SGW-67356
Revision 0

Borehole Summary Report for the Installation of One Monitoring Well in the 200-UP-1 Operable Unit, FY2021

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

Contractor for the U.S. Department of Energy
under Contract 89303320DEM000030

P.O. Box 1464
Richland, Washington 99352

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Terms

bgs	below ground surface
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CPCCo	Central Plateau Cleanup Company
DOW	description of work
Ecology	Washington State Department of Ecology
HCl	hydrochloric acid
Holt	Holt Services, Inc.
ID	identification
IHT	industrial hygiene technician
NMLS	neutron moisture logging system
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
RCT	radiological control technician
Rlm	Ringold Formation member of Wooded Island – lower mud unit
Rtf	Ringold Formation member of Taylor Flat
Rwie	Ringold Formation member of Wooded Island – unit E
SAP	sampling and analysis plan
SGLS	spectral gamma logging system
TD	total depth

1 Introduction

This borehole summary report provides an overview of the well drilling and construction activities performed during the installation of one monitoring well in the 200-UP-1 Operable Unit (OU) in the 200 West Area of the Hanford Site (Figure 1). SGW-63896, *Description of Work for the Installation of Two Monitoring Wells in the 200-BP-5 and 200-UP-1 Groundwater Operable Units, FY20* (hereinafter referred to as the description of work [DOW]), is the controlling document for the installation of the new well. This borehole summary report covers only the installation of well 299-W22-123 (C9566); well 299-E35-6 (C9726) has already been installed, and details are provided in SGW-65873, *Borehole Summary Report for the Installation of Three M-24 Monitoring Wells in 200-BP-5 and 200-PO-1 Operable Units, FY2020*.

The new monitoring well, 299-W22-123 (C9566), was drilled, constructed, and developed between July 20, 2021, and September 22, 2021, by Holt Services, Inc. (Holt) for Central Plateau Cleanup Company (CPCCo). Well site geology, well drilling documentation, well development documentation, and well construction documentation services were provided by GRAM Northwest, LLC. Geophysical logging services were provided by Bay West, LLC.

The monitoring well was installed in response to Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*, Milestone M-024, which requires the installation of sufficient groundwater wells for monitoring, protection, and remediation of groundwater. Monitoring well installation complied with the requirements of the *Resource Conservation and Recovery Act of 1976*; the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA); and the *Atomic Energy Act of 1954*.

Monitoring well 299-W22-123 (C9566) was installed ~23 m (75 ft) east of the 216-S-20 Crib as a replacement well for 299-W22-20, which went dry. Figure 2 shows the locations of the new well. Table 1 lists the well name, well identification (ID) number, Washington State Department of Ecology (Ecology) unique well tag number, and installation dates for the new well. Well summary sheets, borehole logs, geophysical log data reports, final civil survey reports, photo logs, and the well development and testing data sheet for C9566 are presented in Appendix A.

1.1 Drilling, Sampling, and Well Construction Activities

This section summarizes the field activities associated with installing monitoring well C9566.

1.2 General Information

Well C9566 was installed in compliance with WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells,” and the construction specifications identified in the DOW (SGW-63896). 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-2019-07-ADD1, *Hanford Atomic Energy Act Sitewide Well Installation Sampling and Analysis Plan, Addendum 1: Wells 299-E35-6, 299-W19-132, 299-W22-123, 299-W22-125, and 699-S6-E3B* (hereinafter referred to as the sampling and analysis plan [SAP]).

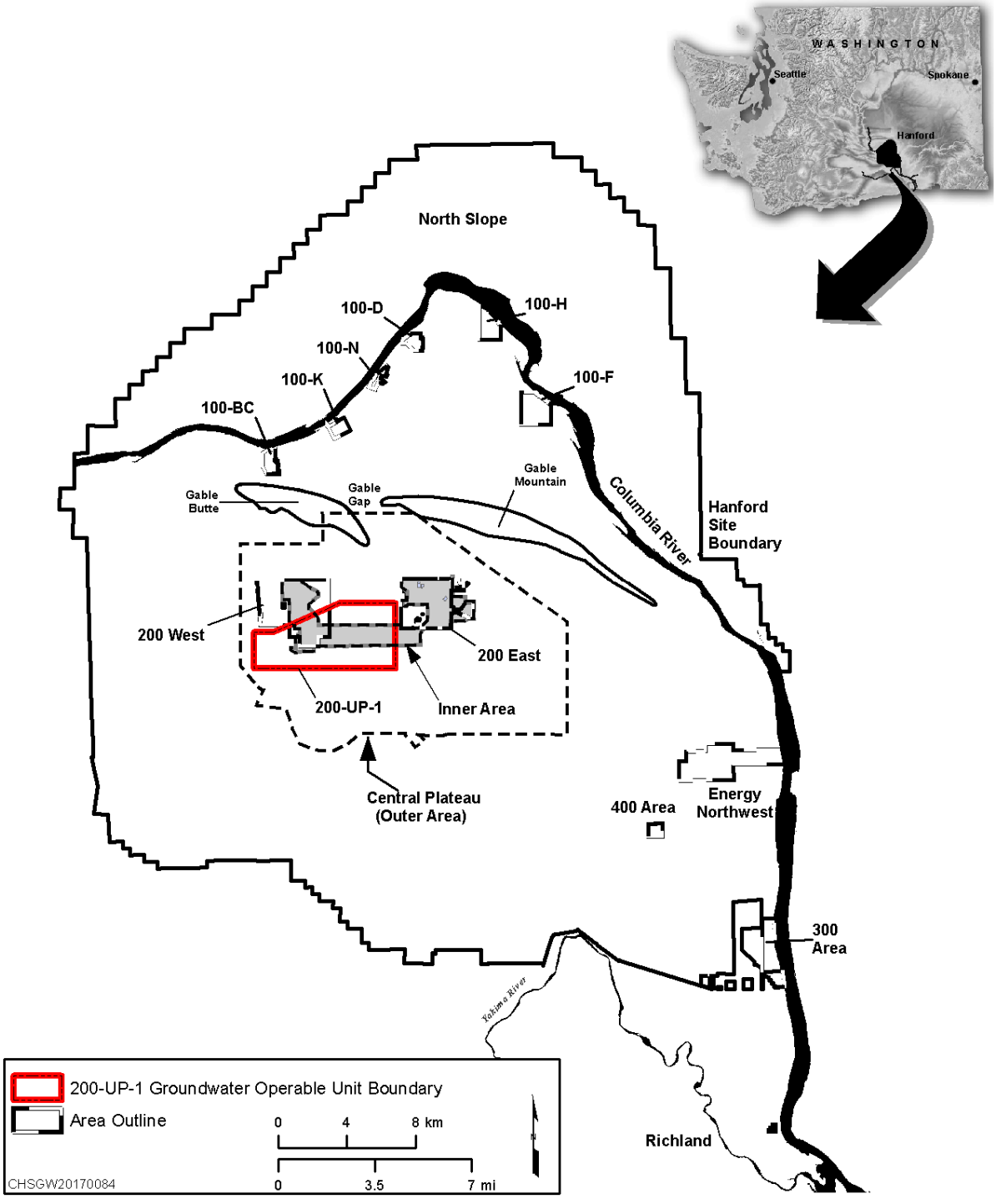

Figure 1. 200-UP-1 OU Boundary on Hanford Site Map

Figure 2. Locations of Installed Well 299-W22-123 (C9566) in the 200-UP-1 OU

Table 1. Project Well Identification and Drilling Date Summary

Well ID Number	Well Name	Well Type	Well Installation Date		Ecology Well Tag Number
			Start	Finish	
C9566	299-W22-123	Monitoring well	7/20/2021	9/22/2021	BMS719

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 well C9566 are summarized in the following sections.

1.2.1.1 Drilling

Well C9566 was drilled using a Terra Sonic TSi™ 150CC track-mounted sonic drilling rig operated by Holt. Well C9566 was initially cased with 10.5 in. outer-diameter (OD) threaded carbon steel temporary casing, then downsized to 9.25 in. OD threaded carbon steel temporary casing. C9566 was further downsized to 8.125 in. OD threaded carbon steel temporary casing to total depth (TD).

1.2.1.2 Sampling

Sampling was conducted in accordance with the DOW (SGW-63896) and the SAP (DOE/RL-2019-07-ADD1). Geologic grab samples were collected and archived at 1.5 m (5 ft) intervals and at major lithologic changes during the drilling of C9566. Archive grab samples were placed in labeled pint-size glass mason jars and in labeled plastic chip tray compartments for storage at the Hanford Geotechnical Sample Library. Additional grab samples were collected every 1.5 m (5 ft) in the planned screened interval and then composited into 3.0 m (10 ft) sieve analysis samples.

Nineteen split-spoon soil samples were collected at C9566, as well as seven groundwater samples. One post-development groundwater sample was also collected at C9566. All samples collected for chemical analysis were collected by CPCCo nuclear chemical operators. Section 1.3 provides additional well-specific sampling information.

1.2.1.3 Geophysical Logging

Well C9566 was geophysically logged using a spectral gamma logging system to detect natural and manmade gamma-emitting radionuclides and a neutron moisture logging system to detect the soil moisture in the vadose zone. C9566 was initially drilled using 10.5 in. OD temporary casing as the first string of casing and was geophysically logged prior to downsizing to 9.25 in. OD temporary casing. The borehole was logged again prior to downsizing to 8.125 in. OD temporary casing. The borehole was logged once again after drilling to TD.

1.2.2 Health and Safety Screening

The health and safety screening included radiological field screening and air monitoring, as discussed in the following sections.

1.2.2.1 Radiological Field Screening

A radiological control technician (RCT) provided continuous coverage radiological surveys during work in the vadose zone and the upper saturated zone at C9566. After reaching 91.1 m (299 ft) below ground surface (bgs) (~13.7 m [45 ft] into the saturated zone), RCT coverage was switched to twice daily (once in the morning and once in the afternoon) for the remainder of drilling, construction, and development activities. The RCT 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 at any point throughout the drilling and construction of C9566.

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1.2.2.2 Air Monitoring for Volatile Chemicals

An industrial hygiene technician (IHT) performed atmospheric monitoring twice daily (once in the morning and once in the afternoon) during drilling activities. The IHT used a photoionization detector and a multi-gas meter to confirm acceptable atmospheric conditions during drilling. Conditions monitored using the photoionization detector included total volatile organic compounds. Conditions monitored using the multi-gas meter included carbon monoxide, hydrogen sulfide, lower explosive limits, ammonia, and oxygen. Areas monitored 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. The IHT detected no exceedance of action levels for any monitored conditions at C9566.

On September 1, 2020, personnel at the C9566 drilling site detected a solvent-like odor during drilling activities. An IHT was called out to the drill site. By the time the IHT arrived onsite, the odor had passed and the IHT did not measure elevated readings. Due to the unidentified odor, a take-cover alarm was issued for the 200 West Area, and all personnel on the drill site took cover in the 2704-S Building near the 222-S Laboratory. After the take cover was lifted, all personnel at the drill site at the time of the odor were sent to the 200 West Area first aid station for a health check. Drilling activities resumed after the health check.

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

Well C9566 was constructed with permanent casing consisting of 4.5 in. OD, 4 in. inner-diameter, Schedule 10S Type 304/304L stainless-steel blank casing, screen, and sump. The screen used for C9566 was continuous vee-wire wrap with a 20-slot (0.020 in.) aperture, and the well had a 1 m (3 ft) sump (consisting of blank casing with a welded end cap) located below the screened interval. Section 2.2 provides further details on the construction materials used for C9566.

1.2.3.2 Well Completion

A straightness test was conducted in the temporary casing at C9566 using a length of carbon steel core barrel that was 6.4 m (21 ft) in length with a 7.0 in. OD. The core barrel passed through the 8.125 in. OD, 7.25 in. inner-diameter temporary casing without binding. The test was conducted and passed prior to setting the permanent well in accordance with WAC 173-160 requirements.

The screen size and filter pack size used for construction at well C9566 were determined based on geologic borehole logs, geophysical logs, and intended well use. The well was constructed with a filter pack consisting of 12-20 mesh Colorado silica sand. The filter pack was settled using a dual-flange surging method.

The annular seal for well C9566 comprised of 0.375 in. coated bentonite pellets placed immediately above the silica sand filter pack of the screened interval, creating a 0.9 m (3 ft) seal. Then 8-20 mesh granular bentonite was placed above the bentonite pellet seal, followed by a cement grout surface seal. Any remaining unfilled annular space near ground surface was filled with high-strength concrete during well pad construction.

The surface completion for well C9566 consists of the permanent casing surrounded by a stainless-steel protective monument with a unique Ecology well tag number riveted to the monument. The surface completion includes 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, ID number, and date of final construction)

embedded on the northern side of the pad. The monument has a lockable cap, and the lock hasp was positioned to face northward. The surface completion also includes four steel bollards (1.8 m [6 ft] long and 8.9 cm [3.5 in.] diameter), the northeast post being 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 1.3 provides further details on well construction.

1.2.3.3 Final Well Development

Final well development for C9566 was conducted after completing subsurface construction activities. The well was developed in a single 7.62 m (25 ft) interval using a 0.75-horsepower submersible pump. The groundwater was pumped while water quality parameters (turbidity, conductivity, dissolved oxygen, pH, and temperature) were monitored. Development was completed when pumped water was measured at ≤5 nephelometric turbidity units (NTUs) and the remaining water quality parameters had stabilized. A LevelTROLL® 700 data logger was used to record the drawdown and recovery data during development activities. Section 1.3 provides well-specific details for well development. The well development and testing data sheet is provided in Appendix A.

1.2.3.4 Washington State Department of Ecology Well Identification

Well C9566 received a unique Ecology well ID number that was stamped into a stainless-steel tag and riveted to the protective monument. When the monument was set, the ID tag was set to face toward the north. Table 1 lists the Ecology tag number for well C9566.

1.3 Well-Specific Information

This section summarizes the drilling, air monitoring, sampling, geophysical logging, construction, and development activities for well 299-W22-123 (C9566).

Drilling began at C9566 on July 20, 2021. Well construction occurred between September 13 and September 22, 2021, and development took place on September 22. Drilling started with 10.5 in. OD temporary casing and was advanced to a depth of 45.9 m (150.5 ft) bgs before downsizing to 9.25 in. OD temporary casing. The 9.25 in. temporary casing was advanced to a depth of 91.7 m (300.7 ft) bgs before downsizing to 8.125 in. OD temporary casing. The 8.125 in. temporary casing was advanced to a depth of 140.4 m (460.5 ft) bgs. The borehole was drilled to a TD of 148.9 m (462.2 ft) bgs. All temporary casing was carbon steel with threaded joints.

Sampling at C9566 included collecting soil samples for geologic archival purposes, 18 split-spoon soil samples within the vadose zone for chemical analysis, as well as seven groundwater samples for chemical analysis. A post-development groundwater sample was also collected.

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 adjacent 1.5 m (5 ft) soil grab samples of similar texture within the planned screened interval. The well screen was ultimately placed at a different interval and the previously obtained sieve analysis samples were only partially analyzed for grain-size distribution.

Continuous split-spoon soil samples were intended to be collected starting within the Hanford formation from 1.8 m (6 ft) above the top of the Cold Creek unit (CCU) to at least 1.2 m (4 ft) below the top of the CCU. Continuous split-spoon soil samples were collected from ~2.3 m (7.5 ft) above the top of the

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CCU to ~0.6 m (2 ft) below the top of the CCU. A single split-spoon soil sample was intended to be collected from 3.0 m (10 ft) below the top of the CCU, and one split-spoon soil sample was collected from ~2.3 to ~3.0 m (7.5 to 10 ft) below the top of the CCU. Continuous split-spoon soil samples were intended to be collected from 4.6 m (15 ft) below the top of the CCU through the bottom of the CCU. Continuous split-spoon soil samples were collected from ~3.8 m (12.5 ft) below the top of the CCU to ~2.3 m (~7.5 ft) above the bottom of the CCU. During drilling, the field geologist identified the bottom of the CCU at 57.3 m (188 ft) bgs. After the borehole reached TD, a review of the geologic contacts (including an evaluation of the geophysical logging data) determined that the bottom of the CCU was located at 61.0 m (200 ft) bgs. Split-spoon soil samples from 58.7 to 61.0 m (192.6 to 200 ft) bgs (as required by the SAP [DOE/RL-2019-07-ADD1]) were not collected.

Two split-spoon soil samples were collected within the Ringold Formation member of Taylor Flat (Rtf) as intended. One split-spoon soil sample was collected within the Ringold Formation member of Wooded Island – unit E (Rwie) as intended. Seven groundwater samples were collected within the Rwie as intended. Groundwater was first tagged at 77.6 m (254.6 ft) bgs on August 3, 2021. A final static water level was tagged at 77.7 m (254.8 ft) bgs on September 22, 2021. Table 2 provides summary information for the samples collected for chemical analysis.

Table 2. Sample Summary for Well 299-W22-123 (C9566)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
7/20/2021	I-01	11.9 – 14.4	Soil	Split-spoon	B3YHL4, B3YHL5, B3YHL6, B3YHL7, B3YHL8
7/21/2021	I-02	34.7 – 37.2	Soil	Split-spoon	B3YHL9, B3YHM0, B3YHM1, B3YHM2, B3YHM3
7/21/2021	I-03	49.6 – 52.1	Soil	Split-spoon	B3YHM4, B3YHM5, B3YHM6, B3YHM7, B3YHM8
7/27/2021	I-04	154.4 – 156.9	Soil	Split-spoon	B3YHP4, B3YHP5, B3YHP6, B3YHP7
7/27/2021	I-05	156.5 – 159.0	Soil	Split-spoon	B3YHP8, B3YHP9, B3YHR0, B3YHR1, B3YHR2
7/27/2021	I-06	159.0 – 161.5	Soil	Split-spoon	B3YHR3, B3YHR4, B3YHR5, B3YHR6, B3YHR7
7/27/2021	I-07	161.3 – 163.8	Soil	Split-spoon	B3YHR8, B3YHR9, B3YHT0, B3YHT1, B3YHT2
7/27/2021	I-08 (duplicate)	169.4 – 171.9	Soil	Split-spoon	B3YHT3, B3YHT4, B3YHT5, B3YHT6, B3YHT7 (B3YHT8, B3YHT9, B3YHV0, B3YHV1, B3YHV2)
7/28/2021	I-09	174.5 – 177.0	Soil	Split-spoon	B3YHV3, B3YHV4, B3YHV5, B3YHV6, B3YHV7
7/28/2021	I-10	177.6 – 180.1	Soil	Split-spoon	B3YHV8, B3YHV9, B3YHW0, B3YHW1, B3YHW2
7/28/2021	I-11	180.0 – 182.5	Soil	Split-spoon	B3YHW3, B3YHW4, B3YHW5, B3YHW6, B3YHW7
7/28/2021	I-12	182.4 – 184.9	Soil	Split-spoon	B3YHX2, B3YHX3, B3YHX4, B3YHX5, B3YHX6

Table 2. Sample Summary for Well 299-W22-123 (C9566)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
7/28/2021	I-13	184.9 – 187.4	Soil	Split-spoon	B3YHX7, B3YHX8, B3YHX9, B3YHY1, B3YHY0
7/28/2021	I-14	187.1 – 189.6	Soil	Split-spoon	B3YHY2, B3YHY3, B3YHY4, B3YHY5, B3YHY6
7/29/2021	I-15	190.1 – 192.6	Soil	Split-spoon	B3YHY7, B3YHY8, B3YHY9, B3YJ00, B3YJ01
N/A	I-16	Not collected[a]	Soil	Split-spoon	N/A
7/29/2021	I-17 (duplicate)	219.7 – 222.2	Soil	Split-spoon	B3YJ12, B3YJ13, B3YJ14, B3YJ15, B3YJ16 (B3YJ07, B3YJ08, B3YJ09, B3YJ10, B3YJ11)
7/29/2021	I-18	225.9 – 228.4	Soil	Split-spoon	B3YJ17, B3YJ18, B3YJ19, B3YJ20, B3YJ21
8/3/2021	I-19	236.0 – 238.5	Soil	Split-spoon	B3YJ22, B3YJ23, B3YJ24, B3YJ25, B3YJ26
8/9/2021	I-20	260.5	Water	Pumped	B3YJ30, B3YJ31, B3YJ32
8/10/2021	I-21 (duplicate)	270.8	Water	Pumped	B3YJ35, B3YJ36, B3YJ37 (B3YJ40, B3YJ41, B3YJ42)
8/11/2021	I-22	281.0	Water	Pumped	B3YJ44. B3YJ45, B3YJ46
8/18/2021	I-23	316.5	Water	Bailed[b]	B3YJ49, B3YJ50, B3YJ51
8/23/2021	I-24	355.5	Water	Bailed[b]	B3YJ54, B3YJ55, B3YJ56
8/25/2021	I-25	395.5	Water	Bailed[b]	B3YJ62, B3YJ63, B3YJ64, B3YJH0
8/31/2021	I-26	436.0	Water	Bailed[b]	B3YJ67, B3YJ68, B3YJ69, B3YJH1
9/22/2021	Post-development	266.0	Water	Pumped	B3YJ76, B3YJ77, B3YJ78, B3YJ79, B3YJ80

a. Sample interval I-16 was not collected due to a field determination of the bottom of the Cold Creek unit that was later revised.

b. Sample intervals I-23 through I-26 were collected via bailer due to a lack of recharge in the borehole at the specified depths.

bgs = below ground surface

HEIS = Hanford Environmental Information System

N/A = not applicable

Geophysical logging was performed through the 10.5 in. OD casing on July 22 and July 26, 2021, using a spectral gamma logging system (SGLS) from ground surface to 45.42 m (149.00 ft) bgs and using a neutron moisture logging system (NMLS) from ground surface to 45.49 m (149.25 ft) bgs. Geophysical logging was performed through the 9.25 in. OD casing on August 12 and August 16, 2021, using SGLS from 45.11 to 89.61 m (148.00 to 294.00 ft) bgs and using NMLS from 45.11 to 78.03 m (148.00 to 256.00 ft) bgs. Geophysical logging was performed through the 8.125 in. OD casing on September 8 and September 9, 2021, using SGLS from 88.39 to 137.47 m (290.00 to 451.00 ft) bgs and using NMLS from 69.80 to 89.61 m (229.00 to 293.99 ft) bgs. Natural and manmade radionuclides were detected during geophysical logging. Radon gas was detected inside the 9.25 in. OD casing from 78 to 90 m (256 to

294 ft) bgs. Elevated concentrations of natural uranium in the formation were detected from approximately 114 to 116 m (373 to 381 ft) bgs, with a peak concentration of ~4.9 pCi/g. Cesium-137 was detected in the formation from 0.6 to 0.9 m (2 to 3 ft) bgs at a concentration of 0.28 to 0.32 pCi/g. Appendix A provides the geophysical logging report for C9566 (HGLP-LDR-1205).

Well construction activities began on September 13, 2021. Well installation materials included 4 in. inner-diameter and 4.5 in. OD, Schedule 10S Type 304/304L stainless-steel blank casing, screen, and sump. A total of 9.15 m (30.01 ft) of continuous vee-wire wrap, stainless-steel screen with a 20-slot (0.020 in.) aperture was used. Stainless-steel centralizers were placed at the bottom and top of the screen interval and at 12.2 m (40 ft) intervals above the screened section. Table 3 provides information on the well construction materials and associated depths for C9566, and Appendix A provides the well summary sheet.

Table 3. Construction Summary for Well 299-W22-123 (C9566)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4 in. Diameter Stainless-Steel Permanent Casing Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
462.2	254.8 (9/22/2021)	6 in. stainless-steel monument	+3.0 – 2.0	N/A	High-strength Concrete	0.0 – 3.3	N/A
		4 in. stainless-steel blank casing	+1.98 – 250.28	N/A	Cement grout	3.3 – 8.7	Type I/II
		4 in. stainless-steel screen	250.28 – 280.29	0.020	Bentonite crumbles	8.7 – 243.8	8-20
		4 in. stainless-steel sump (welded cap)	280.29 – 283.29	N/A	Bentonite pellets	243.8 – 246.8	3/8 in.
					Filter pack sand	246.8 – 280.9	12-20
					Natural fill	280.9 – 285.0	N/A
					Bentonite chips	285.0 – 308.0	3/8 in.
					Bentonite slurry	308.0 – 462.2	N/A

bgs = below ground surface

N/A = not applicable

Final well development at well C9566 was performed after pouring the cement grout surface seal, but prior to the installation of the concrete pad and posts. One ~7.62 (25 ft) interval was used to complete development on the 4 in. inner-diameter stainless-steel casing using a 0.75-horsepower submersible pump. The pump rate for the development interval was 22.0 L/min (5.8 gal/min). For the development interval, pumping was required until the turbidity decreased to ≤5 NTUs and until other key parameters (specific conductance, pH, dissolved oxygen, and temperature) stabilized. A total of 1,295.4 L (342.2 gal) of water was purged during development activities on September 22, 2021. Table 4 presents the results for development, and Appendix A provides the well development and testing data sheet for C9566.

2 Geologic Observations

This chapter summarizes the general geology of the 200-UP-1 OU and the geology encountered at well 299-W22-123 (C9566) during drilling.

