PNNL-13199

Borehole Data Package for Wells 299-E33-334 and 299-E33-335 at Single-Shell Tank Waste Management Area B-BX-BY

D. G. Horton

May 2000

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America

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Pacific Northwest National Laboratory
Richland, Washington 99352

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1.0 Introduction

Two new Resource Conservation and Recovery Act (RCRA) groundwater monitoring wells were installed at the single-shell tank farm Waste Management Area (WMA) B-BX-BY during December 1999 through February 2000 in fulfillment of Tri-Party Agreement (Ecology 1996) Milestone M-24-45. The wells are 299-E33-334 and 299-E33-335. These wells were installed in support of the WMA B-BX-BY assessment to track the movement of contaminant plumes that appear to be entering the WMA from the northeast. Well 299-E33-334 is located outside the southwest corner of the 241-BX tank farm and well 299-E33-335 is located south of the 241-BX tank farm. The locations of all wells in the extended monitoring network for WMA B-BX-BY are shown on Figure 1.

The new wells were constructed to the specifications and requirements described in Washington Administrative Code (WAC) 173-160 and WAC 173-303, in the assessment groundwater monitoring plan (Narbutovskih 2000), and in the description of work for well drilling and installation.[1]

This document compiles information on the drilling, construction, well development, pump installation, and sampling activities applicable to wells 299-E33-334 and 299-E33-335. Appendix A contains copies of the Well Summary Sheets (as-built diagrams), the Well Construction Summary Reports, and the geologist's logs. Appendix B contains results of laboratory analyses of moisture content on samples from 299-E33-334 (moisture data were not collected from well 299-E33-335). Appendix C contains borehole geophysical logs and Appendix D contains analytical results from groundwater samples obtained during well construction. Additional documentation concerning well construction is on file with Bechtel Hanford, Inc.

English units are used in this report because that is the system of units used by drillers to measure and report depths and well construction details. Conversion to metric is made by multiplying feet by 0.3048 to obtain meters or multiplying inches by 2.54 to obtain centimeters.

2.0 Well 299-E33-334

2.1 Drilling

Well 299-E33-334 was drilled using a cable tool rig and drive barrel from 0 to 272 ft below ground surface (bgs) and a cable tool rig and hard tool from 272 ft to the total depth of 285 ft bgs during December 1999. The well was started with temporary 11 3/4-in.-outside-diameter, carbon steel casing

[1] Letter from R. M. Smith, Pacific Northwest National Laboratory, Richland, Washington, to G. C. Henckel, Bechtel Hanford, Inc., dated May 26, 1999, "Description of Work for Drilling of CY 1999 RCRA Groundwater Monitoring Wells."

from 0 to 51.5 ft bgs followed by 8 5/8-in.-outside-diameter, carbon steel casing from 51.5 ft to total depth. Approximately 800 gal of water were added to the borehole below 270 ft to facilitate drilling. At about 207 ft bgs, 1 gal was added to keep sediment in the drive barrel.

Sediments encountered during drilling were Hanford formation sandy gravel and gravelly sand from 0 to 47 ft depth, Hanford formation sand with minor silty sand from 47 to 222 ft depth, and undifferentiated Hanford formation/Plio-Pleistocene sandy gravel and silty sandy gravel from 222 to 280 ft depth. Basalt was encountered at 280 ft to total depth. The water table was measured at 263.85 ft bgs on December 22, 1999. The geologist's log is included in Appendix A.

Grab samples were collected at about 5 ft intervals throughout the borehole for geologic description and archive. Separate samples were collected at the same intervals for analysis of moisture content. The results of the moisture analyses are in Appendix B. In addition, split spoon samples were collected between 265.5 and 268 ft (80% recovery) and between 275 and 277.5 ft (100% recovery) depths for potential, future analysis of hydraulic conductivity and particle size distribution. The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. No contamination was detected.

The well was geophysically logged through the temporary casing using NaI spectral gamma-ray and neutron-neutron moisture instrumentation in December 1999. No man-made radionuclides were noted. The geophysical logs are in Appendix C.

2.2 Well Completion

The permanent casing and screen were installed in well 299-E33-334 in December 1999. A 4-in.-inner-diameter, stainless steel, continuous wire-wrap (0.02-in. slot) screen was set from 282.72 to 257.70 ft bgs. The permanent casing is 4-in.-inner-diameter, stainless steel from 257.7 ft bgs to 2.5 ft above ground surface. The bottom of the screen has a 4-in. stainless steel end cap.

