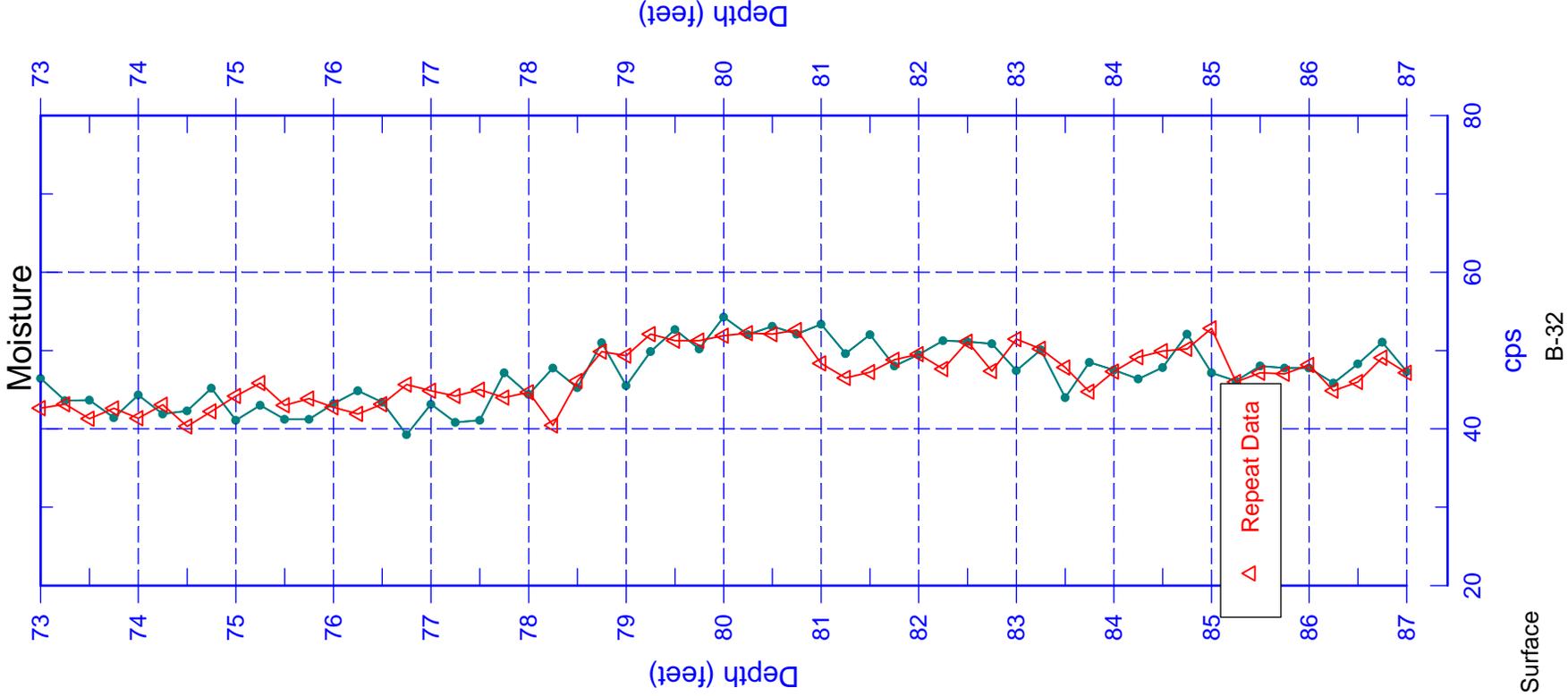
299-E27-137B (C9753)

