1249088
[00065668 4]
SGW-61319
Revision

Borehole Summary Report for the Installation of Five Monitoring Wells in the 200-UP-1 Operable Unit, FY 2017

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

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

P.O. Box 1600
Richland, Washington 99352

RECEIVED
MAY 17 2018
EDMC

Approved for Public Release;
Further Dissemination Unlimited

263

1249088

SGW-61319
Revision

Borehole Summary Report for the Installation of Five Monitoring Wells in the 200-UP-1 Operable Unit, FY 2017

A. A. Raulerson
GRAM Inc

M. J. Hocking
GRAM Inc

Date Published
February 2018

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

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

ch2m

P.O. Box 1600
Richland, Washington 99352

APPROVED
By Erin C Meegan at 12:24 pm, Feb 15, 2018

Release Approval

Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Contents

1 Introduction 1

2 Drilling, Sampling, and Well Construction Activities 1

2.1 General Information 1

2.1.1 Drilling, Sampling, and Borehole Logging 4

2.1.2 Health and Safety Screening 5

2.1.3 Well Construction and Development 5

2.2 Well-Specific Information 6

2.2.1 Well 699-27-68 (C9632) 6

2.2.2 Well 699-29-55 (C9634) 9

2.2.3 Well 699-30-70 (C9635) 12

2.2.4 Well 699-31-50 (C9737) 14

2.2.5 Well 699-30-73 (C9636) 17

3 Geologic Observations 19

3.1 Geology of the 200-UP-1 Operable Unit 19

3.2 Borehole Geology 21

3.2.1 Well 699-27-68 (C9632) 21

3.2.2 Well 699-29-55 (C9634) 22

3.2.3 Well 699-30-70 (C9635) 22

3.2.4 Well 699-31-50 (C9737) 23

3.2.5 Well 699-30-73 (C9636) 24

4 Waste Management 25

4.1 Drill Cuttings 25

4.2 Purgewater 25

5 Civil Survey 25

6 Well Acceptance 26

7 References 26

Appendices

A Well Documentation for 699-27-68 (C9632) ..... **A-i**

B Well Documentation for 699-29-55 (C9634) ..... **B-i**

C Well Documentation for 699-30-70 (C9635) ..... **C-i**

D Well Documentation for 699-31-50 (C9737) ..... **D-i**

E Well Documentation for 699-30-73 (C9636) ..... **E-i**

Figures

Figure 1. Hanford Site Map 2
Figure 2. Locations of the Five New 200-UP-1 OU Monitoring Wells 3

Tables

Table 1. Project Well Identification and Drilling Date Summary 3
Table 2. Well Development Data Summary 7
Table 3. Sample Summary for Well 699-27-68 (C9632) 8
Table 4. Construction Summary for Well 699-27-68 (C9632) 9
Table 5. Sample Summary for Well 699-29-55 (C9634) 10
Table 6. Construction Summary for Well 699-29-55 (C9634) 11
Table 7. Sample Summary for Well 699-30-70 (C9635) 12
Table 8. Construction Summary for Well 699-30-70 (C9635) 14
Table 9. Sample Summary for Well 699-31-50 (C9737) 15
Table 10. Construction Summary for Well 699-31-50 (C9737) 16
Table 11. Sample Summary for Well 699-30-73 (C9636) 17
Table 12. Construction Summary for Well 699-30-73 (C9636) 19
Table 13. Civil Survey Summary 26

Terms

bgs	below ground surface
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
DOW	description of work
Ecology	Washington State Department of Ecology
gpm	gallons per minute
NMLS	neutron moisture logging system
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
RCT	radiological control technician
RLM	Ringold lower mud (unit)
SAP	sampling and analysis plan
SGLS	spectral gamma logging system
SN3	Stoller Newport News Nuclear, Inc.
Tacoma Pump	Tacoma Pump & Drilling Company, Inc.
TD	total depth
VOC	volatile organic compound

Metric Conversion Chart

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

1 Introduction

This borehole summary report provides a general overview of the well drilling and construction activities performed during installation of five monitoring wells in the 200-UP-1 Groundwater Operable Unit (OU) in the Hanford Site Central Plateau (Figure 1). SGW-60568, Rev. 1, *Description of Work for the Installation of Four Monitoring Wells Near the Southeastern Portion of the 200-UP-1 Operable Unit, FY 2017* (hereinafter referred to as the description of work [DOW]), is the controlling document for installation of the new wells. A fifth well was added to the project scope after work had started (Rev. 1).

The wells were drilled, constructed, and developed between May 16 and December 6, 2017, by Tacoma Pump & Drilling, Inc. (Tacoma Pump) for CH2M HILL Plateau Remediation Company (CHPRC). Well site geology, well drilling documentation, and construction documentation services were provided by GRAM Northwest, LLC. Geophysical logging services were provided by Stoller Newport News Nuclear (SN3).

The five new monitoring wells were installed to support characterization of the southeast chromium plume. Contaminants of concern for the 200-UP-1 OU include carbon tetrachloride, uranium, nitrate, chromium (total and hexavalent), iodine-129, technetium-99, and tritium. Installation of the new wells supports Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*. The wells were installed in compliance with the *Resource Conservation and Recovery Act of 1976* and the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).

Table 1 lists the well names, well identification numbers, Washington State Department of Ecology (Ecology) well tag numbers, and installation dates for the five new wells. Well summary sheets, borehole logs, geophysical log data reports, final civil survey reports, photo logs, and the well development and testing data sheets are presented in Appendix A for well 699-27-68 (C9632), Appendix B for well 699-29-55 (C9634), Appendix C for well 699-30-70 (C9635), Appendix D for well 699-31-50 (C9737), and Appendix E for well 699-30-73 (C9636). Figure 2 provides a map of the well locations.

2 Drilling, Sampling, and Well Construction Activities

This chapter summarizes the field activities associated with monitoring wells 699-27-68 (C9632), 699-29-55 (C9634), 699-30-70 (C9635), 699-31-50 (C9737), and 699-30-73 (C9636).

2.1 General Information

The five new wells were constructed in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the CHPRC construction specifications identified in the DOW (SGW-60568). 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-2014-27, *Sampling and Analysis Plan for Remediation Wells in the 200-UP-1 Operable Unit* (hereinafter referred to as the sampling and analysis plan [SAP]), as modified by TPA-CN-0793, *Change Notice for Modifying Approved Documents/Work Plans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: DOE/RL-2014-27, Sampling and Analysis Plan for Remediation Wells in the 200-UP-1 Operable Unit, Rev. 2*.

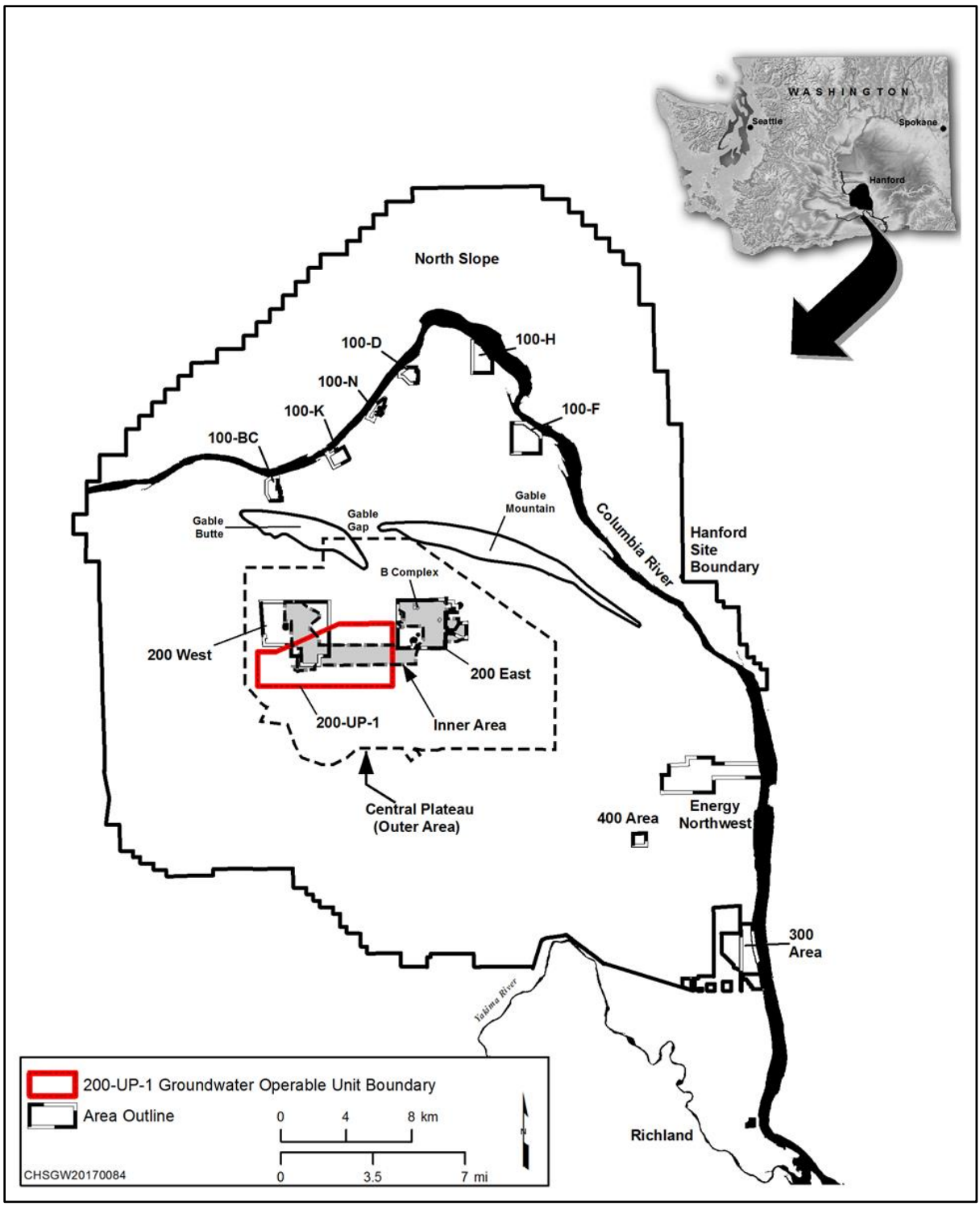


Figure 1. Hanford Site Map

Table 1. Project Well Identification and Drilling Date Summary

Well ID	Well Name	Well Installation Date		Ecology Well Tag Number
		Start	Finish	
C9632	699-27-68	May 25, 2017	August 22, 2017	BJB-536
C9634	699-29-55	June 28, 2017	September 25, 2017	BKG-064
C9635	699-30-70	May 16, 2017	August 24, 2017	BJB-537
C9636	699-30-73	October 11, 2017	December 12, 2017	BKG-065
C9737	699-31-50	August 30, 2017	November 14, 2017	BKG-066

Ecology = Washington State Department of Ecology
ID = identification

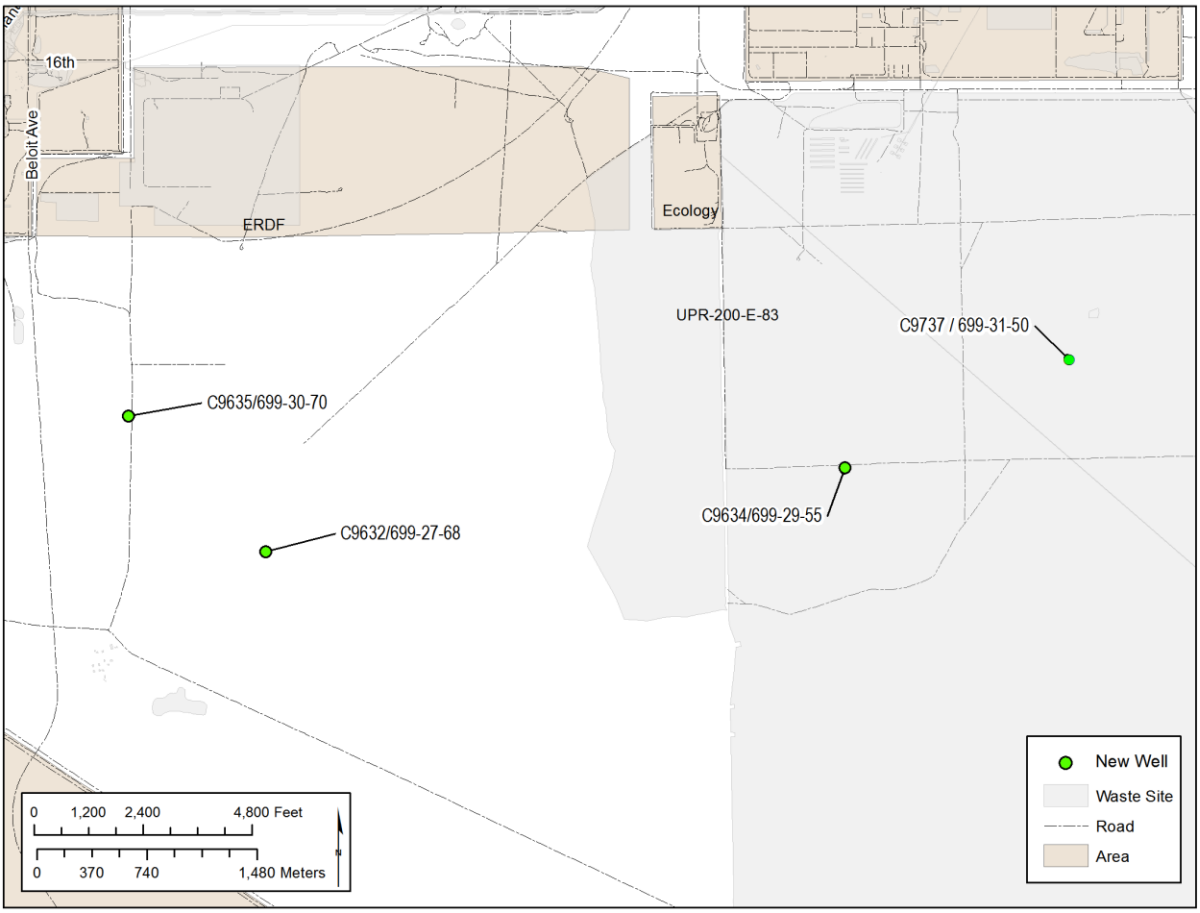


Figure 2. Locations of the Five New 200-UP-1 OU Monitoring Wells

2.1.1 Drilling, Sampling, and Borehole Logging

The drilling, sampling, and borehole logging activities for installing the five new monitoring wells are summarized in the following subsections.

2.1.1.1 Drilling

All five boreholes were drilled with a Foremost DR-24 or Foremost DR-24HD[1] dual rotary drill rig operated by Tacoma Pump. All boreholes were drilled to total depth (TD) with temporary 8 in. outer-diameter (OD) carbon steel casing. Boreholes C9634 and C9737 were drilled using 10-3/4 in. OD starter casing and downsized to 8 in. OD casing due to potential radiological contamination concerns within the first 10 ft of the boreholes. All boreholes were drilled using either a 7-1/4 in. underreamer bit, a 7-1/2 in. tricone bit, or a combination of both. All temporary casing was advanced to TD with an 8-3/4 in. OD and 7-7/8 in. inner-diameter shoe, with the exception of boreholes C9634 and C9737. For C9634 and C9737, 10-3/4-in. OD and 10-1/4 in. inner-diameter shoes were advanced to approximately 15 ft below ground surface (bgs) and 10 ft bgs, respectively, and then downsized to 8-3/4 in. OD and 7-7/8 in. inner-diameter shoes to TD. All boreholes were drilled approximately 10 ft into the Ringold lower mud unit (RLM), unless otherwise noted.

2.1.1.2 Sampling

Sampling was conducted in accordance with the DOW (SGW-60568) and the SAP (DOE/RL-2014-27, as modified by TPA-CN-0793). Geologic grab samples were collected and archived at 5 ft intervals and at major lithologic changes during the drilling of each borehole. Archive grab samples were placed in labeled pint-size glass mason jars and in labeled chip tray compartments for storage. Additional grab samples were collected every 5 ft once water was encountered and then composited into 20 ft sieve analysis samples. Sieve analyses of the composited samples were performed to determine particle-size distribution.

Three to five split-spoon soil samples were collected at each of the boreholes from the saturated zone for chemical analysis. One split-spoon soil sample was collected in the vadose zone at one borehole. Six to 10 groundwater samples were collected from each of the five boreholes during drilling in the saturated zone. The groundwater samples were collected to identify chemical concentrations within the aquifer around the well and to define the vertical distribution of contamination in the aquifer. Hexavalent chromium was measured during the purge as a field parameter to identify when concentrations had stabilized. Post-development groundwater samples were collected during final development of each well. All samples collected for chemical analysis were collected by CHPRC nuclear chemical operators. Section 2.2 provides additional well-specific sampling information.

2.1.1.3 Geophysical Logging

The five boreholes were logged by SN3 using a spectral gamma logging system (SGLS) to detect natural and manmade gamma-emitting radionuclides and a neutron moisture logging system (NMLS) to detect the soil moisture in the vadose zone. Each of the five boreholes was drilled with a single string of 8 in. temporary casing (except C9634 and C9737) and then logged through the 8 in. temporary casing after drilling was completed. In accordance with the DOW (SGW-60568), the first 10 ft at C9634 and C9737 did not require geophysical logging.

---

[1] DR-24 and DR-24HD are tradenames of Foremost Industries LP, Calgary, Alberta, Canada.

2.1.2 Health and Safety Screening

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

2.1.2.1 Radiological Field Screening

A radiological control technician (RCT) performed radiological surveys twice daily, with both morning and afternoon checks during drilling, construction, and development activities. However, the RCT performed continuous coverage during drilling and construction activities for the first 10 ft of boreholes C9634 and C9737 due to potential elevated radiological contamination. 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 during drilling activities at any of the boreholes.

2.1.2.2 Air Monitoring for Volatile Chemicals

Air quality monitoring was performed twice daily by an industrial hygiene technician during drilling activities, once in the morning and once in the afternoon. The industrial hygiene technician checked for VOC contamination using a photoionization detector to confirm that the air quality met lower explosive limit requirements prior to welding activities. Areas monitored for VOCs included the driller's breathing zone near the wellhead, the wellhead or source, any fresh drill cuttings and geologic samples, and any other areas of potential concern.

Very low to zero levels of VOCs were detected downhole during drilling activities. VOCs were not detected in the breathing zone at any of the borehole locations. Additionally, the lower exposure limit was not above 0% at any of the borehole locations.

2.1.3 Well Construction and Development

The following subsections provide additional details on the well construction and development activities.

2.1.3.1 Screen and Casing Materials

All wells were constructed using 4-1/2 in. OD, 4-1/4 in. inner-diameter, Schedule 10S Type 304/304L stainless-steel blanks, screens, and sumps. The screens used were continuous vee-wire wrap with 20-slot (0.020 in.) apertures. All wells used a 3 ft sump (i.e., 3 ft of blank with a welded endcap) located below the lowest screened interval. Section 2.2 provides further details on the construction materials used for each well.

2.1.3.2 Well Completion

A straightness test was conducted on all five wells with a tool that was 20.50 ft in length with a 6 in. OD. The test was conducted prior to setting the permanent well in accordance with the requirements of WAC 173-160.

The screen size and filter pack size used for construction were determined based on sieve analysis results, geologic borehole logs, and intended well use. All wells were constructed with a primary filter pack of 10-20 mesh Colorado silica sand. Wells C9634 and C9635 also used a secondary 8-16 mesh Colorado silica filter pack within the blank casing zones between screens. The primary filter pack was settled using a dual-flange surging method (SGW-60568).

The annular seals for all five wells used 3/8 in. coated bentonite pellets immediately above the silica filter pack of the uppermost screened interval as an approximate 3 ft seal, followed by 20% active solids (by weight) bentonite grout/slurry, followed by granular bentonite in either #8 crumbles or 3/8 in. chip form. The granular bentonite was placed from the top of the bentonite grout/slurry to approximately 9 ft bgs. Type I/II Portland neat cement was used for the surface seal and was placed from the top of the granular bentonite to the ground surface. Any remaining unfilled annular space was filled with high-strength concrete during well pad construction.

The permanent casing was then surrounded by a stainless-steel protective monument with a unique Ecology well tag number riveted to it. All five wells had a 4 ft by 4 ft by 6 in. thick concrete pad constructed around the wellhead protective monument. The well is located within the center of the concrete pad with a brass surveyor's marker (stamped with the well name, identification number, and date of final construction) imbedded on the northern side of the pad. Every monument has a lockable cap, and all lock hasps were positioned to face northward. Four, 6 ft long, 3 in. diameter steel posts (all of which are removable) were placed at the four corners of each concrete pad with 3 ft stickup for wellhead protection. The posts for each well were painted yellow for increased visibility.

Table 1 lists the unique Ecology well tag numbers. Section 2.2 provides further details on construction.

2.1.3.3 Final Well Development

Final well development for all five wells was conducted during construction activities, after the filter pack was added and settled and before the bentonite seal was placed. Each of the five wells was developed using multiple 20 ft development intervals with an electric submersible pump. The groundwater was pumped while water quality parameters (turbidity, conductivity, dissolved oxygen, pH, and temperature) were monitored. Each development interval was completed when the turbidity read <5 nephelometric turbidity units (NTUs) and the remaining water quality parameters stabilized. A LevelTROLL® 700 data logger was used to record the drawdown and recovery data during development activities. Table 2 provides the final water quality data for each well interval. The well development and testing data sheets for each well are provided in their respective appendices.

2.1.3.4 Washington State Department of Ecology Well Identification

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

2.2 Well-Specific Information

This section summarizes the drilling, air monitoring, sampling, geophysical logging, construction, and development activities specific to each well. Table 2 presents well development information for each new monitoring well.

2.2.1 Well 699-27-68 (C9632)

Well 699-27-68 (C9632) was installed between May 25 and August 22, 2017. The borehole was drilled to a TD of 348.39 ft bgs. Drilling began on May 25 using a Foremost DR-24 dual rotary rig. The temporary casing used was 8 in. OD carbon steel with welded joints. The casing was advanced to a depth of 345.64 ft bgs on June 21.

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

Table 2. Well Development Data Summary

Well ID	Well Name	Date Developed	Initial Water Level (ft bgs)	Pump Intake Depth (ft bgs)	Duration Pumped (minutes)	Average Flow Rate (gpm)	Maximum Drawdown (ft)	Final Turbidity (NTU)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	pH	Temperature (°C)	Total Gallons Pumped
C9632	699-27-68	8/15/2017	217.27	276.25	214	25	1.9	3.68	328	8.49	8.05	18.8	5,350
		8/16/2017		254.54	151	25	1.9	3.85	309	8.87	8.05	18.75	3,775
				234.54	115	25	1.8	3.62	332	9.59	8.03	22.50	2,875
				223.64	93	25	1.5	1.58	323	9.50	8.02	23.20	2,325
C9634	699-29-55	9/19/2017	286.05	376.05	149	15	3.59	3.26	412	8.32	8.03	18.1	2,235
				353.05	153	15	3.72	3.51	409	8.13	7.99	18.9	2,295
				314.05	149	15	3.52	3.02	402	9.01	7.99	19.9	2,235
		9/20/2017		294.74	106	15	3.64	1.59	414	9.12	7.99	17.3	1,590
C9635	699-30-70	8/21/2017	219.96	336.90	122	17	0.98	0.94	484	7.03	7.84	23.30	2,074
				326.03	121	17	0.97	4.07	—	6.79	7.91	26.60	2,057
		8/22/2017		306.03	153	17	0.88	0.79	465	7.49	7.20	22.10	2,601
				277.62	68	17	0.25	0.92	491	7.29	7.34	25.20	1,156
				235.49	64	23	0.73	0.86	817	7.06	7.32	24.00	1,472
C9636	699-30-73	12/6/2017	230.94	255.1	119	11.3	0.07	1.57	323	8.87	7.93	14.7	1,345
				245.1	96	11.3	1.30	2.82	315	9.08	7.92	15.9	1,085
C9737	699-31-50	11/8/2017	309.25	385.7	282	10	0.22	2.67	329	8.27	8.04	18.0	2,820
		11/9/2017		365.7	40	9.9	0.68	2.81	339	8.29	7.86	15.7	396
				325.7	207	12.5	0.85	3.27	355	10.28	7.96	18.8	2,590

— = no reading
bgs = below ground surface
gpm = gallons per minute
ID = identification
NTU = nephelometric turbidity unit

Sampling at C9632 included collecting soil samples for geologic archival purposes, composited soil sieve samples for determining particle-size distribution (sieve analysis), three split-spoon samples for chemical analysis, and six groundwater samples for chemical analysis. Geologic archive soil samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Static water was tagged at 217.27 ft bgs on June 1. Sieve analysis samples were collected as 20 ft composites of each 5 ft soil grab sample from the top of the water table to the top of the RLM. A groundwater sample was collected at approximately 20 ft below the water table and at approximately every 20 ft thereafter to TD. Split-spoon samples were collected approximately 20 ft below the water table and at every other water sample depth (approximately every 40 ft) to TD. Table 3 provides sample summary information.

Table 3. Sample Summary for Well 699-27-68 (C9632)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
6/5/2017	I-001	235.21	Water	Pumped	B3B042, B3B043, B3B044, B3B046, B3B047, B3B048, B3B049
6/1/2017	I-002	234.86 – 237.21	Soil	Split spoon	B3B0C4
6/7/2017	I-003	254.60	Water	Pumped	B3B050, B3B051, B3B052, B3B054, B3B055, B3B056, B3B057
6/12/2017	I-004	274.11	Water	Pumped	B3B058, B3B059, B3B060, B3B062, B3B063, B3B064, B3B065
6/8/2017	I-005	275.03 – 275.53	Soil	Split spoon	B3B0C5
6/15/2017	I-006	295.95	Water	Pumped	B3B066, B3B067, B3B068, B3B070, B3B071, B3B072, B3B073
6/20/2017	I-007	315.00	Water	Pumped	B3B074, B3B075, B3B076, B3B078. B3B079. B3B080, B3B081
6/20/2017	I-008	315.50 – 316.50	Soil	Split spoon	B3B0C6
6/21/2017	I-009	335.05	Water	Pumped	B3B082, B3B083, B3B084, B3B086, B3B087, B3B088, B3B089
8/16/2017	Post-development	254.54	Water	Pumped	B3B0B6, B3B0B7, B3B0B8, B3B0C0, B3B0C1, B3B0C2

bgs = below ground surface
HEIS = Hanford Environmental Information System

A geophysical survey using NMLS was performed from the surface to 217.0 ft bgs through the 8 in. OD temporary casing on June 26. SGLS was performed from the surface to 348.0 ft bgs on June 27 and 28 through the 8 in. OD temporary casing. Manmade radionuclides were not detected in the borehole. Appendix A provides the SN3 report for C9632 (HGLP-LDR-1008).

Well completion activities began on July 31. Tacoma Pump performed a straightness test with a 20.50 ft long, 6 in. OD tester. The tester passed through the 8 in. temporary casing without binding. Well installation began on August 1 using 4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blank casing, screen, and sump. A total of 60.10 ft of continuous vee-wire wrap, stainless-steel screen with

0.020 in. apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screen intervals and at 40 ft intervals within and above all subsequent screens. Table 4 provides information on the well construction materials and associated depths for C9632, and Appendix A provides the well summary sheet.

Table 4. Construction Summary for Well 699-27-68 (C9632)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
348.39	216.74 (8/1/2017)	Stainless-steel blank	+2.10 – 214.39	N/A	Concrete	0.00 – 0.50	N/A
		Stainless-steel screen	214.39 – 244.39	0.020	Portland cement	0.50 – 9.50	Type I/II
		Stainless-steel blank	244.39 – 254.39	N/A	Bentonite chips	9.50 – 16.50	3/8 in.
		Stainless-steel screen	254.39 – 284.40	0.020	Bentonite grout/slurry	16.50 – 208.15	N/A
		Stainless-steel sump	284.40 – 287.45	N/A	Bentonite pellets	208.15 – 211.20	3/8 in.
					Colorado silica sand	211.20 – 249.72	10-20
					Bentonite pellets	249.72 – 252.67	3/8 in.
					Colorado silica sand	252.67 – 289.78	10-20
					Bentonite pellets	289.78 – 298.90	3/8 in.
					Bentonite grout/slurry	298.90 – 348.39	N/A

bgs = below ground surface
N/A = not applicable

Well development at C9632 was performed during construction, prior to adding the final bentonite seal. Development operations were conducted on August 15 and 16. A total of four intervals was needed to complete development using a 1.5-horsepower (hp) submersible pump. The average purge rate for all intervals was 25 gallons per minute (gpm). For all development intervals, the requirement was to pump until the turbidity decreased to <5 NTUs and until other key parameters (specific conductance, pH, and temperature) stabilized. The lowest NTU reading was on the fourth interval at 1.58. A total of 14,325 gal of water was purged during development. Table 2 presents the results for all four stages of development for this well, and Appendix A provides the well development and testing data sheet.

2.2.2 Well 699-29-55 (C9634)

Well 699-29-55 (C9634) was installed between June 28 and September 25, 2017. The borehole was drilled to a TD of 453.00 ft bgs. Drilling began on June 28 using a Foremost DR-24HD dual rotary rig. The temporary casings used were 10 in. and 8 in. OD carbon steel with welded joints. The 10 in. casing

was advanced to a depth of 15.08 ft bgs on June 28, and the 8 in. casing was advanced to a depth of 450.00 ft bgs on July 26.

Sampling at C9634 included collecting soil samples for geologic archival purposes, composited soil sieve samples for determining particle-size distribution (sieve analysis), three split-spoon samples for chemical analysis, and seven groundwater samples for chemical analysis. Geologic archive soil samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Static water was tagged at 286.05 ft bgs on September 18. Sieve samples were collected as 20 ft composites of each 5 ft soil grab sample from the top of the water table to the top of the RLM. A groundwater sample was collected at approximately 15 ft below the water table and at approximately every 20 ft thereafter to TD. Split-spoon samples were collected approximately 15 ft below the water table and at every other water sample depth (approximately every 40 ft) to TD. Table 5 provides sample summary information.

Table 5. Sample Summary for Well 699-29-55 (C9634)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
7/12/2017	I-001	300.89	Water	Pumped	B3B0C7, B3B0C8, B3B0C9, B3B0D0, B3B0D1, B3B0D2, B3B0D3, B3B0D4
7/11/2017	I-002	295.50 – 296.00	Soil	Split spoon	B3B0N3
7/13/2017	I-003	320.90	Water	Pumped	B3B0D5, B3B0D6, B3B0D7, B3B0D8, B3B0D9, B3B0F0, B3B0F1, B3B0F2
7/19/2017	I-004	350.80	Water	Pumped	B3B0F3, B3B0F4, B3B0F5, B3B0F7, B3B0F8, B3B0F9, B3B0F6, B3B0H0
7/18/2017	I-005	340.80 – 343.30	Soil	Split spoon	B3B0N4
7/20/2017	I-006	370.90	Water	Pumped	B3B0H1, B3B0H2, B3B0H3, B3B0H4, B3B0H5, B3B0H6, B3B0H7, B3B0H8
7/24/2017	I-007	390.90	Water	Pumped	B3B0H9, B3B0J0, B3B0J1, B3B0J2, B3B0J3, B3B0J4, B3B0J5, B3B0J6
7/24/2017	I-008	391.40 – 391.90	Soil	Split spoon	B3B0N5
7/26/2017	Optional	410.92	Water	Pumped	B3B0J7, B3B0J8, B3B0J9, B3B0K0, B3B0K1, B3B0K2, B3B0K3, B3B0K4
9/19/2017	Post-development	376.05	Water	Pumped	B3B0M1, B3B0M2, B3B0M3, B3B0M4, B3B0M5, B3B0M6, B3B0M7

bgs = below ground surface
HEIS = Hanford Environmental Information System

A geophysical survey using NMLS was performed on July 31 and August 1 from the surface to 435.25 ft bgs through the 8 in. OD temporary casing. SGLS was performed from the surface to 451.0 ft bgs between August 1 and 7 through the 8 in. OD temporary casing. Manmade radionuclides were not detected in the borehole. Appendix B provides the SN3 report for C9634 (HGLP-LDR-1012).

Well completion activities began on August 24. Tacoma Pump performed a straightness test with a 20.50 ft long, 6 in. OD tester. The tester passed through the 8 in. temporary casing without binding. Well installation began on September 5 using 4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blank casing, screen, and sump. A total of 60.03 ft of continuous vee-wire wrap, stainless-steel screen with 0.020 in. apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screen intervals and at 40 ft intervals above the screen. Table 6 presents information on the well construction materials and associated depths for C9634, and Appendix B provides the well summary sheet.

Table 6. Construction Summary for Well 699-29-55 (C9634)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
451.25	286.05	Stainless-steel blank	+2.00 – 284.97	N/A	Concrete	0.00 – 0.50	N/A
		Stainless-steel screen	284.97 – 314.97	0.020	Portland cement	0.50 – 9.41	Type I/II
		Stainless-steel blank	314.97 – 349.97	N/A	Bentonite crumbles	9.41 – 53.20	3/8 in.
		Stainless-steel screen	349.97 – 380.00	0.020	Bentonite grout/slurry	53.20 – 274.07	N/A
		Stainless-steel sump	380.00 – 383.00	N/A	Bentonite pellets	274.07 – 278.85	3/8 in.
					Colorado silica sand	278.85 – 318.20	10-20
					Bentonite pellets	318.20 – 323.45	3/8 in.
					Colorado silica sand	323.45 – 336.20	8-16
					Natural fill	336.20 – 340.10	N/A
					Bentonite pellets	340.10 – 345.15	3/8 in.
					Colorado silica sand	345.15 – 383.60	10-20
					Bentonite pellets	383.60 – 392.70	3/8 in.
					Bentonite grout/slurry	392.70 – 451.25	N/A
					Natural fill	451.25 – 453.00	N/A

bgs = below ground surface
N/A = not applicable

Well development at C9634 was performed during construction, prior to adding the final bentonite seal. Development operations were conducted on September 19 and 20. A total of four intervals was needed to complete development using a 1.5 hp submersible pump. The average purge rate for all intervals was 15 gpm. For all development intervals, the requirement was to pump until the turbidity decreased to <5 NTUs and until other key parameters (specific conductance, pH, and temperature) stabilized. The lowest NTU reading was on the fourth interval at 1.59. A total of 8,355 gal of water was purged during development. Table 2 presents the results for all four stages of development for this well, and Appendix B provides the well development and testing data sheets.

2.2.3 Well 699-30-70 (C9635)

Well 699-30-70 (C9635) was installed between May 16 and August 24, 2017. The borehole was drilled to a TD of 401.85 ft bgs. Drilling began on May 16 using a Foremost DR-24HD dual rotary rig. The temporary casing used was 8 in. OD carbon steel with welded joints. The casing was advanced to a depth of 394.20 ft bgs on June 22.

Sampling at C9635 included collecting soil samples for geologic archival purposes, composited soil sieve samples for determining particle-size distribution (sieve analysis), three split-spoon samples for chemical analysis, and 10 groundwater samples for chemical analysis. Geologic archive soil samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Static water was tagged at 219.96 ft bgs on August 21. Sieve samples were collected as 20 ft composites of each 5 ft soil grab sample from the top of the water table to the top of the RLM. A groundwater sample was collected at approximately 15 ft below the water table and at approximately every 20 ft thereafter to TD. Split-spoon samples were collected approximately 15 ft below the water table and at approximately every 60 ft thereafter to TD, corresponding with a groundwater sample. Table 7 provides sample summary information.

Table 7. Sample Summary for Well 699-30-70 (C9635)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
5/23/2017	I-001	235.50	Water	Pumped	B3B0P4, B3B0P5, B3B0P6, B3B0P8, B3B0P9, B3B0R0, B3B0R1
5/22/2017	I-002	236.95 – 237.45	Soil	Split spoon	B3B122, B3B0P7
5/24/2017	I-003	255.40	Water	Pumped	B3B0R2, B3B0R3, B3B0R4, B3B0R5, B3B0R6, B3B0R7, B3B0R8, B3B0R9
5/25/2017	I-004	275.40	Water	Pumped	B3B0T0, B3B0T1, B3B0T2, B3B0T3, B3B0T4, B3B0T5, B3B0T6, B3B0T7
5/31/2017	I-005	295.40	Water	Pumped	B3B0T8, B3B0T9, B3B0V0, B3B0V1, B3B0V2, B3B0V3, B3B0V4, B3B0V5
5/31/2017	I-006	295.70 – 298.10	Soil	Split spoon	B3B123
6/1/2017	I-007	315.20	Water	Pumped	B3B0V6, B3B0V7, B3B0V8, B3B0V9, B3B0W0, B3B0W1, B3B0W2, B3B0W3

Table 7. Sample Summary for Well 699-30-70 (C9635)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
6/5/2017	I-008	335.20	Water	Pumped	B3B0W4, B3B0W5, B3B0W6, B3B0W7, B3B0W8, B3B0W9, B3B0X1, B3BOX2
6/20/2017	I-009	354.40	Water	Pumped	B3B0X3, B3B0X4, B3B0X5, B3B0X6, B3B0X7, B3B0X8, B3B0X9, B3B0Y0
6/19/2017	I-010	354.05 – 355.45	Soil	Split spoon	B3B124
6/21/2017	I-011	374.40	Water	Pumped	B3B0Y1, B3B0Y2, B3B0Y3, B3B0Y4, B3B0Y5, B3B0Y6, B3B0Y7, B3B0Y8
8/22/2017	Post-development	306.00	Water	Pumped	B3B115, B3B116, B3B117, B3B118, B3B119, B3B120, B3B121

bgs = below ground surface
HEIS = Hanford Environmental Information System

A geophysical survey using NMLS was performed from the surface to 366.51 ft bgs between June 26 and 28 through the 8 in. OD temporary casing. SGLS was performed from the surface to 396.01 ft bgs on June 28 and 29 and on July 3 through the 8 in. OD temporary casing. Manmade radionuclides were not detected in the borehole. Appendix C provides the SN3 report for C9635 (HGLP-LDR-1009).

Well completion activities began on August 3. Tacoma Pump performed a straightness test with a 20.50 ft long, 6 in. OD tester. The tester passed through the casing without binding. Well installation began on August 8 using 4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blank casing, screen, and sump. A total of 90.03 ft of continuous vee-wire wrap, stainless-steel screen with 0.020 in. apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screen intervals and at 40 ft intervals above the screen. Table 8 provides information on the well construction materials and associated depths for C9635, and Appendix C provides the well summary sheet.

Well development at C9635 was performed during construction, prior to adding the final bentonite seal. Development operations were conducted on August 21 and 22. A total of five intervals was needed to complete development using a 1.5 hp submersible pump. The average purge rate for all intervals was 18.2 gpm. For all development intervals, the requirement was to pump until the turbidity decreased to <5 NTUs and until other key parameters (specific conductance, pH, and temperature) stabilized. The lowest NTU reading was on the third interval at 0.79. A total of 9,360 gal of water was purged during development. Table 2 presents the results for all five stages of development for this well, and Appendix C provides the well development and testing data sheet.

Table 8. Construction Summary for Well 699-30-70 (C9635)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
401.85	220.62	Stainless-steel blank	+2.00 – 220.00	N/A	Concrete	+0.50 – 0.50	N/A
		Stainless-steel screen	220.00 – 240.01	0.020	Portland cement	0.50 – 9.00	Type I/II
		Stainless-steel blank	240.01 – 270.00	N/A	Bentonite chips	9.00 – 10.00	3/8 in.
		Stainless-steel screen	270.00 – 310.00	0.020	Bentonite grout/slurry	10.00 – 211.40	N/A
		Stainless-steel blank	310.00 – 320.01	N/A	Bentonite pellets	211.40 – 216.25	3/8 in.
		Stainless-steel screen	320.01 – 350.03	0.020	Colorado silica sand	216.25 – 242.95	10-20
		Stainless-steel sump	350.03 – 353.03	N/A	Colorado silica sand	242.95 – 253.10	8-16
					Bentonite pellets	253.10 – 256.60	3/8 in.
					Colorado silica sand	256.60 – 264.70	8-16
					Colorado silica sand	264.70 – 312.00	10-20
					Bentonite pellets	312.00 – 314.70	3/8 in.
					Colorado silica sand	314.70 – 356.50	10-20
					Bentonite pellets	356.50 – 363.20	3/8 in.
					Bentonite grout/slurry	363.20 – 401.29	N/A
					Natural fill	401.29 – 401.85	N/A

bgs = below ground surface
N/A = not applicable

2.2.4 Well 699-31-50 (C9737)

Well 699-31-50 (C9737) was installed between August 30 and November 14, 2017. The borehole was drilled to a TD of 468.50 ft bgs. Drilling began on August 30 using a Foremost DR-24HD dual rotary rig. The temporary casings used were 10 in. and 8 in. OD carbon steel with welded joints. The 10 in. casing was advanced to a depth of 10.56 ft bgs on August 30, and the 8 in. casing was advanced to a depth of 462.20 ft bgs on September 27.

Sampling at C9737 included collecting soil samples for geologic archival purposes, composited soil sieve samples for determining particle-size distribution (sieve analysis), five split-spoon samples for chemical analysis, and seven groundwater samples for chemical analysis. Geologic archive soil samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Static water was tagged at 309.25 ft bgs on November 11. Sieve samples were collected as 20 ft composites of each 5 ft soil grab sample from the top of the water table to the top of the RLM. Per direction from the project, a single split-spoon sample was taken in the vadose zone approximately 50 ft above the water table. A groundwater sample was collected at approximately 15 ft below the water table and at approximately every 20 ft thereafter to TD. Split-spoon samples were collected approximately 15 ft below the water table and at every other water sample depth (approximately every 40 ft) to TD. Table 9 provides sample summary information.

Table 9. Sample Summary for Well 699-31-50 (C9737)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
9/12/2017	I-001	325.0	Water	Pumped	B3B125, B3B126, B3B127, B3B128, B3B129, B3B130, B3B131, B3B132
9/11/2017	I-002	325.0 – 325.5	Soil	Split spoon	B3B196
9/13/2017	I-003	345.0	Water	Pumped	B3B133, B3B134, B3B135, B3B136, B3B137, B3B138, B3B139, B3B140
9/18/2017	I-004	365.0	Water	Pumped	B3B141, B3B142, B3B143, B3B145, B3B146, B3B147, B3B148, B3B144
9/14/2017	I-005	364.7 – 365.2	Soil	Split spoon	B3B197
9/19/2017	I-006	385.0	Water	Pumped	B3B149, B3B150, B3B151, B3B152, B3B153, B3B154, B3B155, B3B156
9/20/2017	I-007	404.0	Water	Pumped	B3B157, B3B158, B3B159, B3B160, B3B161, B3B162, B3B163, B3B164
9/19/2017	I-008	404.5 – 405.0	Soil	Split spoon	B3B198
9/21/2017	I-009	424.0	Water	Pumped	B3B165, B3B166, B3B167, B3B168, B3B169, B3B170, B3B171, B3B172
9/26/2017	I-010	445.0	Water	Pumped	B3B173, B3B174, B3B175, B3B176, B3B177, B3B178, B3B179, B3B180
9/6/2017	I-012	275.6 – 276.1	Soil	Split spoon	B3D9C1
9/21/2017	I-013	424.5 – 425.0	Soil	Split spoon	B3D9C2
11/9/2017	Post-development	325.7	Water	Pumped	B3B189, B3B190, B3B191, B3B192, B3B193, B3B194, B3B195

bgs = below ground surface
HEIS = Hanford Environmental Information System

A geophysical survey using NMLS was performed on October 2 and 3 from the surface to 309.53 ft bgs through the 8 in. OD temporary casing. SGLS was performed on October 3, 4, and 5 from 0.01 ft bgs to 464.01 ft bgs through the 8 in. OD temporary casing. Manmade radionuclides were not detected in the borehole. Appendix D provides the SN3 report for C9737 (HGLP-LDR-1024).

Well completion activities began on October 10. Tacoma Pump performed a straightness test with a 20.50 ft long, 6 in. OD tester. The tester passed through the casing without binding. Well installation began on October 31 using 4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blank casing, screen, and sump. A total of 75.00 ft of continuous vee-wire wrap, stainless-steel screen with 0.020 in. apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screen intervals and at 40 ft intervals above the screen. Table 10 provides information on the well construction materials and associated depths for C9737, and Appendix D contains the well summary sheet.

Table 10. Construction Summary for Well 699-31-50 (C9737)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
468.50	309.25	Stainless-steel blank	+2.00 – 309.15	N/A	Concrete	+0.50 – 0.00	N/A
		Stainless-steel screen	309.15 – 344.14	0.020	Portland Cement	0.00 – 10.10	Type I/II
		Stainless-steel blank	344.14 – 354.12	N/A	Bentonite grout/slurry	10.10 – 301.53	N/A
		Stainless-steel screen	354.12 – 394.13	0.020	Bentonite pellets	301.53 – 305.15	3/8 in.
		Stainless-steel sump	394.13 – 397.14	N/A	Colorado silica sand	305.15 – 346.02	10-20
					Bentonite pellets	346.02 – 349.05	3/8 in.
					Colorado silica sand	349.05 – 397.50	10-20
					Colorado silica sand	397.50 – 400.10	8-16
					Bentonite pellets	400.10 – 403.80	3/8 in.
					Bentonite grout/slurry	403.80 – 467.50	N/A
					Natural fill	467.50 – 468.50	N/A

bgs = below ground surface
N/A = not applicable

Well development at C9737 was performed during construction, prior to adding the final bentonite seal. Development operations were conducted on November 8 and 9. A total of three intervals was needed to complete development using a 1.5 hp submersible pump. The average purge rate for all intervals was 10.8 gpm. For all development intervals, the requirement was to pump until the turbidity decreased to <5 NTUs and until other key parameters (specific conductance, pH, and temperature) stabilized.

The lowest NTU reading was on the first interval at 2.67. A total of 5,806 gal of water was purged during development. Table 2 presents the results for all three stages of development for this well, and Appendix D provides the well development and testing data sheets.

2.2.5 Well 699-30-73 (C9636)

Well 699-30-73 (C9636) was installed between October 11 and December 12, 2017. The borehole was drilled to a TD of 402.30 ft bgs. Drilling began on October 11 using a Foremost DR-24HD dual rotary rig. The temporary casing used was 8 in. OD carbon steel with welded joints. The casing was advanced to a depth of 399.76 ft bgs on October 26.

Sampling at C9636 included collecting soil samples for geologic archival purposes, composited soil sieve samples for determining particle-size distribution (sieve analysis), three split-spoon samples for chemical analysis, and 10 groundwater samples for chemical analysis. Geologic archive soil samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Static water was tagged at 230.94 ft bgs on December 6. Sieve samples were collected as 20 ft composites of each 5 ft soil grab sample from the top of the water table to the top of the RLM. A groundwater sample was collected at approximately 10 ft below the water table and at approximately every 20 ft thereafter to TD. Split-spoon samples were collected approximately 10 ft below the water table and at approximately every 60 ft to TD. On November 28, a special groundwater sample was collected for purgewater management purposes. Due to issues with water storage space on site, the groundwater needed to be chemically analyzed to determine if it could be transported to the Effluent Treatment Facility. Table 11 provides sample summary information.

Table 11. Sample Summary for Well 699-30-73 (C9636)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
10/17/2017	I-001	240.90 – 241.40	Soil	Split spoon	B3F9V6
10/17/2017	I-002	240.39	Water	Pumped	B3F9V9, B3F9W0, B3F9W1, B3F9W2, B3F9W3, B3F9W4, B3F9W5, B3F9W6
10/18/2017	I-003	260.32	Water	Pumped	B3F9W7, B3F9W8, B3F9W9, B3F9X0, B3F9X1, B3F9X2, B3F9X3, B3F9X4
10/18/2017	I-004	280.00	Water	Pumped	B3F9X5, B3F9X6, B3F9X7, B3F9X8, B3F9X9, B3F9Y0, B3F9Y1, B3F9Y2
10/19/2017	I-005	301.25 – 301.75	Soil	Split spoon	B3F9V7
10/19/2017	I-006	300.27	Water	Pumped	B3F9Y3, B3F9Y4, B3F9Y5, B3F9Y6, B3F9Y7, B3F9Y8, B3F9Y9, B3FB00
10/23/2017	I-007	320.00	Water	Pumped	B3FB01, B3FB02, B3FB03, B3FB04, B3FB05, B3FB06, B3FB07, B3FB08
10/24/2017	I-008	340.25	Water	Pumped	B3FB09, B3FB10, B3FB11, B3FB12, B3FB13, B3FB14, B3FB15, B3FB16
10/24/2017	I-009	360.20 – 360.70	Soil	Split spoon	B3F9V8

Table 11. Sample Summary for Well 699-30-73 (C9636)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
10/25/2017	I-010	360.05	Water	Pumped	B3FB17, B3FB18, B3FB21, B3FB22, B3FB23, B3FB24, B3FB25, B3FB26
10/25/2017	I-011	380.15	Water	Pumped	B3FB27, B3FB28, B3FB29, B3FB30, B3FB31, B3FB32, B3FB33, B3FB34
11/28/2017	Special sample*	279.74	Water	Pumped	B3H032, B3H033, B3H034
12/6/2017	Post-development	255.10	Water	Pumped	B3FB59, B3FB60, B3FB61, B3FB62, B3FB63, B3FB64, B3FB65

* On November 28, 2017, a special groundwater sample was collected. Due to issues with water storage space onsite, the groundwater needed to be chemically analyzed to determine if it could be transported to the Effluent Treatment Facility.

bgs = below ground surface

HEIS = Hanford Environmental Information System

A geophysical survey using NMLS was performed on October 30 from the surface to 250.01 ft bgs through the 8 in. OD temporary casing. SGLS was performed on October 31 and November 1 from the surface to 401.01 ft bgs through the 8 in. OD temporary casing. Manmade radionuclides were not detected in the borehole. Appendix E provides the SN3 report for C9636 (HGLP-LDR-1026).

Well completion activities began on November 7. Tacoma Pump performed a straightness test with a 20.50 ft long, 6 in. OD tester. The tester passed through the casing without binding. Well installation began on November 28 using 4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blank casing, screen, and sump. A total of 35.74 ft of continuous vee-wire wrap, stainless-steel screen with 0.020 in. apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screen and at 40 ft intervals above the screen. Table 12 provides information on the well construction materials and associated depths for C9636, and Appendix E contains the well summary sheet.

Well development at C9636 was performed during construction, prior to adding the final bentonite seal. Development operations were conducted on December 6. A total of two intervals was needed to complete development using a 1.5 hp submersible pump. The average purge rate for all intervals was 11.3 gpm. For all development intervals, the requirement was to pump until the turbidity decreased to <5 NTUs and until other key parameters (specific conductance, pH, and temperature) stabilized. The lowest NTU reading was on the first interval at 1.57. A total of 2,430 gal of water was purged during development. Table 2 presents the results for the two stages of development for this well, and the well development and testing data sheet for this well is provided in Appendix E.

Table 12. Construction Summary for Well 699-30-73 (C9636)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
402.30	230.94	Stainless-steel blank	+2.00 – 229.09	N/A	Concrete	+0.50 – 0.00	N/A
		Stainless-steel screen	229.09 – 264.83	0.020	Portland cement	0.00 – 8.40	Type I/II
		Stainless-steel sump	264.83 – 267.83	N/A	Bentonite chips	8.40 – 13.00	3/8 in.
					Bentonite grout/slurry	13.00 – 219.95	N/A
					Bentonite pellets	219.95 – 224.15	3/8 in.
					Colorado silica sand	224.15 – 267.50	10-20
					Colorado silica sand	267.50 – 271.39	8-16
					Bentonite pellets	271.39 – 280.25	3/8 in.
					Bentonite chips	280.25 – 290.75	3/8 in.
					Bentonite grout/slurry	290.75 – 300.00	N/A
					Bentonite pellets	300.00 – 300.00	3/8 in.
					Bentonite grout/slurry	300.00 – 402.30	N/A

bgs = below ground surface
N/A = not applicable

3 Geologic Observations

This chapter summarizes the general geology of the 200-UP-1 OU and the geology encountered at each of the well sites during drilling.

3.1 Geology of the 200-UP-1 Operable Unit

The 200-UP-1 OU underlies the southern portion of the 200 West Area and includes the Environmental Restoration Disposal Facility. The stratigraphy of this area is comprised of several different sedimentary deposits that lie above the Columbia River Basalt Group. The major units that are found in the 200 West area 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/pre-Hanford fine-grained calcareous sediments of the Cold Creek unit (CCU)
- Miocene-Pliocene Ringold Formation sediments:
  - Sand and gravel sediments of the Ringold Formation, member of Wooded Island, unit E (hereinafter referred to as Ringold unit E)
  - Fine-grained sediments of the Ringold Formation, member of Wooded Island, lower mud unit (hereinafter referred to as Ringold lower mud [RLM])
  - Sand and gravel of the Ringold Formation, member of Wooded Island, unit A (hereinafter referred to as Ringold unit A)
- Miocene Elephant Mountain Member of the Saddle Mountains Basalt of the Columbia River Basalt Group

The Pleistocene Hanford formation is divided into three facies including gravel-dominated, sand-dominated, and slackwater cataclysmic flood and interflood deposits that resulted from the Missoula floods that occurred 15,000 to 12,000 years ago (SGW-60568). The gravel-dominated facies are highly mafic due to a basaltic composition, ranging from approximately 50% to 80%. The sand-dominated facies consists of approximately 50% mafic and 50% quartz-feldspar that is relatively thicker than the gravel-dominated facies and predominantly horizontally laminated of fine- to coarse-grained sand. Below the Hanford formation is the CCU, which consists of fine-grained calcareous sediments and represents mainstream alluvial, calcic paleosol, side stream alluvial, colluvial, and overbank-aeolian environments marginal to the ancestral Columbia River. The Ringold Formation is below the CCU and consists of semiconsolidated fluvial silt, sand, and mostly gravels of Ringold unit E, along with paleosol and lacustrine clay and silt of the RLM below Ringold unit E (SGW-60568). For this project, drilling did not continue below the RLM; therefore, the underlying Ringold unit A and Columbia River Basalt Group were not encountered.

Additional information regarding the geology of the 200 West Area is presented in the following:

- BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*
- BHI-01203, *Nature and Variability of the Plio-Pleistocene Unit in the 200 West Area of the Hanford Site*
- DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*
- PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*
- WHC-SD-EN-TI-011, *Geology of the Northern Part of the Hanford Site: An Outline of Data Sources and the Geologic Setting of the 100 Areas*
- WHC-SD-EN-TI-014, *Hydrogeologic Model for the 200 West Groundwater Aggregate Area*

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

3.2 Borehole Geology

This section describes the geologic characteristics and stratigraphic units that were observed from grab samples during drilling of the five new boreholes (C9632, C9634, C9635, C9737, and C9636). Appendices A through E provide each of the respective borehole logs.

The interpretations included in this report regarding the stratigraphy of each drill site are based on field observations from drill cuttings collected every 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 during the remedial investigation data review and will incorporate the field observations, borehole geophysical logging data, and regional stratigraphic interpretations.

Due to the drilling method used, grab samples may appear more angular than the actual formation. Samples also could consist of less fine-grained sediments due to a graded effect when being lifted out of the ground, along with fines being washed away with the water used to aid in cuttings removal and/or within the water table (which cause the sample to appear coarser). Samples may also have a weaker reaction to 10% diluted hydrochloric acid (HCl) in the presence of water. The following subsections discuss the determination of estimated stratigraphic unit contacts for each of the borehole summaries.

3.2.1 Well 699-27-68 (C9632)

Well 699-27-68 (C9632) is located south of the 200 West Area, approximately 0.75 mi northeast of the Rattlesnake Barricade. The major stratigraphic units encountered include the Hanford formation, lower CCU, Ringold unit E, and RLM.

The Hanford formation was observed from just under the drill pad to a depth of 145 ft bgs. The soil classifications for the formation include sand, silty sand, gravelly silty sand, and silty gravel. The sand ranged from 15% to 40% mafic, and the gravel ranged from 60% to 80% mafic. A moderate to very strong reaction with HCl was observed throughout the Hanford formation. The gravel angularity was subangular to round. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel size ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 35 mm (very coarse pebble).

The lower CCU was observed from 145 to 175 ft bgs and was indicated by violent reactions when tested with HCl. Silty sand was the only soil classification observed within the lower CCU. The sand was primarily felsic, ranging from 60% to 80%. The gravel was primarily mafic, ranging from 70% to 75%. The sediment angularity ranged from subangular to subround. Sand grain size ranged mostly from very fine to medium (62.5 μm to 0.5 mm). The gravel ranged from very fine to coarse pebbles (2 to 32 mm). The maximum gravel size was 24 mm (coarse pebble).

The contact between the lower CCU and the Ringold unit E was at approximately 175 ft bgs due to the lack of reaction when tested with HCl. The soil classifications for Ringold unit E include gravelly sand, sandy gravel, and gravel. Sand composition was dominantly felsic, ranging from 60% to 80%. The gravel composition was dominantly mafic and ranged from 60% to 85%. There was weak to no HCl reaction throughout the formation. The sand angularity ranged from mostly subangular to subround. Gravel angularity ranged from subangular to round. Sand grain size ranged from very fine to very coarse grain (62.5 μm to 2 mm). Gravel ranged from very fine pebbles to small cobbles (2 to 128 mm). The maximum gravel size was 90 mm (small cobble).

The contact between Ringold unit E and the RLM was at approximately 331 ft bgs and was observed to TD of 348.39 ft bgs. The soil classification for the RLM was silty-sandy gravel and gravely sandy silt. The gravel and sand in the RLM is likely remnant in the borehole from the overlying formation. The RLM did not have a reaction when tested with HCl and was dark gray in color. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 62 mm (very coarse pebble).

The final static water level was measured at 217.26 ft bgs on June 21, 2017. Appendix A provides the borehole log for C9632.

3.2.2 Well 699-29-55 (C9634)

Well 699-29-55 (C9634) is located approximately 1.5 mi southeast of US Ecology. Prominent stratigraphic units encountered while drilling included the Hanford formation, Ringold unit E, and RLM.

The Hanford formation was observed from just under the drill pad to approximately 290 ft bgs. The soil classifications for the Hanford formation include sand and gravelly sand. The overall sand composition was predominantly felsic, ranging from 50% to 75%, except for the first 5 ft bgs, which was about 65% mafic. The overall gravel composition was also predominantly felsic, ranging from 40% to 80% when gravel was present. Sediment reactions to HCl ranged from strong to no reaction but were mostly moderate to strong. The sediment angularity ranged from angular to subround. Sand grains ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 35 mm (very coarse pebble).

Contact with the underlying Ringold unit E was observed by a change from sand-dominated to gravel-dominated sediment. Ringold unit E was encountered from approximately 290 to 442 ft bgs. The Ringold unit E soil classifications include sandy gravel, silty gravel, silty-sandy gravel, gravel, and sand. From 440 to 442 ft bgs, the sediment became dominantly mafic and contained large organic fragments. The overall sand composition was felsic, ranging from 50% to 80%. The overall gravel composition ranged from 30% to 80% felsic. There was no reaction to HCl, as the formation was below the water table. The sediment angularity ranged from angular to round. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 35 mm (very coarse pebble).

The contact with the underlying RLM was gradational, indicated by a change in lithology from gravel-dominated to silty. The RLM was encountered from 442 ft bgs to the TD of 453.00 ft bgs. The soil classification was silt and dark greenish-gray in color. Sand and gravel were not observed.

A final static water level was measured at 286.05 ft bgs on September 18, 2017. Appendix B provides the borehole log for C9634.

3.2.3 Well 699-30-70 (C9635)

Well 699-30-70 (C9635) is located approximately 0.5 mi northeast of Rattlesnake Barricade. Prominent stratigraphic units encountered included the Hanford formation, lower CCU, Ringold unit E, and RLM.

The Hanford formation was observed from just under the drill pad to 145 ft bgs. Soil classifications encountered in the Hanford formation include sand, slightly silty sand, gravelly sand, and sandy gravel. The sand composition was felsic-dominated, ranging from 40% to 85%. Gravel composition was mafic-dominated, ranging from 50% to 90%. The HCl reactions ranged from no reaction to very strong, with the majority of the formation either having no reaction or a very strong reaction. The sediment angularity within the Hanford formation was subangular to subround. Sand grain size ranged from very

fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 35 mm (very coarse pebble).

The lower CCU was observed from 145 to 165 ft bgs and was indicated by violent reactions when tested with HCl. Soil classifications include slightly silty sand, gravelly sand, and sandy gravel. Sand composition ranged from 40% to 75% felsic. Gravel composition ranged from 50% to 60% mafic. The sediment angularity ranged from subangular to subround. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to coarse pebbles (2 to 32 mm). The maximum gravel size was 24 mm (coarse pebble).

The transition from the lower CCU to the underlying Ringold unit E was indicated by the lack of reaction when tested with HCl. Ringold unit E was encountered from 165 to 391 ft bgs. Soil classifications encountered include gravel, sandy gravel, silty-sandy gravel, gravely sand, and sand. Sand was primarily felsic, ranging from 40% to 90%. Gravel was primarily mafic, ranging from 20% to 70%. There was predominantly no HCl reaction, except between 320 and 335 ft bgs, where there were weak to very strong reactions. The sediment angularity ranged from angular to round. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine pebbles to small cobbles (2 to 128 mm). The maximum gravel size was 64 mm (small cobble).

Contact between the Ringold unit E and RLM was a gradational contact, transitioning from gravel-dominated to silt-dominated sediment. The RLM was encountered from 391 ft bgs to TD of 401.85 ft bgs. Soil classifications include silty gravel and gravelly sandy silt, which is likely remnant from the overlying formation. The RLM color was a very dark greenish-gray. Sand composition was dominantly felsic, ranging from 70% to 85%. Gravel composition was primarily felsic, ranging from 45% to 95%. There was no reaction with HCl. The sediment angularity ranged from subangular to subround. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to coarse pebbles (2 to 32 mm). The maximum gravel size was 30 mm (coarse pebble).

The final static water level was measured at 219.96 ft bgs on August 21, 2017. Appendix C provides the borehole log for C9635.

3.2.4 Well 699-31-50 (C9737)

Well 699-31-50 (C9737) is located approximately 2 mi southeast of US Ecology. Stratigraphic units encountered are the Hanford formation, Ringold unit E, and RLM.

The Hanford formation was observed from just beneath the drill pad to 290 ft bgs. Soil classifications observed within the formation include sand, silty sand, slightly silty sand, silt, silty-sandy gravel, and slightly silty-gravely sand. The sand was predominantly of felsic composition, ranging from 40% to 80%. The gravel was of mafic composition, ranging from 50% to 70%. Sediment reaction with HCl ranged from no reaction to strong, with most of the reactions being weak to no reaction. Sediment angularity was primarily subangular to subround. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 56 mm (very coarse pebble).

The transition from the Hanford formation to the underlying Ringold unit E was a gradational contact, and the formation was observed from 290 to 460 ft bgs. The soil classifications within the formation include silty sand, gravely silty sand, sand, sandy gravel, and gravel. The sand composition was primarily felsic (except between 410 and 460 ft bgs, as noted below), ranging from 5% to 90% felsic content. The gravel composition was dominantly mafic (except between 410 and 460 ft bgs, as noted below), ranging from 10% to 95% mafic content. There was primarily no reaction with HCl, although a few samples had a weak reaction. Sediment angularity ranged from angular to round, with the majority falling

within the range of angular to subangular. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 35 mm (very coarse pebble).

An anomalous black sediment was observed within Ringold unit E between 410 and 460 ft bgs. Soil classifications within this sediment include sand, gravelly sand, sandy gravel, and gravel. The sediment contained well-defined wood and organic fragments. Sand and gravel were both highly mafic, with 95% mafic content. Sediment angularity ranged from angular to round. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel ranged from very fine to very coarse pebbles (2 to 64 mm). The maximum gravel size was 35 mm (very coarse pebble).

Contact between Ringold unit E and the RLM was indicated by a swift transition from gravel- and sand-dominated to silt-dominated sediments. The RLM was observed from 460 ft bgs to TD of 468.50 ft bgs. The soil classification was silt/clay and the color was bluish-gray. There was no observed HCl reaction. Sand was angular to subangular. Coarse sand (0.5 to 1.0 mm) was the maximum grain size within the RLM and was likely remnant from the overlying formation.

The final static water level was measured at 309.25 ft bgs on November 8. Appendix D provides the borehole log for C9737.

3.2.5 Well 699-30-73 (C9636)

Well 699-30-73 (C9636) is located 0.75 mi north of Rattlesnake Barricade. Stratigraphic units encountered include the Hanford formation, lower CCU, Ringold unit E, and RLM.

The Hanford formation was observed from below the drill pad to 150 ft bgs. Soil classifications within the formation include sand, slightly silty sand, and silty sand. The sand was primarily felsic, ranging from 30% to 70%. There was weak to no reaction with HCl in the formation. The sediments ranged from subangular to subround. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm). Gravel size ranged from very fine to very coarse (2 to 64 mm). The maximum gravel size was 34 mm (very coarse pebble).

The transition from the Hanford formation to the lower CCU was indicated by violent reactions to HCl. The lower CCU was observed from 150 to 190 ft bgs. Soil classifications include slightly silty sand, silty sand, sandy gravel, and gravelly silt. The sand was primarily felsic, ranging from 35% to 60%. The gravel was 50% mafic and felsic material. From 130 to 190 ft bgs, the sediment reacted violently with HCl, then transitioning to no reaction to HCl from 190 to 220 ft bgs. Sediment angularity ranged from angular to subround. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm), and gravel size ranged from very fine to coarse pebbles (2 to 32 mm). The maximum gravel size was 30 mm (coarse pebble).

Ringold unit E is indicated by transition to gravel-dominated sediment and was observed from 190 to 397 ft bgs. Soil classifications within this formation include sandy gravel, silty-sandy gravel, and gravel. Sand composition was a mix of felsic and mafic material, with neither necessarily dominating, ranging from 35% to 65% felsic. The gravel composition was primarily felsic, ranging from 10% to 85%. No HCl reaction was observed. Sediment angularity ranged from angular to round. Sand grain size ranged from very fine to very coarse (62.5 μm to 2 mm), and gravel size ranged from very fine pebbles to small cobbles (2 to 128 mm). The maximum gravel size was 77 mm (small cobble).

A gradational contact occurred between Ringold unit E and the RLM at 397 ft bgs. The RLM was observed from 397 ft bgs to TD of 402.30 ft bgs. Soil classifications within the RLM include silty gravel and silt that was light olive-brown in color. Gravel composition was an even mixture of felsic and mafic material. No HCl reaction was observed. The gravel angularity ranged from angular to round. Sand grain

size ranged from very fine to very coarse (62.5 µm to 2 mm), and gravel ranged from very fine to very coarse pebbles (2 mm to 64 mm). The maximum gravel size was measured at 35 mm (very coarse pebble).

The final static water level was measured at 230.94 ft bgs on December 6. Appendix E provides the borehole log for C9636.

4 Waste Management

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

4.1 Drill Cuttings

Drill cuttings from the vadose zone at boreholes C9632, C9634, C9635, C9737, and C9636 were collected in a spoil pile that was created for return-to-earth purposes. The return-to-earth piles included drill cuttings from the vadose zone to approximately 10 ft above the expected water depth (referred to as the historical high-water mark). Drill cuttings from below the high-water mark were collected in catch tanks and troughs, and water was removed when necessary. The drill cuttings were then placed into designated Environmental Restoration Disposal Facility roll-off boxes. Miscellaneous solid waste associated with sampling activities was contained in clear plastic bags and disposed in the roll-off boxes. The roll-off boxes were then transported to the Environmental Restoration Disposal Facility for disposal at the completion of the project.

4.2 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 regulated purge trucks in accordance with DOE/RL-2009-39, *Investigation-Derived Waste Purgewater Management Action Memorandum*; 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.*

5 Civil Survey

The well locations for 699-27-68 (C9632), 699-29-55 (C9634), 699-30-70 (C9635), 699-31-50 (C9737), and 699-30-73 (C9636) were surveyed using a Trimble® R8 RTK global positioning system and 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. Wells 699-27-68, 699-29-55, 699-30-70, and 699-31-50 were surveyed on November 29, 2017. Well 699-30-73 was surveyed on January 4, 2018. Table 13 identifies the locations of the surveyed wells. Survey reports for each well are provided in Appendices A through E, respectively.

Trimble® is a registered trademark of Trimble Inc., Sunnyvale, California.

Table 13. Civil Survey Summary

Well ID	Well Name	Northing[a] (m)	Easting[a] (m)	Brass Survey Marker Elevation[b] (m)	Top of Casing[b,c] Elevation (m)
C9632	699-27-68	131676.43	569324.76	196.635	197.466
C9634	699-29-55	132230.23	573241.86	210.600	211.396
C9635	699-30-70	132581.66	568428.93	198.211	198.914
C9636	699-30-73	132789.76	567781.90	201.275	202.136
C9737	699-31-50	132959.20	574751.16	216.222	217.032

a. Northing and easting coordinates are based on Washington State Plane coordinates (*North American Datum of 1983* [NAD83]).

b. *North American Vertical Datum of 1988* (NAVD88) values rounded to 0.001 m.

c. Protective casing.

ID = identification

6 Well Acceptance

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

After the wells were completed, representatives from CHPRC and Tacoma Pump performed the inspections for the five wells. Well 699-27-68 was walked down on August 31, 2017. Well 699-29-55 was walked down on September 28, 2017. Well 699-30-70 was walked down on August 31, 2017. Well 699-31-50 was walked down on December 5, 2017. Well 699-30-73 was walked down on December 14, 2017. All wells have been accepted by CHPRC.

7 References

BHI-00184, 1995, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington,* U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0083482H.

BHI-01203, 2000, *Nature and Variability of the Plio-Pleistocene Unit in the 200 West Area of the Hanford Site*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pbadupws.nrc.gov/docs/ML0901/ML090120263.pdf.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

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

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

DOE/RL-2009-80, 2009, *Investigation Derived Waste Purgewater Management Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0094946.

DOE/RL-2011-41, 2011, *Hanford Site Strategy for Management of Investigation Derived Waste*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093937.

DOE/RL-2014-27, 2017, *Sampling and Analysis Plan for Remediation Wells in the 200-UP-1 Operable Unit*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071352H

Modified by:

TPA-CN-0793, 2017, *Change Notice for Modifying Approved Documents/Work Plans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: DOE/RL-2014-27, Sampling and Analysis Plan for Remediation Wells in the 200-UP-1 Operable Unit, Rev. 2*, dated August 22, U.S. Department of Energy, Richland Operations Office, and U.S. Environmental Protection Agency, Richland Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0068662H.

DOE/RL-2016-13, 2016, *Waste Management Plan for the 200-UP-1 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0077117H.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

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

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

PNNL-13858, 2002, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13858.pdf.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

SGW-60568, 2017, *Description of Work for the Installation of Four Monitoring Wells Near the Southeastern Portion of the 200-UP-1 Operable Unit, FY 2017*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

WHC-SD-EN-TI-011, 1992, *Geology of the Northern Part of the Hanford Site: An Outline of Data Sources and the Geologic Setting of the 100 Areas*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-014, 1992, *Hydrogeologic Model of the 200 West Groundwater Aggregate Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196100569.

Appendix A

Well Documentation for 699-27-68 (C9632)

- Well Summary Sheet for C9632
- Borehole Log for C9632
- Geophysical Log Data Report for C9632
- Final Survey Report for C9632
- Photo Log for C9632
- Well Development and Testing Data Sheet for C9632

This page intentionally left blank.

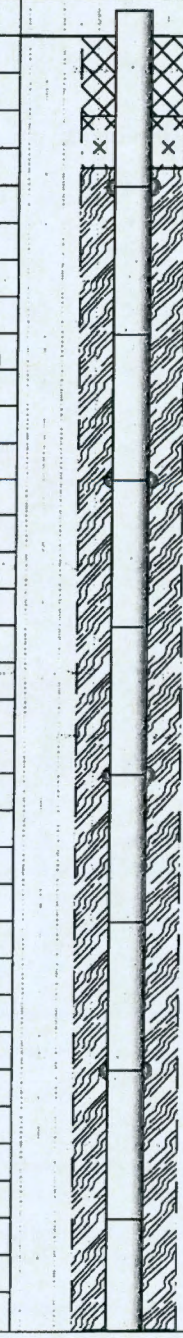
WELL SUMMARY SHEET

Well ID: C9632	Well Name: 699-27-68	Start Date: 5/25/2017
Project: 200-UP-1 4 Monitoring Wells	Location: ~0.75 mi. NE of Rattlesnake Barricade	End Date: 8/21/2017

CONSTRUCTION DATA

Description
WA Dept. of Ecology Tag: BJB-536
Temporary Casing Depths
8" CS Wld. Joints = 345.64 ft bgs
Permanent Well Materials
4-in ID Stainless Steel Blank
2.10' ags - 214.39' bgs
4" ID Stainless Steel 20-Slot Screen
214.39' - 244.39' bgs
4-in ID Stainless Steel Blank
244.39' - 254.39' bgs
4" ID Stainless Steel 20-Slot Screen
254.39' - 284.40' bgs
4" ID Stainless Steel Sump
284.40' - 287.45' bgs
Note: 2" Welded Tab Centralizers are placed top and bottom of each screen and every 40 ft thereafter.