The filter pack is 10 to 20 mesh silica sand from 284.1 to 247.4 ft bgs. The annular seal is 8 mesh bentonite crumbles from 247.4 to 10.5 ft bgs and Portland cement with bentonite from 10.5 ft to the surface. A 4 ft by 4 ft by 6 in. concrete pad was placed around the well at the surface. A protective casing with locking cap, four protective steel posts, and a brass marker stamped with the well number were set into the concrete pad. The as-built diagram for well 299-E33-334 is shown in Figure 2. The Well Summary Sheet and the Well Construction Summary Report are in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in March 2000. The horizontal position of the well was determined by Global Positioning System observations referenced to horizontal control stations established by Rogers Surveying, Inc., Richland, Washington. The coordinates are Washington Coordinate System, South Zone, NAD83(91) datum. Vertical datum is NAVD 1988 and is based on existing bench marks established by the U.S. Corps of Engineers. Survey data are included in Table 1.

Figure 1 - Foldout

Page 2 of Foldout

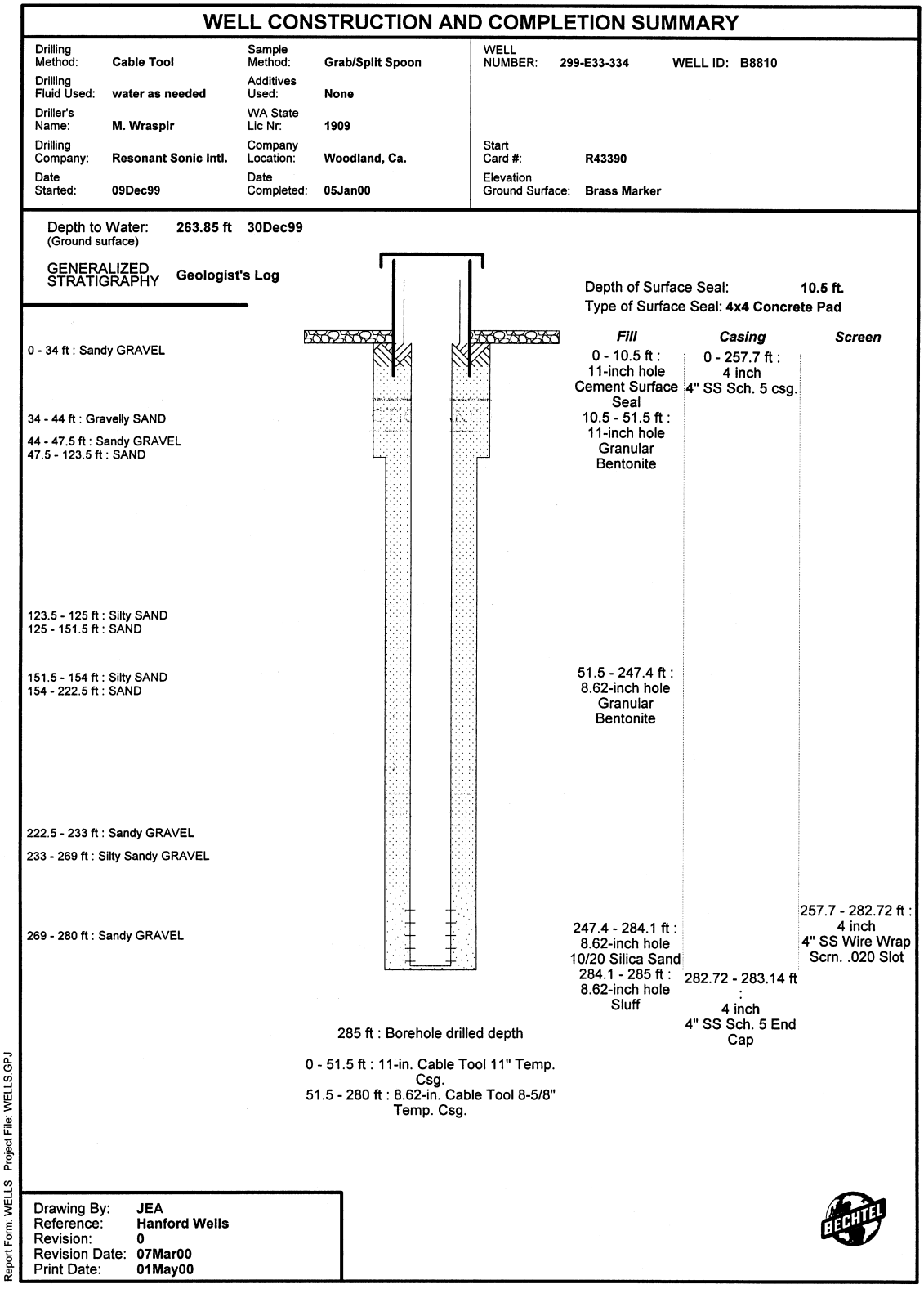


Figure 2. As-Built Diagram for Well 299-E33-334. Elevation reference point is ground surface.

Table 1. Survey Data for New Wells at WMA B-BX-BY

Well Name	Easting m (ft)	Northing m (ft)	Elevation m (ft)	
299-E33-334	573,514,716 (1,881,604.286)	137,256.371 (450,314.820)		Center of Casing
			204.207 (670.003)	"X" on Casing
	573,514.698 (1,881,604.227)	137,256.718 (450,315.958)	203.288 (699.953)	Brass Cap
299-E33-335	573,568.442 (1,881,780.552)	137,222.229 (450,202.806)		Center of Casing
			204.262 (670.183)	"X" on Casing
	573,568.486 (1,881,780.696)	137,222.575 (450,203.941)	203.415 (667.370)	Brass Cap

2.3 Well Development and Pump Installation

Well 299-E33-334 was developed in January 2000. A temporary, 3 hp, submersible pump was used to remove approximately 2,370 gal of formation water from the well at 23 gal/min. The pump intake was 279.17 ft bgs or at about 11.9 ft below the water table. The final turbidity was 0.90 NTU. No drawdown was observed during the test. A groundwater sample was collected from the well at 279.17 ft bgs after well development. The results of the laboratory analysis of the sample are in Appendix D.

A dedicated Hydrostar sampling pump was installed in well 299-E33-334 in January 2000. The sampling pump intake is at 273.47 ft bgs or about 9.6 ft below the water table. Static water level was 263.85 ft bgs on December 30, 1999.

3.0 Well 299-E33-335

3.1 Drilling