2.1 Geology of the 200-UP-1 Operable Unit

The 200-UP-1 OU is in the central western portion of the 200 West Area, which is on the western end of the Hanford Site Central Plateau, located ~32 km (20 mi) north-northwest of Richland, Washington. 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-UP-1 OU include the following (from youngest to oldest):

- Holocene eolian deposits, disturbed sediments, and recent sand and gravel backfill
- Pleistocene sand and gravel sediments of the Hanford formation
- Post-Ringold Formation/pre-Hanford formation deposits – CCU
- Miocene-Pliocene Ringold Formation sediments:
  - Fluvial sands and overbank paleosols of the Rtf
  - Sand and gravel sediments of the Rwie
  - Clay and silt of the Ringold Formation member of Wooded Island – lower mud unit (Rlm)
  - Gravel, sand and paleosols of the Ringold Formation member of Wooded Island – unit A
- Miocene Elephant Mountain Member of the Saddle Mountains Basalt of the Columbia River Basalt Group

The ground surface of the 200-UP-1 OU has been extensively disturbed in some areas by grading, 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-63896).

Table 4. Well Development Data Summary for Well 299-W22-123 (C9566)

Well ID	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)	Final Specific Conductance (µS/cm)	Final Dissolved Oxygen (mg/L)	Final pH	Final Temperature (°C)	Total Gallons Pumped
C9566	299-W22-123	9/22/2021	255.1	266	59	5.8	-0.59	3.26	479	5.72	7.86	18.35	342.2

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

Additional information regarding the geology of the 200-UP-1 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-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*
- 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*

A summary of geologic units encountered throughout the borehole is 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 C9566. Appendix A provides the borehole log.

The interpretations included in this report regarding the stratigraphy of the 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 from field observations, borehole geophysical logging data, and regional stratigraphic interpretations. Samples could appear more homogenous due to grab samples being collected in a stainless-steel bowl prior to observation by the field geologist. Samples may also have a weaker or potentially nonexistent reaction to 10% diluted hydrochloric acid (HCl) in the presence of water added during drilling or in samples collected from below the water table. This section discusses the determination of estimated stratigraphic unit contacts for C9566.

C9566 is located approximately 23 m (75 ft) east of the 216-S-20 Crib. The major stratigraphic units encountered during drilling included the Hanford formation, CCU, Rtf, Rwie, and Rlm.

The Hanford formation was observed from ground surface to 49.4 m (162 ft) bgs. The soil classifications for the Hanford formation included slightly silty sand, sand, and gravelly sand. Silt content ranged from 0% to 15%. Sand content ranged from 80% to 100%, sand composition ranged from 20% to 55% mafic, sand grain size ranged from fine to coarse (125 µm to 1 mm), and sand angularity ranged from angular to rounded. Gravel content ranged from 0% to 20%, gravel composition ranged from 40% to 50% mafic, gravel size ranged from 2 to 18 mm (very fine pebble to coarse pebble), and gravel angularity ranged from subrounded to rounded. No reaction to vigorous reaction to HCl was observed throughout the Hanford formation. Soil colors included gray, very dark gray, light olive-gray, dark olive-gray, light brownish-gray, grayish-brown, light olive-brown, and light yellowish-brown.

The contact between the Hanford formation and the CCU was at 49.4 m (162 ft) bgs, as evidenced by a change to finer lithology and increased HCl reaction. The soil classifications for the CCU included silt, silty sand, silty gravel, and sandy gravel. Silt content ranged from 10% to 97%. Sand content ranged from 3% to 70%, sand composition ranged from 10% to 70% mafic, sand grain size ranged from fine to coarse

(125 µm to 1 mm), and sand angularity ranged from subangular to rounded. Gravel content ranged from 0% to 75%, gravel composition ranged from 70% to 80% mafic, gravel size ranged from 2 to 60 mm (very fine pebble to very coarse pebble), and gravel angularity ranged from angular to rounded. No reaction to a strong reaction to HCl was observed throughout the CCU (reactivity decreased with further depth). Soil colors included light olive-brown, grayish-brown, dark grayish-brown, and brown.

The contact between the CCU and the Rtf was at 61.0 m (200 ft) bgs, as evidenced by a change to finer lithology and decrease in mafic content. The soil classifications for the Rtf included silt, sandy silt, silty sand, and sand. Silt content ranged from 0% to 90%. Sand content ranged from 10% to 100%, sand composition ranged from 25% to 50%, sand grain size ranged from fine to very coarse (125 µm to 1 mm), and sand angularity ranged from angular to rounded. Gravel was not present in the Rtf. No reaction to a very mild reaction to HCl was observed throughout the member. Soil colors included light olive-brown, olive-brown, and light yellowish-brown.

The contact between the Rtf and Rwie was at 71.6 m (235 ft) bgs, as evidenced by a change to coarser lithology. The soil classifications for the Rwie included sand, gravelly sand, silty gravel, silty-sandy gravel, sandy gravel, and gravel. Silt content ranged from 0% to 20%. Sand content ranged from 10% to 100%, sand composition ranged from 5% to 50% mafic, sand grain size ranged from fine to coarse grain (125 µm to 1 mm), and sand angularity ranged from angular to rounded. Gravel content ranged from 0% to 85%, gravel composition ranged from 10% to 90% mafic (skewed towards lower mafic content), gravel size ranged from 2 to 130 mm (very fine pebble to large cobble), and gravel angularity ranged from angular to rounded. No reaction to a mild reaction to HCl was observed throughout the Rwie. Soil colors included olive, olive-gray, light olive-brown, olive-brown, grayish-brown, dark grayish-brown, dark brownish-gray.

The contact between the Rwie and the Rlm was at 139.3 m (457 ft) bgs, as evidenced by the presence of massive dense silt and clay. The soil classification for the Rlm at C9566 is silt. Silt content ranged from 95% to 100%. There was no sand content within this interval. Gravel content ranged from 0% to 5%, gravel composition was 50% mafic, gravel size was 5 to 10 mm (fine pebble to medium pebble), and gravel ranged from subangular to rounded. A mild to moderate HCl reaction was observed throughout this interval of the Rlm. The soil color was pale olive. The borehole was advanced to a TD of 140.9 m (462.2 ft) bgs in the Rlm.

A final static water level was measured at 77.7 m (254.8 ft) on September 22, 2021. Appendix A provides the borehole log for C9566.

3 Waste Management

Waste generated during installation of well C9566 included drill cuttings, purgewater, and miscellaneous solid waste. The waste was managed in accordance with CERCLA and DOE/RL-2016-13, *Waste Management Plan for the 200-UP-1 Groundwater Operable Unit*.

3.1 Drill Cuttings

All drill cuttings from C9566 were collected in tip dumpsters, and water was absorbed using WaterWorks Crystals® when necessary. The drill cuttings were placed into designated Environmental Restoration Disposal Facility roll-off boxes. Any miscellaneous solid waste associated with sampling activities was sealed in clear plastic bags and disposed in the roll-off boxes. The roll-off boxes were transported to the Environmental Restoration Disposal Facility for disposal.

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 location for well 299-W22-123 (C9566) was surveyed 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. Well C9566 was surveyed on October 7, 2021. Table 5 identifies the location of the surveyed well. The survey report for C9566 is provided in Appendix A.

Table 5. 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)
C9566	299-W22-123	133914.00	567593.02	207.995	208.848

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 (0.001 m for D0059).

c. Protective casing.

ID = identification

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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 CPCCo and Holt performed inspections for the new monitoring well. Work site assessments were conducted for well 299-W22-123 (C9566) on September 30, 2021. The well was accepted by CPCCo.

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Appendix A

Well Documentation for 299-22-123 (C9566)

- Well Summary Sheet for C9566
- Well Construction Summary Report for C9566
- Borehole Log for C9566
- Geophysical Log Data Report for C9566
- Well Survey Data Report for C9566
- Well Development and Testing Data Sheet for C9566
- Photo Log for C9566

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WELL SUMMARY SHEET

Well ID: C9566	Well Name: 299-W22-123	Start Date: 7/20/2021
Project: Installation of 1 Well in 200-UP-1 OU	Location: ~0.5km E of 222-S Labs	End Date: 9/22/2021

CONSTRUCTION DATA

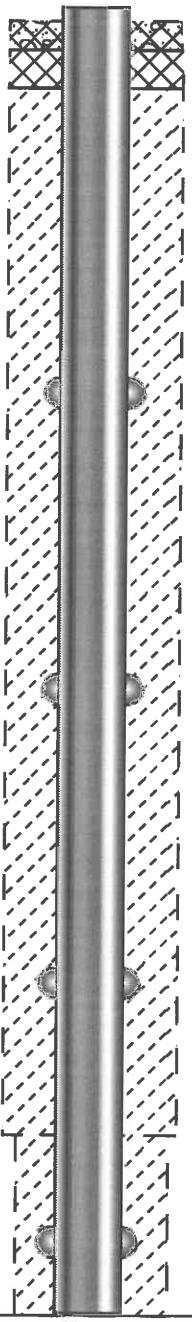
Surface Completion:
4x4x0.5 ft concrete pad with brass survey marker and protective monument (3.0 ft ags - 2.0 ft bgs). WA Ecology tag #: BMS719

Construction Materials:
High Strength Concrete:
0.0 - 3.3 ft bgs
Portland Cement Grout (Type I/II):
3.3 - 8.7 ft bgs
8-20 Mesh Granular Bentonite:
8.7 - 243.8 ft bgs
3/8" Bentonite Pellet Seal:
243.8 - 246.8 ft bgs
12-20 Mesh Filter Pack Sand:
246.8 - 280.9 ft bgs
Natural Fill:
280.9 - 285.0 ft bgs
3/8" Bentonite Chips:
285.0 - 308.0 ft bgs
Bentonite Slurry:
308.0 - 462.2 ft bgs

Well Materials:
4.5" OD TP-304 Sch 10s Blank:
1.98 ft ags - 250.28 ft bgs
4.5" OD TP-304 20-slot (0.020") Screen:
250.28 - 280.29 ft bgs
4.5" OD TP-304 Sump/Cap:
280.29 - 283.29 ft bgs

Hole Dimensions:
10.5" OD Temp. Casing: 150.5 ft bgs
9.25" OD Temp. Casing: 300.7 ft bgs
8.125" OD Temp. Casing: 460.5 ft bgs
7.0" Core Barrel: 462.2 ft bgs

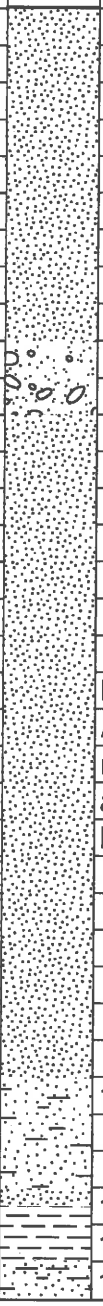
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 25, 50, 75, 100, 125, 150

Graphic Log



Lithologic Description (ft bgs):

0-45 ft: Sand

45-55 ft: Gravelly Sand

55-145 ft: Sand

Notes:
All temporary casing has been removed from ground.
ags = above ground surface
bgs = below ground surface

145-160 ft: Slightly Silty Sand

160-162 ft: Sand
162-170 ft: Silt
170-188 ft: Silty Sand

Reported By:			
Dan Charbonneaux	Geologist		9/30/2021
Print Name	*Title*	*Signature*	*Date*
Reviewed By:			
Jennifer Richart	Manager	J. Richart	10/7/21
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

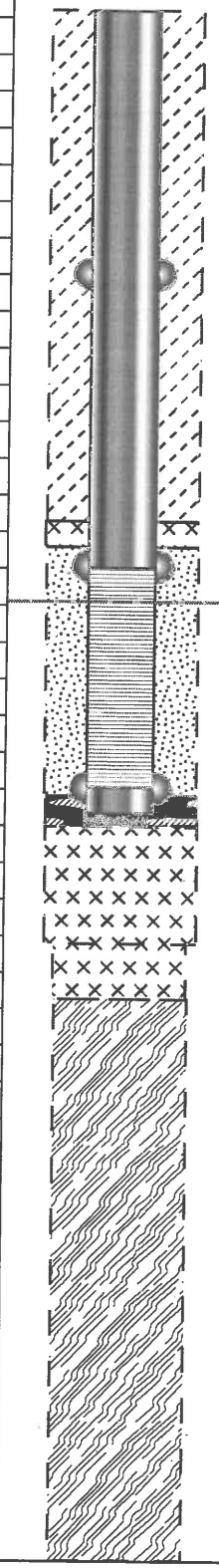
WELL SUMMARY CONTINUATION SHEET

Well ID: C9566 | Well Name: 299-W22-123 | Project: Install of 1 Well in 200-UP-1 OU

CONSTRUCTION DATA

Description
Surface Completion:
4x4x0.5 ft concrete pad with brass survey marker and protective monument (3.0 ft ags - 2.0 ft bgs). WA Ecology tag #: BMS719
Construction Materials:
High Strength Concrete:
0.0 - 3.3 ft bgs
Portland Cement Grout (Type I/II):
3.3 - 8.7 ft bgs
8-20 Mesh Granular Bentonite:
8.7 - 243.8 ft bgs
3/8" Bentonite Pellet Seal:
243.8 - 246.8 ft bgs
12-20 Mesh Filter Pack Sand:
246.8 - 280.9 ft bgs
Natural Fill:
280.9 - 285.0 ft bgs
3/8" Bentonite Chips:
285.0 - 308.0 ft bgs
Bentonite Slurry:
308.0 - 462.2 ft bgs
Well Materials:
4.5" OD TP-304 Sch 10s Blank:
1.98 ft ags - 250.28 ft bgs
4.5" OD TP-304 20-slot (0.020") Screen:
250.28 - 280.29 ft bgs
4.5" OD TP-304 Sump/Cap:
280.29 - 283.29 ft bgs
Hole Dimensions:
10.5" OD Temp. Casing: 150.5 ft bgs
9.25" OD Temp. Casing: 300.7 ft bgs
8.125" OD Temp. Casing: 460.5 ft bgs
7.0" Core Barrel: 462.2 ft bgs
Notes:
All temporary casing has been removed from ground.
ags = above ground surface
bgs = below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
175		170-188 ft: Silty Sand
		188-190 ft: Sandy Gravel
		190-195 ft: Silty Sandy Gravel
200		195-200 ft: Sandy Gravel
		200-205 ft: Silt
		205-215 ft: Sandy Silt
		215-220 ft: Silty Sand
225		220-235 ft: Sand
		235-260 ft: Sandy Gravel
250		Static Water Level: 254.8 ft (9/22/2021)
		260-270 ft: Gravel
275		270-290 ft: Sandy Gravel
		290-300 ft: Sand
300		300-310 ft: Gravel
		310-315 ft: Sandy Gravel
		315-320 ft: Gravel
325		320-325 ft: Silty Gravel
		325-330 ft: Silty Sandy Gravel
		330-335 ft: Silty Gravel
		335-340 ft: Gravel
350		340-375 ft: Sandy Gravel
375		375-385 ft: Gravel

A-6006-992 (REV 0)

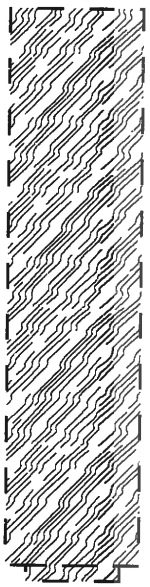
WELL SUMMARY CONTINUATION SHEET

Page 3 of 3

Well ID: C9566 | Well Name: 299-W22-123 | Project: Install of 1 Well in 200-UP-1 OU

CONSTRUCTION DATA

Description	Diagram
Surface Completion:	
4x4x0.5 ft concrete pad with brass survey marker and protective monument (3.0 ft ags - 2.0 ft bgs). WA Ecology tag #: BMS719	
Construction Materials:	
High Strength Concrete:	
0.0 - 3.3 ft bgs	
Portland Cement Grout (Type I/II):	
3.3 - 8.7 ft bgs	
8-20 Mesh Granular Bentonite:	
8.7 - 243.8 ft bgs	
3/8" Bentonite Pellet Seal:	
243.8 - 246.8 ft bgs	
12-20 Mesh Filter Pack Sand:	
246.8 - 280.9 ft bgs	
Natural Fill:	
280.9 - 285.0 ft bgs	
3/8" Bentonite Chips:	
285.0 - 308.0 ft bgs	
Bentonite Slurry:	
308.0 - 462.2 ft bgs	
Well Materials:	
4.5" OD TP-304 Sch 10s Blank:	
1.98 ft ags - 250.28 ft bgs	
4.5" OD TP-304 20-slot (0.020") Screen:	
250.28 - 280.29 ft bgs	
4.5" OD TP-304 Sump/Cap:	
280.29 - 283.29 ft bgs	
Hole Dimensions:	
10.5" OD Temp. Casing: 150.5 ft bgs	
9.25" OD Temp. Casing: 300.7 ft bgs	
8.125" OD Temp. Casing: 460.5 ft bgs	
7.0" Core Barrel: 462.2 ft bgs	
Notes:	
All temporary casing has been removed from ground.	
ags = above ground surface	
bgs = below ground surface	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
385		385-390 ft: Gravelly Sand
		390-395 ft: Sandy Gravel
		395-400 ft: Sand
		400-410 ft: Gravelly Sand
410		410-445 ft: Sand
435		
		445-450 ft: Gravelly Sand
		450-457 ft: Sandy Gravel
		457-462.2 ft: Silt
460		Total Depth: 462.2 ft bgs
485		
510		
535		
560		
585		

A-6006-992 (REV 0)

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WELL CONSTRUCTION SUMMARY REPORT

Start Date: 7/20/2021
Finish Date: 9/22/2021
Page: 1 of 1

Well ID: C9566	Well Name: 299-W22-123
Location: ~0.5km E of 222-S Labs	Ecology Tag #: BMS719
Drilling Company: Holt Services, Inc.	Project: Installation of 1 Monitoring Well in 200-UP-1 OU
Driller: Pete Rosenberg	License #: 2931
	Other Companies: GRAM Northwest, CPCCo, Baywest LLC
	Geologist(s): Dan Charbonneaux, Ryan Bailey, Stacie Sexton

TEMPORARY CASING AND DRILL DEPTH

Size (in.)	Joint Type (Wld or Thd)	Interval (ft.)	Shoe Size (OD/ID) (in.)
10	Thd	0.0 - 150.5	10.5/9.265
9	Thd	150.5 - 300.7	9.25/8.5
8	Thd	300.7 - 460.5	8.125/7.25
		Not Used -	
		- 9/28/21	

Total Drilled Depth: 462.2 **Hole Dia @ TD:** 7.0

DRILLING METHOD

Type of Drill Rig	HOLE DIAMETER (in.) / INTERVAL (ft.)		
Sonic	Diameter: 10.5	From: 0.0	To: 150.5
Sonic	Diameter: 9.25	From: 150.5	To: 300.7
Sonic	Diameter: 8.125	From: 300.7	To: 460.5
Sonic	Diameter: 7.0	From: 460.5	To: 462.2
—	Diameter: —	From: —	To: —

Total Amount of Water Added During Drilling: 20 gal

COMPLETED WELL

Permanent Casing

Size & Material	Depth (ft.)	Slot Size (in.)
4.5" OD TP-304 Sch10s Blnk	1.98ags - 250.28	N/A
4.5" OD TP-304 Screen	250.28 - 280.29	0.020
4.5" OD TP-304 Sump/Cap	280.29 - 283.29	N/A
	-	
	-	
Not Used	-	
	9/28/21	
	-	
	-	

Construction Material

Type	Intervals (ft.) Annular Seal / Filter Pack	Volume (ft.³)	Mesh Size
High Strength Concrete	0.0 - 3.3	2.3	N/A
Cement Grout	3.3 - 8.7	3.2	I/II
Bentonite Crumbles	8.7 - 243.8	110.5	8-20
Bentonite Pellets	243.8 - 246.8	1.2	3/8"
Filter Pack	246.8 - 280.9	21.7	12-20
Natural Fill	280.9 - 285.0	1.4	N/A
Bentonite Chips	285.0 - 308.0	19.3	3/8"
Bentonite Slurry	308.0 - 462.2	42.2	N/A
—	-	—	—

OTHER ACTIVITIES

Well Straightness Test Results: Passed (9/2/2021)

Well Development Date: 9/22/2021	**Well Decommissioned?**	**Yes** ☐ **No** ☒
Saturated Thickness: 25.5 ft		**Date:** —
Pumping Rate (gpm): 5.8	**Description:** —	
Total Volume Purged: 342.2 gal	**Decommissioning Profile Attached?**	**Yes** ☐ **No** ☒
Drawdown: -0.59 ft	**Static Water Level:** 254.8 ft	**Date:** 9/22/2021

COMMENTS/REMARKS

Reference point for all depths provided is ground surface. All temporary casing has been removed from ground.

Title: Geologist

Dan Charbonneaux		9/28/2021
Reported By *Print*	*Signature*	*Date*

Title: Manager

Jennifer Richart		10/7/21
Reviewed By *Print*	*Signature*	*Date*

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OR Doc Type:	WMU Code(s):

A-6003-658 (REV 2)

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BOREHOLE LOG

Page 1 of 13

Date: 7/20/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

Project: Installation of 1 well in 200-UP-1 OU (Monitoring well) | Reference Measure Point: Ground Surface

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 - 45 'bgs Sand (S) 95% sand, 5% silt. Sand: fn-med, sub-ang to rnd, poor sort, strong HCl rxn, 40%M/60%F, 2.5Y5/3 light olive brown. Some clumps. Silt: loose w/clumps. Sand in clump, has qtz + some mica.	Sonic, 8" core barrel, 10" casing to 150.5' bgs. 8" core barrel to 310' bgs.
	G.S. 7/20/21			Archive @ 5'
5			@ 5-10' bgs, 100% sand. Sand now med-coarse, ang-sub-rnd, mod sort, no HCl rxn, 35%M/65%F, qtz, feldspars, mica, basalt. 5Y3/2 dark olive gray, moist.	
	G.S. 7/20/21		10-15' bgs, 100% sand, now ang to sub-ang, poor sort, 50%M/50%F, 5Y3/1 very dark gray. All else same as above.	Archive @ 10' I-01 split-spoon soil sample, 11.9-13.9' bgs, HEIS #s: B3YHL4, B3YHL5, B3YHL6, B3YHL7, B3YHL8
10	I-01 S.S. 7/20/21			100% recovery
	G.S. 7/20/21		15-20' bgs 95% sand, 5% gravel. Sand is now 55%M/45%F, all else same as above. Gravel is 2-8mm, sub-rnd to rnd, 100%M, poor sort.	Archive @ 15'
15				Add ~2gal potable H_2O @ ~15'
	G.S. 7/20/21		20-25' bgs, 90% sand, 5% gravel, 5% silt. Sand now 45%M/55%F, all else same as above. Gravel 2-5mm, sub-ang to sub-rnd, all else same as above. Silt is loose, dry (hat core barrel), mild HCl rxn. 2.5Y5/1 gray. Some clumps of silt + sand.	Archive @ 20'
20				
	G.S. 7/20/21		25-30' bgs, same as above, many clumps present.	Archive @ 25'
25				
	G.S. 7/20/21		30-35' bgs, 95% sand, 5% silt. Sand is fine, ang to sub-rnd, poor sorting, mild HCl rxn, 35%M/65%F, qtz, mica, basalt. Silt is loose w/ many clumps. 2.5Y6/2 light brownish gray	Archive @ 30'
30				
	7/20/21		35-40' bgs, 100% sand. fn-med, sub-ang to sub-rnd, mod sort, slightly moist, mod HCl rxn, 35%M/65%F, qtz, mica, feldspars, basalt. Many clumps. 2.5Y6/3 light yellowish brown.	

Reported By:

Dan Charbonneaux	Geologist		10/25/21
Print Name	Title	Signature	Date

Reviewed By: SARAH SPRINGER (Affiliate) — Digitally signed by SARAH SPRINGER (Affiliate) Date: 2021.10.25 14:29:10 -07'00'

Print Name	Title	Signature	Date

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OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Date: 7/20/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

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
35	G.S. 7/20/21		40-45' bgs, 100% sand, mostly med, little coarse, 40% M/60% F, sub-rnd to sub-ang, mod sort, moist, mild HCl rxn, some clumps, 2.5Y5/2 grayish brown. Qtz, mica, basalt	Archive @ 35'
	I-02 split spoon 7/21/21			I-02 split spoon, 34.7-37.2' bgs, 100% recovery, HEIS # B3YHL9, B3YHM0, B3YHM1, B3YHM2, B3YHM3
			45-55' bgs Gravelly Sand (gS)	
40	G.S. 7/21/21		10% gravel, 90% sand. Gravel: sub-rnd to rnd, 50%M/50%F, 5-15mm, poor sort, basalt & quartzite. Sand: med-coarse, 40%M/60%F, sub-ang to sub-rnd, poor sort, slightly moist, few clumps, mod HCl rxn, 5Y6/2 light olive gray. Sand has qtz, mica, basalt.	Archive @ 40'
				Add ~2gal H_2O @ ~36' (after sampling)
45	G.S. 7/21/21		50-55' bgs, 20% gravel, 80% sand. Gravel: 2-16mm, sub-ang to rnd, mod sort, 40%M/60%F, basalt, qtzite, other rx. Sand: med-coarse, sub-ang to sub-rnd, mod sort, 45%M/55%F, mostly dry, mod HCl rxn, very few clumps, 5Y6/2 light olive gray. Sand has qtz, mica, basalt.	Archive @ 45' bgs
				I-03 split spoon, 49.6-52.1' bgs, 100% recovery, HEIS #s: B3YHM4, B3YHM5, B3YHM7, B3YHM6, B3YHM7, B3YHM8
50	G.S. 7/21/21			Archive @ 50' bgs
	I-03 split spoon 7/21/21		55-145' bgs Sand (S)	
			100% sand, fn to med, sub-ang to rnd, mod sort, 40%M/60%F, qtz, basalt, mica, moist, mild HCl rxn, some clumps, 2.5Y5/3 light olive brown.	
55	G.S. 7/21/21			Archive @ 55' bgs
			60-65' bgs, 100% sand, med-coarse, 45%M/55%F, v. mild HCl rxn, 5Y6/2 light olive gray. All else same as above.	Add ~2gal H_2O @ ~55'
60	G.S. 7/21/21			Archive @ 60' bgs
			65-70' bgs, 100% sand, 40%M/60%F, damp, v. mild HCl rxn, 2.5Y5/3 light olive brown, All else same as above.	
			70-75' bgs, 100% sand, fn-med, mild HCl rxn, All else same as above. Many clumps.	
65	G.S. 7/21/21			Archive @ 65' bgs
			75-80' bgs, Same as above except ~~M 35%/65%F~~ 30%M/70%F OC 10/19/21	Add ~2gal H_2O @ 65'
			80-85' bgs, mostly dry, mod HCl rxn. All else same as above.	
70	G.S. 7/21/21			Archive @ 70' bgs
			85-90' bgs, moist, v. mild HCl rxn, 25%M/75%F, 5Y6/2 light olive gray. All else same as above.	