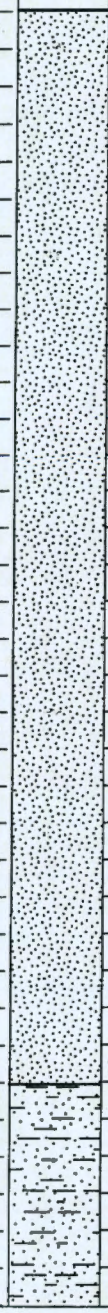
Diagram



GEOLOGIC/HYDROLOGIC DATA

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

Graphic Log



Lithologic Description (ft bgs)

0 - 145 ft: Sand [(S)]

145 - 175 ft: Silty Sand [(mS)]

Reported By:			
Cameron Ryan Burns	Geologist		9/24/17
Print Name	Title	Signature	Date
Reviewed By:			
Kelly Whitley	Well Coordinator	Kelly Whitley	9/27/17
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

SGW-61319, REV. 0

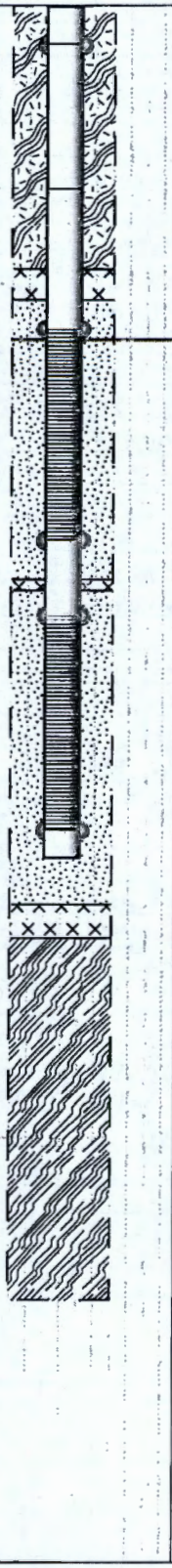
WELL SUMMARY CONTINUATION SHEET

Well ID: C9632 | Well Name: 699-27-68 | Project: 200-UP-1 4 Monitoring Wells

CONSTRUCTION DATA

Description
Well Construction Materials
Type I-II Portland Cement
0.00' - 9.50' bgs
3/8" Bentonite Crumbles
9.50' - 16.50' bgs
Bentonite Slurry
16.50' -208.15' bgs
3/8" Coated Bentonite Pellets
208.15' - 211.20' bgs
10-20 Colorado Silica Sand
211.20' - 249.72' bgs
3/8" Coated Bentonite Pellets
249.72' - 252.67' bgs
10-20 Colorado Silica Sand
252.67' - 289.78' bgs
3/8" Coated Bentonite Pellets
289.78' - 298.90' bgs
Bentonite Slurry
298.90' - 348.39' bgs
Note:
A straightness test was performed and passed prior to well construction, per WAC 173-160 requirements.
All temporary casings have been fully removed from the ground.
All depths represented are in feet below ground surface (ft bgs) unless otherwise noted.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 175, 200, 225, 250, 275, 300, 325, 350, 375

Graphic Log

Lithologic Description (ft bgs)
175 - 180 ft: Silty Gravel [(mG)]
180 - 195 ft: Gravelly Silty Sand [(gmS)]
195 - 200 ft: Sand [(S)]
200 - 210 ft: Silty Sand [(mS)]
210 - 235 ft: Gravel [(G)]
Depth to Water = 217.27 ft bgs (8/15/2017)
235 - 245 ft: Gravel [(G)]
245: Sandy Gravel [(sG)]
250: Gravel [(G)]
275: Sandy Gravel [(sG)]
280: Gravelly Sand [(gS)]
300: Sandy Gravel [(sG)]
330: Silty Sandy Gravel [(msG)]
340 : Gravelly Sandy Silt [(gsM)]
Total Depth = 348.39 ft bgs

A-6006-992 (REV 0)

BOREHOLE LOG

Page 1 of 9
Date: 5-25-17

Well ID: C9632 | Well Name: 699-27-68 | Location: ~0.75 mi NE of Rattlesnake Barricade
Project: 200-UP-1 4 Monitoring Wells | 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
			0-145 : Sand (S)	Dual Air Rotary w/Tricone, 8" case
0				
5	G.S.		@ 5' bgs: 5% silt, 95% v.fn.-med. sand; s: 30%m/70%f; dry, well sorted-mod. well sorted, sub. ang.-sub. rnd., ~~violent~~ strong HCl rxn, 10YR 4/3 brown AR 5.25.17	
10	G.S.		@10' bgs: 8% silt, 92% v.fn.-med. sand; s: 85%m/85%f; dry, well sorted, strong HCl rxn, 10YR 6/2 light brownish gray	
15	G.S.		@ 15' bgs: 5% silt, 95% v.fn.-crs. sand (fn.-med.); s: 25%m/75%f; dry, well sorted, strong HCl rxn, 10YR 5/2 grayish brown	
20	G.S.		@20' bgs: 8% silt, 92% v.fn.-med. sand; s: 30%m/70%f; dry, well sorted, strong HCl rxn, 10YR 4/2 dark grayish brown	
25	G.S.		@25' bgs: 5% silt, 95% v.fn.-v.crs. sand; s: 30%m/70%f; dry, mod. well sorted, strong HCl rxn, 10YR 5/2 grayish brown	
30	G.S.		@ 30' bgs: 8% silt 92% v.fn.-v.crs. sand (v.fn.-med.); s: 25%m/75%f; dry, mod. well sorted, mod. HCl rxn, 10YR 5/2 grayish brown	

Reported By:			
Andrew Raulerson	Staff Geologist	[signature]	5-25-17
Print Name	Title	Signature	Date
Reviewed By:			
Sarah Springer	geologist	[signature]	06-28-17
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Date: 5.25.17

*AR 5.25.17

Well ID: C9632 | Well Name: ~~699-28~~ 699-27.68 | Location: ~0.75 mi NE of Rattlesnake barricade

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.		0-145: Sand (s)	Dual tier Rotary w/ Tricone, 8" case
	*AR 5.25.17		@35' bgs: 10% silt, 90% sand (v.fn.-v.crs.); s: 25%m/75% f; dry, mod. well sorted, sub.ang.-sub. rnd., strong HCl rxn, 10YR 4/2 dark grayish brown	
40	G.S.		@40' bgs: 5% silt, 90% v.fn.-v.crs. sand, 5% v.fn.-v.crs. pebbles (max 35mm); s: 35%m/65% f, p: 60% m/40% f; dry, mod. sorted, sub.ang.-sub.rnd., strong HCl rxn, 10YR 6/2 light brownish gray	
45	G.S.		@45' bgs: 5% silt, 92% v.fn.-v.crs. sand, 3% vfn.-fn. pebbles; s: 30%m/70%f, p: 70%m/30%f; dry, mod. well sorted, strong HCl rxn, 10YR 5/2 grayish brown	
50	G.S.		@50' bgs: 3% silt, 97% sand (v.fn.-v.crs.); s: 35% m/65% f; dry, well sorted, strong HCl rxn, 10YR 5/3 brown	
55	G.S.		@55' bgs: 3% silt, 97% sand (v.fn.-v.crs); s: 30% m/70% f; dry, well sorted, mod. HCl rxn, 10YR 5/2 grayish brown	
60	G.S.		@60' bgs: 5% silt, 95% v.fn.-med. sand (15% mica); s: 35%m/65% f; dry, well sorted, very strong HCl rxn, 10YR 5/2 grayish brown	
65	G.S.		@65' bgs: 5% silt, 95% v.fn-med. sand (15% mica); s: 40%m/60%f; dry, well sorted, weak HCl rxn, 10YR 5/2 grayish brown	
70	G.S.		@70' bgs: 5% silt, 95% v.fn.-med. sand (20% mica); s: 35%m/65% f; dry, well sorted, mod. HCl rxn, 10YR 5/3 brown	

Reported By:

Print Name	Title	Signature	Date
Andrew Rawlerson	Staff Geologist	Andrew R	5.30.17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 9

Date: 5-30-17

Well ID: C9632 | Well Name: 699-27-68 | Location: ~0.75 mile NE of Railroad Terminal

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
	G.S.		0-145: Sand (s)	Bad air Rotary, 4 Hours, 8" casing
75	KF for		@ 75' bgs: 0% silt, 94% v.fn.-med. sand; s: 35% m/65% f; dry, well sorted, sub ang.-sub rnd., very strong HCl rxn, 10YR 5/2 grayish brown	
80	G.S.		@ 80' bgs: 3% silt, 97% v.fn.-med. sand; s: 40% m/60% f; dry, well sorted, very strong HCl rxn, 10YR 5/2 grayish brown	
85	G.S.		@ 85' bgs: 9% silt, 91% v.fn.-med. sand; s: 35% m/65% f; dry, well sorted, strong HCl rxn, 10YR 5/3 brown	
90	G.S.		@ 90' bgs: 5% silt, 95% v.fn.-med. sand; s: 30% m/70% f; dry, well sorted, strong HCl rxn, 10YR 5/2 grayish brown	
95	G.S.		@ 95' bgs: 9% silt, 91% v.fn.-crs. sand (v.fn.-med); s: 30% m/70% f; dry, well sorted, very strong HCl rxn, 10YR 5/2 grayish brown	
100	G.S.		@ 100' bgs: 3% silt, 97% sand (fn.-crs.); s: 35% m/65% f; dry, well sorted, no HCl rxn, 10YR 5/2 grayish brown	
105	G.S.		@ 105' bgs: 5% silt, 95% v.fn.-crs. sand; s: 40% m/60% f; dry, well sorted, no HCl rxn, 10YR 6/2 light brownish gray	
110	G.S.		@ 110' bgs: 5% silt, 95% v.fn.-v.crs. sand; s: 40% m/60% f; dry, well sorted, no HCl rxn, 10YR 5/2 grayish brown	

Reported By: Andrew Rawlings — Print Name | Sub Geologist | Signature | 5-30-17 Date

A-6002-893 (REV 0)

BOREHOLE LOG (Cont.)

Page 4 of 9

Date: 5·30·17

Well ID: C9632 | Well Name: 699·27·68 | Location: ~0.75mi NE of Rattlesnake Ridge

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. AR 5.30.17		0 – 145: Sand (S)	Dual Air Rotary w/ Tri-cone, 8" casing
			@115' bgs: 5% silt, 95% fn. - v. crs. sand (med); S: 35% m / 65% f; dry, well sorted, sub.ang. - sub. rnd., very weak HCl rxn, 10YR 5/2 grayish brown	
120	G.S.		@120' bgs: 5% silt, 95% v.fn. - med. sand; S: 25% m / 75% f; dry, well sorted, very weak HCl rxn, 10YR 6/2 light brownish gray	
125	G.S.		@125' bgs: 5% silt, 95% v.fn. - med. sand (fine); S: 30% m / 70% f; dry, well sorted, no HCl rxn, 10YR 5/2 grayish brown	
130	G.S.		@130' bgs: 3% silt, 97% v.fn. - med. sand; S: 35% m / 65% f; dry, well sorted, very weak HCl rxn, 10YR 6/2 light brownish gray	
135	G.S.		@135' bgs: 4% silt, 96% fn. - crs. sand (med. - crs.); S: 40% m / 60% f; dry, well sorted, no HCl rxn, 10YR 6/2 light brownish gray	
140	G.S.		@140' bgs: 3% silt, 97% v.fn. - med. sand; S: 40% m / 60% f; dry, well sorted, no HCl rxn, 10YR 5/2 grayish brown	
145	G.S.		145 – 175: Silty Sand (mS)	
			@145' bgs: 35% silt, 65% vfn. - med. sand; S: 20% m / 80% f; slightly moist - dry, well sorted, sub.ang. - sub.rnd., strong HCl rxn, 10YR 5/3 brown	
150	G.S.		@150' bgs: 25% silt, 75% v.fn. - med. sand; S: 30% m / 70% f; dry, well sorted, weak HCl rxn, 10YR 5/3 brown	

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	Andrew	5·31·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

AR 5.31.17

Date: 5.31.17

Well ID: C9632 | Well Name: ~~699-28~~699-27-68 | Location: ~0.75 mi NE of Rattlesnake Barricade

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. AR 5.31.17		145-175 : Silty Sand (mS)	Dual tir Rotary w/Tricone, 8" casing
			@155' bgs: 40% silt, 60% sand (v.fn.-med.); s: 35%m/65%f; slightly dry, well sorted, sub.ang.-sub.rnd., strong HCl rxn, 10YR 5/3 brown	
160	G.S.			
			@160' bgs: 35% silt, 65% sand (v.fn.-med.; fine); s: 35%m/65%f; dry, well sorted, strong HCl rxn, 10YR 5/3 brown	
165	G.S.			
			@165' bgs: 35% silt, 60% v.fn.-med. sand, 5% pebbles; s: 25%m/75%f, p: 70%m/30%f (24mm max); dry, mod. sorted, very strong HCl rxn, 10YR 4/3 brown	
170	G.S.			
			@170' bgs: 30% silt, 61% v.fn.-v.crs. sand, 9% v.fn.-crs. pebbles (max 20mm); s: 40%m/60%f, p: 75%m/25%f; dry, mod. sorted, very strong HCl rxn, 10YR 4/4 dark yellowish brown	
175	G.S.		175-180 : Silty Gravel (mG)	
			@175' bgs: 30% silt, 30% v.fn.-v.crs. sand, 40% v.fn.-crs. pebbles (max 30mm); s: 30%m/70%f, p: 75%m/25%f; slightly moist, poorly sorted, sub.ang.-sub.rnd., weak HCl rxn., 10YR 4/4 dark yellowish brown (AR 5.31.17)	
180	G.S.		180-195 : Gravelly Silty Sand (gmS)	
			@180' bgs: 20% silt, ~~5~~ 50% v.fn.-v.crs sand, 20% v.fn.-crs. pebbles (max 27mm); s: 20%m/80%f, p: 80%m/20%f; dry, poorly sorted, sub.ang.-sub.rnd., weak HCl rxn, 10YR 4/4 dark yellowish brown (AR 5.31.17)	
185	G.S.			
			@185' bgs: ~~15% silt~~, 21% silt, 59% v.fn.-v.crs. sand, 20% v.fn.-crs. pebbles (max 20mm); s: 25%m/75%f; p: 70%m/30%f;	
190	G.S.			
			@190' bgs: 25% silt, 55% v.fn.-v.crs. sand, 20% v.fn.-crs pebbles; s: 25%m/75%f, p: 75%m/25%f (max 29mm);	

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	Andrew R	5.31.17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 6 of 9

Date: 5.31.17

Well ID: C9632 | Well Name: 699-27-68 | Location: ~0.75 mi NE of Rattlesnake Barricade

AR 6.1.17

Depth (ft)	Graphic ~~Sample~~ Log	AR 6.1.17 ~~Graphic Log~~ Sample	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	195-200: Sand (S)	Dual Air Rotary w/ Tricone 8" case
AR 5.31.17			@ 195' bgs: 10% silt, 90% v.fn. - v.crs. sand (crs.); s: 35%m/65%f; slightly moist, well sorted, sub.ang. - sub.rnd., no HCl rxn, 10YR 5/3 brown	
200		G.S.	200-210: Silty Sand (mS)	
			@ 200' bgs: 35% silt, 65% v.fn. - med. sand (fine); s: ~~80~~ 20%m/80%f; slightly moist, well sorted, sub. ang. - sub. rnd., very strong HCl rxn, 10YR 4/3 brown	
205		G.S.		
			@ 205' bgs: 20% silt, 75% v.fn. - v.crs. sand, 5% v.fn. - fn. pebbles (max 6mm); s: 35%m/65%f, p: 65%m/35%f; mod. sorted, weak HCl rxn, 10YR 4/3 brown	
210		G.S.	210 - 235: Sandy Gravel (SG)	
			@ 210' bgs: 3% silt, 20% v.fn. - v.crs. sand, 77% v.fn. - v.crs pebbles (max 54mm); s: 25%m/75%f, p: 70%m/30%f; dry, poorly sorted, sub.ang. - rnd., very weak HCl rxn, 10YR 4/2 dark grayish brown	
215		G.S.		
			@ 215' bgs: 3% silt, 25% v.fn. - v.crs. sand, 73% v.fn. - v.crs. pebbles (max 45 mm); s: 35%m/65%f, p: 80%m/20%f;	Water encountered @ 217' bgs 6.1.17
220		G.S.		
			@ 220' bgs: 2% silt, 40% v.fn. - v.crs. sand, 58% v.fn. - crs. pebbles (max 30mm); s:	
225		G.S.		
			@ 225' bgs: 5% silt, 40% v.fn. - v.crs. sand, 55% v.fn. - crs. pebbles (max 28mm); s: 20%m/80%f, p: 80% m/20%f; 10YR 4/3 brown	
230		G.S.		
			@ 230' bgs: 8% silt, 30% v.fn. - v.crs. sand, 62% v.fn. pebbles - small cobbles (max 75mm); s: 25%m/75%f, p+c: 80%m/20%f; slightly moist, 10YR 4/2 dark grayish brown	

Reported By:

Print Name	Title	Signature	Date
Andrew Ramlerson	Staff Geologist	[signature]	6.1.17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 7 of 9

Date: 6·1·17

Well ID: C9632 | Well Name: 699·27·68 | Location: ~0.75 mi NE of Rattlesnake Barricade

AR 6·1·17

Depth (ft)	Graphic ~~Sample~~ Log	AR 6·1·17 ~~Graphic Log~~ Sample	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
235 AR 6·1·17		G.S.	235-245: Gravel (G)	Dual Air Rotary w/ tricone, 8" case
		W.S.	@235' bgs: 5% silt, 5% v.fn.-v.crs. sand, 90% v.fn.-v.crs. pebbles (max 55mm); s: 30%m/70%f, p: 85%m/15%f; slightly moist, poorly sorted, sub. ang.- sub.rnd., no HCl rxn, 10YR 5/2 grayish brown	SS# I-002, HEIS: B3B044, 234.86' bgs - 237.21' bgs, Liner B 6·1·17
240		G.S.	@240' bgs: 2% silt, 10% v.fn.-v.crs. sand, 88% v.fn. pebbles - small cobbles (max 70mm); s: 40%m/60%f, p+c: 80%m/20%f; wet, sub.ang.-rnd., poorly sorted, no HCl rxn, 10YR 2/2 very dark brown	H_2O sample # I-001, HEIS: B3B042, B3B043, B3B044, B3B046, B3B047, B3B048; Actual depth 235.21' bgs, 6·5·17
245		G.S.	245-250: Sandy Gravel (sG)	
			@245' bgs: 5% silt, 35% v.fn.-v.crs. sand, 60% v.fn. pebbles - small cobbles (max 90mm); wet, poorly sorted, sub.ang.-rnd., no HCl rxn; s: 30%m/70%f, g: 70%m/30%f; 10YR 3/1, very dark gray	
250		G.S.	250-275: Gravel (G)	
			@250' bgs: 3% silt, 7% v.fn.-v.crs. sand, 90% v.fn.-crs. pebbles (max 31mm); AR 6·6·17 s: 30%m/70%f, g: 75%m/25%f; wet, poorly sorted, sub.ang.-sub.rnd., no HCl rxn, 10YR 4/2 dark grayish brown	
255		W.S. ~~G.S.~~		~~H_2O sample # I-001, HEIS: B3B042, B3B043, B3B044, B3B046, B3B047, B3B048, Actual depth 235.21' bgs, 6·5·17~~
			@255' bgs: 3% silt, 12% v.fn.-v.crs. sand, 85% v.fn.-v.crs. pebbles; s: 25%m/75%f, g: 60%m/40%f; AR 6·6·17 ~~wet~~ 10YR 3/2 very dark grayish brown	H_2O sample I-003, HEIS: B3B050, B3B051, B3B052, B3B054, B3B055, B3B056; Actual depth 254.60' bgs, 6·7·17
260		G.S.	@260' bgs: 5% silt, 10% v.fn.-v.crs. sand, 85% v.fn.-v.crs. pebbles (max 34mm); s: 40%m/60%f, g: 70%m/30%f; 10YR 4/3 brown	
265		G.S.	@265' bgs: 5% silt, 15% v.fn.-v.crs. sand, 80% v.fn. pebbles - small cobbles (max 85mm); s: 30%m/70%f, g: 60%m/40%f; 10YR 5/2 grayish brown	May not represent all sand at this depth, a large amount of sand came out around 262'-263' bgs.
270		G.S.	@270' bgs: 3% silt, 10% v.fn.-v.crs. sand, 87% v.fn.-small cobbles (max 90mm); s: 30%m/70%f, g: 65%m/35%f; 10YR 3/2 very dark grayish brown	

AR 6·26·17

Reported By:

Print Name	Title	Signature	Date
Andrew Rawlerson	Staff Geologist	[signature]	6·7·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 8 of 9

Date: 6·13·17

Well ID: CQ632 | Well Name: 699·27·68 | Location: ~0.75 mi NE of Rattlesnake Barricade

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. W.S.		250 - 275 Gravel (G)	Dual Air Rotary w/ tri cone 8" casing
	S.S.		@ 275' bgs: 2% silt, 8% v.fn.-v.crs. sand, 90% v.fn.- v.crs. pebbles (58mm max); S: 30%m/70%f, g: 60%m/40%f; wet, poorly sorted, sub.ang.-rnd., no HCl rxn, 10YR 3/1 very dark gray	S.S. #I-005, HEIS: B3B055, ~~255~~ 275.03' bgs-275.53' bgs, Liner A, 6-8-17
280	G.S.		275 - 280 : Sandy Gravel (sG)	H_2O sample I-004, HEIS: B3B058, B3B059, B3B060, B3B062, B3B063
			@280' bgs: 10% silt, 45% v.fn.- v.crs. sand, 45% v.fn.- v.crs. pebbles (max 36mm); S: 30%m/70% f, g: 60%m/40%f; wet, poorly sorted, sub.ang.-sub.rnd., no HCl rxn, 10YR 4/3 brown	B3B064; Actual Depth 274.11' bgs, 6-12-17
285	G.S.		280 - 300' : Gravelly Sand (gS)	
			@285' bgs: 10% silt, 75% v.fn.- v.crs. sand, 15%, v.fn.- small pebbles cobbles (max 65mm); S: 40%m/60% f; g: 60%m/40%f; wet, poorly sorted, sub.ang.-rnd., no HCl rxn, 10YR 3/2 very dark grayish brown	
290	G.S.		@290' bgs: 10% silt, 80% v.fn.- crs. sand, 10% v.fn.- crs. pebbles (max 28mm); S: 30%m/70%f, g: 70%m/30%f; ~~AE 6-13-17~~ same as above	
295	G.S. W.S.		@295' bgs: 10% silt, 75% v.fn.- v.crs. sand, 15% v.fn.- crs. pebbles (max 28mm); S: 35%m/65% f, g: 70%m/30%f; same as above	H_2O sample I-006, HEIS: B3B066, B3B067, B3B068, B3B070, B3B071, B3B072; Actual Depth 295.95' bgs, 6-15-17
300	G.S.		~~@300' bgs:~~ 300' - 330 Sandy Gravel (sG): [55% S, 35% G, 10% M]; Sand: fine-med. grn., well sort., 95% f - 5% m, ang.-sub ang. (60% fine - 40% med grn.); Gravel: v. poor sort, ang-rnd., basalt/quartzite mix, 5mm - 40mm (pebbles); Silt: in suspension; HCl rxn: N/A (saturated); Color: ~~5Y 5/1~~ 2.5Y 4/4 olive brown; ~~[illegible]~~ Saturated.	
305	G.S.			
310	G.S.		@ 305' Sandy Gravel (sG). Sand: fine-v. crse grn. (60% fine, 20% med., 20% v. crse grn.); Gravel: 3mm - 65mm (granule - cobble); Color: 2.5Y 5/3 lt. olive brown.	

Reported By:

Andrew Rawlerson / Jess Hocking | Staff Geologist / Sr. Geologist | [signature] | 6·19·17

Print Name | Title | Signature | Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 6-19-2017

Well ID: C9632 | Well Name: 699-27-68 | Location: ~0.75mi. NE from Rattlesnake Bar.

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./W.S.		300-330 : Sandy Gravel (SG)	DUAL ROTARY W/
	S.S.		Same as above (@ 315' bgs)	
				8" casing.
				H_2O sample I-007, HEIS: B3B074, B3B075,
				B3B076, B3B078, B3B079, B3B080; 315.0'
320	G.S.			bgs Actual Depth, 6.20.17
			@ 320' bgs: 3% silt, 22% v.fn.-v.crs. sand, 75% v.fn.-crs pebbles; s: 40%m/60%f. g: 60%m/40% f (max 28mm); wet, poorly sorted, rnd.-sub. ang., no HCl rxn, 10YR 3/1 very dark gray	SS # I-008, HEIS: B3B0C6, 315.5' bgs - 316.5' bgs, Liner A, 6.20.17
325	G.S.		@ 325' bgs: 5% silt, 20% v.fn.-v.crs. sand, 75% v.fn.-v.crs. pebbles (max. 34mm); s: 70%f/30% m, g: 60%m/40%f; 10YR 4/2 dark grayish brown	
330	G.S.		@ 330' bgs: 3% silt, 22% v.fn.-v.crs. sand, 75% v.fn.-v.crs. pebbles (max 48mm); s: 45%m/55%f, g: 60%m/40%f; 10YR 3/1 very dark gray	*Driller noticed formation change @ ~331' bgs ~~Rum @ 331' AR~~ 6.21.17
335	G.S. W.S.		330-340: Silty Sandy Gravel (msG)	RLM @ 331' bgs
			@ 335' bgs: 20% silt, 20% v.fn.-v.crs. sand, 60% v.fn.-v.crs. pebbles (max 44mm); s: 40%m/60%f, g: 60%m/40%f; wet, poorly sorted, rnd.-sub. ang., no HCl rxn, 10YR 5/2 grayish brown	RLM 6.21.17 H_2O sample I-009, HEIS: B3B082, B3B083, B3B084, B3B086, B3B087, B3B088; Actual Depth 335.05' bgs 6.21.17
340	G.S.		@ 340' bgs: 30% silt, 30% v.fn.-v.crs. sand, 40% v.fn.-v.crs. pebbles (max 56mm); 10YR 4/1 dark gray; s: 30%m/70%f, g: 60%m/40%f.	*Likely that gravel is remnant from upper formation
345	G.S.		340-348.39: Gravely Sandy Silt (gsM)	
			@ 345' bgs: 60% silt, 20% v.fn.-v.crs. sand, 20% v.fn.-v.crs. pebbles (max 62mm); s: 40%m/60%f, g: 60%m/40%f; wet, poorly sorted, rnd.-sub. ang., no HCl rxn, 10YR 4/1 dark gray.	*TD reached @ 348.39' bgs
350				

Reported By:

Print Name	Title	Signature	Date
Andrew Rawlerson	AR 6.21.17 Staff Geologist		6.21.17

A-6006-993 (REV 0)

This page intentionally left blank.

699-27-68 (C9632)
Log Data Report

Borehole Information

Log Date	2017-06-28	Filename	C9632_HG-NM_2017-06-28	Site	200-UP-1
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
217.0	06/26/17	SN3	06/21/17	348.39	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Welded Steel	Air Rotary	1.8	8 5/8	8	5/16	-1.8	345.64

Borehole Notes

The onsite geologist provided the total depth and casing depth. Casing diameters and thicknesses were measured by the logging engineer. The maximum logging depth achieved was 348.5 ft. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 1Ld	**Type**	60% HPGe SGLS[2]
Effective Calibration Date	01/26/17	**Serial No.**	47-TP-32211A
Calibration Reference	HGLP-CC-150, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 1Hd	**Type**	NMLS[3] (CPN 503DR)
Effective Calibration Date	02/23/17	**Serial No.**	H310700352
Calibration Reference	HGLP-CC-151, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	**3**	**4**	**5 Repeat**		
HEIS Number	1019945	1019946	1019947		
Date	06/27/17	06/28/17	06/28/17		
Logging Engineer	Spatz	Meisner/Spatz	Spatz		
Start Depth (ft)	0.0	187.0	312.0		
Finish Depth (ft)	188.0	348.0	347.0		
Count Time (sec)	100	100	100		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	1.0	1.0		
Log Speed (ft/min)	N/A	N/A	N/A		
Pre-Verification	C9632ALD2017 0627AV00CAB 1	C9632ALD2017 0628AV00CAB 1	C9632ALD2017 0628AV00CAB 1		
Start File	AD000000	AD018700	BD031200		

[1] depth to water inside casing
[2] Spectral Gamma Logging System
[3] Neutron Moisture Logging System

Log Run	3	4	5 Repeat		
Finish File	AD018800	AD034800	BD034700		
Post-Verification	C9632ALD2017 0627AV00CAA 1	C9632ALD2017 0628BV00CAA 1	C9632ALD2017 0628BV00CAA 1		
Depth Return Error (in.)	1.5	N/A	0.0		
Comments	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made		

NMLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1019948	1019949			
Date	06/26/17	06/26/17			
Logging Engineer	Spatz/McClellan	Spatz			
Start Depth (ft)	0.0	190.0			
Finish Depth (ft)	217.0	207.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9632AHD2017 0626AV00CAB 1	C9632AHD2017 0626AV00CAB 1			
Start File	AD000000	BD019000			
Finish File	AD021700	BD020700			
Post-Verification	C9632AHD2017 0626BV00CAA 1	C9632AHD2017 0626BV00CAA 1			
Depth Return Error (in.)	N/A	0.0			
Comments	None	None			

Logging Operation Notes

Logging was conducted with a centralizer on the sondes.

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

Analysis Notes

Analyst	P.D. Henwood	Date	07/21/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

Casing correction for a 5/16-in. thick casing was applied to the collected data.

A water correction was applied below 217 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in an EXCEL template identified as ALD20170126 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

An interpreted data set was created for this borehole. Depth overlaps from consecutive log runs were removed from 187and 188 ft. This results in a data set where only one data point is presented for each depth.

NMLS data are reported in percent volumetric moisture content because the 8-in. casing size fits the calibration condition. Typically the casing sizes utilized do not fit the calibration conditions and results are reported in counts per second.

HGU[4] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Calibration Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected in this borehole.

Based on low K, T and total gamma, voids may exist behind the casing at approximately 219 ft and from 262 to 278 ft. The logging sonde was performing correctly in these intervals.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

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

List of Log Plots

Depth Reference is ground surface.

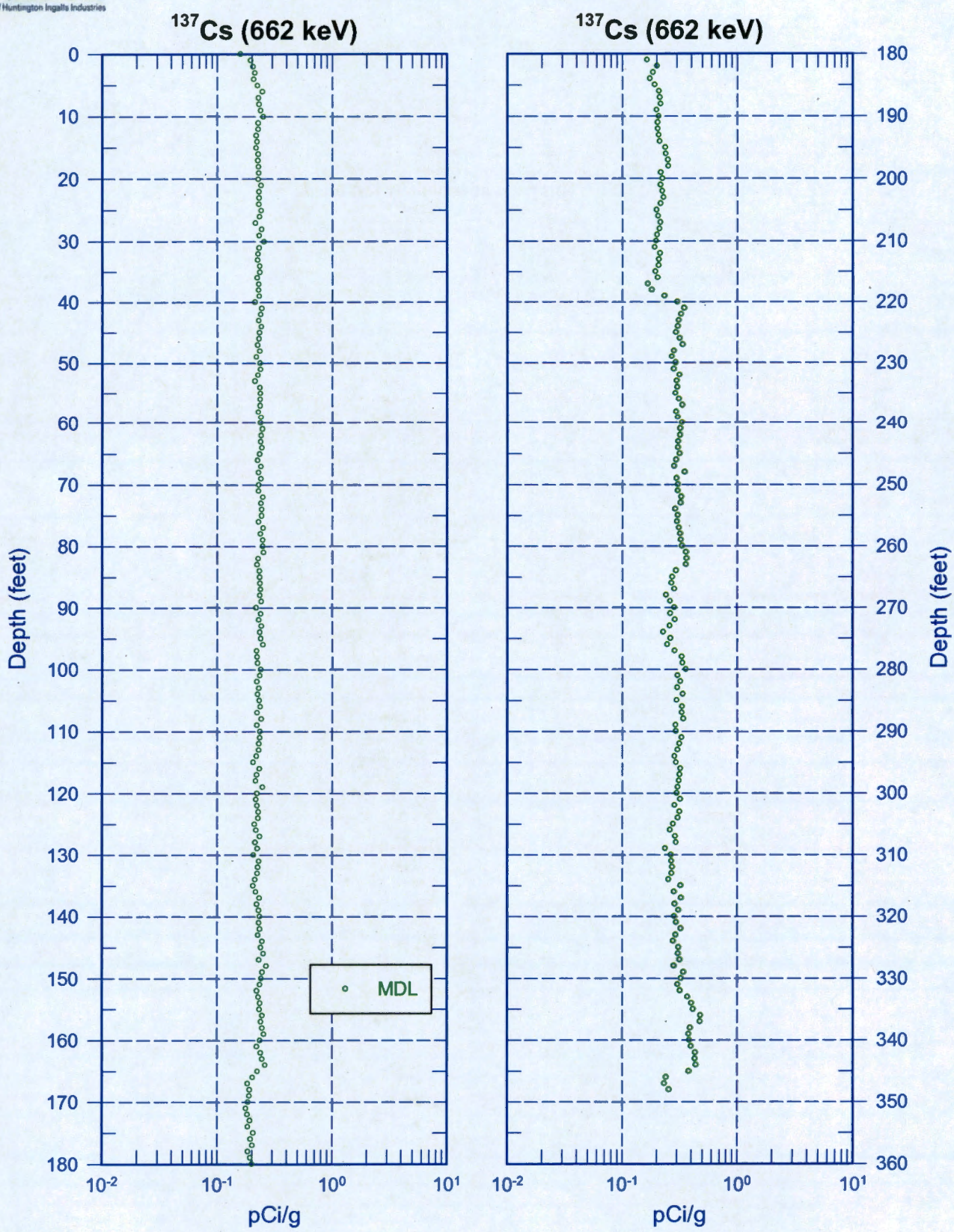
Manmade Radionuclides (0-360 ft)
Natural Gamma Logs (0-160 ft)
Natural Gamma Logs (150-310 ft)
Natural Gamma Logs (300-460 ft)
Combination Plot (0-120 ft)
Combination Plot (120-240 ft)
Combination Plot (240-360 ft)
Combination Plot (0-360 ft)
Total Gamma & Moisture (0-160 ft)
Total Gamma & Moisture (150-310 ft)
Total Gamma & Hanford Gamma Unit (0-360 ft)
Repeat Section of Natural Gamma Logs (312-347 ft)
Moisture Repeat Section (190-207 ft)

[4] Hanford Gamma Unit

This page intentionally left blank.

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

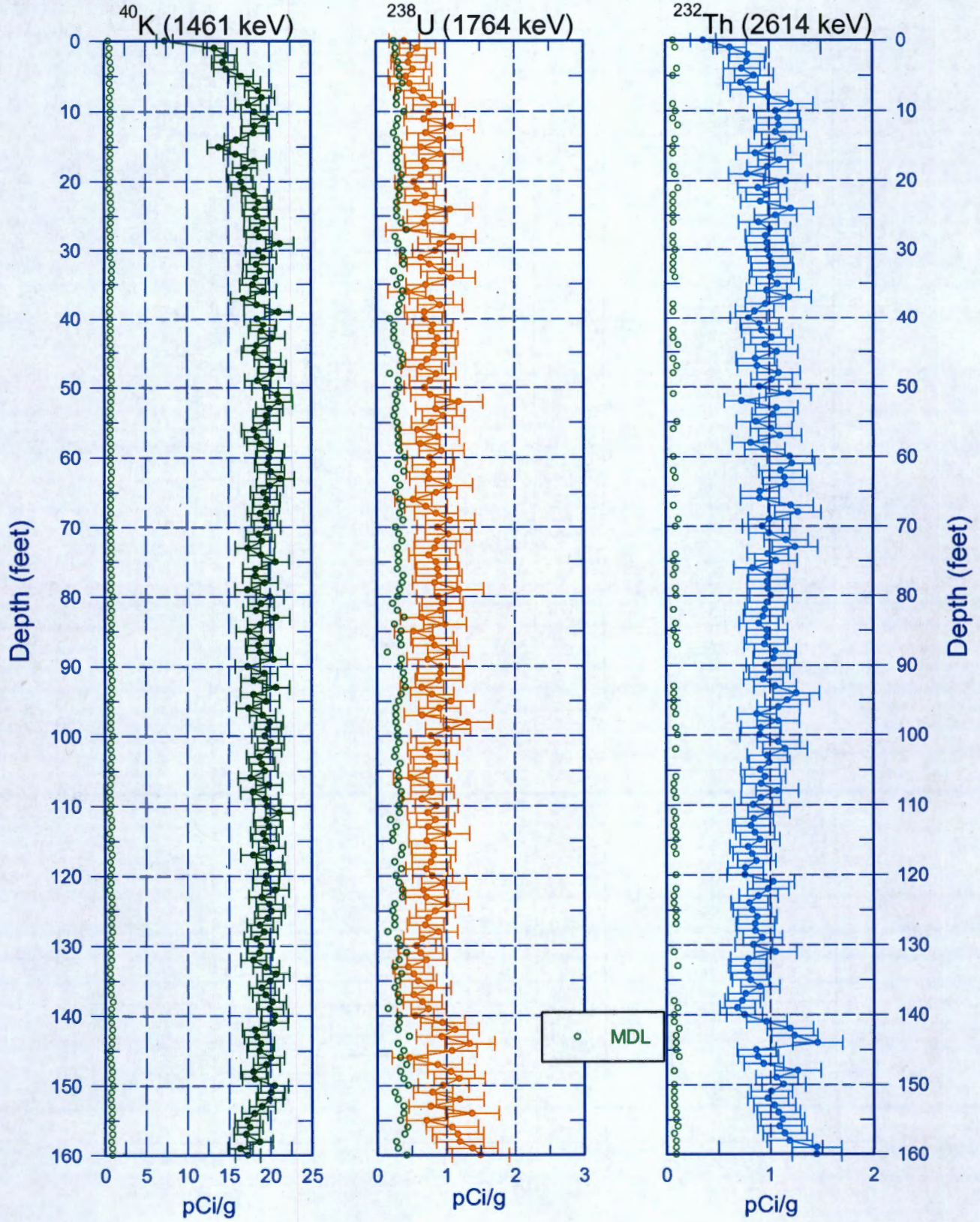
699-27-68 (C9632)
Manmade Radionuclides



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

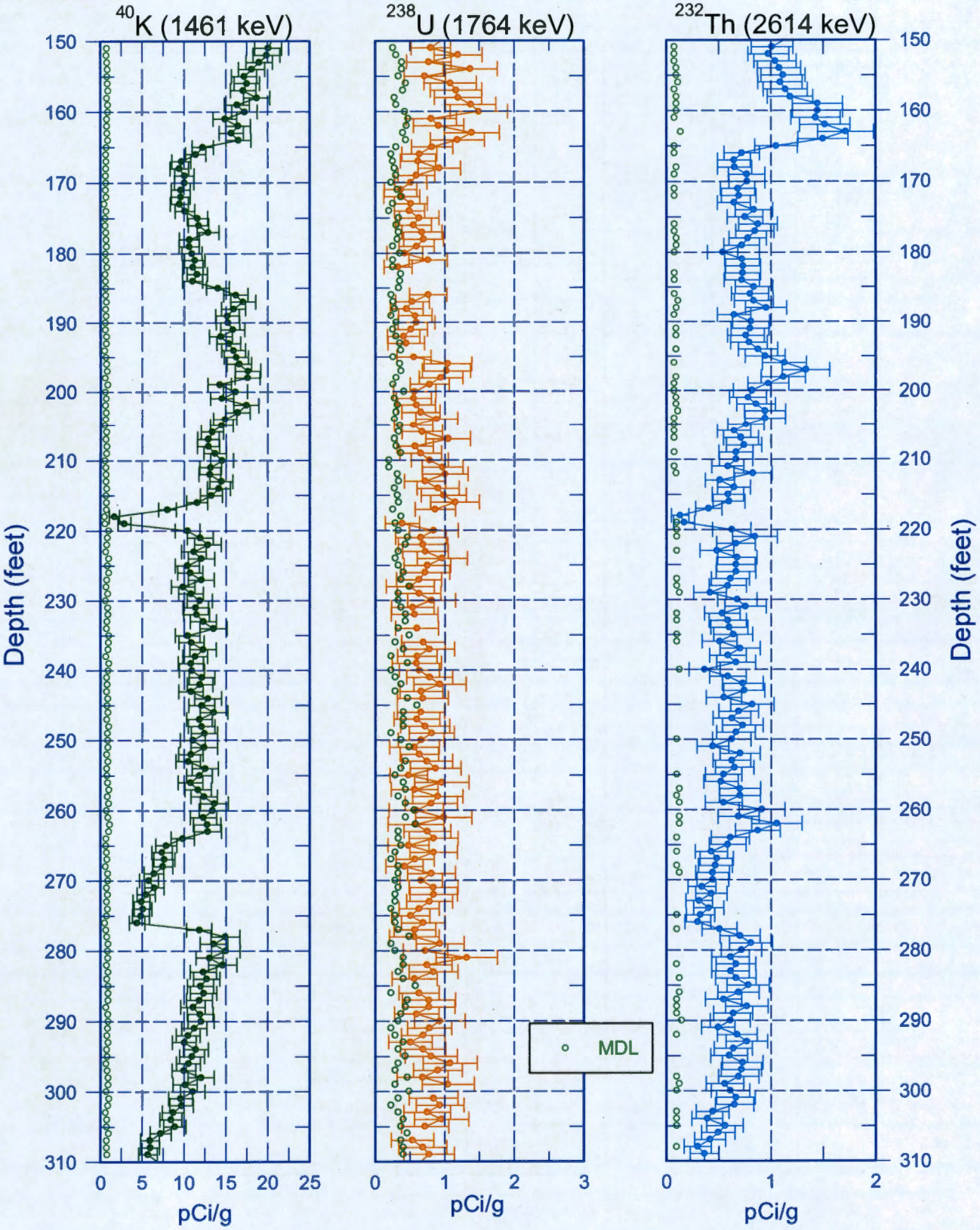
699-27-68 (C9632)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632)
Natural Gamma Logs

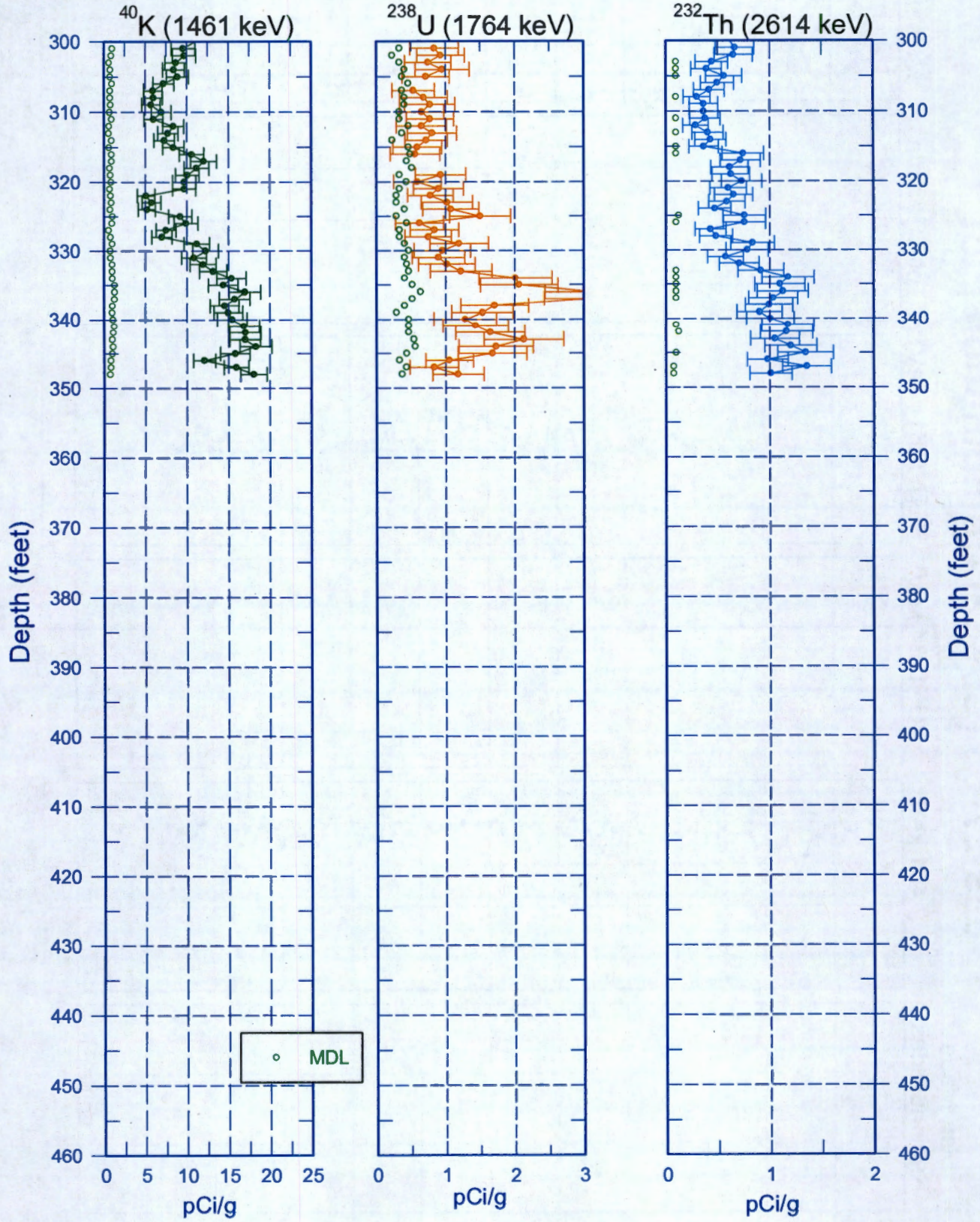


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632)

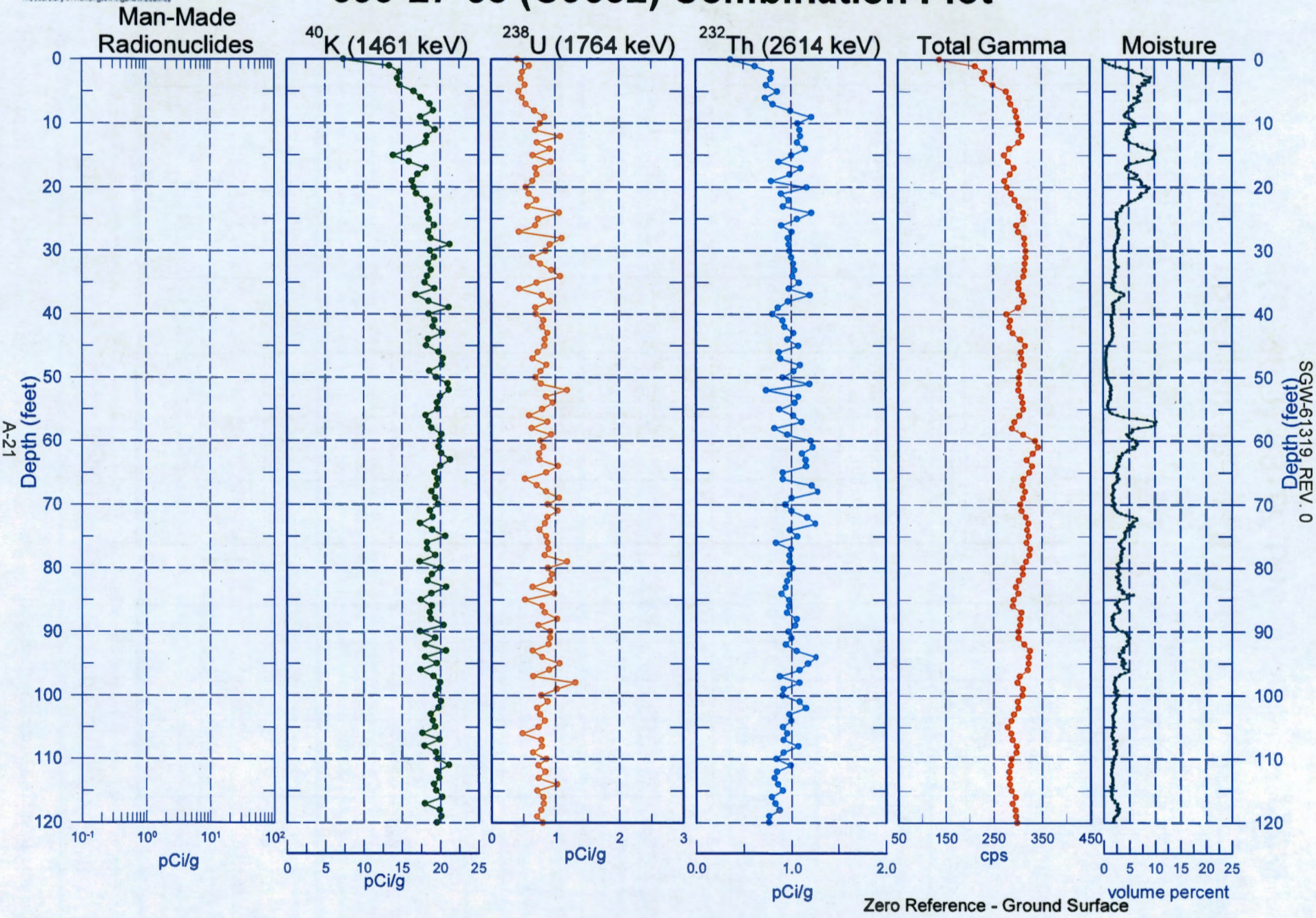
Natural Gamma Logs



Zero Reference - Ground Surface

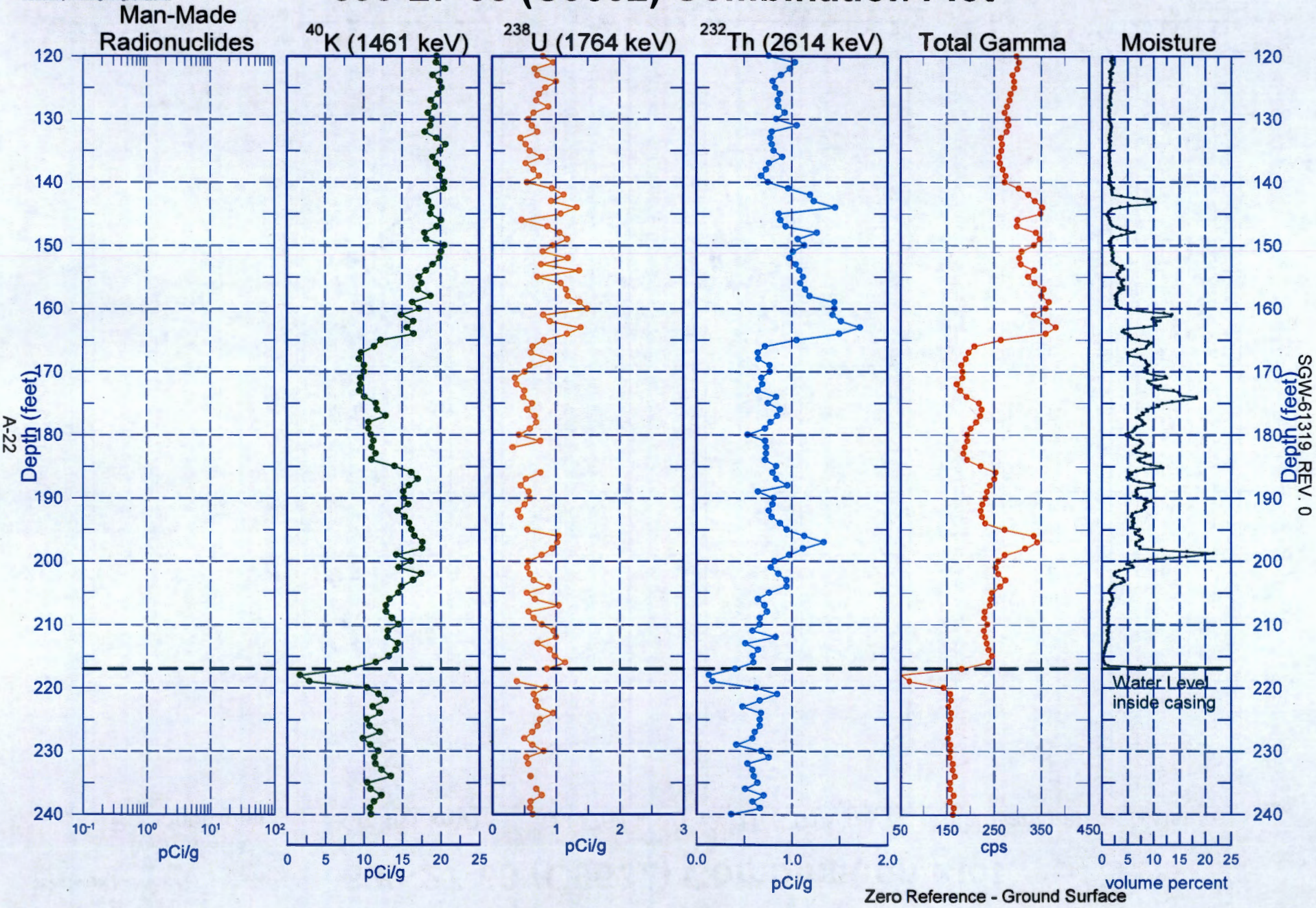
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632) Combination Plot



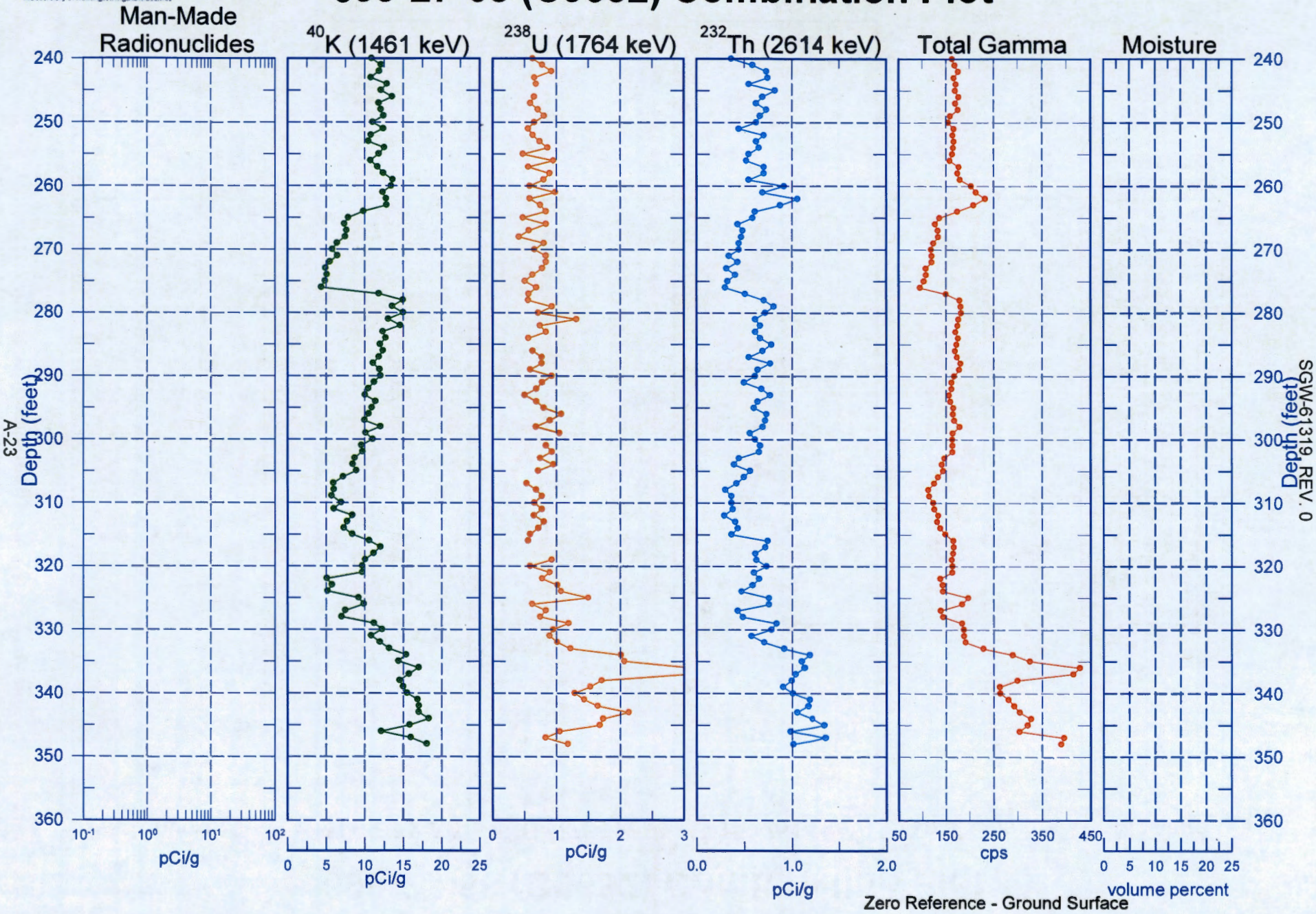
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632) Combination Plot



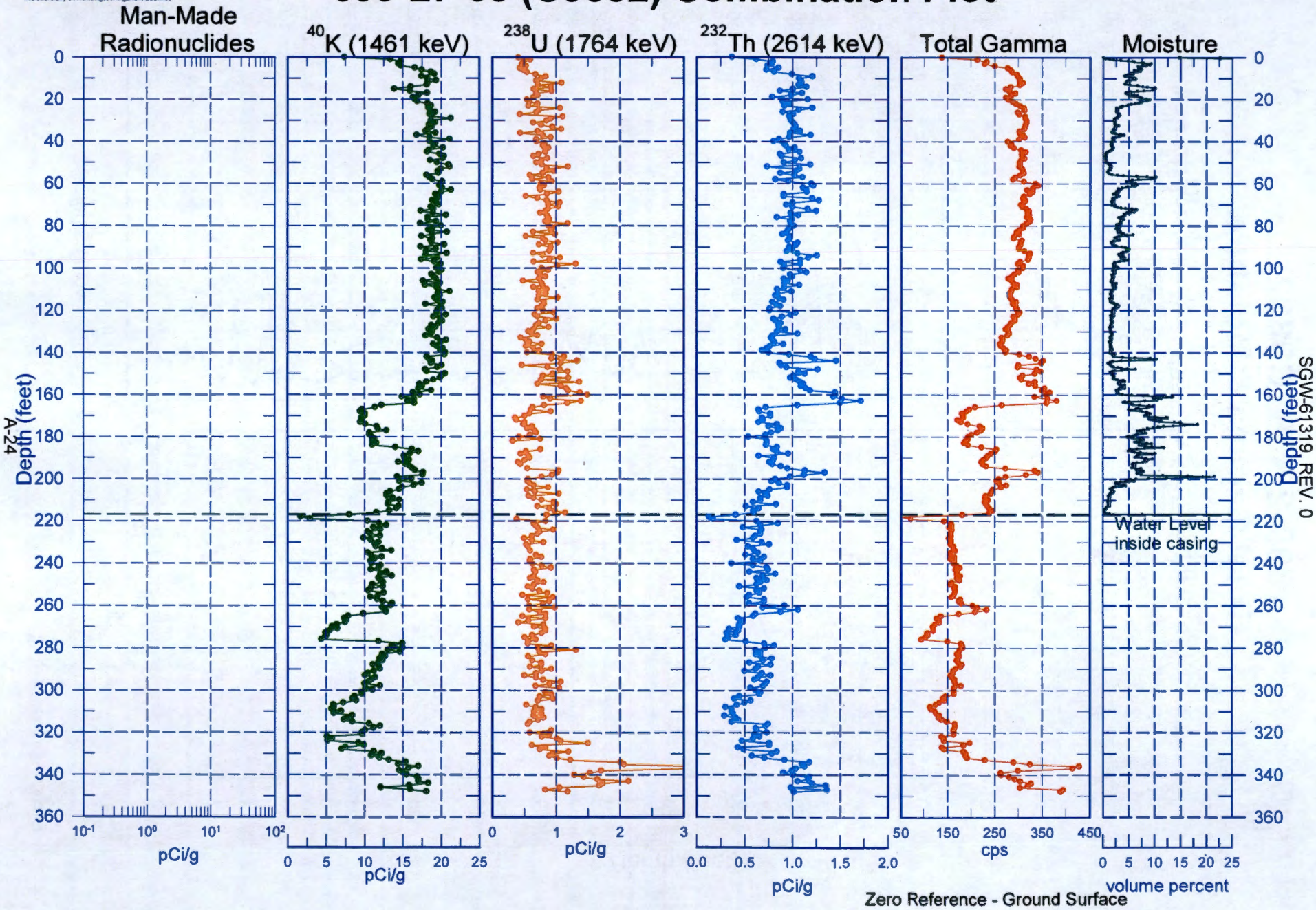
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632) Combination Plot



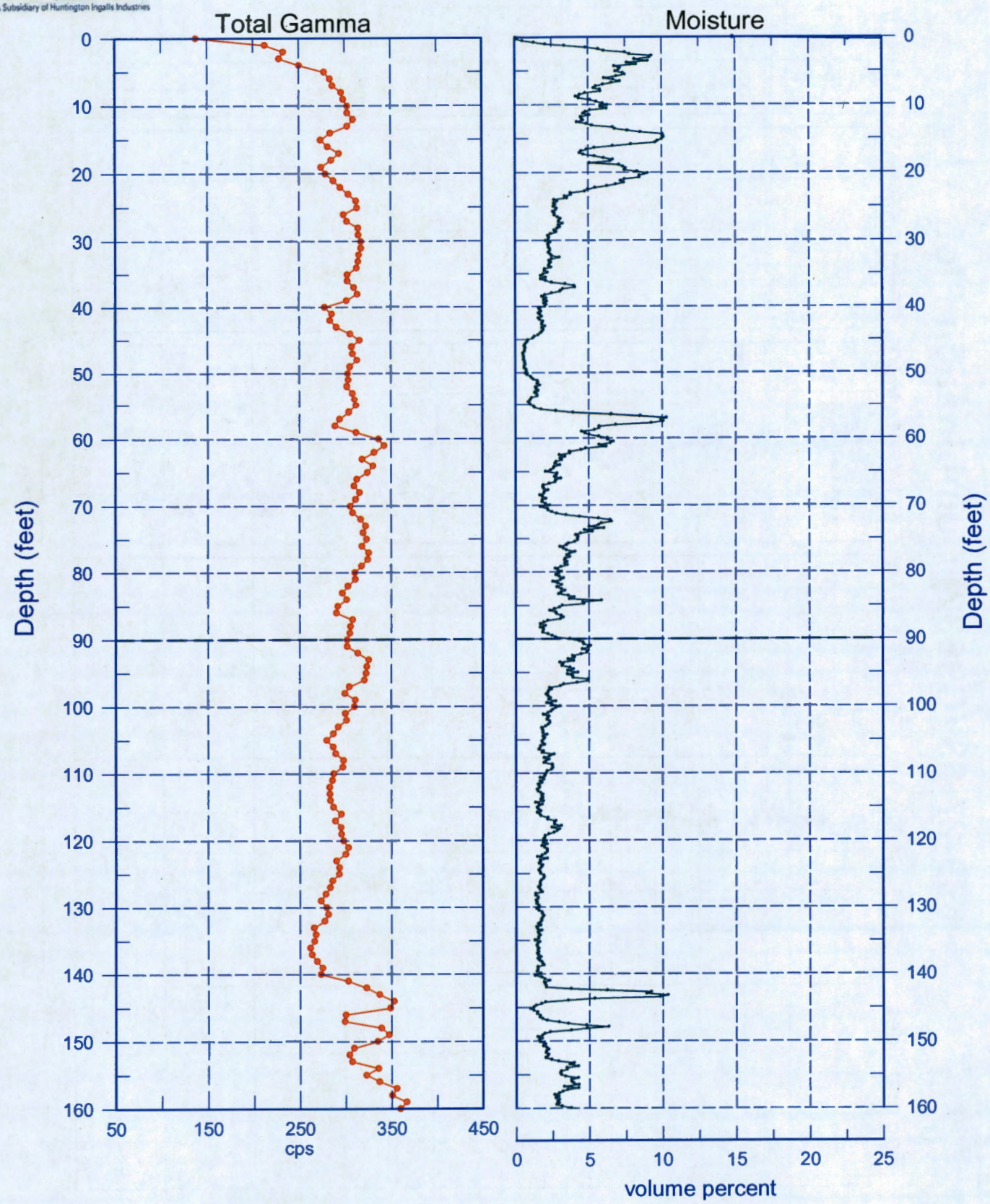
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632) Combination Plot



Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

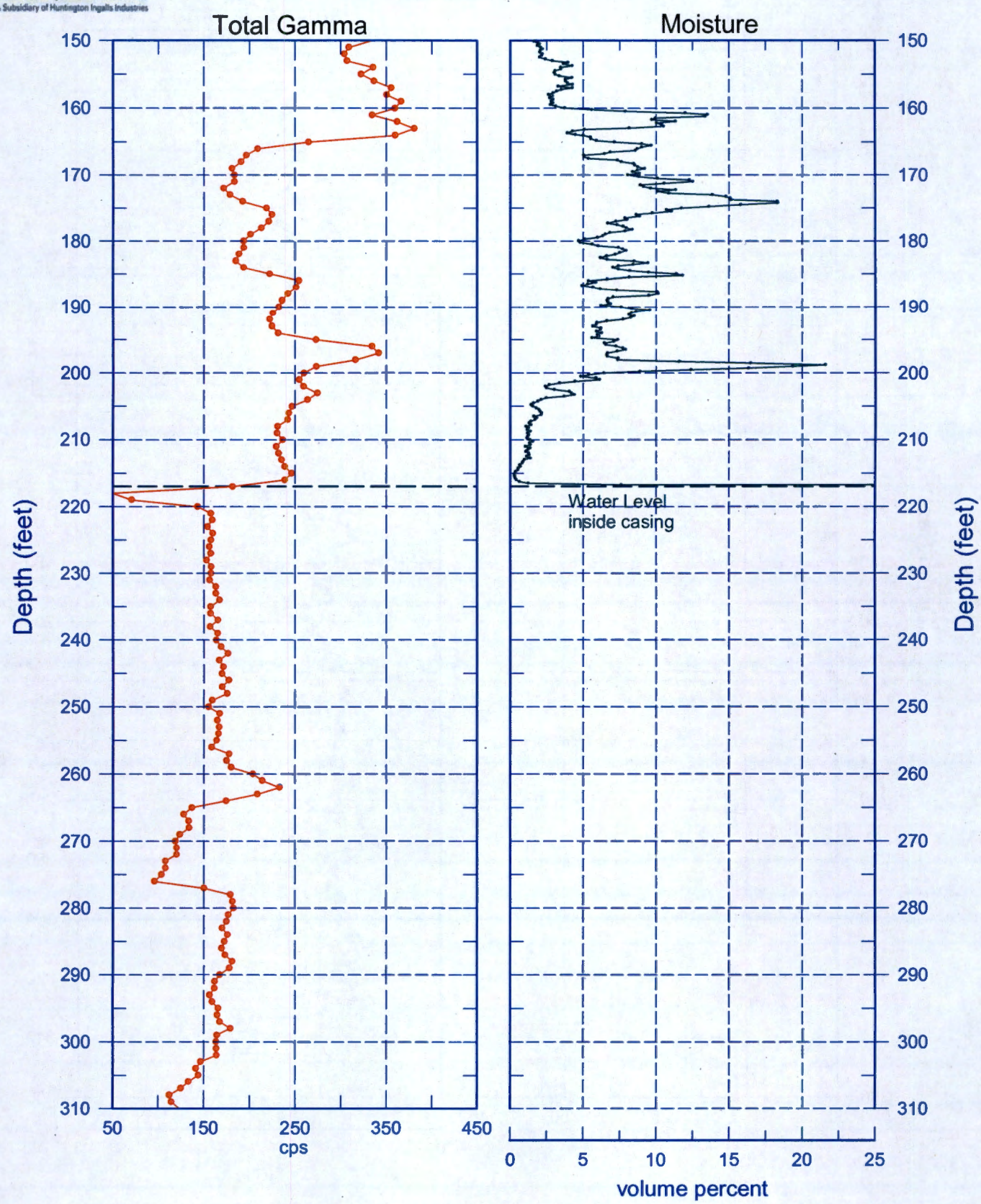
699-27-68 (C9632)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

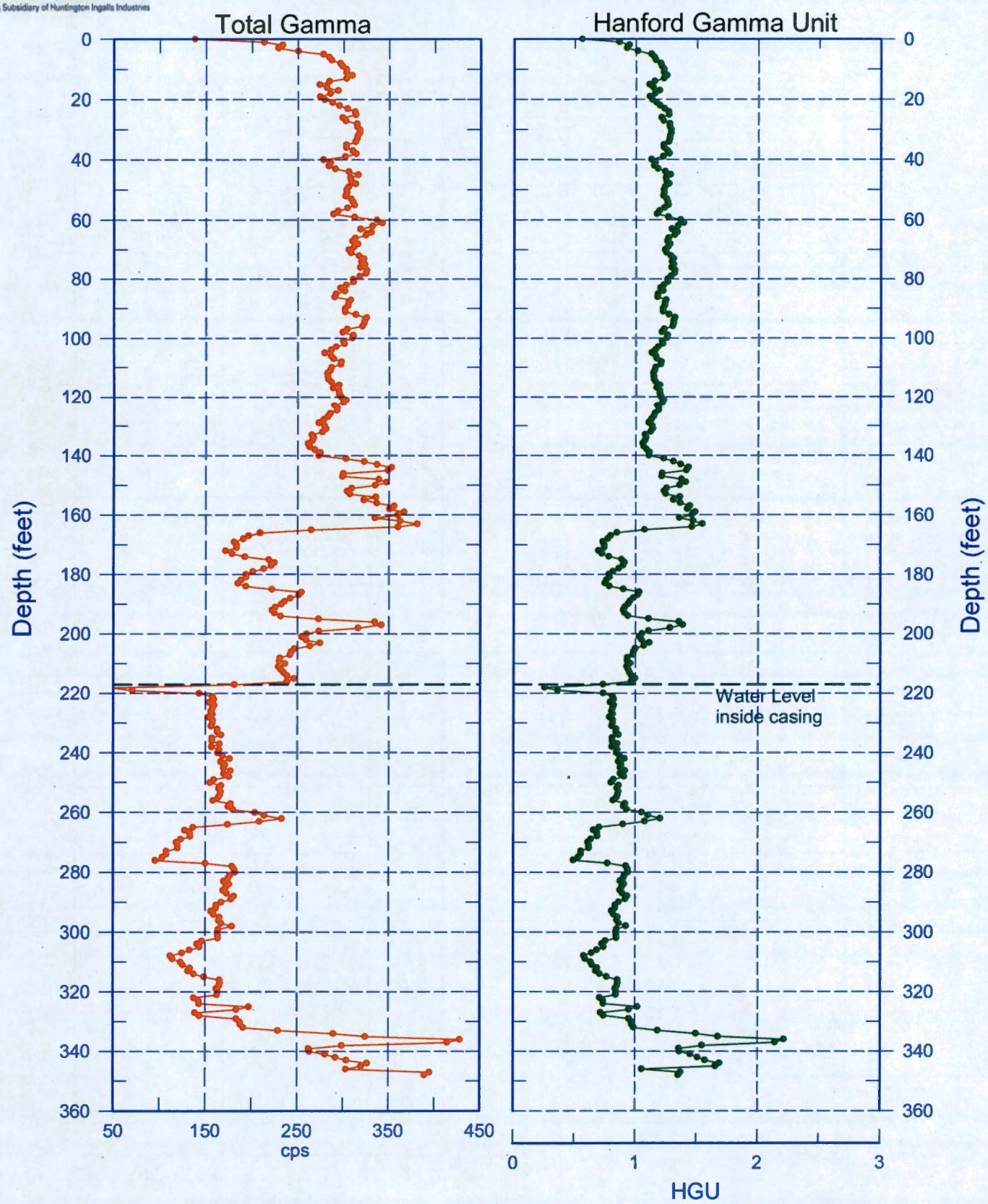
699-27-68 (C9632)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632)
Total Gamma & Hanford Gamma Unit

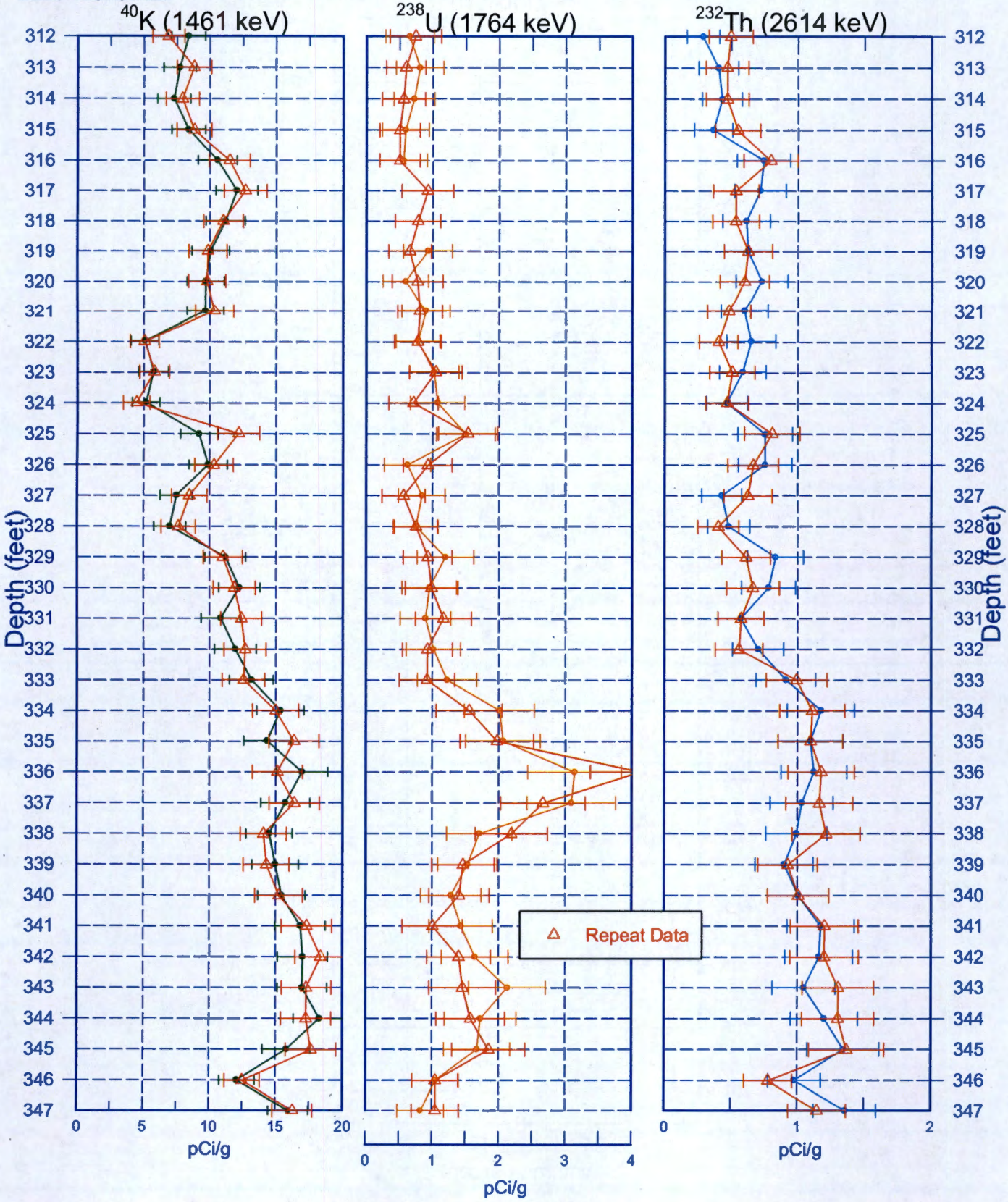


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632)

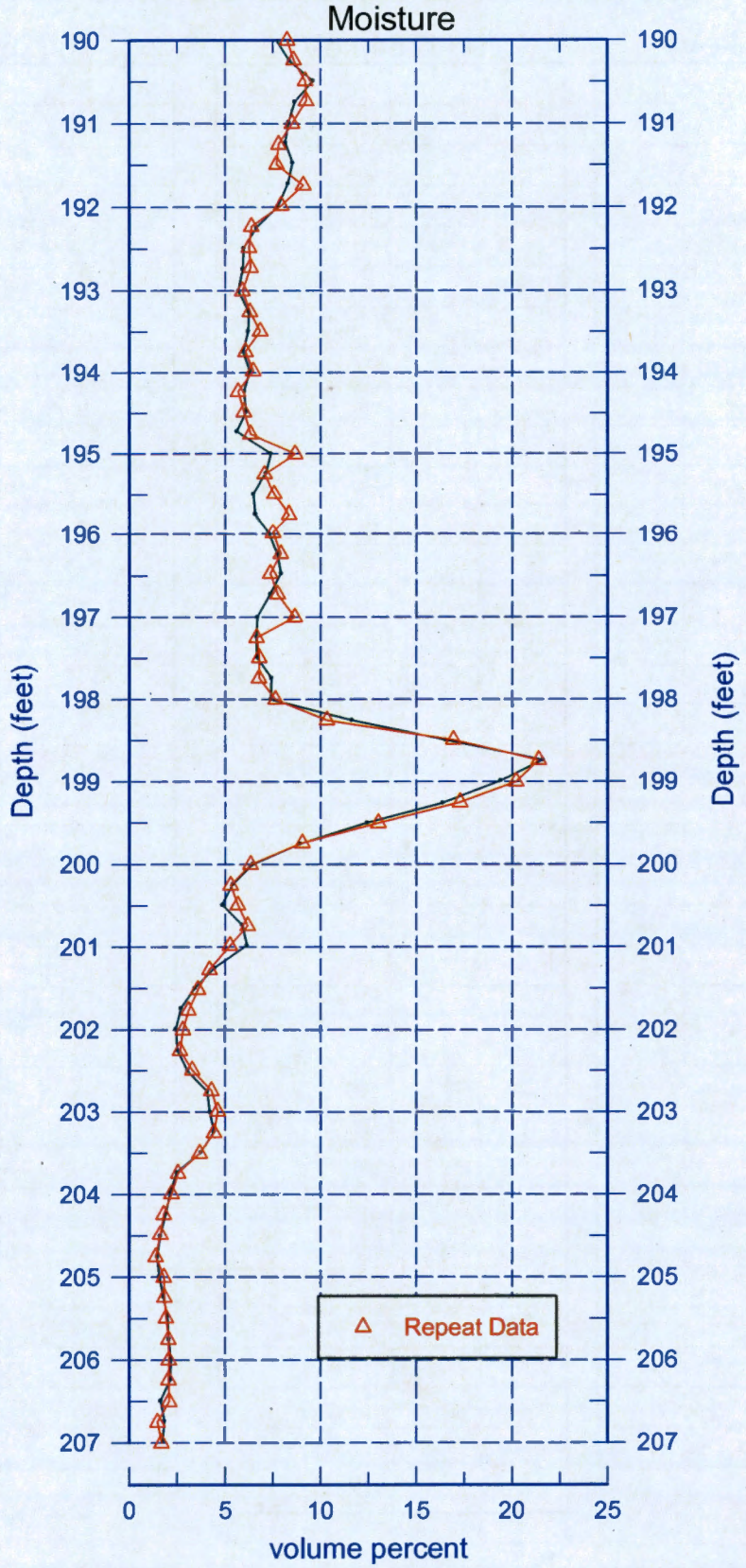
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-27-68 (C9632)
Moisture Repeat Section



Zero Reference - Ground Surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 11/02/17	Requestor: Matthan G. Wilson (CHPRC)
Date of Survey: 11/29/17	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of UP-1 Well C9632 (699-27-68) located southeast of 200W Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:

Washington State Reference Network

Vertical Control Monuments:

HSWB-071 (COE) and HSWB-072 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9632	699-27-68	569324.76	131676.43		Center of Casing
				197.474	Top Baseplate, N.Edge
				197.466	Top Outer 6"SS Casing, N.Edge
				196.635	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

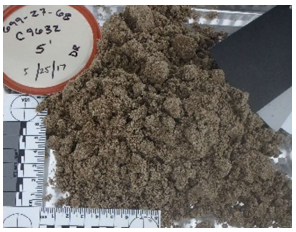
Surveyor Statement:

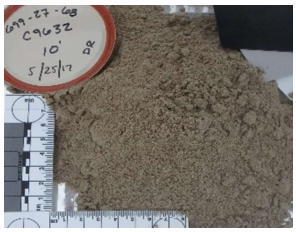
I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
11-29-17

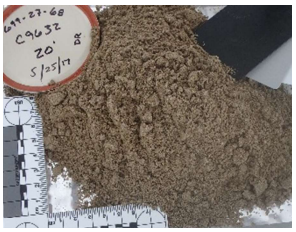
This page intentionally left blank.