The sonic drilling method was used to begin well 299-E33-335 in December 1999. Temporary worker, 11 3/4-in.-outside-diameter, carbon steel casing was placed from the surface to 50.4 ft bgs. An air rotary drill rig was used to finish the drilling and placed temporary 8 5/8-in.-outside-diameter, carbon steel casing from 50 ft to 286 ft bgs. No water was added to the borehole during drilling; however, about 800 gal were added during completion activities to control hydraulic head.

Sediments encountered during drilling were Hanford formation sandy gravel and silty sandy gravel from the surface to about 58 ft depth; Hanford formation sand from 58 ft to about 226 ft depth; and undifferentiated Hanford formation/Plio-Pleistocene silty sandy gravel and sandy gravel from 226 ft to 280.5 ft depth. Basalt was encountered at 280.5 ft to total depth (286 ft bgs). Water level was measured at 264.40 ft bgs on February 9, 2000. The geologist's log is included in Appendix A.

Grab samples were collected for lithologic description and archive at approximately 5 ft intervals from 55 ft to the bottom of the borehole. In addition, split spoon samples were collected from 149 to 151.5 ft, 180 to 182.4 ft, and 209.8 to 212.2 ft bgs for future paleomagnetic analysis to aid stratigraphic interpretation. The borehole cuttings were monitored regularly for organic vapors and radionuclide contaminants. No contamination was found.

Well 299-E33-335 was geophysically logged through the temporary casing using NaI spectral gamma-ray and neutron-neutron moisture instrumentation in February 2000. No man-made radionuclides were noted. The geophysical logs are in Appendix C.

3.2 Well Completion

Well 299-E33-335 was completed in February 2000. During initial completion activities, the permanent 4-in.-inner-diameter casing and screen accidentally were lifted about 10 ft as the temporary casing was being removed. Consequently, all the stainless steel casing and screen were removed from the borehole and the screen was visually inspected for damage. None was apparent. The sand pack was drilled out of the borehole and well completion resumed.

A 4-in.-inner-diameter, stainless steel, wire wrap (0.02-in. slot) screen was set in well 299-E33-335 from 280.03 to 260.01 ft bgs. A stainless steel end cap was put on the bottom end of the screen. Permanent, 4-in.-inner-diameter, stainless steel casing was installed from 260.01 ft bgs to 2.2 ft above ground surface. The total length of the well from top of the permanent casing to bottom of the endcap is 282.63.