Reported By:

Dan Charbonneau — Print Name | Geologist — Title | Signature | 10/25/21 — Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

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Date: 7/21/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

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. 7/21/21		90-95' bgs, 100% sand, Med-fine, sub-ang to rnd, mod sort, 30%M/70%F, qtz, mica, basalt, mostly dry, mild HCl rxn, few clumps. 2.5Y6/2 light brownish gray.	Archive @ 75' bgs Add ~2gal H_2O @ ~75'
80	G.S. 7/21/21		@ 95-100', sand now 25%M/75%F. Moist. V. mild HCl rxn. Some clumps. All else same as above.	Archive @ 80' bgs
85	G.S. 7/21/21		@100-105', sand now fn-coarse (little fine), 35%M/65%F, slightly moist, mild HCl rxn, few clumps. All else same as above.	Archive @ 85' bgs.
90	G.S. 7/21/21		105-110', sand now med-course, 30%M/70%F, v. mild HCl rxn, no clumps. All else same as above.	Add ~2gal H_2O @ ~85'
95	G.S. 7/21/21		110-115', sand now fn-med, 25%M/75%F, damp, mild HCl rxn, many clumps. 2.5Y5/3 light olive brown. All else same as above.	Archive @ 90' bgs
			115-120', no HCl rxn, all else same as above.	Archive @ 95' bgs
100	G.S. 7/21/21		120-125', sand now 30%M/70%F, moist. All else same as above.	Add ~2gal H_2O @ ~95' bgs
			125-130', 95% sand, 5% silt. Sand: same as above, fn-med (very little med). Silt: loose, non-plastic, many clumps, moist, strong HCl rxn, 2.5Y5/3 light olive brown.	Archive @ 100' bgs
105	G.S. 7/21/21		130-135', 100% sand, fn-med, mod HCl rxn, some clumps 2.5Y5/3 light olive brown. All else same as sand above.	Archive @ 105' bgs.
			135-140', same as above.	Add ~2gal H_2O @ ~105'
110	G.S. 7/22/21		140-145', 35%M/65%F, otherwise same as above.	Archive @ 110' bgs
			145-160 'bgs Slightly Silty Sand ((m)S) 85% sand, 15% silt. Sand: Mostly fine, little medium, sub-ang to rnd, poor sort, 30%M/70%F, qtz, mica, basalt. Silt: loose, semiplastic, strong HCl rxn, many clumps, moist,	

Reported By:

Dan Charbonneaux — Print Name | Geologist — Title | Signature | 10/25/21 — Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

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Date: 7/22/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S bldgs

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
115	G.S. 7/22/21		2.5Y5/3 light olive brown.	Archive @ 115' bgs
			150-155', 85% sand, 15% silt. Sand: ~~20%~~ all fine, 20%M/80%F, sub-rnd to rnd, mod sort, qtz, mica, very little basalt. Silt: Mostly loose, semi-plastic, mod HCl rxn, many clumps, moist, 2.5Y5/3 light olive brown. DC 7/27/21	Add ~2gal H_2O @ ~115'
120	G.S. 7/22/21			Archive @ 120' bgs
			@156', 80% sand, 20% silt. Silt now plastic. All else the same. Strong HCl rxn.	
125	G.S. 7/22/21			Archive @ 125' bgs
			@159', sand now fn-med, 30%M/70%F, very moist, 2.5Y4/3 olive brown. All else same as above.	Add ~2gal H_2O @ ~125'
130	G.S. 7/22/21		160 - 162' bgs (Sand) (S)	Archive @ 130' bgs
			90% sand, 10% silt. Sand: fn-med (very little med), sub-ang to sub-rnd, poor sort, 30%M/70% F, qtz, mica, little basalt. Silt: loose w/ clumps, moist, vigorous HCl rxn, 2.5Y6/3 light yellowish brown. ~~Silt is tan~~ DC 7/27/21	
135	G.S. 7/22/21			Archive @ 135' bgs.
			162 - 170' bgs Silt (M)	
			97% silt/clay, 3% sand. Sand: fine, rnd, poor sort, 10%M/90%F (small sample size), qtz, basalt. Silt: massive, sticky, moist, vigorous HCl rxn, plastic, 2.5Y5/3 ~~olive brown~~ (light olive brown). DC 7/27/21	
140	G.S. 7/22/21			Archive @ 140' bgs
			165-170', 95% silt & clay, 5% sand. Silt/clay now 2.5Y4/4 olive brown. All else the same as above.	
145	G.S. 7/22/21			Archive @ 145' bgs
			170 - 185' bgs Silty Sand (mS)	
			55% sand, 45% silt. Sand: fn-med (little med), sub-ang to rnd, well sorted, 15%M/85%F, qtz, mica, little basalt. Silt: loose, many clumps, semiplastic to plastic, vigorous HCl rxn, moist, 2.5Y5/2 grayish brown.	
150	G.S. 7/22/21			Archive @ 150' bgs
			175-180', 70% sand, 30% silt. Sand: fn-med, 20%M/80%F, silt: 2.5Y5/4 light olive brown. All else same as above.	10" casing to 150.5' bgs 9" casing to 300.7' bgs

Reported By:

Dan Charbonneau	Geologist		10/25/21
Print Name	Title	Signature	Date

BOREHOLE LOG (Cont.)

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Date: 7/27/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

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.		180-165' bgs, 60% sand, 40% silt. Sand: fn-med (very little med), sub-ang to sub-rnd, mod sorted, 15%M/85%F, qtz, mica, little basalt. Silt: loose, many clumps, mostly plastic, vigorous HCl rxn, moist, 2.5Y 5/4 light olive brown.	Archive @ 155' bgs
	7/27/21 I-04 S.S. 7/27/21			I-04 split-spoon @ 154.4' - 156.9' bgs, 100% recovery. HEIS #s: B3YHP4, B3YHP5, B3YHP6, B3YHP7
	I-05 S.S. 7/27/21			
	G.S.			Archive @ 160' bgs
160	7/27/21 I-06 S.S. 7/27/21		185-188', 50% sand, 50% silt. Sand is all fine, sub-ang to rnd, 10%M/90%F. Silt is plastic. All else same as above.	I-05 split-spoon @ 156.5' - 159.0' bgs, 100% recovery. HEIS: B3YHP8, B3YHP9, B3YHR0, B3YHR1, B3YHR2
	G.S. 7/27/21 I-07 S.S. 7/27/21			
	G.S. 7/27/21		188' - 190' bgs Sandy Gravel (sG)	Archive @ 162' bgs
165			55% gravel, 40% sand, 5% silt. Gravel: 2-60mm, sub-rnd to rnd, poor sort, 70%M/30%F, basalt, quartzite, met/sed rx. Sand: fn-coarse, sub-ang to rnd, 50%M/50%F, qtz, mica, basalt.	DC 7/27/21 I-06 split-spoon @ 159.0 - 161.5' bgs, 100% recovery. HEIS #: B3YHR3, B3YHR4, B3YHR5, B3YHR6, B3YHR7
	G.S.		Silt: loose, moist, mild-mod HCl rxn, 10YR4/2 dark grayish brown.	Archive @ 165' bgs
170	7/27/21 I-08 S.S. 7/27/21		DC 10/14/21 DC 10/14/21 (nG) 190-195' bgs Silty-Sandy Gravel (nasG) DC 7/29/21	I-07 split-spoon @ 161.3 - 163.8' bgs. 100% recovery, HEIS #s: B3YHR8, B3YHR9, B3YHT0, B3YHT1, B3YHT2
			75% gravel, 10% sand, 15% silt. Gravel: 2-245mm, ang to sub-rnd, poor sort, 75%M/25%F, basalt, quartzite, other met/sed rx (few). Sand: fn-coarse (mostly coarse), sub-ang to sub-rnd, 70%M/30%F, basalt, mica, qtz (little). Silt: ~~loose~~ DC 7/29/21 compacted, nanplastic, no HCl rxn to v. mild HCl rxn. Lightly cemented.	
175	G.S.			Archive @ 170' bgs
	7/27/21 I-09 S.S. 7/28/21			I-08 + dup split-spoon @ 169.4' - 171.9' bgs, 100% recovery. HEIS #: B3YHT3, 4, 5, 6, 7, 8, 9, B3YHV0, 1, 2, 3 (dup)
	I-10 S.S. 7/28/21			
	G.S.		10YR4/2 dark grayish brown, Moist.	Archive @ 175' bgs
180	7/28/21 I-11 S.S. 7/28/21			I-09 split-spoon @ 174.5 - 177.0' bgs, 100% recovery. HEIS: B3YHV3, 4, 5, 6, 7.
	I-12 S.S. 7/28/21		195-200' bgs Sandy Gravel (sG)	
	G.S. 7/28/21		70% gravel, 20% sand, 10% silt. Gravel: 2-22mm, sub-ang to sub-rnd, mod sort, 80%M/20%F, basalt, ~~mica, little qtz~~ DC 7/29/21 quartzite, other rx (little). Sand: fn-coarse (average med), 70%M/30%F, basalt, mica, qtz.	I-10 split-spoon @ 177.6 - 180.1' bgs, 100% recovery, HEIS: B3YHV8, 9, B3YHW0, 1, 2.
185	7/28/21 I-13 S.S. 7/28/21		Silt: Compacted, non-plastic to semiplastic, no HCl rxn, moist, v. light cementation. 10YR4/3 brown.	Archive @ 180' bgs
	G.S. 7/29/21 I-14 S.S. 7/28/21			I-11 split-spoon @ 180.0 - 182.5' bgs, 100% recovery, HEIS #s: B3YHX2, 3, 4, 5, 6, 7, 8 DC 7/29/21
	G.S.		200-205' bgs Silt (M)	Archive @ 185' bgs
190	7/28/21 I-15 S.S. 7/29/21		10% sand, 90% silt. Sand: fn, sub-rnd to rnd, poor sort, 50%M/50%F, qtz, mica, basalt. Silt: compacted, massive, plastic, no HCl rxn, moist, no cementation, 2.5YR5/3 light olive brown.	I-12 split-spoon @ 184.4-184.9' bgs, 100% recovery. HEIS #: B3YHX2, 3, 4, 5, 6.

Reported By:

Dan Charbonneaux	Geologist		DC 7/27/21 7/27 10/25/21
Print Name	Title	Signature	Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

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Date: 7/28/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

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. 7/29/21		205-215' bgs Sandy Silt (sM) 40% sand, 60% silt. Sand: fn, sub-rnd to rnd, 40%M/60%F, poor sort, qtz, mica, basalt. Silt: Compacted, massive, plastic, V. mild HCl rxn, moist, 2.5Y4/3 olive brown.	I-13 split-spoon @ 184.9-187.4' bgs, 100% recovery, HEIS: B3YHX7, 8, 9, B3YHY0, 1.
	G.S.		35% on 10/14/21 5% gravel	I-14 split-spoon @ 187.1-189.6' bgs. 100% recovery, HEIS: B3YHY2, 3, 4, 5, 6.
200	7/29/21		210-215' bgs, ~~25%~~ sand, 60% silt. Sand now 30%M/70%F, little basalt present. Compacted "chunks of soil" have orange-colored streaks (not likely from rust on core barrel), 2.5Y5/3 light olive brown. All else the same as above.	Archive @ 188' bgs; Archive @ 190' bgs; I-15 split-spoon @ 190.1'-192.6' bgs, 100% recovery, HEIS #s: B3YHY7, 8, 9, B3YJ00, 1.
	G.S.			
205	7/29/21		215-220' bgs Silty Sand (mS) 60% sand, 40% silt. Sand: 15%M/85%F, all fine, sub-rnd to rnd, poor sort, qtz, mica, little basalt. Silt: Compacted, massive, semi-plastic to plastic, no HCl rxn, moist, 2.5Y5/3 light olive brown.	Archive @ 195' bgs; Archive @ 200' bgs; Archive @ 205' bgs
	G.S.			Archive @ 210' bgs
210	7/29/21		220'-235' bgs Sand (S) 100% sand, fn-med, sub-ang to sub-rnd, poor sort, 75%F/25%M, qtz, mica, basalt, some feldspars. No HCl rxn, mostly dry (hot core barrel), 2.5Y6/3 light yellowish brown. Some clumps.	I-16 not collected.
215	G.S. 7/29/21		225-230', 95% sand, 5% silt. Sand same as above. Silt: loose w/some clumps, moist, no HCl rxn, non-plastic, 2.5Y6/3 light yellowish brown.	Archive @ 215' bgs
220	G.S. 7/29/21			Archive @ 220' bgs
	I-17 S.S. 7/29/21		230-235', 100% sand. Sand now fn-coarse (mostly med), ang to sub-rnd, poor sort, 20%M/80%F, qtz, feldspars, mica, basalt. Moist, no HCl rxn, 2.5Y5/3 light olive brown.	I-17 (+dup) @ 219.7-222.2' bgs. 100% recovery. HEIS: B3YJ12, 13, 14, 15, 16 (B3YJ07, 08, 09, 10, 11 dup) (split-spoon)
225	G.S. 7/29/21			Archive @ 225' bgs
	I-18 S.S. 7/29/21		237' Yellow-Orange staining found on split spoon	I-18 @ 225.9-228.4' bgs (split-spoon), 100% recovery, HEIS: B3YJ17, 18, 19, 20, 21.
230	G.S. 8/3/21		Sandy Gravel (sG) RB 8/3/2021 235-260' bgs ~~Gravelly Sand~~ (gS) 70% sand, fn-med, sub-rnd to sub-ang, poor sorted, 80% F 20% M, qtz, mica, basalt, some feldspar. No HCL rxn. Moist. 30% Gravel, rounded, sub ang, 2-65 mm	Archive @ 230' bgs

Reported By:

Dan Charbonneaux/Ryan Bailey — Print Name

Geologist — Title

Signature

10/25/21 — Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.) Page 7 of 13

Date: 8/3/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5 Km E of 222-S labs

Depth (ft)	Sample	Graphic Log	Sample Description: Sedimnent 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. 8/3/21		50% F, 50% M, 2.5 Y 5/2 grayish brown	Archive @ 235' bgs
	DC 8/3/21 I-19 8/3/21 SS			I-19 split-spoon @ 236.0 - 238.5' bgs, 100% recovery, HEIS: B3YJ22, B3YJ23, B3YJ24, B3YJ25, B3YJ26
240	G.S. 8/3/21		240-245' bgs, same as last except; sand 90% F 10% M, 60% sand 40% gravel, Mild HCL RxN, mostly dry (hot core barrel)	Archive @ 240' bgs
245	G.S. 8/3/21		245-250' bgs, same as last except; gravel had large 130 mm rounded felsic; No HCL RxN, 50% sand 50% gravel	Archive @ 245' bgs
250	G.S. 8/3/21		250-255' bgs, same as last except; gravel 75% sand 25% large 100mm rock, sand is 90% F 10% M, rounded. angular, 2.5Y 4/2 dark grayish brown, saturated	Archive @ 250' bgs
				Static H_2O: 254.8' bgs (9/22/2021)
255	G.S. 8/3/21		255-260' bgs same as last except; some fines are washed out, gravel is between 2mm-50mm 90% felsic 10% mafic, saturated, 2.5y 4/2 dark grayish brown	Archive @ 255' bgs
260	G.S. 8/4/21 I-20 H_2O 8/9/21		260-270' bgs Gravel (G) 85% gravel 15% sand; gravel size is 2mm-120mm, rnd-ang, poorly socted, 90% M 10% F, ign rx; Sand is fine, sub rnd-ang, poorly socted, 80% mafic 20% felsic, qtz-basalt-feldspars, NO HCL RxN	Archive @ 260' bgs; H_2O sample I-20 @ 260.5' bgs. B3YJ30, B3YJ31, B3YJ32.
265	G.S. 8/4/21			Archive @ 265' bgs
270	G.S. 8/9/21 I-21 H_2O 8/10/21		265-270.' 80% gravel, 15% sand, 5% silt. Gravel: 2-85 mm, sub-ang to rnd, poorly sorted, 60% M/20% F, basalt, quartzite, misc. ign rx. Sand: fn - coarse (mostly coarse), ang to sub-rnd, 50% M/50% F, basalt, qtz, feldspars, mica. Silt: loose, no clumps, saturated, no HCl rxn, 2.5Y 5/2 grayish brown. Silt is non-plastic.	I-21 H_2O sample @ 270.6' bgs + I-21 dup. B3YJ35, 36, 37 (B3YJ40, 41, 42 dup) Archive @ 270' bgs

Reported By:

Don Charbonneaux / Ryan Bailey — Geologist — Title — Signature — Date

Print Name

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 8 of 13

Date: 8/10/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5 km East 222-S Labs

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. 8/10/21		270 - 290 'bgs Sandy Gravel (sG) 75% gravel, 20% sand, 5% silt. Gravel: 2-60mm, sub-rnd to rnd, poorly sorted, 25%M/75%F, quartzite, basalt, misc. ign + met rx. Sand: fn - coarse (V. little fn), sub-ang to sub-rnd, 10%M/90%F, mostly qtz, basalt, mica. Silt: loose, non-plastic, moist, no HCl rxn, 5Y5/3 olive.	Archive @ 275' bgs
280	G.S. 8/10/21 I-22 H_2O 8/11/21			Archive @ 280' bgs I-22 H_2O sample @ 281.9' bgs, HEIS#s B34J45, B34J46.
285	G.S. 8/11/21		275 - 280', 40% gravel, 60% sand. Gravel: 5-60mm, 30%M/70%F, sand: med to coarse, saturated. All else same as above.	Archive @ 285' bgs
290	H_2O I-23 8/11/21 DC 8/26/21 G.S. 8/11/21		280-285', 75% gravel, 15% sand, 10% silt. Gravel: 5-90mm, 20%M/80%F, sand: fn - med, 20%M/80%F, all else same as above. Silt: loose, non-plastic, saturated, no HCl rxn, 5Y5/2 olive gray.	~~I-23 H_2O sample @ 286.0' bgs (Kabis). HEIS#s: B34J49, B34J50, B34J51.~~ DC 8/26/21 Archive @ 290' bgs
295	G.S. 8/11/21		285-290', 70% gravel, 20% sand, 10% silt. Gravel: 3-60mm, sub-ang to rnd, 25%M/75%F, sand: 15%M/85%F, silt: 5Y4/2 olive gray. All else same as above	Archive @ 295' bgs
300	G.S. 8/11/21		290-300' bgs Sand (S) 100% sand. Sand: fn - med, sub-ang to sub-rnd, poorly sorted, 10%M/90%F, qtz, mica, basalt. Saturated, no HCl rxn, 5Y5/3 olive.	Archive @ 300' bgs 9" casing to 300.7' bgs. 8" casing to 460.5' bgs
305	G.S. 8/17/21		295-300', same as above 300-310' bgs Gravel (G) 80% gravel, 15% sand, 5% silt. Gravel: 2-70mm, ang to rnd, mod sort, 25%M/75%F, basalt, qtzite, misc. ign + met rx. Sand: fn - coarse, sub-ang to rnd, 15%M/85%F, qtz, mica, basalt. Silt: loose, nonplastic, saturated, no HCl rxn, 2.5Y5/2 grayish brown.	8" core barrel to 310' bgs 7" core barrel to 462.2' bgs Archive @ 305' bgs
310	G.S. 8/17/21		305-310', 80% gravel, 20% sand. Sand now med-coarse (mostly med), 20%M/80%F. Gravel now 8-60mm, 15%M/85%F, sub-rnd to rnd. Several gravels have dark brown cement (non-calcareous) with sand stuck on. 2.5Y4/3 olive brown. All else same as above.	Archive @ 310' bgs

Reported By:

Dan Charbonneaux (Print Name) | Geologist (Title) | (Signature) | 10/25/21 (Date)

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

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Date: 6/17/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

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	G.S. 6/17/21 I-23 H_2O 6/18/21		310-315' bgs Sandy Gravel (sG) 60% gravel, 30% sand, 10% silt. Gravel: 5-80mm, sub-rnd to rnd, poor sort, 10%M/90%F, basalt, qtzite, misc. ign + met. rx. Some basalts have red-brown weathering rind w/ dark brown flaky non-calcareous cement.	Archive @ 315' bgs. I-23 H_2O sample @ 316.5' bgs (Kabis). HEIS #s: B34J49, B34J50, B34J51. Sample likely not representative of H_2O @ 316.5' bgs.
320	G.S. 6/18/21		Sand: fn-coarse, sub-ang to rnd, 15%M/85%F, qtz, feldspars, mica, basalt. Silt: loose, nonplastic, saturated, no HCl rxn, 2.5Y 5/3 light olive brown.	Archive @ 320' bgs
			315-320' bgs Gravel (G)	
325	G.S. 6/18/21		60% gravel, 10% sand, 10% silt. Gravel: 2-120mm, ang to rnd, 90%M/90%F, poor-mod sort., Basalt, qtzite, misc ign + met rx, some basalts have cements as above. Sand: fn-coarse, ang to rnd, 20%M/80%F, qtz, feldspars, some mica, basalt, Silt: loose, non-plastic to semiplastic, saturated, no HCl rxn, 2.5Y5/2 grayish brown.	Archive @ 325' bgs.
330	G.S. 6/18/21			Archive @ 330' bgs
			320-325' bgs Silty Gravel (mG) 10 oc 6/18/21 70% gravel, 10% sand, 20% silt. Gravel: 2-90mm, sub-rnd to rnd, 15%M/85%F, poor sort, basalt, qtzite, misc. ign + met. rx, some basalts w/ cement as above.	
335	G.S. 6/19/21		Sand: fn-med, ang to sub-rnd, 5%M/95%F, qtz, feldspars, little mica & basalt. Silt: sticky, semiplastic to plastic, no HCl rxn, saturated, 5Y5/3 olive.	Archive @ 335' bgs
340	G.S. 6/19/21		325-330' bgs Silty Sandy Gravel (msG) 70% gravel, 15% sand, 15% silt. Gravel: 5-80mm, sub-rnd to rnd, poor to mod sort, 10%M/90%F, qtzite, basalt, misc ign + met rx, basalts not cemented. Sand: fn-med, sub-ang to sub-rnd, 5%M/95%F, qtz, feldspars, V. little mica, little basalt. Silt: sticky, loose, semi-plastic, no HCl rxn, saturated, 5Y5/3 olive.	Archive @ 340' bgs
345	G.S. 6/19/21			Archive @ 345' bgs
			330-335' bgs Silty Gravel (mG) 75% gravel, 10% sand, 15% silt. Gravel: 6-100mm, sub-rnd to rnd, poor to mod sort, 15%M/85%F, basalt, qtzite, misc ign + met rx. Some patches of caliche an gravels, white color w/ mod HCl rxns. Sand: fn-med, sub-ang to sub-rnd, 10%M/90%F, qtz, f-span, basalt, little mica. Silt: sticky, semiplastic to plastic, overall	
350	G.S. 6/19/21			Archive @ 350' bgs

Reported By:

Dan Charbanneaux	Geologist		10/25/21
Print Name	Title	Signature	Date

BOREHOLE LOG (Cont.)