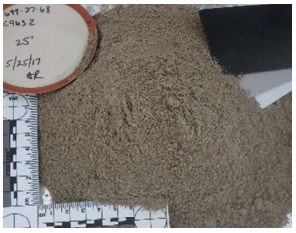
Photo Log

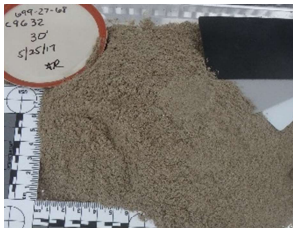

0-5 bgs


5-10 bgs

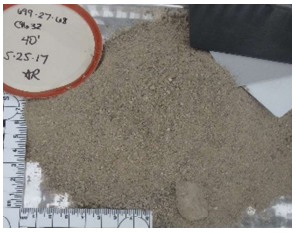
10-15 bgs


15-20 bgs

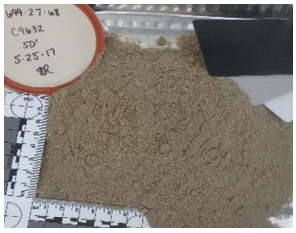

20-25 bgs

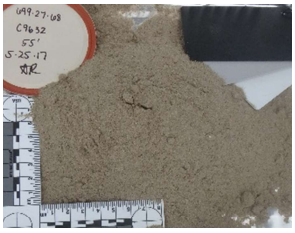

25-30 bgs

30-35 bgs

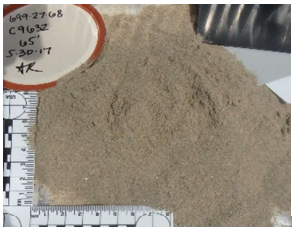

35-40 bgs

40-45 bgs


45-50 bgs

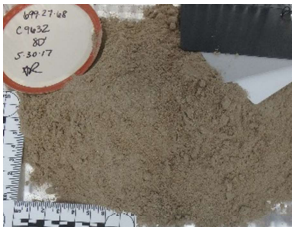

50-55 bgs

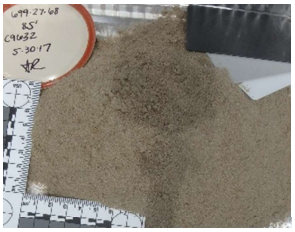
55-60 bgs

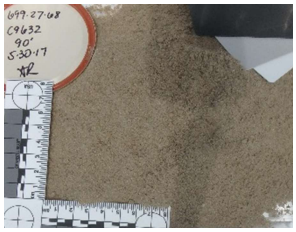

60-65 bgs

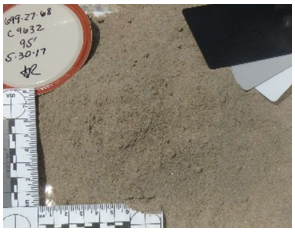
65-70 bgs

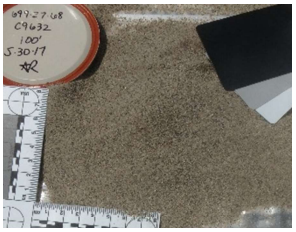
70-75 bgs

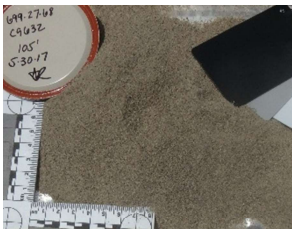

75-80 bgs

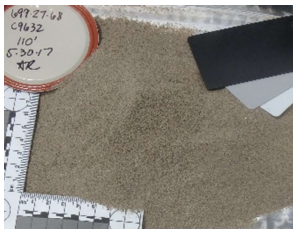

80-85 bgs

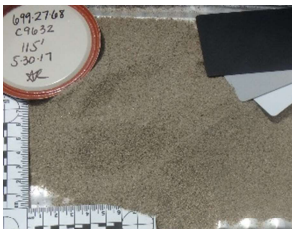

85-90 bgs

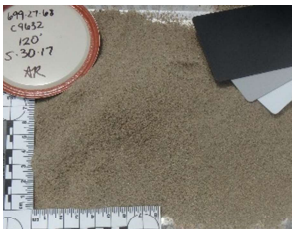

90-95 bgs

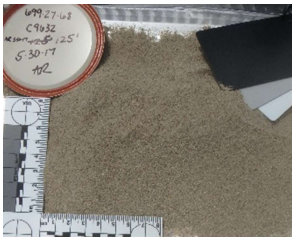

95-100 bgs

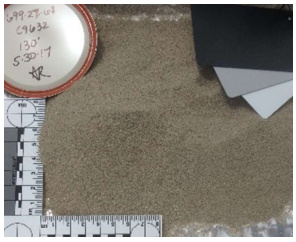

100-105 bgs

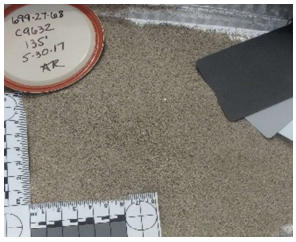

105-110 bgs


110-115 bgs


115-120 bgs

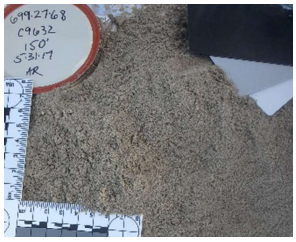

120-125 bgs


125-130 bgs


130-135 bgs

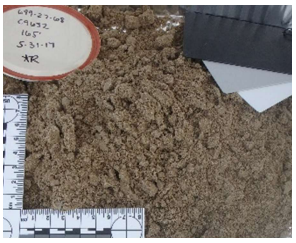
135-140 bgs

140-145 bgs


145-150 bgs

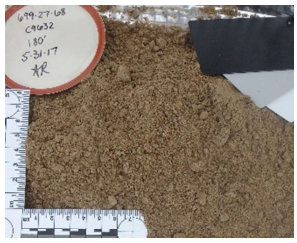
150-155 bgs

155-160 bgs


160-165 bgs

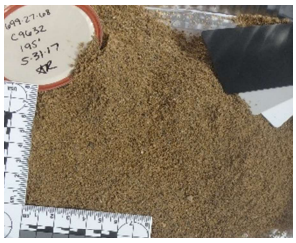
165-170 bgs

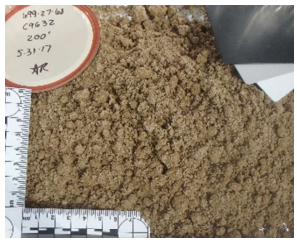
170-175 bgs

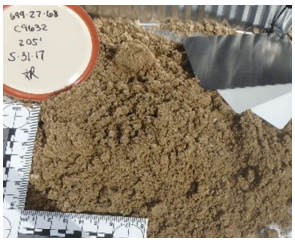

175-180 bgs

180-185 bgs

185-190 bgs

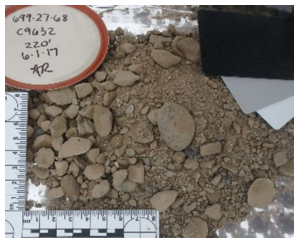

190-195 bgs


195-200 bgs


200-205 bgs

205-210 bgs

210-215 bgs


215-220 bgs

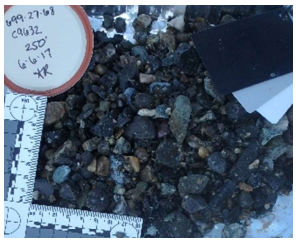
220-225 bgs

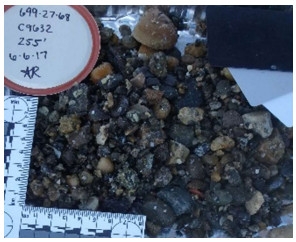
225-230 bgs

230-235 bgs

235-240 bgs

240-245 bgs


245-250 bgs


250-255 bgs

255-260 bgs

260-265 bgs

265-270 bgs

270-275 bgs

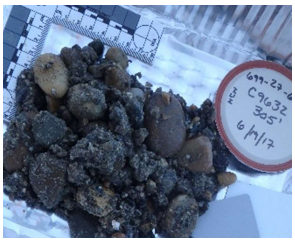
275-280 bgs

280-285 bgs

285-290 bgs

290-295 bgs

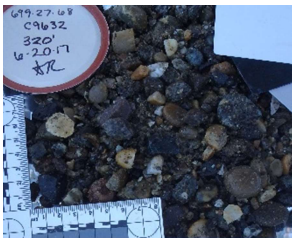
295-300 bgs



300-305 bgs

305-310 bgs

310-315 bgs



315-320 bgs

320-325 bgs

325-330 bgs

330-335 bgs

335-340 bgs

340-345 bgs

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9632 | Well Name: 699-27-68 | Date: 8·16·17

Location: ~0.75mi NE of Rattlesnake Barricade

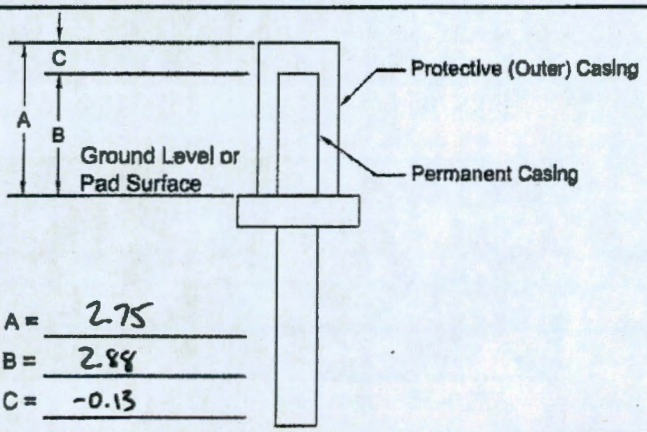
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 8·16·17	—	N/A
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 8·16·17	—	284.00' bgs
Date: —	—	—



A = 2.75
B = 2.88
C = -0.13

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)
254.54	13.16	35.52	2.95	3.85	0707	0938	25	1.9
234.54	13.89	15.53	3.85	3.62	1017	1212	25	1.8
223.64	16.23	4.54	4.55	1.58	1251	1424	25	1.54

Total Pumped: 10325 gallons

Pump Model: Grundfos X

Troll Serial Number and Pressure Range (PSI and depth): 168724; 30psi/69ft

Comments:

Data file name: C9632_develop_int2_081517
C9632_develop_int3_081617
C9632_develop_int4_081617

Prepared By:

Andrew Rauterson (Print Name) | [signature] (Signature) | 8·16·17 (Date)

Reviewed By:

Kelly Whitley (Print Name) | Kelly Whitley (Signature) | 9/27/17 (Date)

For Office Use Only

OR Doc Type:

WMU Code(s):

A-6005-205 (REV 2)

This page intentionally left blank.

Appendix B

Well Documentation for 699-29-55 (C9634)

- Well Summary Sheet for C9634
- Borehole Log for C9634
- Geophysical Log Data Report for C9634
- Final Survey Report for C9634
- Photo Log for C9634
- Well Development and Testing Data Sheet for C9634

This page intentionally left blank.

WELL SUMMARY SHEET

Well ID: C9634	Well Name: 699-29-55	Start Date: 6/28/2017
Project: 200-UP-1 5 Monitoring Wells	Location: 1.5 mi. SE of US Ecology	End Date: 9/25/2017

CONSTRUCTION DATA

WA Dept. of Ecology Tag: BKG 064

Surface Construction:

4' x 4' x 6" Concrete Pad with brass survey marker and protective monument

Temporary Casing Depths:

10" C.S. = 15.08 ft bgs

8" C.S. Wld. Joints = 450.00 ft bgs

Permanent Well Materials:

4" S.S. Blank
2.00 ft ags - 284.97 ft bgs

4" S.S. 20-slot Vee-Wire Screen
284.97 ft bgs - 314.97 ft bgs

4" S.S. Blank
314.97 ft bgs - 349.97 ft bgs

4" S.S. 20-slot Vee-Wire Screen
349.97 ft bgs - 380.00 ft bgs

4" S.S. Blank
380.00 ft bgs - 383.00 ft bgs

Well Completion Materials:

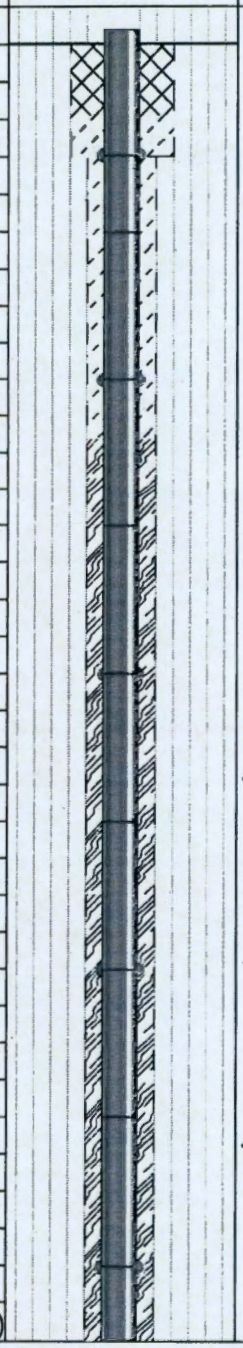
Concrete
0.00 - 0.50 ft bgs

Type I/II Portland Cement
0.50 ft bgs - 9.41 ft bgs

3/8" Bentonite Crumbles
9.41 ft bgs - 53.20 ft bgs

(continued pg. 2)

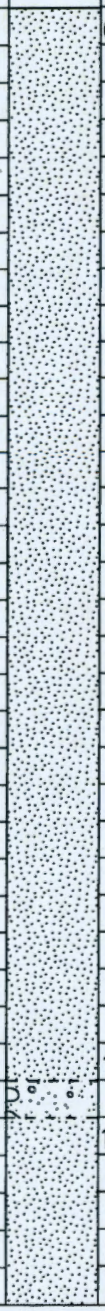
Diagram



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

GEOLOGIC/HYDROLOGIC DATA

Graphic Log



Lithologic Description (ft bgs)

0 - 145 ft: Sand [S] Hanford fm.

145 - 150 ft: Gravelly Sand [gS]

150 - 220 ft: Sand [S]

Reported By:			
Jess Hocking (Print Name)	Sr. Geologist (Title)	(Signature)	1/30/2018 (Date)
Reviewed By:			
Kelly Whitley (Print Name)	Well Coordinator (Title)	Kelly Whitley (Signature)	1/31/18 (Date)

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

WELL SUMMARY CONTINUATION SHEET

Well ID: C9634 | Well Name: 699-29-55 | Project: 200-UP-1 5 Monitoring Wells

CONSTRUCTION DATA

Well Completion Materials:

Bentonite Grout/Slurry
53.20 ft bgs - 274.07 ft bgs

3/8" Bentonite Pellets
274.07 ft bgs - 278.85 ft bgs

10-20# Colorado Silica Filter Pack
278.85 ft bgs - 318.20 ft bgs

3/8" Bentonite Pellets
318.20 ft bgs - 323.45 ft bgs

8-16# Silica Sand Backfill
323.45 ft bgs - 336.20 ft bgs

Natural Fill
336.20 ft bgs - 340.10 ft bgs

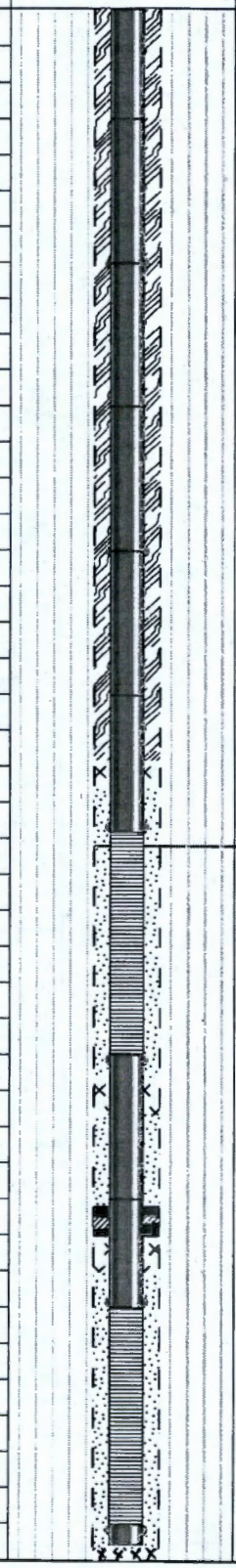
3/8" Bentonite Pellets
340.10 ft bgs - 345.15 ft bgs

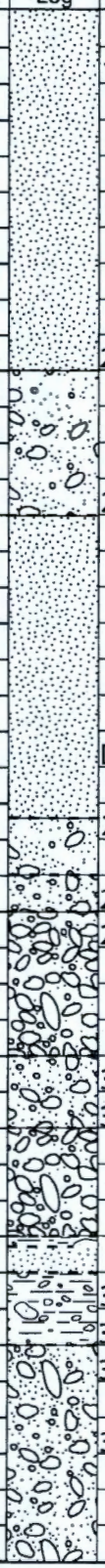
10-20# Colorado Silica Filter Pack
345.15 ft bgs - 383.60 ft bgs

3/8" Bentonite Pellets
383.60 ft bgs - 392.70 ft bgs

Bentonite Grout/Slurry
392.70 ft bgs - 451.25 ft bgs

Natural Fill
451.25 ft bgs - 453.00 ft bgs





GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 175, 200, 225, 250, 275, 300, 325, 350, 375

Graphic Log

Lithologic Description (ft bgs)

150 - 220 ft: Sand [S]

220 - 240 ft: Gravelly Sand [gS]

240 - 282 ft: Sand [S]

DTW = 286.05 ft bgs (9/19/2017)

282 - 290 ft: Gravelly Sand [gS]

Ringold Fm., Unit E

290 - 295 ft: Sandy Gravel [sG]

295 - 315 ft: Gravel [G]

315 - 325 ft: Sandy Gravel [sG]

325 - 340 ft: Gravel [G]

340 - 341 ft: Silty Gravel [mG]

341 - 345 ft: Sand [S]

345 - 355 ft: Silty Gravel [mG]

355 - 390 ft: Sandy Gravel [sG]

WELL SUMMARY CONTINUATION SHEET

Well ID: C9634 | Well Name: 699-29-55 | Project: 200-UP-1 5 Monitoring Wells

CONSTRUCTION DATA

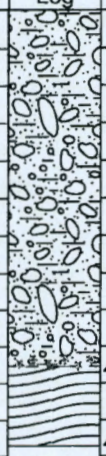
Description

Diagram

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 400, 425, 450, 475

Graphic Log



Lithologic Description (ft bgs)

390 - 442 ft: Silty Sandy Gravel [msG]

442 ft: Organic (wood) Fragments

442 - 453 ft: Clay [M]

Ringold Fm., Lower Mud Unit

Total Depth = 453.00 ft bgs (7/26/2017)

Definitions:

ags = above ground surface
bgs = below ground surface
C.S. = Carbon Steel
S.S. = Stainless Steel
WAC = Washington Administrative Code
Wld. = Welded

Note:

A straightness test was performed and passed on 8/24/2017 prior to well construction, per WAC 173-160 requirements.

Centralizers are placed approximately 40 feet apart.

All temporary casing has been removed from the ground.

All depths represented are in feet below ground surface (ft bgs) unless otherwise noted.

A-6006-992 (REV 0)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 12
Date: 6-28-17

Well ID: C9634 | Well Name: 699-29-55 | Location: 1.5 mi SE of Geology
Project: 200-UP1 Monitoring Wells | 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'				Dual Air Rotary with Tricone
			0-145' : Sand (S)	
			at 5' bgs : 2% silt, 96% sand v. fine to v. coarse, 2% v. fine to medium pebble; max 10mm; moist; moderate to very well sorted;	10" wld. temp casing.
				Hanford fm.
5	GS		sub-angular to sub-rounded; (S) 65 mafic, 35 felsic; (g) 50 mafic, 50 felsic; strong rxn with HCl; light olive brown, 2.5Y 5/3;	
10	GS		at 10' bgs : 5% silt, 90% sand v. fine to v. coarse, 5% v. fine to medium pebble; max 9mm; moist; moderately sorted; angular to subangular; (S) 40% mafic, 60% felsic; (g) 55 felsic, 45 mafic; strong rxn with	
15	GS		HCl; grayish brown, 2.5Y 5/2	switch to under reamer
			at 15' bgs: ~~8% pebbles~~ 6.28.17 CRB 5% silt, 87% sand v. fine to v. coarse, 8% gravel; max 4mm; moderately sorted; angular to subangular; moist; (S) 40 mafic, 60 felsic;	8" wld. temp. casing.
20	GS		(g) 55 mafic, 45 felsic; 2.5Y 5/2, grayish brown	
			at 20' bgs: moist; max ~~20~~ 9mm; 5% silt, 5% gravel, 90% sand; (g) 55 mafic, 45 felsic; (S) 60 felsic, 40 mafic; (g) angular to subangular;	6.28.17 CRB
25	GS		2.5Y 6/2, light brownish grey; mod. sort	
			at 25' bgs: slightly moist; max 10mm; 5% silt, 5% gravel v. fine to med., 90% sand v. fine to v. coarse; moderately sorted; (S) 65 felsic 35 mafic; (g)	
30	GS		55 mafic, 45 felsic; angular to subangular 2.5Y 6/2, light brownish grey	
			at 30' bgs: slightly moist; 3% silt, 3% gravel v. fine to medium, 94% sand, v. fine to v. coarse; (S) 70% felsic 30% mafic; (g) 55 mafic & 45 felsic;	SEE PG 2

Reported By: Cameron Burnt — Geologist — [signature] — 6.28.17
Print Name — Title — Signature — Date

Reviewed By: Sarah Springer — Lic. Geologist — [signature] — 09-25-17
Print Name — Title — Signature — Date

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

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Date: 6.28.17

Well ID: C9634 | Well Name: 699-29-55 | Location: 1.5 mi SE of Ecology

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	GS		0-145' : Sand	Dual Air Rotary
		6.28.17 CB	at 30' bgs: strong rxn to HCl, angular	with under Reamer
			to subangular; 2.5Y 5/2, olive grey	8" wld. temp. casing.
			at 35' bgs: slightly moist; strong rxn	
			w/ HCl; 5% silt, 2% gravel v. fine to,	
40	GS		93% sand v. fn. to v. crs.; angular to	
			subangular; (s) 35% mafic 65% felsic;	
			(g) 50 mafic 50 felsic; ~~moderate~~ 6.28.17 CB	
			well-sorted; 2.5Y 5/3, light olive	
			brown	
45	GS		at 40' bgs: 5% silt, 94% sand v. fn. to	
			v. crs., 1% gravel v. fine; max 4mm;	
			strong rxn w/ HCl; angular to subangular; (s)	
			65% felsic, 35% mafic; (g) 50 mafic	
			50 felsic; slightly moist; 2.5Y 6/2	
50	GS		light brownish grey;	
			at 45' bgs: 5% silt, 5% gravel v. fn to fn,	
			90% sand v. fn. to v. crs.; 65% felsic 35	
			mafic; (gravel) 50 mafic 50 felsic; strong	
			rxn w/ HCl; slightly moist; angular to	
55	GS		subangular; 2.5Y 5/2 grayish brown;	
			well sorted	
			at 50' bgs: 5% silt, 3% gravel v. fn,	
			92% sand; (s) 70% felsic, 30% mafic;	
			(g) 50 mafic, 50 felsic; strong rxn w/	
60	GS		HCl; slightly moist; angular to	
			sub angular; well sorted; 2.5Y 5/3	
			light olive brown; 4mm max	
			at 55' bgs; 5% silt, 8% gravel v. fine to	
			medium, 87% sand v. fn. to v. crs; max 7mm	
65	GS		(s) 65% felsic 35% mafic; (g) 55 felsic	
			45 mafic; slightly moist; angular to	
			sub angular; moderate to well sorted;	
			2.5Y 5/2, grayish brown; strong	
			rxn w/ HCl	
70	GS		at 60' bgs: 8% silt, 89% sand v. fn to	
			v. crs.; 3% gravel v. fn to fn.; max 4mm;	
			strong rxn w/ HCl; slightly moist;	
			(s) 65 felsic 35 mafic; (g) 50 felsic 50	
			mafic; angular to subangular Cont Pg 3	

Reported By:

Print Name	Title	Signature	Date
Cameron Burns	Geologist		6.28.17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 12

Date: 6-28-17

Well ID: C9634 | Well Name: 699-29-55 | Location: 1.5 mi SE of Beverly

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	GS		0-145: Sand	Dual Air Rotary w/ Under-Reamer
			at 60' bgs; 2.5Y 6/2 light brownish grey	8" wld. temp. casing.
			at 65' bgs: 8% silt, 88% sand v. fn to v. crs; 4% gravel v. fn to fn.; max 4mm	
80	GS		strong rxn w/ HCl; (sand) 70 felsic 30 mafic; (g) 50 mafic 50 felsic; angular to subangular;	
			slightly moist; 2.5Y 6/2 light brownish grey; well sorted to moderately sorted	
			at ~~65~~ 6-28-17 CB 70' bgs: 3% silt, 7%	
85	GS		gravel v. fn to fn, sand 90% v. fn to v. crs.; max 4mm; strong rxn w/ HCl;	
			angular to subangular (s) 60 felsic 40 mafic;	
			(g) 60 mafic 40 felsic; slightly moist; 2.5Y 5/2	
			grayish brown; well sorted	
90	GS		at 75' bgs: slightly moist; 5% silt,	
			3% gravel v. fn. to fn.; max 5mm; strong	
			rxn w/ HCl; angular to subangular; (s) 65	
			felsic 35 mafic; (g) 55 mafic 45 felsic;	
			well sorted; 2.5Y 6/3 light yellowish	
95	GS		brown	
			at 80' bgs: 5% silt, 93% s, 2% g v.f. to f.;	
			max 4mm; (s) 35m 65f; (g) 50m 50f; ang to sub ang;	
			dry; well sorted; no rxn w/ HCl; 2.5Y 6/2	
			light brownish grey.	
100	GS			
			at 85' bgs: 4% silt, 1% gravel, 96% s;	
			max 3mm; (s) 35m 65f; (g) 50m 50f; ang to sub-	
			ang; dry; well-sorted; no rxn w/ HCl; 2.5Y 5/3	
6-28-17 CB 105 ~~110~~	GS		light olive brown	
			at 90' bgs: 6% silt, 4% gravel v. fn to fn, 90%	
			s v. fn to v. crs; max 4mm; (s) 70f 30m; (g) 50f	
			50m; ang to sub-ang; well-sorted; strong rxn w/	
			HCl; dry; 2.5Y 7/2 lite grey	
110	GS			
			at 95' bgs: 3% silt, 3% g v. fn to fn, 94%	
			s v. fn to v. crs; (s) 70f 30m; (g) 50f 50m; a. to s.a.;	
			moderate to well sorted; strong rxn w/ HCl; dry;	
			2.5Y 7/3 pale brown	

Reported By:

Print Name	Title	Signature	Date
Cameron Burns	Geologist	[signature]	6-29-17 CB ~~6-28-17~~ 6-29-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 6-29-17

Well ID: C9634 | Well Name: 699-29-55 | Location: 1.5 mi SE of Ecology

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	GS		0 – 149 Sand	Dual Air Rotary w/ Under
			at 100' bgs: 3% silt, 92% sand v.f.n. to v.crs.;	Reamer;
			5% g v.f.n to med; max 5mm; dry; vs strong rxn	@ 115' bgs approximately
			w/HCl; (s) 65F 35M; (g) 50M 50F; a. to s.a.;	20 gal H_2O added
			moderately sorted; 2.5Y 5/2 greyish brown	8" wld. temp. casing
120	GS			
			at 105' bgs: 5% m, 3% g v.f.n to f.n,	
			92% s v.f.n to v.crs; max 3mm; dry; (s)	
			65F 35F; (g) 50F 50M; strong rxn w/HCl;	
			a. to s.a.; moderately sorted; 2.5Y 5/2	
125	GS		greyish brown	
			at 110' bgs: 5% m, 5% g v.f.n. to f.n, 90%	
			s v.f.n to v.crs; max 3mm; dry; (s) 60F 40M;	
			(g) 55F 50M; strong rxn w/HCl; a. to s.a.;	
130	GS		2.5Y 5/2 grayish brown; well sorted	
			at 115' bgs: 5% m, 5% g v.f.n to f.n, 90%	
			s v.f.n to v.crs; max 2mm; dry; (s) 60F 40M;	
			(g) 55F 45M; strong rxn w/HCl; a. to	6-29-17 CB
135	GS		s.a.; 2.5Y 5/2 grayish brown; well sorted.	@ 135 to ~~140~~, at 153' bgs,
				add approximately 150 gal
			at 120' bgs: moist due to added H_2O; 3% m,	H_2O
			97% s, v.f. to v.crs.; (s) 60F 40M; well-sorted	
			a. to s.a.; weak rxn w/ HCl; 2.5Y 4/2; dark	
140	GS		greyish brown	
			at 125' bgs; moist due to added H_2O; (s) 60F	
			40M; 3% m, 97% s. v.f.n. to v.crs.; well sorted; a. to	
			s.a.; strong rxn w/HCl; 10YR 4/2,	
145	GS		dark greyish brown	
			at 130' bgs; moist due to added H_2O; 3%	
			m, 97% s. v.f.n. to v.crs.; a. to s.a.; well	
			sorted; (s) 55F 45M; strong rxn w/ HCl;	
150	GS		2.5Y 5/2 grayish brown	
			at 135' bgs; 3% m, 94% s v.f.n. to v.crs,	
			3% g v.f.n; max 3mm; (g) 60M 40F; (s) 65	
			F to 35M; well sorted; a. to s.a.; 2.5Y 4/2	

Reported By:

Print Name	Title	Signature	Date
Cameron Burns	Geologist	[signature]	6-29-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 6-29-17

Well ID: C9634 | Well Name: 699-29-55 | Location: 1.5 mi SE of Ecology

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	GS		0-145 Sand	Dual Air Rotor w/
			~~at 140' bgs;~~ 6-29-17 CB	Under Reamer
			at 140' bgs; moist from added water;	
			2% m, 98% s, v.fn to v.crs. (g)60% 40m; well	153' to 172.78' bgs,
			sorted; a. to s.a.; no rxn w/HCl; 2.5Y 3/2 very	add ~200 gal H_2O
160	GS		dark greyish brown	8" wld. temp. casing.
			~~at 145' bgs:~~ 6-29-17 CB	
			145-150 Gravelly Sand (gS)	
			at 145' bgs: moist from added water;	
165	GS		g 20% v.fn to crs, 5% m, 75% s v.fn. to	
			v.crs.; max 16mm; strong rxn w/ HCl; (s) 50m	
			50% (g) 60m 40%; angular to s.a.; moderate	
			sorting; 2.5Y 3/1 very dark grey.	
170	GS		~~at 150' bgs;~~ 6-29-17 CB	
			150-220' Sand (s)	
			at 150' bgs: wet; 5% g, 8% m, 87% sand v.fn	
			to v.crs. (g)65% 35m; (g) 50% 50m; ang to s.ang;	Switch to tri-cone bit @172' bgs
			weak rxn w/HCl; moderate sorting; 2.5Y	
175	GS.		4/2 dark grey brown	
				Archive @ 175' bgs
			at 155' bgs: wet, 10% m, 5% g, v.fn to med,	
			5 85% v.fn to v.crs.; max 5mm; (g) 60% 40m;	~50 gal H_2O added between
			(g) 60m 40%; angular to s.a.; moderately sorted; strong	~175'-194' bgs
180	G.S.		rxn to HCl; 2.5Y 4/2 dark grayish brown	
				Archive @ 180' bgs
			at 160' bgs: wet, 10% m, 5% g v.fn. to fn.,	
			85% s v.fn. to v.crs.; max 3mm; (g) 65% 35m;	
			(g) 50m 50%; a. to s.a; moderate sorting; 2.5Y	
185	G.S.		4/2 dark grayish brown; strong rxn w/HCl	
				Archive @ 185' bgs
			at 165' bgs: wet, 10% m, 5% g v.fn to fn.,	
			85% s v.fn to v.crs; (g) m45 35%; (g) m50 50%; a. to	
			s.a.; well-sorted; strong rxn w/HCl; 2.5Y 4/2 dark	
190	G.S.		grayish brown	
				Archive @ 190' bgs

Reported By:

Print Name	Title	Signature	Date
Cameron Burns / Julie Johanson	Geologist / Project Geologist	[signature]	7-10-17 JAJ 7-10-17 ~~6-29-17~~

BOREHOLE LOG (Cont.)

Page 6 of 12

Date: 6-29-17

Well ID: C9634 | Well Name: 699-29-54 | Location: 1.5 mi SE of Ecology

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.		190-220' Sand (S)	Dual Air Rotor w/
			at 170' bgs: 8% m, 8% g v.fn to med; 84%	JMJ 7-10-17 ~~Under Reamer~~ tri-cone bit
			f v.fn. to v.crs.; max 4mm; strong rxn to HCl;	Archive @ 195' bgs
			(S) 65% 3-5m; (g) 90% 50m; a. to s.a.; moderately	~100 gal H_2O added @ ~194' bgs
			sorted; 2.5Y 4/2 dark grayish brown	Poor Recovery 194'-214' bgs,
200	G.S.			Add ~150 gal of H_2O.
			@175' bgs: 2% silt, 90% v.fn.-v.crs. sand, 8% v.fn.-fn.	Archive @ 200' bgs
			peb.; max 7mm; mod. sorted; slightly moist-dry (H_2O due	
			to being added); sub ang.-sub.rnd.; s: 30%m/70%f; g: 20%	8" wld. temp. casing.
			m/80%f; mod. HCl JMJ 7-10-17 rxn; 10YR 5/3 brown	
205	G.S.		@180' bgs: 2% silt, 95% v.fn.-v.crs. sand; 3% v.fn.-fn. peb.; max	
			5mm; moist (due to added H_2O); s: 25%m/75%f; g: 25%m/75%f;	Archive @ 205' bgs.
			mod. HCl rxn; 2.5Y 5/2 grayish brown	
			@185' bgs: 2% silt, 96% v.fn.-v.crs. peb; 2% v.fn-v.crs. peb; max 3mm 35 JMJ 7-10-17	
			s: 30%m/70%f; g: 40%m/60%f; weak-mod. HCl rxn; 2.5Y 4/2	
210	G.S.		dark grayish brown	
			@190' bgs; 2% silt, 94% v.fn.-v.crs. sand; 4% v.fn.-med. peb;	Archive @ 210' bgs.
			max 10mm; slightly moist, ang.-sub. rnd.; s: 35%m/65%f,	
			g: 45%m/55%f, weak-mod. HCl rxn; 2.5Y 6/2 light brownish	
			gray.	Poor Recovery, Add ~150 gal H_2O
215	G.S.		@195' bgs: 2% silt, 92% v.fn.-v.crs. sand; 6% v.fn-fn. peb;	214'-234' bgs
			max 5mm; moist, sub.ang.-sub.rnd.; s: 35%m/65%f, g: 65%m/	Archive @ 215' bgs
			35%f, wk.-mod. HCl rxn, 2.5Y 5/2 grayish brown	
			@200' bgs: 2% silt, 98% v.fn.-v.crs. sand; max 2mm; moist	
			due to added H_2O; s: 30%m/70%f, wk.-mod. HCl rxn, 2.5Y	
220	G.S.		4/3 olive brown	
			@205' bgs: 2% silt, 98% v.fn.-v.crs. sand; max 2mm; moist-	Archive @ 220' bgs.
			wet (due to added H_2O); s: 35%m/65%f; 2.5Y 4/3 olive brown;	
			wk. HCl rxn,	
			@210' bgs: 5% silt, 95% v.fn.-v.crs. sand; max 2mm;	
225	G.S.		wet due to added H_2O; s: 35%m/65%f; ~5% muscovite; wk.-mod.	
			HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 225' bgs
			@215' bgs: 5% silt, 94% v.fn.-v.crs. sand, 1% v.fn. peb;	
			max 3mm; s: 40%m/60%f, g: 70%m/30%f; mod. HCl rxn; silt:	
			2.5Y 5/3 light olive brown, sand: 2.5Y 4/3 olive brown	
230	G.S.		220'-240': Gravelly Sand (gS)	
			1% silt JMJ 7-10-17 85% v.fn.-v.crs. sand; 14% v.fn.-med. peb.;	Archive @ 230' bgs
			max 12mm; moist-wet, mod.-poorly sorted; ang.-sub.ang.;	
			s: 35%m/65%f, g: 70%m/30%f; wk. HCl rxn; 2.5Y 5/2	
			grayish brown	

Reported By:

Print Name	Title	Signature	Date
C. Burns / Julie Johanson	Geologist / Project Geologist	Julie Johanson	7-10-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 7-10-17

Well ID: C9634 | Well Name: 699-29-55 | Location: ~1.5 mile ~~NE~~ SE of Ecology JRS 7-11-17

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
235	G.S		220-240 : Gravelly Sand (gS) @ 225' bgs: 5% silt, 85% v.fn.-v.crs. sand; 10% v.fn. peb.; max 3mm; wet; mod sorted; sub. ang.; s: 35% m/65% f, g: 50% m/50% f; wk.-mod. HCl rxn; 2.5Y 4/3 olive brown; (wet due to added H_2O)	Dual Air Rotary w/ tri-cone bit. Archive @ 235' bgs. 8" wld. temp. casing.
			@ 230' bgs: 3% silt, 87% v.fn.-v.crs. sand, 10% v.fn.-~~fn.~~ v.crs. peb.; max ~~7mm~~ 34 JRS 7-10-17; ang.-sub ang.; s: 25% m/75% f, g: 40% m/60% f; mod. HCl rxn; 2.5Y 4/2 dark grayish brown	
240	G.S.		@ 235' bgs: 5% silt, 85% v.fn.-v.crs. sand; 10% v.fn. peb.; max 3mm; mod sorted, sub ang.; s: 30% m/70% f, g: 50% m/50% f; wk.-mod. HCl rxn; 2.5Y 4/3 olive brown JRS 7-10-17	~150 gal H_2O added 234'-254'. Archive @ 240' bgs. Formation change @ 240' bgs; any graphic log inconsistancies are due to different Geologists interpretations.
245	G.S.		240-~~228~~ 282: Sand (S) 3% silt; 95% v.fn.-v.crs. sand; 2% v.fn.-med. peb.; max 9mm; moist due to added H_2O; mod.-well sorted; sub. ang.; s: 25% m/75% f, g: ~50% m/50% f; v.wk. HCl rxn; 2.5Y 4/3 olive brown	Archive @ 245' bgs.
			@ 245' bgs: 3% silt, 92% v.fn.-v.crs. sand, 5% v.fn.-crs. peb.; max 26mm; mod.-poorly sorted; moist-wet; s: 25% m/75% f, g: 75% m/25% f; wk.-mod. HCl rxn; 2.5Y 4/2 dark grayish brown	
250	G.S.			Poor Recovery ~245-255' bgs. Archive @ 250' bgs. ~175 gal H_2O added 255-275' bgs.
255	G.S.			Archive @ 255' bgs
260	G.S.			Archive @ 260' bgs
265	G.S.			Archive @ 265' bgs
270	G.S.			Archive @ 270' bgs.

Reported By:

Print Name	Title	Signature	Date
Julie Johanson / Jess Hocking	Project Geologist / Sr. Geologist	Julie Johanson / [signature]	7/11/2017

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 7-11-2017

Well ID: C9634 | Well Name: 699-29-55 | Location: ~1.5mi. SE of US ECOLOGY

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.		240 – 282' : Sand (S), [cont'd from pg. 7] 3% silt; 95% v.fn. – v. crs. sand; 2% v.fn – med. peb.; max 9mm; moist due to added H_2O, mod-well sort; sub. ang; 25%m/75%f, g: ~50%m/50%f; v.wk HCl rxn; 2.5Y 4/3 olive brown @ 245'bgs: 3% silt, 92% v.fn – v.crs sand, 5% v.fn – v.crs peb; max 26mm; mod-poor sort; moist-wet; s: 25% m/75%f, g: 75% m/25%f; wk-mod HCl rxn; 2.5Y 4/2 d. grayish brown	Dual Air Rotary w/tri-cone bit 8" temp. casing. – wld. Archive @ 275' bgs.
280	G.S.			Archive @ 280' bgs
			282 – 290' : Gravelly Sand (gS) (85% S, 15% G); Sand: med – v.crs grn., mod-poor sort, sub ang – ang., 75%f/25%m, moist, no rxn to HCl, 2.5Y 4/2 d. grayish brown; Gravel: 2-20mm (max 20mm) granule – pebble, poor – v.poor sort, basalt/quartzite mix, 80%f/20%m.	
285	G.S.			Archive @ 285' bgs
▽				DTW @ 289' bgs (7/11/17)
290	G.S.			Archive @ 290' bgs
			290 – 295' : Sandy Gravel (sG) (50% S, 45% G, 5% M); Sand: med. – v.crs grn., mod sort, sub ang – ang., 70%f/30%m, wet, no rxn to HCl, 2.5Y 4/2 d. grayish brown; Gravel: 5mm – 20mm (max 20mm) granule – pebble, poor sort, basalt/quartzite mix, 70%m/30%f; Silt: in suspension.	Ringold, Unit E @ 290' bgs.
295	G.S. 50% S.S.			Archive @ 295' bgs. Splitspoon sample – I-002 DRIVEN: 295 – 296.5' bgs Sleeve A (295.5 – 296' bgs) collected; HEIS #: B3BØN3 1500 hrs – 7/11/2017.
			295 – 319' : Gravel (G) (100% G); Gravel: ang. – sub. rnd., wet, poor – v. poor sort, no rxn to HCl, 2mm – 25mm (max 25mm) granule – pebble, basalt/quartzite mix, 80%m/20%f, 2.5Y 5/1 gray.	
300	G.S.			driller added approx 190 gal H_2O to aid in drilling from approx 307 to 321' bgs
			@ 296 Gravel (G); (80% G, 20% S); Gravel the same; Sand: med – v.crs grn., mod. sort, sub. ang – ang.; 60%f/40%m, saturated, no rxn to HCl, 2.5Y 4/2 d. grayish brown.	
305	G.S.			
			@300 Gravel (G); (100% G) in grab sample – approx 20% silt & or sand observed; gravel subangular to angular; fine to coarse grained; moderate sorting; no rxn to HCl; 2.5Y 4/2 d. grayish brown; 60% 40m	
310	G.S.			@312' bgs driller noted a change in drilling – possible South change

Reported By:

Jess Hocking / C. Burns	Sr. Geologist / Geologist		7/12/17
Print Name	Title	Signature	Date

BOREHOLE LOG (Cont.)

Page 9 of 12

Date: 7.12.17

Well ID: C9634 | Well Name: 699-29-55 | Location: 1.5 miles SE of Ecology

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.		295 - 315' (G) Gravel (continued from p. 8)	Dual Air Rotary w/
			@ 305' bgs: 100% gravel in grab sample;	Tri-Cone Bit
			20% silt or sand observed; gravel s. ang to	8" wld. temp. casing.
			ang.; 60% 40m; fn to med grain; mod. sort;	
			no rxn to HCl; 2.5Y 4/2 d. grey brown	
320	G.S.			
	W.S.		@ 310' bgs: 100% g in gs.; 20% silt or	W.S. @ 320.9' bgs.
			sand observed; s. ang to ang; 60% 40m;	DTW @ 289.05' bgs (7-13-17)
			fn to coarse grain; mod to poor sort;	I-003, pumped; HEIS #:
			no rxn to HCl; 2.5Y 4/2 d. grey brown	B3BØD5, B3BØD6, B3BØD7,
325	G.S.		315 - 325' (SG) Sandy Gravel	B3BØD9, B3BØFØ, B3BØF1,
			@ 315' bgs: 70g 20s 10m; (sand) fn to	B3BØD8 (Cr^{+6})
			v. crs; 60% 40m, ang to s. ang.; moderate	
			sorting; no rxn to HCl; (Gravel) fn to crs,	ARCHIVE @ 325' bgs
			50% 50m, ang to s. ang, moderate to	
330	G.S.		poor sorting; 2.5Y 4/2 d. grey brown	
			@ 320' bgs: 70g 20s 10m; (S) fn to	ARCHIVE @ 330' bgs
			crs; 60% 40m, ang to s. ang; mod sort;	
			(g) fn to crs.; 60% 40m, ang to s. ang,	
335	G.S.		poor sorting to mod. sorting; 2.5Y 4/2 d.	
			grey brown	ARCHIVE @ 335' bgs
			* sand collected after final blowout	
			from ~305 - 320' bgs: not collected	
340	G.S.		w/ previous samples: 5% silt 95% sand:	ARCHIVE @ 340' bgs
			(S) v. fn to crs, poor sort, ang to s. ang,	
	100%		50% 50m; no rxn w/ HCl, 2.5Y 4/1	Splitspoon sample:
			d. grey	I-005, 340.8 - 343.3' bgs
	S.S.			100% rec., HEIS # B3BØN4
345	G.S.		325 - 340' Gravel (G)	LINER "B" collected.
			(100% G): Gravel: ang.-sub. rnd, v. poor sort,	DTW @ 285.8' bgs (7-18-17)
			moist - wet, 60% m / 40% f, basalt / quartzite mix,	H_2O sample: Pumped,
			2mm - 15mm (max 15mm) granule - pebble, no	I-004, ~~340.8~~ 339.8' bgs
			rxn to HCl, 2.5Y 5/1 Gray.	HEIS #: B3BØF3, B3BØF4,
350	G.S.			B3BØF5, B3BØF7, B3BØF8,
	W.S.		@ 330' Gravel (G) - (100% G): 70% m / 30% f,	B3BØF9, B3BØF6 (Cr^{+6})
			2mm - 10mm (max 10mm) granule - pebble,	
			moist to wet, no rxn to HCl, basalt/quartzite	Archive @ 345' bgs.
			mix, ang-sub. rnd., 2.5Y 4/1 d. gray.	

Reported By:

Print Name	Title	Signature	Date
C. Burns / J. Hocking	Geologist / Sr. Geologist	[signature]	7/13/17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 7-13-2017

Well ID: C9634 | Well Name: 699-29-55 | Location: ~1.5 mi. SE of US ECOLOGY

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.		@ 335' Gravel (G) - (100% G); 70% f/30% m, 2-20mm (max 20mm) granule-pebble, basalt/quartzite mix, v. poor sort, no rxn to HCl, moist-wet, sub. ang. - sub. rnd., 2.5Y 5/1 Gray.	DUAL ROTARY w/Tri-cone 8" wld. temp. casing.
				Archive @ 350' bgs
				DTW @ 286.3' bgs (7.19.17)
360	G.S.		340-341' Silty Gravel (mG) (75% G, 20% M, 5% S); Gravel: 50% f/50% m, 2-25mm (max 25mm) granule-pebble, basalt/quartzite mix, poor-v. poor sort, no rxn to HCl, wet, ang.-sub. rnd.; Silt: % high, mixed in solution w/water (not represented in archive sample), fluid, 2.5Y 5/3 lt. olive brown; Sand: med.-crse grn., ang.-sub ang., 2.5Y 4/3 lt. yellowish brown, damp, no rxn to HCl; Both silt & sand highly felsic.	Archive @ 355' bgs
				Archive @ 360' bgs
365	G.S.			Archive @ 365' bgs
370	G.S. W.S.		341-345' Sand (s) (100% S); Sand: fine-med. grn., ang.-sub ang., 2.5Y 3/1 v. dark gray, damp, no rxn to HCl, well sort, 50% m/50% f; possible sand lens...	Archive @ 370' bgs ~100 Gal H_2O added between 350-370' to aid drilling.
				W.S. @ 370.86' bgs
375	G.S.		@ 344' Sand (s); (90% S, 10% G); Gravel: chips of basalt/quartzite, ang., max size = 20mm pebbles; Sand: same as above.	I-006, pumped, HEIS#: B3BØH1, B3BØH2, B3BØH3, B3BØH5, B3BØH6, B3BØH7, B3BØH4 (Cr^{+6})
			345-355' Silty Gravel (mG) (45% G, 40% M, 15% S). Gravel: ang.-sub rnd., poor-v. poor sort, basalt/quartzite mix, 10-30mm (max 30mm) pebbles, no rxn to HCl, wet, 60% m/40% f; Silt: % high, fluid, 2.5Y 3/2 v. dark grayish brown, wet; Sand: v. fine-fine grn., same color as silt, v. well sort, wet, no rxn to HCl, unable to tell mafic/felsic content due to color (when wet).	
380	G.S.			DTW @ 286.0' bgs (7.20-17)
				Archive @ 375' bgs.
				Archive @ 380' bgs
385	G.S.			Archive @ 385' bgs
			355-390' Sandy Gravel (sG) (75% G, ~~10~~ 15% S, ~~5~~ 10% M). Gravel: ang-rnd., v. poor sort, basalt/quartzite mix, 2-25mm (max 25mm) granules-pebbles, no rxn to HCl, wet, 70% f/30% m; Sand: med.-v. crse grn., poor sort, predom. felsic, wet, no rxn to HCl, 2.5Y 4/3 olive brown; Silt: % low, majority washed out in suspension.	
390	G.S. W.S.			Archive @ 390' bgs.
	75%			DTW @ 285.9' bgs (7.24.17)
	S.S.			W.S. @ 390.87' bgs
				I-007, pumped, HEIS#: B3BØH9, B3BØJØ, B3BØJ1, B3BØJ3,

Reported By:

Print Name	Title	Signature	Date
Jess Hocking	Sr. Geologist		7/19/17

BOREHOLE LOG (Cont.)

Date: 7-19-2017

Well ID: C9634 | Well Name: 699-29-55 | Location: ~1.5 mi. SE of US ECOLOGY

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	GS		355 - 390' Sandy Gravel (sG) - (75% G, ~~10~~ 15% S, ~~5~~ 10% M) MSH 8-19-17 [cont'd from pg. 10]	DUAL ROTARY w/ Tri-cone 8" wld. temp. casing.
			@ 360' Sandy Gravel (sG) (75% G, ~~15~~ 20% S, 5% M) MSH 8-19-17; Sand % increase.	HEIS # (cont'd): B3BØJ4, B3BØJ8, B3BØJ2 (cr^6)
400	GS		@ 365' Sandy Gravel (sG) (75% G, ~~10~~ 15% S, ~~5~~ 10% M) MSH 8-19-17; Sand % decrease.	I-008, splitspoon sample: 75% rec. (390.9 - 392.9' bgs); HEIS #: B3BØN5, Liner "B" collected.
			@ 370' Sandy Gravel (sG) (75% G, 20% S, 5% M); Sand % increase. 2.5Y 4/4 olive brown.	
405	GS		@ 375' Sandy Gravel (sG) (75% G, 15% S, 10% M); Sand % decrease, crse - v.crse, poor sort, wet; Silt % increase, in suspension, fluid, 70% f / 30% m.	
410	GS W.S.		@ 380' Sandy Gravel (sG) (~~75~~ 65% G, 30% S, 5% M) MSH 8-20-17; Gravel % decrease, ang. - rnd., wet, max 35mm pebbles, v. poor sort; Sand % increase, crse - v.crse, v. poor sort, ang. - sub. ang., 2.5Y 3/2 v. dark grayish brown, 60% m / 40% f, wet; Silt % decrease, in suspension, fluid.	Optional H_2O sample: @ 410.9' bgs, pumped, HEIS #: B3BØK0, B3BØJ7, B3BØJ8, B3BØJ9, B3BØK1, B3BØK2, B3BØK3.
415	GS		@ 385' Sandy Gravel (sG) (70% G, 25% S, 5% M); Gravel % increase; Sand % decrease; Silt % no change.	
420	GS		390 - 442 Silty Sandy Gravel (msG) (45% G, 35% S, 20% M); Gravel: ang. - sub. rnd., poor sort, wet, basalt/quartzite mix, 80% f / 20% m, 2-35mm (max 35mm) granule - pebble; Sand: fine - mod. grn., well sort, wet, 80% f / 20% m, ang. - sub. ang., 2.5Y 4/3 olive brown; Silt % increase, in suspension, fluid, 2.5Y 5/4 lt. olive brown.	
425	GS		395' - Silty Sandy Gravel, (~~75% g, 20% s, 5% m~~) 50% g, 30% s, 20% m 7-25-17 RB gravel % increase, sand % decrease	
430	GS			

Reported By:

Print Name	Title	Signature	Date
Jess Hocking / C. Bupus	Sr. Geologist / Geologist		7/26/17

BOREHOLE LOG (Cont.)

Page 12 of 12

Date: 7-29-17

Well ID: C9634 | Well Name: 699-29-95 | Location: 65 m SE of Ecology

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	G4		390 - 442 silty Sandy Gravel (MSG)	Dual Air Rotary w/
			(continued, pg 11)	TriCone
				8" wld. temp. casing.
			400' - silty Sandy Gravel (MSG)	
			(g 40%, 35%s, 25%m), gravel % ↓, sand % ↑,	
440	G4		silt % ↑	@ 440' wood is
				encountered, massive
442	G4		405' - silty sandy Gravel (MSG)	organic fragments -
			(45%g, 35%s, 20%m), gravel ↑, mb	turned black as soon
				as it hit the air,
445	G4		410' - silty sandy Gravel (MSG)	turned H_2O black
			(35%g, 45%s, 20%m), gravel ↓, sand ↑	as well.
			415' - silty sandy Gravel (MSG)	
			(35g 45s 20m)	
450	G.S.		420' - silty sandy Gravel (MSG)	TD @ 453.0' bgs.
			(35g 45s 20m)	
			425 - silty sandy gravel (MSG)	
			(30g, 55s, 15m) g ↓ mb s ↑	
			430 - silty sandy gravel (MSG)	
			(30g, 50s, 20m)	
			435 - silty sandy gravel (MSG)	
			(30g, 50s, 20m)	
			440 - silty sandy Gravel (MSG)	
			(30g, 50s, 20m) sand appears to be more	
			mafic	
			453'	RLM @ 442' bgs.
			442 - ~~450~~ Mud	
			GLEY1 4/5GY dark green grey; ~~[illegible]~~ 7-26-17	
			100% clay, wet, Formation: Ringold Lower Mud	

Reported By:

Print Name	Title	Signature	Date
C Brown	Geology		7/26/17

A-6006-993 (REV 0)

Stoller Newport News Nuclear

699-29-55 (C9634)
Log Data Report

Borehole Information

Log Date	2017-08-07	Filename	C9634_HG-NM_2017-08-07	Site	200-UP-1

DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
286.05	07/25/17	SN3	07/27/17	453.0	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Welded Steel	Air Rotary	1.2	10 7/8	10 1/4	5/16	-1.2	15.08
Welded Steel	Air Rotary	2.15	8 5/8	8	5/16	-2.15	450.0

Borehole Notes

The onsite geologist provided the total depth and casing depth. Casing diameters and thicknesses were measured by the logging engineer. The maximum logging depth achieved was 451 ft. Static water is reported by the geologist at 286.05. Depth to water inside the casing was determined by the logging engineer to be at approximately 435 ft. Zero reference is ground surface. The logging engineer noted water in the annulus between the 10- and 8-in. casings.

Logging Equipment Information

Logging System	Gamma 1Ld	Type	60% HPGe SGLS[2]
Effective Calibration Date	01/26/17	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-150, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 1Mc	Type	NMLS[3] (CPN 503DR)
Effective Calibration Date	04/19/17	Serial No.	H340207279
Calibration Reference	HGLP-CC-155, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	4	5	6 Repeat	7	8 Repeat
HEIS Number	1019983	1019984	1019985	1019986	1019987
Date	08/01/17	08/02/17	08/03/17	08/07/17	08/07/17
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0.0	32.0	216.0	423.0	280.0
Finish Depth (ft)	33.0	216.98	424.0	451.0	325.0
Count Time (sec)	100	100	100	100	100
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0	1.0
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A

[1] depth to water inside casing
[2] Spectral Gamma Logging System
[3] Neutron Moisture Logging System

Log Run	4	5	6 Repeat	7	8 Repeat
Pre-Verification	C9634ALD2017 0801AV00CAB 1	C9634ALD2017 0802BV00CAB1	C9634ALD2017 0803CV00CAB1	C9634ALD2017 0807DV00CAB 1	C9634ALD2017 0807DV00CAB 1
Start File	AD000000	BD003200	CD021600	DD042300	ED028000
Finish File	AD003300	BD021698	CD042400	DD045100	ED032500
Post-Verification	C9634ALD2017 0801AV00CAA 1	C9634ALD2017 0802BV00CAA 1	C9634ALD2017 0803CV00CAA 1	C9634ALD2017 0807EV00CAA1	C9634ALD2017 0807EV00CAA1
Depth Return Error (in.)	0	1.0 high	0.5 high	N/A	1.0 high
Comments	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made

NMLS Log Run Information

Log Run	1	2	3 Repeat		
HEIS Number	1019980	1019981	1019982		
Date	07/31/17	08/01/17	08/01/17		
Logging Engineer	Spatz	Spatz	Spatz		
Start Depth (ft)	0.0	281.0	280.0		
Finish Depth (ft)	282.0	435.25	324.0		
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)	N/A	N/A	N/A		
Pre-Verification	C9634AMC2017 0731AV00CAB 1	C9634AMC2017 0801BV00CAB1	C9634AMC2017 0801BV00CAB1		
Start File	AD000000	BD028100	CD028000		
Finish File	AD028200	BD043525	CD032400		
Post-Verification	C9634AMC2017 0731AV00CAA 1	C9634AMC2017 0801CV00CAA 1	C9634AMC2017 0801CV00CAA 1		
Depth Return Error (in.)	0.5 high	N/A	0.5 high		
Comments	None	None	None		

Logging Operation Notes

Logging was conducted with a centralizer on the sondes.

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

Analysis Notes

Analyst	P.D. Henwood	Date	08/28/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

Casing correction for a 5/8-in. thick casing was applied to the data to 15 ft and 5/16-in. for the remainder of the borehole.

A water correction was applied below 286 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in an EXCEL template identified as ALD20170126 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

An interpreted data set was created for this borehole. Depth overlaps from consecutive log runs were removed from 32 and 33 ft, 216 and 217 ft, and 423 and 424 ft. This results in a data set where only one data point is presented for each depth.

NMLS data are reported in percent volumetric moisture content from 15 to 286 ft because the 8-in. casing size fits the calibration condition. The interval from 0 to 15 ft was double cased, and below 286 ft there was formation water. There is no calibration available for these conditions. Moisture presented in counts per second in the Total Gamma and Moisture plots is indicated for the entire borehole to 435 ft.

HGU[4] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Calibration Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected in this borehole.

Based on low K, Th and total gamma, voids may exist behind the casing at approximately 282 to 286 ft, 310 to 319 ft, 436 to 438, and at 447 ft. The logging sonde was performing correctly in these intervals.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. Percent volumetric moisture is presented from 15 to 286 ft where static water begins. Below 286 ft, the count rate is shown and may be an indicator of porosity. It also may be useful to indicate voids behind the casing such as from 310 to 320 ft. The moisture log count rate is elevated from 0 to 15 ft where water was apparently introduced into the annular space between the 8- and 10-in. casings.

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

List of Log Plots

Depth Reference is ground surface.

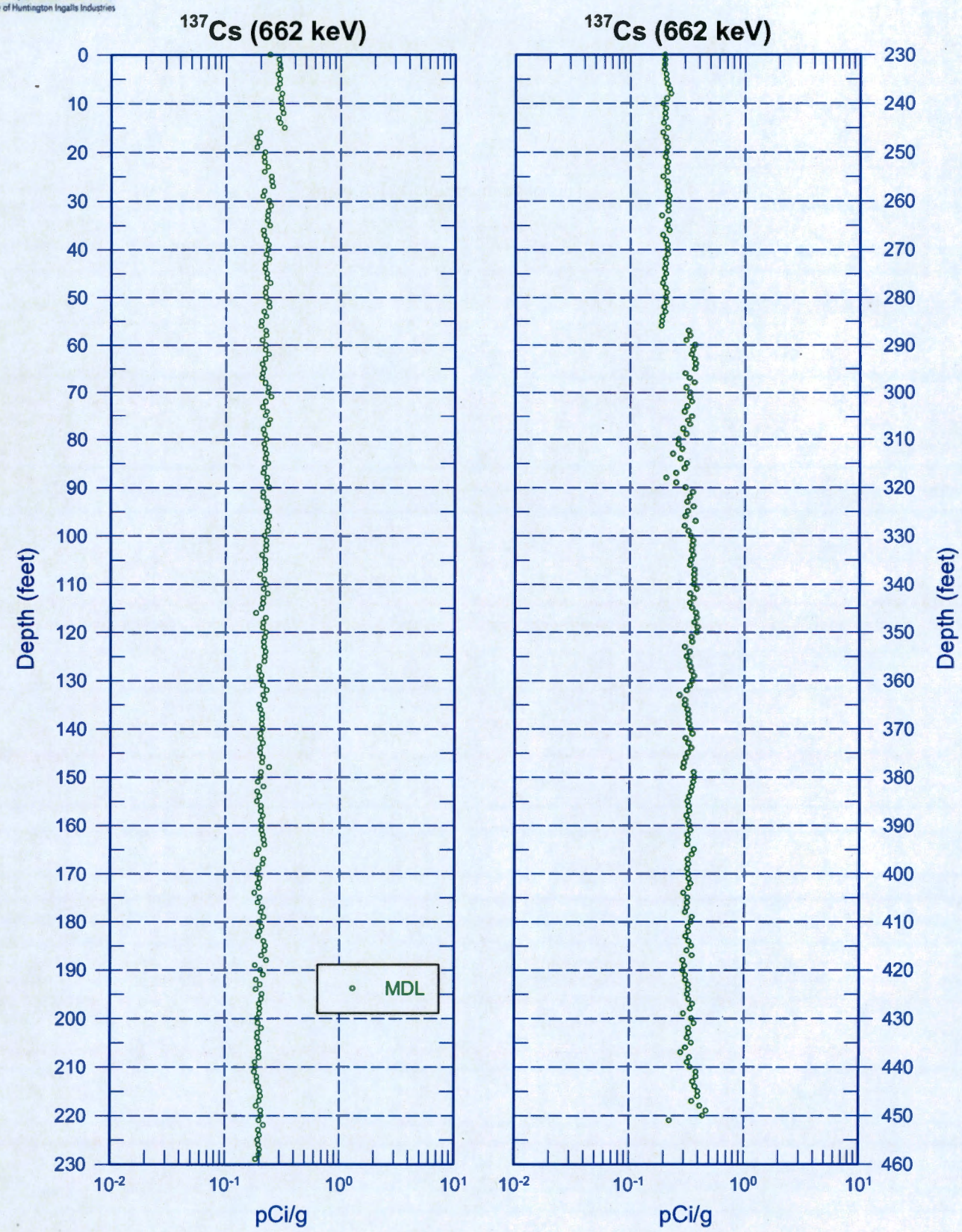
Manmade Radionuclides (0-460 ft)
Natural Gamma Logs (0-160 ft)
Natural Gamma Logs (150-310 ft)
Natural Gamma Logs (300-460 ft)
Combination Plot (0-120 ft)
Combination Plot (120-240 ft)
Combination Plot (240-360 ft)
Combination Plot (360-480 ft)
Combination Plot (0-460 ft)
Total Gamma & Moisture (0-160 ft)
Total Gamma & Moisture (150-310 ft)
Total Gamma & Moisture (300-460 ft)
Total Gamma & Hanford Gamma Unit (0-460 ft)
Repeat Section of Natural Gamma Logs (280-325 ft)
Moisture Repeat Section (280-324 ft)

[4] Hanford Gamma Unit

This page intentionally left blank.