Repeat Section of Natural Gamma Logs



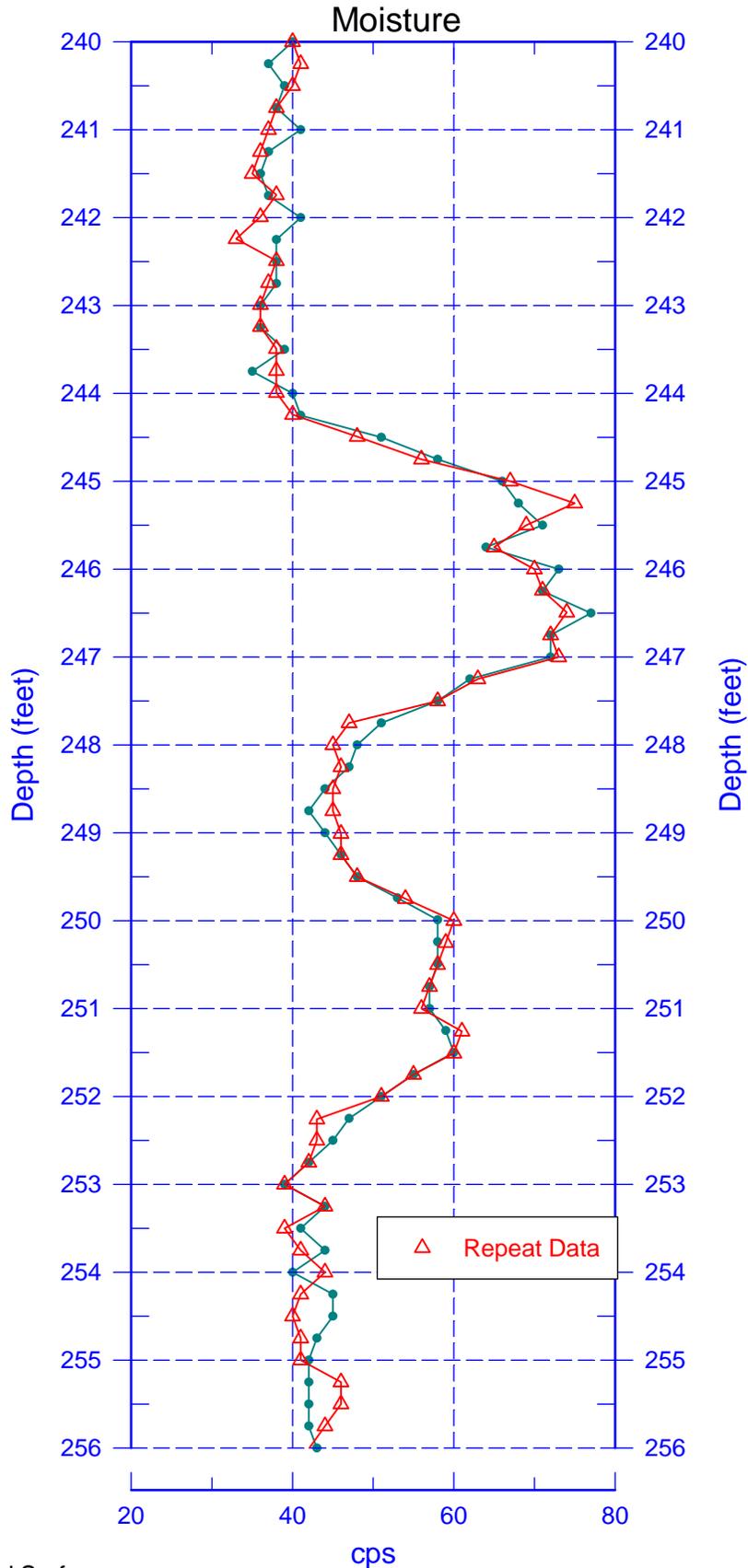
Zero Reference - Ground Surface

299-E27-137B (C9753) Moisture Repeat Section



299-E27-137B (C9753)

Moisture Repeat Section



Zero Reference - Ground Surface

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WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend
	Company: CHPRC
Date Requested: 09/30/19	Requestor: Matthan G. Wilson (CHPRC)
Date of Survey: 11/07/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of BP-5 Well C9753 (299-E27-137B) located southeast of B-Farm in 200E Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2E-11 (CHPRC) and 2E-12 (CHPRC)

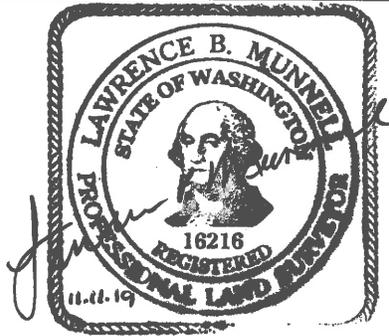
Well ID	Well Name	Easting	Northing	Elevation	
C9753	299-E27-137B	574332.45	136625.32		Center of Casing
				208.486	• Top Inner 8" Casing, N.Edge
				208.798	• Top Outer Casing, N.Edge Stamped "X"
				208.029	• Brass Survey Marker

Notes:
Brass Survey Marker elevation was taken on top of domed brass cap in concrete.

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.