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Date: 6/19/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

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
355	G.S. 6/23/21 I-24 H2O		no HCl rxn, aside from caliche previously noted. Very damp, 5Y4/3 olive.	Archive @ 355' bgs. H2O sample I-24 @ 355.5' bgs (Kabis sampler). Sample collected without purge, likely doesn't represent water @ 355.5'
			335 - 340' bgs Gravel (G)	
360	G.S. 6/19/21		80% gravel, 10% sand, 10% silt. (Sands & silt washed out during sample collection, percentages reflect what remains - actual sediment is finer). Gravel: sub-ang to rnd, 10 - 40mm, 10%M/90%F, poor sort, basalt, qtzite, misc. ign + met rx. Sand: sub-ang to rnd, fn-med, 20%M/80%F, qtz, f-spars, basalt. Silt: loose, gooey, saturated, no HCl rxn, 5Y5/2 olive gray. Silt is non-plastic.	Archive @ 360' bgs. HEIS # B3YJ54, B3YJ55, B3YJ56
365	G.S. 6/23/21			Archive @ 365' bgs
			340 - 375' bgs Sandy Gravel (sG)	Heaving sands from ~360' bgs to
370	G.S. 6/23/21		60% gravel, 35% sand, 5% silt. Gravel: 5 - 80mm, sub-ang to rnd, poor sort, 15%M/85%F, qtzite, basalt, misc ign + met rx. Sand: fn - coarse (little fn), ang to sub-rnd, 20%M/80%F, qtz, f-spars, basalt, mica. Silt: loose, nonplastic, very damp, no HCl rxn,	Archive @ 370' bgs
375	GS 8/24/21		same patches of orange-red staining, 5Y 2.5Y4/3 DC 8/19/21 olive brown.	Archive @ 375' bgs
			@ 345-350', 55% gravel, 40% sand, 5% silt. Gravel sub-rnd to rnd, Sand sub-ang to sub-rnd, 25%M/75%F.	
380	GS 8/24/21		from 7± DC 8/19/21 patches of orange-red staining. All else same as above.	
			350-355', 55% gravel, 45% sand. Sand now 20%M/80%F, med - coarse. All else same as above. 2.5Y5/3 olive,	Archive @ 380' bgs
385	GS 8/24/21		40% sand, 5% silt DC 8/19/21 355 - 360', 55% gravel, ~~43% sand, 2% silt~~ silt is pressed around edges of core barrel, otherwise loose, nonplastic, all else same as above. No staining patches.	Archive @ 385' bgs
390	GS 8/24/21		360 - 365', 60% gravel, 30% sand, 10% silt. Gravel now 20%M/80%F. Sand now fn - med, 15%M/85%F. Silt: clumpy, non-plastic to semiplastic, v. mild HCl rxn, 2.5Y4/3 olive brown. All else same as above.	Archive @ 390' bgs
			70% gravel, 20% sand DC 8/23/21	
			365 - 370', ~~65% gravel, 25% sand~~, 10% silt. Gravel now 5 - 70mm, Sand now 10%M/90%F. Wet, no HCl rxn	

Reported By:

Dan Charbonneau / SES Senior Geologist	Geologist / Geologist		10/25/21
Print Name	Title	Signature	Date

BOREHOLE LOG (Cont.)

Date: 8/23/2021

Well ID: C4566 | Well Name: 299-W22-127 | Location: ~0.5km E of 222-S Labs

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
395	G.S. 8/24/21* I-25 H_2O 8/25/21		Some patches of yellow orange staining. All else same as above.	Archive @ 395' bgs.* *Archive @ 395 brought up 8/24 but logged 8/25
			370-375'. same as above:	
			375-385 → Gravel (G)	
	G.S.		375-380': 80% g/15% s/5% m G:	
400	8/25/21		80% m/20% f, rnd-sub ang, max = 12 cm	Archive @ 400'
			S: wet, non-semi plastic; 2.5Y 4/3	
			(olive brown); med-fn grain	I-25 H_2O (Kabik) sample,
			380-385: 80% g/20% s	395.5' bgs. HEIS #s: B3YJH0, DC 8/25/21
	G.S.		G: max ~ 8 cm; all else same	B3YJ62, B3YJ63, B3YJ64,
405	8/25/21		S: coarse-fn grained; vis. qtz; wet	B42JH0. Sample likely not
			10YR 4/2 (DK Brownish Grey)	representative of H_2O @ 395.5' bgs.
			385-390 → ~~gravelly Sand (gS)~~ Sandy gravel (sG)	Archive @ 405'
	G.S.		385-390: 30% g/60% s/10% m	
410	8/25/21		G: max ~ 6cm (mostly 5 cm or less)	Archive @ 410'
			all else same	
			S: coarse to fn grained; vis qtz & mica;	
			strong coarse component (50%)	
	G.S.		10YR 4/2 (DK brownish grey)	
415	8/26/21			Archive @ 415'
			390-395' bgs Sandy Gravel (sG)	
			60% Gravel, 30% sand, 10% silt. Gravel: 5-60 mm, DC 8/25/21	
			sub-rnd to rnd, mod poor sort, 20% M/80% F, basalt, DC 8/25/21	
	G.S.		qtzite, misc ign + met rx. Sand: fn-coarse (little	
420	8/26/21		med), sub-ang to sub-rnd, 15% M/85% F, qtz, f-spar,	Archive @ 420'
			mica, basalt. Silt: clumpy, slightly sticky, semi-plastic,	
			damp, no HCl rxn, 2.5Y 4/3 olive brown.	
			395-400' bgs Sand (S)	
	G.S.		5% gravel, 95% sand. Gravel: 20-30 mm, rounded, poor	Archive @ 425'
425	8/26/21		sort, 100% F, mostly quartzite. Sand: med-coarse, little	
			fine, sub-ang to sub-rnd, 15% M/85% F, qtz, feldspars,	
			much mica, basalt. Wet, no HCl rxn, 2.5Y 4/3 olive brown.	
	G.S.		DC 8/25/21	
430	8/26/21		400-~~415~~ 410' bgs Gravelly Sand (gS)	Archive @ 430'
			15% gravel, 85% sand. Gravel: 20-35 mm, rounded, poor	
			sort, 30% M/70% F, quartzite, basalt, misc ign + met rx.	
			Sand: med-coarse, little fn, sub-ang to sub-rnd, 15% M/85%	
			F, qtz, feldspars, much mica, basalt. Wet, no HCl rxn, 2.5Y 4/3 olive brown	

Reported By:

Dan Charbonneaux/SS Sexton	Geologist/Geologist		10/25/21
Print Name	Title	Signature	Date

BOREHOLE LOG (Cont.)

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Date: 8/26/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5km E of 222-S Labs

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
435	G.S. 8/30/21		405-410', 20% gravel, 80% sand. All else same as above.	Archive @ 435' bgs
	I-26 H_2O Sample		410-445' bgs Sand (S)	I-26 H_2O (Kabis) @ 436' bgs, likely not representative of H_2O @ 436'. HEIS #: B34J67, B34J68, B34J69, B42JH2.
440	G.S. 8/31/21		95% sand, 5% silt. Sand: fn-med (little coarse), sub-ang to sub-rnd, poor sort, 8% M/92% F, qtz, feldspars, much mica, little basalt. Silt: loose, slightly clumpy, non-plastic, wet, no HCl rxn, 5Y5/2 olive gray.	Archive @ 440' bgs
			415-420', same as above.	Drilling harder & ranting @ 436' bgs, no apparent change in formation.
445	G.S. 8/31/21		420-425', 93% sand, 7% silt, all else same as above.	Archive @ 445' bgs
			425-430' 90% sand, 10% silt, silt now non-plastic to semiplastic.	
450	G.S. 9/1/21		430-435', 93% sand, 7% silt. Sand now fn-coarse, 10% M/90% F. All else same as above. Saturated.	Archive @ 450' bgs
			435-440, 90% sand, 10% silt. Sand now 5% M/95% F. Silt is loose/clumpy. All else same as above.	
455	G.S. 9/1/21		440-445, 88% sand, 7% silt, 5% gravel. Sand now has little fn, silt is loose & nonplastic. Gravel: 15-80mm, rnd, 10% M/90% F, quartzite, basalt.	Archive @ 455' bgs
	G.S. 9/2/21		Some gravels have brown, flaky non-carbonate cement w/ matrix grains stuck on, 2.5Y5/2 grayish brown. All else same as above.	Archive @ 457' bgs
460	G.S. 9/2/21			Archive @ 460' bgs.
TD 462.2'	G.S. 9/2/21		445-450' bgs Gravelly Sand (gS)	Archive @ 462' bgs
465			15% gravel, 77% sand, 8% silt. Gravel: 10-70mm, sub-rnd to rnd, poor sort, 20% M/80% F, quartzite, basalt, some gravels have brown, non-calcareous cement w/ matrix grains stuck on. Sand: fn-med (little coarse), sub-ang to sub-rnd, 10% M/90% F, qtz, mica, feldspars, little basalt. Silt: loose, few clumps, nonplastic, damp wet, no HCl rxn, 2.5Y5/2 grayish brown.	Total depth: 462.2' bgs. DI 4/7/21
470				

Reported By:

Dan Charbonneaux	Geologist		10/25/21
Print Name	Title	Signature	Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

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Date: 9/1/2021

Well ID: C9566 | Well Name: 299-W22-123 | Location: ~0.5 km E of 222-S Labs

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
475			450 - 457' bgs Sandy Gravel (sG) 65% gravel, 30% sand, 5% silt. Gravel: 15 - 90mm, ang to rnd, poor sort, 50% M/50% F, basalt, quartzite mostly. No cement. Sand: fn - coarse, sub- ang to sub-rnd, 25% M/75% F, qtz, mica, feldspars, basalt. Silt: loose, nonplastic to semiplastic, some clumps, wet, no HCl rxn, 2.5Y4/2 dark grayish brown. 455 - 457' bgs, same as above, clay/silt content increases w/ proximity to next unit. Somewhat gradational/ contact.	
480				
485			457 - 462.2' bgs, Silt (M) 5% gravel, 95% silt/clay. Gravel: 5 - 10mm, sub-ang to rnd, 50% M/50% F, quartzite, basalt, dacite, mica, well sorted. Gradational, most gravel at top, fines down. Silt/clay: Massive, plastic, ~~no HCl rxn~~, mostly dry, mild - mod HCl rxn. 5Y6/3 pale olive.	
490	Not Used	9/27/21		Not Used 9/27/21
495			460 - 462.2' 100% silt/clay. All else same as above.	
500				
505				
510				

Reported By:

Dan Charbonneaux	Geologist		10/25/21
Print Name	Title	Signature	Date

A-6006-993 (REV 0)

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299-W22-123 (C9566)
Log Data Report

Borehole Information

Log Date[1]	09/08/2021	Filename	C9566_HG-NM_2021-09-08	Site	200-UP-1
DTW[2] (ft)	**DTW Date**	**DTW Source**	**Drill Date[3]**	**Total Depth[4] (ft)**	**Depth Datum**
255.4 & 293.5	08/12/2021 & 09/07/2021	GRAM NW & Bay West	09/02/2021	460.0	Ground Surface

New borehole drilling is commonly accomplished using a telescoping method. Geophysical logging is conducted through each casing string, often including short overlaps with previous log runs. During well completion, the temporary drill casing is removed, and the permanent casing is installed. Geophysical logging is conducted through the temporary casings so that completion materials do not affect the data. This report presents results from geophysical logging through the temporary drill casings.

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
			Outer	Inside			
Threaded Steel	Holt Sonic	TC[5]-NA	10.52	10.02	0.25	0.25 AGS[6]	150.5 BGS[7]
Threaded Steel	Holt Sonic	TC-NA	9.27	8.77	0.25	0 AGS	300.7 BGS
Threaded Steel	Holt Sonic	TC-NA	8.00	7.46	0.27	0 AGS	460.5 BGS

Borehole Notes

The onsite geologist provided the total depth and casing depths. When accessible, the logging engineers measure the casing wall thicknesses using an ultrasonic thickness gauge, the outside diameters using a circumference tape, and then calculate the inside diameters. Those field measurements are made to compare against more detailed dimension measurements made on February 3, 2021 for the 8-in., and January 1, 2021 for the 9- and 10-in. casings. For consistency between boreholes using this specific type of sonic casing, the February 3, 2021 and January 1, 2021 measurements were used for casing corrections during data analysis and are reported in the table above.

Logging Equipment Information

Logging System	Gamma 4Nc	**Type**	60% Coaxial HPGe (SGLS[8])
Effective Calibration Date	May 18, 2021	**Serial No.**	45-TP22010A
Calibration Reference	HGLP-CC-215, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53023, Rev. 0, Change 3

Logging System	Gamma 4Mc	**Type**	He-3 (CPN 503DR) (NMLS[9])
Effective Calibration Date	January 6, 2021	**Serial No.**	H340207279
Calibration Reference	HGLP-CC-208, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53024, Rev. 0, Change 3

[1] Log date, by convention, is the final date of geophysical logging
[2] Depth to water inside casing during logging
[3] Drill date is the date when drilling is completed prior to logging of the final casing string
[4] Total depth is the reported depth of the borehole prior to logging of the final casing string
[5] Temporary casing
[6] Above ground surface
[7] Below ground surface
[8] Spectral gamma logging system
[9] Neutron moisture logging system

SGLS Log Run Information

Log Run	1	2	3 Repeat	6
HEIS Number	1021655	1021656	1021657	1021658
Date	07/22/2021	07/26/2021	07/26/2021	08/12/2021
Logging Engineer	Spatz/McClellan	Spatz/McClellan	Spatz/McClellan	Spatz
Start Depth (ft)	0.00	77.00	133.00	148.00
Finish Depth (ft)	78.00	149.00	148.00	241.00
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	C9566DNc202107 22AV00CAB1	C9566DNc202107 26BV00CAB1	C9566DNc20210 726BV00CAB1	C9566DNc202108 12CV00CAB1
Start File	AD000000	BD007700	CD013300	CD014800
Finish File	AD007800	BD014900	CD014800	CD024100
Post-Verification	C9566DNc202107 22AV00CAA1	C9566DNc202107 26CV00CAA1	C9566DNc20210 726CV00CAA1	C9566DNc202108 12DV00CAA1
Depth Return Error (in.)	0	N/A	0	NA
Comments	None	None	None	Take-cover alarm

SGLS Log Run Information

Log Run	7	8 Repeat	11	12 Repeat
HEIS Number	1021659	1021660	1021661	1021662
Date	08/12/2021	08/16/2021	09/07/2021	09/07/2021
Logging Engineer	Spatz	Spatz	Patterson/Thurnau /C. Meisner	Patterson/Thurnau/ C. Meisner
Start Depth (ft)	242.00	228.00	290.00	370.00
Finish Depth (ft)	294.00	270.00	451.00	386.00
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	C9566DNc202108 12CV00CAB1	C9566DNc20210 816EV00CAB1	C9566DNc202109 07EV00CAB1	C9566DNc202109 07EV00CAB1
Start File	DD024200	ED022800	ED029000	FD037000
Finish File	DD029400	ED027000	ED045100	FD038600
Post-Verification	C9566DNc202108 12DV00CAA1	C9566DNc20210 816EV00CAA1	C9566DNc202109 07FV00CAA1	C9566DNc202109 07FV00CAA1
Depth Return Error (in.)	LOW 13	LOW 3	NA	LOW 3
Comments	Restart depth error 1-ft low	Depth error interval determined	Log run ‘E’ designation repeated	None

NMLS Log Run Information

Log Run	4	5 Repeat	9	10 Repeat
HEIS Number	1021663	1021664	1021665	1021666
Date	07/26/2021	07/26/2021	08/16/2021	08/16/2021
Logging Engineer	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0.0	133.0	148.0	219.0
Finish Depth (ft)	149.25	148.0	256.0	230.0
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	C9566DMc20210726AV00CAB1	C9566DMc20210726AV00CAB1	C9566DMc20210816CV00CAB1	C9566DMc20210816CV00CAB1
Start File	AD000000	BD013300	CD014800	DD021900
Finish File	AD014925	BD014800	CD025600	DD023000
Post-Verification	C9566DMc20210726BV00CAA1	C9566DMc20210726BV00CAA1	C9566DMc20210816DV00CAA1	C9566DMc20210816DV00CAA1
Depth Return Error (in.)	NA	HIGH 0.5	LOW 0.5	0
Comments	None	None	Depth readout froze. Returned to surface to re-zero and then continue log run.	None

NMLS Log Run Information

Log Run	13	14	15 Repeat	NA – all below
HEIS Number	1021667	1021668	1021669	
Date	09/08/2021	09/08/2021	09/08/2021	
Logging Engineer	Patterson/Thurnau/ C. Meisner	Patterson/Thurnau /C. Meisner	Patterson/Thurnau /C. Meisner	
Start Depth (ft)	229.00	258.50	250.00	
Finish Depth (ft)	266.25	293.99	260.00	
Count Time (sec)	15	15	15	
Live/Real	R	R	R	
Shield (Y/N)	N	N	N	
MSA Interval (ft)	0.25	0.25	0.25	
Log Speed (ft/min)	NA	NA	NA	
Pre-Verification	C9566DMc20210908EV00CAB1	C9566DMc20210908EV00CAB1	C9566DMc20210908EV00CAB1	
Start File	ED022900	FD025850	GD025000	
Finish File	ED026625	FD029399	GD026000	
Post-Verification	C9566DMc20210908GV00CAA1	C9566DMc20210908GV00CAA1	C9566DMc20210908GV00CAA1	
Depth Return Error (in.)	NA	NA	LOW 1	
Comments	Excessive count rates observed from 258.5 to 266.25 ft.	Resumed log after software & system restart.	None	

Logging Operation Notes

Centralizers were installed on the sondes during logging. All verification measurements passed the respective acceptance criteria. SGLS verification measurements were acquired in the KTh-02 field verifier. The maximum SGLS logging depth achieved was 451 ft where the cable lost tension weight, which is approximately 9.5 ft above reported casing depth. The sonde, upon extraction, was reported as being coated with mud and silt along its entire 8-ft length by the logging engineers. Zero depth reference is ground surface.

Depth to water in this report is reported at two different depths. NMLS log run 9 reached water at approximately 255.4 ft inside the 9-in. casing, and log run 14 reached water at approximately 293.5 ft inside the 8-in. casing. The discrepancy is due to water being evacuated from inside the casing for well testing purposes. Static water level is reported at or near 255.4 ft.

The logging engineer terminated log run 6 at 241 ft due to a take-cover alarm coming from a nearby facility. After the all-clear was announced, SGLS logging was restarted as log run 7. No SGLS data were lost, though a 13-in. depth return error was observed at the end of the log run.

SGLS repeat log run 8 identified where the 13-in. depth return error occurred during log run 7. The error occurred when the restart depth for log run 7 was set 1 ft too low. The depth interval for repeat log run 8 was selected specifically to overlap log runs 6 and 7 to investigate the suspected depth return error. By comparing the two data sets, the depth error was easily identified and corrected.

After terminating log run 9, and when the NMLS sonde was moving up the borehole to a new log depth, the depth control readout froze and became inoperable. The sonde was returned to the surface and re-zeroed using the backup Depth Event Counter. After reinitializing the logging computer and reestablishing depth control, the sonde was returned to the appropriate depth and completed log run 10 without further incident.

For log run 11, the file log run identifier ‘E’ was reused in error. It was previously used for SGLS log run 8. No data was overwritten or lost; the date and depths are also included in the file names, ensuring each spectrum file has a distinct identification.

Logging engineers terminated NMLS log run 13 at 266.25 ft. An excessive count rate anomaly occurred during NMLS logging, which was suspected to be a result of a power surge related to turning on an unrelated system in the logging compartment that could have affected the DHMCA parameter file. After the logging program was reinitialized, logging continued without incident. Field review of the unprocessed data collected from 258.5 to 266.25 ft indicated the data were invalid, so the interval was relogged during log run 14. Invalid data from log run 13 have been removed from the published data set.

Analysis Notes

Analyst	R.R. Spatz & A.D. Pope	**Date**	11/18/2021
Reference(s)	SGRP-PRO-OP-53040, Rev. 1, Chg. 1; SGRP-PRO-OP-53051, Rev. 0, Chg. 2		

Casing corrections applied to SGLS data are shown in table below.

Casing Thickness (in.)	Depth Interval (ft)	Casing / Log Run No.	Water Correction
0.25	0 - 149	One / 1, 2, and 3	No
0.50	148 - 150	Two / 4	No
0.25	151 - 294	Two / 4 and 5	Yes, 256 - 294 ft
0.52	290 - 300	Three / 11	Yes, 294 - 300 ft
0.27	301 - 451	Three / 11 and 12	Yes, 301 - 451 ft

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Radionuclide concentrations were calculated in an EXCEL template identified as DNc_20210518_CC215_assay using an efficiency function and corrections for system dead time as determined by annual calibration.

For log run 7, a 1.0-ft depth adjustment was made to the SGLS data set to account for the depth error introduced upon return from the take-cover event described above. The adjustment corrects for a depth error as noted by the logging engineer occurring from recorded depths 242 to 294 ft, which after the adjustment become 243 to 295 ft.

Thickness and diameter corrections for a 0.27-in. thick 8.00-in. outside diameter (OD) casing, and for 9.27- and 10.52-in. OD casings (both 0.25-in. thick) were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in both counts per second (cps) and vol% moisture for data acquired through the first two casing strings. Third casing string NMLS data were acquired through both second and third casings, which is outside the range of borehole conditions for conversion to vol%. Third string NMLS data are therefore only presented in cps. Conversions from cps to vol% moisture were performed using an EXCEL template identified as DMc_HoltSonic_MCNP_assay. This template also provides corrections for the reinforced/thickened casing joints typical of Holt sonic drill casings.

It is important to note that the gamma data uncertainties are reported at 2 standard deviations, and the moisture data uncertainties are reported at 1 standard deviation.

HGU[10] is an empirical unit of gamma activity used 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

Cesium-137 (Cs-137) was detected in very low concentrations just below the ground surface at the 2- and 3-ft depths. Spectral analysis assessed the concentrations at 0.32 and 0.28 picocuries per gram (pCi/g), respectively.

The increased attenuation effects of the thickened casing joints are evident as sharp decreases in concentration and cps primarily seen on the K-40 and total gamma log plots, respectively. Ten-foot-long casing segments were installed between approximately 0 and 451.0 ft. No corrections are made for the effects of the thickened joints on either the SGLS spectra or the NMLS cps data sets.

Radon (Rn-222) gas was building in below water inside the casing (256 to 294 ft) during logging of the second casing string. Bi-214 has decay gamma-ray lines at both 609- and 1764-keV, which are employed to assay naturally occurring U-238 concentrations in the formation. During logging, if radon is present, its Bi-214 daughter also contributes 609- and 1764-keV gamma-rays; consequently, when analyzed the U-238 concentration is overestimated proportional to the radon concentration inside the casing. This phenomenon presents itself as a divergence of the 609- and 1764-keV Bi-214 assays for U-238 concentrations.

At approximately the 254-ft depth, there is a probable void behind the casing due to a washout corresponding with the groundwater contact, showing up as anomalously low KUTh concentrations and low gross gamma activity.

An approximately 6-ft thick interval of elevated concentrations of natural uranium is present between about 373 and 381 ft, with a peak concentration of about 4.9 pCi/g at 380 ft.

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. An example of increased moisture content is found at the 146-ft depth.

The natural gamma (KUTh) and moisture repeat sections indicate that the systems were working properly.

[10] Hanford Gamma Unit

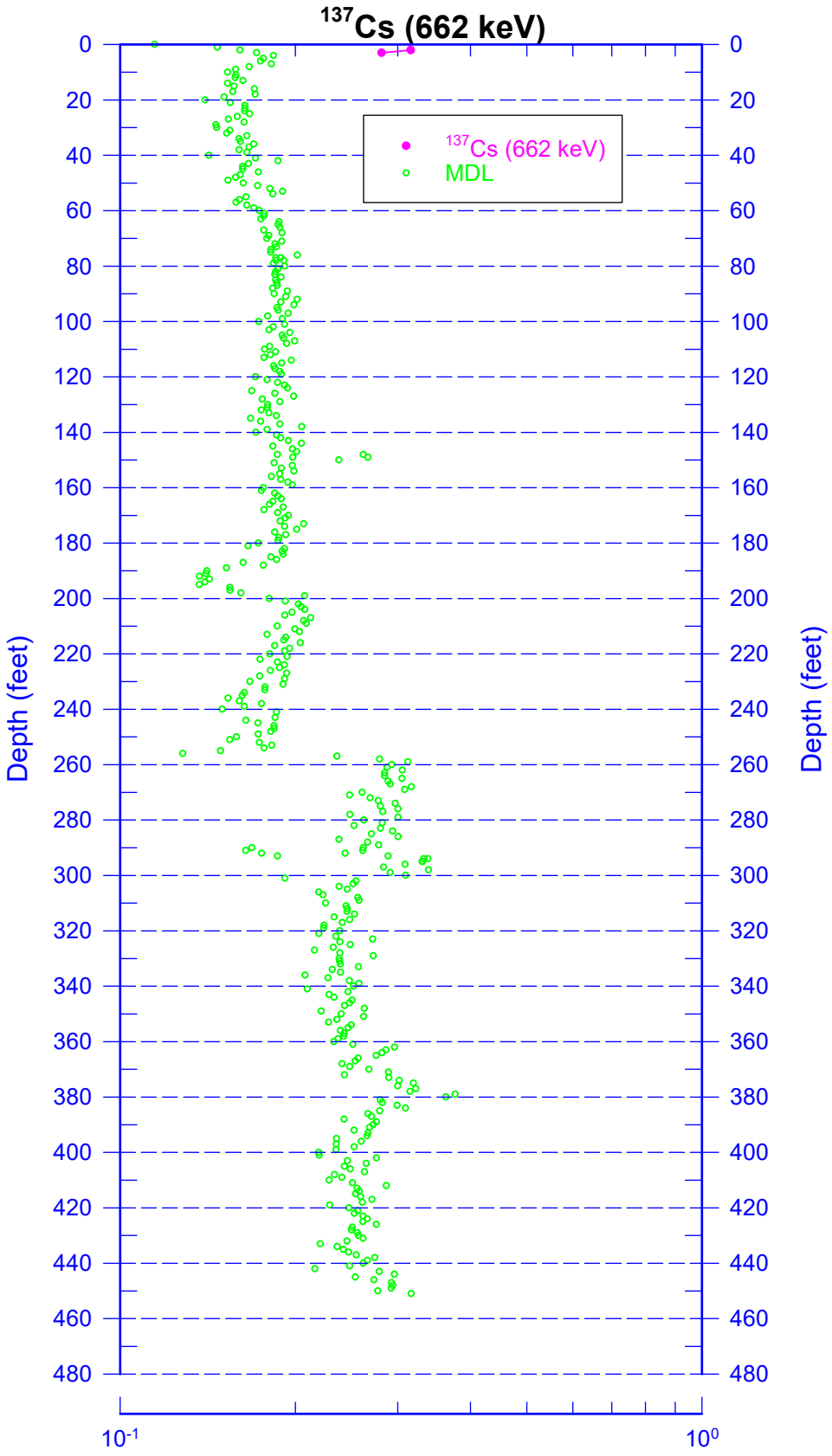
List of Log Plots

Zero depth reference is ground surface.