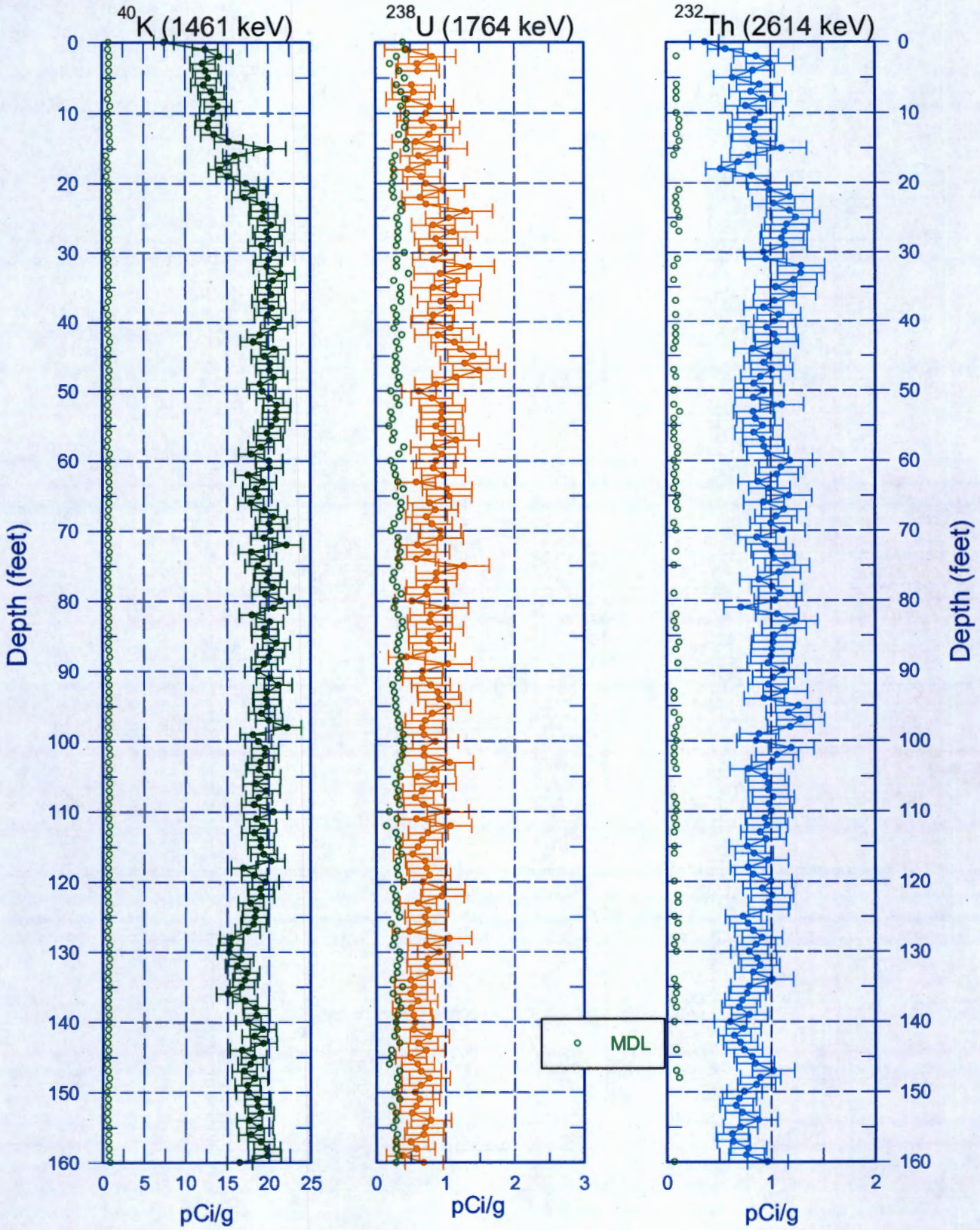
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634)
Manmade Radionuclides



Zero Reference - Ground Surface

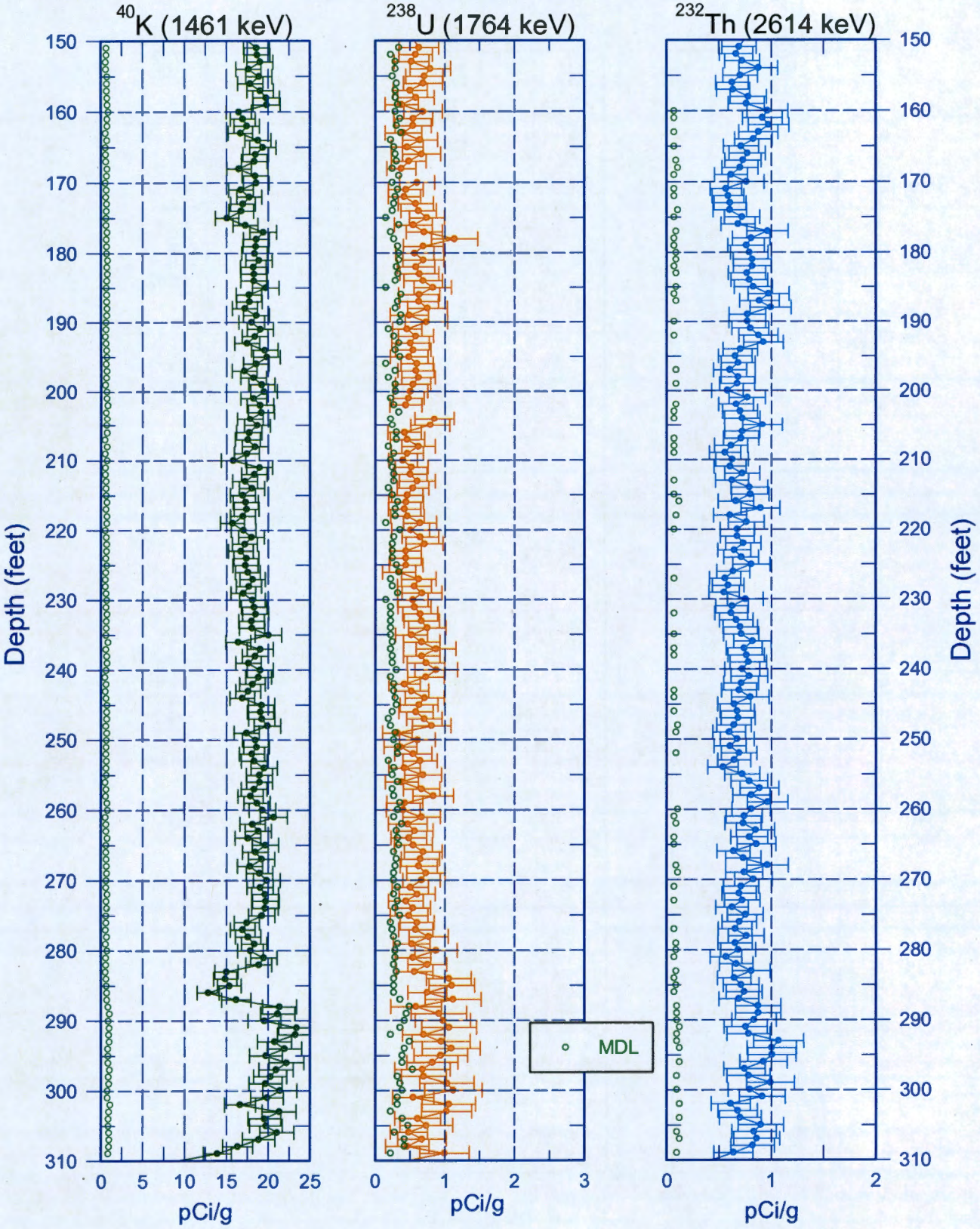
699-29-55 (C9634)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634)
Natural Gamma Logs

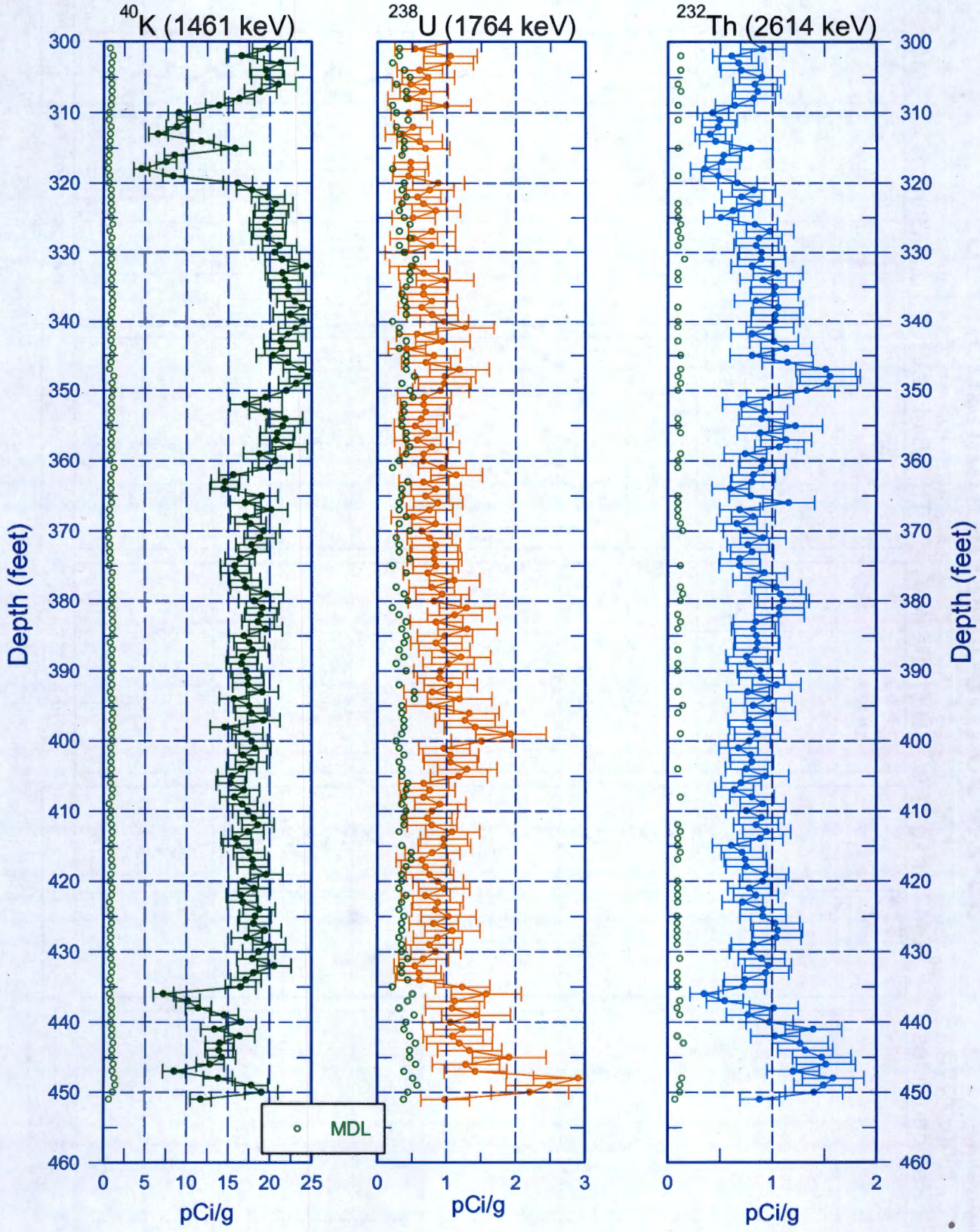


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634)

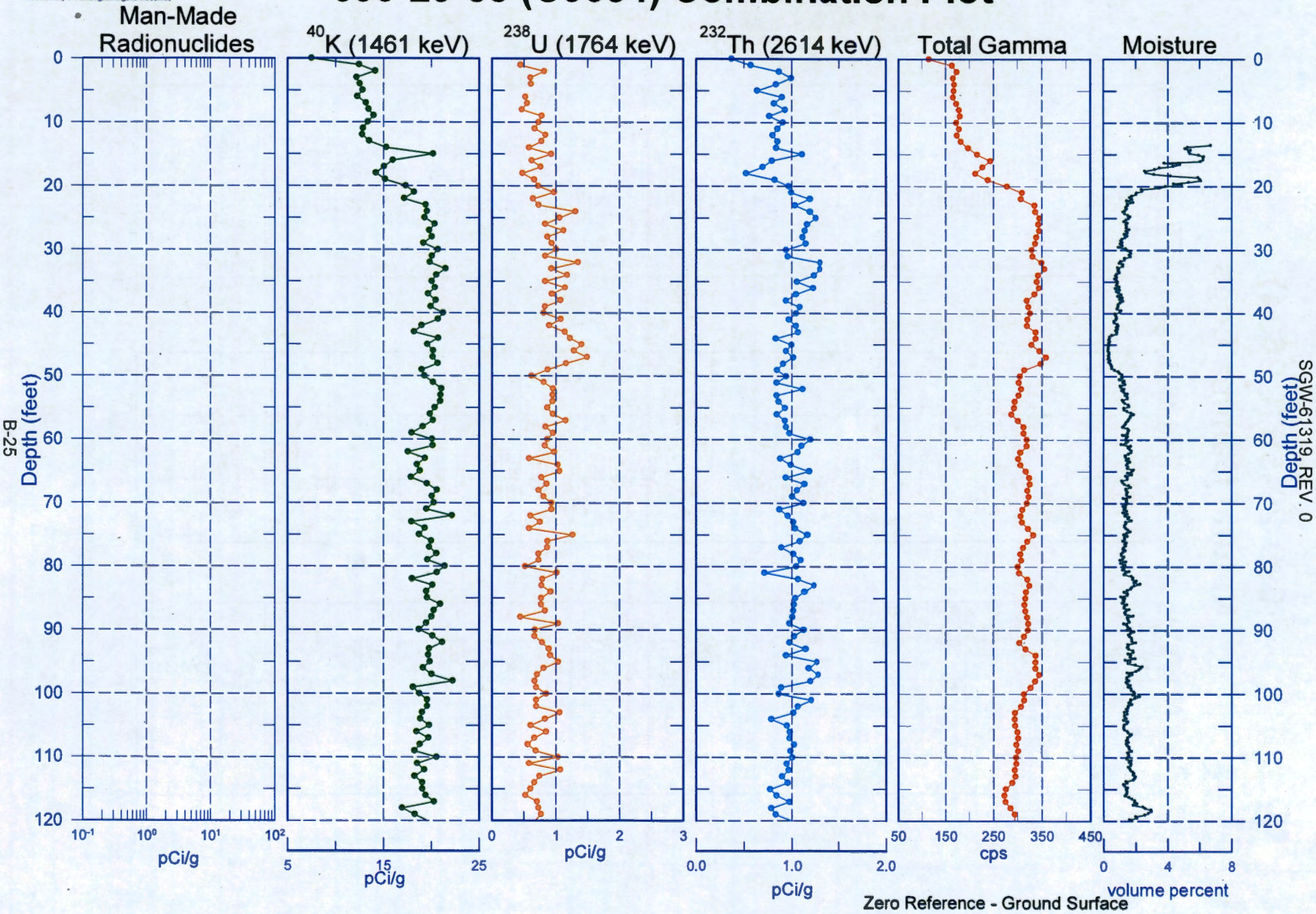
Natural Gamma Logs



Zero Reference - Ground Surface

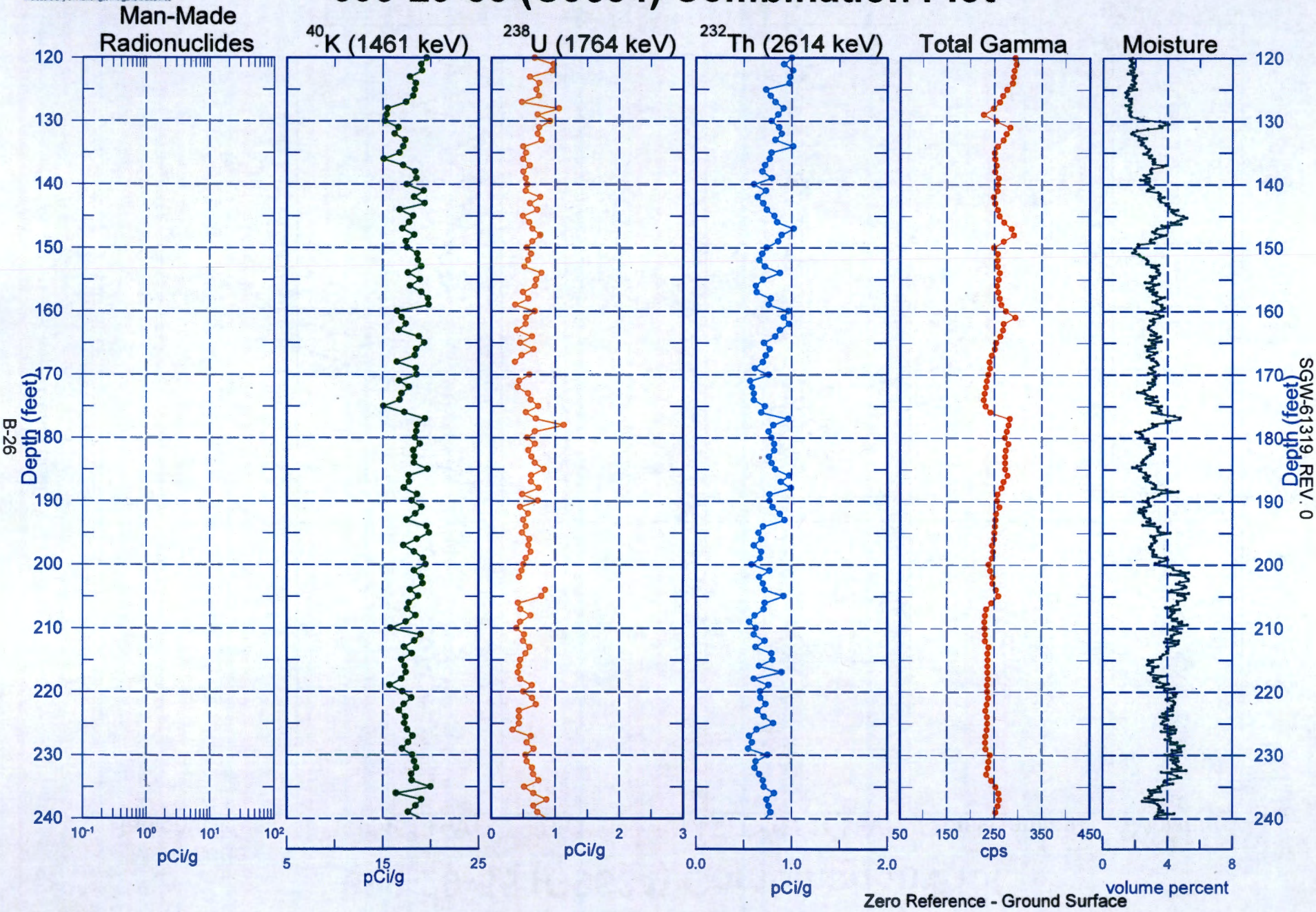
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634) Combination Plot



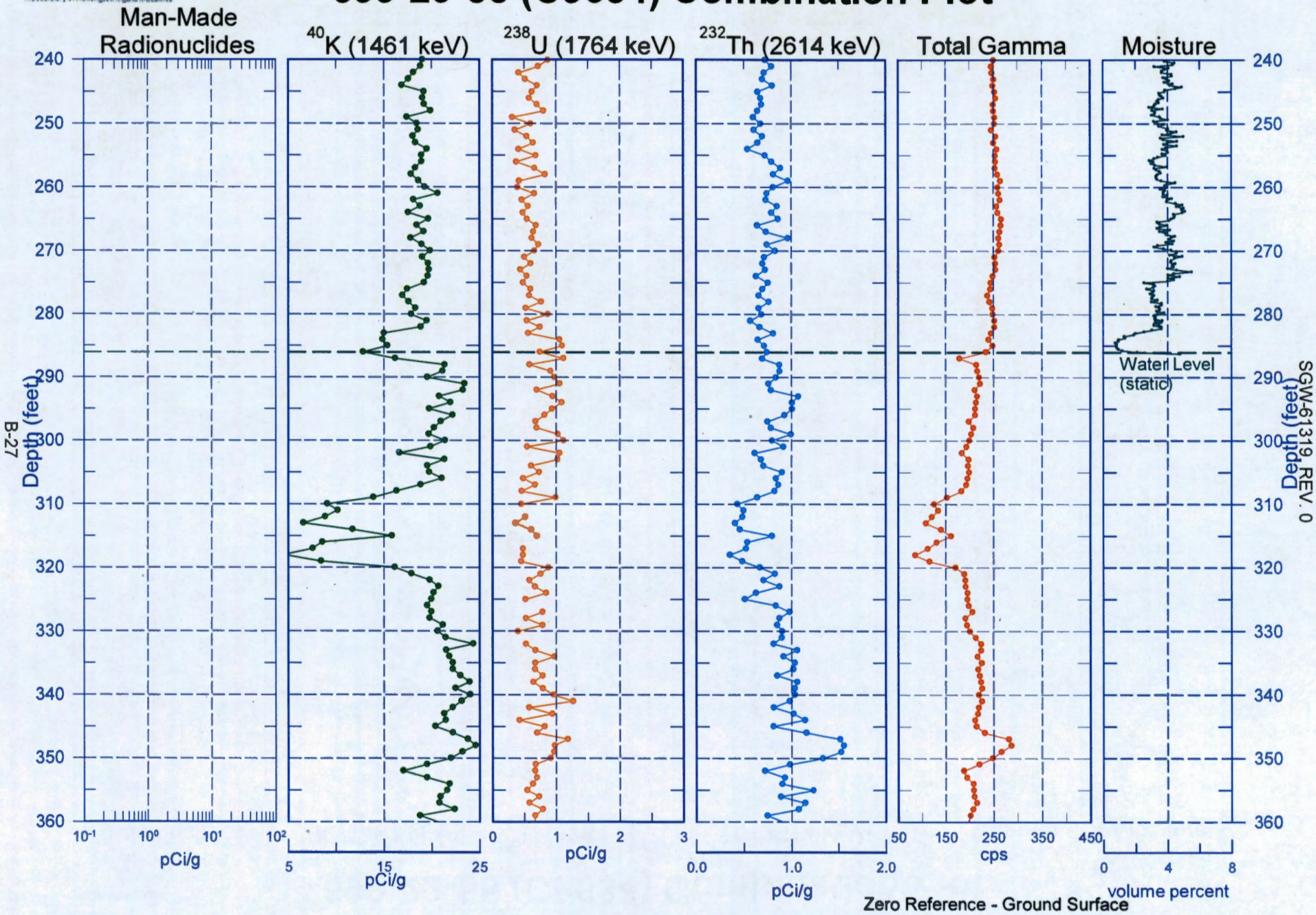
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634) Combination Plot



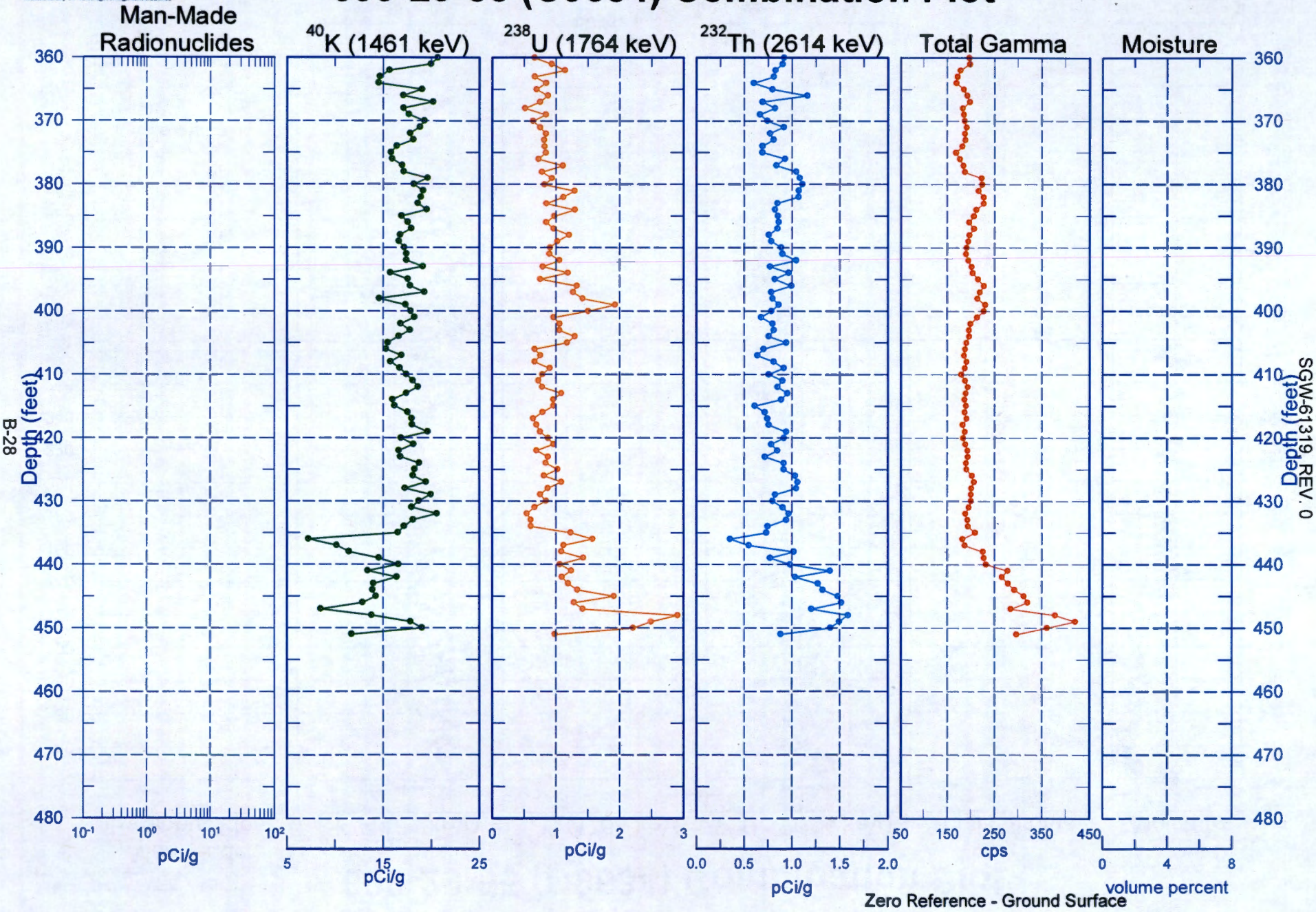
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634) Combination Plot



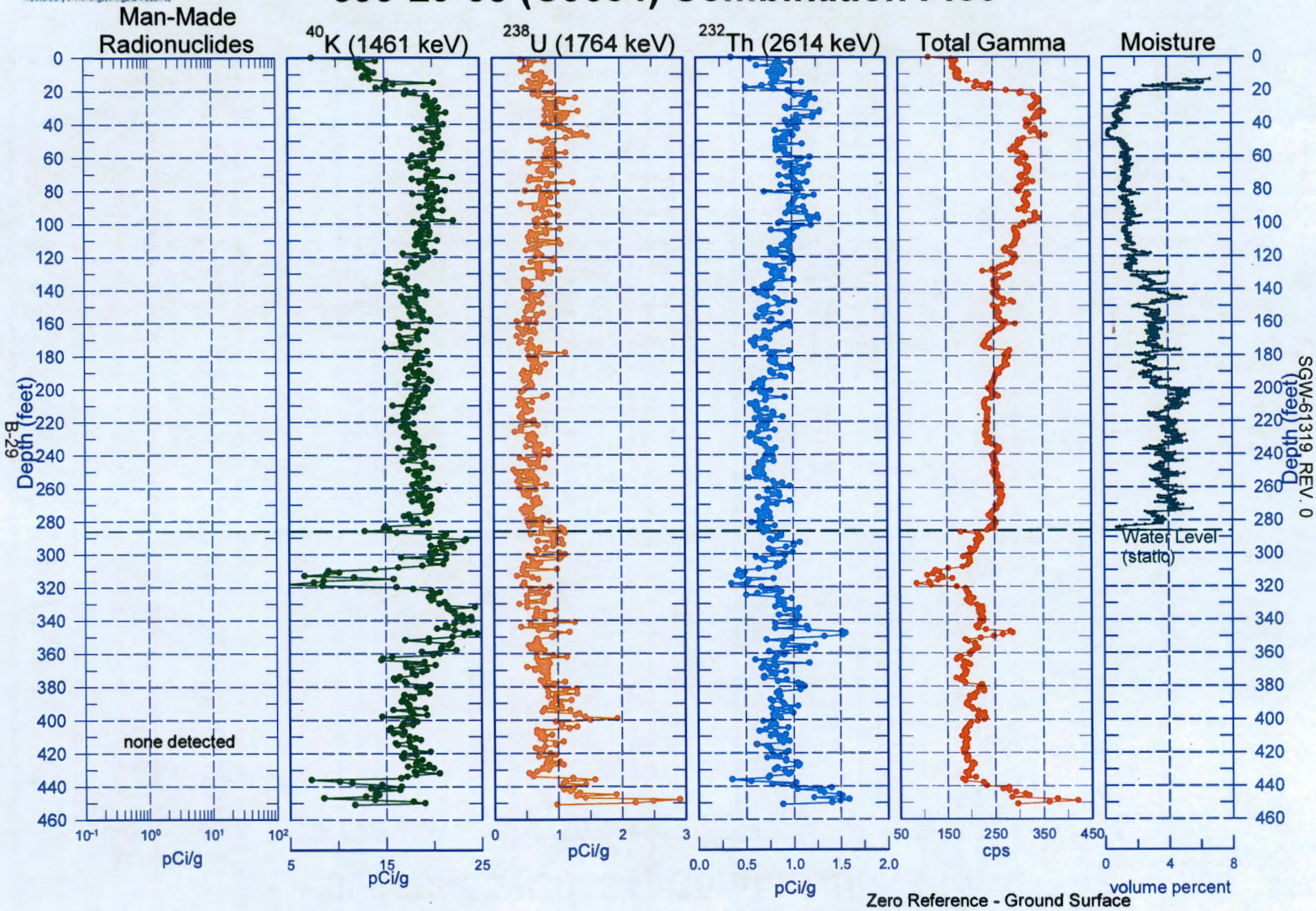
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634) Combination Plot



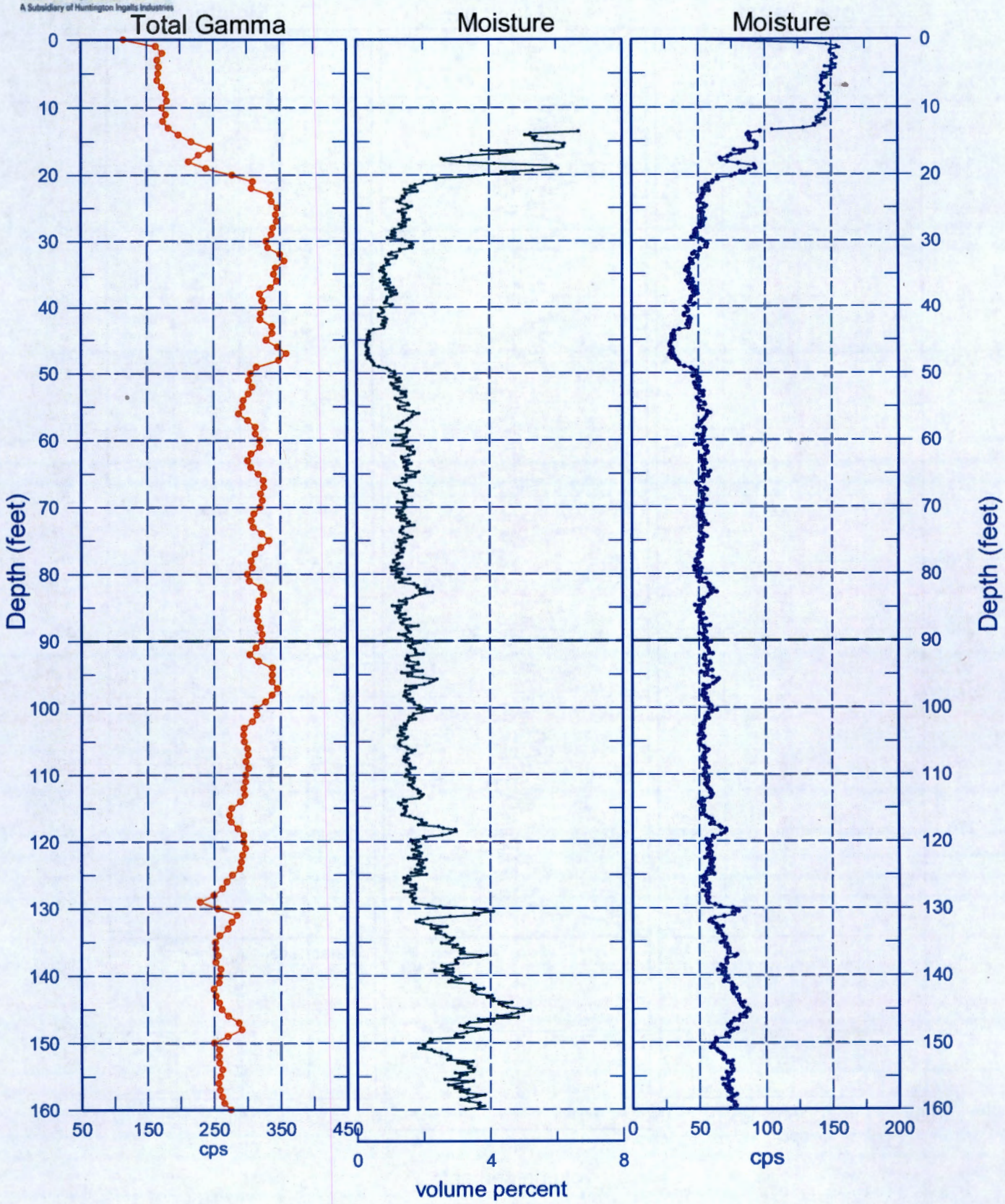
Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634) Combination Plot



Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

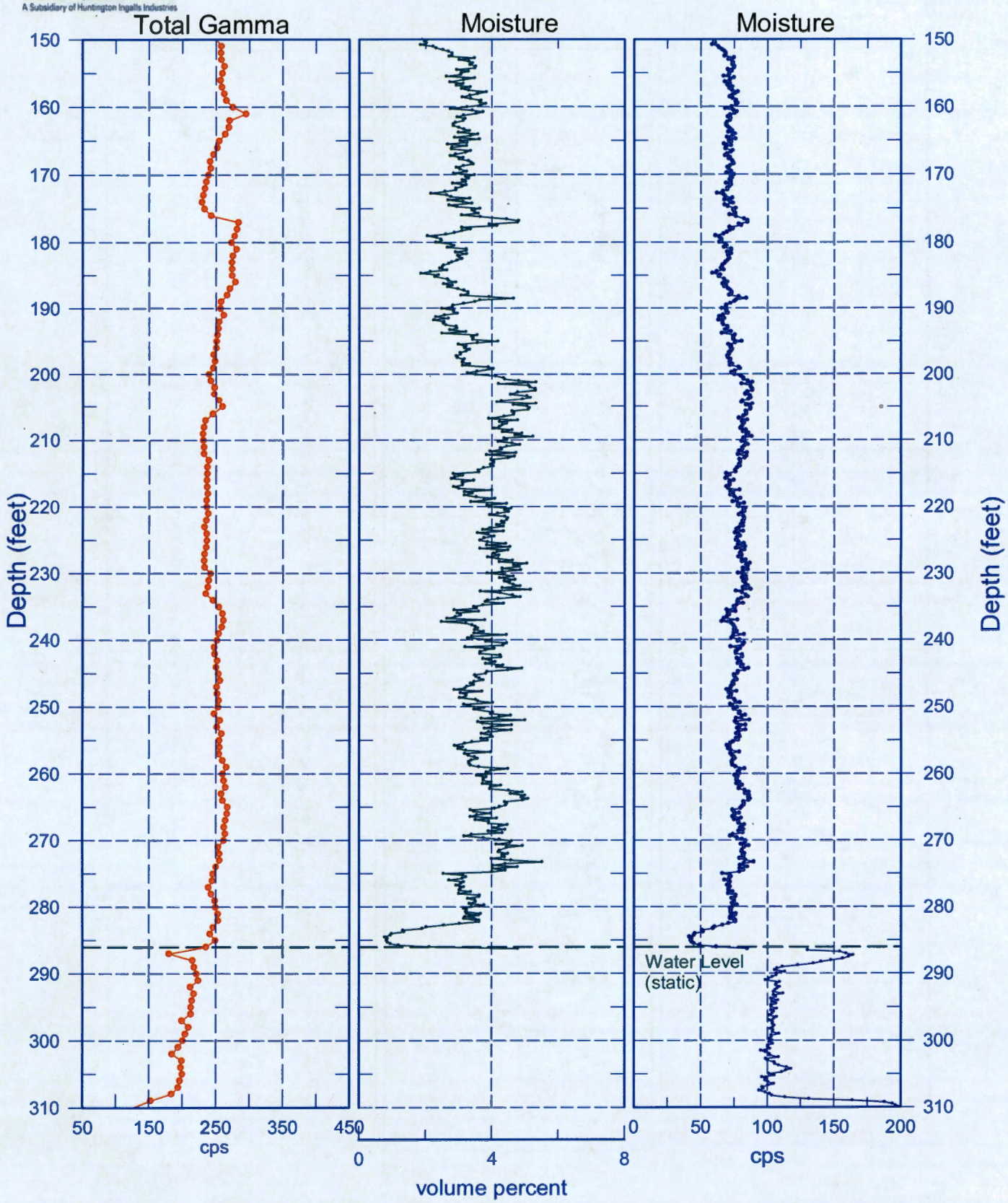
699-29-55 (C9634)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

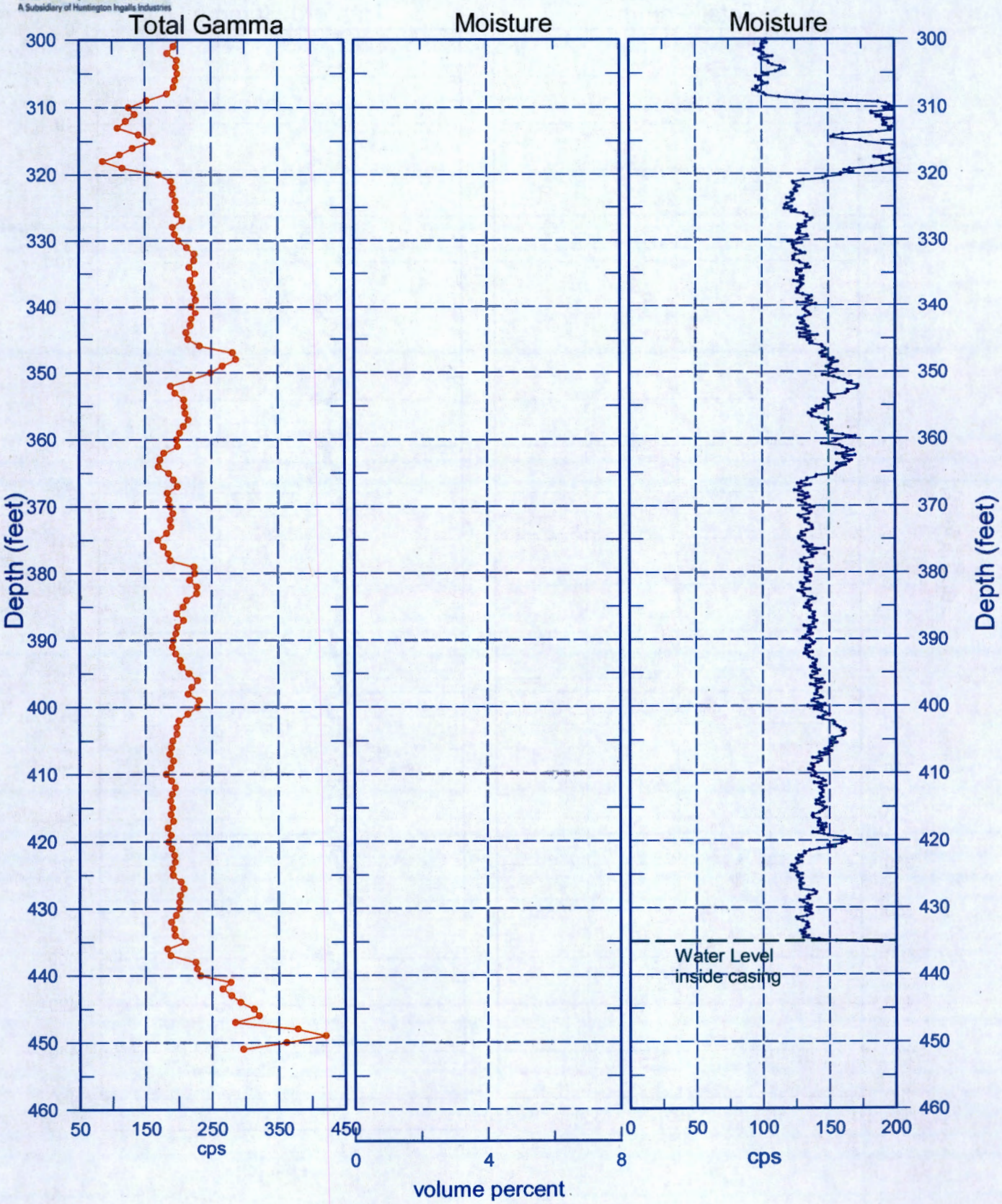
699-29-55 (C9634)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

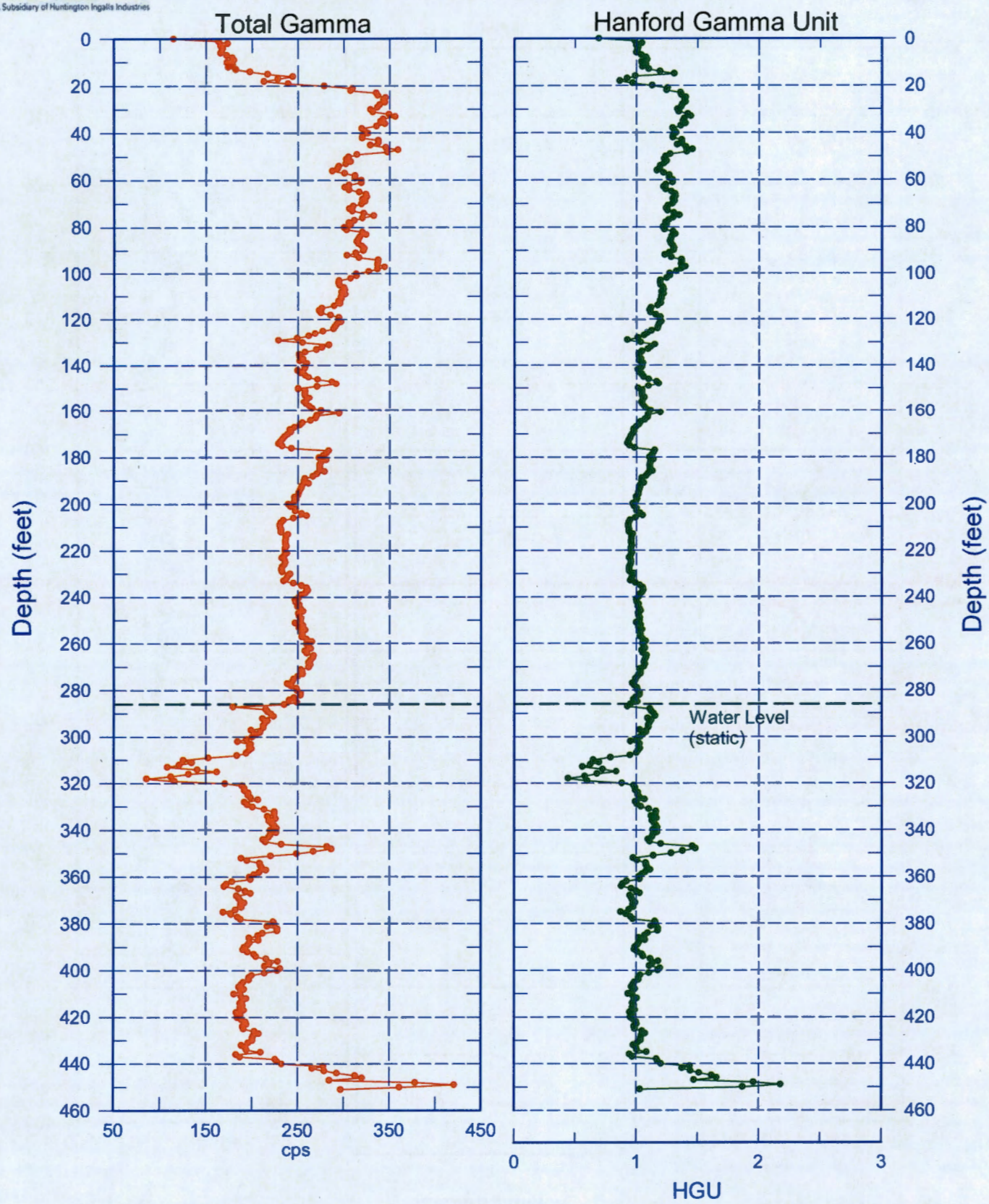
699-29-55 (C9634)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634)
Total Gamma & Hanford Gamma Unit

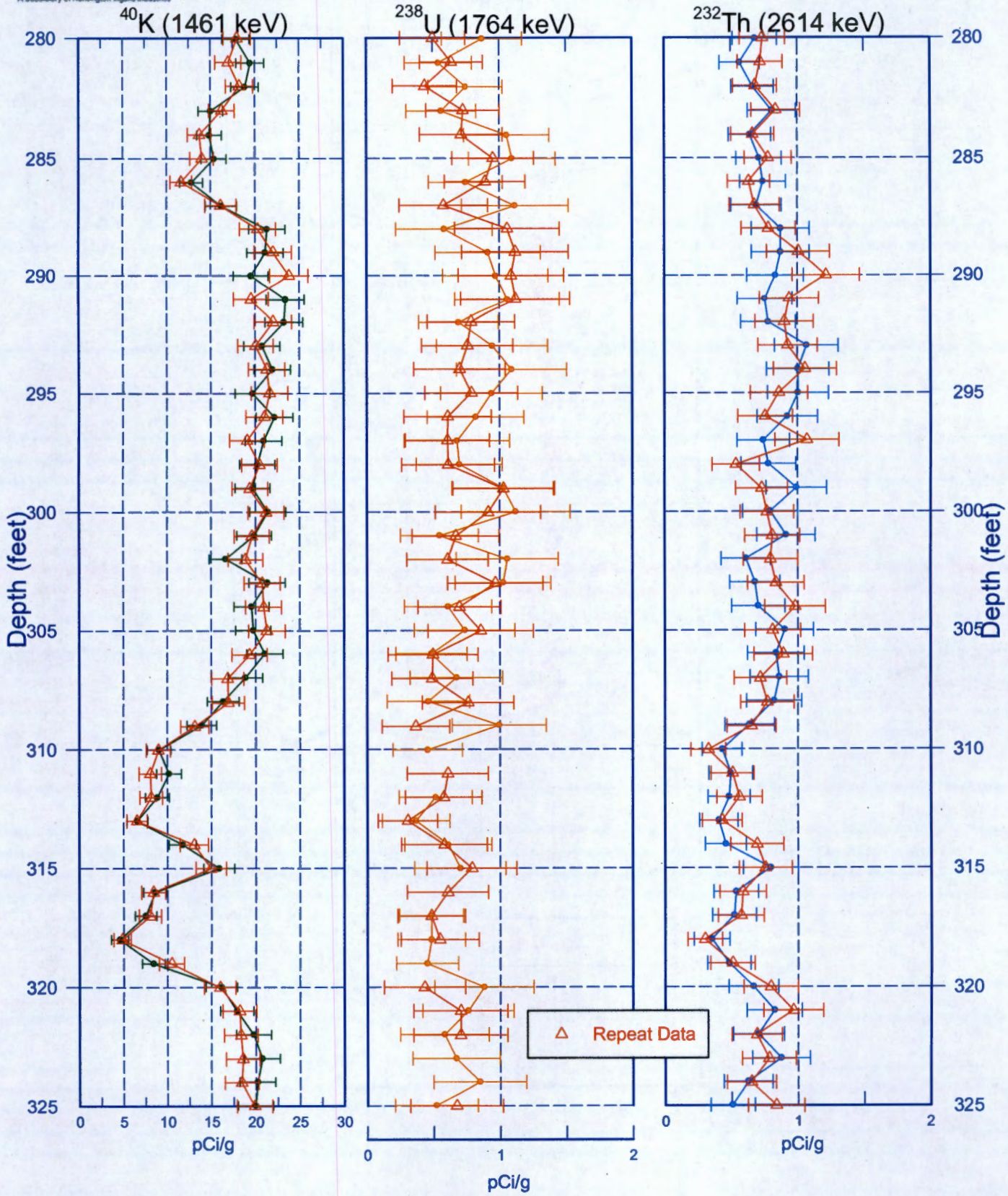


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634)

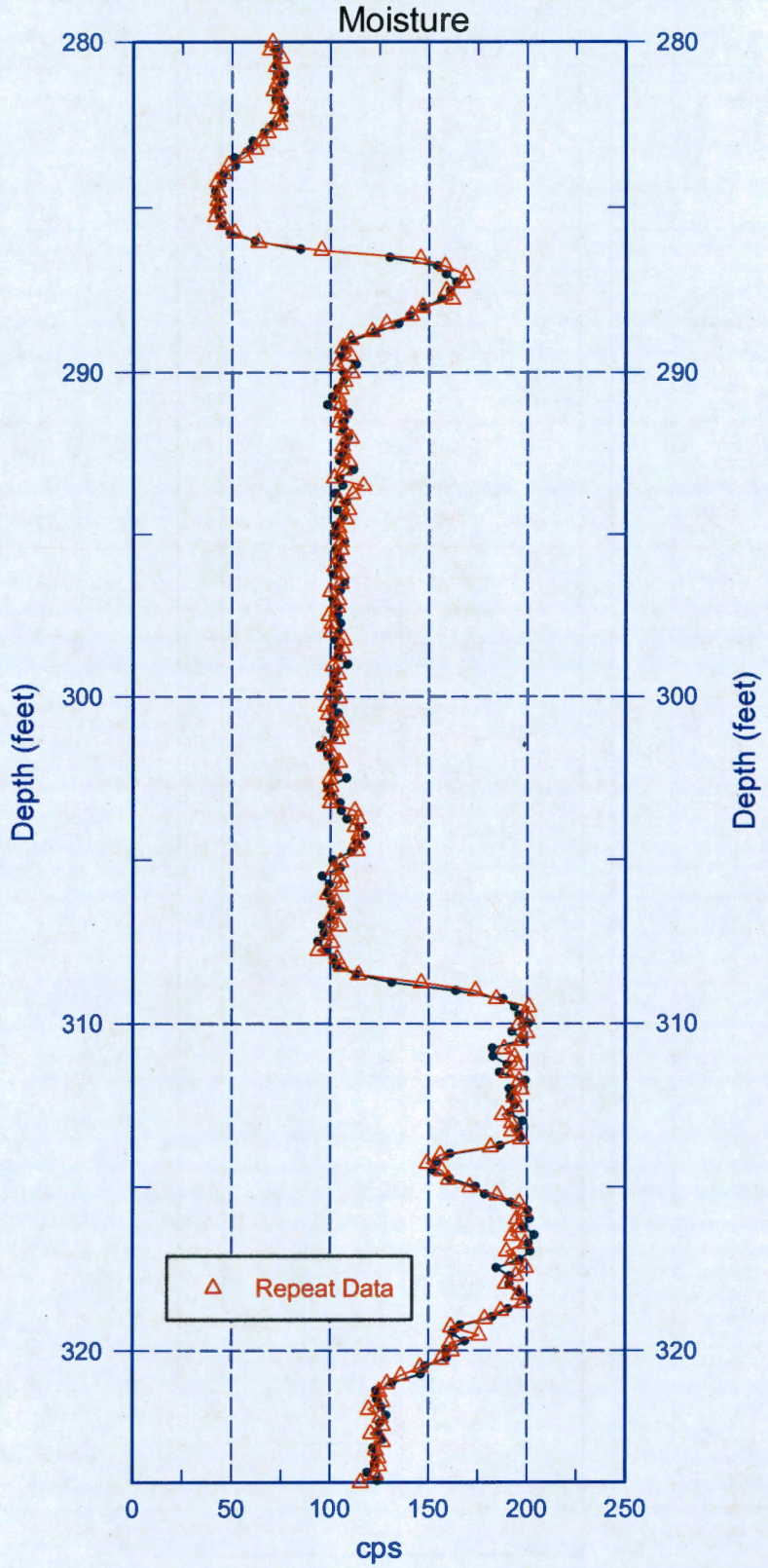
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-29-55 (C9634)
Moisture Repeat Section



Zero Reference - Ground Surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 11/02/17	Requestor: Matthan G. Wilson (CHPRC)
Date of Survey: 11/29/17	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of UP-1 Well C9634 (699-29-55) located on south side of BC Controlled Area, south of 200E Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:

Washington State Reference Network

Vertical Control Monuments:

HSWB-074 (COE) and HSWB-075 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9634	699-29-55	573241.86	132230.23		Center of Casing
				211.403	Top Baseplate, N.Edge
				211.396	Top Outer 6"SS Casing, N.Edge
				210.600	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.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
11-29-17

This page intentionally left blank.

Photo Log

0-5 bgs

5-10 bgs

10-15 bgs

15-20 bgs

20-25 bgs

25-30 bgs

30-35 bgs

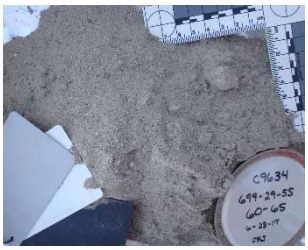
35-40 bgs

40-45 bgs

45-50 bgs

50-55 bgs

55-60 bgs


60-65 bgs

65-70 bgs

70-75 bgs

75-80 bgs

80-85 bgs

85-90 bgs

90-95 bgs

95-100 bgs

100-105 bgs

105-110 bgs

110-115 bgs

115-120 bgs

120-125 bgs

125-130 bgs

130-135 bgs

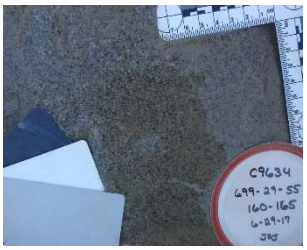
135-140 bgs

140-145 bgs

145-150 bgs

150-155 bgs

155-160 bgs



160-165 bgs

165-170 bgs

170-175 bgs

175-180 bgs

180-185 bgs

185-190 bgs

190-195 bgs

195-200 bgs

200-205 bgs

205-210 bgs

210-215 bgs

215-220 bgs

220-225 bgs

225-230 bgs

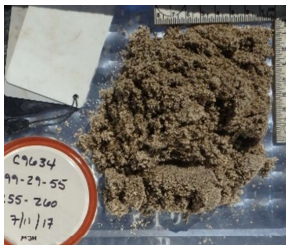
230-235 bgs

235-240 bgs

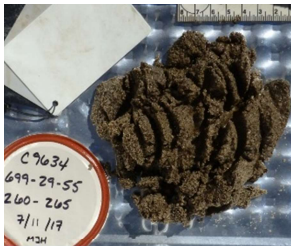
240-245 bgs

245-250 bgs

250-255 bgs

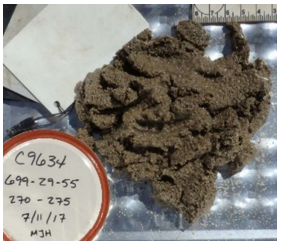


255-260 bgs

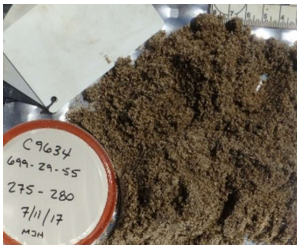


260-265 bgs

265-270 bgs



270-275 bgs



275-280 bgs

280-285 bgs

285-290 bgs

290-295 bgs

295-300 bgs

300-305 bgs

305-310 bgs

310-315 bgs

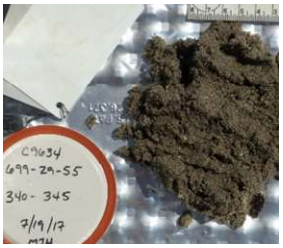
315-320 bgs

320-325 bgs

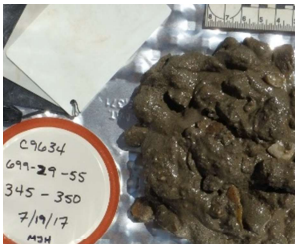
325-330 bgs

330-335 bgs

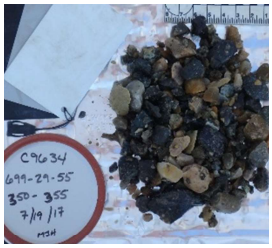
335-340 bgs



340-345 bgs



345-350 bgs



350-355 bgs

355-360 bgs

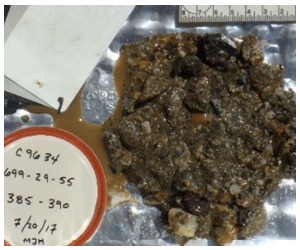
360-365 bgs

365-370 bgs

370-375 bgs

375-380 bgs

380-385 bgs



385-390 bgs

390-395 bgs

395-400 bgs

405-410 bgs

410-415 bgs

415-420 bgs

420-425 bgs

425-430 bgs

430-435 bgs

435-440 bgs

440-442 ft bgs

442-445 ft bgs

This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9634	Well Name: 699-29-55	Date: 9.19.17

Location: 1.5m SE of Ecology

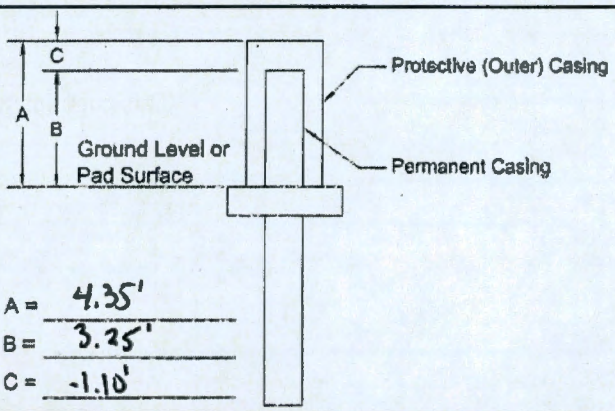
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 9.19.17	~~9.19.17~~ AR 9.19.17 286.05'bgs	—
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 9.19.17	386.05'bgs	—
Date: —	—	—



A = 4.35'
B = 3.25'
C = -1.10'

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)
376.05	4.18	88.60	29.4	3.26	0645	0914	15	3.59
353.05	4.03	65.60	59.6	3.51	0941	1214	15	3.72
314.05	4.26	26.60	35.8	3.02	1238	1507	15	3.52

Total Pumped: 6765 gallons

Pump Model: Grundfos 1.5 HP D-P2-1729

Troll Serial Number and Pressure Range (PSI and depth): 403065 ~~30psi~~ 70m / 231 ft AR 9.19.17

Comments:
Digital Data file names:
c9634_dev_int1_2017-09-19 All info on 1 file
~~c9634_dev_int2_2017-09-19~~ AR 9.19.17
~~c9634_dev_int3_2017-09-19~~ AR 9.19.17

Prepared By:

Print Name	Signature	Date
Andrew Rauterson	[signature]	9.19.17

Reviewed By:

Print Name	Signature	Date
Kelly Whitley	Kelly Whitley	11/6/17

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6005-205 (REV 2)

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9634	Well Name: 699-29-55	Date: 9.20.17
Location: 1.5 mi SE of Ecology		

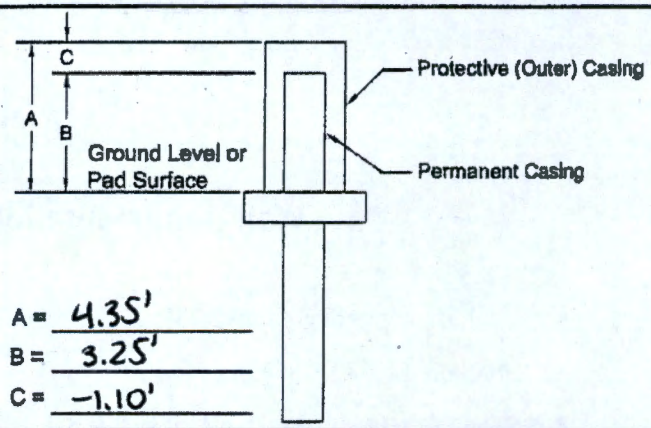
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 9.20.17	—	N/A
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 9.20.17	—	386.05' bgs
Date: —	—	—



A = 4.35'
B = 3.25'
C = -1.10'

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)
244.74'	4.12	7.29	12.1	1.59	0650	0836	15	3.64

Total Pumped: 1,590 gal.

Pump Model: Grundfos 1.5 hp D-P2-1729

Troll Serial Number and Pressure Range (PSI and depth): 403065 70m/231ft

Comments:

~~AR 9.20.17~~ ~~C9634_dev_int 4_2017-09-20~~ AR 9.20.17

Prepared By:

Andrew Rawlerson — *Print Name*

[signature] — *Signature*

9-20-17 — *Date*

Reviewed By:

Kelly Whitley — *Print Name*

Kelly Whitley — *Signature*

11/6/17 — *Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6005-205 (REV 2)

Appendix C

Well Documentation for 699-30-70 (C9635)

- Well Summary Sheet for C9635
- Borehole Log for C9635
- Geophysical Log Data Report for C9635
- Final Survey Report for C9635
- Photo Log for C9635
- Well Development and Testing Data Sheet for C9635

This page intentionally left blank.

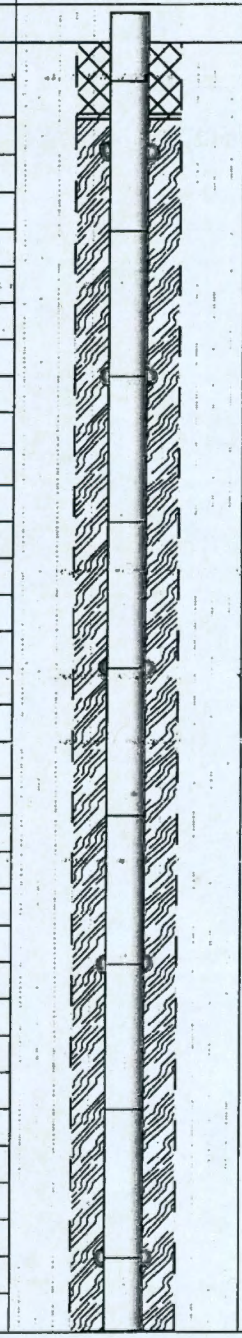
WELL SUMMARY SHEET

Well ID: C9635	Well Name: 699-30-70	Start Date: 5/16/2017
Project: 200-UP-1 4 Monitoring Wells	Location: ~ 0.5 mi. NE of Rattlesnake Barricade	End Date: 8/24/2017

CONSTRUCTION DATA

Description
WA Dept. of Ecology Tag: BJB-537
Temporary Casing Depths
8" CS Wld. Joints = 394.20 ft bgs
Permanent Well Materials
4" ID Riser
2.00' - 220.00' bgs
4" ID Stainless Steel 20-Slot Screen
220.00' - 240.01' bgs
4" ID Stainless Steel Blank
240.01' - 270.00' bgs
4" ID Stainless Steel 20-Slot Screen
270.00' - 310.00' bgs
4" ID Stainless Steel Blank
310.00' - 320.01' bgs
4" ID Stainless Steel 20-Slot Screen
320.01' - 350.03' bgs
4" ID Stainless Steel Sump
350.03' - 353.03' bgs
Note: 2" Welded Tab Centralizers are placed top and bottom of each screen and every 40 ft thereafter.

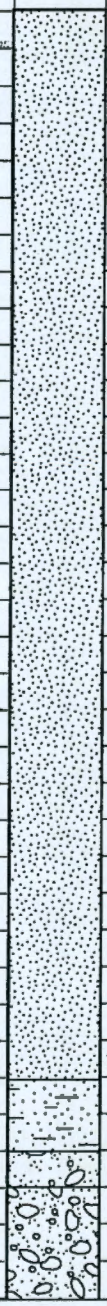
Diagram



GEOLOGIC/HYDROLOGIC DATA

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

Graphic Log



Lithologic Description (ft bgs)

0 - 145 ft: Sand [(S)]

145 - 155 ft: Slightly Silty Sand [((m)S)]

155 - 160 ft: Gravelly Sand [(gS)]

160 - 190 ft: Sandy Gravel [(sG)]

Reported By:			
Cameron Ryan Burns	Geologist		9/26/17
Print Name	Title	Signature	Date

Reviewed By:			
Kelly Whitley	Well Coordinator	Kelly Whitley	9/27/17
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

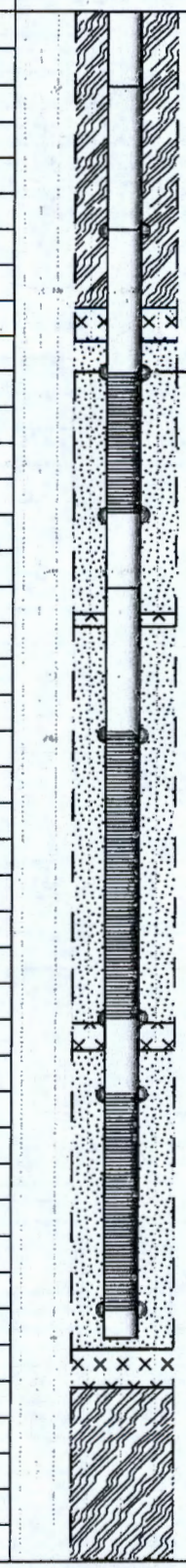
WELL SUMMARY CONTINUATION SHEET

Well ID: C9635 | Well Name: 699-30-70 | Project: 200-UP-1 4 Monitoring Wells

CONSTRUCTION DATA

Description
Well Construction Materials
Type I-II Portland Cement
0.50 ft bgs - 9.50 ft bgs
3/8" Bentonite Chips
9.00 ft bgs - 10.00 ft bgs
Bentonite Slurry
10.00 ft bgs - 211.40 ft bgs
3/8" Coated Bentonite Pellets
211.40 ft bgs - 216.25 ft bgs
10-20 Colorado Silica Sand
216.25 ft bgs - 242.95 ft bgs
8-16 Colorado Silica Sand
242.95 ft bgs - 253.10 ft bgs
3/8" Coated Bentonite Pellets
253.10 ft bgs - 256.60 ft bgs
8-16 Colorado Silica Sand
256.60 ft bgs - 264.70 ft bgs
10-20 Colorado Silica Sand
264.70 ft bgs - 312.00 ft bgs
3/8" Coated Bentonite Pellets
312.00 ft bgs - 314.70 ft bgs
10-20 Colorado Silica Sand
314.70 ft bgs - 356.50 ft bgs
3/8" Coated Bentonite Pellets
356.50 ft bgs - 363.20 ft bgs
Bentonite Slurry
363.20 ft bgs - 401.29 ft bgs
Natural Fill
401.29 ft bgs - 401.85 ft bgs

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 175, 200, 225, 250, 275, 300, 325, 350, 375

Graphic Log

Lithologic Description (ft bgs)

190 - 210 ft: Sand [(S)]

210 - 220 ft: Gravelly Sand [(gS)]

220 - 300 ft: Sandy Gravel [(sG)]

Depth to Water = 220.62 ft bgs (8/22/2017)

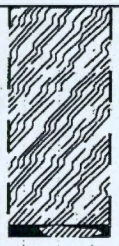
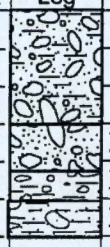
300 - 320 ft: Silty Sandy Gravel [(msG)]

320 - 360 ft: Sandy Gravel [(sG)]

360 - 385 ft: Silty Sandy Gravel (msG)

WELL SUMMARY CONTINUATION SHEET

Well ID: C9635 | Well Name: 699-30-70 | Project: 200-UP-1 4 Monitoring Wells

CONSTRUCTION DATA			GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
		375		
				385 - 391 ft: Sandy Gravel [(sG)]
				391 - 395 ft: Silty Gravel [(mG)]
		400		395 - 401.85 ft: Gravelly Silty Sand [(gmS)]
				Total Depth = 401.85 ft bgs
		425		
		450		
		475		
		500		
Note:		525		
A straightness test was performed and passed prior to well construction, per WAC 173-160 requirements.		550		
All temporary casings have been fully removed from the ground.				
All depths represented are in feet below ground surface (ft bgs) unless otherwise noted.		575		

A-6006-992 (REV 0)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 11

Date: 5-16-17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

Project: 200-UP-1 Monitoring Wells | 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				Dual Air Rotary w/under reamer
			0-145: Sand (s)	Archive @ 5' bgs
			5% silt, 90% v.fn.-v.crs sand (mostly med.), 5% v.fn.-v.crs. peb; max 34 mm; moist, mod.-poorly sorted; ang.-sub. rnd.; sand: 40% mafic / 60% felsic, gravel: 85%m / 15%f; v. strg. HCl rxn; 10YR 4/3 brown	
5	G.S.		@ 5' bgs ↑	
10	G.S.		@ 10' bgs: 5% silt, 94% v.fn.-v.crs. sand (fn.-med.); 1% v.fn.-fn. peb.; max 5 mm; slightly moist, mod.-well sorted; sub.ang.-sub.rnd. s: 30%m / 70%f, g: 90%m / 10%f; v.strg. HCl rxn, 10YR 4/3 brown	Archive @ 10' bgs.
15	G.S.		@ 15' bgs: 5% silt, 95% v.fn.-v.crs. sand (fn.-med.), max 2mm; slightly moist, well sorted; s: 30%m / 70%f, v.strg. HCl rxn, 10YR 4/3 brown	Archive @ 15' bgs
20	G.S.		@ 20' bgs: 5% silt, 95% v.fn.-v.crs. sand (fn.-med.), max. 2mm; dry - slightly moist, mod.-well sorted; s: 25% m / 75% f, strong HCl rxn, 10YR 5/3 brown	Archive @ 20' bgs
25	G.S.		@ 25' bgs: 5% silt, 86% sand (med.-v.crs.), 9 ~~40~~% v.fn.-med. peb.; max. 31 mm; dry, poorly sorted; sub.ang.-sub. rnd.; sand: 30%m / 70%f, pebbles: 80%m / 20%f; reacts with HCl, 10YR 5/3 brown	Archive @ 25' bgs
30	G.S.		@ 30' bgs: 5% silt, 90% v.fn.-v.crs. sand, 5% v.fn.-med. peb; max 8 mm; dry, ~~poorly sorted~~ mod.-poorly sorted; sub.ang.-sub.rnd. s: 30%m / 70%f, pebbles: 50%m / 50%f, no HCl rxn, 10YR 5/3 brown	Archive @ 30' bgs

Reported By:

Print Name	Title	Signature	Date
Julie Johnson / Andrew Rawlerson	Project Geologist / Staff Geologist	Julie Johnson / [signature]	5-16-17

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	geologist	[signature]	06-28-17

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Date: 5-16-17

Well ID: C96035 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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
	G.S.		0-145: sand (s)	Dual Air Rotary w/under reamer
35	AR 6-20-17		@35' bgs: 5% silt, 90% sand, 5% pebbles (s: v.fn.-v.crs., peb.: f-~~med~~ AR 5-16-17); max 6mm; dry, mod.-well sorted, s: AR 5-16-17 20%m/80%f, pebbles: 50%m/50%f, no HCl rxn, 2.5Y 5/3 light olive brown; sub.ang.-sub.rnd.	Archive @ 35'
40	G.S.		@40' bgs: 10% silt, 90% v.fn.-v.crs. sand; max 3mm; dry, well sorted, s: 25%m/75%f, no HCL rxn, 10YR 4/3 brown	Archive @ 40'
45	G.S.		@45' bgs: 8% silt, 90% v.fn-v.crs. sand, 2% pebbles; max 8mm; dry, mod.-well sorted, s: 20%m/80%f, pebbles: 50%m/50%f, no HCl rxn, 10YR 4/3 brown	Archive @ 45'
50	G.S.		@50' bgs: 5% silt, 95% v.fn.-v.crs. sand; max 3mm; dry, well sorted, s: 20%m/80%f, ~~pebble~~ weak HCl rxn, 10YR 5/3 brown AR 5-16-17	Archive @ 50'
55	G.S.		@55' bgs: 5% silt, 95% v.fn.-v.crs. sand (m.-~~crs.~~ AR 5-16-17) dry, well sorted, s: 15%m/85%f, no HCl rxn, 10YR 5/3 brown	Archive @ 55'
60	G.S.		@60' bgs: 5% silt, 95% v.fn.-v.crs. sand; dry, well sorted, s: 30%m/70%f, no HCl rxn, 10YR 5/3 brown	Archive @ 60'
65	G.S.		@65' bgs: 5% silt, 95% v.fn.-v.crs. sand (fn.-med.) dry, well sorted, s: 30%m/70%f, no HCl rxn, 10YR 4/3 brown	Archive @ 65'
70	G.S.		@70' bgs: 5% silt, 95% v.fn.-v.crs. sand (v.fn.-med.), dry, well sorted, s: 15%m/85%f, strong HCl rxn, 10YR 5/3 brown	Archive @ 70'

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	[signature]	5-16-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 5-16-17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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
			AR 5-16-17 ~~@ 75' bgs:~~ 0 - 145 : Sand (S)	Dual Air Rotary Rig
75	G.S.		@ 75' bgs: 10% silt, 90% sand (v.f.s. - v.crs.), dry, well sorted, s: 15% m / 85% f, weak HCl rxn, 10YR 5/3 brown, sub.ang. - sub. rnd.	with Under Reamer Archive @ 75'
	AR 6-20-17			
80	G.S.		@ 80' bgs: 8% silt, 92% v.fn. - v.crs. sand (v.fn.-med.), dry, well sorted, s: 20% m / 80% f (~30% mica), weak HCl rxn, 10YR 6/3 pale brown	Archive @ 80'
85	G.S.		@ 85' bgs: 8% silt, 92% v.fn. - crs. sand (v.fn-med), dry, well sorted, s: 15% m / 85% f (~30% mica), weak rxn. w/ HCl, 10YR 6/3 pale brown	Archive @ 85'
90	G.S.		@ 90' bgs: 2% silt, 98% sand (v.fn. - v.crs), dry, well sorted, s: 25% m / 75% f (~30% mica), weak HCl rxn, 10YR 5/3 brown	Archive @ 90'
95	G.S.		@ 95' bgs: 5% silt, 95% v.fn. - v.crs. sand, dry well sorted, s: 15% m / 85% f (~30% mica), weak HCl rxn, 10YR 6/3 pale brown	Archive @ 95'
100	G.S.		@ 100' bgs: 5% silt, 95% v.fn. - v.crs. sand, dry well sorted, s: 15% m / 85% f, weak HCl rxn, 10YR 5/3 brown	Archive @ 100'
105	G.S.		@ 105' bgs: 2% silt, 98% v.fn. - v.crs. sand, dry, well sorted, s: 25% m / 75% f, weak HCl rxn, 10YR 4/3 brown	Archive @ 105'
110	G.S.		@ 110' bgs: 2% silt, 98% v.fn. - v.crs. sand, dry, well sorted, s: 30% m / 70% f, weak HCl rxn, 10YR 5/2 greyish brown	Archive @ 110'

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	[signature]	5-17-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 5.17.17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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. AR 6.20.17		0-145 : Sand (S)	Dual Air Rotary Rig w/Under Reamer
			@ 115' bgs: 2% silt, 98% sand (v.fn.-v.crs.), dry, well sorted, sub.ang.-sub rnd., s: 30%m/70%f, weak HCl rxn, 10YR 5/3 brown	Archive @ 115'
120	G.S.		@ 120' bgs: 5% silt, 95% sand (v.fn.-v.crs.), dry, well sorted, s: 30%m/70%f, weak HCl rxn, 10YR 5/3 brown	Archive @ 120'
125	G.S.		@ 125' bgs: 2% silt, 98% v.fn-v.crs. sand, dry, well sorted, s: 30%m/70%f, weak HCl rxn, 10YR 4/3 brown	Archive @ 125'
130	G.S.		@ 130' bgs: 2% silt, 98% v.fn.-v.crs. sand, dry, well sorted, s: 30%m/70%f, weak HCl rxn, 10YR 6/3 pale brown	Archive @ 130'
135	G.S.		@ 135' bgs: 8% silt, ~~99%~~ 92% v.fn.-v.crs. sand (med.-crs.), dry, well sorted, s: 35%m/65%f, weak HCl rxn, 10YR 5/3 brown (AR. 5.17.17)	Archive @ 135'
140	G.S.		@ 140' bgs: 5% silt, 95% v.fn.-v.crs sand (med.-crs.), dry, well sorted, s: 35%m/65%f, no HCl rxn, 2.5Y 6/2 light brownish grey	Archive @ 140'
145	G.S.		145-155 : ~~15% silt, 85% sand (v.fn.-v.crs.)~~ (A.R. 5.17.17) Slightly Silty Sand (m)S	
			@ 145' bgs: 15% silt, 85% v.fn-v.crs. sand (v.fn.-med.), slightly moist, well sorted, sub.ang.-sub.rnd., s: 30%m/70%f, very strong HCl rxn, 10YR 6/3 pale brown	Archive @ 145'
150	G.S.		@ 150' bgs: 11% silt, 84% sc.fn-v.crs. sand, 5% pebbles (max 11mm), slightly moist, well-mod. sorted, s: 25%m/75%f, pebbles: 50%m/50%f, very strong HCl rxn, 10YR 4/3 brown	Archive @ 150'

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	[signature]	5.17.17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 5·17·17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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.		155 – 160 : Gravelly sand (gS)	Dual Air Rotary Rig w/Under Reamer
	AR 6.26.17		@155' bgs: 5% silt, 75% sand, 20% gravel (max 24mm), slightly moist, poorly sorted, sub.ang. - sub.rnd., s: 30%m/70%f, g: 60%m/40%f, very strong HCl rxn, 10YR 5/3 brown	Archive @ 155'
	G.S.		160 – 190 : Sandy gravel (sG)	
160			@160' bgs: 5% silt, 55% sand, 40% gravel (max 22mm), moist, poorly sorted, ang. - sub.rnd., s: 60%m/40%f, g: 70%m/40%f, strong HCl rxn, 10YR 4/4 dark yellowish brown	Archive @ 160'
165	G.S.		@165' bgs: 5% silt, 60% v.fn. - v.crs. sand, 35% gravel (max 22mm); moist, poorly sorted, sub. ang. - sub rnd., s: 40%m/60%f, g: 60%m/40%f, strong HCl rxn, 10YR 3/3 dark brown	Archive @ 165'
170	G.S.		@170' bgs: 5% silt, 60% v.fn. - v.crs. sand, 35% gravel (max 11mm); moist, poorly sorted, sub.ang. - sub. rnd., s: 40%m/60%f, g: 60%m/40%f, no HCl rxn, 10YR 4/3 brown	Archive @ 170'
175	G.S.		@175' bgs: 5% silt, 55% v.fn. - v.crs. sand, 40% gravel (max 24mm); moist, poorly sorted, sub.ang. - sub.rnd., s: 60%m/40%f, g: 70%m/30%f, no HCl rxn, 10YR 3/3 dark brown	Archive @ 175'
180	G.S.		@180' bgs: 5% silt, 55% v.fn. - v.crs. sand, 40% gravel (max 30mm); moist, poorly sorted, sub.ang. - sub.rnd., s: 30%m/70%f, g: 60%m/40%f, no HCl rxn, 10YR 3/3 dark brown	Archive @ 180'
185	G.S.		@185' bgs: 10% silt, 60% v.fn. - v.crs. sand, 30% gravel (max 25mm); moist, poorly sorted, sub.ang. - sub.rnd., s: 25%m/75%f, g: 70%m/30%f, no rxn w/ HCl, 10YR 4/3 brown	Archive @ 185'
			190 – 210 : Sand (S)	
190	G.S.		@190' bgs: 5% silt, 90% sand, 5% gravel (max 27mm) moist, mod. - well sorted, sub.ang. - sub.rnd., s: 20%m/80%f, g: 80%m/20%f, no rxn w/ HCl, 10YR 4/4 dark yellowish brown	Archive @ 190'

Reported By:

Print Name	Title	Signature	Date
Andrew Rauterson	Staff Geologist		5·17·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 5.17.17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5mile NE of Rattlesnake Barricade

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. AR 6.20.17		190 - 210 : Sand (S)	Dual Air Rotary Rig w/ Under Reamer
			@195' bgs: silt 5%, 86% v.fn.-v.crs. sand, 9% gravel (max 28mm); moist, mod. sorted, sub.ang.-sub. rnd., s: 30%m/70%f, g: 80%m/20%f, no HCl rxn, AR 5.17.17 10YR 3/4 dark yellowish brown	Archive @ 195'
200	G.S.		@200' bgs: 5% silt, 95% v.fn.-v.crs. sand (v.fn.-med.); moist, well sorted, s: 20%m/80%f, no HCl rxn, 10YR 3/4 dark yellowish brown	Archive @ 200'
205	G.S.		@205' bgs: 6% silt, 85% sand (v.fn.-v.crs.), 9% gravel; slightly moist, well sorted, s: 40%m/60%f, g: 75%m/25%f (max 9mm), no HCl rxn, 10YR 5/3 brown	Archive @ 205'
210	G.S.		210 - 220: Gravelly Sand (gS)	
			@210 bgs: 5% silt, 80% v.fn.-v.crs. sand, 15% gravel (max 9mm), slightly moist, mod. sorted, sub.ang.-sub. rnd., s: 40%m/60%f, g: 60%m/40%f, no HCl rxn, 10YR 5/3 brown	Archive @ 210'
215	G.S.		@215' bgs: 3% silt, 77% v.fn.-v.crs. sand (med-crs.), 20% gravel (max 14mm), dry, poorly sorted, s: 40%m/60%f, g: 60%m/40%f, no HCl rxn, 10YR 4/2 dark greyish brown	Archive @ 215'
220	G.S.		220 - 250 : Sandy Gravel (sG)	
			@220' bgs: 3% silt, 7% v.fn.-v.grs. sand, 90% v.fn.-crs. pebbles (max 31mm), wet (likely due to added water), poorly sorted, ang.-sub.rnd., s: 40%m/60%f, g: 70%m/30%f, no HCl rxn, 2.5Y 3/3 dark olive brown	Archive @ 220' ~200gal H_2O added from 216'-226' DTW: 220.76' (5-18-17)
225	G.S.		@225' bgs: 1% silt, 19% v.fn.-v.crs. sand (v.crs.), 80% v.fn.-crs. pebbles (med.) (max 18mm), wet, poorly sorted, sub.ang.-sub.rnd., s: 40%m/60%f, g: 80%m/20%f, no HCl rxn, 10YR 2/2 very dark brown	Archive @ 225' likely wet due to added water more sand observed than was collected in archives from 220' bgs - 250' bgs
230	G.S		@230' bgs: 1% silt, 15% vfn.-v.crs. sand, AR 5.22.17 84% v.fn.-crs. pebbles (max 32mm); moist, poorly sorted, sub. ang.-sub. rnd., s: 40%m/60%f, g: 75%m/25%f, no HCl rxn, 10YR 3/1 very dark grey	Archive @ 230' wet due to added water Added ~100gal H_2O from 226' bgs - 236' bgs.