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WELL DEVELOPMENT AND TESTING DATA

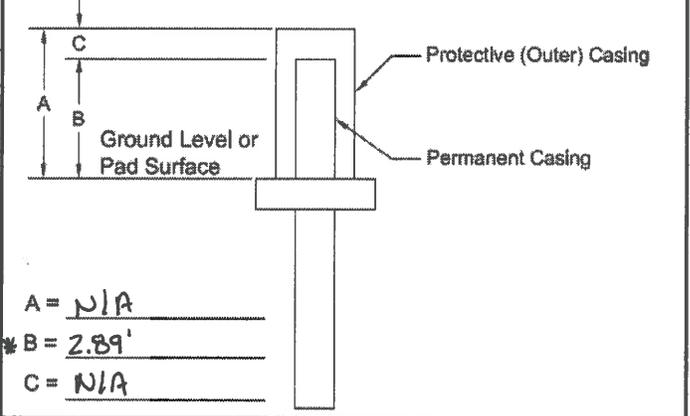
Well ID: C9753 Well Name: 299-E27-137B Date: 9/6/19

Location: ~0.5 km SE of C9752

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

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

Initial Conditions		
	Start of Job	End of Job
STATIC WATER LEVEL:		
Date: <u>9/5/19</u>	<u>282.98' bgs</u>	<u>N/A</u>
Date: <u>9/6/19</u>	<u>282.98' bgs</u>	<u>283.05' bgs</u>
DEPTH TO BOTTOM:		
Date: <u>9/5/19</u>	<u>328.3' top of stainless</u>	<u>N/A</u>
Date: <u>9/6/19</u>	<u>N/A</u>	<u>328.3' top of stainless</u>



Intake Depth (ft bgs)	Specific Capacity (gpm/ft)	Troll Depth (ft bwt)	Turbidity (NTU)		Pump Start	Pump Stop	Pumping Rate (gpm)	Maximum Drawdown (ft)
			Initial	Final				
<u>318.9'</u>	<u>~1,250</u>	<u>34.67'</u>	<u>2.83</u>	<u>0.65</u>	<u>0805</u>	<u>0830</u>	<u>~75</u>	<u>0.06</u>
<u>297.8'</u>	<u>~2,000</u>	<u>13.53'</u>	<u>0.83</u>	<u>0.28</u>	<u>0919</u>	<u>1130</u>	<u>~80(max)</u>	<u>0.04</u>
<u>JUL 9/23/19</u>								

Total Pumped: Interval 1: ~2,100 gal; Interval 2: ~10,200 gal; Total: 12,300 gal

Pump Model: GRUNDFOS X GFB55100-7-6, 60 Hz, 10 HP, single phase

Troll Serial Number and Pressure Range (PSI and depth): In-site Level Troll 700 series, range 70m/23166 S/N 553248

Comments: Log filenames: C9753_001-9-6-19_develop and C9753_002-9-6-19_develop

* Stainless temporary setup during development; development conducted prior to the installation of monument

Interval 1 initial flow meter reading = 003412 x 100 gal; final reading = 003433 x 100 gal