Manmade Radionuclides (0-480 ft)
Natural Gamma Logs (0-160 ft)
Natural Gamma Logs (150-310 ft)
Natural Gamma Logs (300-460 ft)
Combination Plot (0-480 ft)
Combination Plot (0-120 ft)
Combination Plot (120-240 ft)
Combination Plot (240-360 ft)
Combination Plot (360-480 ft)
Total Gamma & Moisture (0-160 ft)
Total Gamma & Moisture (150-310 ft)
Moisture (0-160 ft)
Moisture (150-310 ft)
Moisture with Uncertainties (0-160 ft)
Moisture with Uncertainties (150-310 ft)
Total Gamma & Hanford Gamma Unit (0-480 ft)
Repeat Section of Natural Gamma Logs (133-148 ft)
Repeat Section of Natural Gamma Logs (228-270 ft)
Repeat Section of Natural Gamma Logs (370-386 ft)
Moisture Repeat Section (133-148 ft)
Moisture Repeat Section (219-230 ft)
Moisture Repeat Section (250-260 ft)

Bay West
Customer-Focused Environmental & Industrial Solutions

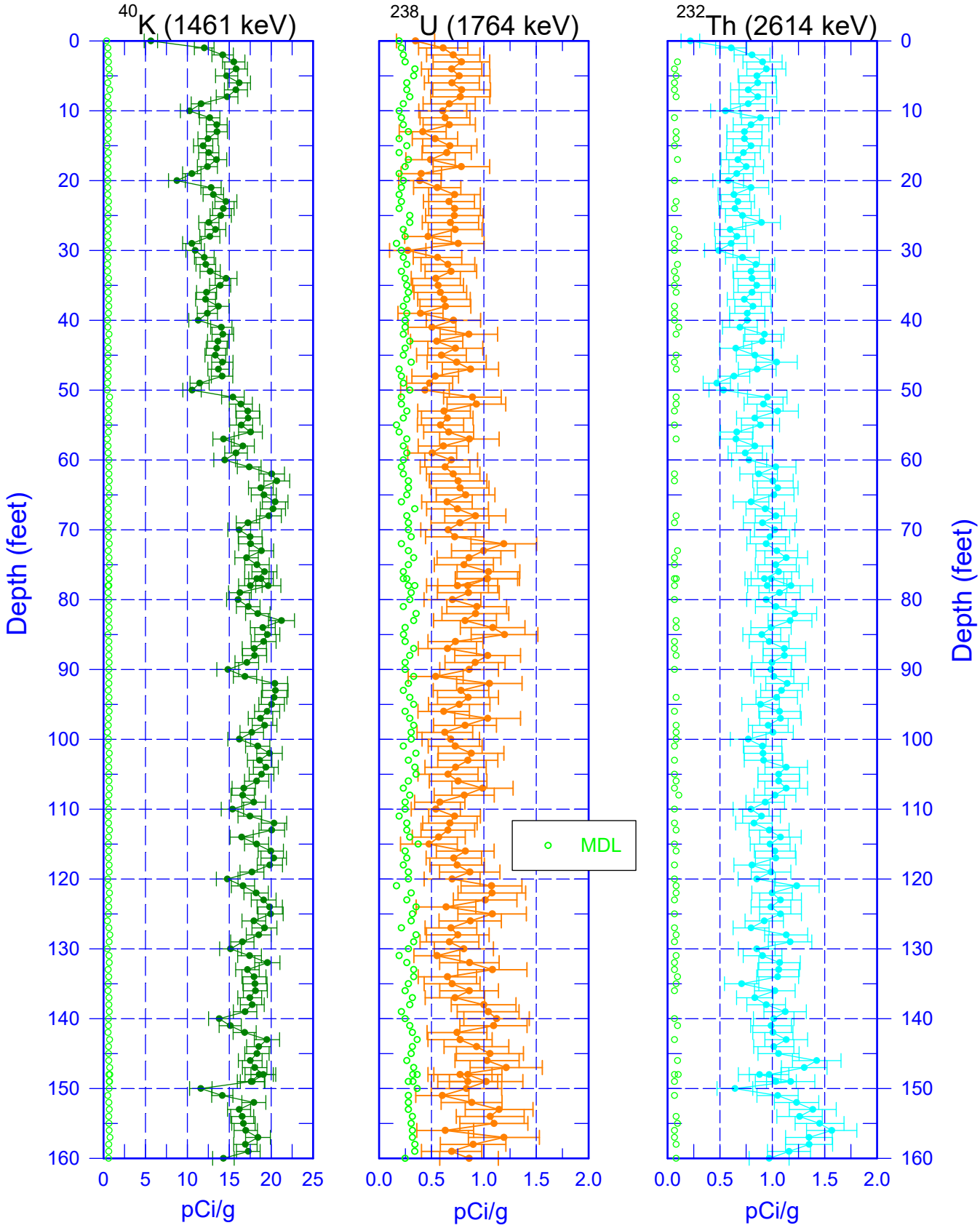
299-W22-123 (C9566)
Manmade Radionuclides



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

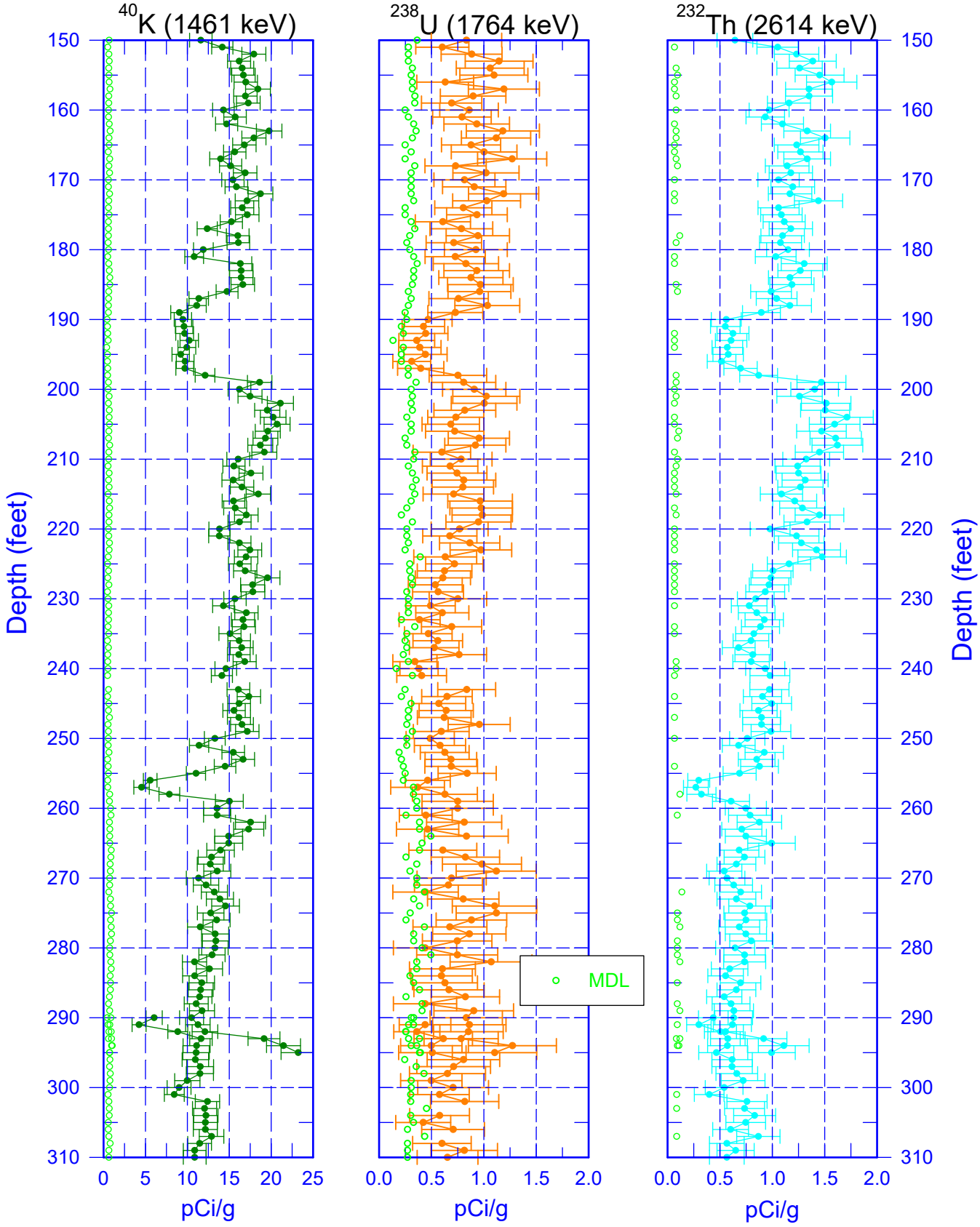
299-W22-123 (C9566)
Natural Gamma Logs



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

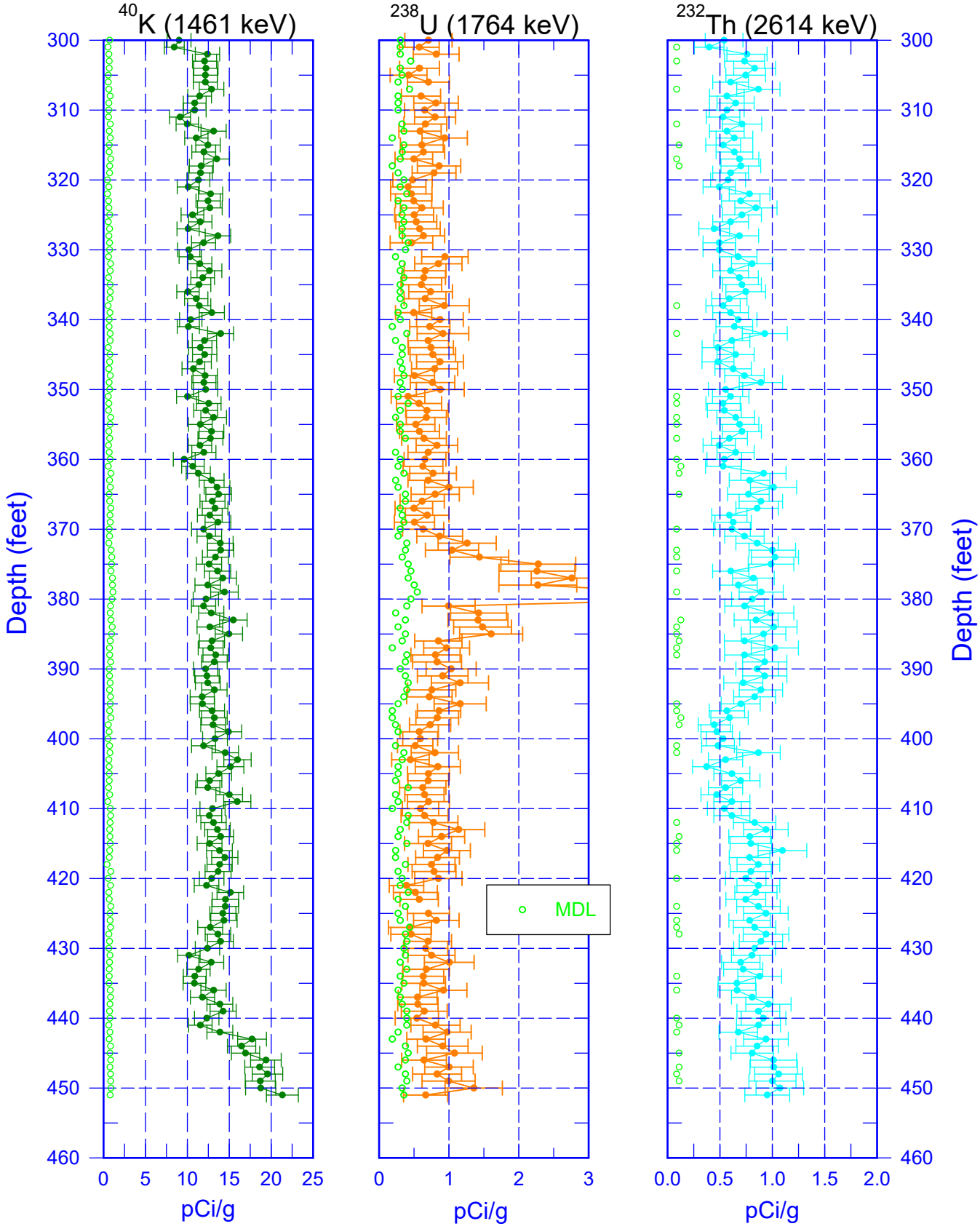
299-W22-123 (C9566)
Natural Gamma Logs



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

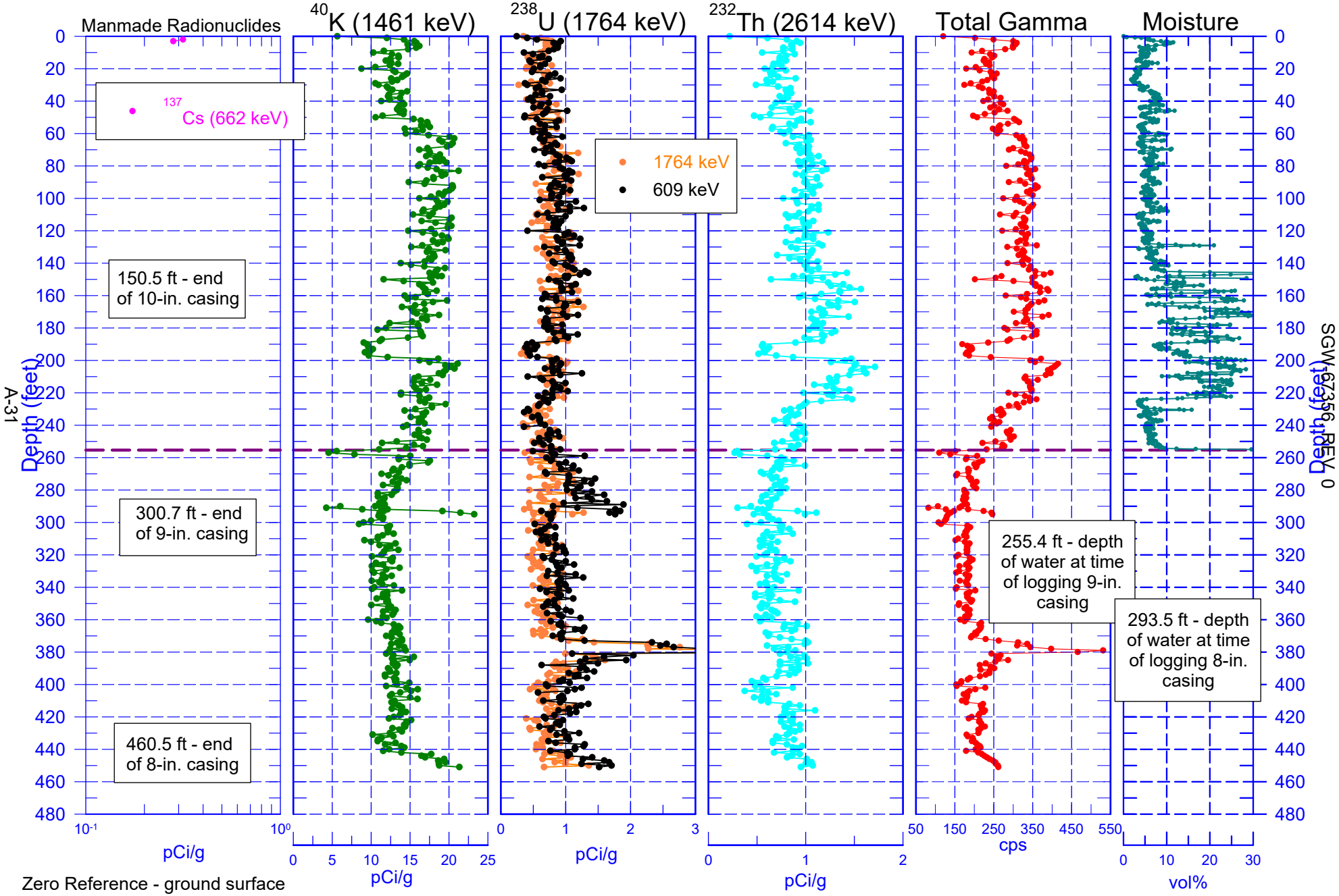
299-W22-123 (C9566)
Natural Gamma Logs



Zero Reference - ground surface

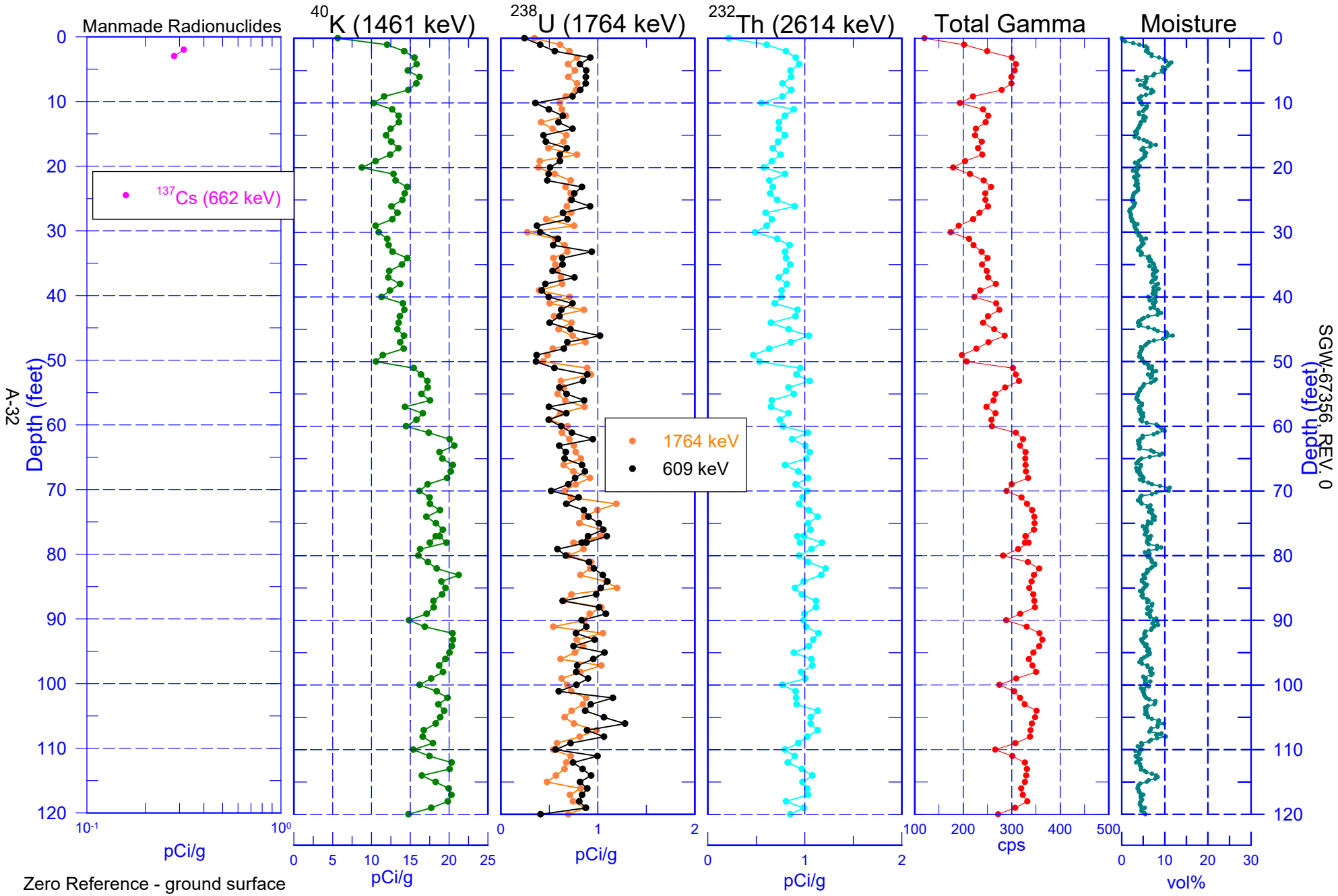
Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566) Combination Plot



Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566) Combination Plot



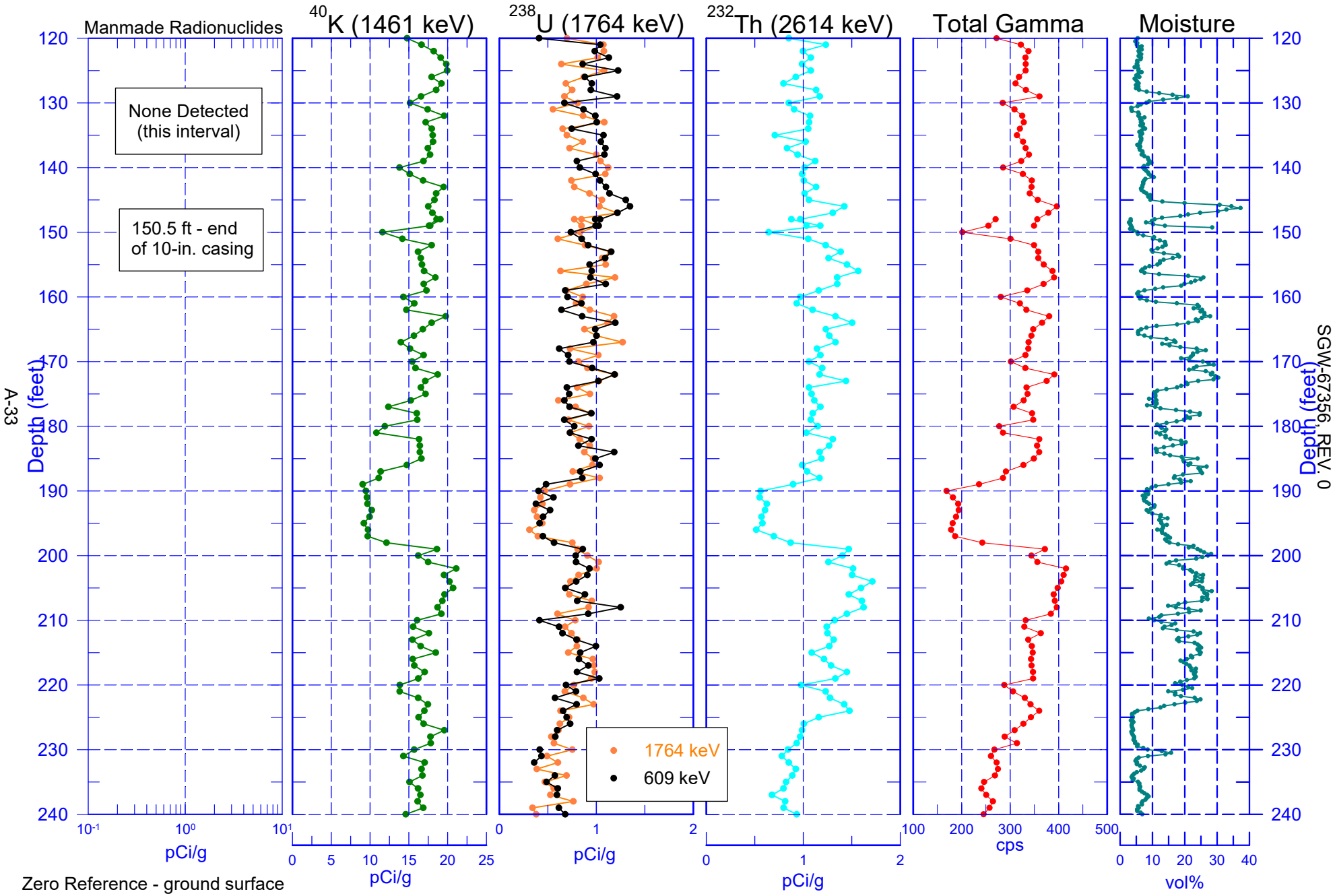
Zero Reference - ground surface

A-32

SGW-67356, REV. 0

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566) Combination Plot



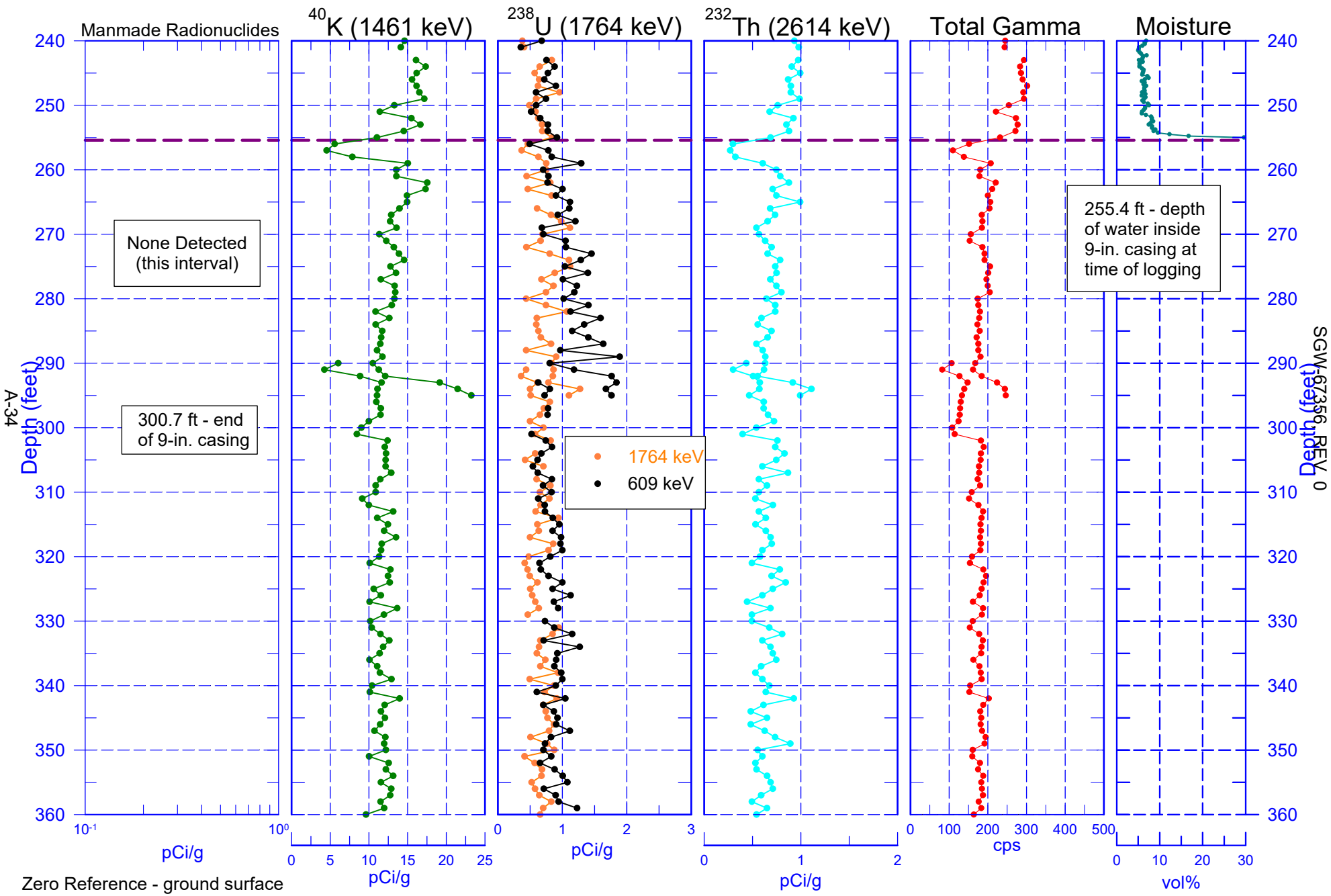
Zero Reference - ground surface

A-33

SGW-67356, REV. 0

Bay West
Customer-Focused Environmental & Industrial Solutions

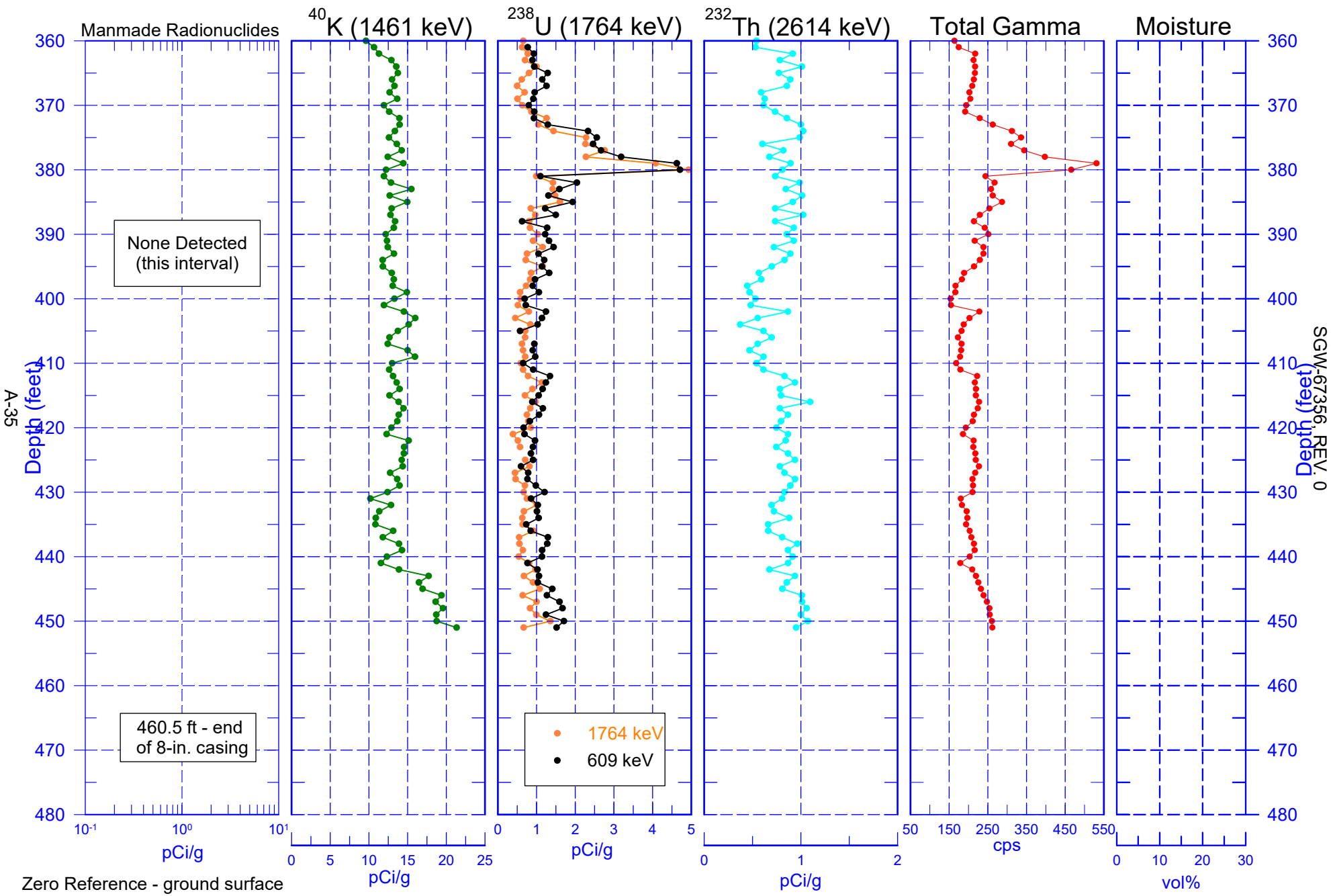
299-W22-123 (C9566) Combination Plot



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566) Combination Plot



A-35

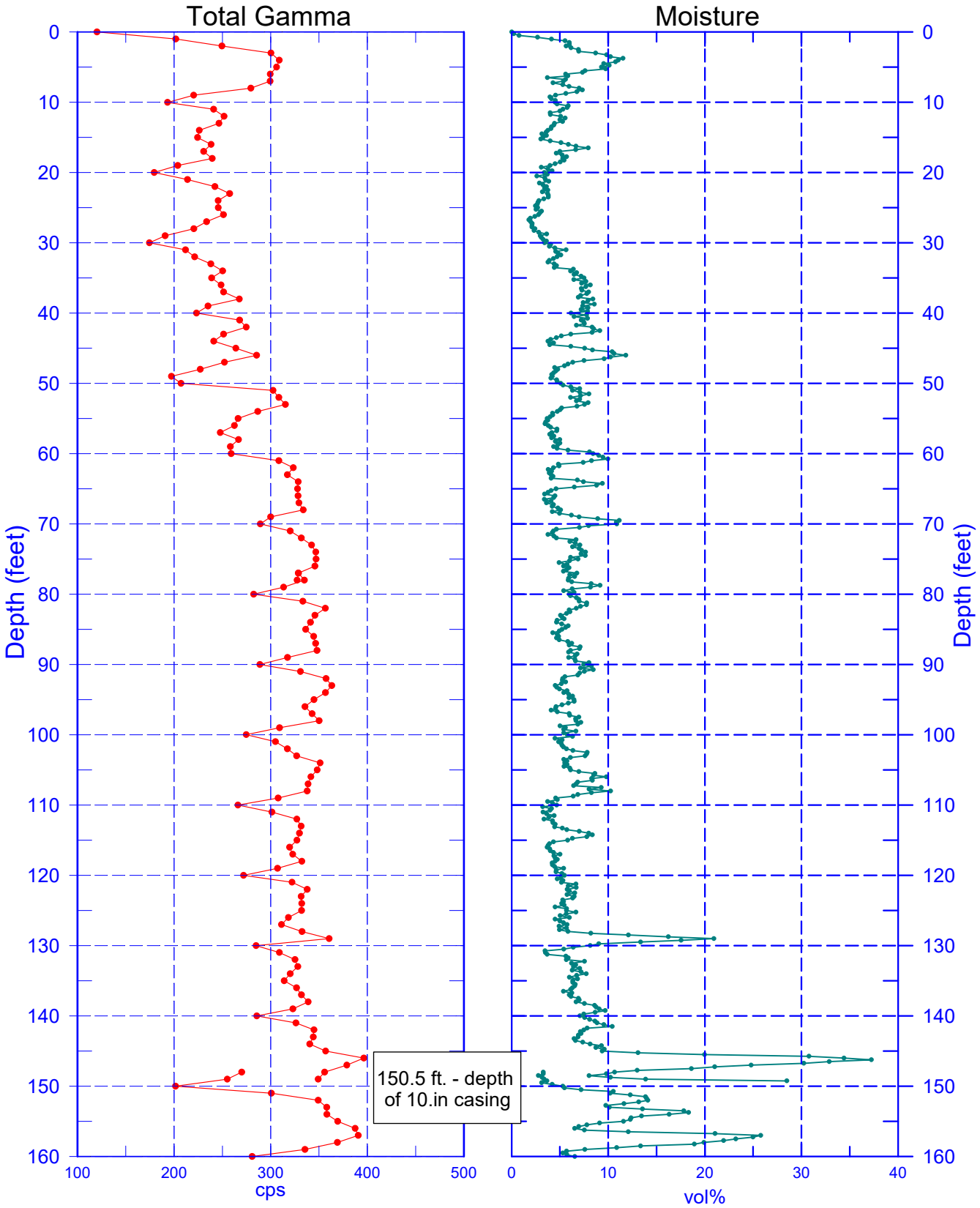
SGW-67356, REV. 0

Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Total Gamma & Moisture

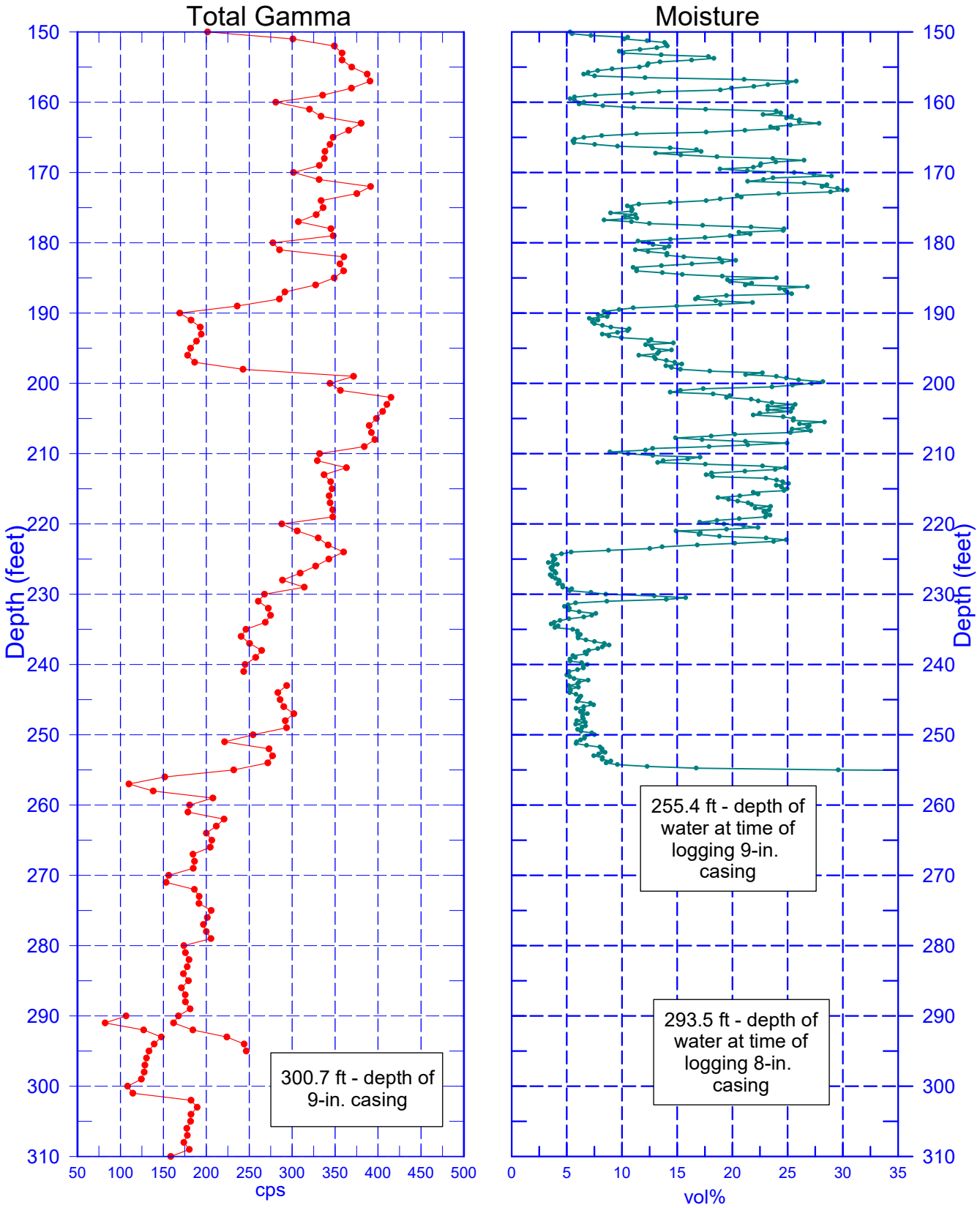


Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

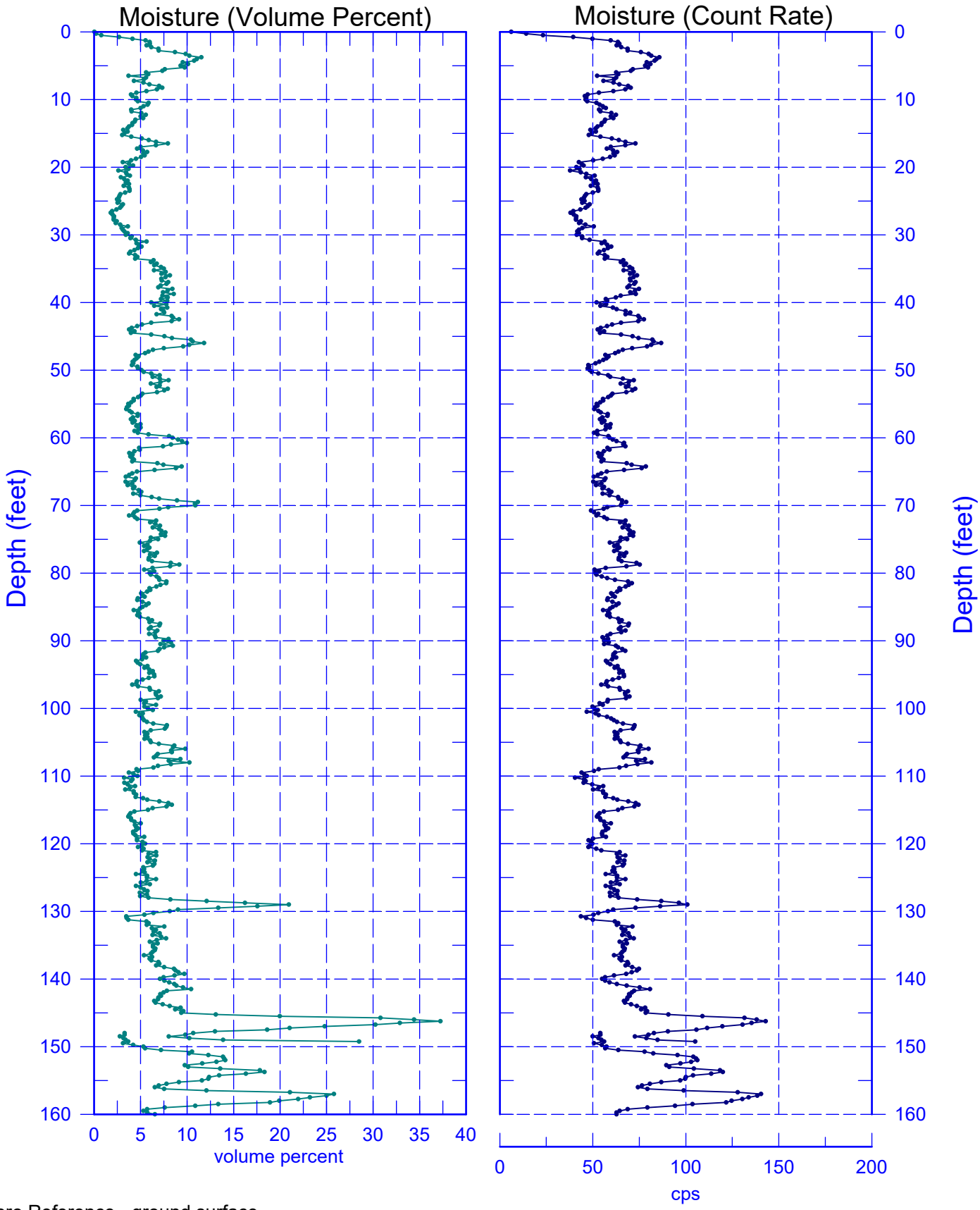
Total Gamma & Moisture



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

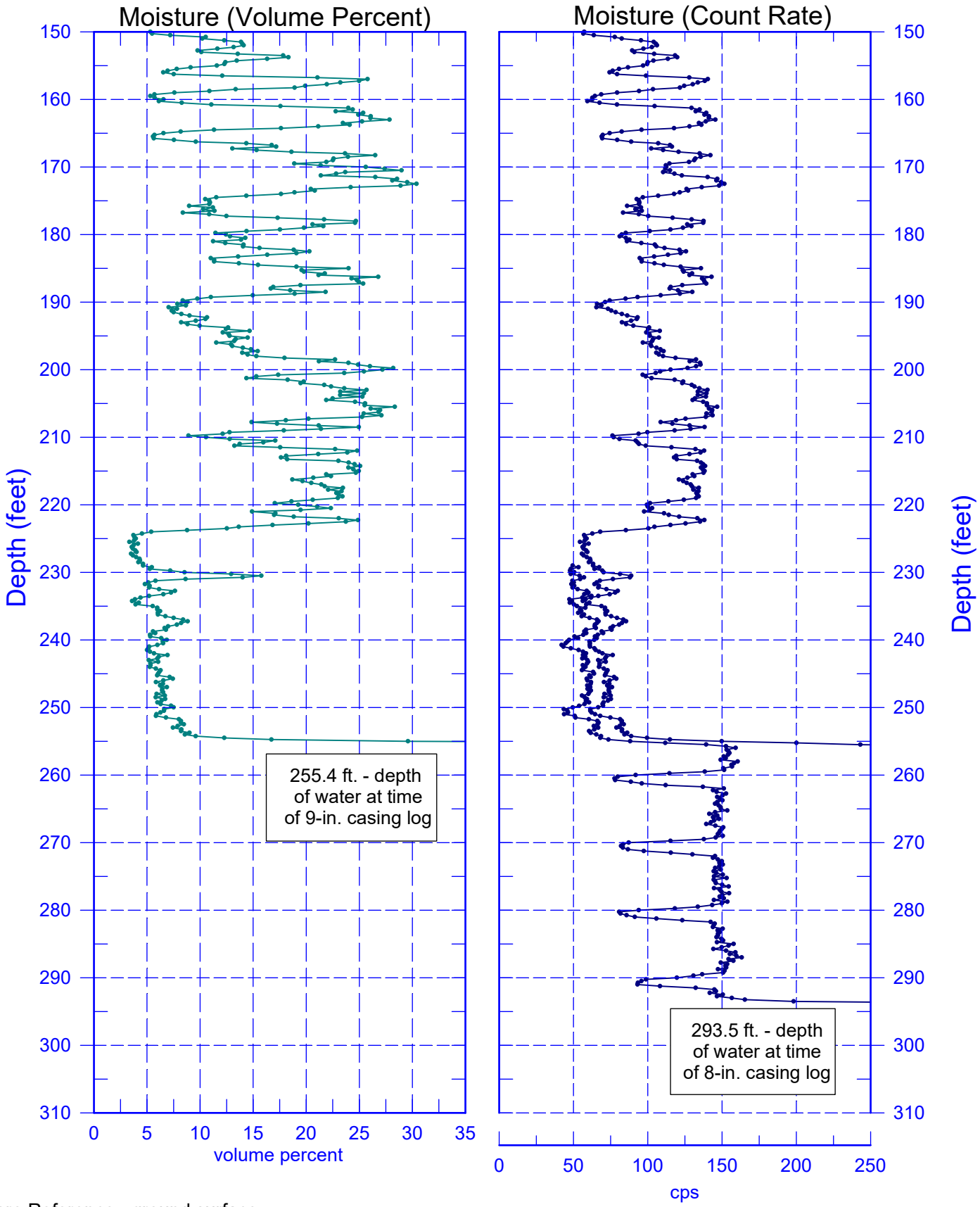
299-W22-123 (C9566)
Moisture



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

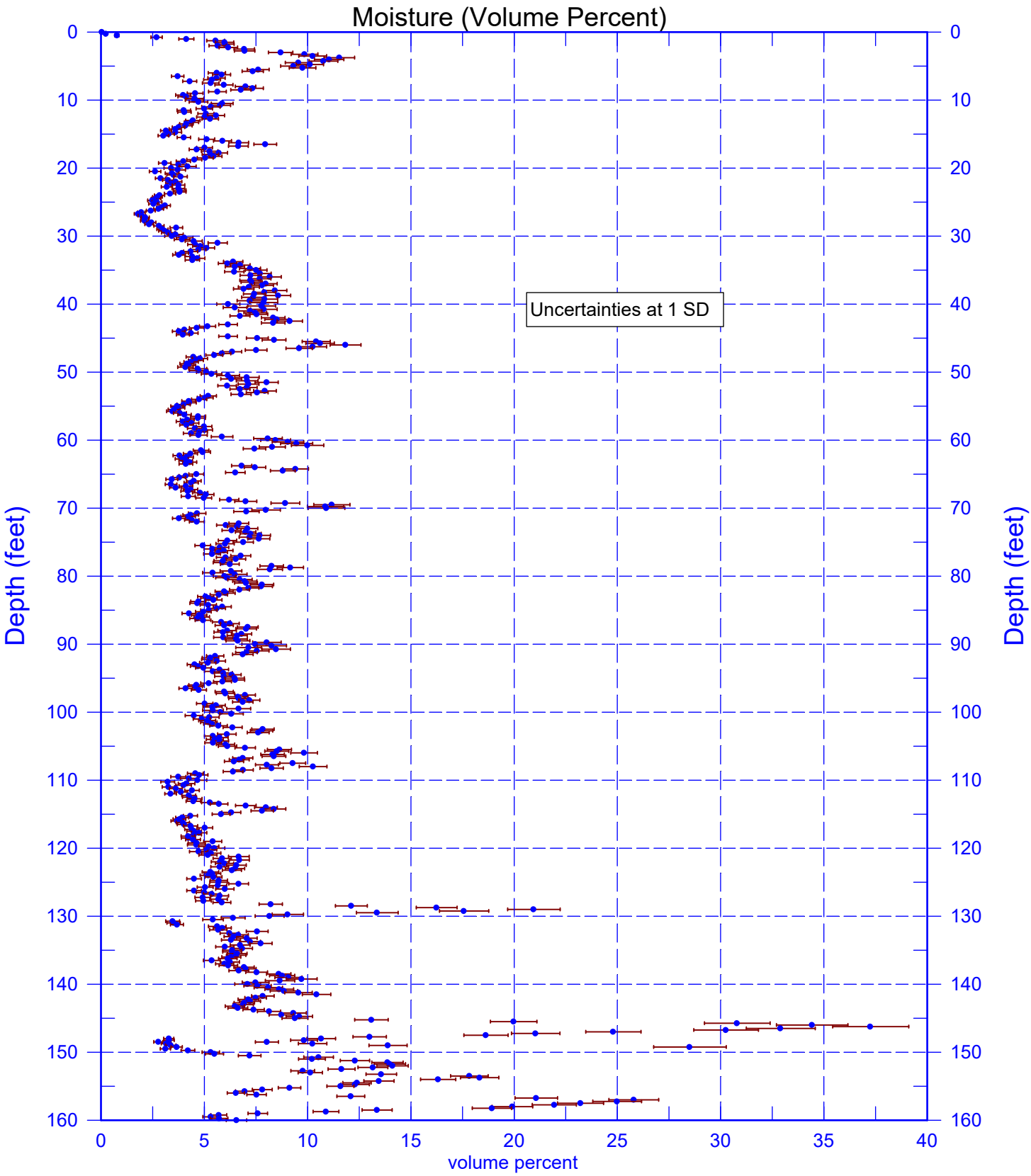
299-W22-123 (C9566)