Reported By:

Print Name	Title	Signature	Date
Andrew Roulerson	Staff Geologist	AR	5-22-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 7 of 11

Date: 5.22.17

Well ID: ~~C9653~~ C9635 (AR 5.23.17) | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
235	G.S.		220 - 250: Gravel (G)	Dual Air Rotary Rig w/Under Reamer
	WS I-001 SS		@235' bgs: 1% silt, 15% v.fn.-v.crs. sand, 84% v.fn.- v.crs.	Switch drill bit to Tri Cone
	I-002		pebbles (max 40mm); moist, poorly sorted, sub.ang.-ang.,	@236' bgs
			s: 40%m/60%f, p: 80%m/20%f, no rxn HCl,	Split Spoon Sample I-002
			10YR 2/2 very dark brown	236.05' bgs to 238.45' bgs
	G.S.			Liner B - 236.95' bgs to 237.95'
240			@240' bgs: 1% silt, 10% sand v.fn.-v.crs., 89% v.fn.-crs.	bgs 5.22.17 HEIS#: B3B122
			pebbles (max 30mm); wet, poorly sorted, ang.-sub.ang.,	5.22.17
			s: 40%m/60%f, p: 70%m/30%f, no HCl rxn, 10YR 3/1	more sand is in formation than
			very dark grey	is present in samples while
	G.S.			in water table 220' bgs-250' bgs
245			@245' bgs: 3% silt, 7% v.fn.-v.crs. sand, 90% v.fn.-v.crs.	Archive @ 245'
			pebbles (max 35mm); wet, poorly sorted, ang.-sub.ang.,	more silt present than in
			s: 40%m/60%f, p: 70%m/30%f, no HCl rxn, 10YR 3/1	sample
			very dark grey	H_2O sample I-001 HEIS: B3B0P4, B3B0P5
	G.S.		250 - 300: Sandy Gravel (SG)	B3B0P6, B3B0P8, B3B0P9, B3B0R0; 235.45' bgs
250			@250' bgs: 3% silt, 35% v.fn.-v.crs. sand, 62% v.fn.-	Archive @ 250' 5.23.17
			crs. pebbles (max 28mm); wet, poorly sorted, ang.-sub.	
			ang., s: 25%m/75%f, p: 75%m/25% f, no HCl rxn,	
			10YR 3/2 very dark greyish brown	
255	G.S.			
	WS I-003		@255' bgs: 5% silt, 50% v.fn.-v.crs. sand, 45% v.fn.-	Archive @ 255'
			crs. pebbles (max 28mm); wet, poorly sorted, s: 25%m/75%	H_2O sample I-003 HEIS: B3B0R4,
			f, p: 70%m/30%f, no HCl rxn, 10YR 3/1 very dark	B3B0R7, B3B0R3, B3B0R6, B3B0R5
			grey	B3B0R2 AR 5.24.17 5.24.17
260	G.S.			
			@260' bgs: ~5% silt (observed), ~20% ~~v.fn.-v~~ sand (observed), 75% v.fn.- (SMJ 5-25-17)	Archive @ 260' bgs.
			v.crs. peb.; max 52 mm; wet, poorly sorted, ang.-rnd.; g: 40%m/60%f,	Due to drilling method, sand + silt
			No HCl rxn; 10YR 3/3 dark brown (gravel overall)	were observed but (SMJ 5-25-17) water was no able
				to be collected
265	G.S.			
			@265' bgs: 8% silt, 20% v.fn.-v.crs. sand, 72% v.fn.- crs. peb. max	Archive @265' bgs
			27mm; ang-sub.rnd.; s: 30%m/70%f, g: 40%m/60%f; No HCl rxn;	
			2.5Y 4/3 olive brown	
270	G.S.			
			@270' bgs: ~5% silt (observed), ~20% sand (observed), 75% v.fn.-v.crs peb.;	Archive @ 270' bgs
			max 33mm; g: 50%m/50%f; s: ~10%m/90%f; No HCl rxn; Overall	
			gravel: 2.5Y 4/3 olive brown	

Reported By:

Print Name	Title	Signature	Date
Andrew Rauterson / Julie Johanson	Staff Geologist / Project Geologist		5-25-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 5-25-17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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. W.S. I-004		220 – 300 : Sandy Gravel (sG)	Dual Air Rotary w/tri-cone
			10% silt, 30% v.fn.-v.crs. sand; 60% v.fn.-v.crs. peb.; max 39 mm; wet; poorly sorted; ang.-rnd.; s: 35%m/65%f; g: 55%m/45%f; No HCl rxn; 10YR 4/3 brown	Archive @ 275' bgs A final blow out produced a larger amount of sand than was represented in archive grab samples 260-275; additional
280	G.S.		Sand: 45% m/55% f in blow out @280' bgs: 10% silt, 15% v.fn.-v.crs. sand, 75% v.fn.-crs. peb; max 29 mm; s: 35%m/65%f, g: 70%m/30%f; No HCl rxn; 10YR 4/3 brown	Archive @ 255-275' bgs blowout w/sand. H_2O Sample I-004, HEIS# B3B0T0, B3B0T1, B3B0T2, B3B0T4, B3B0T5, B3B0T6 @ 275.57' bgs 5-25-17 Archive @ 280' bgs
285	G.S.		@285' bgs: 10% silt, 50% v.fn.-v.crs. sand, 40% v.fn.-v.crs. peb; max 33mm; s: 40%m/60%f, g: 30%m/70%f; 2.5Y 5/3 light olive brown; No HCl rxn; ang.-rnd.	SMJ 5-30-17 ~~Archive~~ Archive @ 285' bgs
290	G.S.		@290' bgs: 5% silt, 20% v.fn.-v.crs. sand, 75% v.fn.-v.crs. peb; max 37mm; ang.-rnd; s: 30%m/70%f, g: 50%m/50%f, No HCl rxn; 2.5Y 5/3 light olive brown	Archive @ 290' bgs
295	G.S. W.S. I-005 S.S. I-006		@295' bgs: 10% silt, 15% v.fn.-v.crs. sand, 75% v.fn.-v.crs. peb; max 36mm; s: 30%m/70%f, g: 45%m/55%f, No HCl rxn; 2.5Y 5/3 light olive brown.	Archive @ 295' bgs Final clean out indicated possibly more silt or fn. sand. H_2O Sample I-005; @ 295.41' bgs 5-31-17 HEIS# B3B0T8, B3B0T9, B3B0V0, B3B0V2,
300	G.S.		300 – 320 : Silty Sandy Gravel (msG) 15% silt, 25% v.fn.-v.crs. sand, 60% v.fn.-v.crs. peb.; max 39 mm; wet, poorly sorted; ang.-sub rnd.; s: 35%m/65%f, g: 60%m/40%f; No HCl rxn; 2.5Y 4/3 olive brown (silt)	Archive @ 300' bgs B3B0V3, B3B0V4 Split Spoon Sample I-006 @ 295.7'-298.1' bgs, 5-31-17, Liner B; HEIS# B3B123
305	G.S.		@305' bgs: 15% silt, 35% v.fn.-v.crs. sand; 50% v.fn.-v.crs. peb; max 41 mm; s: 30%m/70%f, g: 65%m/35%f; No HCl rxn; 2.5Y 4/3 olive brown	Archive @ 305' bgs
310	G.S.		@310' bgs: 15% silt, 20% v.fn.-v.crs. sand; 65% v.fn.-v.crs peb.; max 39 mm; ang.-rnd.; s: 30%m/70%f, g: 65%m/35%f; No HCl rxn; 2.5Y 4/3 olive brown	Archive @ 310' bgs

Reported By:

Julie Johanson / Print Name | Project Geologist / Title | Signature | SMJ 5-31-17 ~~5-25~~ 5-31-17 Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 5-31-17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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. H2O S. I-007		300-320 : Silty Sandy Gravel (msG). @315' bgs: 15% silt, 40% v.fn.-v.crs. sand, 45% v.fn.-v.crs. peb; max 40mm; wet, poorly sorted; ang.-rnd.; s: 30%m/70%f; g: 60%m/40%f; No HCl rxn; 2.5Y 4/3 olive brown	Dual Air Rotary w/tri-cone. Archive @ 315' bgs. H_2O Sample I-007 @ 315.22' bgs 6-1-17; HETS# B3B0V6, B3B0V7, B3B0V8, B3B0W0, B3B0W1, B3B0W2
320	G.S.		320-360 : Sandy Gravel (sG) 10% silt, 35 ~~40%~~ v.fn.-v.crs. sand, 55% v.fn.-v.crs. peb.; max 38mm; wet, poorly sorted, ang.-sub.rnd.; s: 35%m/65%f, g: 50%m/50%f; v.weak HCl rxn; 2.5Y 5/3 light olive brown	Archive @ 320' bgs.
325	G.S.		@325' bgs: 5% silt, 40% v.fn.-v.crs. sand; 55% ~~f-m~~ v.fn.-v.crs. peb.; max 37mm; ang.-rnd.; s: 35%m/65%f; g: 45%m/55%f; strg. HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 325' bgs
330	G.S.		@330' bgs: 5% silt, 45% v.fn.-v.crs. sand; 50% v.fn.-v.crs. peb.; max 38mm; s: 35%m/65%f, g: 40%m/60%f; v.strg. HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 330' bgs.
335	G.S. W.S. I-008		@335' bgs: 10% silt, 40 ~~35%~~ v.fn.-v.crs. sand; 50% v.fn.-v.crs. peb.; max 37mm; ang.-sub.rnd.; s: 35%m/65%f, g: 40%m/60%f; v.weak HCl rxn; 2.5Y 4/3 olive brown	Archive @ 335' bgs. H_2O Sample I-008 @ 335.24' bgs; 6-5-17; HETS# B3B0W4, B3B0W5, B3B0W6, B3B0W8, B3B0W9, B3B0X1
340	G.S.		@340' bgs: 10% silt, 35% v.fn.-v.crs. sand; 55% v.fn.-v.crs.; max 39mm; ang.-rnd.; s: 30%m/70%f, g: 40%m/60%f; No HCl rxn; 2.5Y 4/3 olive brown f (SMS 06-13)	Archive @ 340' bgs
345	G.S.		@345' bgs: 10% silt, 45% v.fn.-v.crs. sand, 45% v.fn.-v.crs. peb; max 55mm; s: 35%m/65%f, g: 40%m/60%f; No HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 345' bgs
350	G.S.		@350' bgs: 5% silt, 40% v.fn.-v.crs sand, 55% v.fn.-v.crs. peb; max 47mm; s: 30%m/70%f, g: 45%m/65%f; No HCl rxn; 2.5Y 4/3 olive brown	Archive @ 350' bgs

Reported By:

Print Name	Title	Signature	Date
Julie Johanson	Project Geologist	Julie Johanson	6-6-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 6-6-17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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. H2O I-009		320 - 360 : Sandy Gravel (sG)	Dual Air Rotary w/tri-cone.
	S.S. I-010		@ 355' bgs: 10% silt, 30% v.fn.-v.crs. sand, 60% v.fn.-v.crs. peb; max 60 mm; wet; poorly sorted; ang.-rnd.; s: 30%m/70%f, g: 40%m/60%f; No HCl rxn; 2.5Y 4/3 olive brown	Archive @ 355' bgs Split Spoon Sample ~~I-008~~ I-010 SMS 6-20-17; 6-19-17; 354.05'-355.45' bgs; HETS# ~~B3BOC6~~ B3B124 SMS 6-20-17 H2O sample I-009; 6-20-17; @ 354.45' bgs; HETS# B3BOX3, B3BOX4, B3BOX5, B3BOX7, B3BOX8, B3BOX9
360	G.S.		360 - 385 : Silty Sandy Gravel (msG)	
			15% silt (observed); 15% v.fn.-v.crs. sand (collected); 70% v.fn.-v.crs. peb.; max 35 mm; wet, poorly sorted.; ang.-sub.rnd.; s: 30%m/70%f; g: 60%m/40%f; No HCl rxn; 2.5Y 4/3 olive brown	Archive @ 360' bgs Drilling changed @ 363' bgs
365	G.S.		@ 365' bgs: 11% silt; 24% v.fn.-v.crs. sand; 65% v.fn.-v.crs. peb; max 35 mm; ang.-rnd.; s: 25%m/75%f, g: 50%m/50%f; No HCl rxn; 2.5Y 4/3 olive brown	Archive @ 365' bgs
370	G.S.		@ ~~6~~ 370' bgs: 11% silt; 44% v.fn.-v.crs. sand, 46% v.fn.-v.crs. peb; max 60 mm; s: 60%m/40%f, g: 55%m/45%f; No HCl rxn; 2.5Y 3/2 very dark grayish brown	Archive @ ~~36~~ 370' bgs SMS 6-20-17
375	H2O I-011 G.S.		@ 375' bgs: 11% silt; 15% v.fn.-v.crs. sand; 74% v.fn.-sm. cob.; max 64 mm; s: 40%m/60%f, g: 45%m/55%f; No HCl rxn; 2.5Y 3/2 very dark grayish brown	Archive @ 375' bgs H2O Sample I-011; 6-21-17; @ 374.44' bgs; HETS# B3BO41, B3BO42, B3BO43, B3BO45, B3BO46, B3BO47.
380	G.S.		@ 380' bgs: 11% silt (observed), 25% v.fn.-v.crs. sand; 64% v.fn.-v.crs. peb.; max 40 mm; s: 45%m/55%f, g: 30%m/70%f; No HCl rxn; 2.5Y 4/3 olive brown	Archive @ 380' bgs
385	G.S.		385' - 391 : Sandy Gravel (sG)	Archive @ 385' bgs
			10% silt (observed); 15% v.fn.-v.crs. sand; 75% v.fn.-v.crs. peb; max 53 mm; wet; poorly sorted; ang.-rnd.; s: 20%m/80%f, g: 40%m/60%f; No HCl rxn; 2.5Y 4/3 olive brown	
390	G.S.			
	G.S.		@ 390' bgs: 10% silt, 30% v.fn.-v.crs. sand, 60% v.fn.-v.crs. peb; max 45 mm; s: ~~20% v.fn.-v.crs. m/80% f~~ 25 m/75 f SMS 6-22-17, g: 55%m/45%f; v. weak HCl rxn; 2.5Y 4/3 olive brown	Archive @ 390' bgs Archive @ 391' bgs RLM @ 391' bgs
			391 - 395 : Silty Gravel (mG)	Drilling smoother @ 391' bgs

Reported By:

Julie Johanson (Print Name) | Project Geologist (Title) | Julie Johanson (Signature) | 6-22-17 (Date)

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 6-22-17

Well ID: C9635 | Well Name: 699-30-70 | Location: ~0.5 mile NE of Rattlesnake Barricade

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			391 - 395 : Silty Gravel (mG) 30% silt, 25% v.fn.-v.crs. sand; 45% v.fn.-crs. peb.; max 30mm; wet; poorly sorted; s: 30%m/70%f, g: 55%m/45%f; No HCl rxn; 2.5Y 6/3 light yellowish brown; chuncks of silt stone; non-plastic.	Dual Rotary Rig w/tri-cone Sample not collected @ 395' due to no recovery.
400	G.S.		395 - 401.85': Gravelly Sandy Silt (gsM) @ 400' bgs: ~~65%~~ 70 JMJ 6-22-17 silt, ~~15%~~ 20 JMJ 6-22-17 v.fn.-fn. sand, ~~20%~~ 10 JMJ 6-22-17 v.fn.-crs. peb.; max 30mm; wet, poorly sorted, s: ~15%m/~85%f, g: ~5%m/~95%f; No HCl rxn; GLEY1 3/5G very dark greenish gray; med.-high plasticity; silt stone: 2.5Y 4/2 dark grayish brown; No plasticity.	Archive @ 400' bgs JMJ 6-22-17 TOT. TD: 401.85' bgs
405				
410				

Reported By:

Julie Johanson — Print Name

JMJ 6-22-17 Project Geologist — Title

Julie Johanson — Signature

6-22-17 — Date

A-6006-993 (REV 0)

This page intentionally left blank.

699-30-70 (C9635)
Log Data Report

Borehole Information

Log Date	2017-07-03	Filename	C9635_HG-NM_2017-07-03	Site	200-UP-1
DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
220.8	06/22/17	Geologist	06/22/17	401.85	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Welded Steel	Air Rotary	1.75	8 3/4	8	3/8	-1.75	394.20

Borehole Notes

The onsite geologist provided the total depth and casing depth. Casing diameters and thicknesses were measured by the logging engineer. The maximum logging depth achieved was 396 ft, approximately two ft below the bottom of casing. Zero reference is ground surface.

DTW reported above is static water level measured by the on-site geologist on June 22, 2017. DTW inside the casing was measured by SN3 at 366.55 ft on June 28, 2017 and 344.95 ft on July 3, 2017.

Logging Equipment Information

Logging System	Gamma 4Nc	Type	60% HPGe SGLS[2]
Effective Calibration Date	04/18/17	Serial No.	45-TP22010A
Calibration Reference	HGLP-CC-154, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 4Mc	Type	NMLS[3] (CPN 503DR)
Effective Calibration Date	04/19/17	Serial No.	H340207279
Calibration Reference	HGLP-CC-155, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	5	6	7	8 Repeat	
HEIS Number	1019956	1019957	1019958	1019959	
Date	06/28/17	06/29/17	07/03/17	07/03/17	
Logging Engineer	Felt	Spatz	Felt/Pope	Felt/Pope	
Start Depth (ft)	0.0	115.0	295.0	130.0	
Finish Depth (ft)	116.0	296.0	396.01	170.0	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	

[1] depth to water
[2] Spectral Gamma Logging System
[3] Neutron Moisture Logging System

Log Run	5	6	7	8 Repeat	
Pre-Verification	C9635DNC2017 0628AV00CAB 1	C9635DNC2017 0629BV00CAB1	C9635DNC2017 0703CV00CAB1	C9635DNC2017 0703CV00CAB1	
Start File	AD000000	BD011500	CD029500	DD013000	
Finish File	AD011600	BD029600	CD039601	DD017000	
Post-Verification	C9635DNC2017 0628AV00CAA 1	C9635DNC2017 0629BV00CAA 1	C9635DNC2017 0703DV00CAA 1	C9635DNC2017 0703DV00CAA 1	
Depth Return Error (in.)	0.0	0.5 low	N/A	0.5 high	
Comments	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	

NMLS Log Run Information

Log Run	1	2	3	4 Repeat	
HEIS Number	1019960	1019961	1019962	1019963	
Date	06/26/17	06/27/17	06/28/17	06/28/17	
Logging Engineer	Felt/Pope	Felt	Felt	Felt	
Start Depth (ft)	0.0	44.01	260.0	200.0	
Finish Depth (ft)	45.01	261.0	366.51	235.25	
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)	N/A	N/A	N/A	N/A	
Pre-Verification	C9635DMC2017 0626AV00CAB 1	C9635DMC2017 0627BV00CAB1	C9635DMC2017 0628CV00CAB1	C9635DMC2017 0628CV00CAB1	
Start File	AD000000	BD004401	CD026000	DD020000	
Finish File	AD004501	BD026100	CD036651	DD023525	
Post-Verification	C9635DMC2017 0626BV00CAA 1	C9635DMC2017 0627BV00CAA 1	C9635DMC2017 0628DV00CAA 1	C9635DMC2017 0628DV00CAA 1	
Depth Return Error (in.)	0.0	1.0 high	N/A	0.0	
Comments	None	None	None	None	

Logging Operation Notes

Logging was conducted with a centralizer on the sondes.

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

Analysis Notes

Analyst	P.D. Henwood	Date	08/03/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

Casing correction for a 3/8-in. thick casing was applied to the collected data.

A water correction for water inside the casing was applied below 345 ft. However, static water was approximately at 220.8 ft in depth. No correction is applied for formation water.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in an EXCEL template identified as DNC20170418 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

An interpreted data set was created for this borehole. Depth overlaps from consecutive log runs were removed from 115 and 116 ft and from 295 and 296 ft. This results in a data set where only one data point is presented for each depth.

NMLS data are reported in percent volumetric moisture content to 220 ft because the 8-in. casing size fits the calibration condition. However, the calibration condition is not met below static water. Moisture data below 220 ft are reported in counts per second.

HGU[4] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Calibration Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected in this borehole.

Based on low K, Th, and total gamma, voids may exist behind the casing at approximately 221 to 225 ft, 255 to 265 ft, 308 to 313 ft, and 318 to 325 ft where gamma count rates are significantly reduced and moisture content behind the casing appears elevated. The logging sonde was performing correctly in these intervals.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. Below the static water level where the sonde is reflecting formation water, the apparent moisture content may generally reflect porosity and appears to increase where voids are suspected behind the casing.

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

List of Log Plots

Depth Reference is ground surface.

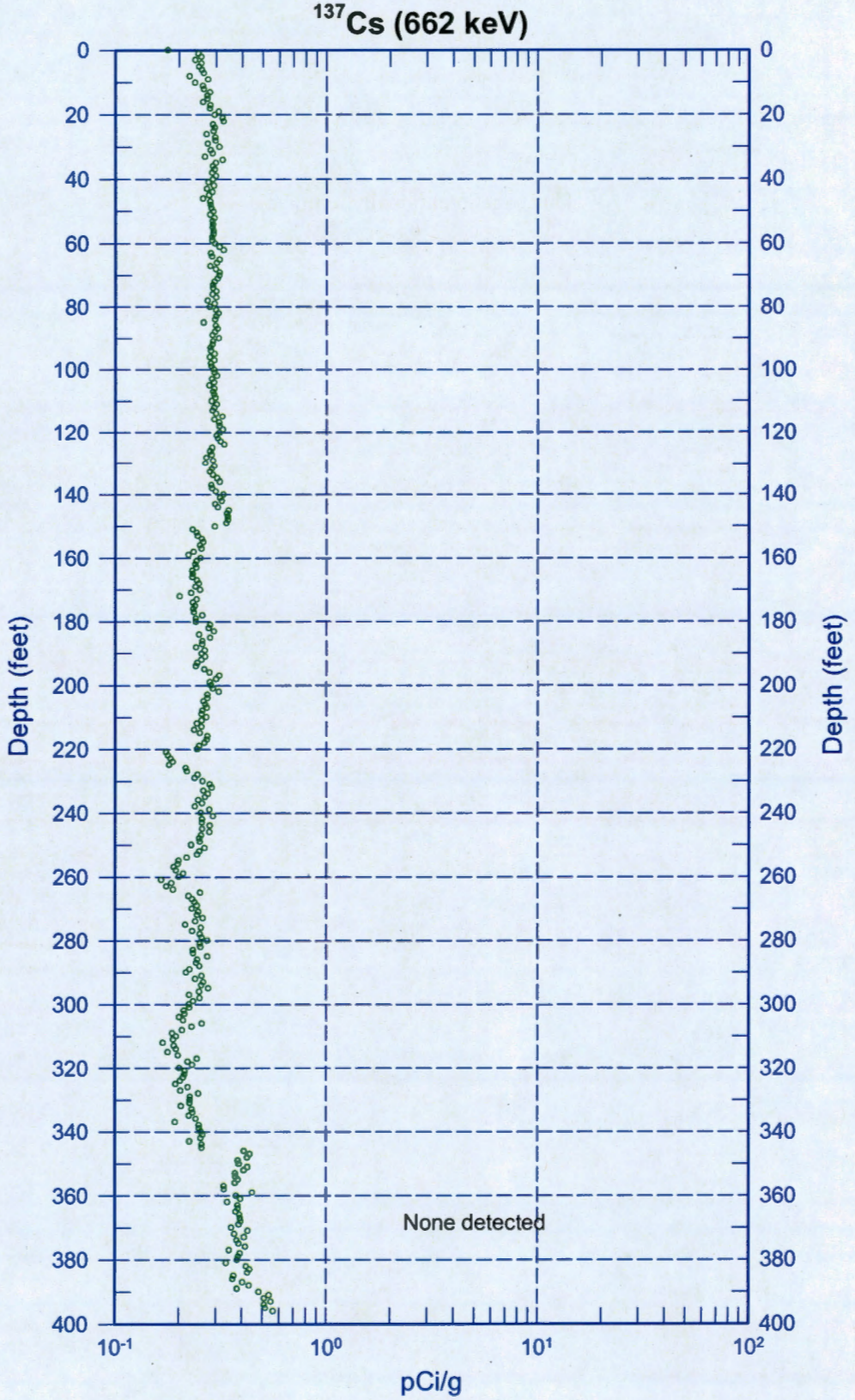
Manmade Radionuclides (0-400 ft)
Natural Gamma Logs (0-160 ft)
Natural Gamma Logs (150-310 ft)
Natural Gamma Logs (300-460 ft)
Combination Plot (0-120 ft)
Combination Plot (110-230 ft)
Combination Plot (220-340 ft)
Combination Plot (330-450 ft)
Combination Plot (0-400 ft)
Total Gamma & Moisture (0-160 ft)
Total Gamma & Moisture (150-310 ft)
Total Gamma & Moisture (300-460 ft)
Total Gamma & Hanford Gamma Unit (0-400 ft)
Repeat Section of Natural Gamma Logs (130-170 ft)
Moisture Repeat Section (200-236 ft)

[4] Hanford Gamma Unit

This page intentionally left blank.

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

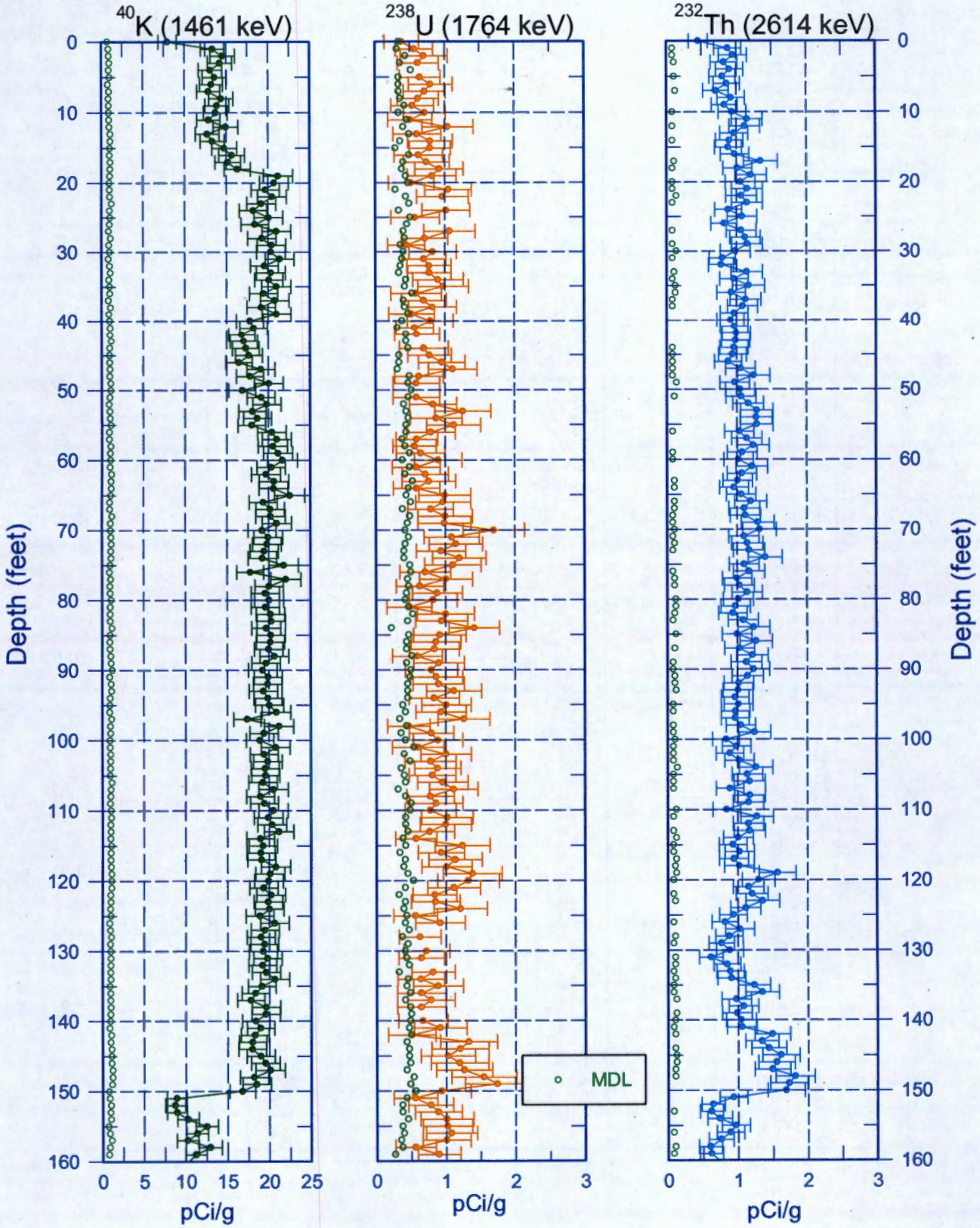
699-30-70 (C9635)
Manmade Radionuclides



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

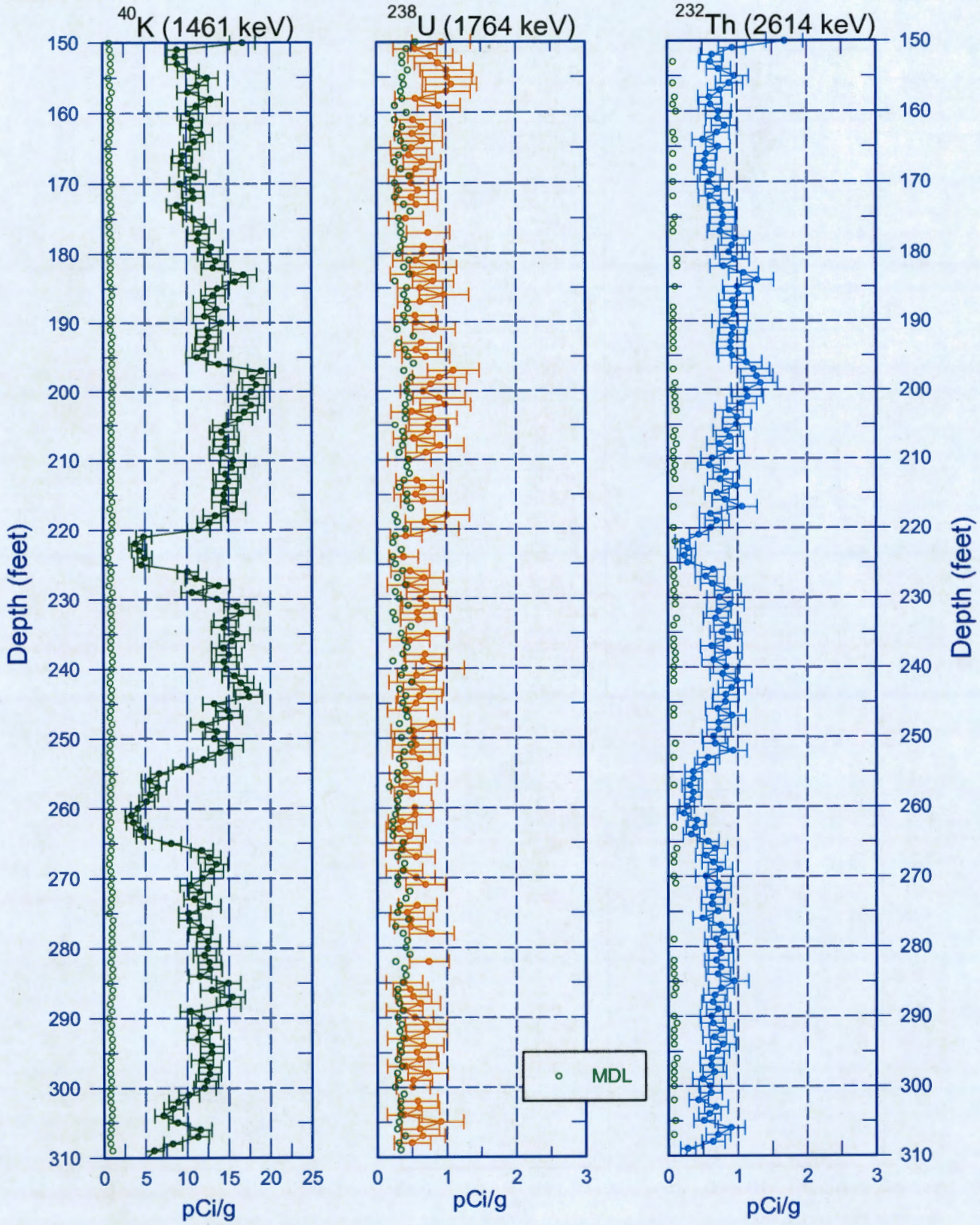
699-30-70 (C9635)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

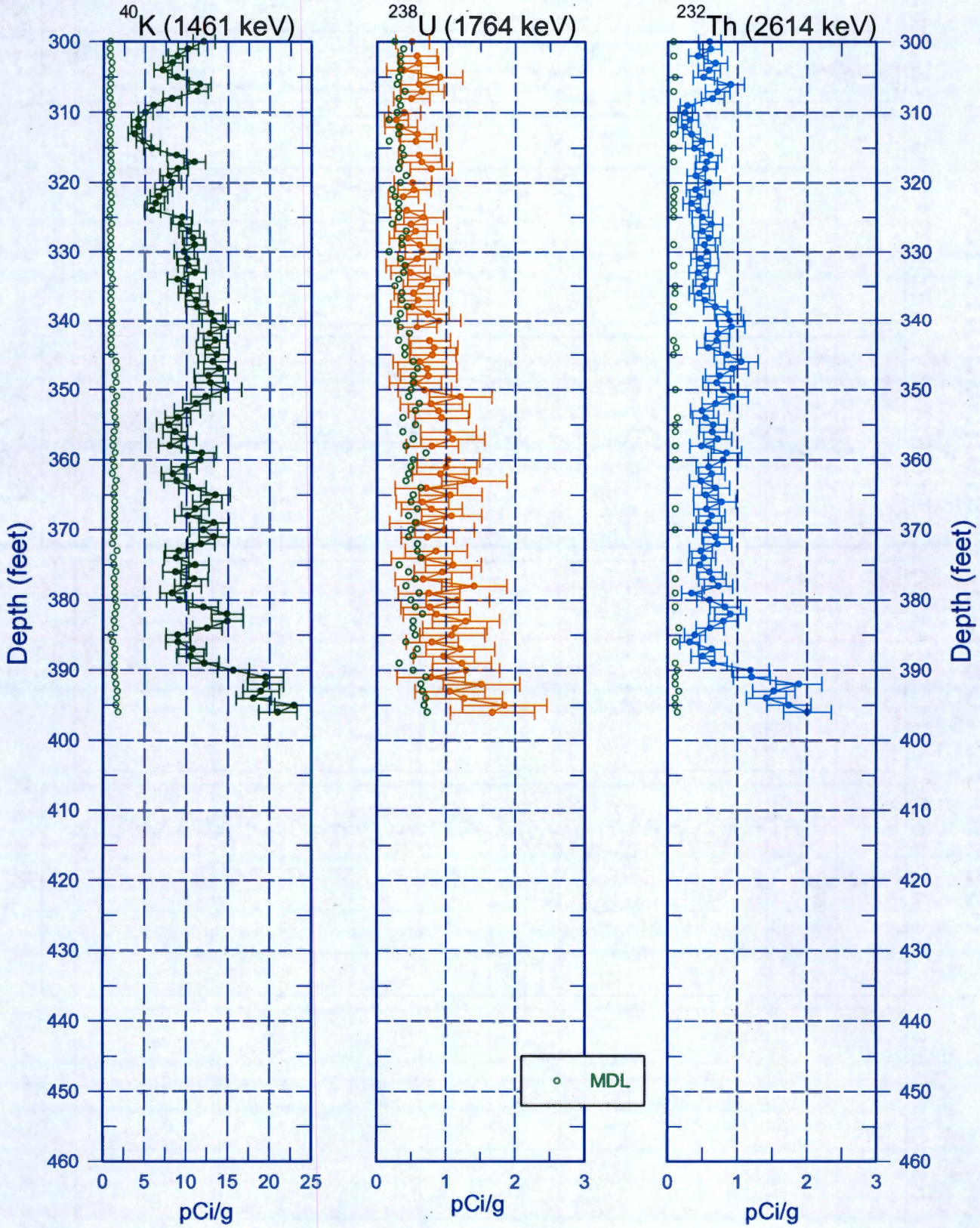
699-30-70 (C9635)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

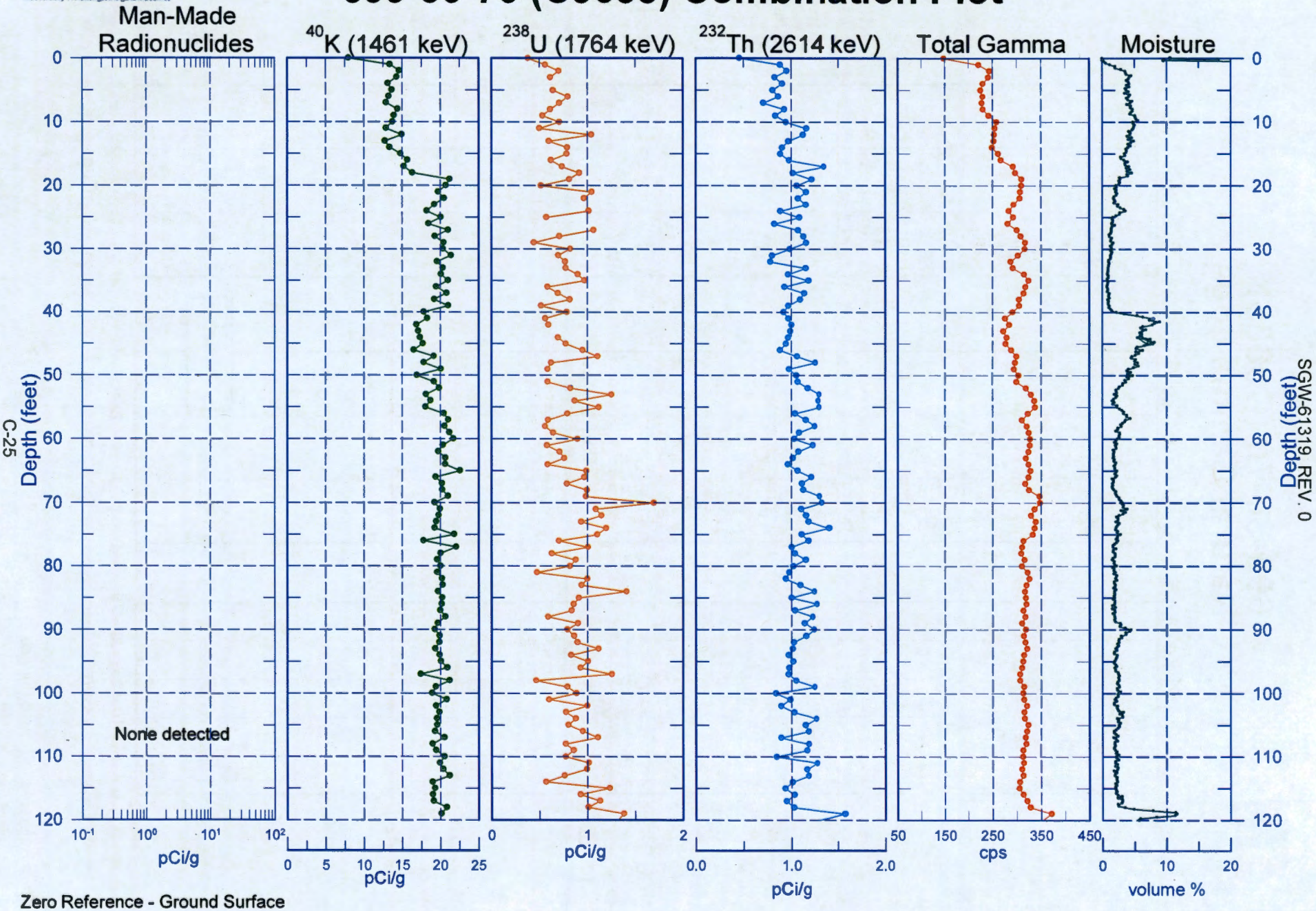
699-30-70 (C9635)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

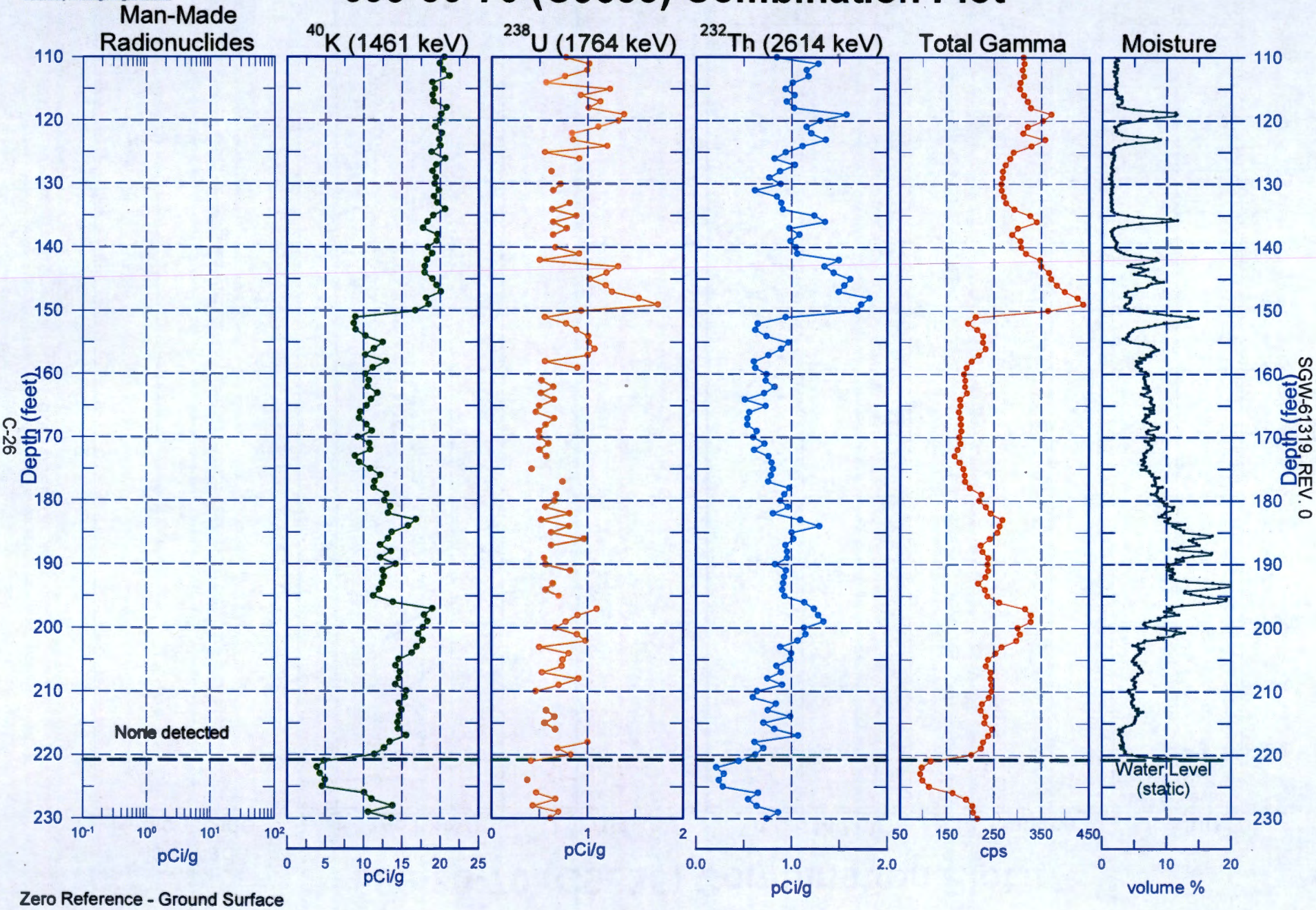
699-30-70 (C9635) Combination Plot



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

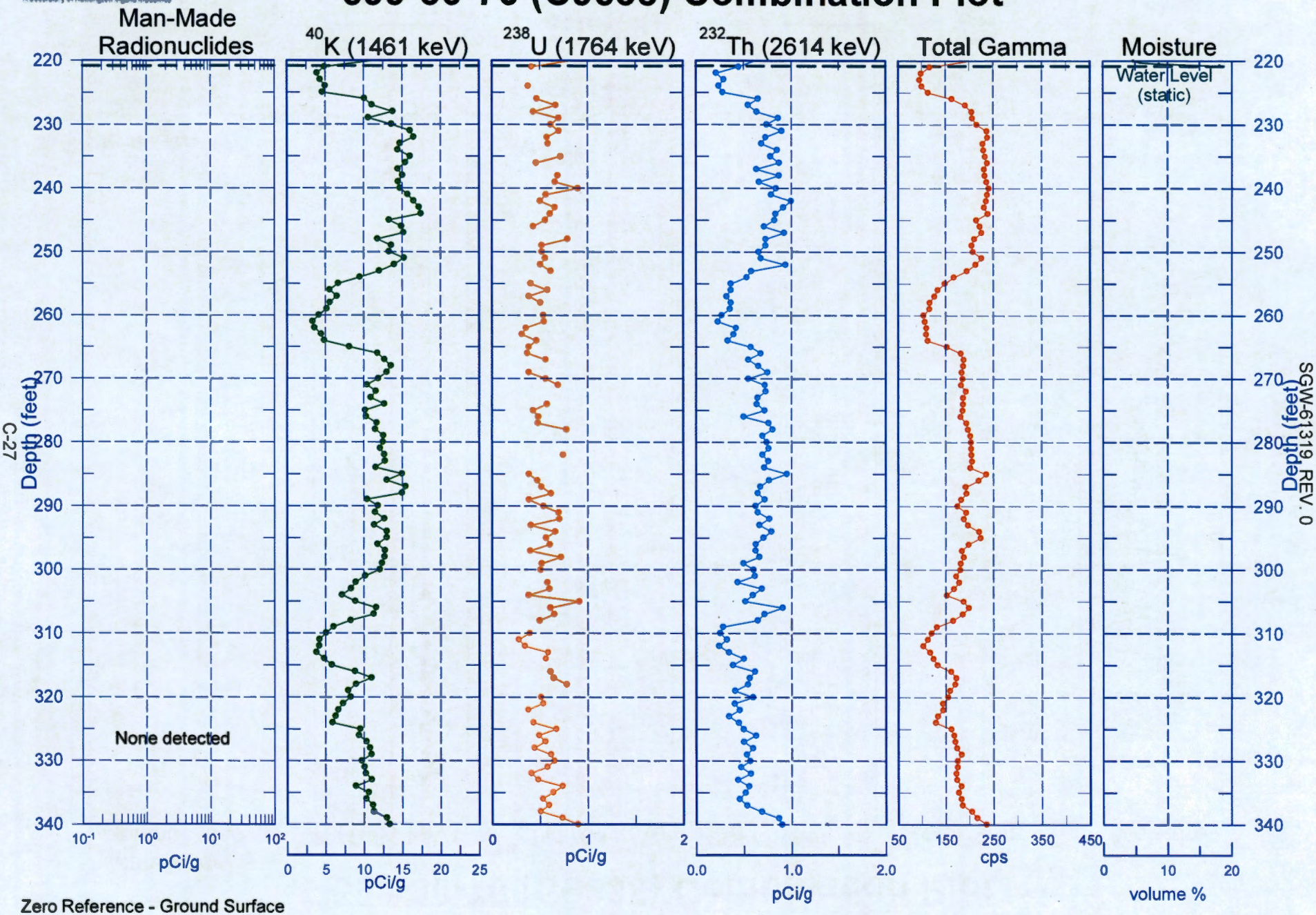
699-30-70 (C9635) Combination Plot



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

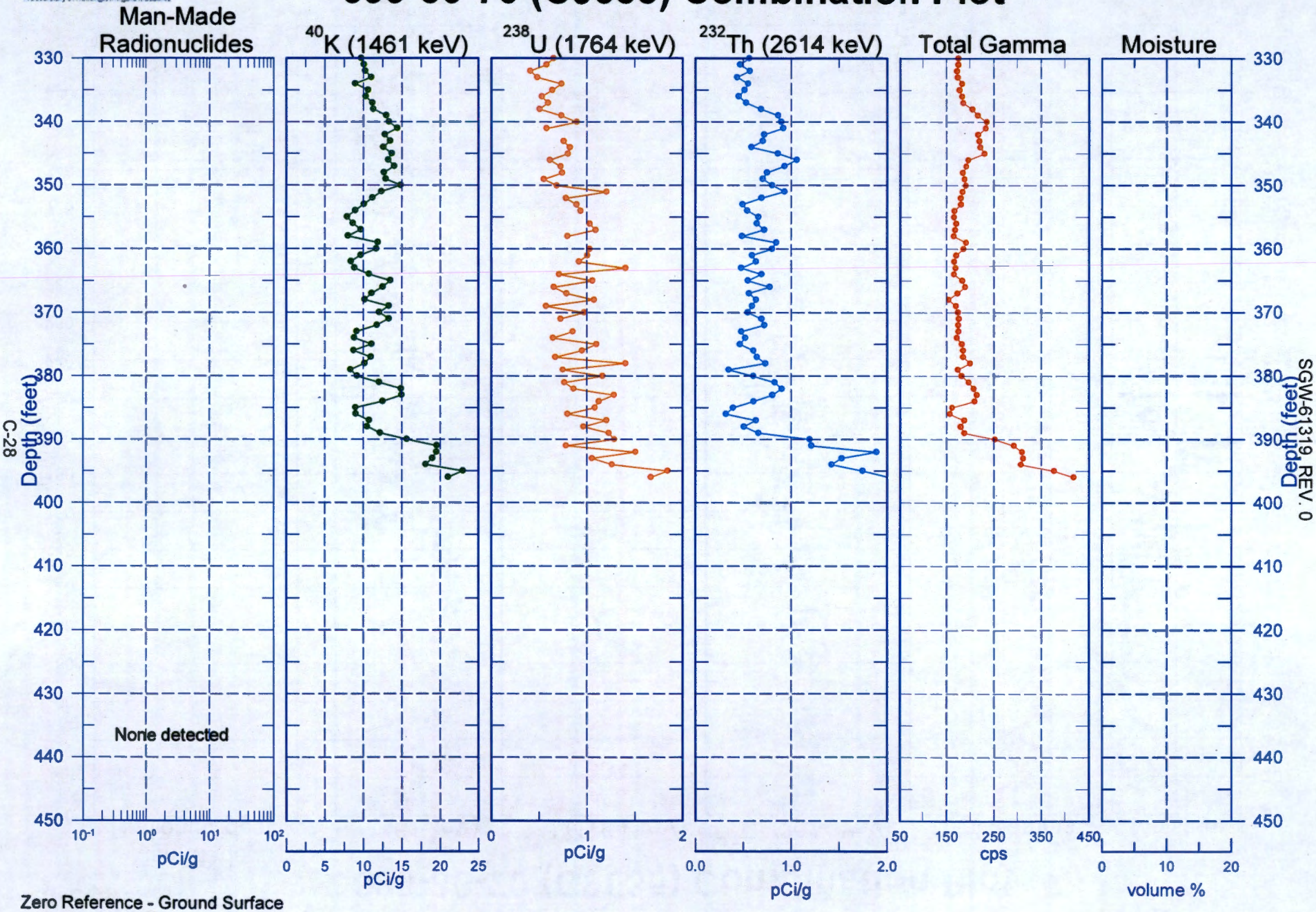
699-30-70 (C9635) Combination Plot



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

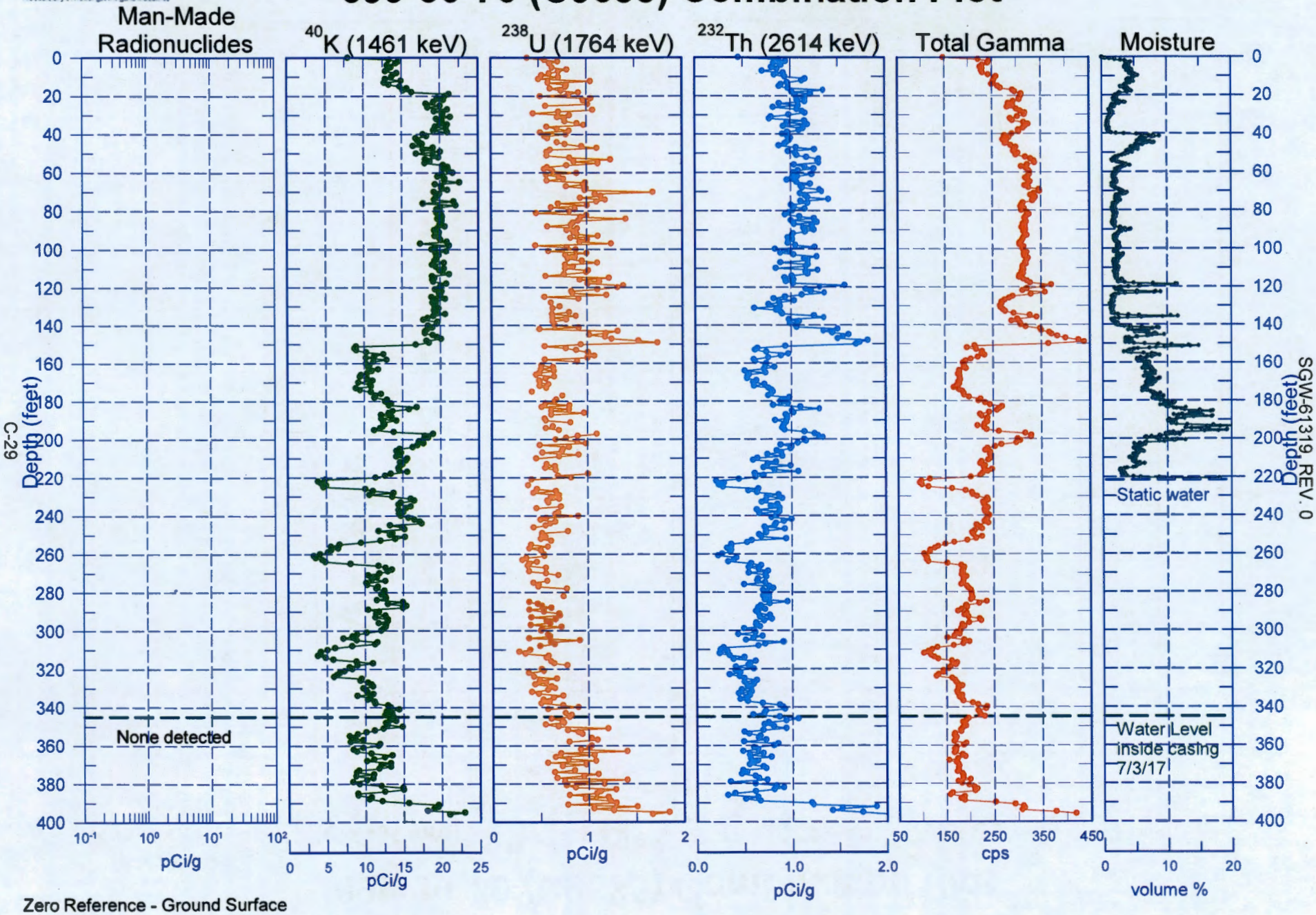
699-30-70 (C9635) Combination Plot



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

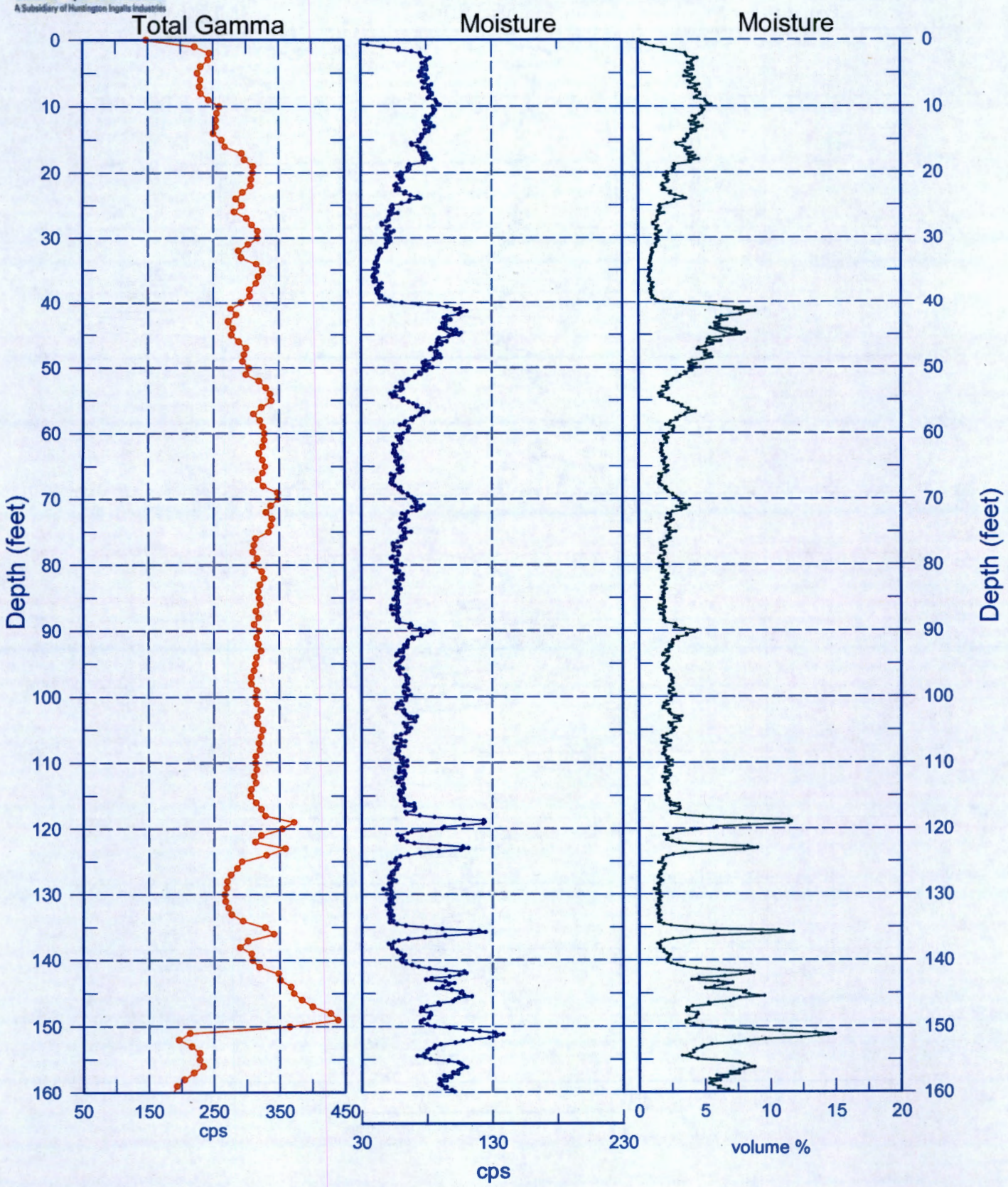
699-30-70 (C9635) Combination Plot



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

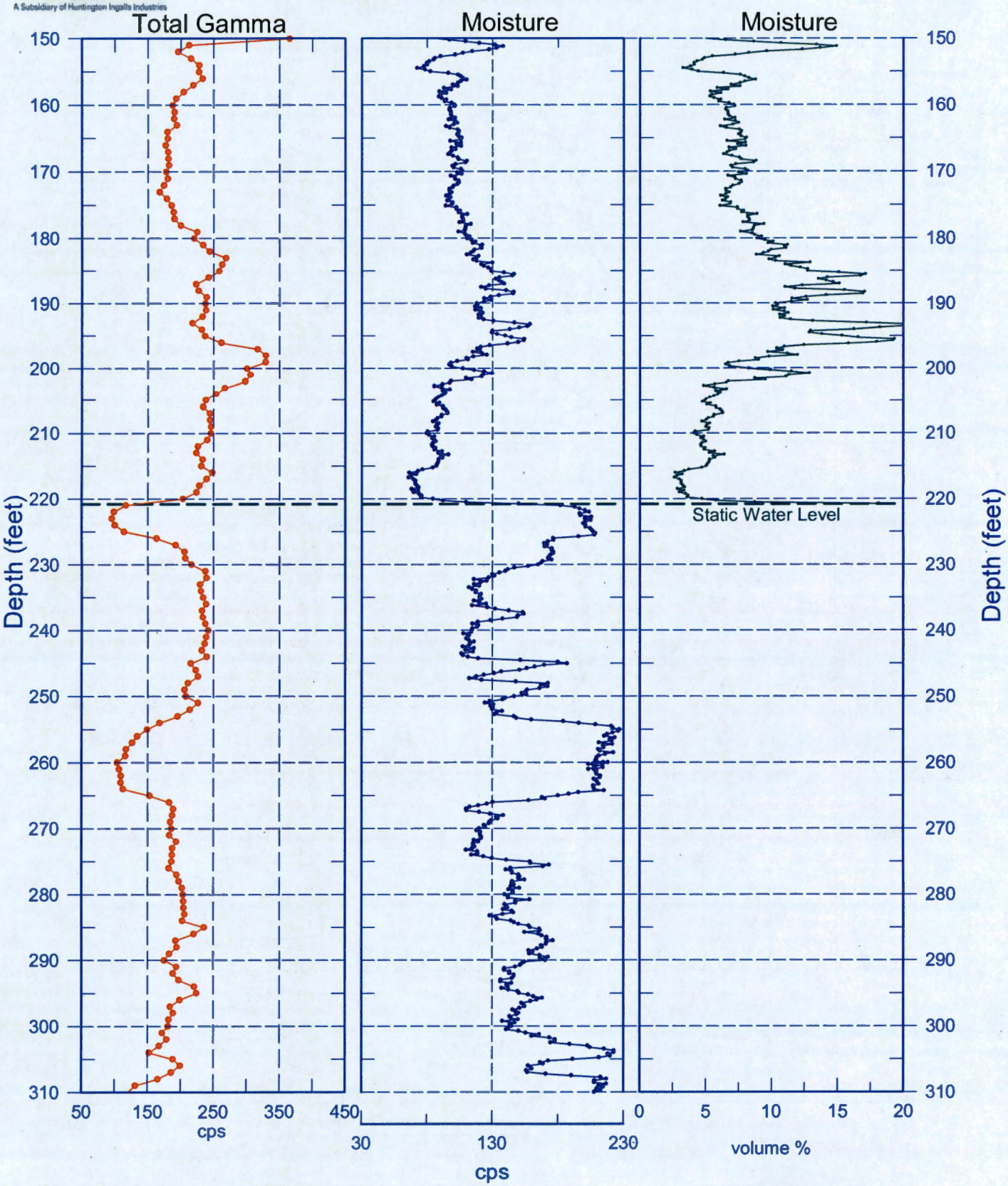
699-30-70 (C9635)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

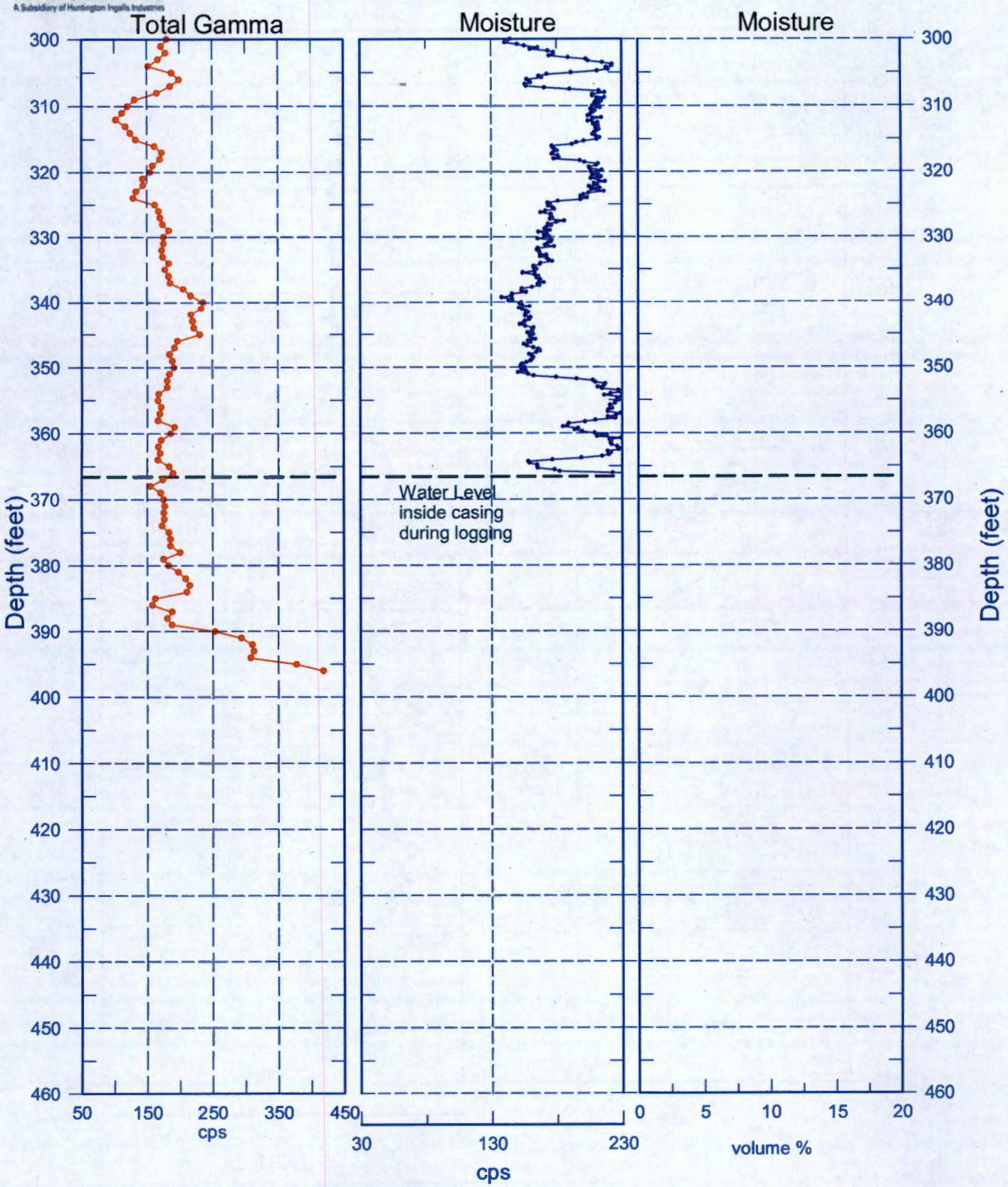
699-30-70 (C9635)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

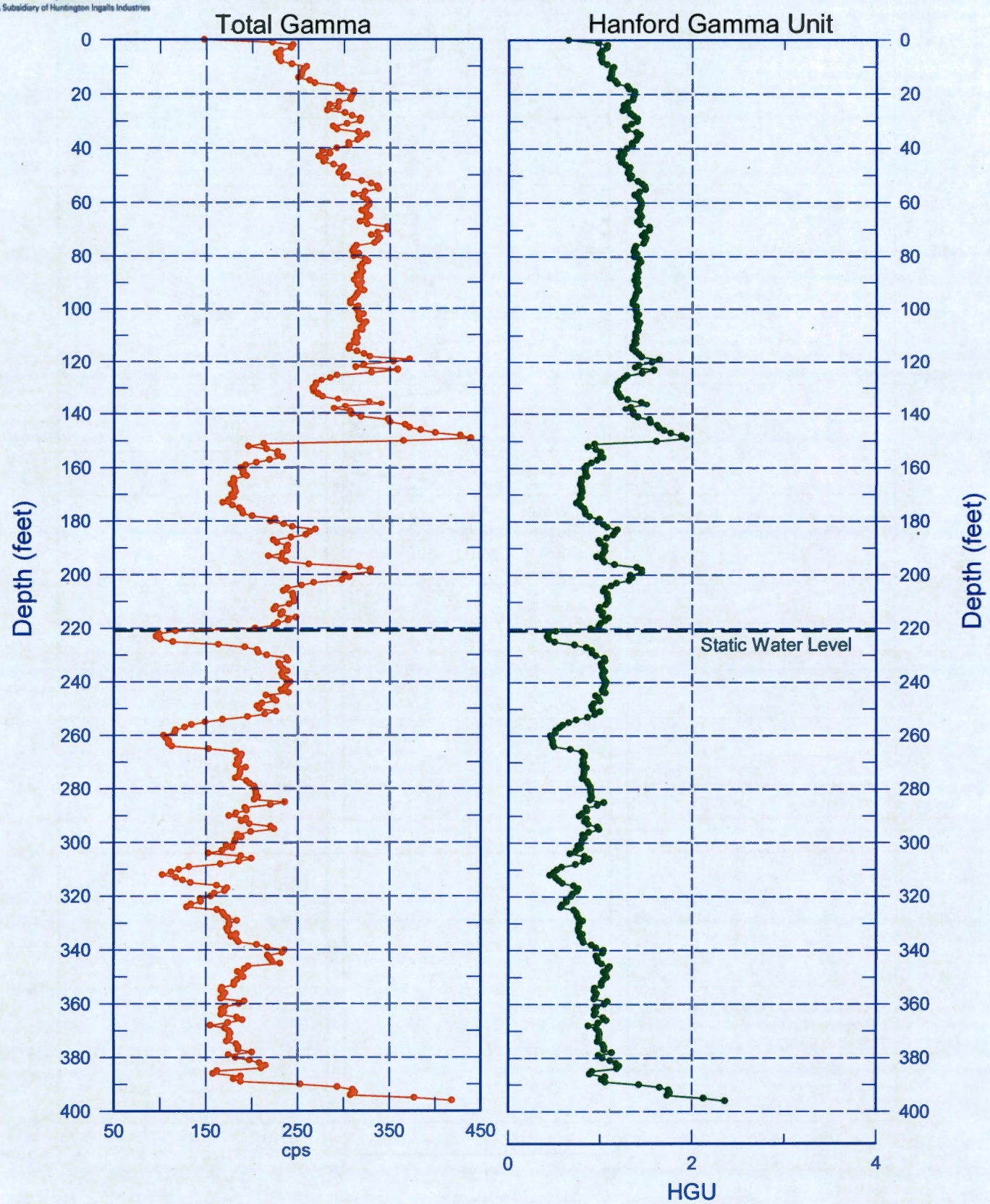
699-30-70 (C9635)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-30-70 (C9635)
Total Gamma & Hanford Gamma Unit

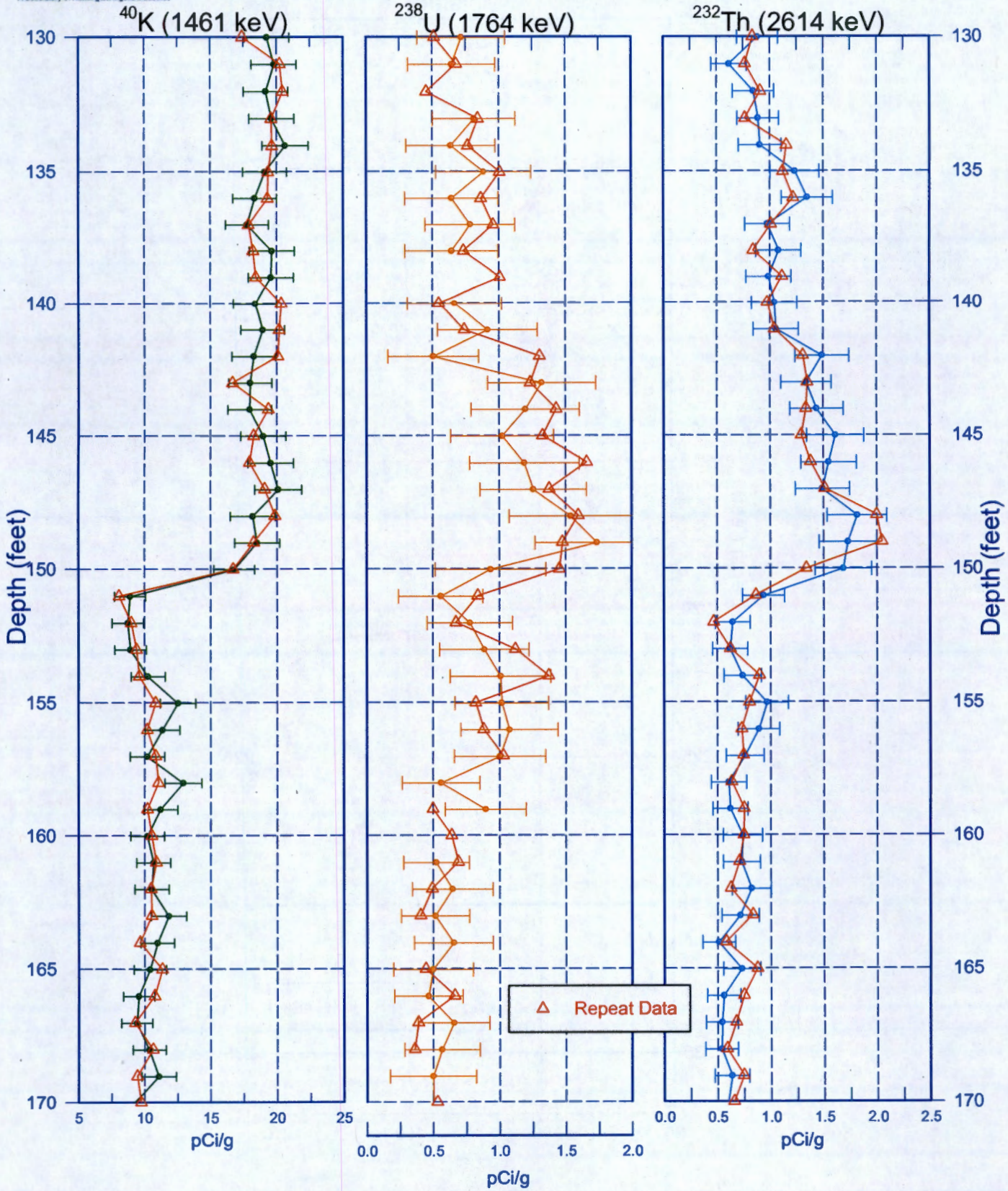


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-30-70 (C9635)

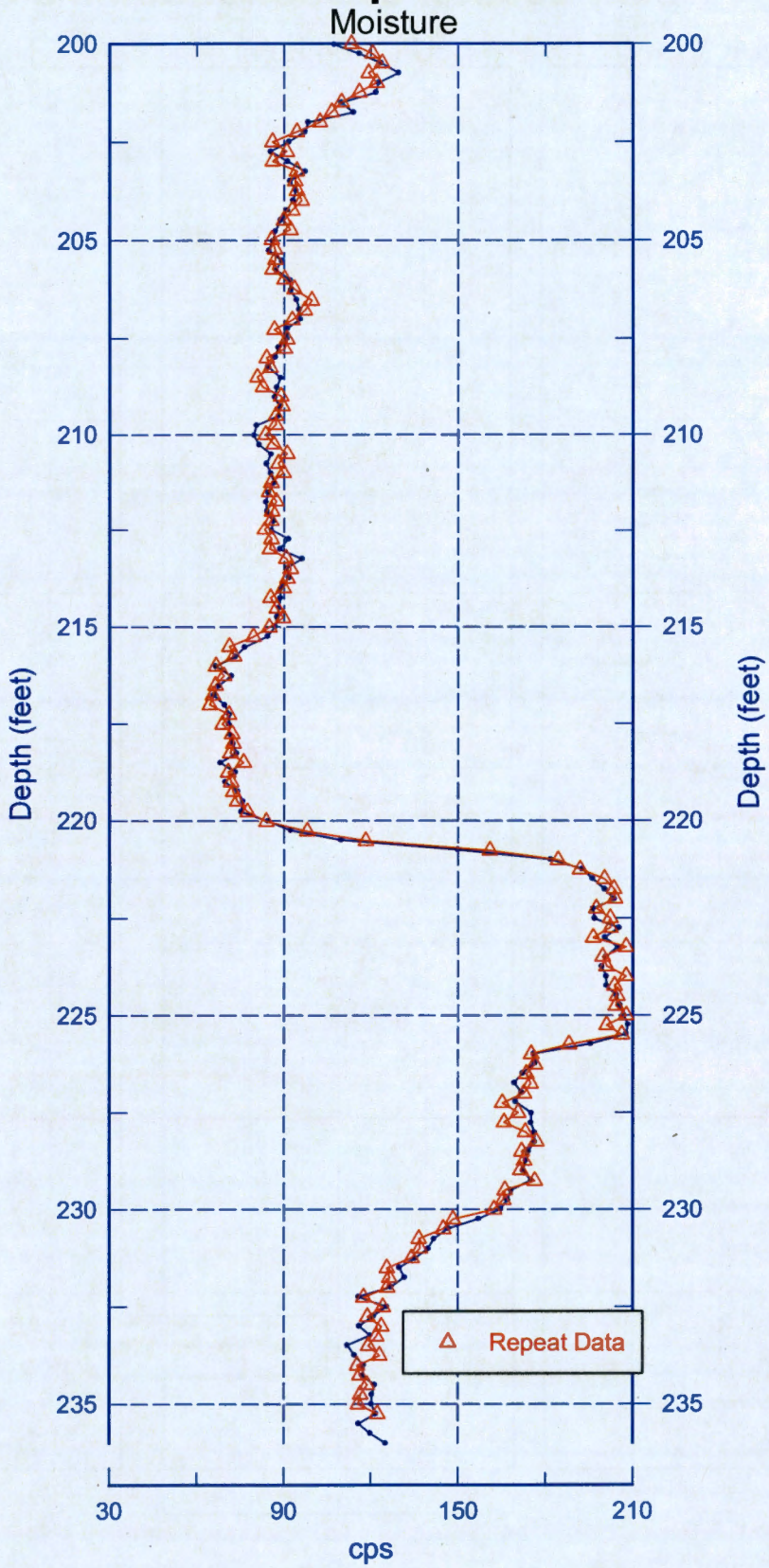
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

699-30-70 (C9635)
Moisture Repeat Section



Zero Reference - Ground Surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 11/02/17	Requestor: Matthan G. Wilson (CHPRC)
Date of Survey: 11/29/17	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of UP-1 Well C9635 (699-30-70) located southeast of 200W Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
HSWB-071 (COE) and HSWB-072 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9635	699-30-70	568428.93	132581.66		Center of Casing
				198.614	Top Inner 4"Casing, N.Edge
				198.914	Top Outer Casing,N.Edge Stamped "X"
				198.211	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.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
11-24-17

This page intentionally left blank.