The filter pack consists of 10-20 mesh silica placed around the casing from 281.9 to 250.5 bgs. The annular seal is granular bentonite pellets (8 mesh) between 250.5 ft and 10.9 ft bgs. Portland cement with bentonite was placed from 10.9 ft to the surface. About 0.7 ft of fine-grained sediment was in the bottom of the well after well completion.

A 4 ft by 4 ft by 6 in. concrete pad was placed around the well at the surface. A protective casing with locking cap, four protective steel posts, and a brass marker stamped with the well number were set into the concrete. The as-built diagram for well 299-E33-335 is shown in Figure 3. The Well Summary Sheet and the Well Construction Summary Report are included in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in March 2000. The horizontal position of the well was determined by Global Positioning System observations referenced to horizontal control stations established by Rogers Surveying, Inc., Richland, Washington. The coordinates are

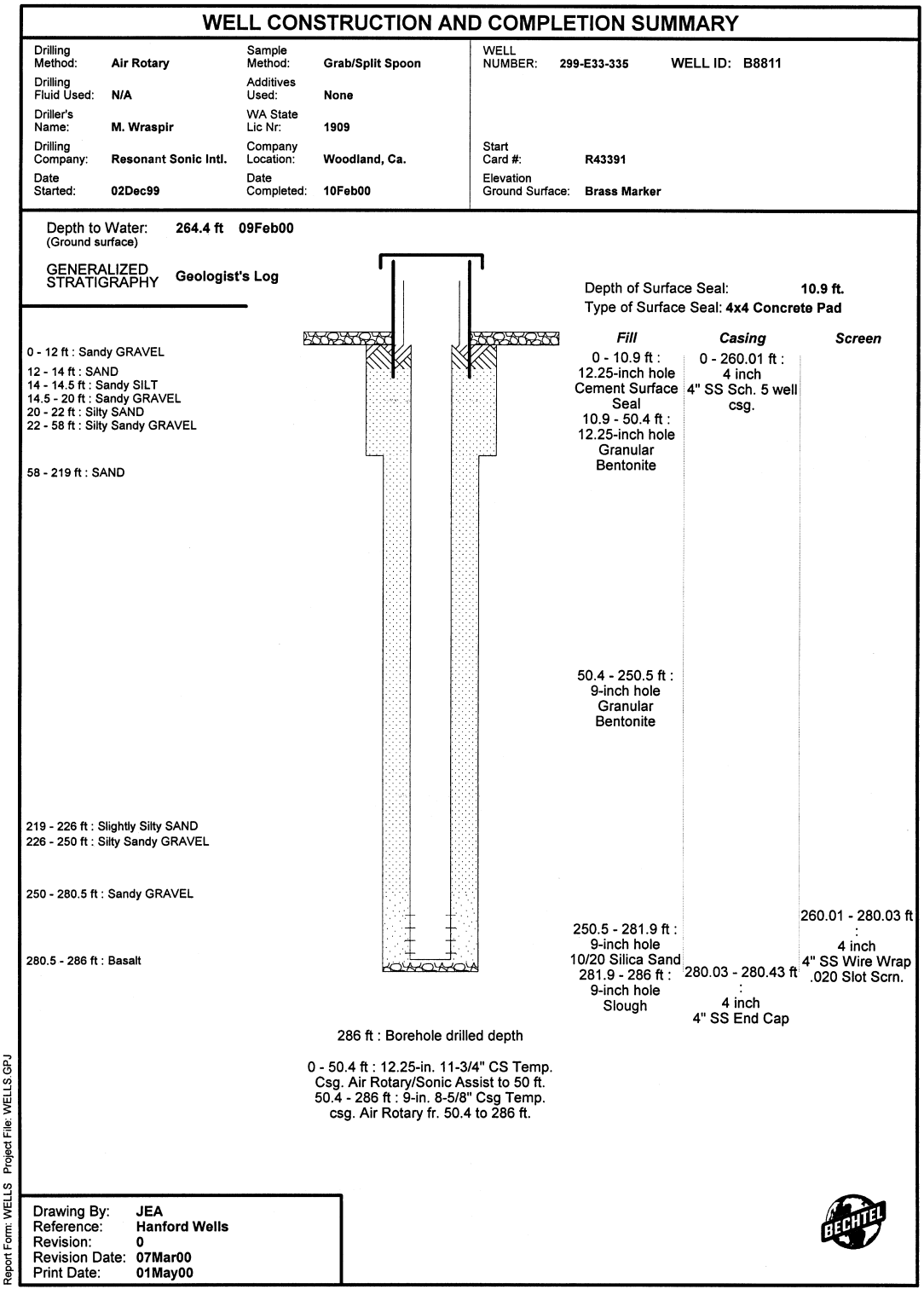


Figure 3. As-Built Diagram for Well 299-E33-335. Elevation reference point is ground surface.