Moisture



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

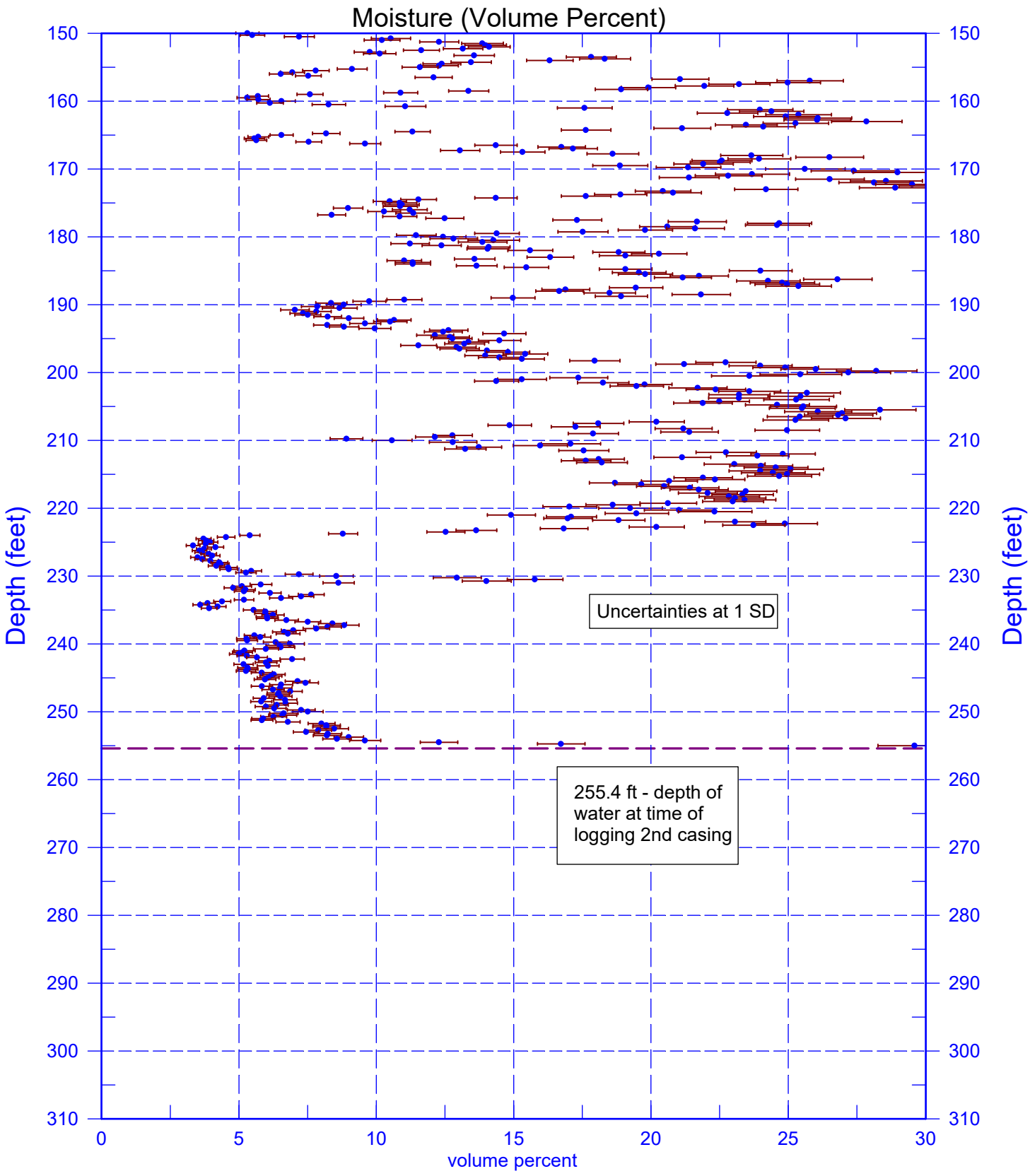
299-W22-123 (C9566)
Moisture with Uncertainties



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)
Moisture with Uncertainties

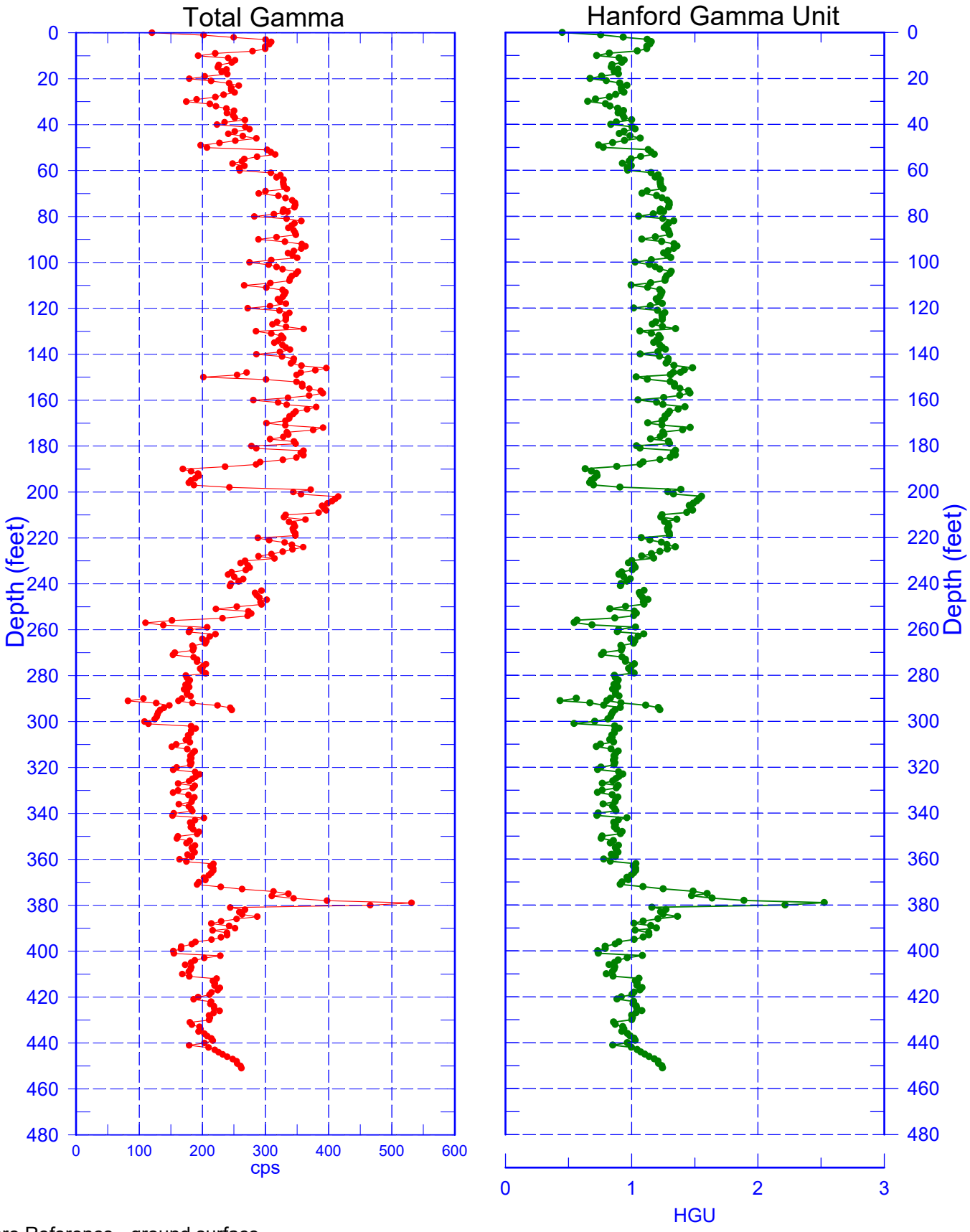


Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Total Gamma & Hanford Gamma Unit

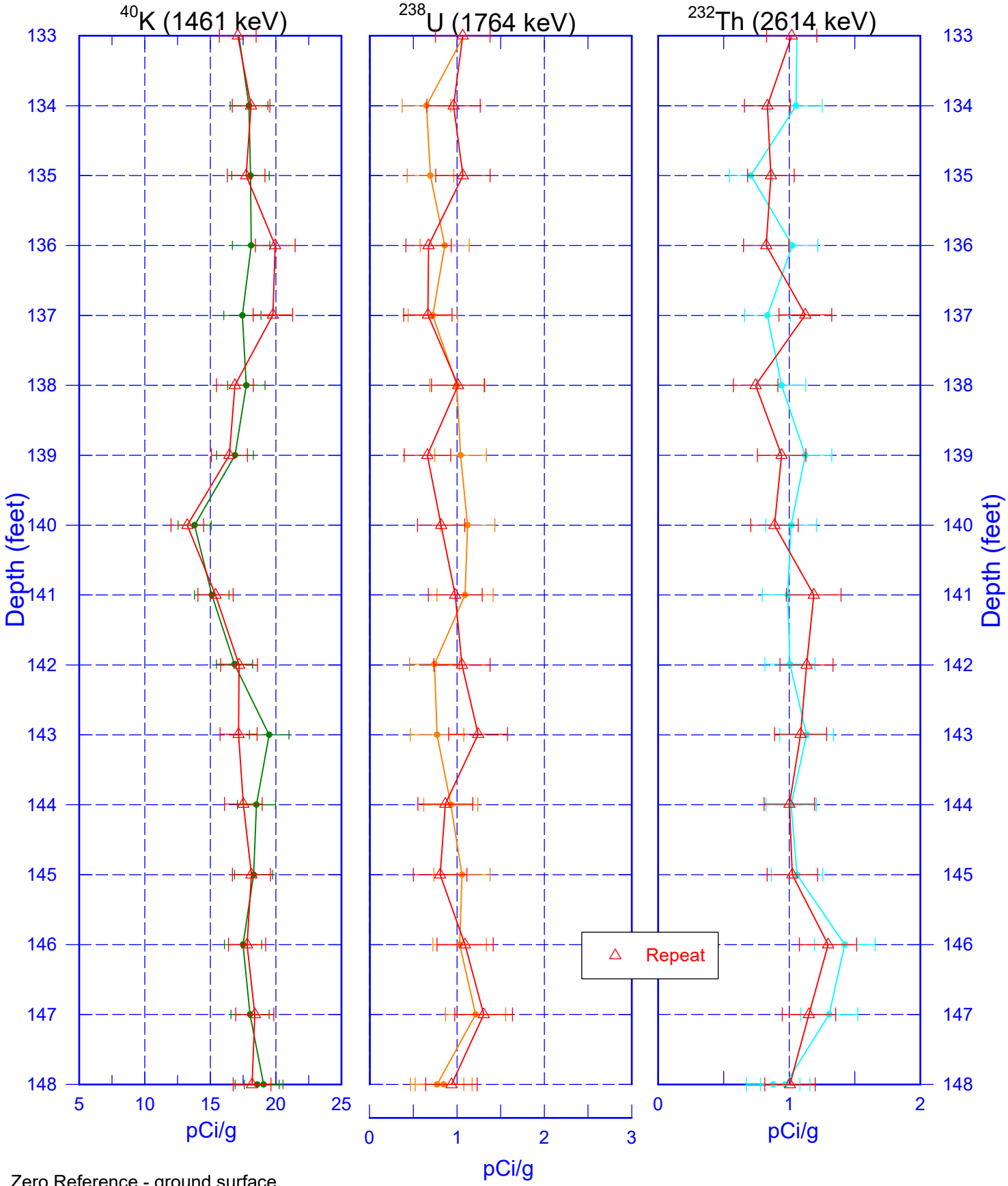


Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Repeat Section of Natural Gamma Logs

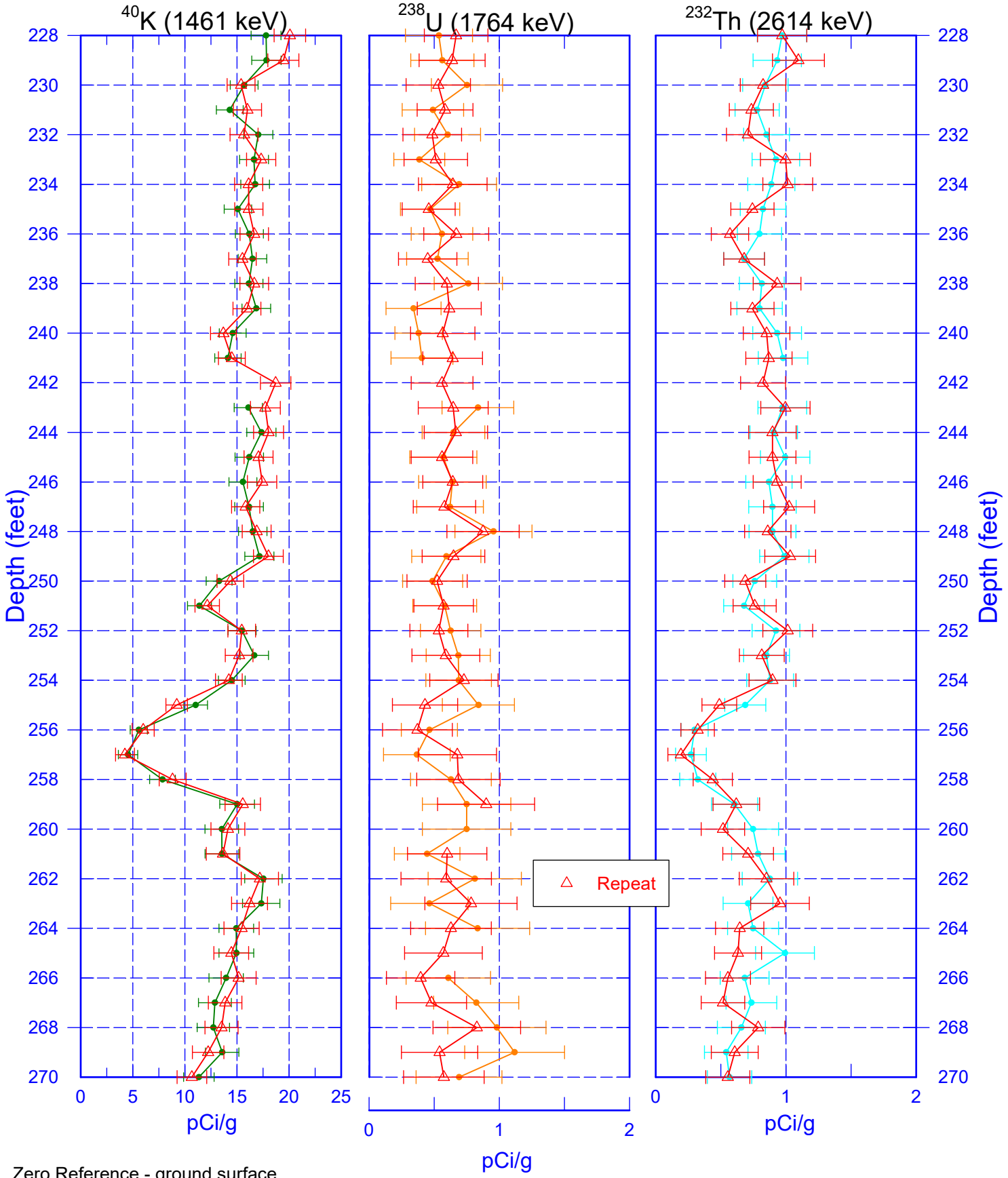


Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Repeat Section of Natural Gamma Logs



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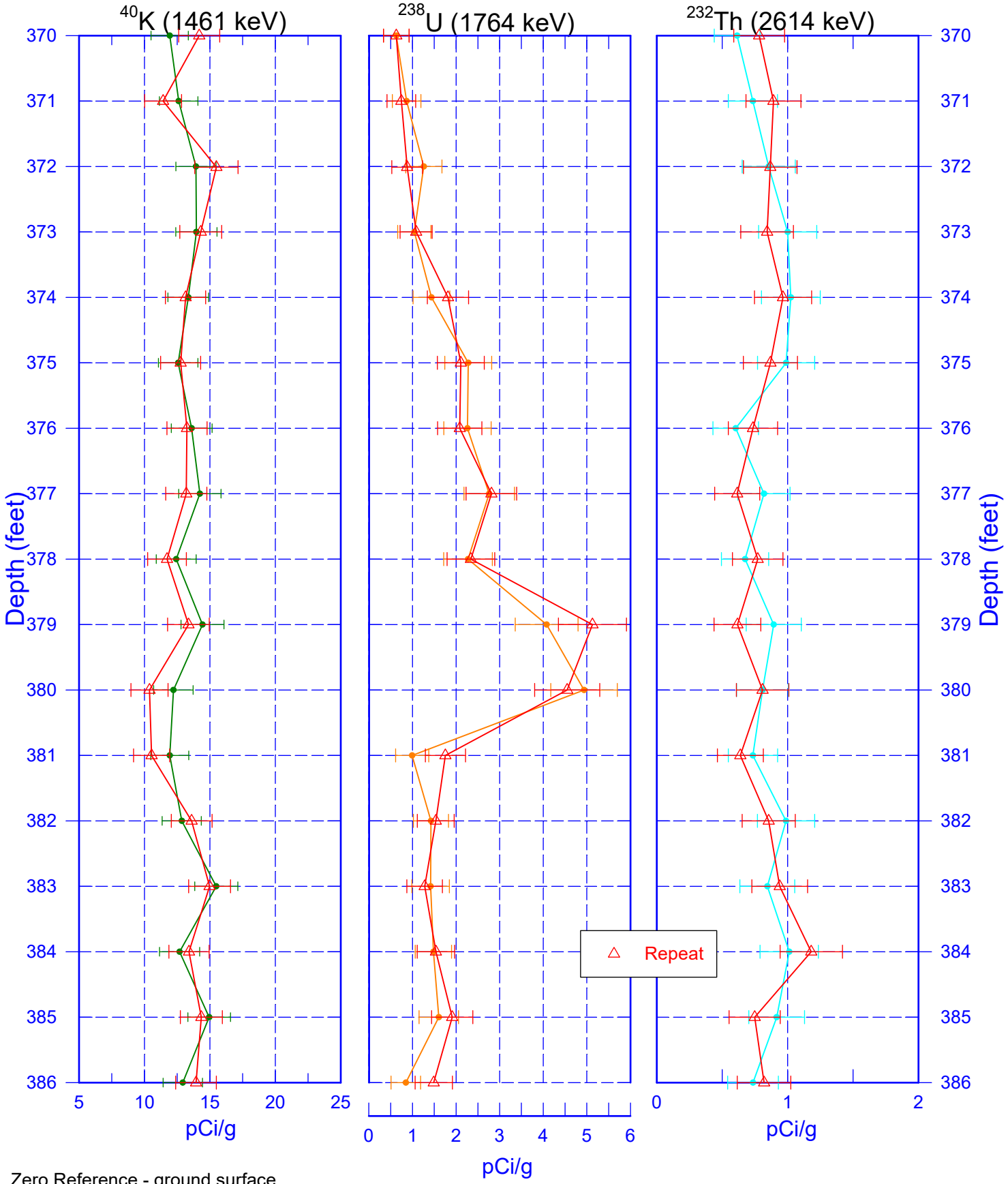
Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Repeat Section of Natural Gamma Logs

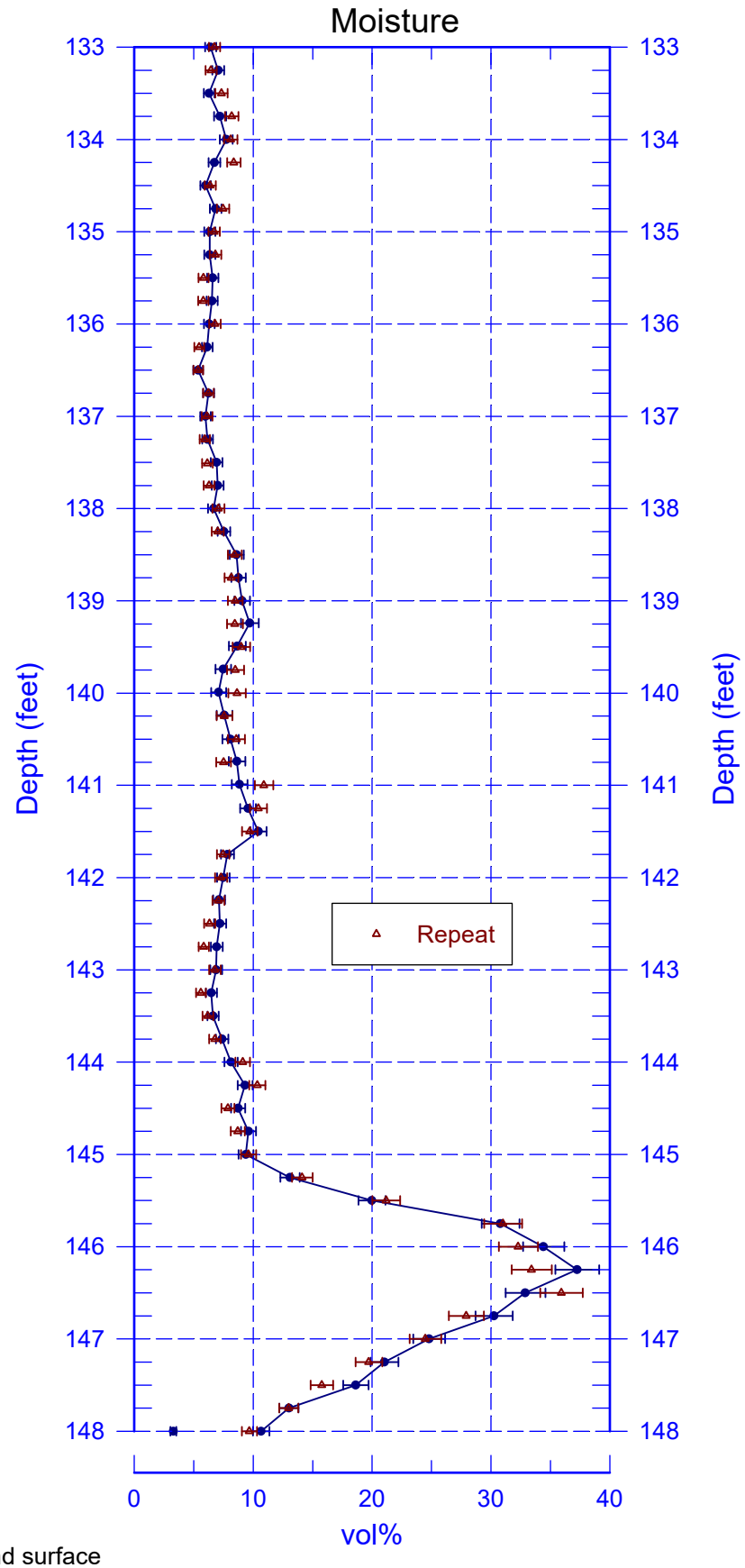


Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Moisture Repeat Section



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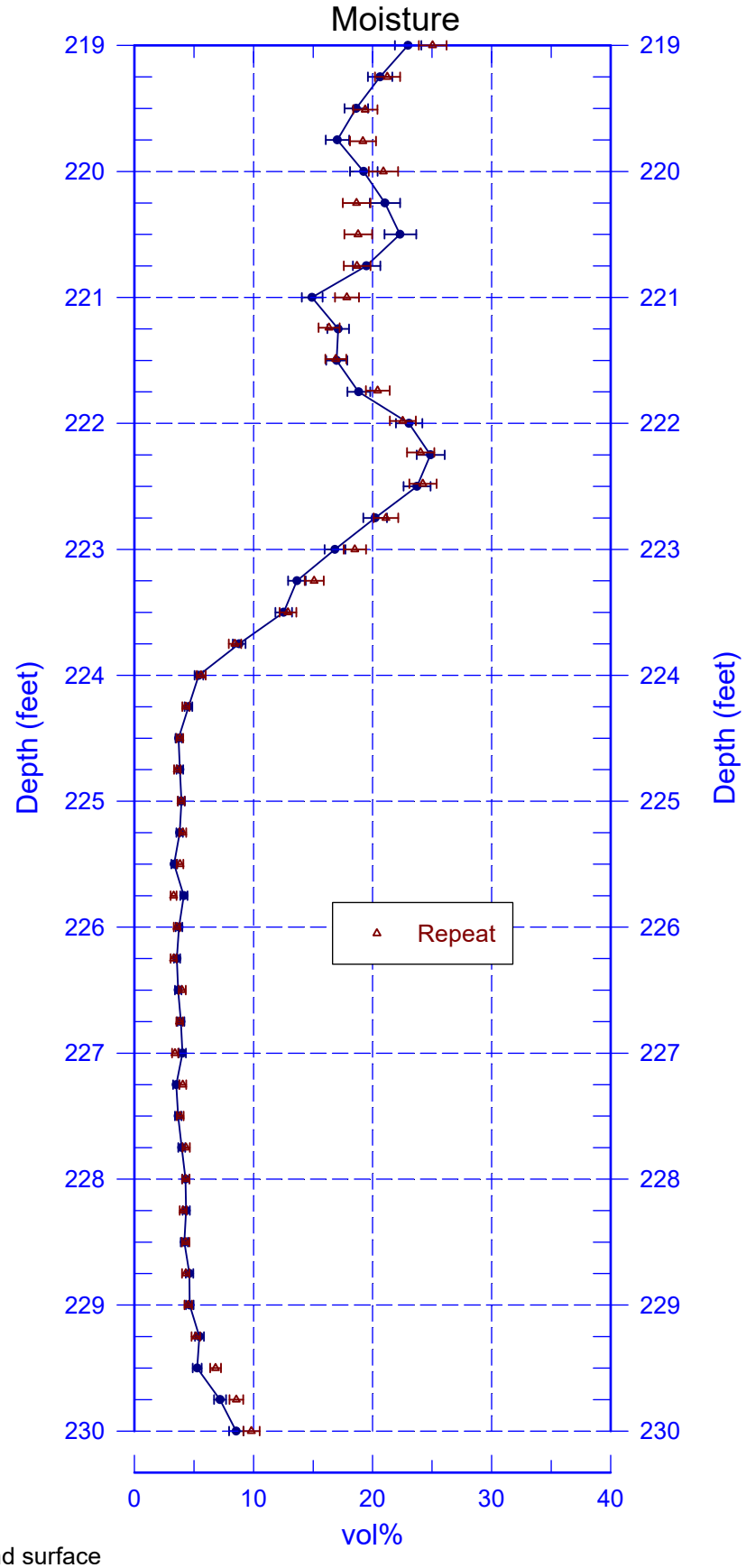
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Moisture Repeat Section