Photo Log

0-5 bgs

5-10 bgs

10-15 bgs

15-20 bgs

20-25 bgs

25-30 bgs

30-35 bgs

35-40 bgs

40-45 bgs

45-50 bgs

50-55 bgs

55-60 bgs

60-65 bgs

65-70 bgs

70-75 bgs

75-80 bgs

80-85 bgs

85-90 bgs

90-95 bgs

95-100 bgs

100-105 bgs

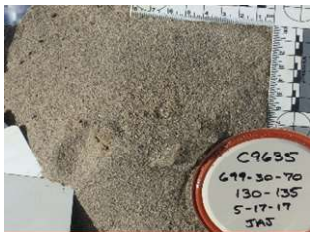
105-110 bgs

110-115 bgs

115-120 bgs

120-125 bgs

125-130 bgs



130-135 bgs

135-140 bgs

140-145 bgs

145-150 bgs

150-155 bgs

155-160 bgs

160-165 bgs

165-170 bgs

170-175 bgs

175-180 bgs

180-185 bgs

185-190 bgs

190-195 bgs

195-200 bgs

200-205 bgs

205-210 bgs

210-215 bgs

215-220 bgs

220-225 bgs

225-230 bgs

230-235 bgs

235-240 bgs

240-245 bgs

245-250 bgs

250-255 bgs

255-260 bgs

260-265 bgs

265-270 bgs

270-275 bgs

275-280 bgs

280-285 bgs

285-290 bgs

290-295 bgs

295-300 bgs

300-305 bgs

305-310 bgs

310-315 bgs

315-320 bgs

320-325 bgs

325-330 bgs

330-335 bgs

335-340 bgs

340-345 bgs

345-350 bgs

350-355 bgs

355-360 bgs

360-365 bgs

365-370 bgs

370-375 bgs

375-380 bgs

380-385 bgs

385-390 bgs

390-395 bgs

395-400 bgs

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9635 | Well Name: 699-30-70 | Date: 8-21-17

Location: ~0.5mi. NE of Rattlesnake Barricade.

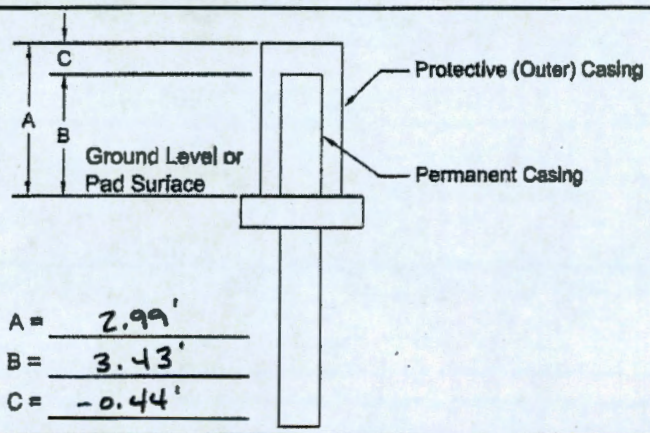
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 8/21/17	219.96' bgs	N/A
Date:		
DEPTH TO BOTTOM:		
Date: 8/21/17	353.03' bgs	N/A
Date:		



A = 2.99'
B = 3.43'
C = -0.44'

	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)
1.	336.90	17.35	115.14	278	0.94	1040	1242	17	0.98'
2.	326.03	17.53	104.33	66.2	4.07	1308	1509	17	0.97'

Total Pumped: 4131 gal.

Pump Model: 1.5 hp Grundfos 22 SQE - 220

Troll Serial Number and Pressure Range (PSI and depth): # 403065 / 60 psi / Various depths.

Comments:

FIELD CALIBRATION PAGE 2 OF REPORT 32.

HYDROCHEMISTRY PAGE 3 OF REPORT 32.

Prepared By:

Jess Hocking — Print Name | [signature] — Signature | 8/21/17 — Date

Reviewed By:

Kelly Whitley — Print Name | Kelly Whitley — Signature | 9/27/17 — Date

For Office Use Only

OR Doc Type:

WMU Code(s):

This page intentionally left blank.

Appendix D

Well Documentation for 699-31-50 (C9737)

- Well Summary Sheet for C9737
- Borehole Log for C9737
- Geophysical Log Data Report for C9737
- Final Survey Report for C9737
- Photo Log for C9737
- Well Development and Testing Data Sheet for C9737

This page intentionally left blank.

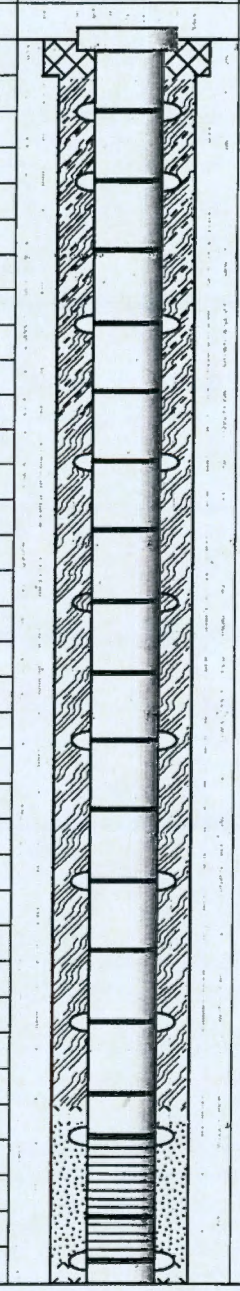
WELL SUMMARY SHEET

Well ID: C9737	Well Name: 699-31-50	Start Date: 8/30/17
Project: 200-UP-1 4 Monitoring Wells	Location: ~2 miles SE of Ecology	End Date: 11/14/17

CONSTRUCTION DATA

Description
WA Dept. of Ecology Tag: BKG 066
Surface Construction:
4' x 4' x 6" Concrete Pad with brass survey marker and protective monument
Temporary Casing Depths:
10" Carbon Steel = 10.56 ft bgs
8" C.S. Wld. Joints = 462.42 ft bgs
Permanent Well Materials:
4" ID Riser
2.00 ft ags - 309.15 ft bgs
4" ID Stainless Steel 20-Slot screen
309.15 ft bgs - 344.14 ft bgs
4" ID Stainless Steel Blank
344.14 ft bgs - 354.12 ft bgs
See page 2 for continuation)
Well Completion Materials:
Type I/II Portland Cement
0.00' bgs - 10.10' bgs
Bentonite Grout Slurry
10.10' bgs - 301.53' bgs
Bentonite Pellet Seal
301.53' bgs - 305.15' bgs
10-20 Colorado Silica Sand
305.15' bgs - 346.02' bgs
Bentonite Pellet Seal
346.02 ft bgs - 349.05 ft bgs
(See page 2 for continuation)
All 8" and 10" temporary casing completely removed from ground
ags = above ground surface
bgs = below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 50, 100, 150, 200, 250, 300

Graphic Log

Lithologic Description (ft bgs)
0 - 40 ft: Sand [S]
40 - 85 ft: Silty Sand [mS]
85 - 95 ft: Silt [M]
95 - 125 ft: Slt. Silty Sand [(m)S]
125 - 160 ft: Sand [S]
160 - 170 ft: Slt. Silty Sand [(m)S]
170 - 185 ft: Sand [S]
185 - 210 ft: Silty Sand [mS]
210 - 215 ft: Slt. Silty Gravelly Sand [(m)gS]
215 - 240 ft: Silty Sandy Gravel [msG]
240 - 250 ft: Slt. Silty Gravelly Sand [(m)gS]
250 - 260 ft: Silty Sand [mS]
260 - 270 ft: Slt. Silty Sand [(m)S]
270 - 300 ft: Silty Sand [mS]
300 - 320 ft: Gravelly Silty Sand [gmS]
320 - 355 ft: Gravel [G]

Reported By:			
Andrew Raulerson	Staff Geologist	[signature]	11/21/2017
Print Name	*Title*	*Signature*	*Date*

Reviewed By:			
Kelly Whitley	Well Coordinator	Kelly Whitley	12/7/17
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

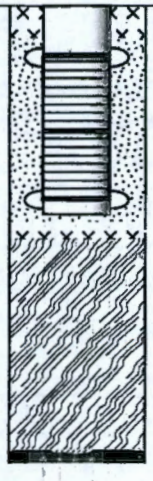
WELL SUMMARY SHEET

Well ID: C9737	Well Name: 699-31-50	Start Date: 8/30/17
Project: 200-UP-1 4 Monitoring Wells	Location: ~2 miles SE of Ecology	End Date: 11/14/17

CONSTRUCTION DATA

Description
WA Dept. of Ecology Tag: BKG 066
Surface Construction:
4' x 4' x 6" Concrete Pad with brass
survey marker and protective
monument
Temporary Casing Depths:
10" Carbon Steel = 10.56 ft bgs
8" C.S. Wld. Joints = 462.42 ft bgs
Permanent Well Materials:
(Continued from page 1)
4" ID Stainless Steel Blank
344.14 ft bgs - 354.12 ft bgs
4" ID Stainless Steel 20-slot Screen
354.12 ft bgs - 394.13 ft bgs
4" ID Stainless Steel Sump/End Cap
394.13 ft bgs - 397.14 ft bgs
Well Completion Materials:
(Continued from page 1)
10-20 Colorado Silica Sand
349.05' bgs - 397.50' bgs
8-16 Colorado Silica Sand
397.50 ft bgs - 400.10 ft bgs
Bentonite Pellet Seal
400.10 ft bgs - 403.80 ft bgs
Bentonite Grout Slurry
403.80 ft bgs - 467.50 ft bgs
Natural Fill
467.50 ft bgs - 468.50 ft bgs
All 8" and 10" temporary casing
completely removed from ground
ags = above ground surface
bgs = below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
350		355 - 360 ft: Gravelly Silty Sand [gmS]
		360 - 365 ft: Gravelly Sand [gS]
		365 - 385 ft: Sand [S]
		385 - 395 ft: Sandy Gravel [sG]
		395 - 400 ft: Sand [S]
400		400 - 415 ft: Sandy Gravel [sG]
		415 - 420 ft: Gravel [G]
		420 - 430 ft: Sandy Gravel [sG]
		430 - 445 ft: Gravel [G]
450		Organic Material (wood) @ 445 ft
		445 - 450 ft: Sandy Gravel [sG]
		450 - 455 ft: Sandy Gravel [gS]
		455 - 460 ft: Sand [S]
		460 - 468.5 ft: Sandy Clay [sM]
		TD = 468.5 ft bgs

Reported By: Andrew Raulerson (Print Name)	Staff Geologist (Title)	(Signature)	11/21/2017 (Date)
Reviewed By: Kelly Whitley (Print Name)	Well Coordinator (Title)	Kelly Whitley (Signature)	12/7/17 (Date)

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

BOREHOLE LOG

Date: 8.30.17

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2mi SE of Ecology

Project: 200-UP-1 | 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	G.S.		@5': Sand (S) 0'-40'	Dual Air Rotary w/ 7" tricone, 10" casing
			95% v.fn.-crs. sand, 5% v.fn.-crs. pebbles (max 56 mm); mod. sorted, sub.ang.-sub.round, no HCl rxn, ~~AB~~ 8.30.17 3/1 10YR, dry, Hanford formation	Archive @ 5 ft bgs.
5	G.S.		@5'-10': 5% silt, 95% sand (v.fn.-crs.); well sorted, sub.ang.-sub.rnd., weak HCl rxn, 10YR 5/3, dry, 70%f/30%m	
				Archive @ 10 ft bgs.
10	G.S.		10'-15': 3% silt, 97% v.fn.-med. sand (60%f/40%m); mod. HCl rxn, 10YR 5/2 grayish brown, dry. reat'o same as above (SAA)	8" casing
15	G.S.			Archive @ 15 ft bgs.
			15'-20': 3% silt, 97% v.fn.-med. sand (60%f/40%m); strong HCl rxn, 10YR 5/2 grayish brown, SAA	
20	G.S.		20'-25': 3% silt, 94% v.fn.-v.crs. sand (75%f/25%m), 3% v.fn.-fn. pebbles (max 5mm) (50%f/50%m); mild HCl rxn, 10YR 6/2 light brownish gray, SAA.	Archive @ 20 ft bgs
25	G.S.		25'-30': 3% silt, 94% v.fn.-v.crs. sand (75%f/25%m); SAA	Archive @ 25 ft bgs
30	G.S.		30'-35': 3% silt, 97% v.fn.-v.crs. sand (80%f/20%m); 10YR 7/3 very pale brown, SAA.	Archive @ 30 ft bgs.

Reported By:			
Andrew Rauterson	Staff Geologist	Adr	8.30.17
Print Name	Title	Signature	Date

Reviewed By:			
Sarah Springer	geologist (PG)	Sarah Springer	10-25-17
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

BOREHOLE LOG

Date: 8·30·17

Well ID: C9737 | Well Name: 699-31-50 | Location: ~200i SE of the Ecology

Project: 200-UP-1 | 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
35	G.S.		35'-40': Sand (S) 0'-40' 3% silt, 97% v.fn.-v.crs. sand (75%f/25%m); strong HCl rxn, well sorted, sub.ang.-sub.rnd., dry, 10YR 7/3 very pale brown	Dual Air Rotary w/ 7" tricone 8" casing; Archive @ 35 ft bgs
40	G.S.		40'-45': Silty Sand (mS) 40'-85' 30% silt, 70% v.fn.-fn. sand (75%f/25%m); strong HCl rxn, well sorted, sub.ang.-sub.rnd., dry, 10YR 7/2 light gray	Archive @ 40 ft bgs
45	G.S.		20% silt, 80% v.fn.-v.crs. sand (70%f/30%m); strong HCl rxn, well sorted, sub.ang.-sub.rnd., dry 10YR 7/2 light gray; 45'-50':	Archive @ 45 ft bgs.
50	G.S.		50'-55': 35% silt, 65% v.fn.-crs. sand (80%f/20%m); strong HCl rxn, 10YR 7/2 light gray; SAA (same as above)	Archive @ 50 ft bgs
55	G.S.		55'-60': 30% silt, 70% v.fn.-fn. sand (80%f/20%m); SAA	Archive @ 55 ft bgs
60	G.S.		60'-65': 20% silt, 80% v.fn.-crs. sand (70%f/30%m); 10YR 6/2 light brownish gray, SAA	Archive @ 60 ft bgs
65	G.S.		65'-70': 30% silt, 70% v.fn.-med. sand (80%f/20%m); 10YR 7/2 light gray, SAA	Archive @ 65 ft bgs.

Reported By: Andrew Rawlerson (Print Name) | Staff Geologist (Title) | [signature] (Signature) | 8·30·17 (Date)

Reviewed By: Print Name | Title | Signature | Date

For Office Use Only

OR Doc Type: | WMU Code(s):

BOREHOLE LOG

Date: 8.30.17

Well ID: C9737	Well Name: 699-31-50	Location: ~2 mi SE of Ecology
Project: 200-UP-1		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
70	G.S.		70'-75': Silty Sand (mS) 40'-85' 20% silt, 80% v.fn.-crs. sand (60%f/40%m); weak HCl rxn, sub.ang.-sub.rnd., well sorted, dry, 10YR 6/2 light brownish gray	Dual Air Rotary w/7" tricone 8" casing; Archive @ 70 ft bgs.
75	G.S.		75'-80': 20% silt, 80% v.fn.-med. sand (70%f/30%m); 10YR 7/2 light gray; same as above (SAA)	Archive @ 75 ft bgs.
80	G.S.		80'-85': 20% silt, 80% v.fn.-crs. sand (60%f/40%m); 10YR 7/2 light gray, SAA.	Archive @ 80 ft bgs.
85	G.S.		85'-90': Silt (M) 85'-95' 90% silt, 10% v.fn.-fn. sand (70%f/30%m); well sorted, weak HCl rxn, sub.ang.-sub.rnd., dry, 10YR 8/2 very pale brown	Archive @ 85 ft bgs.
90	G.S.		90'-95': 80% silt, 20% v.fn.-fn. sand (80%f/20%m); very weak HCl rxn, 10YR 7/3 very pale brown, SAA	Archive @ 90 ft bgs.
95	G.S.		95'-100': Silty Sand (mS) 95'- 30% silt, 70% v.fn.-crs. sand (70%f/30%m); very weak HCl rxn, sub.ang.-sub.rnd., well sorted, dry, 10YR 6/3 pale brown	Archive @ 95 ft bgs.
100	G.S.		100'-105': 20% silt, 80% v.fn.-crs. sand (70%f/30%m); 10YR 7/3 very pale brown, SAA	Archive @ 100 ft bgs.

Reported By:			
Andrew Rauterson	Staff Geologist	[signature]	8.30.17
Print Name	Title	Signature	Date

Reviewed By:			
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

BOREHOLE LOG

Date: 8.30.17

Well ID: C9737 | Well Name: 699-31-5D | Location: ~2mi SE of Ecology

Project: 200-UP-1 | 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
105	G.S.		105'-110': Slightly Silty Sand ((m)S) 95'-125' 20% silt, 80% v.fn.-fn. sand (80%f/20%m); well sorted, sub.ang.-sub.rnd., dry, very weak HCl rxn, 10YR 6/3 pale brown	Dual Air Rotary w/ 7" tricone 8" casing; Archive @ 105 ft bgs.
110	G.S.		110'-115': 20% silt, 80% v.fn.-med. sand (70%f/30%m); no HCl rxn, 10YR 6/2 light brownish gray, same as above (SAA)	Archive @ 110 ft bgs.
115	G.S.		115'-120': 20% silt, 80% v.fn.-med. sand (75%f/25%m); 10YR 6/3 pale brown, no HCl rxn, SAA	Archive @ 115 ft bgs.; Begin using 7" under reamer bit
120	G.S.		120'-125': 20% silt, 80% v.fn. sand (80%f/20%m); SAA	Archive @ 120 ft bgs.
125	G.S.		AR 8.31.17 ~~Slightly Silty Sand [(m)S]~~ Sand(S) 125'-160' 125-130: 10% silt, 90% v.fn.-med. sand (70%f/30%m); well sorted, sub.ang.-sub.rnd., no HCl rxn, dry, 10YR 6/3 pale brown	Archive @ 125 ft bgs.
130	G.S.		130'-135': 10% silt, 90% v.fn.-med. sand (80%f/20%m); same as above	Archive @ 130 ft bgs.
135	G.S.		135'-140': 10% silt, 90% sand v.fn.-med (70%f/30%m); 10YR 5/2 grayish brown, same as above	Archive @ 135 ft bgs.

Reported By:

Print Name	Title	Signature	Date
Andrew Rawlerson	Staff Geologist	[signature]	

Reviewed By:

Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type: | WMU Code(s):

BOREHOLE LOG (Cont.)

Date: 8.31.17

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2 mi SE of Ecology

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
140	G.S.		~~Slightly Silty Sand [(m)S]~~ AR 8.31.17 Sand (S) 125'-140'	Dual tier Rotary w/ 7" under reamer bit
			140'-145': 10% silt, 90% v.fn.-med. sand (60% f/40% m); well sorted, sub.ang.-sub.rnd., dry, no HCl rxn, 10YR 6/2 light brownish gray	Archive @ 140 ft bgs.
				Archive @ 145 ft bgs
145	G.S.		145'-150': 10% silt, 90% v.fn.-med. sand (60% f/40% m); same as above, 10YR 5/2 grayish brown.	* very slight moisture inc.
				Archive @ 150 ft bgs.
150	G.S.		150'-155': 10% silt, 90% v.fn.-med. sand (60% f/40% m); 10YR 6/3 pale brown, weak HCl rxn, same as above	* very slight moisture inc.
155	G.S.		~~Sand (S)~~ AR 8.31.17 155'-160': 10% silt, 90% v.fn.-med. sand (55% f/45% m); same as above	Archive @ 155 ft bgs.
160	G.S.		Slightly Silty Sand [(m)S] 160'-170' 160-165': 20% silt, 80% v.fn.-med. sand (60% f/40% m); no HCl rxn, same as above	Archive @ 160 ft bgs.
165	G.S.		165'-170': 20% silt, 80% v.fn.-med. sand (60% f/40% m); same as above, 10YR 6/2 light brownish gray	Archive @ 165 ft bgs.
170	G.S.		Sand (S) 170'-185' 170'-175': 10% silt, 90% sand v.fn.-med. (55% f/45% m); same as above	Archive @ 170 ft bgs
175	G.S.		Sand (S) 175'-180': 8% silt, 92% v.fn.-med. sand (60% f/40% m); well sorted, sub.ang.-sub.rnd., dry, no HCl rxn, 10YR 5/2 grayish brown	Archive @ 175 ft bgs.

Reported By:			
Andrew Raulerson	Staff Geologist	Ah Rl	8.31.17
Print Name	Title	Signature	Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 8.31.17

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2mi SE of Ecology

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
180	G.S.		Sand (S) 170'-185'	Dual Air Rotary w/ 7"
			180'-185': 9% silt, 91% v.fn.-med. sand (55%f/	under reamer bit
			45%m); well sorted, sub.ang.-sub.rnd., no HCl	
			rxn, dry, 10YR 6/2 light brownish gray	Archive @ 180 ft bgs
185	G.S.		Silty Sand (mS) 185'-210'	Archive @ 185 ft bgs.
			185'-190': 30% silt, 70% sand v.fn.-crs. (60%f/	
			40%m); well sorted, sub.ang.-sub.rnd., no HCl	
			rxn, dry, 10YR 6/3 pale brown	
190	G.S.			Archive @ 190 ft bgs.
			190'-195': 35% silt, 65% v.fn.-crs. sand (55%f/	
			45%m); strong HCl rxn, same as above	
195 ~~190~~ AR 8.31.17	G.S.			Archive @ 195 ft bgs
			195'-200': 25% silt, 70% v.fn.-v.crs. sand (60%f/	
			40%m), 5% v.fn.-fn. pebbles (50%f/50%m) (max 7mm);	
			same as above	
200 ~~195~~ AR 8.31.17	G.S.			Archive @ 200 ft bgs
			200'-205': 25% silt, 66% v.fn.-v.crs. sand (60%f/	
			40%m), 9% v.fn.-med. pebbles (50%f/50%m; max	
			15mm); 10YR 6/1 gray, same as above	
205 ~~200~~ AR 8.31.17	G.S.			Archive @ 205 ft bgs
			205'-210': 25% silt, 66% v.fn.-v.crs. sand (60%f/	
			40%m), 9% v.fn.-med. pebbles (50%f/50%m; max	
			12mm); no HCl rxn, same as above	Archive @ 210 ft bgs
			AR 8.31.17 Slightly Silty Gravelly Sand 210'-215'	
210 ~~205~~ AR 8.31.17	G.S.		~~Gravelly Silty Sand (gmS)~~ ~~Silty Sandy Gravel (msG)~~	~~Gravelly Silty Sand (gmS) 210'-~~
			210'-215': 20% silt, 60% sand v.fn.-v.crs. (60%f/	~~Add~~ AR 8.31.17
			40%m), 20% v.fn.-med. pebbles (60%m/40%f; max	
			14mm); poorly sorted, ~~sub.~~ AR 8.31.17 ang.-sub.rnd., no HCl	
			rxn, 10YR 6/2 light brownish gray	Archive @ 215 ft bgs.
215 ~~210~~ AR 8.31.17	G.S.		Silty Sandy Gravel (msG) 215'-	
			215'-220': 12% silt, 55% v.fn.-v.crs. sand (50%f/	Added 50gal. of H_2O for
			50%m), 33% v.fn.-crs. pebbles (70%m/30%f) (max	recovery and @ 215' bgs
			30mm); poorly sorted, ang.-sub.rnd., no HCl rxn, wet, 10	
			YR 2/2 very dark brown	

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	[signature]	8.31.17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 8·31·17

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2 mi SE of Ecology

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
220	G.S.		~~Gravelly Silty Sand (grmS)~~ Silty Sandy Gravel (msG) 215'-240': 220'-225': 11% silt, 55% sand (f.n.-v.crs. (50% f/50% m), 34% v.fn.-crs. pebbles (40% f/60% m; max 20mm); wet, poorly sorted, ang.-sub.rnd., no HCl rxn, 10YR 2/2 very dark brown	Add ~150 gal. H_2O between 220-235' bgs for Recovery aid. Dual Air Rig w/ 7" under reamer
225	G.S.		225'-230': 11% silt, 55% v.fn.-v.crs. sand (50% f/50% m), 34% v.fn.-crs. pebbles (50% f/50% m; max 20mm); same as above	Archive @ 220 ft bgs Archive @ 225 ft bgs.
230	G.S.		230'-235': 11% silt, 51% v.fn.-v.crs. sand (50% f/50% m), 38% v.fn.-crs. pebbles (40% f/60% m) (max 28mm); same as above	Archive @ 230 ft bgs.
235	G.S.		235'-240': 11% silt, 50% v.fn.-v.crs. sand (50% f/50% m), 39% v.fn.-crs. pebbles (40% f/60% m; max 20mm); same as above	Archive @ 235 ft bgs.
240	G.S.		Slightly Silty Gravely Sand ((m)gS) 240'-250' 240'-245': 15% silt, 70% v.fn.-v.crs. sand (50% f/50% m), 15% v.fn.-med. pebbles (40% f/60% m; max 9mm); wet, ang.-sub.ang., poorly sorted, no HCl rxn, 10YR 3/2 very dark grayish brown	Archive @ 240 ft bgs.
245	G.S.		245'-250': 20% silt, 70% v.fn.-v.crs. sand (60% f/40% m), 10% v.fn.-crs. pebbles (50% f/50% m; max 19mm); same as above	Archive @ 245 ft bgs
250	G.S.		Silty Sand (mS) 250'- 250'-255': 25% silt, 70% v.fn.-v.crs sand (40% f/60% m), 5% v.fn-fn. pebbles (50% f/50% m; max 5mm); wet, poorly sorted, ang.-sub.ang., no HCl rxn, 10YR 3/2 very dark grayish brown	Archive @ 250 ft bgs
255	G.S.			Archive @ 255 ft bgs.

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	Adr	8·31·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 9-5-2017

Well ID: C9737 | Well Name: 699-31-50 | Location: ~ 2 mi SE of US ECOLOGY

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
260	G.S.		260 - 270' Slightly Silty Sand [(m)S]; (85% S, 15% M); Sand: 60% v. crse grn., 20% crse grn., 20% med. grn., sub. rnd. - ang., wet (due to added H_2O), well sort, 90% m / 10% f, no rxn to HCl, 10YR 2/2 v. drk. brown; Silt: unconsolidated, non. plastic, in solution w/ added H_2O, % decrease; Hanford fm.	Dual Rotary w/ under-reamer 8" casing - welded.
				Archive @ 260' bgs
265	G.S.			Add ~ 150 gal H_2O to aid in cuttings recovery.
				Archive @ 265' bgs
			270 - 300' Silty Sand [mS]; (75% S, 25% M); Sand: 50% v. crse grn., 50% crse grn., sub. rnd. - ang., wet (due to added H_2O), well sort, 70% m / 30% f, no rxn to HCl, 10YR 3/4 d. yellowish brown; Silt: non-plastic, in solution w/ added H_2O, % increase, unconsolidated; Hanford fm.	
270	G.S.			Archive @ 270' bgs
275	G.S.			Archive @ 275' bgs
	S.S. 75%		@ 280' Silty Sand: damp (no H_2O added), 60% m / 40% f, 10YR 3/2 v. drk. grayish brown; no other change; Hanford fm.	Splitspoon sample, I-012 275.1 - 276.6' bgs (refusal), 75% rec., LINER B (275.6 - 276.1) collected, HEIS#: B3D9C1
280	G.S.		@ 285' Silty Sand; (70% S, 30% M); 60% v. fine grn., 35% fine grn., 5% crse grn., v. well sort, slt. damp, weak rxn to HCl, 50% m / 50% f; Silt: % increase, slt. damp - dry, loose, non-plastic; 10YR 4/2 d. grayish brown; Hanford fm.	Dual Rotary w/ tri-cone 8" casing - welded.
285	G.S.			Archive @ 280' bgs.
			@ 290' Silty Sand; (70% S, 30% M); 70% v. fine grn., 20% fine grn., 10% med. grn., v. well sort, slt. damp, no - weak rxn to HCl, 60% f / 40% m; Silt the same; 10YR 4/3 brown; Ringold Fm.	Archive @ 285' bgs.
290	G.S.			Archive @ 290' bgs
				Ringold Fm., Unit E contact ~ 290' bgs.
295	G.S.		@ 295' Silty Sand; (70% S, 30% M); 70% v. fine grn., 20% fine grn., 10% v. crse grn., 10YR 5/3 brown, weak rxn to HCl; Silt the same; Ringold Fm.	Archive @ 295' bgs

Reported By:

Print Name	Title	Signature	Date
Jess Hocking	Sr. Geologist	J Hocking	9/6/2017

BOREHOLE LOG (Cont.)

Date: 9-6-2017

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2 mi. SE of US ECOLOGY

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
300	G.S.		300 - 320' Gravelly Silty Sand [gmS]; (50% S, 25% G, 25% M); Sand: 60% v. fine grn., 20% fine grn., 20% med. grn., dry, poor sort, sub. rnd - ang., 70% f / 30% m, no rxn to HCl, 2.5Y 5/2 grayish brown.; Gravel: 10mm max (pebbles), ang., basalt / quartzite mix, v. poor sort, dry, Silt: % same, dry, loose, non-plastic; Ringold Fm.	Dual Rotary w/tri-cone 8" casing - welded.
305	G.S.			Archive @ 300' bgs.
				Archive @ 305' bgs
			@ 305' Gravelly Silty Sand [gmS]; (65% S, 25% M, 10% G); Sand: % increase, 60% v. fine grn., 20% fine grn., 20% med. grn., dry, v. well sort, sub. ang - ang., 80% f / 20% m, no rxn to HCl, 2.5Y 5/2 grayish brown; Silt the same; Gravel: % decrease, 6mm max (pebbles), ang., basalt / quartzite mix, med. sort.; Ringold Fm.	
310	G.S.			Archive @ 310' bgs
				H_2O observed @ 312' bgs (via E-tape)
315	G.S.			Archive @ 315' bgs.
			@ 310' Gravelly Silty Sand [gmS]; (60% S, 25% M, 15% G); % Gravel increase, same as above otherwise.	STATIC H_2O @ 309.76' bgs (9/11/17)
				Archive @ 320' bgs.
320	G.S.			
			@ 315' Gravelly Silty Sand [gmS]; (60% S, 25% M, 15% G); same as above, slightly more basalt than quartzite (~60% basalt to 40% quartzite).	
325	G.S./W.S. 50% S.S.			Archive @ 325' bgs.
			320 - 355' Gravel [G]; (95% G, 5% S); Gravel: 2-10mm (pebble - granule) 50% granule, 50% pebble, ang - sub. ang, dry, v. poor sort, no rxn to HCl, basalt/quartzite mix; Sand: 100% v. crse grn., dry, ang. - sub ang, 90% f / 10% m, v. poor sort, 2.5Y 5/1 gray.	Splitspoon sample (I-002) Driven 325 - 326.5' bgs Liner B collected (325 - 325.5); HEIS#: B3B196; 50% rec.
330	G.S.			H_2O sample (I-001) @ 325' bgs; Flowrate = 1.25 gpm HEIS#: B3B128, B3B125, B3B126, B3B127, B3B129, B3B130, B3B131
			@ 325' Gravel [G]; (95% G, 5% S); same as above - moisture changes from dry to slightly damp.	
335	G.S.			
			@ 330' Gravel [G]; (100% G); wet, ang. - sub. ang., v. poor sort, 60% granule, 40% pebble, 2-20mm range, cont'd —	ARCHIVE @ 330' bgs ARCHIVE @ 335' bgs.

Reported By:

Jess Hocking (Print Name) | Sr. Geologist (Title) | [signature] (Signature) | 9/12/17 (Date)

BOREHOLE LOG (Cont.)

Date: 9-12-2017

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2mi. SE of US ECOLOGY

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
340	G.S.		@ 330' (cont.d) Gravel [G]; (100% G); wet, ang.-sub. ang., v. poor sort, 60% granule, 40% pebble, 2-20mm range, basalt/quartzite mix, 60%m/40%f (rocks); color = 2.5Y 3/1 v. dark gray.	Dual Rotary w/tricone 8" wld. casing. ARCHIVE @ 340' bgs
345	G.S./W.S.		@ 335' Gravel [G]; (100%); wet, ang.-sub.ang., v. poor sort, 70% granule, 30% pebble, 2-20mm range, basalt/quartzite mix, 50%m/50%f (rocks); color = 2.5Y 3/1 v. dark gray.	ARCHIVE @ 345' bgs. H_2O sample (I-003) @ 345' bgs; Flowrate = 3gpm HEIS #: B3B133, B3B134, B3B135, B3B137, B3B138, B3B139, B3B140.
350	G.S.		@ 340' Gravel [G]; (100% G); wet, ang.-sub.ang., mod. sort, 80% granule, 20% pebble, 2-10mm range, basalt/quartzite mix, 60%f/40%m (rocks); color = 2.5Y 3/2 v. dark grayish brown.	Archive @ 350' bgs
355	G.S.			Archive @ 355' bgs
360	G.S.		@ 345' Gravel [G]; (100% G); wet, ang.-sub.ang., poor sort, 70% pebbles, 30% granule, 2-10mm range, basalt/quartzite mix, 50%m/50%f (rocks); color = 2.5Y 4/2 d. grayish brown.	Archive @ 360' bgs
365	G.S./W.S. S.S. 100%		@ 350' Gravel [G]; (100% G); wet, ang.-sub.rnd., v. poor sort, 2-25mm range, 70% pebbles, 30% granules, basalt/quartzite mix, 50%m/50%f (rocks); 2.5Y 4/2 d. grayish brown.	Archive @ 365' bgs (appears to be heaving sands) Splitspoon sample I-005 Driven 363.7-366.2' bgs; 100% rec., HEIS #: B3B197
370	G.S.		355-360' Gravelly Silty Sand [gmS]; (60%S, 25%M, 15%G); wet, Sand: v.fine-med. (60% v.fine - 40% med.), ang-sub.ang., 90%f, 10%m, v. well sort; Silt: loose, in suspension, non-plastic; Gravel: ang.-sub.rnd., 2-25mm range, basalt/quartzite mix, 60%m/40%f (rocks); Color = 2.5Y 5/6 lt. olive brown.	H_2O sample I-004 collected @ 365' bgs; Flowrate = 0.5gpm; HEIS #: B3B141, B3B142, B3B143, B3B145, B3B146, B3B147, B3B148, B3B144. Archive @ 370' bgs
375	G.S.			Archive @ 375' bgs.

Reported By:

Print Name	Title	Signature	Date
Jess Hocking / Nathan Bowlers	Lead (NB) 9/13/17		9/15/17

BOREHOLE LOG (Cont.)

Date: 9/13/2017

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2mi. SE of US ECOLOGY

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
380	G.S.		360-365' Gravelly Sand [gS]; (85% S, 10% G, 5% M); Sand: v.fine-v.crse grn. (70% v.fine, 15% med, 15% v.crse), well sort, wet, 90% f / 10% m, ang.-sub ang.; Gravel: ang.-sub. ang., 2-30 mm range, basalt/quartzite mix, 90% f / 10% m (rocks), poor sort; Silt: in suspension, loose, non-plastic; Color: 2.5Y 4/3 olive brown.	Dual Rotary w/tricone 8" wld. casing.
				Archive @ 380' bgs.
385	G.S. W.S.			Archive @ 385' bgs.
				H_2O sample @ 385' bgs., I-006; Flowrate = 5gpm., HEIS #: B3B149, B3B150, B3B151, B3B152, B3B153, B3B154, B3B155, B3B156
			365-385' Sand [S]; (95% S, 5% M); Sand: v.fine-v.crse grn. (70% v.fine, 15% med, 15% v.crse), well sort, wet, 90% f / 10% m, ang.-sub ang.; Silt: in suspension, loose, non-plastic; Color: 2.5Y 4/3 olive brown (possibly heaving sand).	
390	G.S.			Archive @ 390' bgs.
395	G.S.		385-395' Sandy Gravel [sG]; (60% G, 30% S, 10% M); Gravel: 2-30mm, rnd-ang., v. poor sort, saturated, 90% f/10% m (rocks), predom. pebbles, basalt/quartzite mix; Sand: v.fine-crse grn. (80% v.fine - 20% crse), 90% f/10% m, saturated, mod. sort, ang-sub. ang; Silt: % increase, loose, non-plastic, in suspension; Color: 2.5Y 4/3 olive brown.	Archive @ 395' bgs.
400	G.S.			Archive @ 400' bgs.
	G.S./W.S.			Archive @ 404' bgs.
405	75% P.S.		395-400' Sand [S]; (90% S, 5% G, 5% M); Sand: v.fine-med. grn. (60% med. grn, 20% fine grn., 20% v.fine grn.), v. well sort, ang.-sub. ang., saturated, 100% f/0% m; Gravel: poor sort, ang.-sub. ang., 2-10mm, mostly pebbles, basalt/quartzite mix, 90% f/10% m (rocks); Silt: loose, non-plastic, in suspension; Color: 2.5Y 4/3 olive brown.	Splitspoon sample, I-008, Driven 404-406' bgs, 75% rec. Liner "B" collected (404.5-405' bgs), HEIS#: B3B198
410	G.S.			H_2O sample, I-007, @ 404' bgs; Flowrate = 5.3gpm, HEIS #: B3B157, B3B158, B3B159, B3B160, B3B161, B3B162, B3B163, B3B164
415	G.S.		400-415' Sandy Gravel [sG]; (60% G, 30% S, 10% M); Gravel: 2-35mm granules-pebbles, v. poor sort, 90% f/10% m (rocks), basalt/quarteite mix, ang.-rnd., saturated; Sand: % decrease, fine-v. crse grn. (50% fine - 50% v.crse),	Archive @ 410' bgs
			[cont'd on page 12]	Archive @ 415' bgs.

Reported By:

Jess Hocking	Sr. Geologist	[signature]	9/19/2017
Print Name	Title	Signature	Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 9-19-2017

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2mi. SE of US ECOLOGY

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
420	G.S.		Sandy Gravel [SG] (cont'd from pg. 11) Sand: saturated, 90% f / 10% m, mod. sort, ang. - sub. ang.; Silt: loose, non-plastic, in suspension; Color: 2.5Y 4/3 olive brown.	DUAL ROTARY w/ tricone 8" wld. casing
	G.S.			Archive @ 420' bgs
425	W.S. 25% G.S.		@ 410' Sandy Gravel [SG]; (65% G, 30% S, 5% M); Gravel: 2-30mm granule - pebbles (70% pebbles), rnd.-ang., v. poor sort, basalt/quartzite mix, 95% m/5% f (rocks), saturated; Sand: saturated, 95% m/5% f, mod. sort, ang. - sub. ang., v.fine - crse grn. (50% v.fine - 50% crse); Silt: loose, non-plastic, in suspension; Color: 2.5Y 2.5/1 black.	Archive @ 424' bgs
				Splitspoon, I-013, sample driven: 424 - 425.5' bgs, 25% rec.; NCOs take Liner "A" (424.5 - 425' bgs); HEIS#: B3D9C2
430	G.S.			@ 410' Color changes to black, predom. mafic sediment; ~~possibly Ringold Unit A contact???~~ MJH 9.25.17
			415 - 420' Gravel [G]; (100% G); Gravel: 2-20mm granule - pebbles (50% granule - 50% pebble), rnd-ang., v. poor sort, basalt/quartzite mix, 95% m/5% f (rocks), saturated; Color: 2.5Y 2.5/1 black.	
435	G.S.			H_2O sample, I-009, @ 424' bgs; Flowrate = 9gpm; HEIS#: B3B165, B3B166, B3B167, B3B168, B3B169, B3B170, B3B171, B3B172
440	G.S.		420 - 430 Sandy Gravel [SG]; (75% G, 20% S, 5% M); Gravel: 2-20mm granule - pebbles (60% granule - 40% pebbles), rnd.-ang., v. poor sort, basalt/quartzite mix, 95% m/5% f (rocks), saturated. Sand: fine - v.crse grn. (60% v. crse - 40% fine), saturated, 95% m/5% f, mod. sort, ang. - sub. ang.; Silt: loose, non-plastic, in suspension; Color: 2.5Y 2.5/1 black.	Archive @ 430' bgs
445	G.S./W.S.			Archive @ 435' bgs
				Archive @ 440' bgs
			@ 424' Sandy Gravel [SG]; (55% G, 40% S, 5% M); Gravel: 2-30mm granule - pebble (80% granule - 20% pebble), rnd.-ang., v. poor sort, basalt/quartzite mix, 95% m/5% f (rocks), saturated; Sand: 100% v. crse grn., saturated, 100% m, well sort, ang. - sub. ang.; Silt: non-plastic, wet, loose, in suspension; Color: 2.5Y 2.5/1 black.	Archive @ 445' bgs.
450	G.S.			Organic fragments (wood) observed @ 445' bgs.
455	G.S.			H_2O sample, I-010, @ 445' bgs, Flowrate = 7.5gpm, HEIS#: B3B173, B3B174, B3B175, B3B176, B3B177, B3B178, B3B179, B3B180
			@ 425.5' Sandy Gravel [SG]; (55% G, 40% S, 5% M); M = sign of blue clay (~2.5% clay, 2.5% silt) - smearable.	

Reported By:

Print Name	Title	Signature	Date
Jess Hocking	Sr. Geologist	[signature]	9/26/17

BOREHOLE LOG (Cont.)

Date: 9/26/2017

Well ID: C9737 | Well Name: 699-31-50 | Location: ~2mi. SE of US ECOLOGY

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
460	G.S.		430-445' Gravel [G]; (95% G, 5% M); Gravel: 2-30mm granule-pebble (50% granule - 50% pebble), rnd.-ang., poor sort, basalt/quartzite mix, 95%m/5%f (rocks), saturated; Silt: in suspension, loose, non-plastic; Color: 2.5Y 2.5/1 black.	Dual Rotary w/tricone 8" wld. casing
465				Archive @ 450' bgs. Archive @ 455' bgs. Archive @ 460' bgs. Archive @ 468.5' bgs.
			@ 435' Gravel [G]; (90% G, 5% S, 5% M); Gravel: same as above, % decrease; Sand: fine-med. grn. (60% fine - 40% med.), ang.-sub. ang., saturated, well sort, 90%m/10%f; Silt: in suspension, loose, non-plastic; Color: 2.5Y 2.5/1 black.	RLM contact @ 460' bgs.
	G.S.			TD @ 468.5' bgs. (9/26/17)
470				DTB ~~TD~~ @ 467.5' bgs (9/27/17) MJH 9-28-17
				DTW @ 309.10' bgs (9/27/17)
475			445-450' Sandy Gravel [sG]; (75% G, 20% S, 5% M); Gravel: 2-35mm granule - pebble (60% pebble - 40% granule), poor sort, rnd-ang., basalt/quartzite mix, 95%m/5%f (rocks), saturated; Sand: v. fine - med. grn. (50% v. fine, 25% fine, 25% med.), saturated, ang.-sub.ang, 90%m/10%f, well sort; Silt: in suspension, loose, non-plastic; Color: 2.5Y 2.5/1 black.	
480				
485			450-455' Gravelly Sand [gS]; (80% S, 10% G, 10% M); Sand: v.fine - med. grn (60% med, 20% fine, 20% v.fine), v. well sort, saturated, ang.-sub.ang., 95%m/5%f; Gravel: 2-40mm granule-pebble (90% granule - 10% pebble), poor sort, rnd.-ang., saturated, basalt/quartzite mix, large chips of mica present, 95%m/5%f (rocks); Silt: loose, in suspension, non-plastic; Color: 2.5Y 2.5/1 black	
490				
495			455-460' Sand [S]; (90% S, 10% M); Sand: fine-med. grn. (50% med - 50% fine), v. well sort, saturated, ang.-sub. ang., 95%m/5%f; Silt: loose, in suspension, non-plastic; large chips of mica still present; Color: 2.5Y 2.5/1 black.	

Reported By:

Jess Hocking	Sr. Geologist	[signature]	9/26/17
Print Name	Title	Signature	Date

A-6006-993 (REV 0)

SGW-61319, REV. 0

BOREHOLE LOG (Cont.)

Date: 9-26-2017

Well ID: C9737 | Well Name: 699-31-50 | Location: ~ 2mi. SE of US ECOLOGY

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
			460 – 468.5' Sandy Silt/CLAY [SM]. (80% M, 20% S); Silt/CLAY: massive, plastic, saturated, matrix; Sand: crse grn. (100% crse grn.), ang. - sub. ang., poor sort, saturated; Color: GLEY 5/5b – 5/1 bluish gray; RLM contact.	DUAL ROTARY w/ tricone 8" wld. casing.
	NOT USED			

Reported By:

Jess Hocking — Print Name | Sr. Geologist — Title | Signature | 9/26/17 — Date

A-6006-993 (REV 0)

699-31-50 (C9737)
Log Data Report

Borehole Information

Log Date	2017-10-05	Filename	C9737_HG-NM_2017-10-05	Site	200-UP-1

DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
309.05	10/02/17	HII	09/25/17	467.5	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Welded Steel	Air Rotary	1.6	10 7/8	10 1/4	5/16	-1.6	10.56
Welded Steel	Air Rotary	2.1	8 5/8	8	5/16	-2.1	462.2

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing stick-up and casing diameters. The maximum logging depth achieved was 464 ft. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 1LD	Type	60% Coaxial HPGe (SGLS)[2]
Effective Calibration Date	01/26/2017	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-150, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 1HD	Type	He-3 (CPN 503DR) NMLS[3]
Effective Calibration Date	02/23/2017	Serial No.	H310700352
Calibration Reference	HGLP-CC-151, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	4	5	6	7 Repeat	
HEIS Number	1020088	1020089	1020090	1020091	
Date	10/03/17	10/04/17	10/05/17	10/05/17	
Logging Engineer	Felt/Spatz	Spatz/Felt	Spatz	Spatz	
Start Depth (ft)	0.01	122.0	324.0	416.0	
Finish Depth (ft)	123.0	325.01	464.01	462.01	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	NA	NA	NA	NA	

[1] depth to water inside casing
[2] Spectral Gamma Logging System
[3] Neutron Moisture Logging System

Log Run	4	5	6	7 Repeat	
Pre-Verification	C9737ALD2017 1003AV00CAB1	C9737ALD2017 1004BV00CAB1	C9737ALD2017 1005CV00CAB1	C9737ALD2017 1005CV00CAB1	
Start File	AD000001	BD012200	CD032400	DD041600	
Finish File	AD012300	BD032501	CD046401	DD046201	
Post-Verification	AV00CAA1	BV00CAA1	DV00CAA1	DV00CAA1	
Depth Return Error (in.)	0.0	1.0 high	N/A	0.5 low	
Comments	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	

NMLS Log Run Information

Log Run	1	2 Repeat	3		
HEIS Number	1020092	1020093	1020094		
Date	10/02/17	10/03/17	10/03/17		
Logging Engineer	Spatz	Felt	Felt		
Start Depth (ft)	0.0	30.0	247.01		
Finish Depth (ft)	248.5	61.02	309.53		
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	C9737AHD2017 1002AV00CAB1	C9737AHD2017 1003BV00CAB1	C9737AHD2017 1003BV00CAB1		
Start File	AD000000	BD003000	CD024701		
Finish File	AD024850	BD006102	CD030953		
Post-Verification	AV00CAA1	CV00CAA1	CV00CAA1		
Depth Return Error (in.)	0.0	N/A	0.0		
Comments	None	None	None		

Logging Operation Notes

A centralizer was installed on the sondes.

Analysis Notes

Analyst	P.D. Henwood	Date	11/02/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 5/8-in. thick casing was applied to the log data to 10.5 ft and 5/16-in. for the remainder of the borehole.

A water correction was applied below 309 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in an EXCEL template identified as ALD20170126 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

An interpreted data set was created for this borehole. Depth overlaps from consecutive log runs or where two casings existed were removed from 122 and 123 ft and from 324 and 325 ft. This results in a data set where only one data point is presented for each depth.

NMLS data are reported in percent volumetric moisture content from 10.5 ft to water level at 309 ft. Data are not reported from the double-cased interval from ground surface to 10.5 ft.

HGU[4] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Calibration Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected in this borehole.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

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

List of Log Plots

Depth Reference is ground surface.

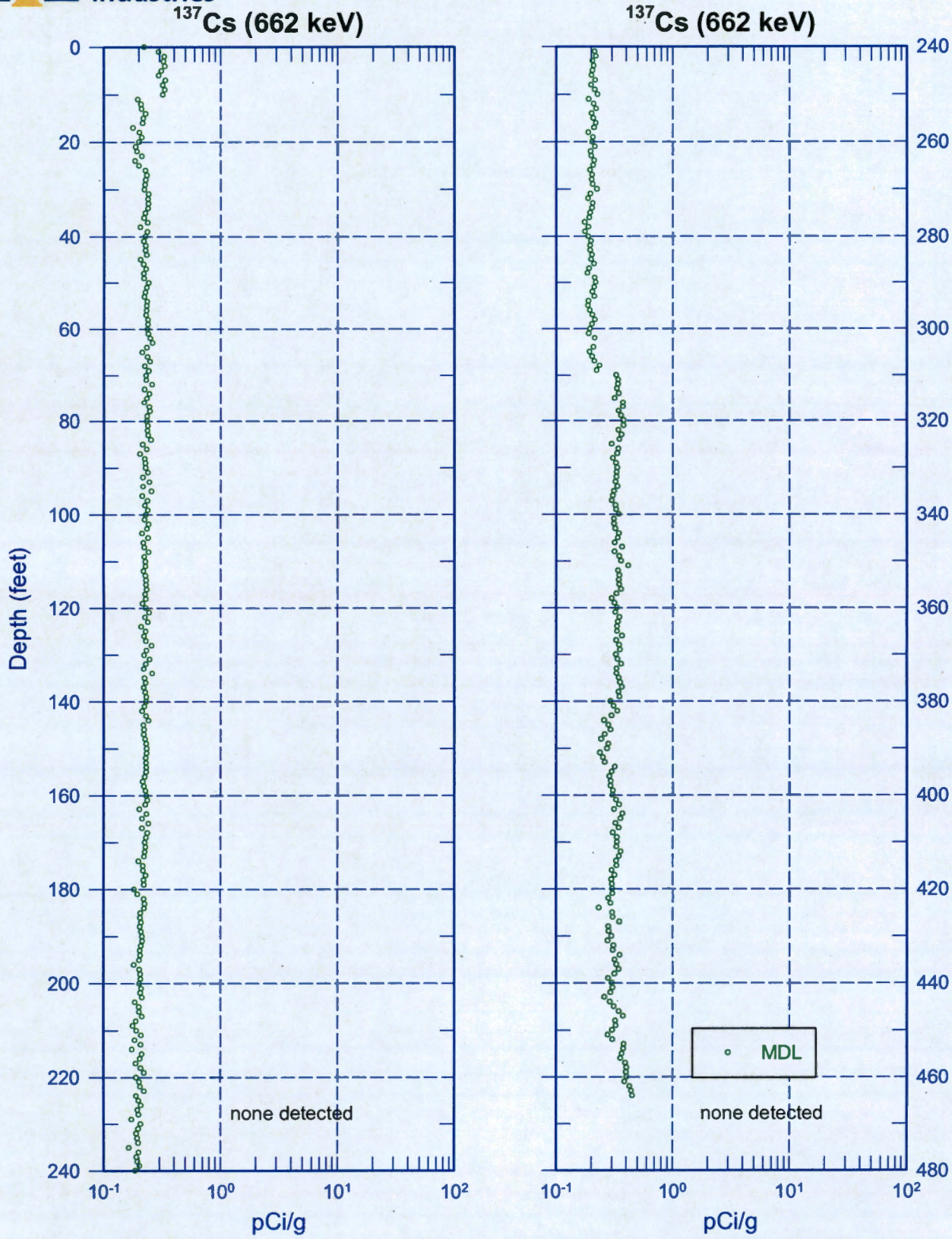
Manmade Radionuclides (0-480 ft)
Natural Gamma Logs (0-160 ft)
Natural Gamma Logs (150-310 ft)
Natural Gamma Logs (310-470 ft)
Combination Plot (0-120 ft)
Combination Plot (120-240 ft)
Combination Plot (240-360 ft)
Combination Plot (360-480 ft)
Combination Plot (0-480 ft)
Total Gamma & Moisture (0-160 ft)
Total Gamma & Moisture (150-310 ft)
Total Gamma & Hanford Gamma Unit (0-480 ft)
Repeat Section of Natural Gamma Logs (416-462 ft)
Moisture Repeat Section (30-62 ft)

[4] Hanford Gamma Unit

This page intentionally left blank.