Interval 2 initial reading = 003433 x 100 gal; final reading = 003535 x 100 gal

Prepared By: Brandon Thurnou Brandon Thurnou 9/6/19
Print Name Signature Date

Reviewed By: Jennifer Richardt J. Richardt 9/23/19
Print Name Signature Date

For Office Use Only
OR Doc Type: _____ WMU Code(s): _____

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C9753 Photo Log



0-5 ft bgs



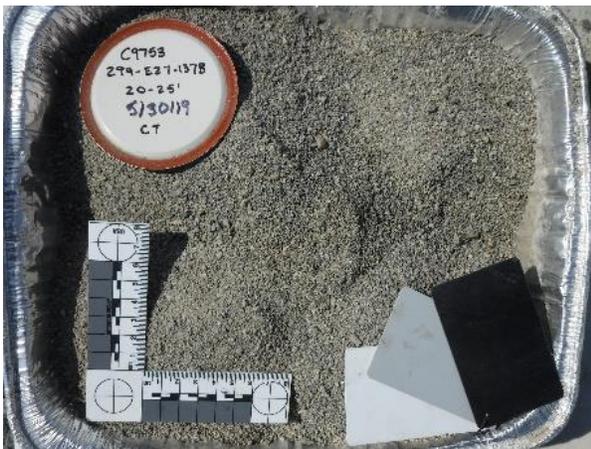
5-10 ft bgs



10-15 ft bgs



15-20 ft bgs



20-25 ft bgs



25-30 ft bgs



30-35 ft bgs



35-40 ft bgs



40-45 ft bgs



45-50 ft bgs



50-55 ft bgs



55-60 ft bgs



60-65 ft bgs



65-70 ft bgs



70-75 ft bgs



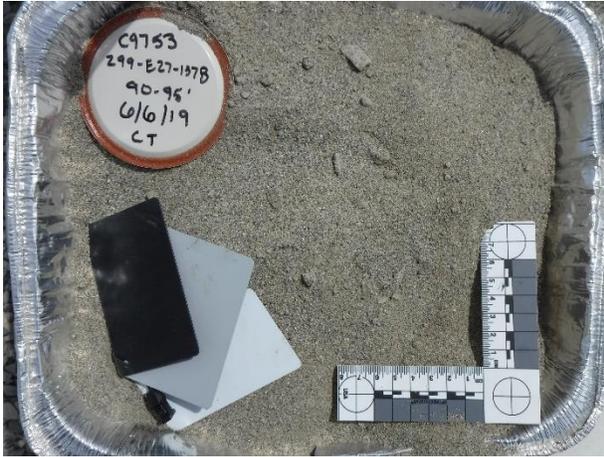
75-80 ft bgs