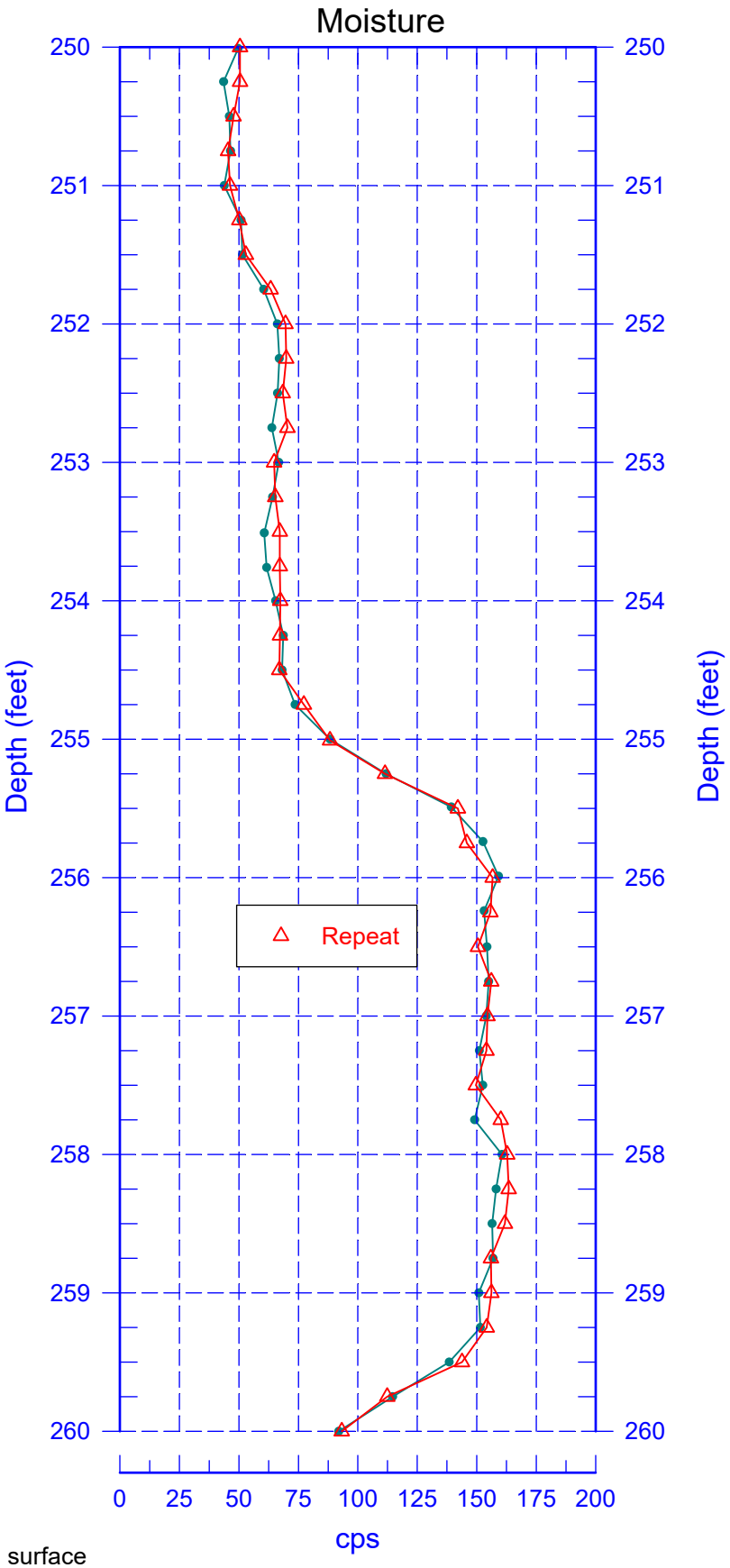


Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

299-W22-123 (C9566)

Moisture Repeat Section



Zero Reference - ground surface

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend Company: CPCC
Date Requested: 09/30/21	Requestor: Steven E. Imhoff (CPCC)
Date of Survey: 10/07/21	Surveyor / Company: Lawrence B. Munnell / CPCC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of Well C9566 (299-W22-123) located east of S-Plant in 200W Area.	Horizontal Datum: NAD83 (91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-59 (CPCC) and 2W-67 (CPCC)

Well ID	Well Name	Easting	Northing	Elevation	
C9566	299-W22-123	567593.02	133914.00		Center of Casing
				208.848	Top Outer Casing, N.Edge, Stamped X
				208.533	Top Inner 4" Casing, N.Edge
				207.995	Brass Survey Marker

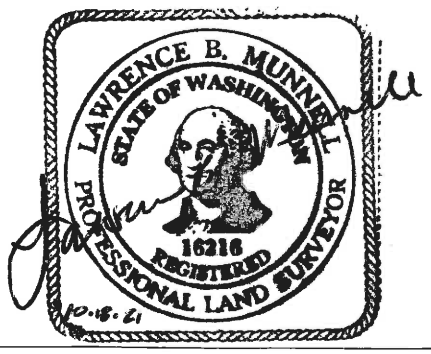
Notes:

Brass Survey Marker elevation was taken on top 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: C9566	Well Name: 299-W22-123	Date: 9/28/2021

Location: ~0.5km E of 222-S Labs

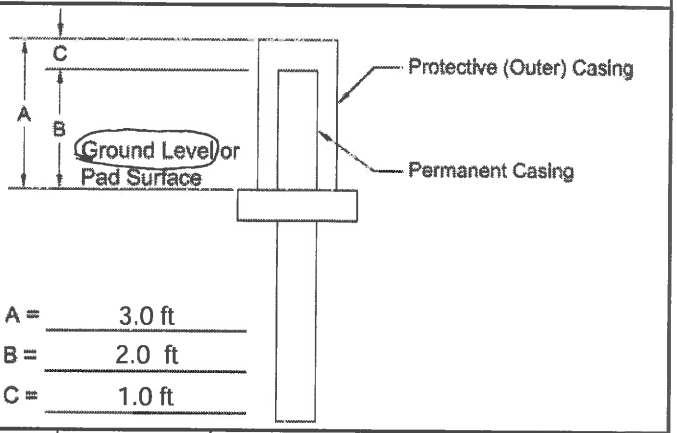
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 9/22/2021	255.1 ft bgs	254.8 ft bgs
Date: -	-	-
DEPTH TO BOTTOM:		
Date: 9/22/2021	283.3 ft bgs	283.0 ft bgs
Date: -	-	-



A = 3.0 ft
B = 2.0 ft
C = 1.0 ft

Intake Depth (ft bgs)	Specific Capacity (gpm/ft)	Troll Depth (ft bwt)	Turbitidy (NTU) Initial	Turbitidy (NTU) Final	Pump Start	Pump Stop	Pumping Rate (gpm)	Maximum Drawdown (ft)
266	-9.83	9.3	6.43	3.26	0952	1051	5.8	-0.59
				Not Used				
				9/28/21				

Total Pumped: 342.2 gal

Pump Model: Grundfos 5 SQE-320, 0.75 hp

Troll Serial Number and Pressure Range (PSI and depth): In-Situ LevelTroll 700 Vented, S/N 816603, 30psi/69ft depth

Comments:

Test name on iPad is "C9566 Dev 9/22/21"

Prepared By:

Dan Charbonneaux		9/28/2021
Print Name	*Signature*	*Date*

Reviewed By:

Jennifer Richart		10/7/21
Print Name	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

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Photo Archive Log for C9566

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

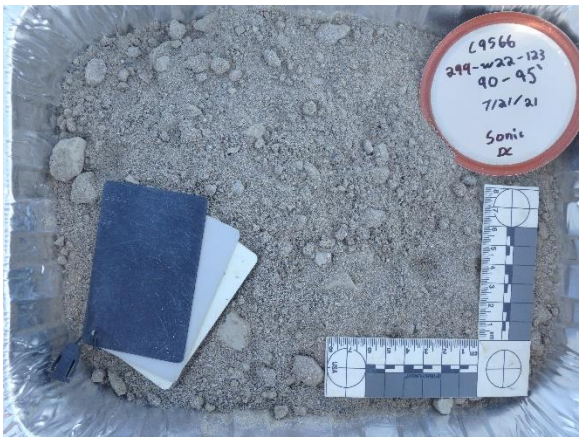
65 – 70 ft bgs

70 – 75 ft bgs

75 – 80 ft bgs

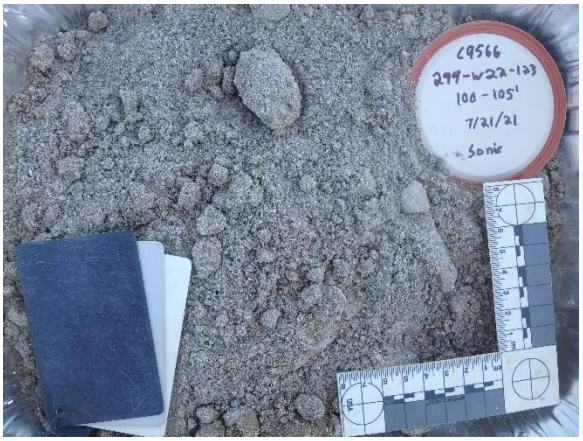
80 – 85 ft bgs

85 – 90 ft bgs



90 – 95 ft bgs

95 – 100 ft bgs



100 – 105 ft bgs

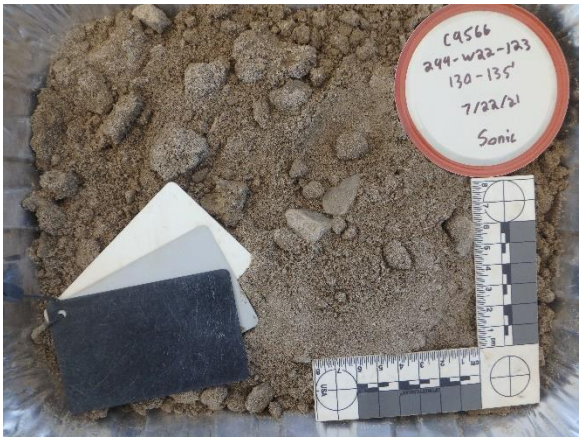
105 – 110 ft bgs

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

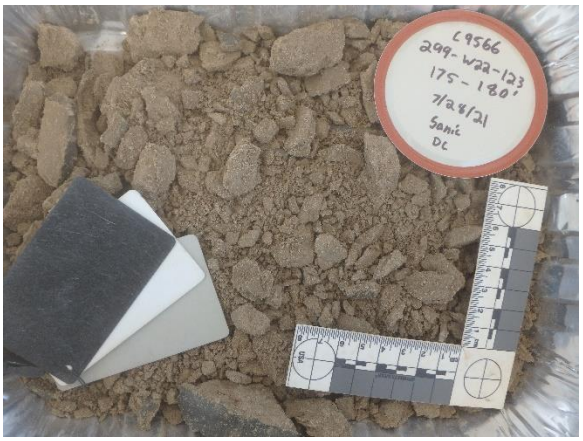
155 – 160 ft bgs

160 – 162 ft bgs

162 – 165 ft bgs

165 – 170 ft bgs

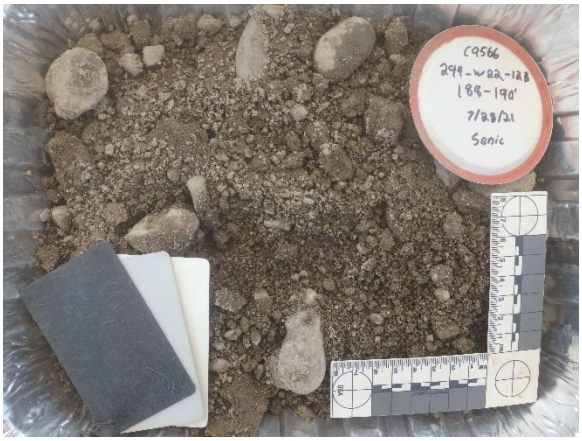
170 – 175 ft bgs



175 – 180 ft bgs

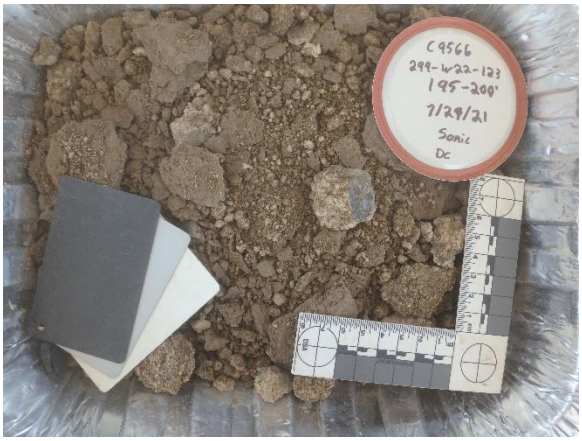
180 – 185 ft bgs

185 – 188 ft bgs



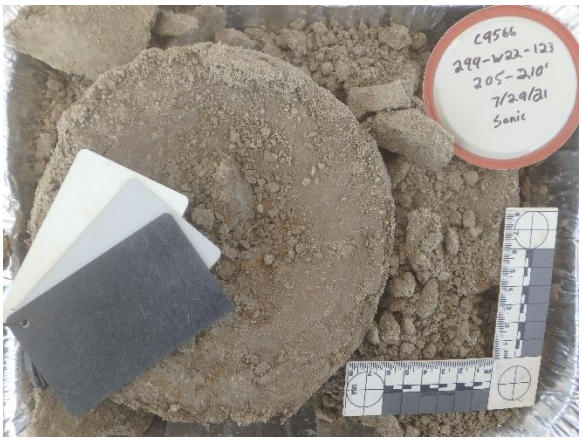
188 – 190 ft bgs

190 – 195 ft bgs



195 – 200 ft bgs

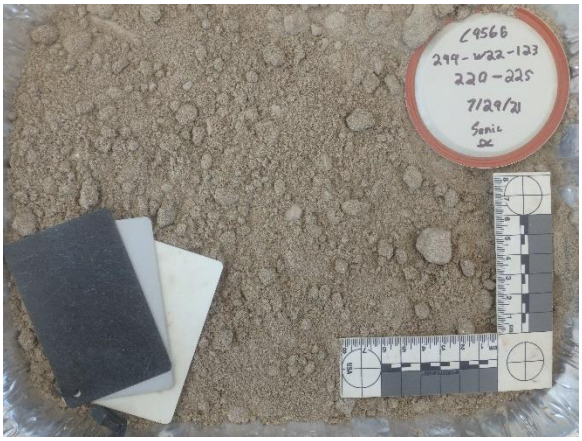
200 – 205 ft bgs



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

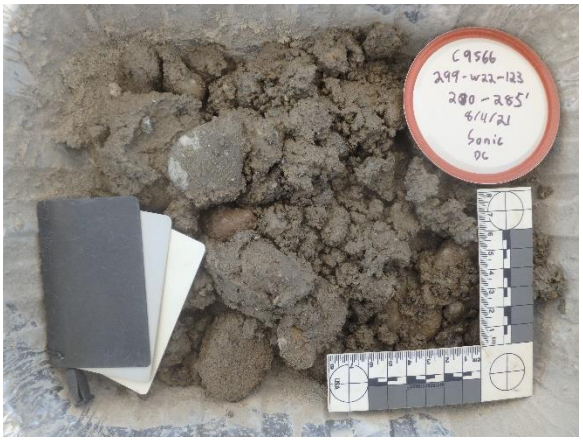
255 – 260 ft bgs

260 – 265 ft bgs

265 – 270 ft bgs

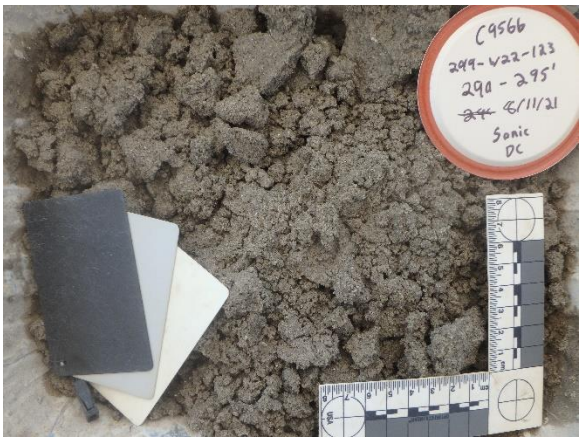
270 – 275 ft bgs

275 – 280 ft bgs



280 – 285 ft bgs

285 – 290 ft bgs



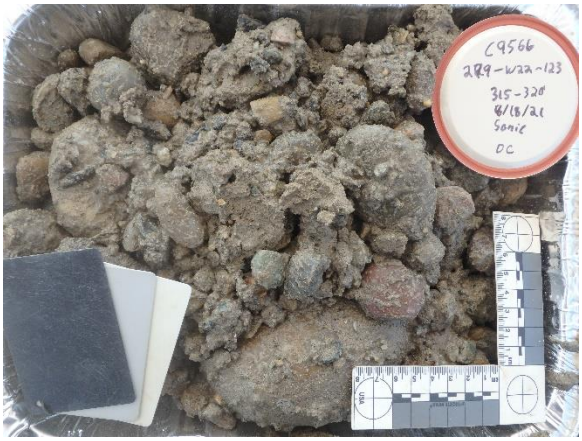
290 – 295 ft bgs

295 – 300 ft bgs

300 – 305 ft bgs

305 – 310 ft bgs

310 – 315 ft bgs



315 – 320 ft bgs

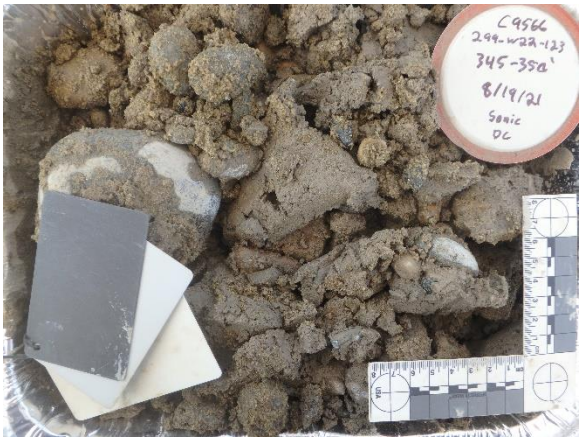
320 – 325 ft bgs

325 – 330 ft bgs

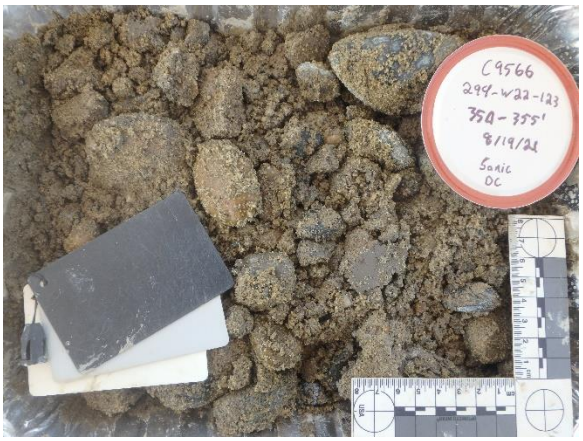
330 – 335 ft bgs

335 – 340 ft bgs

340 – 345 ft bgs



345 – 350 ft bgs



350 – 355 ft bgs

355 – 360 ft bgs

360 – 365 ft bgs

365 – 370 ft bgs

370 – 375 ft bgs

375 – 380 ft bgs

380 – 385 ft bgs

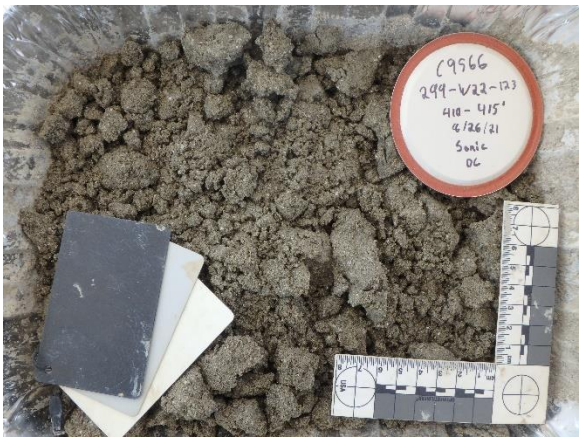
385 – 390 ft bgs

390 – 395 ft bgs

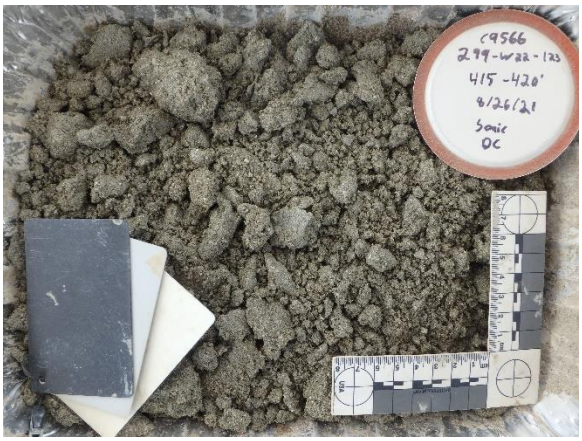
395 – 400 ft bgs

400 – 405 ft bgs

405 – 410 ft bgs



410 – 415 ft bgs



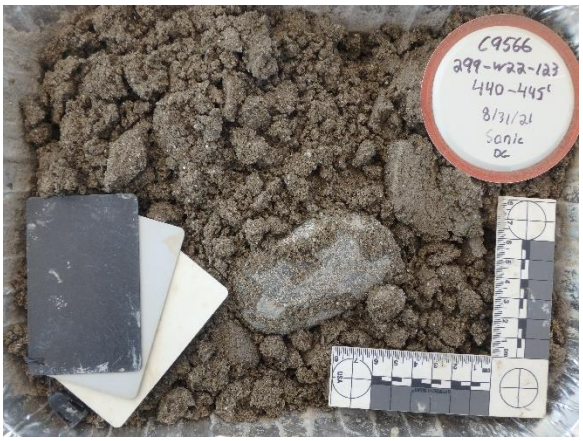
415 – 420 ft bgs

420 – 425 ft bgs

425 – 430 ft bgs

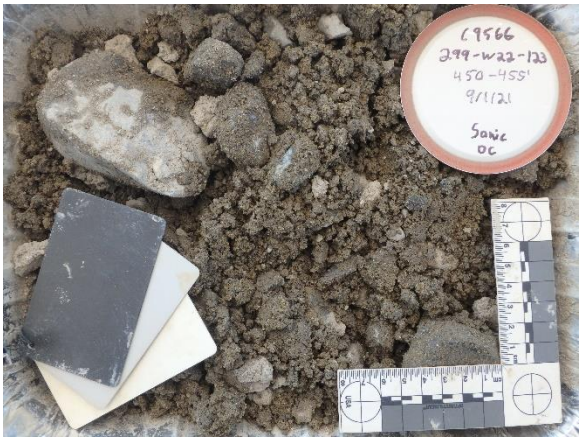
430 – 435 ft bgs

435 – 440 ft bgs



440 – 445 ft bgs

445 – 450 ft bgs



450 – 455 ft bgs

455 – 457 ft bgs

457 – 460 ft bgs

460 – 462 ft bgs