Huntington Ingalls Industries

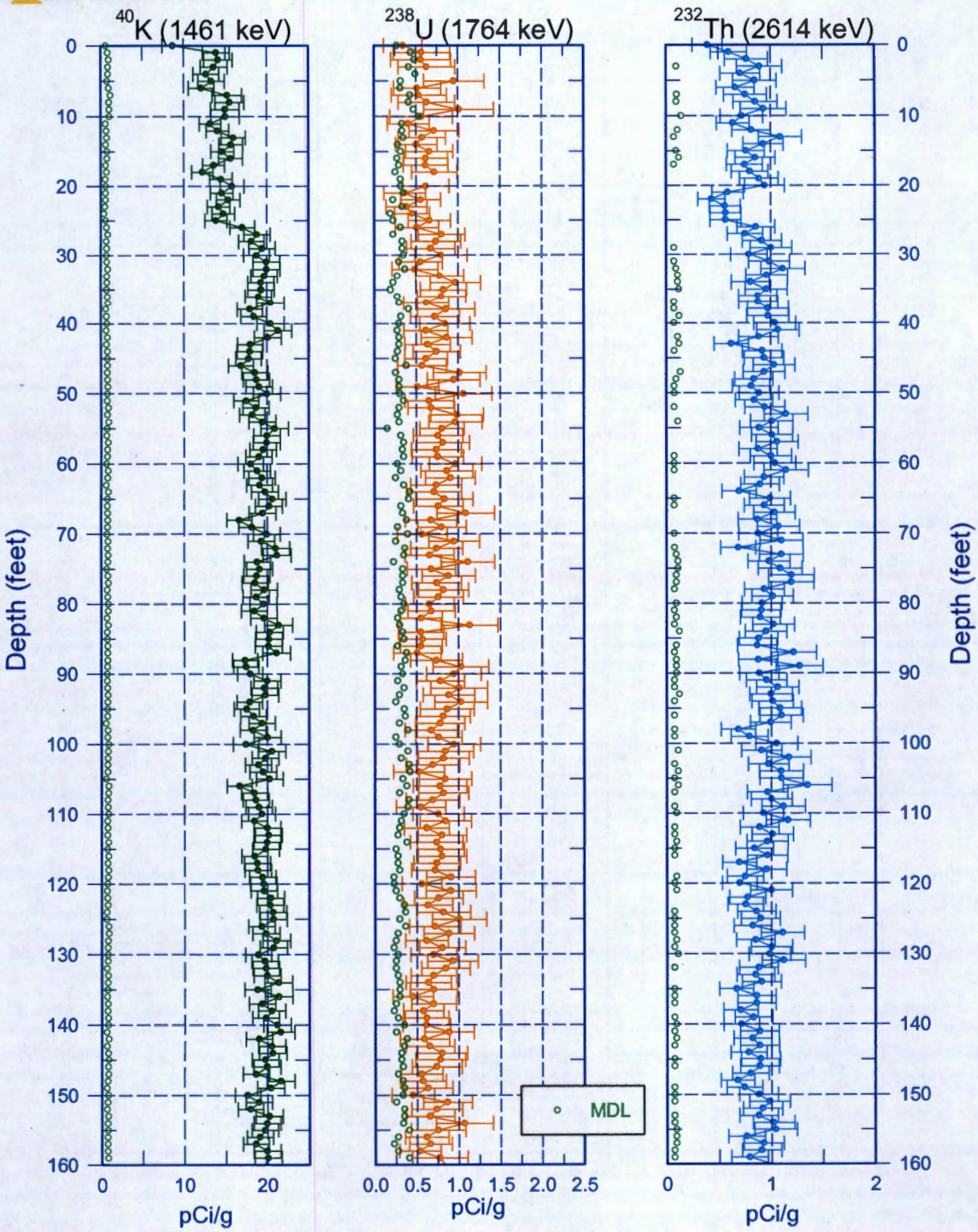
699-31-50 (C9737)
Manmade Radionuclides



Zero Reference - Ground Surface

Huntington Ingalls Industries

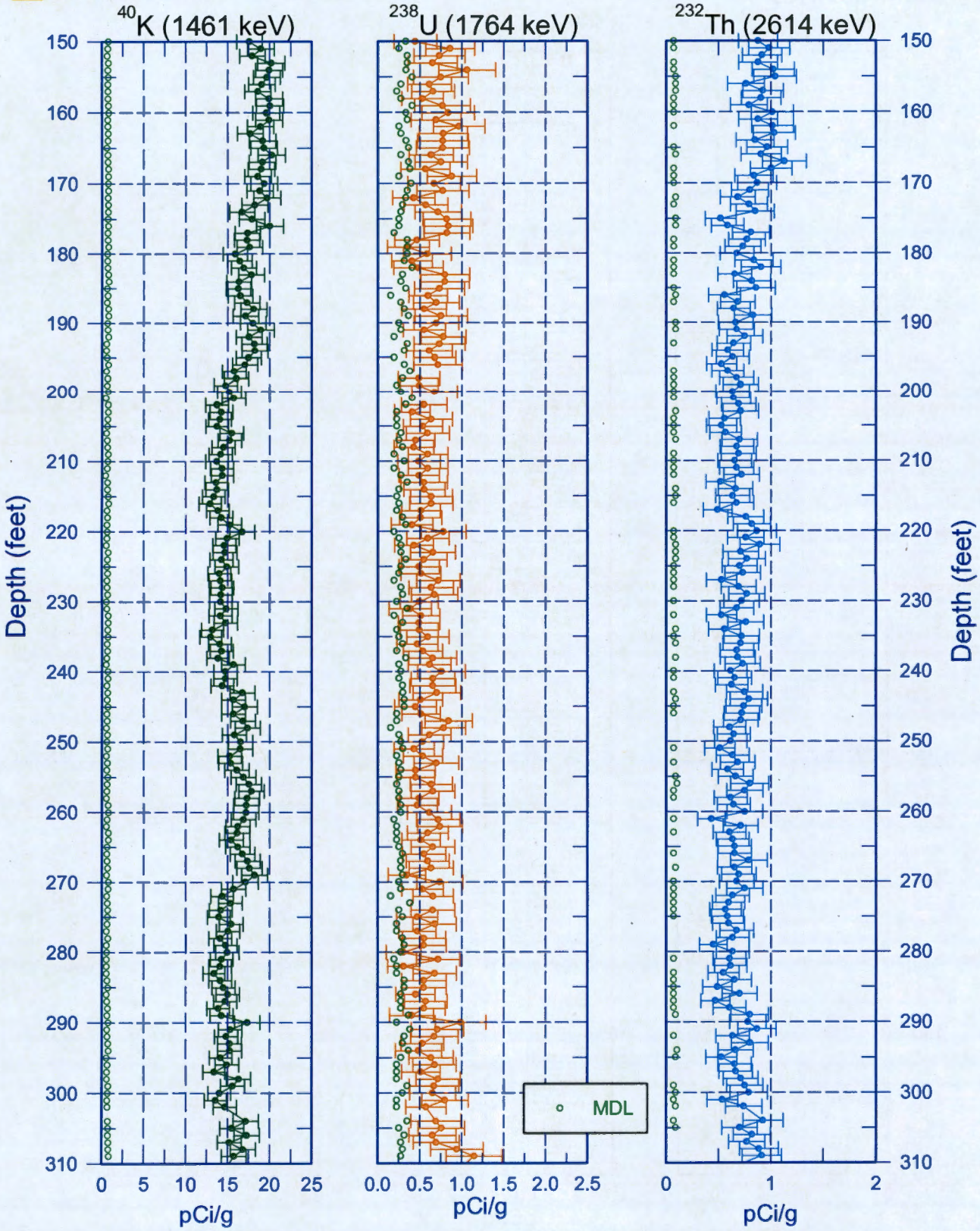
699-31-50 (C9737)
Natural Gamma Logs



Zero Reference - Ground Surface

Huntington Ingalls Industries

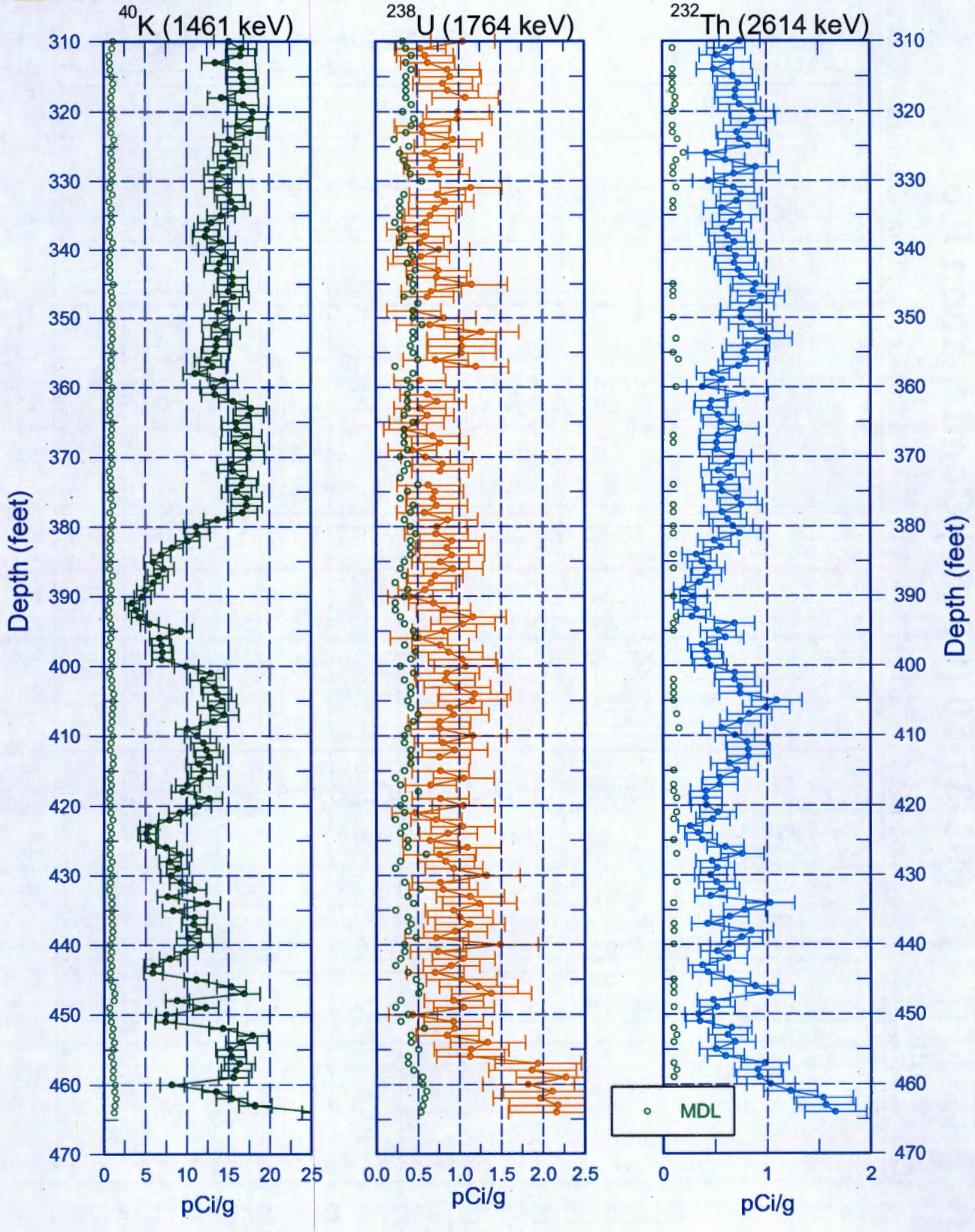
699-31-50 (C9737)
Natural Gamma Logs



Zero Reference - Ground Surface

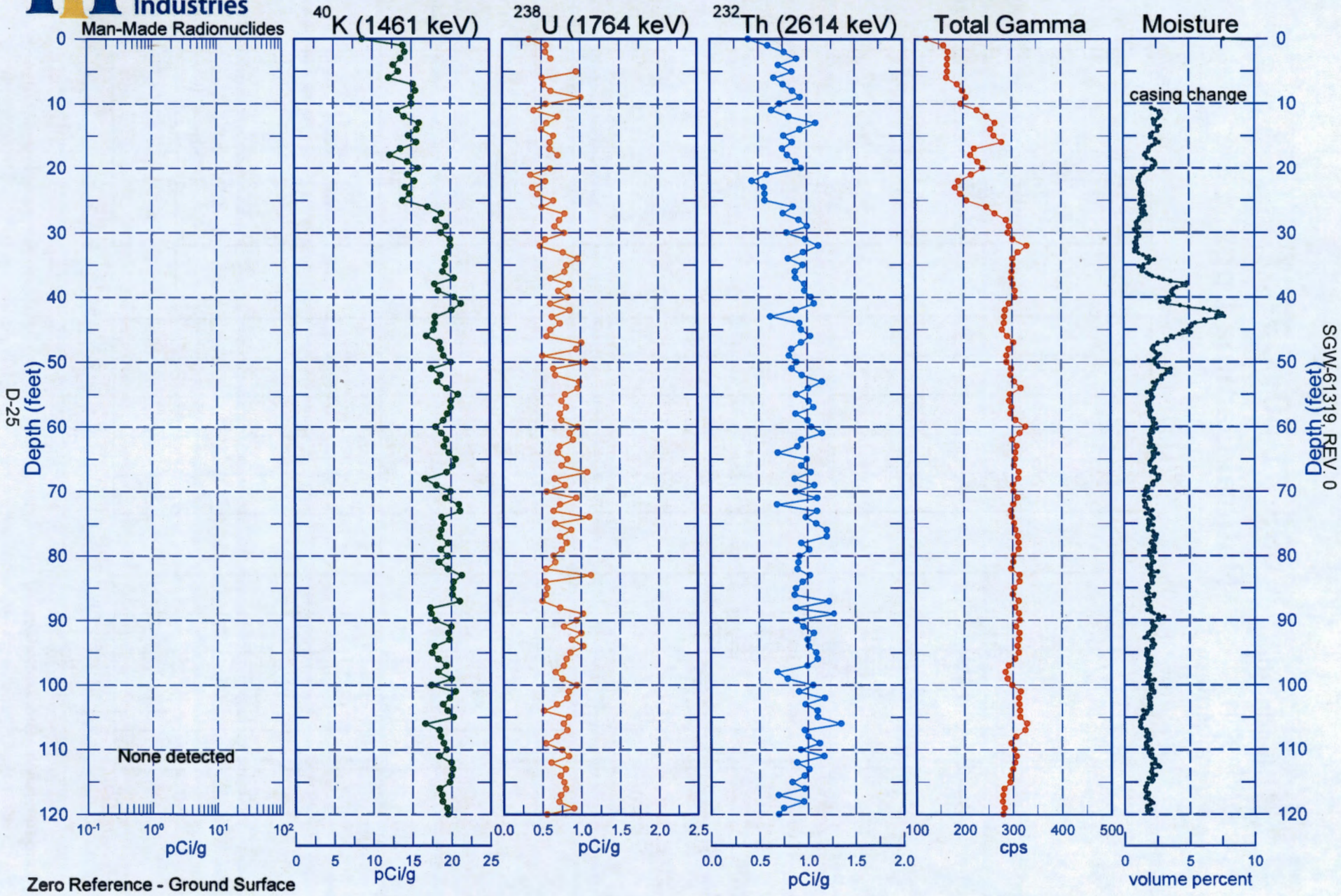
Huntington Ingalls Industries

699-31-50 (C9737)
Natural Gamma Logs



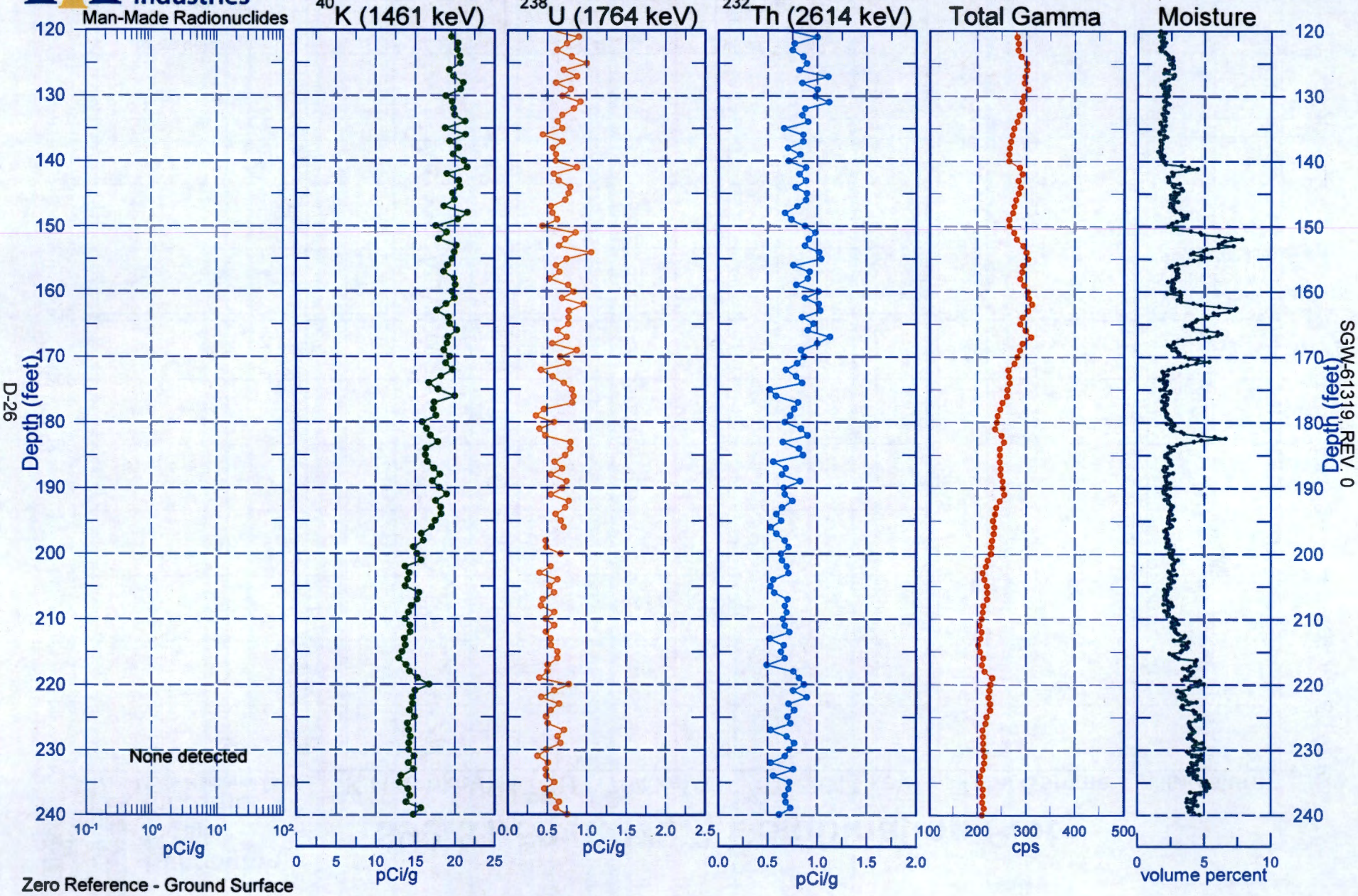
Zero Reference - Ground Surface

699-31-50 (C9737) Combination Plot

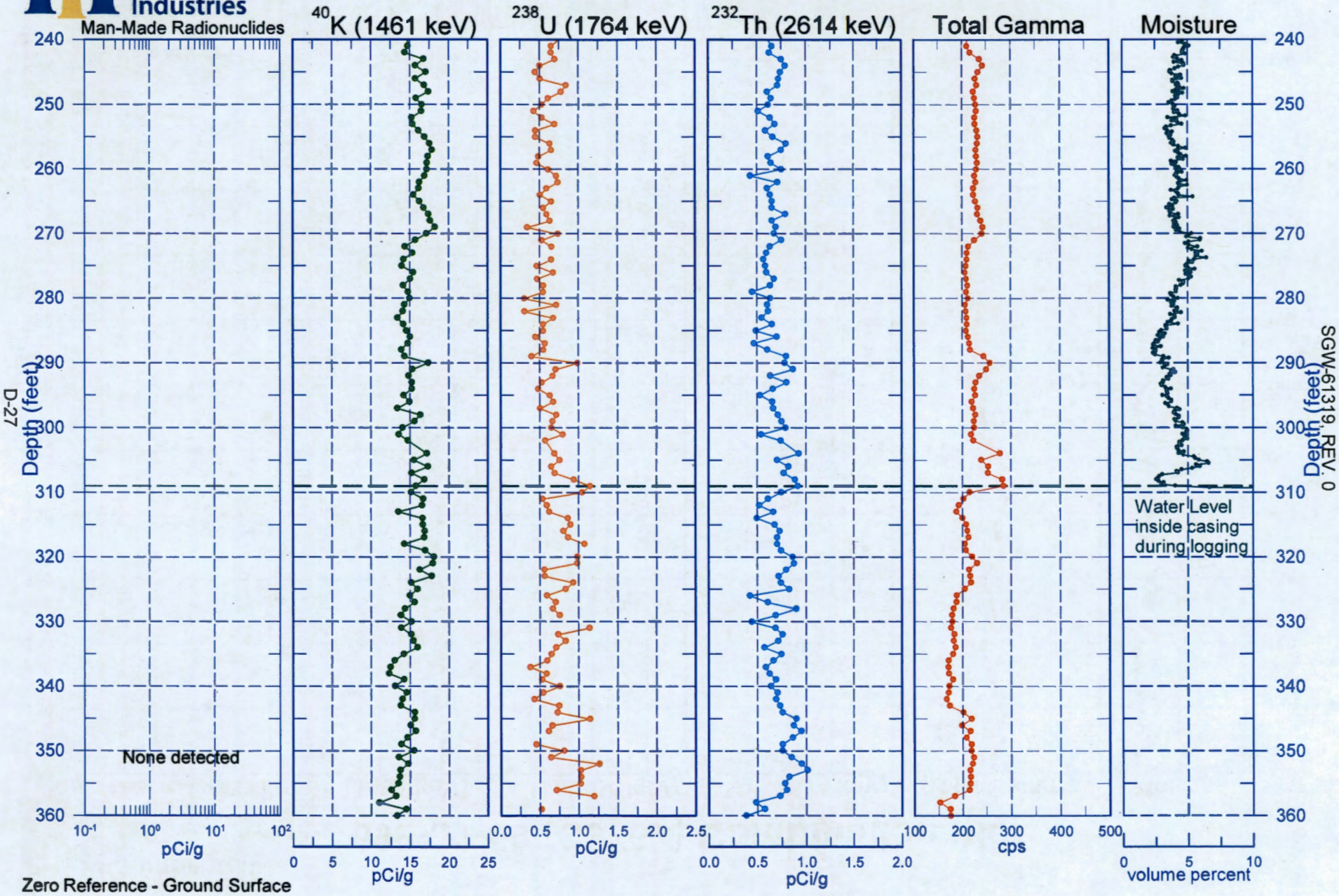


Huntington Ingalls Industries

699-31-50 (C9737) Combination Plot

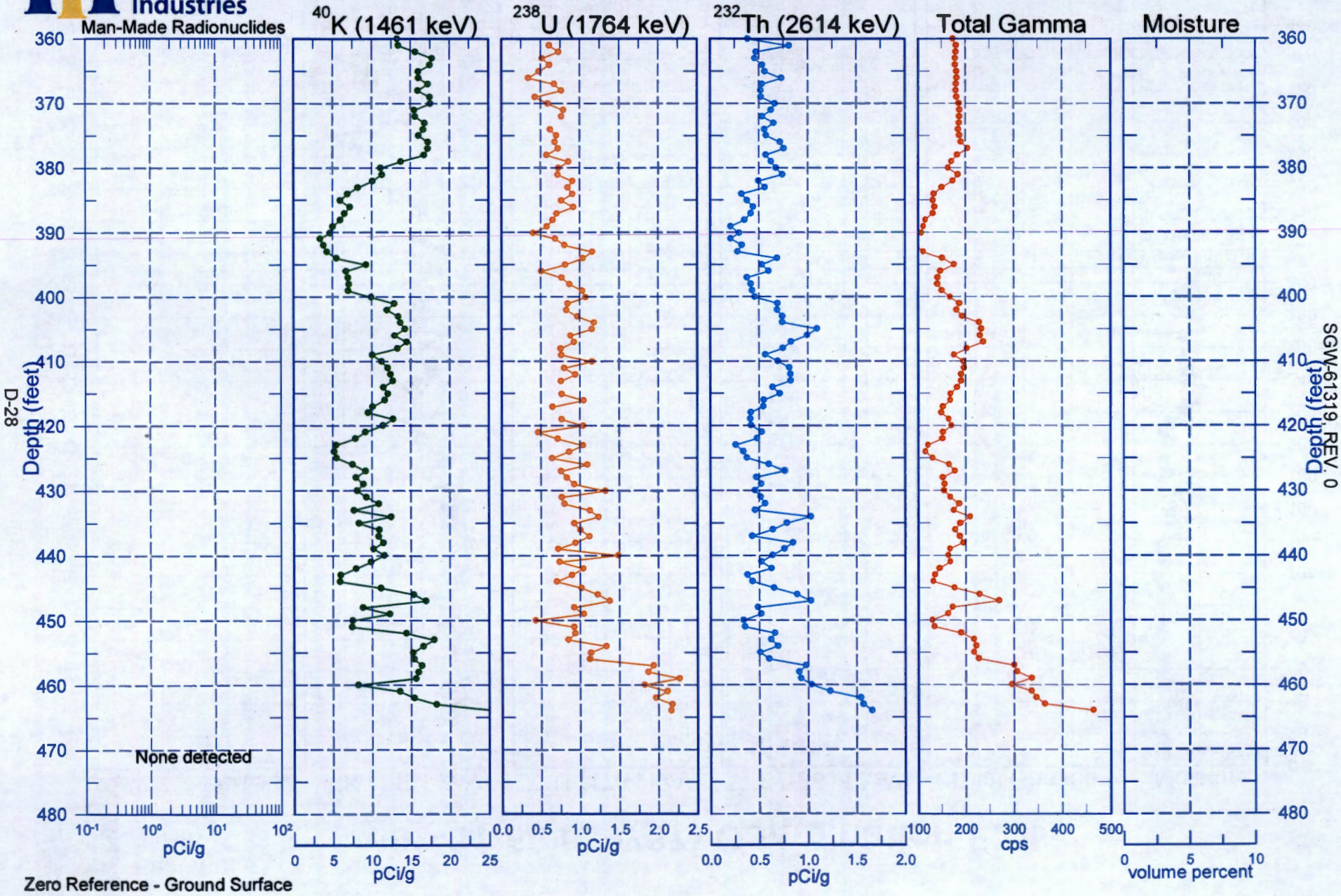


699-31-50 (C9737) Combination Plot



Huntington Ingalls Industries

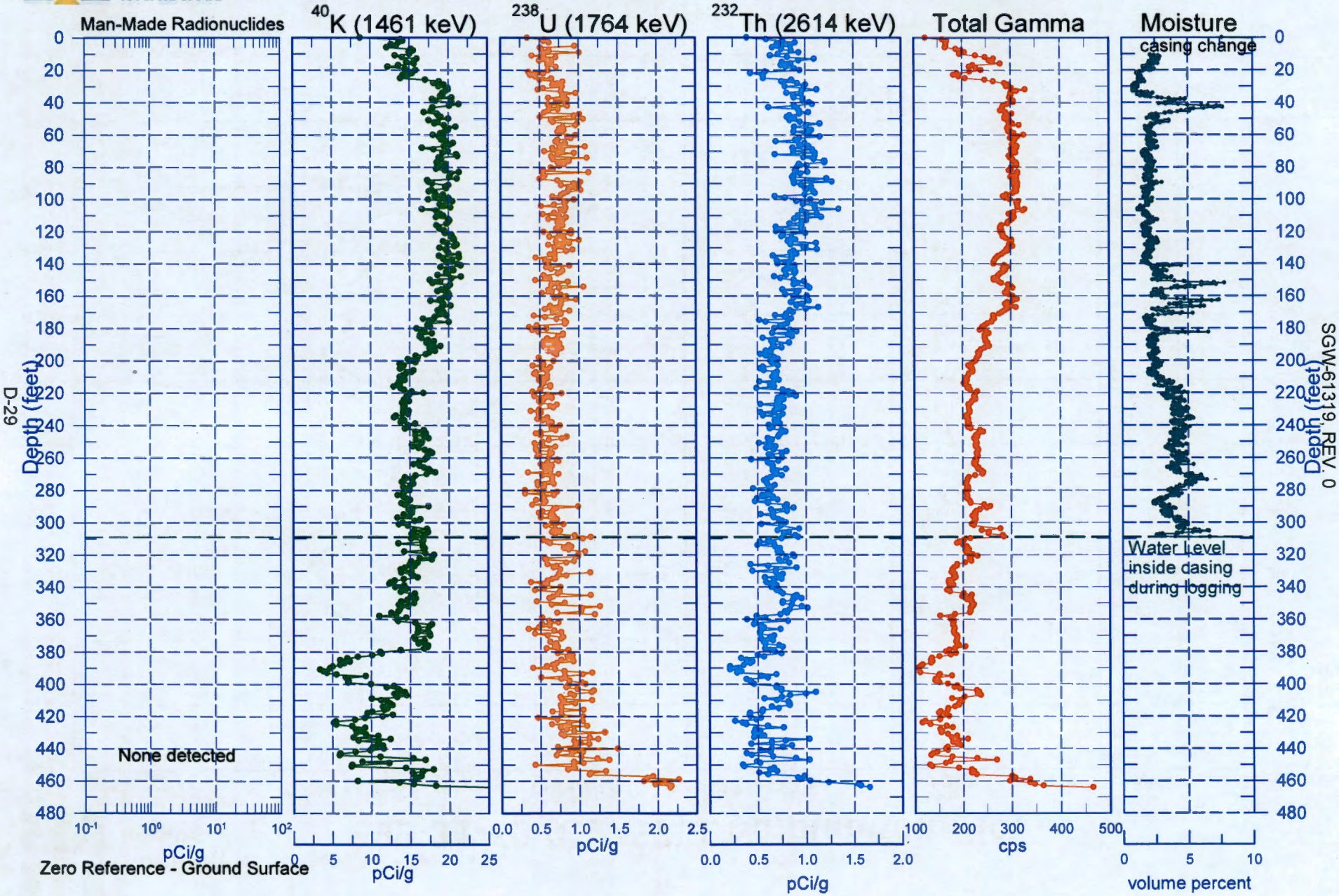
699-31-50 (C9737) Combination Plot



Zero Reference - Ground Surface

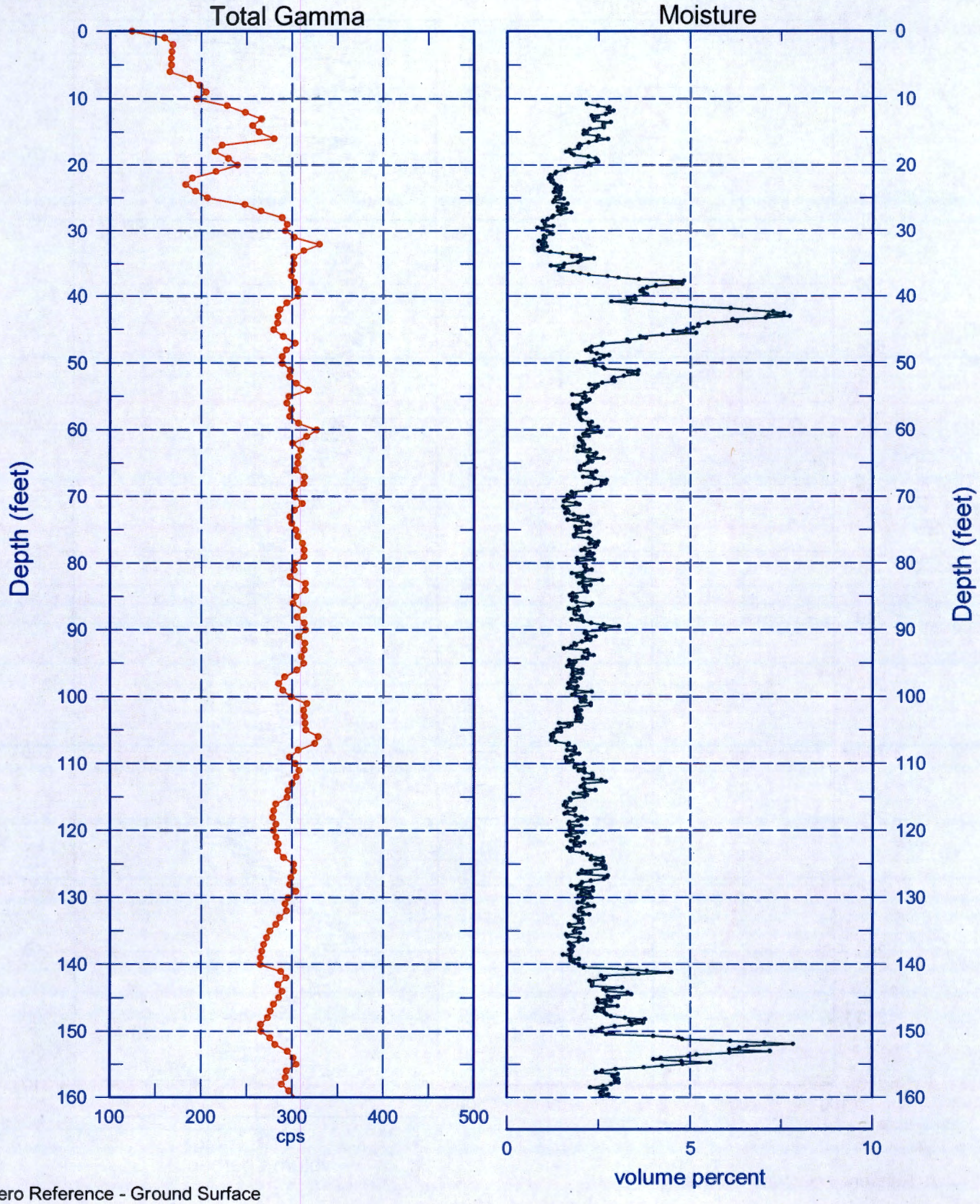
Huntington Ingalls Industries

699-31-50 (C9737) Combination Plot



Huntington Ingalls Industries

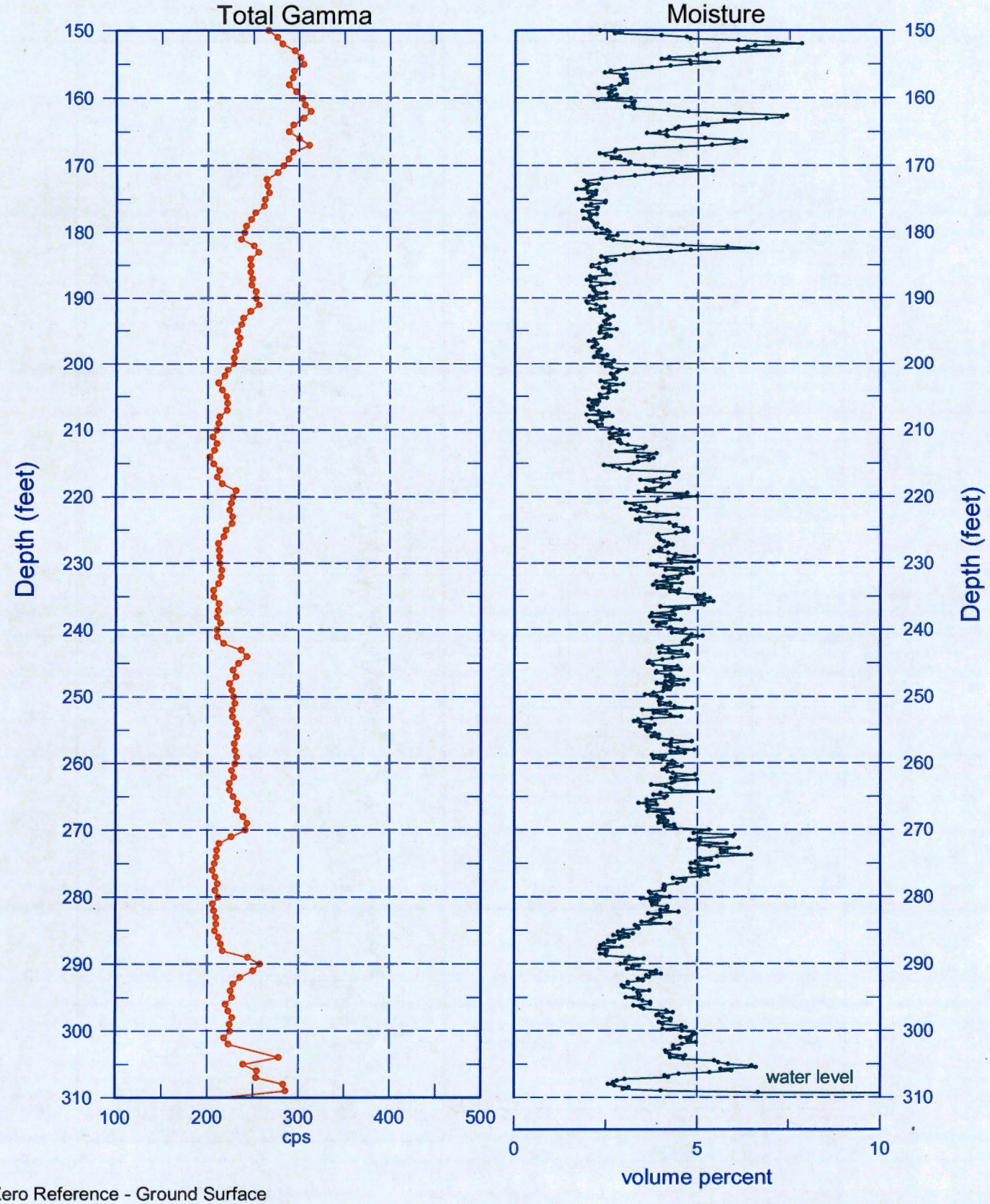
699-31-50 (C9737)
Total Gamma & Moisture



Zero Reference - Ground Surface

Huntington Ingalls Industries

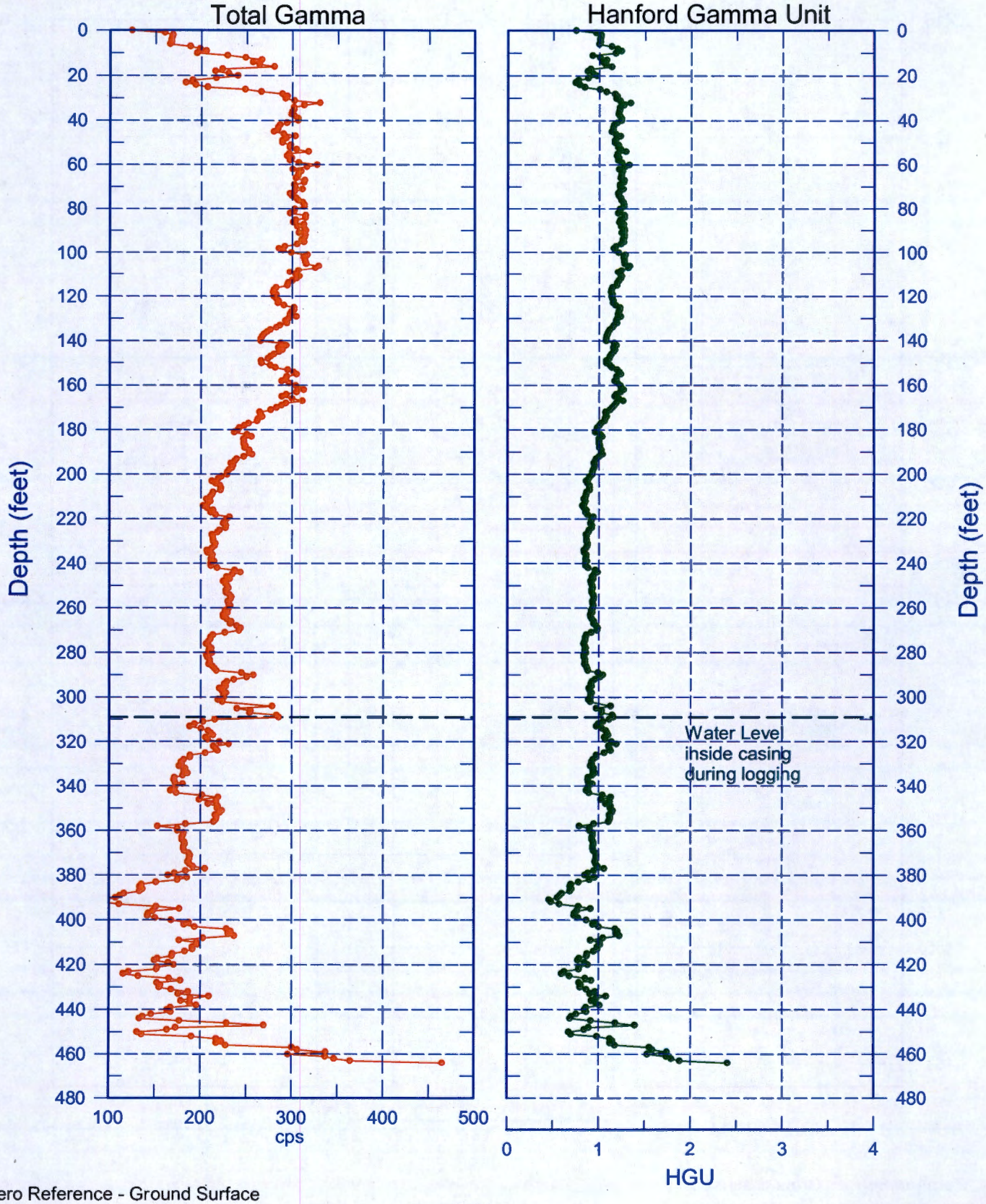
699-31-50 (C9737)
Total Gamma & Moisture



Zero Reference - Ground Surface

Huntington Ingalls Industries

699-31-50 (C9737)
Total Gamma & Hanford Gamma Unit

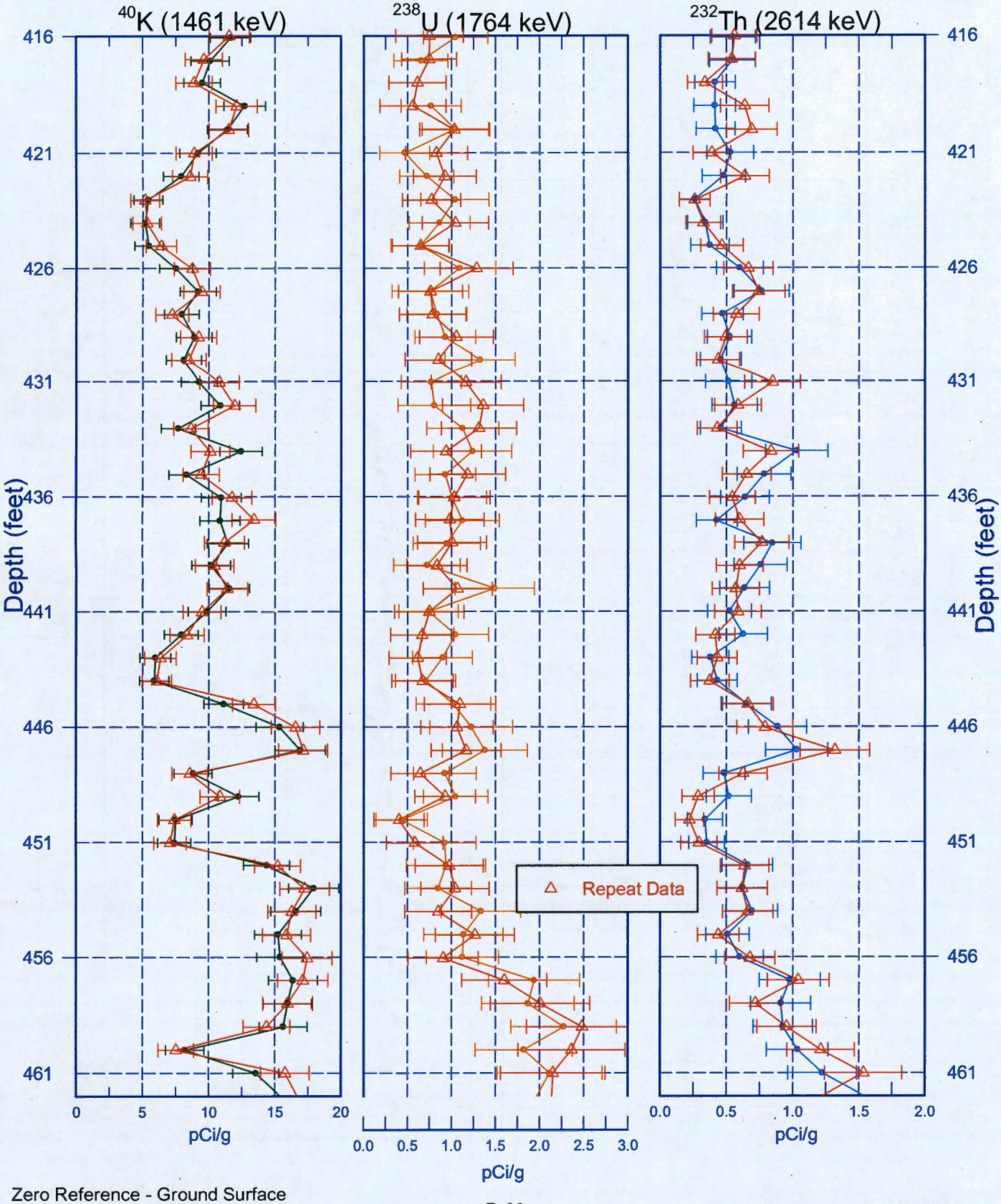


Zero Reference - Ground Surface

Huntington Ingalls Industries

699-31-50 (C9737)

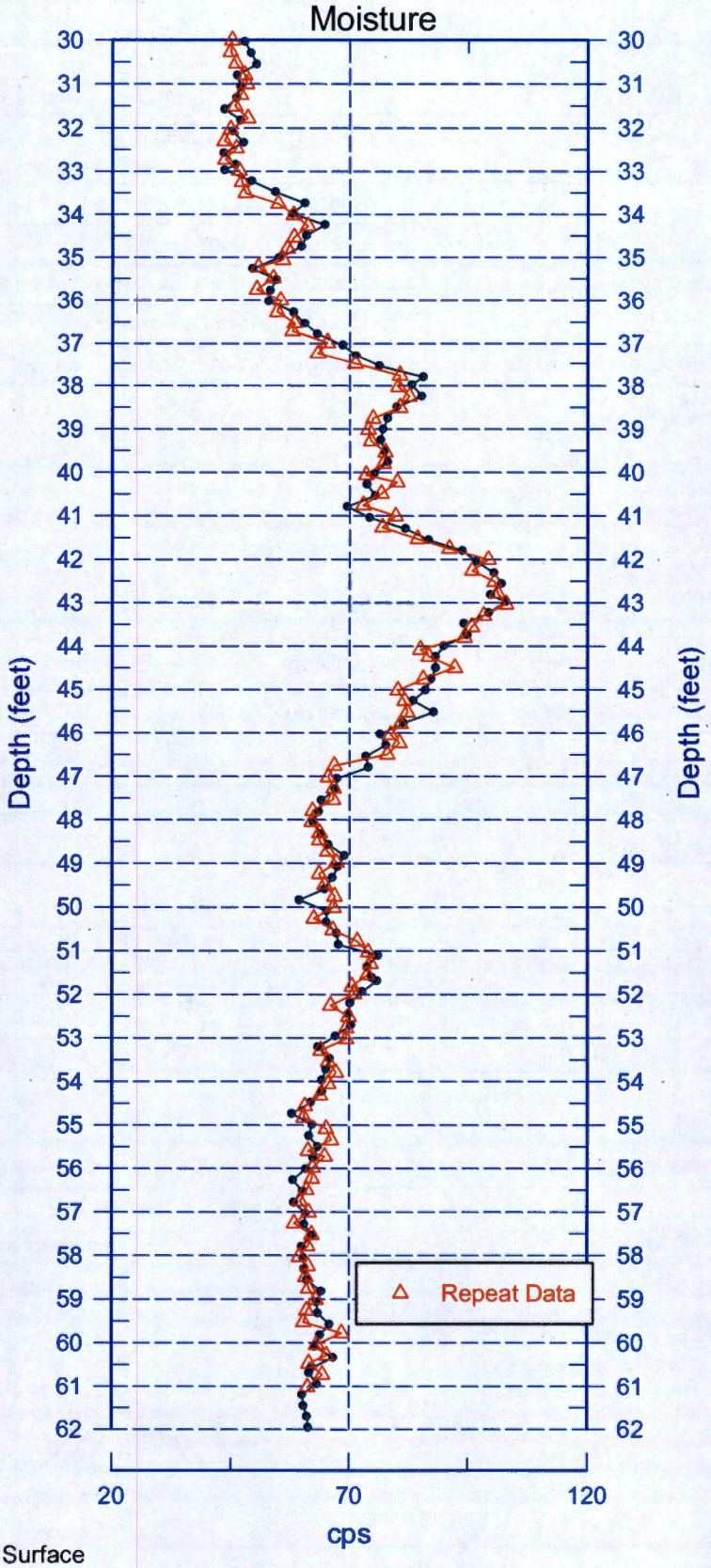
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Huntington Ingalls Industries

699-31-50 (C9737)
Moisture Repeat Section



Zero Reference - Ground Surface

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 11/02/17	Requestor: Matthan G. Wilson (CHPRC)
Date of Survey: 11/29/17	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of UP-1 Well C9737 (699-31-50) located on southeast side of BC Controlled Area, south of 200E Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:

Washington State Reference Network

Vertical Control Monuments:

HSWB-074 (COE) and HSWB-075 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9737	699-31-50	574751.16	132959.20		Center of Casing
				216.737	Top Inner 4"SS Casing, N.Edge
				217.032	Top Outer Casing,N.Edge Stamped "X"
				216.222	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:

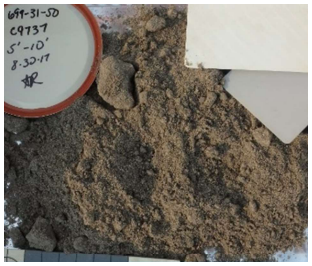
I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
11-29-17

This page intentionally left blank.

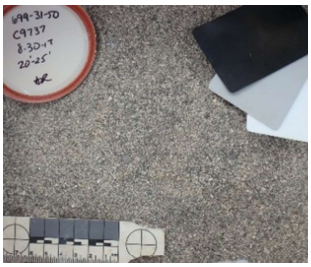
Photo Log

0-5 bgs

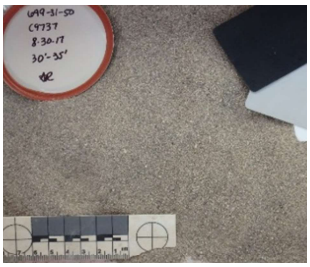

5-10 bgs

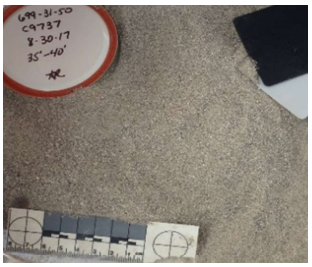
10-15 bgs

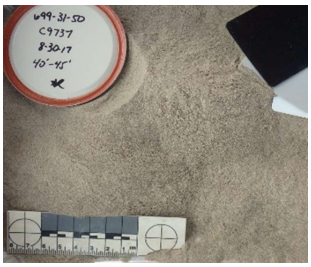
15-20 bgs


20-25 bgs

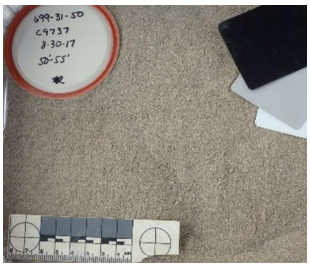
25-30 bgs


30-35 bgs


35-40 bgs

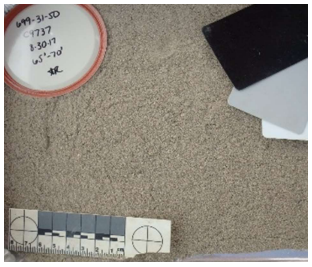

40-45 bgs

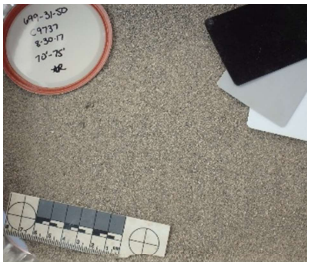
45-50 bgs

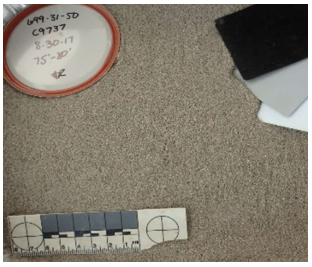

50-55 bgs

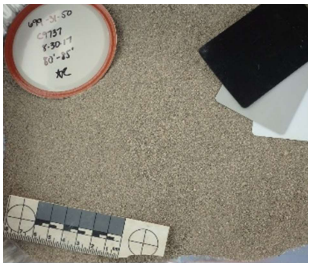
55-60 bgs

60-65 bgs


65-70 bgs

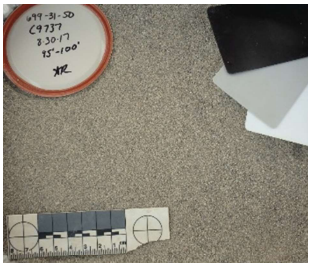

70-75 bgs


75-80 bgs


80-85 bgs

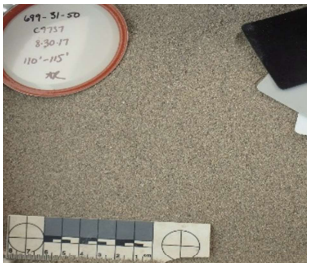
85-90 bgs

90-95 bgs


95-100 bgs

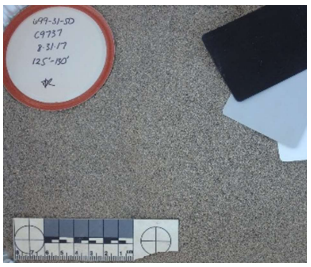
100-105 bgs

105-110 bgs


110-115 bgs

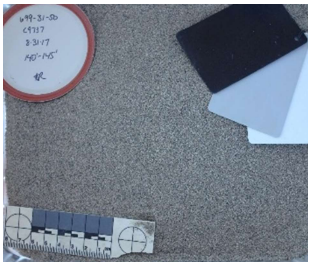
115-120 bgs

120-125 bgs


125-130 bgs

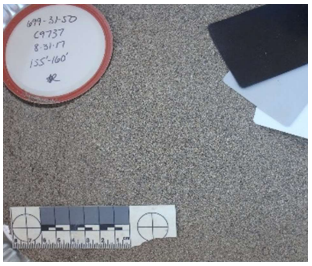
130-135 bgs

135-140 bgs


140-145 bgs

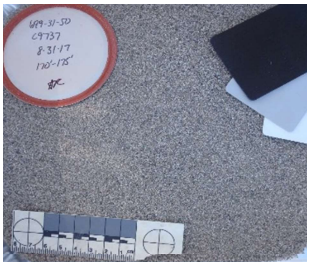
145-150 bgs

150-155 bgs

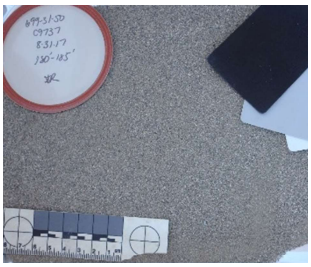

155-160 bgs

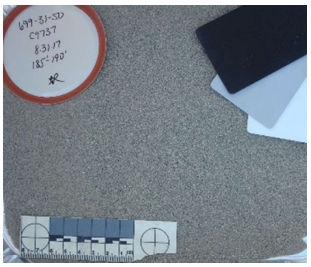
160-165 bgs

165-170 bgs


170-175 bgs

175-180 bgs


180-185 bgs


185-190 bgs

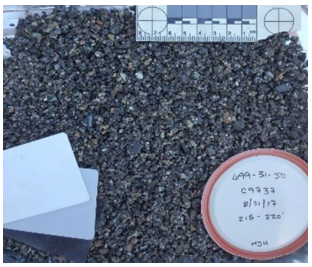
190-195 bgs

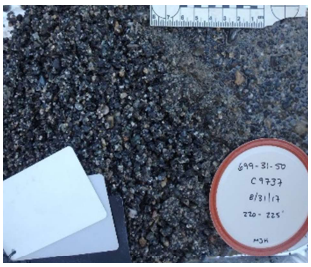
195-200 bgs

200-205 bgs

205-210 bgs

210-215 bgs


215-220 bgs

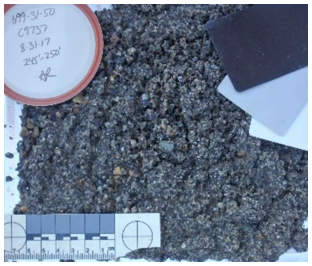

220-225 bgs

225-230 bgs

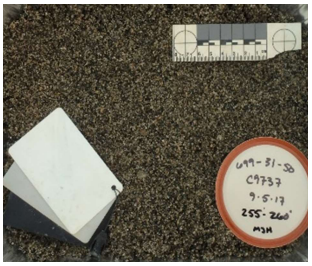
230-235 bgs

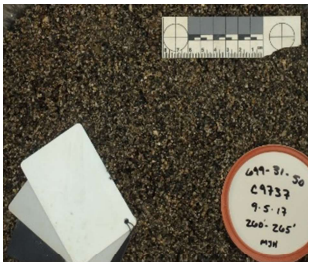
235-240 bgs

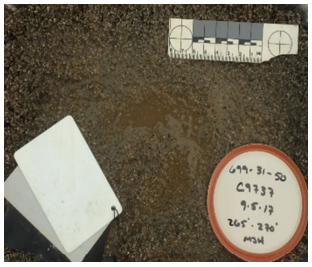
240-245 bgs

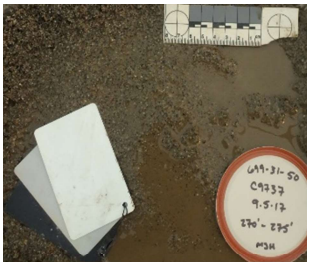

245-250 bgs

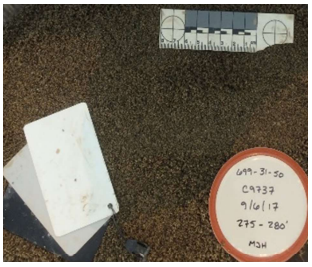
250-255 bgs

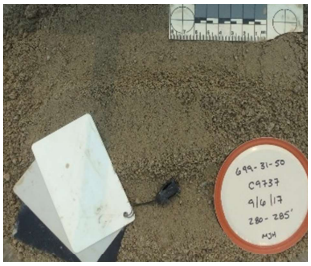

255-260 bgs

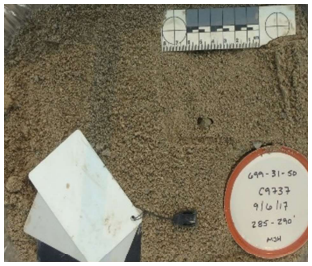

260-265 bgs


265-270 bgs


270-275 bgs

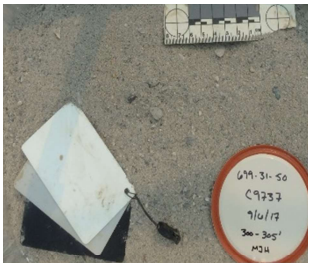

275-280 bgs


280-285 bgs


285-290 bgs

290-295 bgs

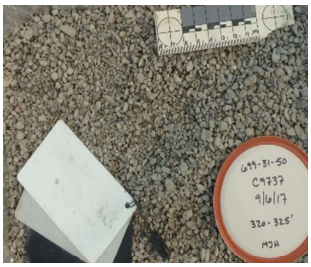
295-300 bgs


300-305 bgs

305-310 bgs

310-315 bgs

315-320 bgs


320-325 bgs

325-330 bgs

330-335 bgs

335-340 bgs

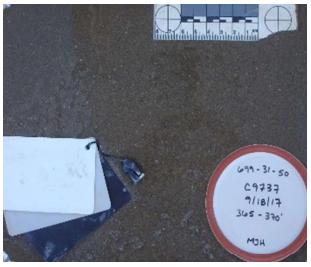
340-345 bgs

345-350 bgs

350-355 bgs

355-360 bgs

360-365 bgs


365-370 bgs

370-375 bgs

375-380 bgs

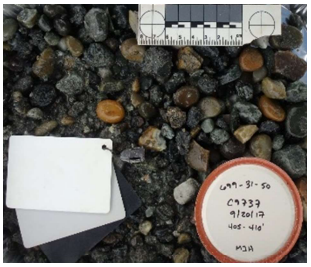
380-385 bgs

385-390 bgs

390-395 bgs

395-400 bgs

400-405 bgs



405-410 bgs

410-415 bgs

415-420 bgs

420-425 bgs

425-430 bgs

430-435 bgs

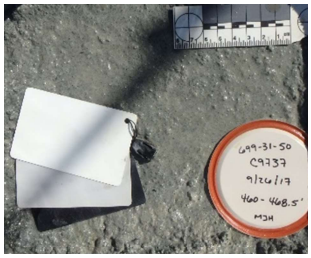
435-440 bgs

440-445 bgs

445-450 bgs

450-455 bgs

455-460 bgs



460-465 bgs

This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9737 | Well Name: 699-31-50 | Date: 11.8.17

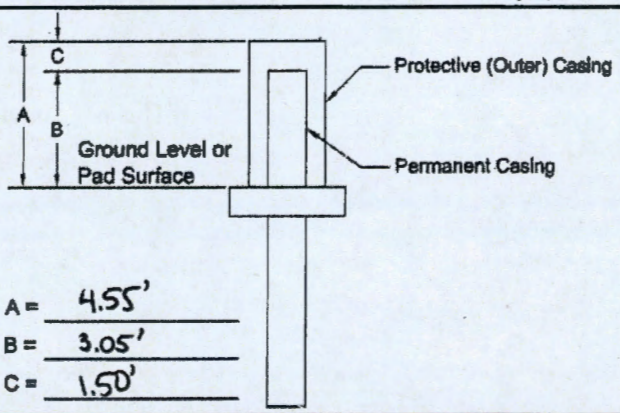
Location: ~2mi SE of Ecology

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: 11.8.17	209.25	N/A
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 11.8.17	397.1'	N/A
Date: —	—	—



A = 4.55'
B = 3.05'
C = 1.50'

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)
76.52	45.5	75.12	81.9	2.67	0915	1357	10	0.22

Total Pumped: 2820 gallons

Pump Model: Grundfos X Model D P2 1729

Troll Serial Number and Pressure Range (PSI and depth): 403065 70m

Comments:

Interval 1: C9737_dev_int1_11-8-2017 (no space; AR 11.8.17)

C9737_dev int2_11-8-2017

* Development performed during well construction. KW 12/7/17

continued on 2nd page

Prepared By:

Andrew Raulerson (Print Name) | Signature | 11.8.17 (Date)

Reviewed By:

Kelly Whitley (Print Name) | Signature | 12/7/17 (Date)

For Office Use Only

OR Doc Type: | WMU Code(s):

A-6005-205 (REV 2)

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9737	Well Name: 699-31-50	Date: 11-9-17

Location: 2 miles SE of Ecology

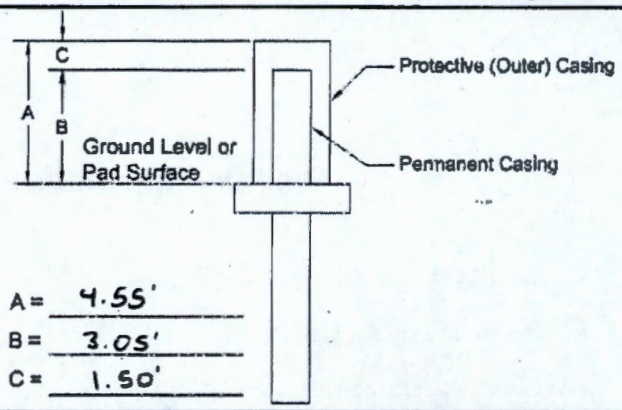
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 11-9-17	309.6	309.6
Date:		
DEPTH TO BOTTOM:		
Date: 11-9-17	397.1	397.1
Date:		



A = 4.55'
B = 3.05'
C = 1.50'

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)
365.77	14.6	56.17	4.96	2.81	0700	0740	9.9	0.68
325.70	11.8	16.15	98.1	3.27	0825	1152	10	0.85

Total Pumped: 2,986 gallons

Pump Model: Grundfos X Model D P2 1729

Troll Serial Number and Pressure Range (PSI and depth): SN:403065 Depth:70m/231ft

Comments:

Interval 2 continuation from 11-8-17 (365.77)

Test: C9737 _ dev 2 cont. _ 368.7
C9737 _ dev 3 _ 325.7

* Development performed during well ~~development~~ construction. KW 12/7/17

Prepared By:

James Patterson — *Print Name*
James Patterson — *Signature*
11-9-17 — *Date*

Reviewed By:

Kelly Whitley — *Print Name*
Kelly Whitley — *Signature*
12/7/17 — *Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6005-205 (REV 2)

Appendix E

Well Documentation for 699-30-73 (C9636)

- Well Summary Sheet for C9636
- Borehole Log for C9636
- Geophysical Log Data Report for C9636
- Final Survey Report for C9636
- Photo Log for C9636
- Well Development and Testing Data Sheet for C9636

This page intentionally left blank.

WELL SUMMARY SHEET

Well ID: C9636	Well Name: 699-30-73	Start Date: 10/11/2017
Project: 200 UP-1	Location: 0.75 mi N of Rattlesnake Gate	End Date: 12/6/2017

CONSTRUCTION DATA

Description

WA Dept. of Ecology Tag: BKG 065

Surface Construction:

4' x 4' x 6" Concrete Pad with brass survey marker and protective monument (2.00' ags)

Temporary Casing Depth:

8" C.S. Wld. Joints = 399.76 ft bgs

Permanent Well Materials:

4" ID SS Riser

2.00 ft ags - 229.09 ft bgs

(Continued on page 2)

Well Completion Materials:

Cement Grout

0.00 ft bgs - 8.40 ft bgs

Bentonite Chips

8.40 ft bgs - 13.00 ft bgs

Bentonite Slurry

13.00 ft bgs - 219.95 ft bgs

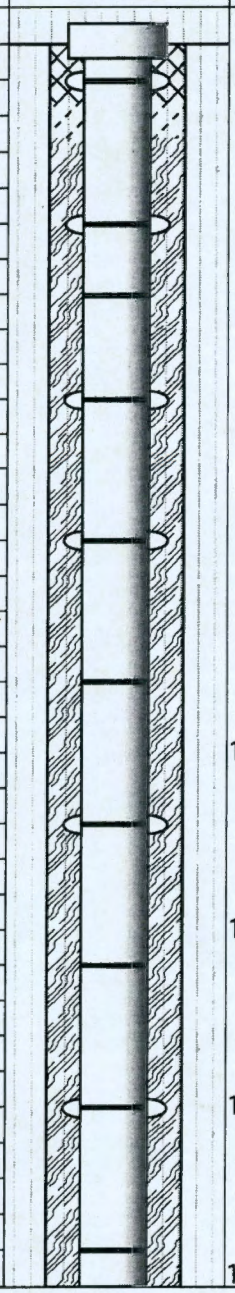
(Continued on page 2)

All 8" temporary casing completely removed from ground

ags - above ground surface

bgs - below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 25, 50, 75, 100, 125, 150, 175

Graphic Log

Lithologic Description (ft bgs)

0 - 30 ft: Slightly Silty Sand [(m)S]

30 - 50 ft: Sand [S]

50 - 140 ft: Slightly Silty Sand [(m)S]

140 - 165 ft: Silty Sand [mS]

165 - 195 ft: Sandy Gravel [sG]

Reported By:			
Andrew Raulerson	Staff Geologist	[signature]	12/11/2017
Print Name	*Title*	*Signature*	*Date*

Reviewed By:			
Kelly Whitley	Well Coordinator	Kelly Whitley	12/20/17
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

WELL SUMMARY SHEET

Well ID: C9636	Well Name: 699-30-73	Start Date: 10/11/2017
Project: 200 UP-1	Location: 0.75 mi N of Rattlesnake Gate	End Date: 12/6/2017

CONSTRUCTION DATA

Description

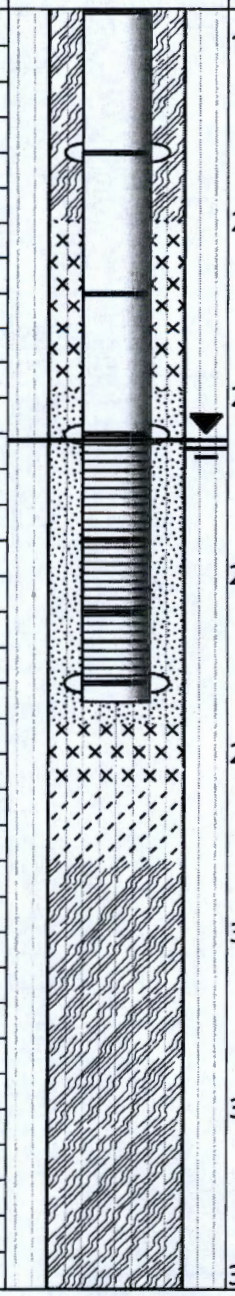
WA Dept. of Ecology Tag: BKG 065

Permanent Well Materials:
4" ID SS Riser
2.00 ft ags - 229.09 ft bgs
4" ID Stainless Steel 20-slot screen
229.09 ft bgs - 264.83 ft bgs
4" ID Stainless Steel sump
264.83 ft bgs - 267.83 ft bgs

Well Completion Materials:
(Continued from page 2)
Bentonite Slurry
13.00 ft bgs - 219.95 ft bgs
Bentonite Pellets
219.95 ft bgs - 224.15 ft bgs
10-20 Silica Sand
224.15 ft bgs - 267.50 ft bgs
8-16 Silica Sand
267.50 ft bgs - 271.39 ft bgs
Bentonite Pellets
271.39 ft bgs - 280.25 ft bgs
Bentonite Chips
280.25 ft bgs - 290.75 ft bgs
Bentonite Slurry
290.75 ft bgs - 300.00 ft bgs
Bentonite Pellets
300.00 ft bgs - 300.00 ft bgs
Bentonite Slurry
300.00 ft bgs - 402.30 ft bgs
(Continued on page 3)

All 8" temporary casing completely removed from ground
ags - above ground surface
bgs - below ground surface

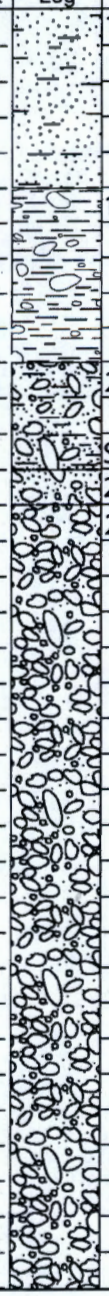
Diagram



Depth in Feet: 175, 200, 225, 250, 275, 300, 325, 350

GEOLOGIC/HYDROLOGIC DATA

Graphic Log



Lithologic Description (ft bgs)

165 - 195 ft: Sandy Gravel [sG]
195 - 220 ft: Gravelly Silt [gM]
220 - 235 ft: Silty Sandy Gravel [msG]
Static water level at 230.94 (12/6/2017)
235 - 240 ft: Sandy Gravel [sG]
240 - 390 ft: Gravel [G]

Reported By:			
Andrew Raulerson	Staff Geologist	[signature]	12/11/2017
Print Name	*Title*	*Signature*	*Date*

Reviewed By:			
Kelly Whitley	Well Coordinator	Kelly Whitley	12/20/17
Print Name	*Title*	*Signature*	*Date*

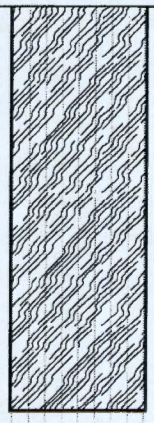
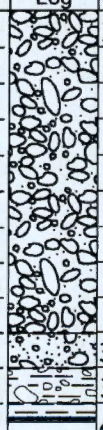
For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

WELL SUMMARY SHEET

Well ID: C9636	Well Name: 699-30-73	Start Date: 10/11/2017
Project: 200 UP-1	Location: 0.75 mi N of Rattlesnake Gate	End Date: 12/6/2017

CONSTRUCTION DATA			GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
WA Dept. of Ecology Tag: BKG 065		350		240 - 390 ft: Gravel [G]
Well Completion Materials:				
(Continued from page 2)				
Bentonite Slurry				
300.00 ft bgs - 402.30 ft bgs		375		
				390 - 395 ft: Sandy Gravel [sG]
				395 - 400 ft: Silty Gravel [mG]
		400		400 - 402.3 ft: Silt [M]
				TD = 402.30 ft bgs
All 8" temporary casing completely removed from ground				
bgs - below ground surface				

Reported By:			
Andrew Raulerson	Staff Geologist		12/11/2017
Print Name	*Title*	*Signature*	*Date*
Reviewed By:			
Kelly Whitley	Well Coordinator	Kelly Whitley	12/20/17
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 11
Date: 10.11.17

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75 mi N of Rattlesnake Gate
Project: 200-UP-1 | 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'– 30' : Slightly Silty Sand ((m)S)	Dual Air Rotary Rig w/
0			0'-5': 15% silt, 85% v.fn.-fn. sand (70%m/30% f); well sorted, sub.ang.-sub.rnd., slightly moist, violent HCl rxn, 10YR 4/2 Dark greyish brown.	8" casing + 7" tri cone Hanford formation: ground surface to ~220'
5	G.S.		5'-10': 11% silt, 89% v.fn.-med. sand (40%m/60%f); well sorted, dry, no HCl rxn, 10YR 5/2 Greyish Brown, rest same as above (SAA).	Archived @ 5' Archived @ 10'
10	G.S.		10'-15': 15% silt, 84% vfn.-med. sand (30%m/70%f), 1% v.fn.-fn. pebbles (max 5mm); mild HCl rxn, rest SAA.	Archived @ 15'
15	G.S.		15'-20': 15% silt, 85% vfn.-med. sand (40%m/60%f); no HCl rxn, rest SAA.	Archived @ 20'
20	G.S.		20'-25': 15% silt, 85% vfn.-crs. sand (45%m/55%f); SAA.	Archived @ 25'
25	G.S.		25'-30': 20% silt, 80% v.fn.-v.crs. sand (40%m/60%f); SAA	Archived @ 30'
30	G.S.		30'– 50' : Sand (S) 30'-35': 3% silt, 95% crs.-v.crs. sand (65%m/35%f), 2% v.fn. pebbles (max 4mm); well sorted, sub. ang.-sub. rnd., dry, no HCl rxn, 10YR 4/1 Dark gray	Archived @ 35'

Reported By: Andrew Rauterson (Print Name) | Staff Geologist (Title) | [signature] (Signature) | 10.11.17 (Date)

Reviewed By: Sarah Springer (Print Name) | geologist (PG) (Title) | [signature] (Signature) | 10-30-17 (Date)

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Date: 10·11·17

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75 mi N of Rattlesnake Gate

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.		30'-50': Sand (S)	Dual Air Rotary Rig w/ 8" casing + 7" tricone
			35'-40': 2% silt, 96% crs.-v.crs. sand (60%m/40%f), 2% v.fn.-crs. pebbles (max 24mm); mod. sorted, sub. ang.-sub. rnd., dry, no HCl rxn, 10YR 4/1 Dark gray.	Archived @ 40'
40	G.S.		40'-45': 2% silt, 93% crs.-v.crs. sand (60%m/40%f), 5% v.fn.-v.crs. pebbles (max 34mm); SAA. (same as above)	Archived @ 45'
45	G.S.		45'-50': 8% silt, 92% sand v.fn.-crs (40%m/60%f); well sorted, 10YR 5/2 Grayish brown, rest SAA.	Archived @ 50'
50	G.S.		50' - 140': Slightly Silty Sand [(m)S]	
			50'-55': 15% silt, 85% v.fn.-med. sand (30%m/60%f); well sorted, sub.ang.-sub.rnd, dry, no HCl rxn, 10YR 5/2 Grayish brown.	Archived @ 55'
55	G.S.		55'-60': 11% silt, 89% v.fn.-v.crs sand (50%m/50%f); 10YR 5/1 Gray, rest SAA.	Archived @ 60'
60	G.S.		60'-65': 16% silt, 84% v.fn.-fn. sand (30%m/70%f); weak HCl rxn, 10YR 5/3 Brown, rest SAA.	Archived @ 65'
65	G.S.		65'-70': 13% silt, 87% v.fn.-med. sand (40%m/60%f); all SAA.	Archived @ 70'
70	G.S.		70'-75': 20% silt, 80% v.fn. sand (50%m/50%f); all SAA.	Archived @ 75'

Reported By:

Print Name	Title	Signature	Date
Andrew Rauderson	Staff Geologist	[signature]	10·11·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10·11·17

Well ID: C9636 | Well Name: 699-3D-73 | Location: 0.75 mi N of Rattlesnake Gate

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.		50' - 140' : Slightly Silty Sand [(m) SZ] 75'-80': 18% silt, 82% v.fn.-fn. sand (45% m / 55% f); well sorted, sub. ang. - sub. rnd., dry, no HCl rxn, 10 YR 5/2 Grayish brown.	Dual Air Rotary Rig w/ 8" casing + 7" tricone Archived @ 80'
80	G.S.		80'-85': 20% silt, 80% v.fn. sand (50% m / 50% f); all same as above (SAA).	Archived @ 85'
85	G.S.		85'-90': 11% silt, 89% v.fn.-crs. sand (40% m / 60% f); all SAA.	Archived @ 90'
90	G.S.		90'-95': 20% silt, 80% v.fn. sand (50% m / 50% f); SAA.	Archived @ 95'
95	G.S.		95'-100': 11% silt 89% v.fn.-med. sand (40% m / 60% f); 10 YR 5/3 Brown, rest SAA.	Archived @ 100'
100	G.S.		100'-105': 15% silt, 85% v.fn.-fn. sand (40% m / 60% f); all SAA.	Archived @ 105'
105	G.S.		105'-110': 16% silt, 84% v.fn.-med. sand (50% m / 50% f); all SAA.	Archived @ 110'
110	G.S.		110'-115': 11% silt, 89% v.fn.-med. sand (50% m / 50% f); all SAA.	Archived @ 115'

Reported By:

Print Name	Title	Signature	Date
Andrew Rauterson	Staff Geologist	[signature]	10·11·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10.12.17

Well ID: C9634 | Well Name: 699-30-73 | Location: 0.15 mi N of Rattlesnake Gate

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.		50' - 140' : Slightly Silty Sand [(m)S]	Dual Air Rotary Rig w/
			115'-120': 11% silt, 89% v.fn.- med. sand (55% m/45% f); well sorted, sub. ang. - sub. rnd., dry, no HCl rxn, 10YR 5/2 grayish brown.	8" casing & 7" tricone Archived @ 120'
120	G.S.		120'-125': 11% silt, 89% v.fn.- med. sand (45% m/55% f); all same as above (SAA).	Archived @ 125'
125	G.S.		125'-130': 11% silt, 89% v.fn.- crs. sand (60% m/40% f); all SAA.	Archived @ 130'
130	G.S.		130'-135': 20% silt, 80% v.fn- fn. sand (50% m/50% f); very high HCl rxn, 10YR 4/3 Brown, rest SAA.	Archived @ 135'
135	G.S.		135'-140': 11% silt, 89% v.fn.- med. sand (50% m/50% f); no HCl rxn, 10YR 5/2 Grayish brown, rest, SAA.	Archived @ 140'
140	G.S.		140' - 165': Silty Sand (mS)	
			140'-145': 25% silt, 75% v.fn.- med. sand (40% m/60% f); well sorted, sub. ang. - sub. rnd., dry, no HCl rxn, 10YR 5/2 Grayish brown.	Archived @ 145'
145	G.S.		145'-150': ~~30S~~ AR 10.12.17 35% silt, 65% v.fn.-fn. sand; mild HCl rxn, rest SAA. 10YR 4/3 Brown.	Archived @ 150'
150	G.S.		150'-155': 35% silt, 65% v.fn. sand; violent HCl rxn, 10YR 4/4 Dark yellowish brown, rest SAA.	Archived @ 155'

Reported By: Andrew Ramlersin (Print Name) | Staff Geologist (Title) | [signature] (Signature) | 10.12.17 (Date)

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10·12·17

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75mi N of Rattlesnake Barricade

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.		140'-165': Silty Sand (mS)	Dual Air Rotary Rig w/ 8" casing & 7" tricone
			155'-160': 40% silt, 60% v.fn. sand; well sorted, sub.rnd.-sub.ang., dry, violent HCl rxn, 10YR 6/3 pale brown.	Archived @ 160'
100	G.S.		160'-165': 35% silt, 60% v.fn. sand, 5% coarse pebbles (max 25mm) (50%m/50%f); poorly sorted, 10YR 5/3 brown. rest SAA	Archived @ 165'
165	G.S.		165'-195': Sandy Gravel (sG)	
			165'-170': 10% silt, 50% v.fn.-v.crs. sand (65% m/35%f), 40% v.fn.-crs. pebbles (max 20mm; 60%m/40%f); poorly sorted, sub.rnd.-ang., dry, violent HCl rxn, 10YR 5/3 brown.	Archived @ 170'
170	G.S.		170'-175': 5% silt, 65% v.fn.-crs sand (60%m/40%f), 30% v.fn.-crs. pebbles (max 28mm) (50%m/50%f); 10YR 4/2 Dark grayish brown, rest SAA.	Archived @ 175'
175	G.S.		175'-180': 5% silt, 50% v.fn.-crs sand (60% m/40%f), 45% v.fn.-crs. pebbles (max 25 mm; 50%m/50%f); same as above.	Archived @ 180'
180	G.S.		180'-185': 5% silt, 55% v.fn.-crs. sand (60%m/40%f), 40% v.fn.-crs. pebbles (max 27mm; 50%m/50%f); 10YR 3/3 Dark brown. Rest SAA.	Archived @ 185'
185	G.S.		185'-190': 5% silt, 50% v.fn.-v.crs. sand (60%m/40%f), 45% v.fn.-crs. pebbles (max 22mm); same as above.	Archived @ 190'
190	G.S.		190'-195': 2% silt, 53% v.fn.-v.crs. sand (75%m/25%f), 45% v.fn.-crs. pebbles (max 20mm; 70%m/30%f); no HCl rxn, same as above 10YR 3/2 very dark grayish brown	Archived @ 195'

Reported By:

Print Name	Title	Signature	Date
Andrew Rawlerson	Staff Geologist	[signature]	10·12·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10.12.17

Well ID: C9634 | Well Name: 699-30-73 | Location: 0.75 mi N of Rattlesnake Gate

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.		~~145' : Sandy Gravel (sG)~~ AR 10.12.17	Dual Air Rotary rig w/ 8"
			~~145'-200'~~ AR 10.12.17	casing + 7" tricone
			195'-220' : Gravelly silt (gM)	
			195'-200' : 75% silt, 5% v.fn. sand, 20% med.-crs.	Archived @ 200'
			pebbles (max 16mm; 50%m/50%f); poorly sorted,	
200	G.S.		sub.rnd.-sub.ang., dumpy (so low-med. moisture),	
			no HCl rxn, 10YR 5/4 yellowish brown.	
			200'-205' : 80% silt, 5% v.fn. sand, 15% med.	Archived @ 205'
			pebbles (max 14mm; 50%m/50%f); same as	
			above SAA.	
205	G.S.			
			205'-210' : 80% silt, 5% v.fn. sand, 15%	Archived @ 210'
			med.-crs. pebbles (max 30mm; 50%m/50%f);	
			SAA	
210	G.S.			
			210'-215' : 85% silt, 5% v.fn. sand, 10%	Archived @ 215'
			fn.-med. pebbles (max 8mm); 10YR 4/4 AR 10.12.17	
			4/3 brown, SAA.	
215	G.S.			
			215'-220' : 80% silt, 5% v.fn. sand, 15%	Archived @ 220'
			v.fn.-fn. pebbles (max 8mm); Same as	
			above.	
220	G.S.		220'-235' : Silty Sandy Gravel (msG)	
			220'-225' : 15% silt, 50% v.fn.-v.crs. sand	Archived @ 225'
			(35%m/65%f), 35% v.fn.-crs. pebbles	Ringold unit E: ~220' to
			(max 21mm; 60%m/40%f); poorly sorted,	~397'
			sub.rnd.-ang., dry, no HCl rxn, 10YR 5/2	
225	G.S.		Grayish brown.	
			225'-230' : 12% silt, 48% v.fn.-v.crs. sand	Archived @ 230'
			(35%m/65%f), 40% v.fn.-crs. pebbles (max	
			18mm; 75%m/25%f); SAA.	
230	G.S.			Water @ 229.91' bgs
			230'-235' : 11% silt, 59% fn.-v.crs. sand (50%m/	Archived @ 235'
			50%f), 30% v.fn.-crs. pebbles (max 17mm; 70%m/	
			30%f); 10YR 4/2 dark grayish brown, rest, SAA.	

Reported By: Andrew Rauterson (Print Name) | Staff Geologist (Title) | [signature] (Signature) | 10.16.17 (Date)

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10·16·17

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75 mi N of Rattlesnake Gate

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
235	G.S.		235'– 240': Sandy Gravel (SG)	Dual Air Rotary Rig w/ 8"
			235'-240': 5% silt, 55% v.fn.-v.crs. sand (65%m | 35%f), 40% v.fn.-crs. pebbles (max 16mm; 70% m | 30% f); poorly sorted, subrnd.-ang., dry, no HCl rxn, 10YR 4/2 dark grayish brown.	casing & 7" tricone
				Archived @ 240'
240	G.S.		240'– 390': Gravel (G)	I-001: Sleeve A (240.90'-241.40')
	SS W.S.		240'-245': 1% silt, 15% v.fn.-v.crs. sand, 84% v.fn.-crs. pebbles (max 16mm; 75%m | 25%f); poorly sorted, subrnd.-ang., wet, no HCl rxn, 10YR 2/2 very dark brown.	HEIS #: B3F9V6
				I-002: 240.39', HEIS #: B3F9V9, B3F9W0, B3F9W1, B3F9W3, B3F9W4, B3F9W5
245	G.S.			Archived @ 245'
			245'-250': 1% silt, 9% v.fn.-v.crs. sand, 90% v.fn.-crs. pebbles (max 28mm; 80%m | 20%f); 10YR 3/1 very dark gray, rest Same As Above (SAA).	Archived @ 250'
250	G.S.			
			250'-255': 1% silt, 10% v.fn.-v.crs. sand, 89% v.fn.-v.crs. pebbles (max 40mm; 70%m | 30%f); all SAA.	Archived @ 255'
255	G.S.			
			255'-260': 2% silt, 15% v.fn.-v.crs. sand, 83% v.fn.-v.crs. pebbles (max 35mm; 75%m | 25%f); all SAA.	Archived @ 260'
260	G.S. W.S.			
			260'-265': 5% silt, 10% v.fn.-v.crs. sand, 85% v.fn.-v.crs. pebbles (max 44mm; 80%m | 20%f); all SAA.	I-003: 260.32', HEIS #: B3F9W7, B3F9W8, B3F9W9, B3F9X1, B3F9X2, B3F9X3
				Archived @ 265'
265	G.S.			
			265'-270': 5% silt, 10% v.fn.-v.crs. sand, 85% v.fn.-v.crs. pebbles (max 40mm; 90%m | 10%f); round-angular, rest SAA.	Archived @ 270'
270	G.S.			
			270'-275': 2% silt, 10% ~~sand~~ v.fn.-v.crs. sand, 88% v.fn.-crs. pebbles (30mm max; 80%m | 20%f); all SAA.	Archived @ 275'

AR 10-16-17

AR 10-18-17

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	[signature]	10·18·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10·18·17

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75 mi N of Rattlesnake Gate

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.		240 – 390': Gravel (G)	Dual Air Rotary rig w/8"
			275-280': 2% silt, 8% v.fn.-v.crs. sand, 90% v.fn. – v.crs. pebbles (max 32mm; 85%m/15%f); poorly sorted, subrnd.-ang., wet, no HCl rxn, 10YR 3/1 very dark gray.	case + 7" tricone Archived @ 280'
280	WS/G.S.		280'-285': 5% silt, 15% v.fn.-v.crs sand, 80% v.fn.-v.crs. pebbles (max 34mm; 75%m/25%f); all same as above (SAA)	I-004: 280.08', HEIS#: B3F9X5, B3F9X6, B3F9X7, B3F9X9, B3F9Y0, B3F9Y1 Archived @ 285'
285	G.S.		285'-290': 1% silt, 19% v.fn.-v.crs. sand, 80% v.fn. – v.crs. pebbles (max 32mm; 80%m/20%f); round – angular, 10YR 4/1 dark gray, rest SAA.	Archived @ 290'
290	G.S.		290'-295': 1% silt, 9% v.fn.-v.crs. sand, 90% v.fn.-v.crs. pebbles (max 33mm; 75%m/25%f); 10YR 3/1 very dark gray, rest SAA.	Archived @ 295'
295	G.S.		295'-300': 1% silt, 9% v.fn.-v.crs. sand, 90% v.fn.-v.crs. sand (max 44mm; 90%m/10%f); all SAA.	Archived @ 300'
300	G.S.		300'-305': (95% G, 5% M); Gravel: crse-v.crse, ang.-rnd., v. poor sort, max 40mm, basalt/quartzite mix (85%f/15%m rocks), wet; Silt: in suspension, loose.	I-005: Sleeve B (301.25'-301.75') HEIS#: B3F9V7 I-006: 300.27', HEIS#: B3F9Y3, B3F9Y4, B3F9Y5, B3F9Y7, B3F9Y8, B3F9Y9
	W.S.			
	S.S.			
305	G.S.		305-310': (95% G, 5% S); Gravel: crse-v.crse, ang.-rnd., v. poor sort, max 40mm, basalt/quartzite mix (85%f/15%m rocks), wet; Sand: fine grn., ang.-sub.ang, well sort, 10 YR 4/2 d. grayish brown.	Archived @ 305' Archived @ 310'
310	G.S.		310-315': (100% G); Gravel: crse.-v.crse, ang.-rnd., v. poor sort, max 50mm, basalt/quartzite mix (70%f/30%m rocks), wet.	Archived @ 315'

Reported By:

Print Name	Title	Signature	Date
Andrew Rawlerson / Jess Hocking	Sr. Geologist	Staff Geologist	10/23/17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10-23-2017

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75 mi. N. of Rattlesnake Barricade

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Shape, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
315	G.S.		315-320': (100% G); Gravel: crse-v. crse, ang.-rnd., v. poor sort, 40 mm max, basalt/quartzite mix (60% f/40% m rocks), wet.	DUAL ROTARY W/TRICONE 8" Wld. CASING Archived @ 320' Archived @ 325'
320	G.S./W.S.		320-325': (100% G); Gravel: 45mm max, (80% f/20% m rocks); same as above.	I-007, 320' bgs, FLOW = 5 GPM; HEIS #: B3FB01, B3FB02, B3FB03, B3FB05, B3FB06, B3FB07. (10/23/17)
325	G.S.		325-330': (95% G, 5% S); Gravel: crse-v.crse, ang.-rnd., v. poor sort, 35mm max, basalt/quartzite mix (80% f/20% m rocks), wet; Sand: fine-med., ang.-sub. ang., well sort, 10YR 4/3 brown.	Archived @ 330'
330	G.S.		330-335': (95% G, 5% S); Gravel: 50mm max, (80% f/20% m rocks), otherwise same as above; Sand: same as above.	Archived @ 335'
335	G.S.		335-340': (95% G, 5% S); Gravel: 45mm max, (50% f/50% m rocks), otherwise same as above; Sand: same as above.	Archived @ 340'
340	G.S./W.S.		340'-345': 5% v.fn.-v.crs sand, 95% v.fn. pebbles - v.crs. pebbles (60% m/40% f); same as above (max 48mm)	Archived @ 345'
			345'-350': 5% v.fn.-v.crs. sand, 95% v.fn.-v.crs. pebbles (max 54mm; ~~65%~~ 35% m/65% f); same as above.	Archived @ 350' I-008, 340' bgs, FLOW = 15gpm; HEIS #: B3FB09, B3FB10, B3FB11, B3FB13, B3FB14, B3FB15
345	G.S.		350'-355': 5% v.fn.-v.crs sand, 95% v.fn.-v.crs. pebbles (max 58mm; 50% m/50% f); same as above.	Archived @ 355'
350	G.S.			