80-85 ft bgs



85-90 ft bgs



90-95 ft bgs



95-100 ft bgs



100-105 ft bgs



105-110 ft bgs



110-115 ft bgs



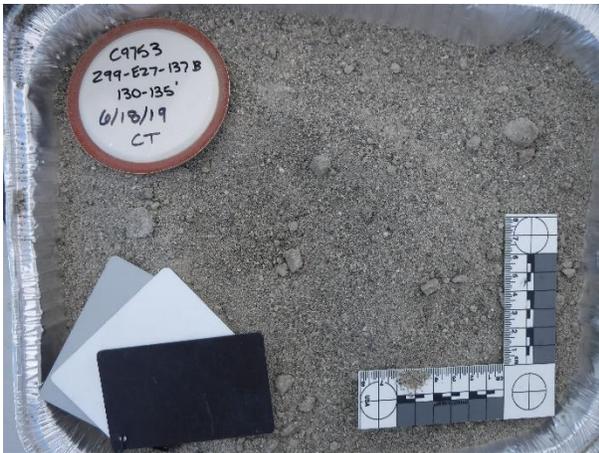
115-120 ft bgs



120-125 ft bgs



125-130 ft bgs



130-135 ft bgs



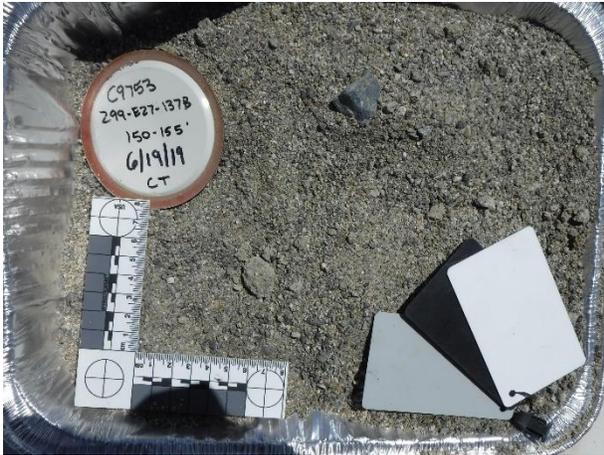
135-140 ft bgs



140-145 ft bgs



145-150 ft bgs



150-155 ft bgs



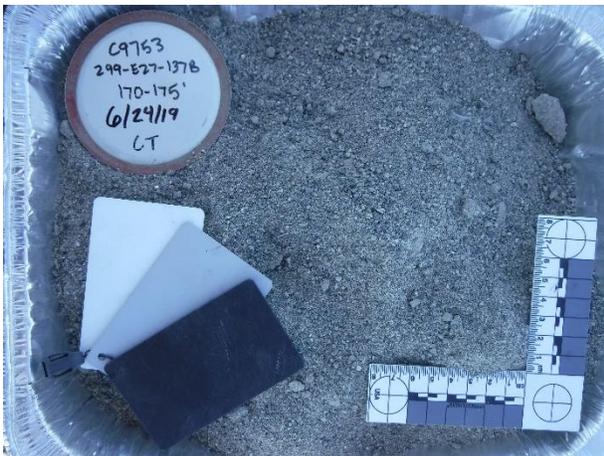
155-160 ft bgs



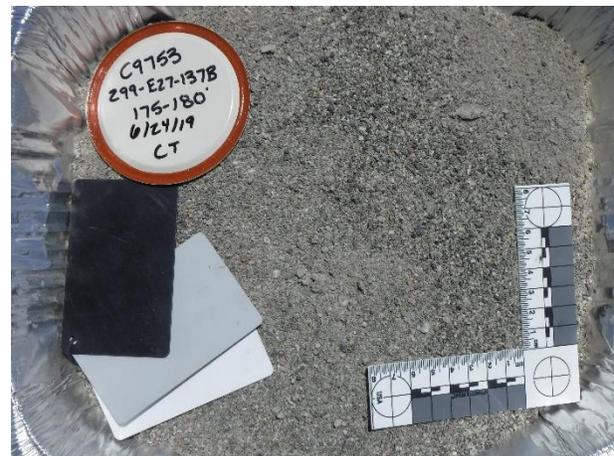
160-165 ft bgs



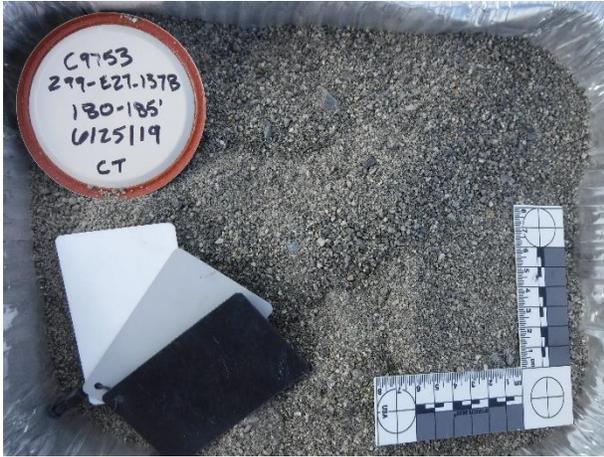
165-170 ft bgs



170-175 ft bgs



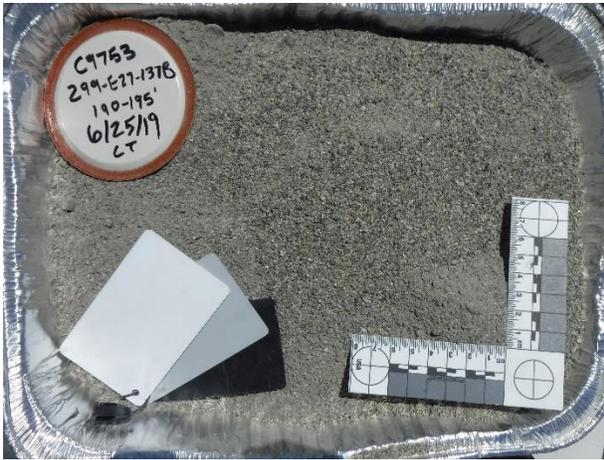
175-180 ft bgs



180-185 ft bgs



185-190 ft bgs



190-195 ft bgs



195-200 ft bgs



200-205 ft bgs