Reported By:

Print Name	Title	Signature	Date
Jess Hocking / Andrew Rawlerson	Sr. Geologist / Staff Geologist		10-24-17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10·24·17

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75 mi N of Rattlesnake Gate

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.		240' - 390': Gravel (G)	Dual Air Rotary Rig w/
			355'-360': 10% v.fn.-v.crs. sand, 90% v.fn.-v.crs. pebbles (max 74mm; 50%m/50%f) and small cobbles; mod.-poorly sorted, round - angular, wet, no HCl rxn, 10YR 3/1 very dark gray.	8" case + 7" tricone Archived @ 360' I-009, Sleeve B(360.2'-360.7') HEIS#: B3F9V8
360	WS/G.S.		360'-365': 5% v.fn.-v.crs. sand, 95% v.fn. pebbles - small cobbles (max 65mm; 40%m/60%f); same as above	I-010, 360.05', HEIS#: B3FB17, B3FB18, B3FB21, B3FB23, B3FB24, B3FB25 Archived @ 365'
365	G.S.		365'-370': 10% v.fn.-v.crs. sand, 90% v.fn. pebbles - small cobbles (max 75mm; 35%m/65%f); same as above.	Archived @ 370'
370	G.S.		370'-375': 5% v.fn.-v.crs. sand, 95% v.fn.-v.crs. pebbles (max 58mm) (40%m/60%f); same as above.	Archived @ 375'
375	G.S.		375'-380': 5% v.fn.-v.crs. sand, 95% v.fn.-v.crs. pebbles (max 55mm; 50%m/50%f); same as above.	Archived @ 380'
380	WS/G.S.		380'-385': 5% v.fn.-v.crs. sand, 95% v.fn. pebbles - small cobbles (max 77mm; 40%m/60%f); same as above.	I-011, 380.15', HEIS#: B3FB27, B3FB28, B3FB29, B3FB31, B3FB32, B3FB33 Archived @ 385'
385	G.S.		385'-390': 10% v.fn.-crs. sand, 90% v.fn.-v.crs. pebbles (max 60mm; 60%m/40%f); 10YR 2/2 very dark brown, rest same as above.	Archived @ 390'
390	G.S.		390' - 395': Sandy Gravel (SG)	
			390'-395': 15% v.fn.-v.crs. sand, 10% silt, 75% v.fn.-v.crs. pebbles (50mm max; 60%m/40%f); poorly sorted, ang.-rnd., wet, no HCl rxn, 10YR 2/2 very dark brown.	Archived @ 395'

Reported By:

Print Name	Title	Signature	Date
Andrew Rauterson	Staff Geologist	[signature]	10·25·17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Date: 10.25.17

Well ID: C9636 | Well Name: 699-30-73 | Location: 0.75mi N of Rattlesnake Gate

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			AR 10.25.17 395'-400' : ~~Sandy Gravel (sG)~~ Silty Gravel (mG) 395'-400': 25% silt, 10% v.fn.-med. sand, 65% v.fn.-v.crs. pebbles (35mm max; 50% m/50% f); poorly sorted, rnd.-ang.; wet, no HCl rxn, 10YR 6/2 light brownish gray.	Dual Air Rotary Rig w/ 8" casing to 7" tri cone @ ~397 changed from gravel to more sand/silt. Archived @400'
400			400'-405' : Silt (M) 400'-405': 84% silt, 8% v.fn.-med. sand, 8% v.fn.-crs pebbles (max 24mm): mod. sorted, sub.rnd.-sub.ang.; wet, no HCl rxn, 2.5Y 5/3 light olive brown.	~~Archived @400'~~ AR 10.25.17 TD: 402.30' due to back-fill overnight Ringold Lower Mud contact: ~397' Archived @405'
405				

Reported By:

Print Name	Title	Signature	Date
Andrew Raulerson	Staff Geologist	[signature]	10.25.17

A-6006-993 (REV 0)

This page intentionally left blank.

699-30-73 (C9636)
Log Data Report

Borehole Information

Log Date	2017-11-02	Filename	C9636_HG-NM_2017-11-02	Site	200-UP-1

DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
389	10/31/17	HII	10/26/17	402.3	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Welded Steel	Dual Rotary	4.75	8 5/8	8	5/16	-4.75	399.76

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing stick-up and casing diameter. Static water is reported at 229.95 by the geologist. Water inside the casing was measured by the logging engineer at 389 ft. The maximum logging depth achieved was 401 ft. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 1Ld	Type	60% Coaxial HPGe (SGLS)[2]
Effective Calibration Date	01/26/2017	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-150, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 1Hd	Type	He-3 (CPN 503DR) NMLS[3]
Effective Calibration Date	02/23/2017	Serial No.	H310700352
Calibration Reference	HGLP-CC-151, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	3	4	5 Repeat		
HEIS Number	1020116	1020117	1020118		
Date	10/31/17	11/01/17	11/02/17		
Logging Engineer	Felt/Spatz	Spatz	Spatz		
Start Depth (ft)	0.0	219.0	140.0		
Finish Depth (ft)	220.0	401.01	181.01		
Count Time (sec)	100	100	100		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	1.0	1.0		
Log Speed (ft/min)	NA	NA	NA		
Pre-Verification	C9636ALD2017 1031AV00CAB1	C9636ALD2017 1101BV00CAB1	C9636ALD2017 1102CV00CAB1		

[1] depth to water inside casing
[2] Spectral Gamma Logging System
[3] Neutron Moisture Logging System

Log Run	3	4	5 Repeat		
Start File	AD000000	BD021900	CD014000		
Finish File	AD022000	BD040101	CD018101		
Post-Verification	AV00CAA1	BV00CAA1	CV00CAA1		
Depth Return Error (in.)	1.0 high	2.0 low	1.0 high		
Comments	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made		

NMLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1020119	1020120			
Date	10/30/17	10/31/17			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	210.0			
Finish Depth (ft)	250.01	235.01			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	NA	NA			
Pre-Verification	C9636AHD2017 1030AV00CAB1	C9636AHD2017 1031BV00CAB1			
Start File	AD000000	BD021000			
Finish File	AD025001	BD023501			
Post-Verification	AV00CAA1	BV00CAA1			
Depth Return Error (in.)	2.5 high	2.5 high			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes.

Analysis Notes

Analyst	P.D. Henwood	Date	11/27/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 5/16-in. thick casing was applied to the log data.

A water correction was applied below 389 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in an EXCEL template identified as ALD20170126 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

An interpreted data set was created for this borehole. Depth overlaps from consecutive log runs or where two casings existed were removed from 219 and 220 ft. This results in a data set where only one data point is presented for each depth.

NMLS data are reported in percent volumetric moisture content from ground surface to the static water level at 229.9 ft. Data are not reported below the static water level even though no water existed in the borehole from 229 to 389 ft.

HGU[4] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Calibration Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected in this borehole.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

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

List of Log Plots

Depth Reference is ground surface.

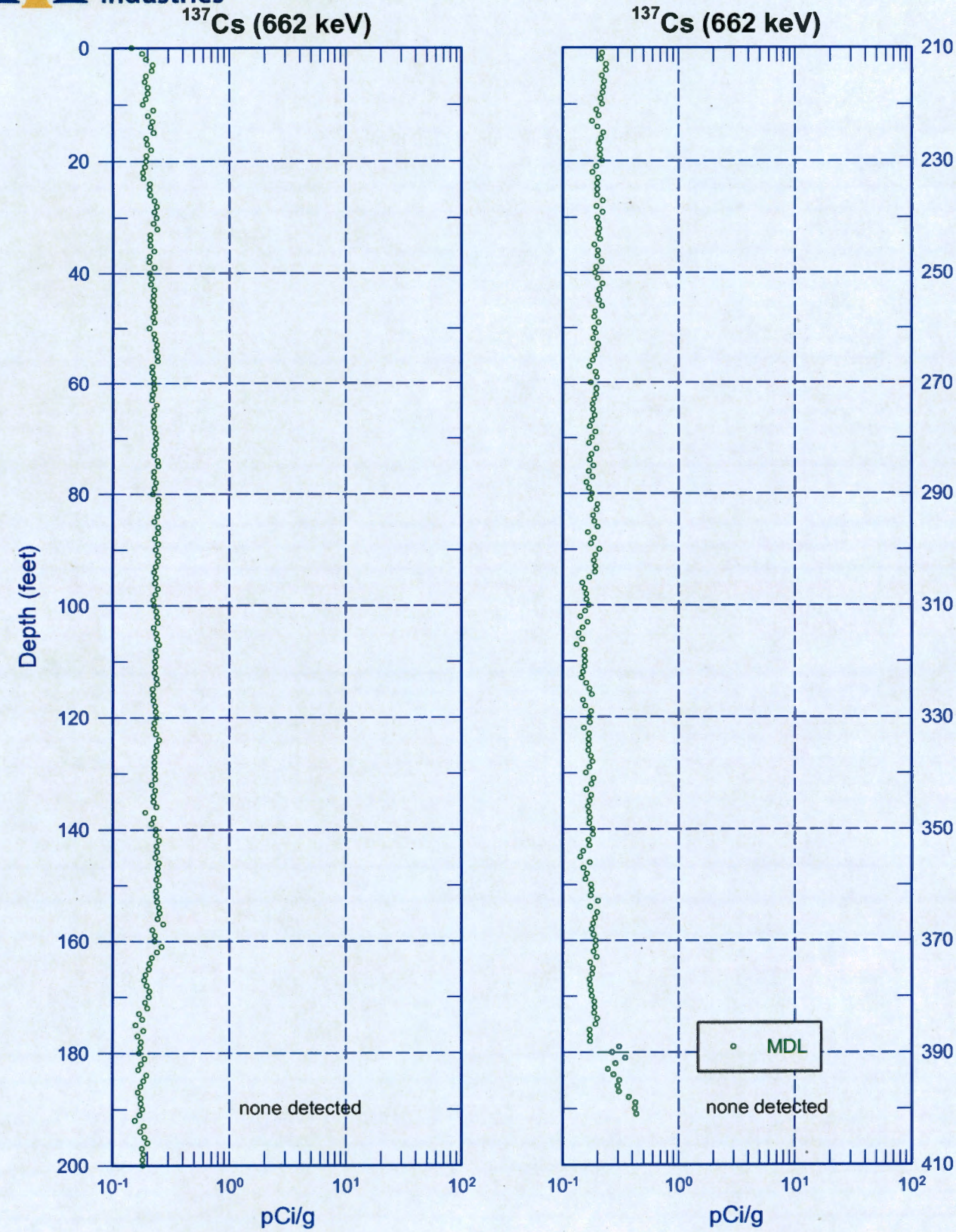
Manmade Radionuclides (0-410 ft)
Natural Gamma Logs (0-160 ft)
Natural Gamma Logs (150-310 ft)
Natural Gamma Logs (300-460 ft)
Combination Plot (0-120 ft)
Combination Plot (110-230 ft)
Combination Plot (220-340 ft)
Combination Plot (330-450 ft)
Combination Plot (0-420 ft)
Total Gamma & Moisture (0-160 ft)
Total Gamma & Moisture (150-310 ft)
Total Gamma & Hanford Gamma Unit (0-410 ft)
Repeat Section of Natural Gamma Logs (140-181 ft)
Moisture Repeat Section (210-235 ft)

[4] Hanford Gamma Unit

This page intentionally left blank.

Huntington Ingalls Industries

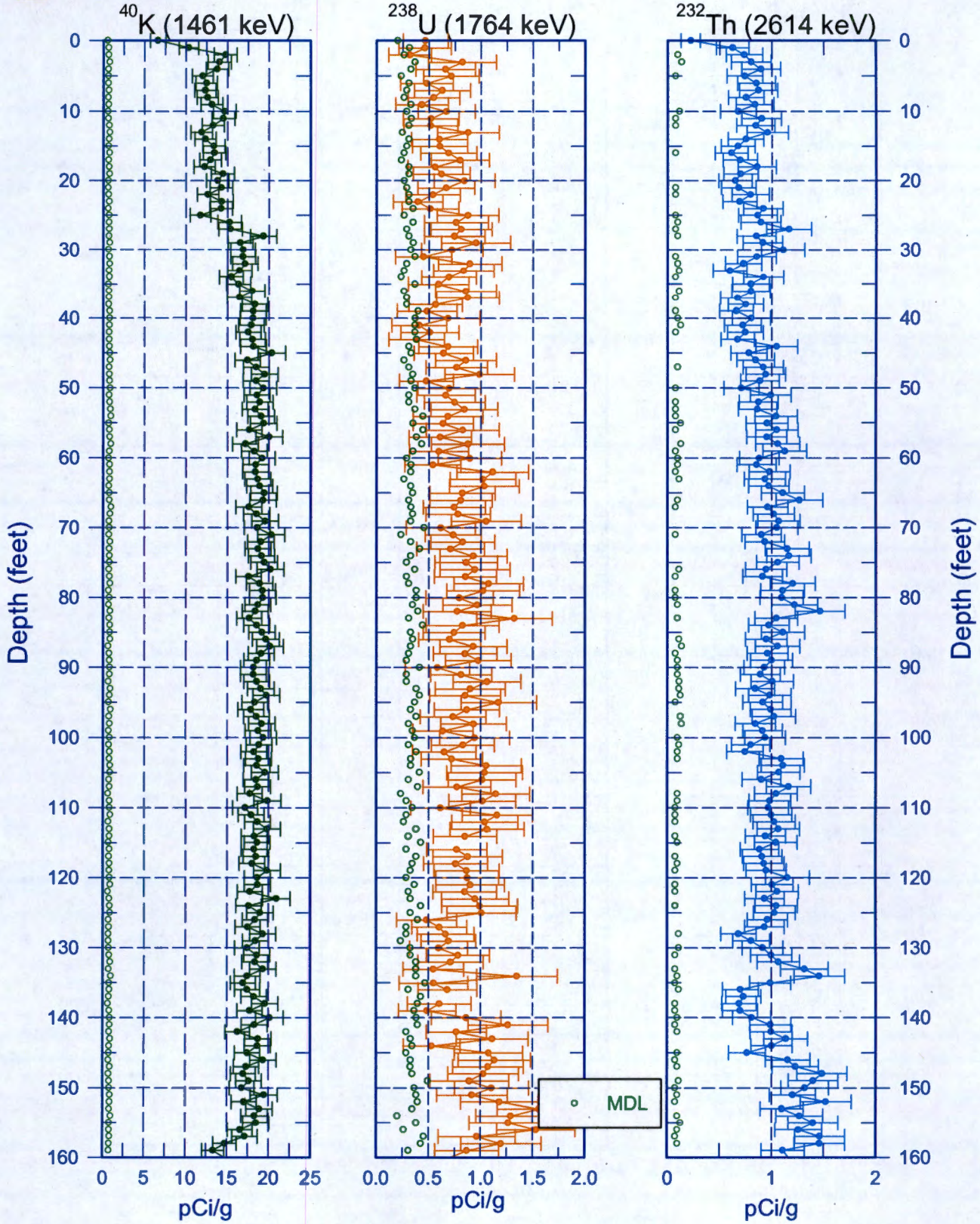
699-30-73 (C9636)
Manmade Radionuclides



Zero Reference - Ground Surface

Huntington Ingalls Industries

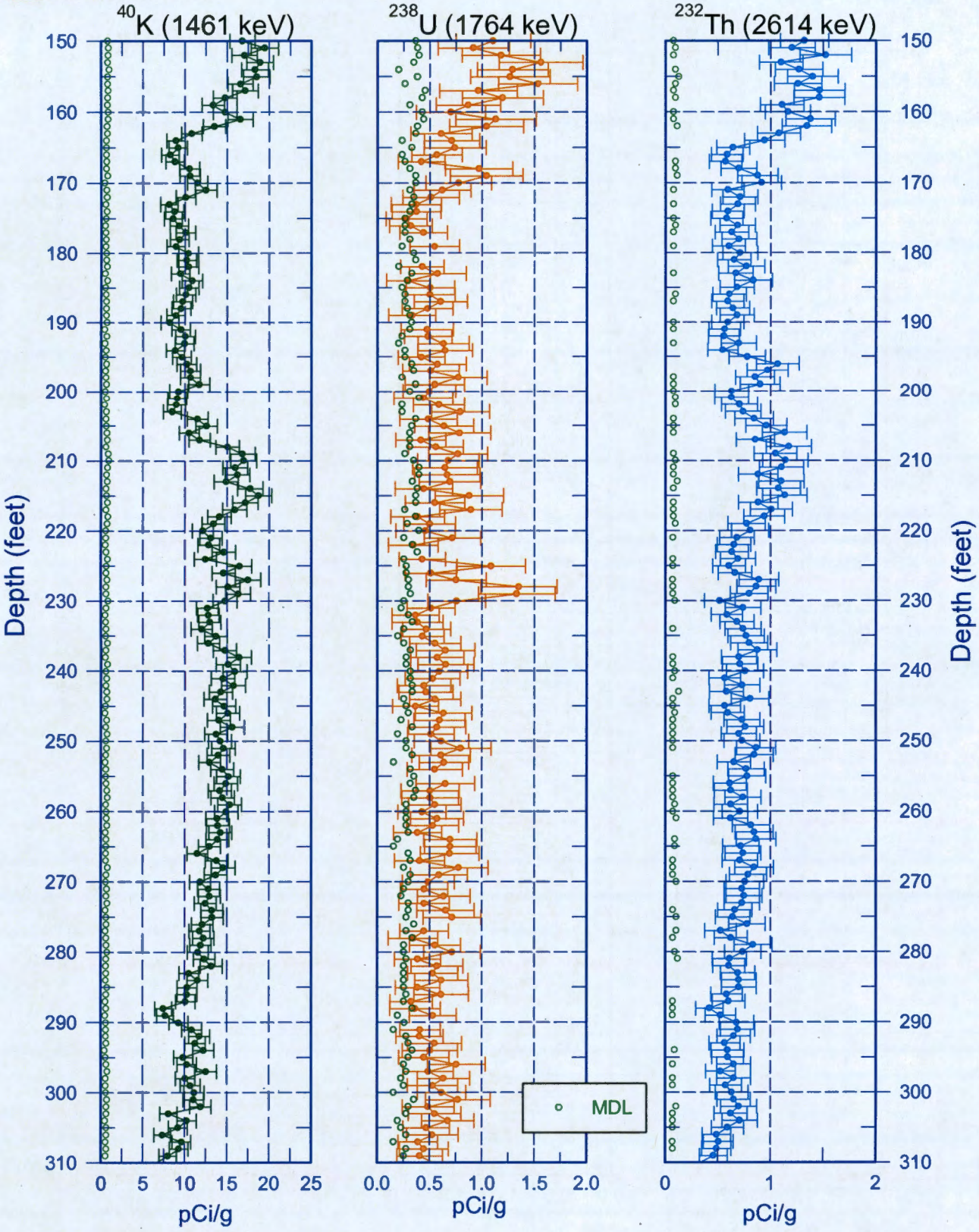
699-30-73 (C9636)
Natural Gamma Logs



Zero Reference - Ground Surface

Huntington Ingalls Industries

699-30-73 (C9636)
Natural Gamma Logs

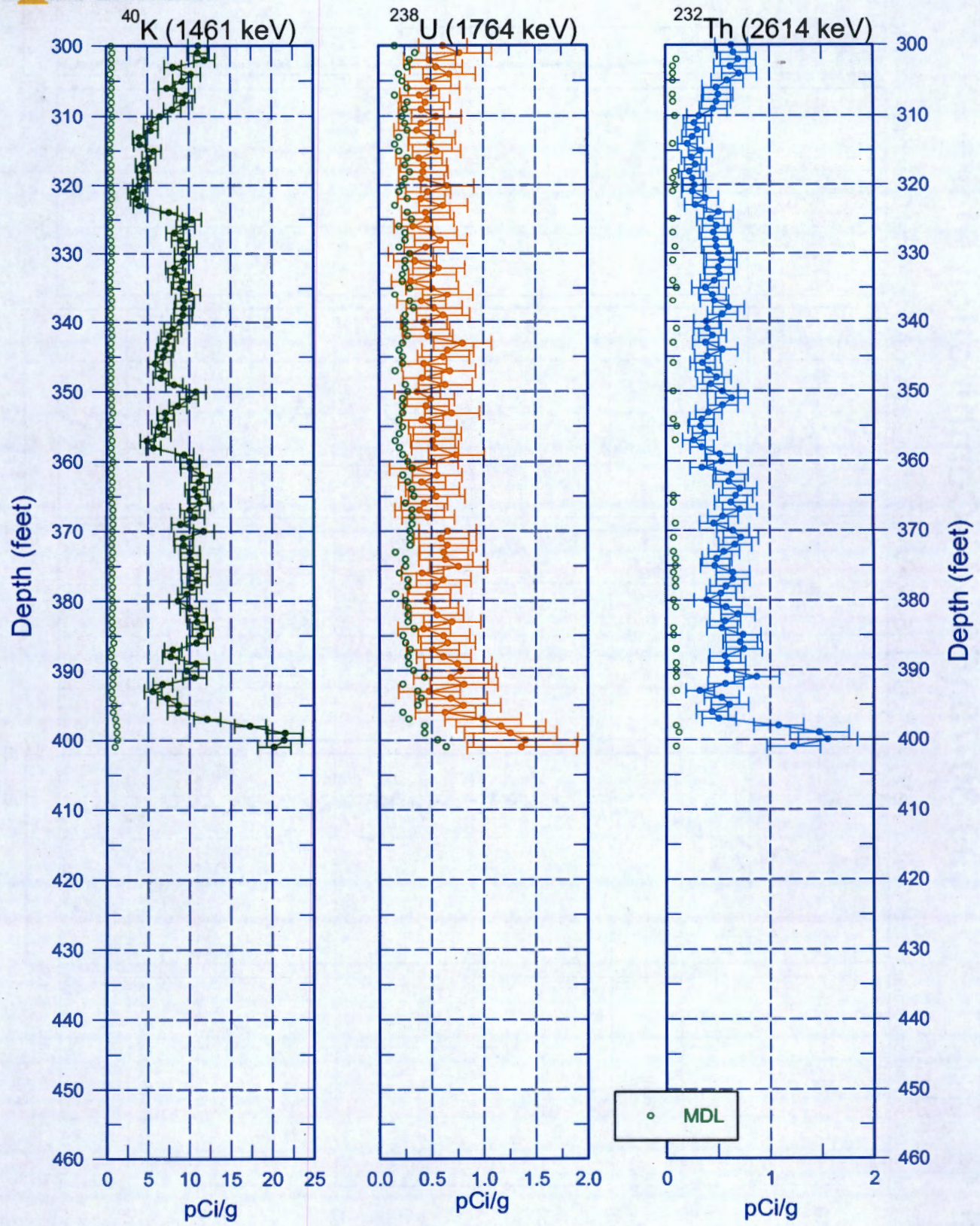


Zero Reference - Ground Surface

Huntington Ingalls Industries

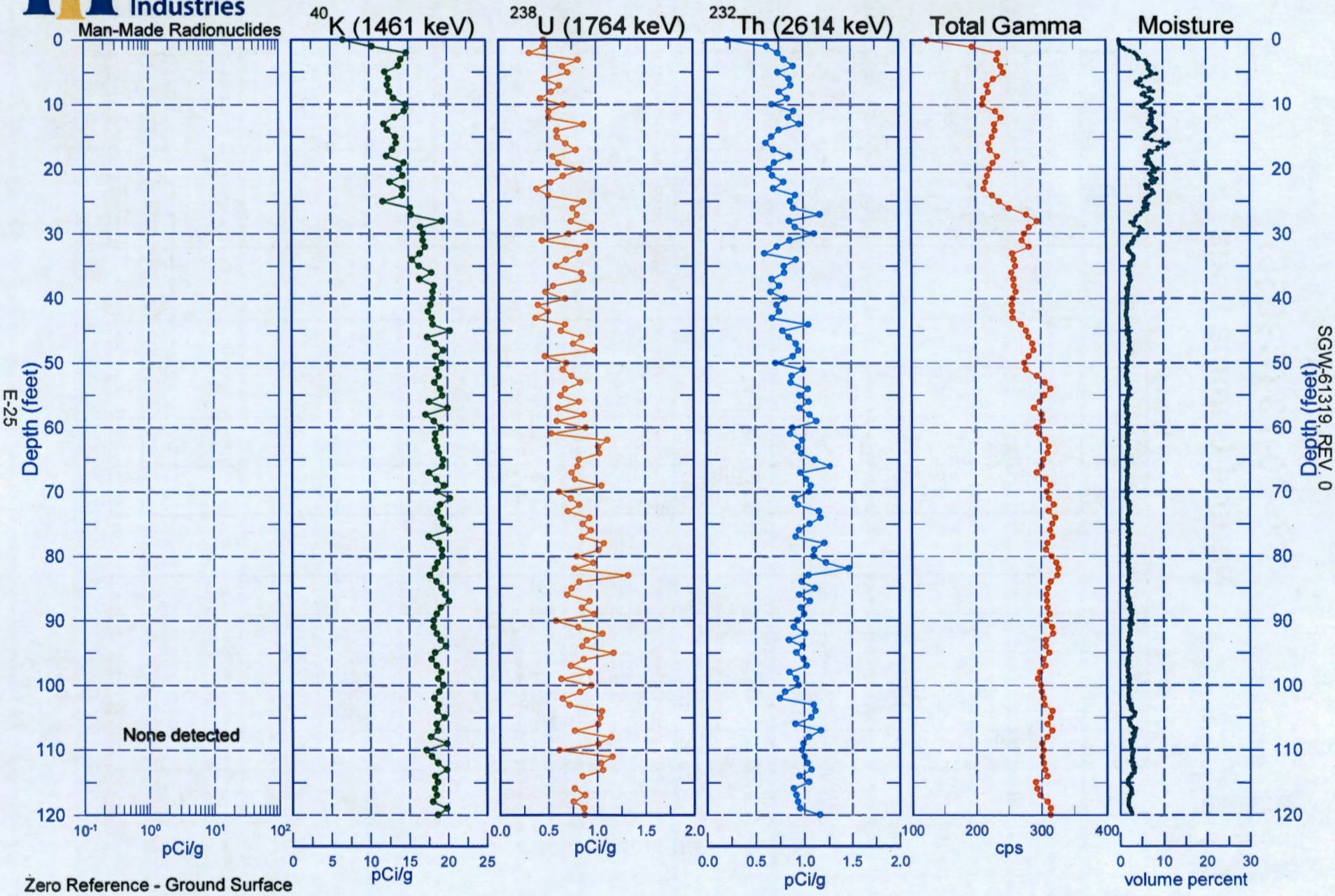
699-30-73 (C9636)

Natural Gamma Logs



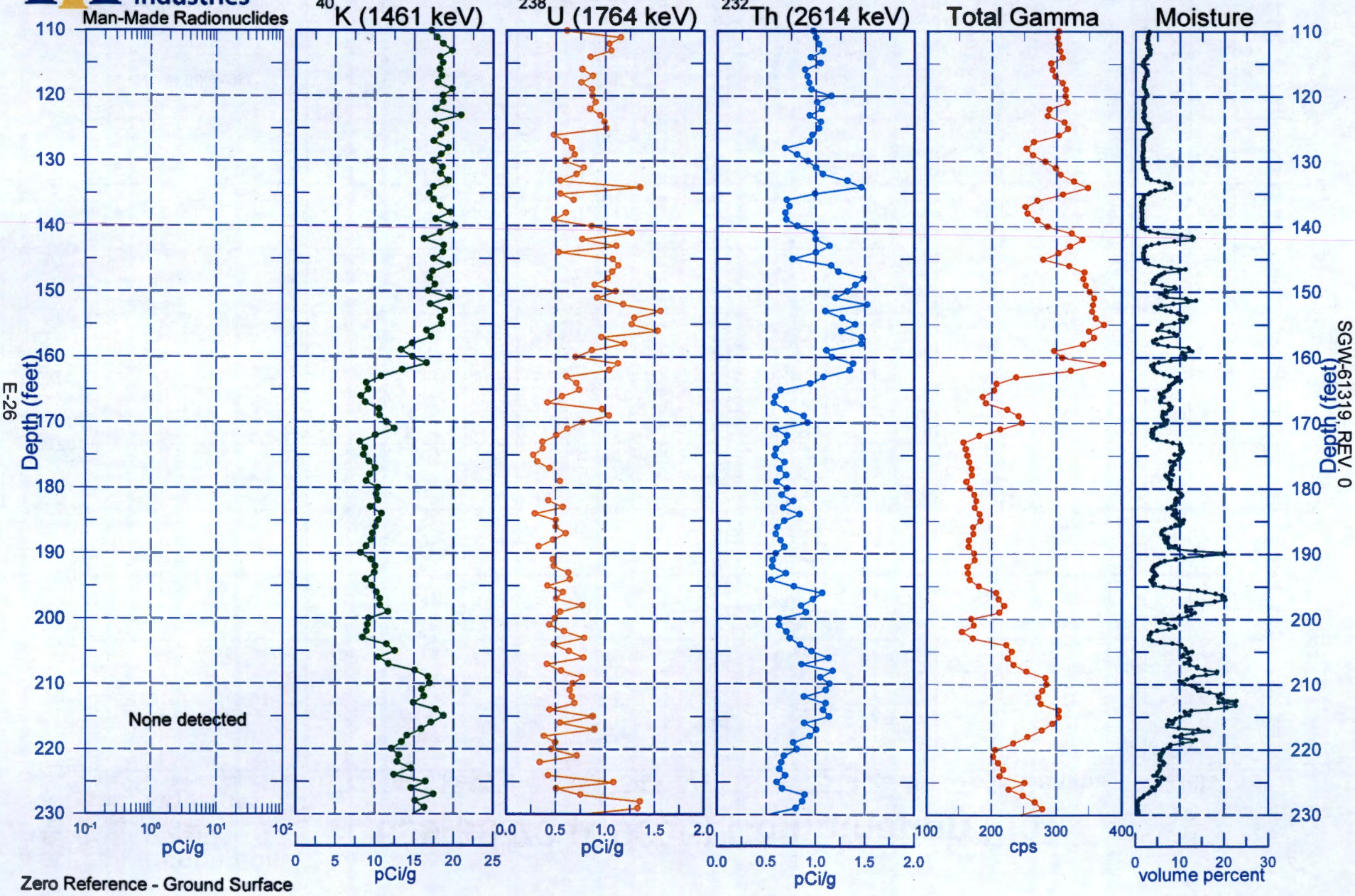
Zero Reference - Ground Surface

699-30-73 (C9636) Combination Plot



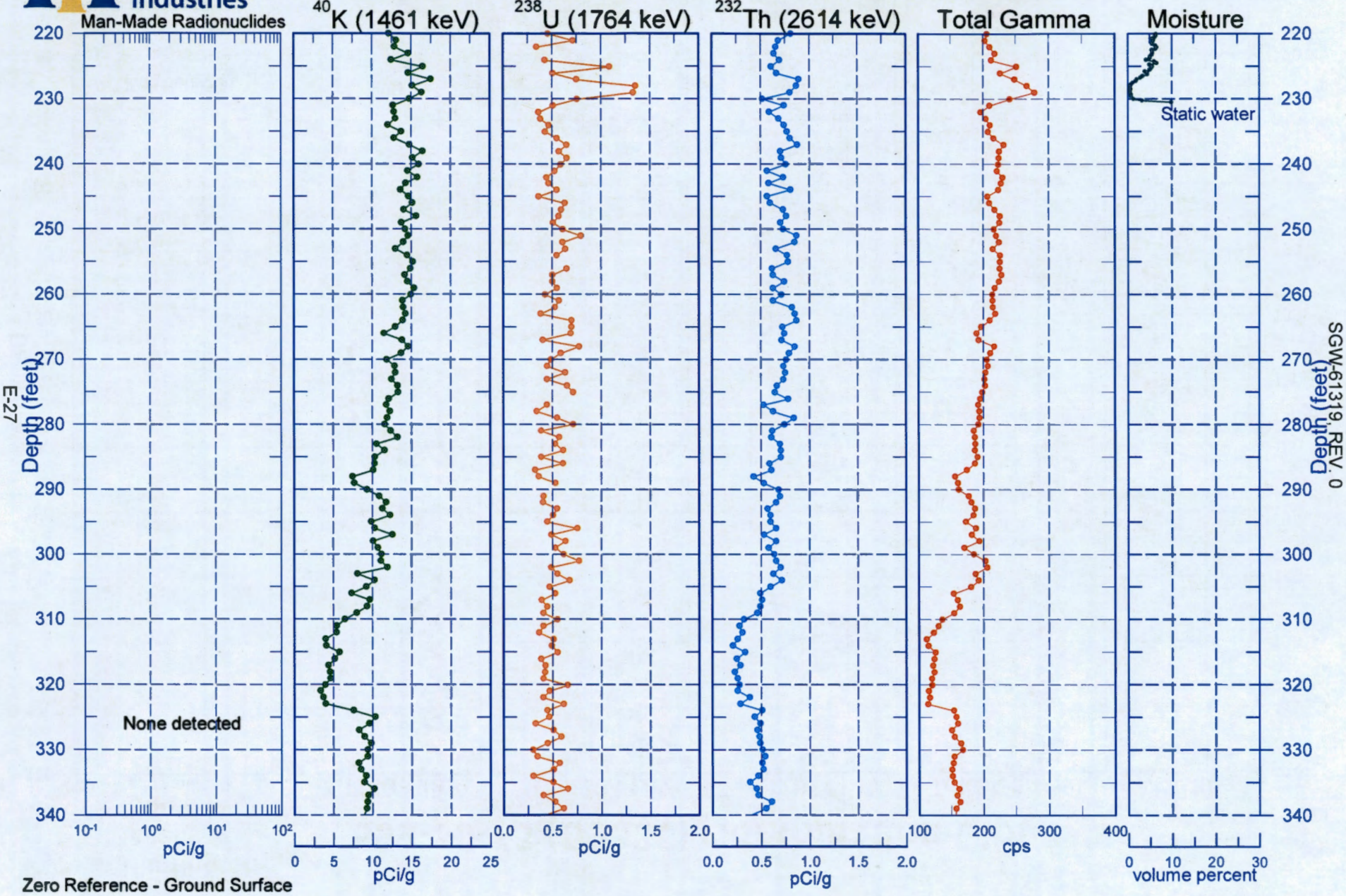
Huntington Ingalls Industries

699-30-73 (C9636) Combination Plot



Huntington Ingalls Industries

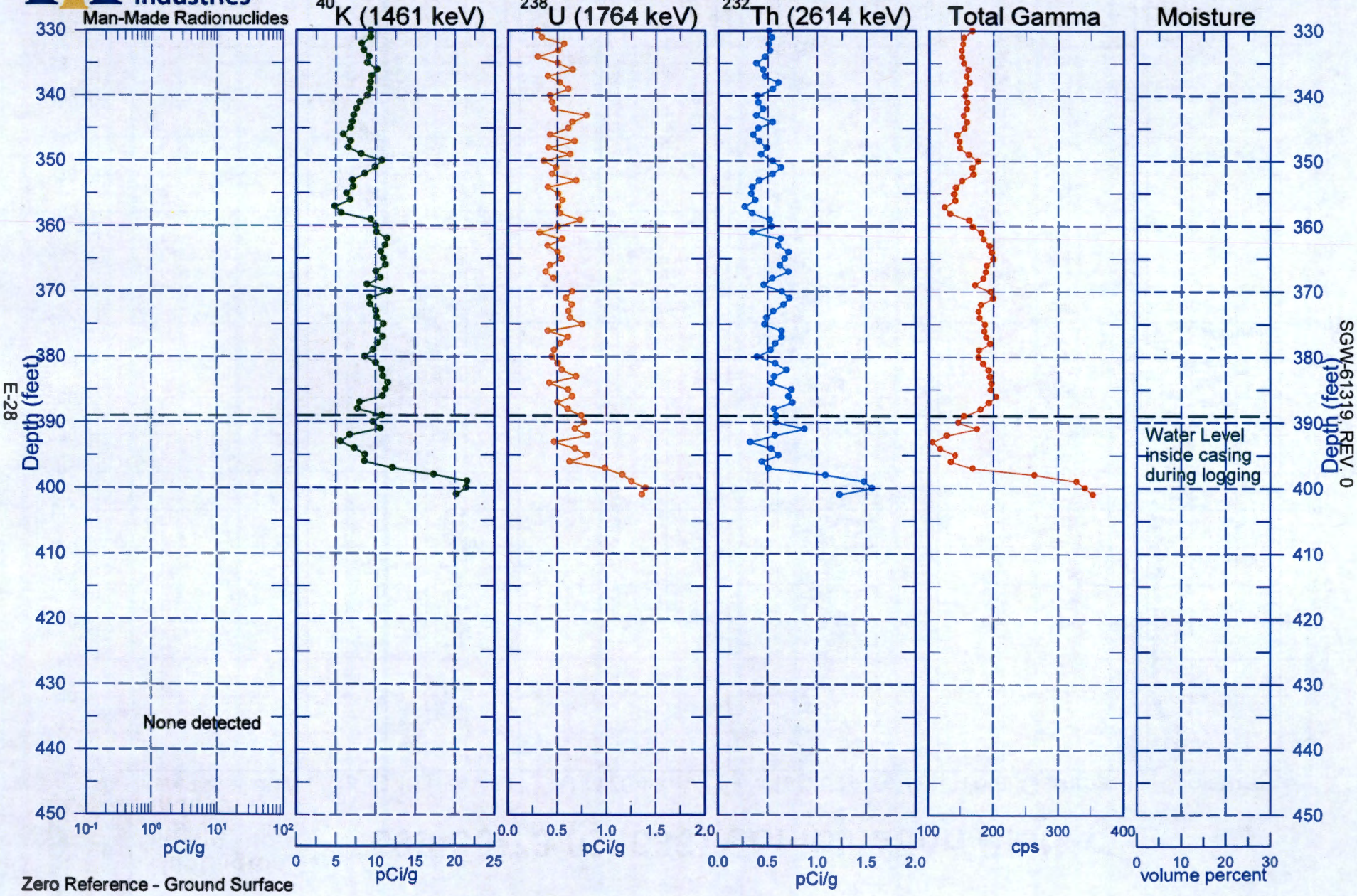
699-30-73 (C9636) Combination Plot



Zero Reference - Ground Surface

Huntington Ingalls Industries

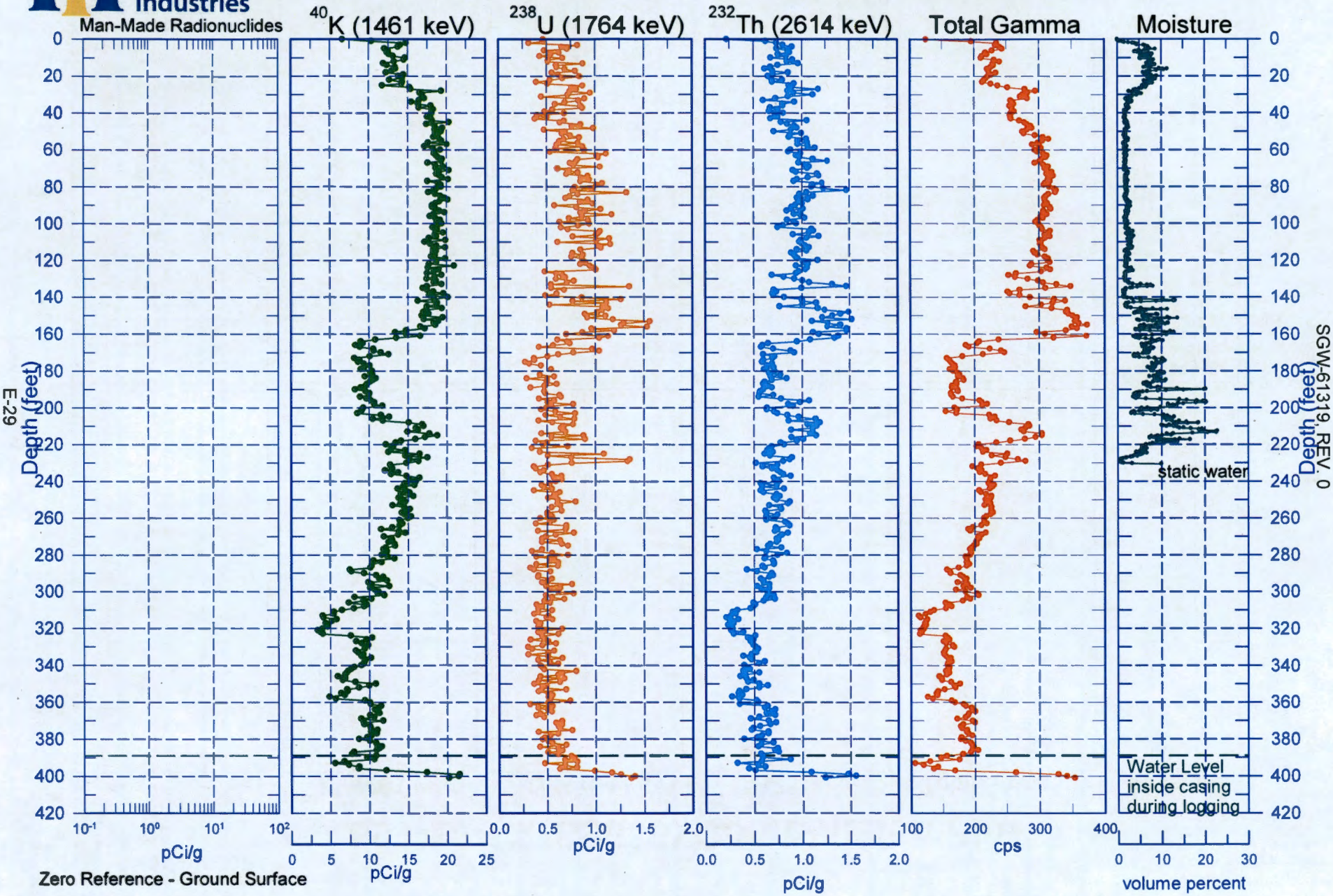
699-30-73 (C9636) Combination Plot



Zero Reference - Ground Surface

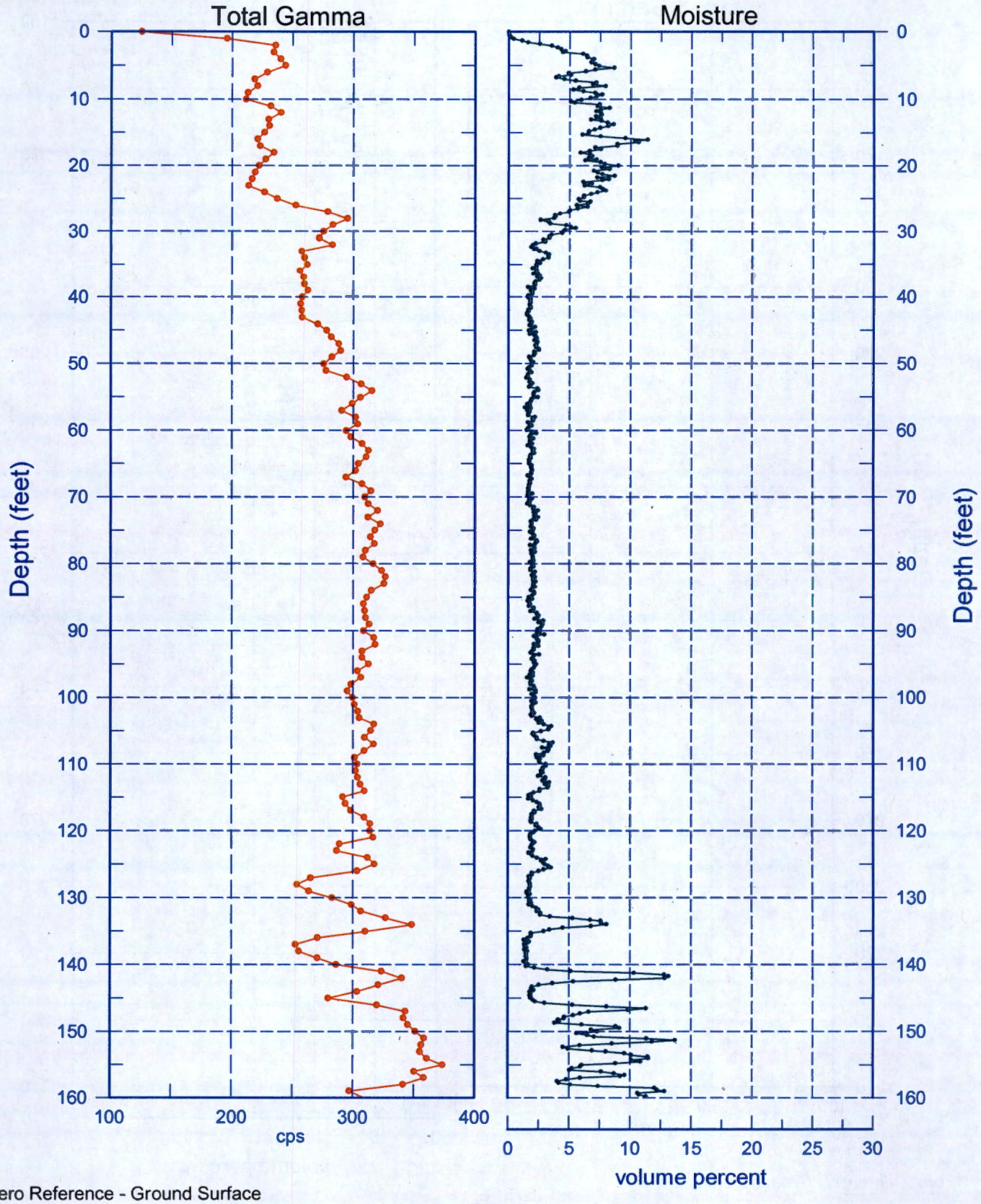
Huntington Ingalls Industries

699-30-73 (C9636) Combination Plot



Huntington Ingalls Industries

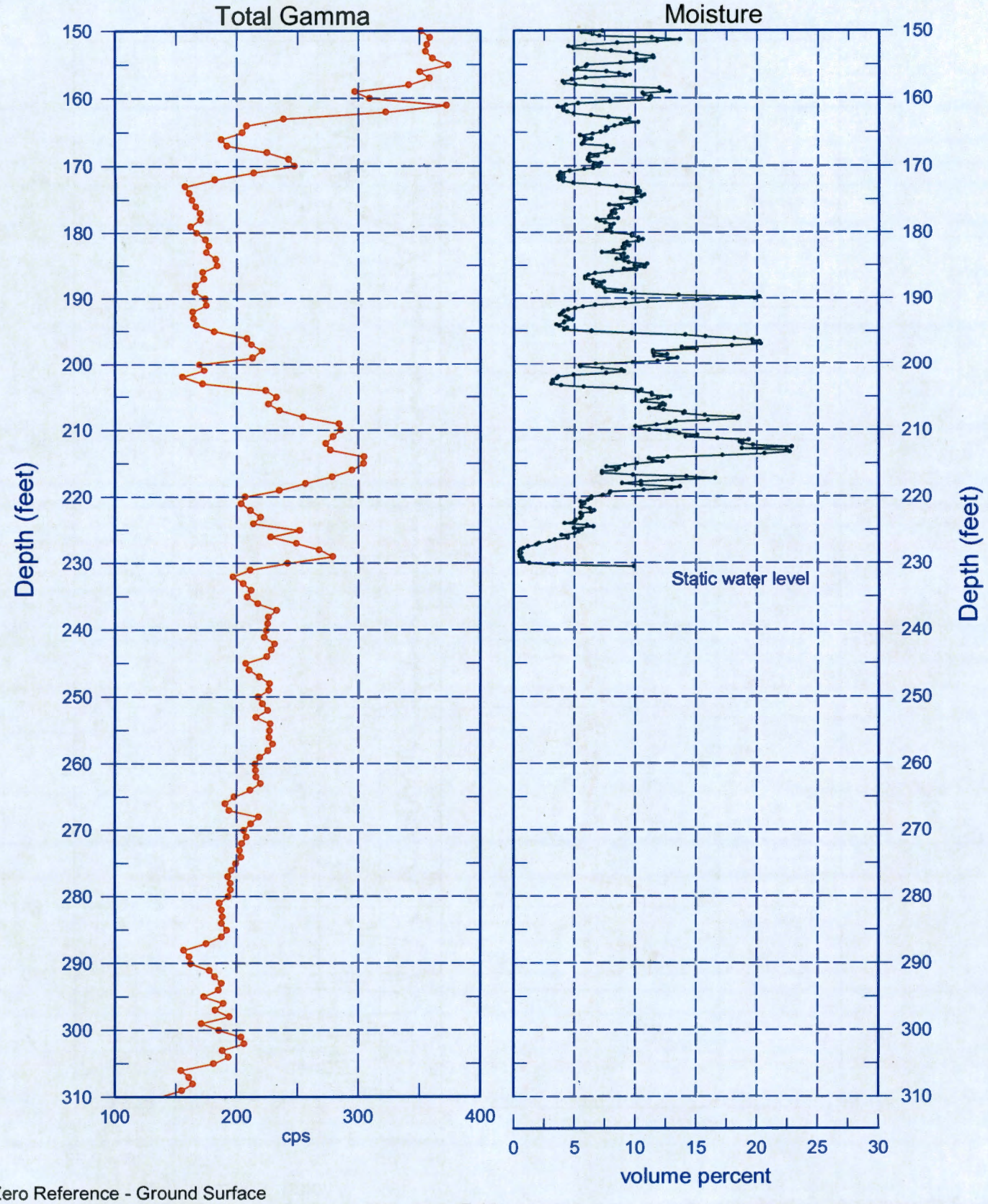
699-30-73 (C9636)
Total Gamma & Moisture



Zero Reference - Ground Surface

Huntington Ingalls Industries

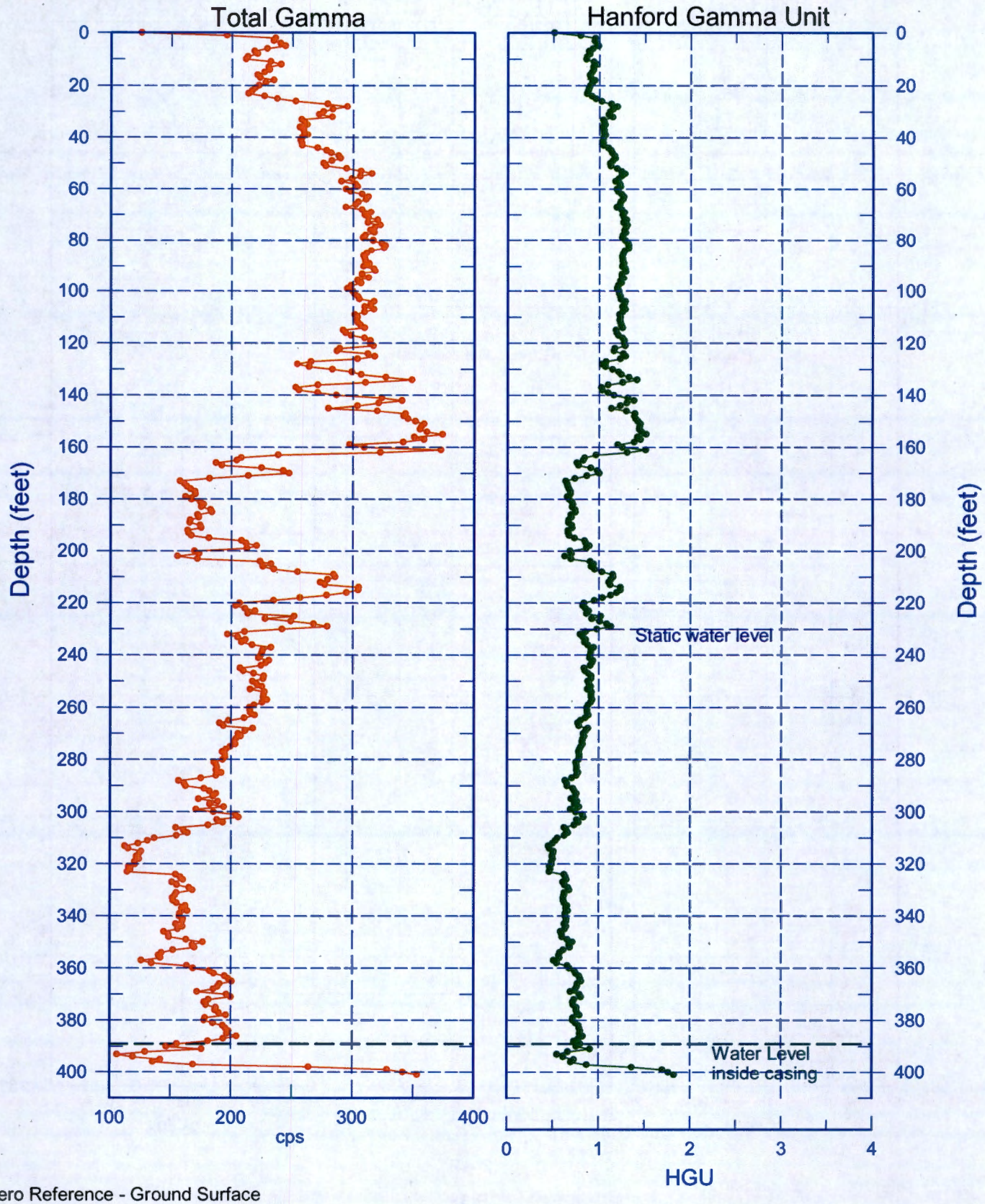
699-30-73 (C9636)
Total Gamma & Moisture



Zero Reference - Ground Surface

Huntington Ingalls Industries

699-30-73 (C9636)
Total Gamma & Hanford Gamma Unit

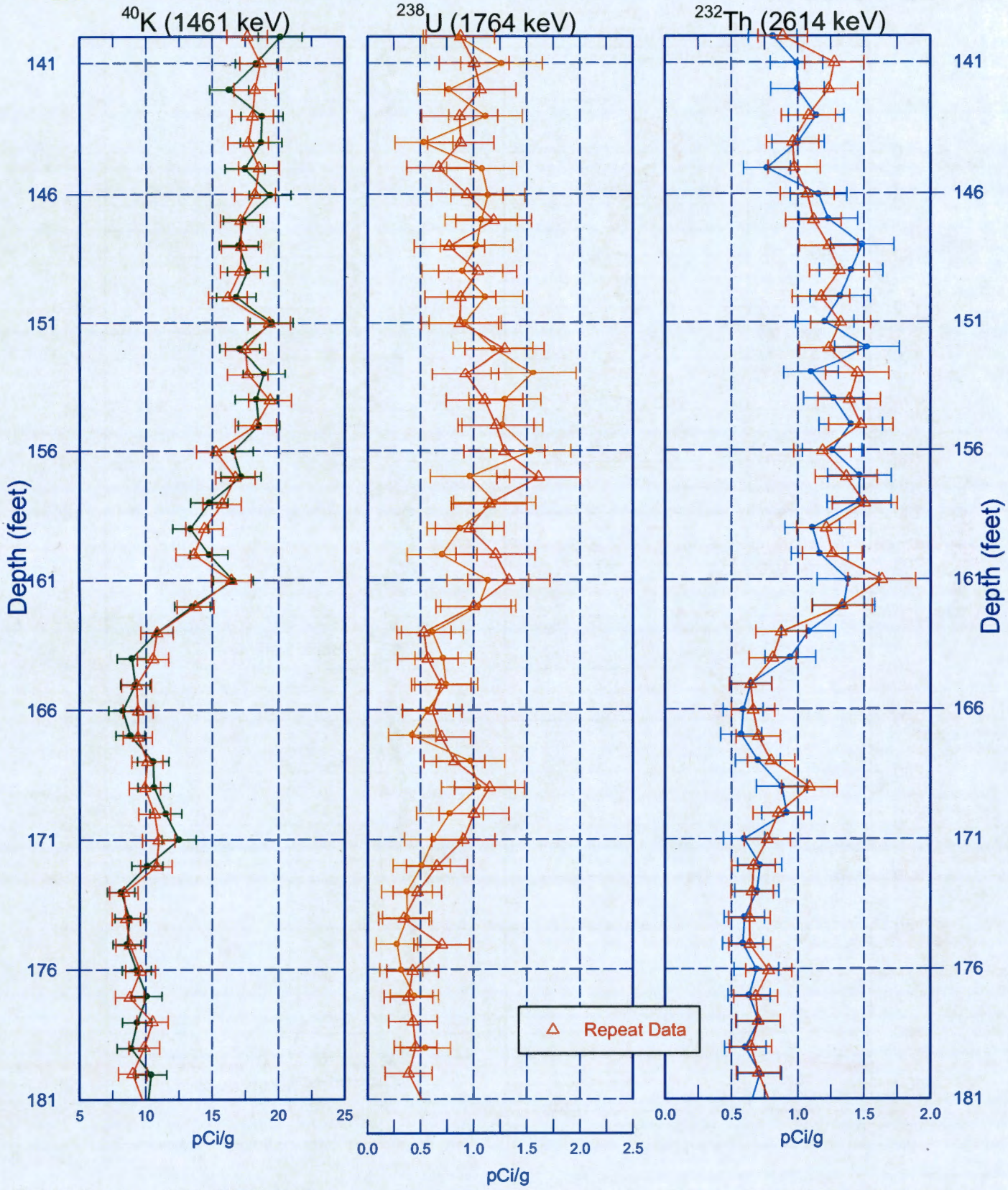


Zero Reference - Ground Surface

Huntington Ingalls Industries

699-30-73 (C9636)

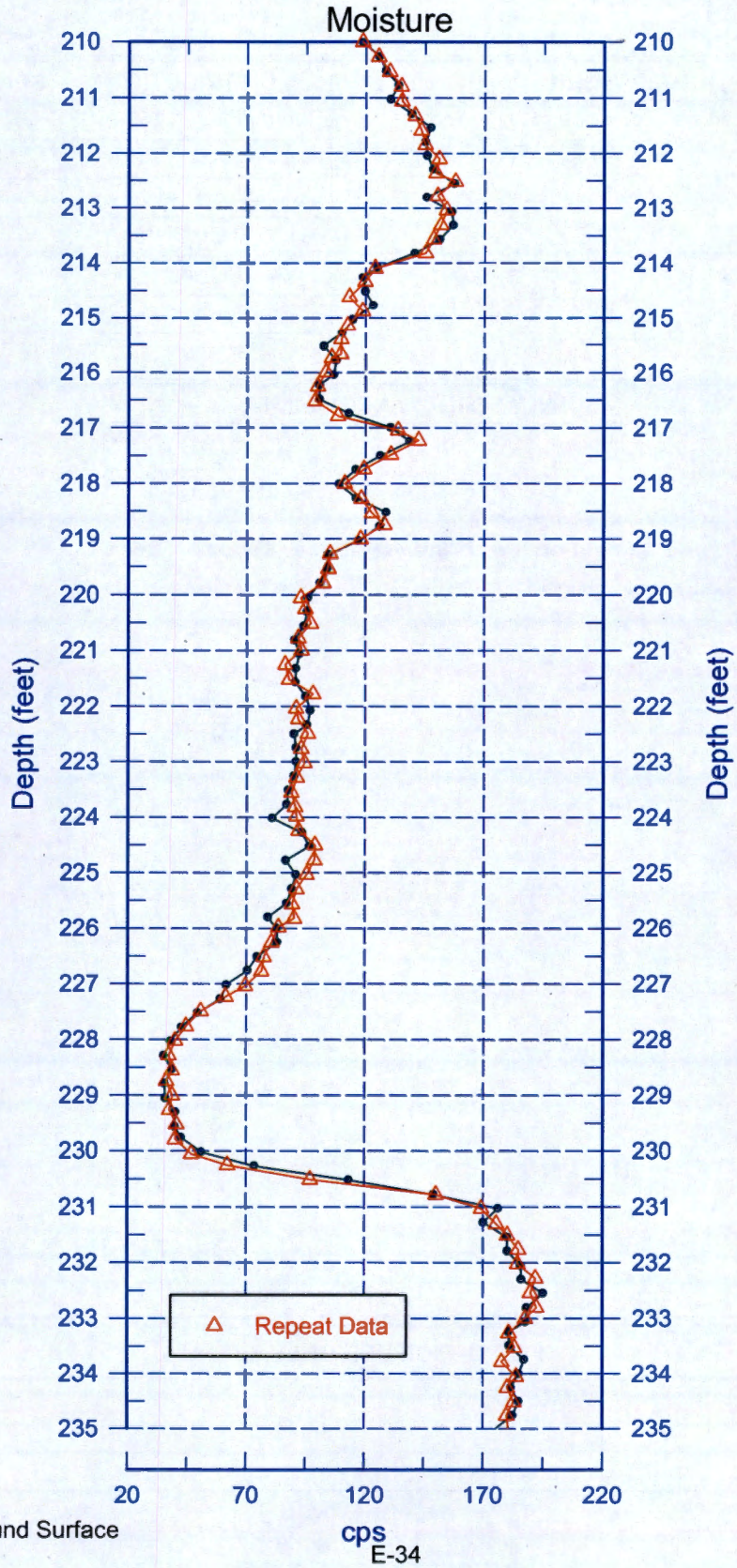
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Huntington Ingalls Industries

699-30-73 (C9636)
Moisture Repeat Section



Zero Reference - Ground Surface

SURVEY DATA REPORT

Request No. 181-047

Project No.	Title	File No.
	UP-1 Well C9636 (699-30-73) Final Survey	6AT12R26

Job. No.	Prepared By	Date	Reviewer
CACN: 304399-JPRC	N.P. Fastabend	1/4/18	LBM

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casing) and elevations of UP-1 Well C9636(699-30-73) located south of 200W Area.	Survey File	OR		
	M.G. Wilson	1		
	K.M. Whitley	1		
	J.L. Smoot	1		
	J.B. Geiger	1		
Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)	B.J. Howard	1		
	A.J. Green	1		

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheet

FOR OFFICE USE ONLY

OR Doc Type:	WMU Code(S):

A-6006-495 (REV 1)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 12/19/17	**Requestor:** Matthan G. Wilson (CHPRC)
Date of Survey: 01/04/18	**Surveyor / Company:** Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of UP-1 Well C9636 (699-30-73) located south of 200W Area.	**Horizontal Datum:** NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
HSWB-071 (COE) and HSWB-072 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9636	699-30-73	567781.90	132789.76		Center of Casing
				201.835	Top Inner 4"Casing, N.Edge
				202.136	Top Outer Casing,N.Edge Stamped "X"
				201.275	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.

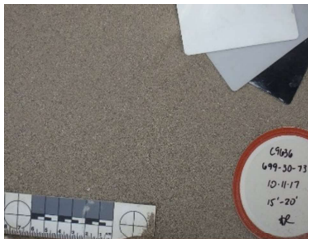
LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
1-4-18

Photo Log

0-5 bgs

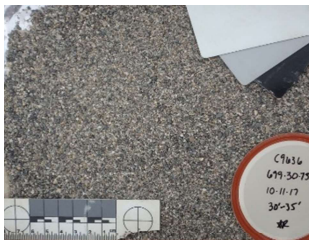
5-10 bgs

10-15 bgs


15-20 bgs

20-25 bgs

25-30 bgs


30-35 bgs

35-40 bgs

40-45 bgs

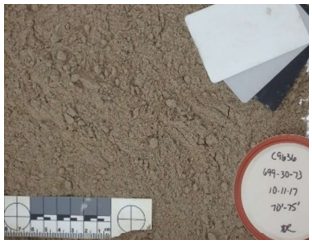
45-50 bgs

50-55 bgs

55-60 bgs

60-65 bgs

65-70 bgs

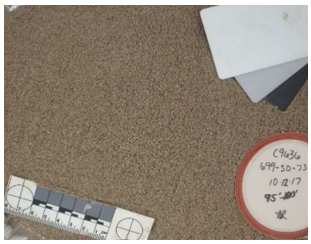

70-75 bgs

75-80 bgs

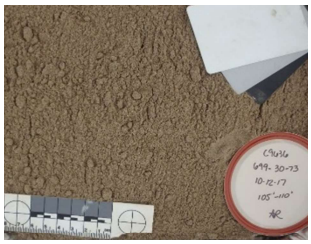
80-85 bgs

85-90 bgs

90-95 bgs


95-100 bgs

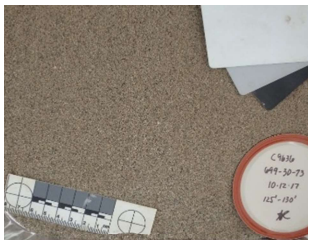
100-105 bgs


105-110 bgs

110-115 bgs

115-120 bgs

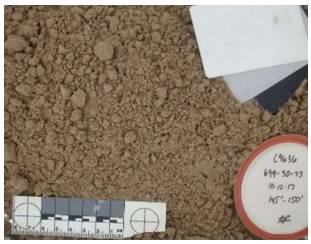
120-125 bgs


125-130 bgs

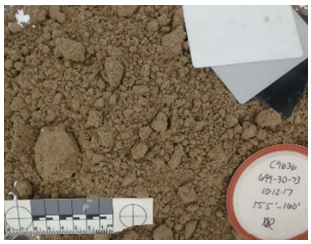
130-135 bgs

135-140 bgs

140-145 bgs

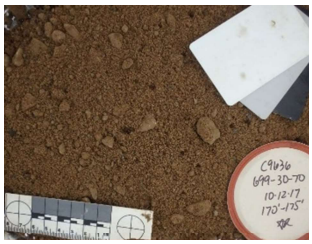

145-150 bgs

150-155 bgs


155-160 bgs

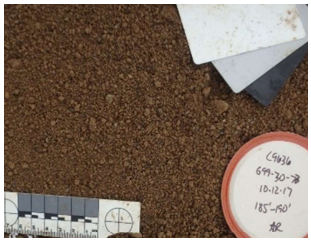
160-165 bgs

165-170 bgs


170-175 bgs

175-180 bgs

180-185 bgs


185-190 bgs

190-195 bgs

195-200 bgs

200-205 bgs

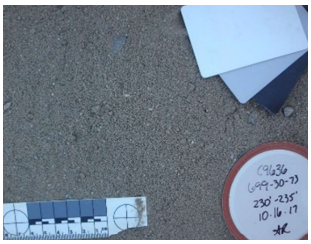
205-210 bgs

210-215 bgs

215-220 bgs

220-225 bgs

225-230 bgs


230-235 bgs

235-240 bgs

240-245 bgs

245-250 bgs

250-255 bgs

255-260 bgs

260-265 bgs

265-270 bgs

270-275 bgs

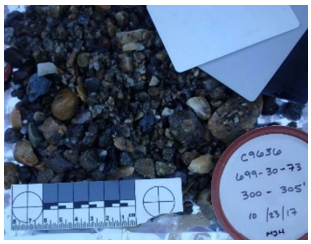
275-280 bgs

280-285 bgs

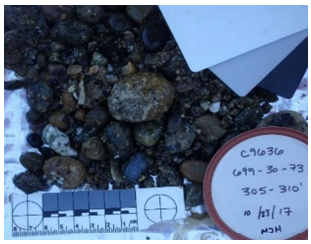
285-290 bgs

290-295 bgs

295-300 bgs



300-305 bgs



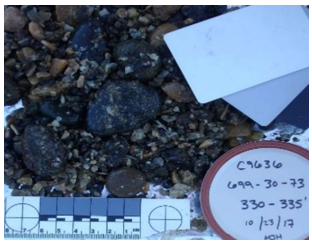
305-310 bgs

310-315 bgs

315-320 bgs

320-325 bgs

325-330 bgs

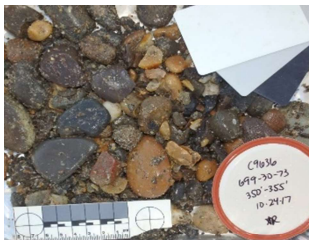


330-335 bgs

335-340 bgs

340-345 bgs

345-350 bgs



350-355 bgs

355-360 bgs

360-365 bgs

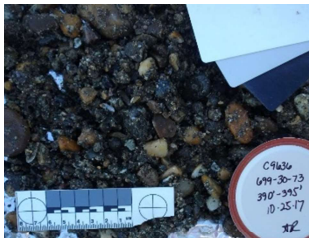
365-370 bgs

370-375 bgs

375-380 bgs

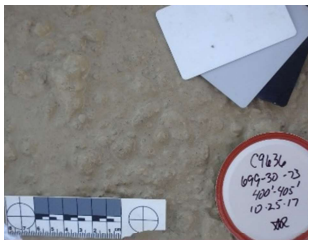
380-385 bgs

385-390 bgs



390-395 bgs

395-400 bgs



400-405 bgs

This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9636	Well Name: 699-30-73	Date: 12·6·17

Location: 0.75mi N of Rattlesnake Gate

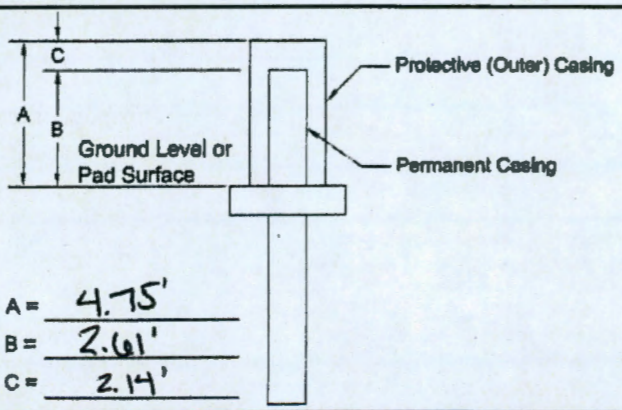
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 12·6·17	230.94	N/A
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 12·6·17	267.8	N/A
Date: —	—	—



A = 4.75'
B = 2.61'
C = 2.14'

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)
255.1	161.4	24.16	45.2	1.57	0838	1037	11.3	0.07
245.1	8.7	14.16	111	2.82	1054	1230	11.3	1.30

Total Pumped: 2430

Pump Model: Grundfos X Model B P1 0243

Troll Serial Number and Pressure Range (PSI and depth): S/N 4030165 70m/231ft

Comments:
Interval 1 file: C9636_derint1_12-6-17 2017 AR 12.6.17

Interval 2 File: C9636_derint2_12-6-2017

Transducer giving readings that don't match up with calculations.

Prepared By:

Print Name	Signature	Date
Andrew Raulerson	[signature]	12·6·17

Reviewed By:

Print Name	Signature	Date
Kelly Whitley	Kelly Whitley	12/19/17

For Office Use Only

OR Doc Type:	WMU Code(s):

This page intentionally left blank.

Distribution

Onsite

CH2M HILL Plateau Remediation Company – Electronic Distribution

D.P. Capelle

R.M. Carter

C.S. Cearlock

J.B. Geiger

A.J. Green

J.L. Hammons

B.J. Howard

P.W. Humphreys

J.P. McDonald

V.J. Rohay

S.M. Sexton

J.L. Smoot

S.D. Springer

K.K. Stiles

K.M. Whitley

C.D. Wittreich

This page intentionally left blank.