205-210 ft bgs



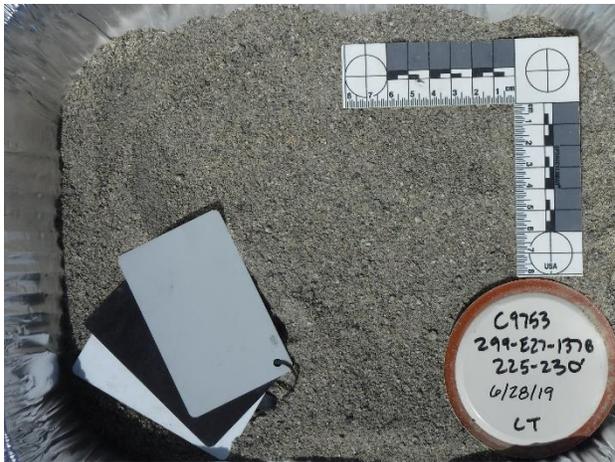
210-215 ft bgs



215-220 ft bgs



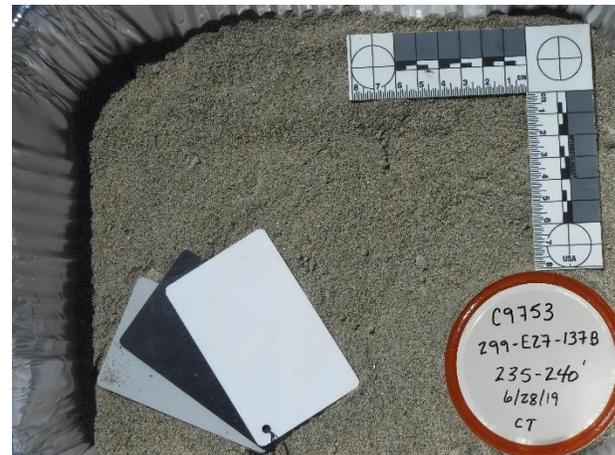
220-225 ft bgs



225-230 ft bgs



230-235 ft bgs



235-240 ft bgs



240-245 ft bgs



245-250 ft bgs



250-255 ft bgs



255-260 ft bgs



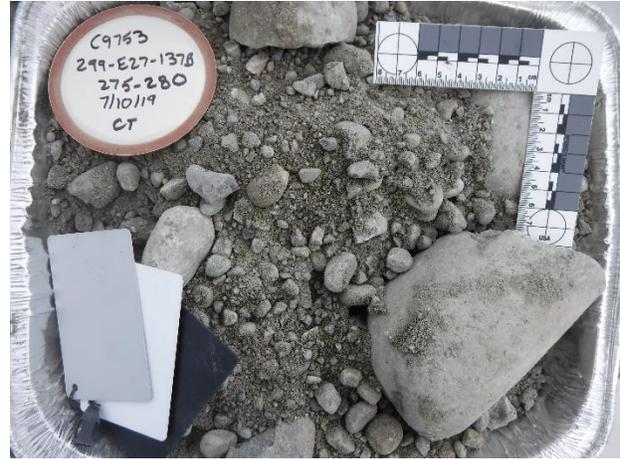
260-265 ft bgs



265-270 ft bgs



270-275 ft bgs



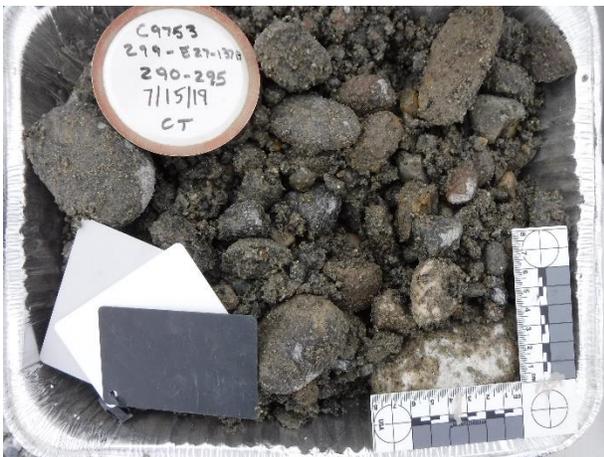
275-280 ft bgs



280-285 ft bgs



285-290 ft bgs



290-295 ft bgs



295-300 ft bgs



300-305 ft bgs



305-310 ft bgs



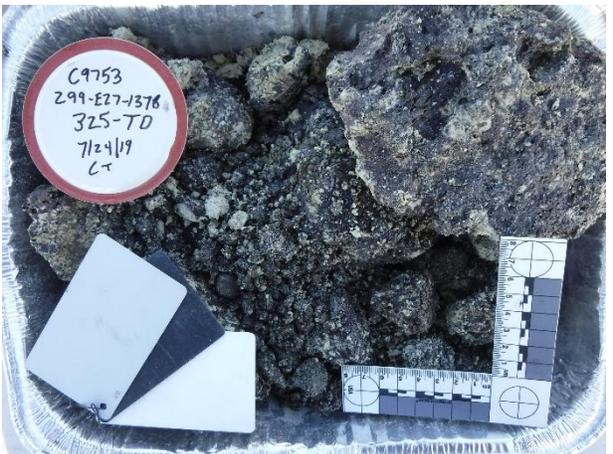
310-315 ft bgs



315-320 ft bgs



320-325 ft bgs



325-326.25 ft bgs

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