Washington Coordinate System, South Zone, NAD83(91) datum. Vertical datum is NAVD 1988 and is based on existing bench marks established by the U.S. Corps of Engineers. Survey data are included in Table 1.

3.3 Well Development and Pump Installation

Well 299-E33-335 was developed in February 2000. A temporary submersible pump was used to remove approximately 2280 gal of formation water from the well. Drawdown was less than 0.1 ft at 22 to 23 gal/min. The pump intake was at 272.2 ft bgs or at about 7.6 ft below the water table. The final turbidity was 0.74 NTU. A groundwater sample was collected after well development from 272.2 ft bgs. Analytical results are in Appendix D.

A dedicated Hydrostar sampling pump was installed in well 299-E33-335 in February 2000. The sampling pump intake is at 270.9 ft bgs or at about 6.5 ft below the water table. The static water level was 264.4 ft bgs on February 9, 2000.

4.0 References

Ecology - Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. 1996. *Hanford Federal Facility Agreement and Consent Order*. Document No. 89-10, Rev. 4 (The Tri-Party Agreement), Ecology, Olympia, Washington.

Narbutovskih, S. M. 2000. *Groundwater Quality Assessment Plan for Single-Shell Waste Management Area B-BX-BY at the Hanford Site*. PNNL-13022, Pacific Northwest National Laboratory, Richland, Washington.

RCRA - Resource Conservation and Recovery Act. 1976. Public Law 94-580, as amended, 90 Stat. 2795, 42 USC 6901 et seq.

WAC 173-160, Washington Administrative Code. *Minimum Standards for Construction and Maintenance of Wells*. Olympia, Washington.

WAC 173-303, Washington Administrative Code. *Dangerous Waste Regulations*. Olympia, Washington.

Appendix A

Well Construction and Completion Documentation

WELL SUMMARY SHEET

Page 1 of 2

Date: 12/27/99

Well ID: B8810		Well Name: 299-E33-334	
Location: outside SW corner 241-BX Tank Farm / 200E		Project: RCRA Drilling FY 2000	
Prepared By: L.D. Walker	Date: 12/27/99	Reviewed By: DC Weekes	Date: 1/10/00
Signature: LD Walker		Signature: DC Weekes	

CONSTRUCTION DATA

Description	Diagram
Portland Cement Type I, II 0' → 10.5' below ground surface	
Temporary casing 11 3/4" OD 0' → 51.5' bgs	
Stainless Steel. casing, type 304, sched. 5, 4½" OD / 4" ID +2.5' → 257.70' bgs	
Granular bentonite 10.5' → 247.4'	
Temporary casing 8 5/8" OD 51.5' → 280'	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0' → 34': ~~Silty~~ Sandy GRAVEL
25		34' → 44': Gravelly SAND
		44' → 47.5': Sandy GRAVEL
50		47.5' → 123.5': SAND
75		
100		
125		123.5' → 125': Silty SAND
		125' → 151.5': SAND

BHI-EE-189 (12/97)

WELL SUMMARY SHEET

Date: 12/27/99

Well ID: B8810		Well Name: 299-E33-334	
Location: outside SW corner 241-BX Tank Farm/200E		Project: RCRA Drilling FY 2000	
Prepared By: L.D. Walker	Date: 12/27/99	Reviewed By: DC Weekes	Date: 1/10/00
Signature: L.D. Walker		Signature: DC Weekes	

CONSTRUCTION DATA

Description	Diagram
All depths in feet below ground	
All temporary casing removed from ground.	
Silica Sand 10-20 mesh 247.4' → 284.1'	
crushed basalt / sluff 284.1' → 285'	
Stainless Steel screen Cont. wire-wrap 0.020-in slot, type 304 ss 4½" OD / 4" ID 257.70' → 282.72'	
SS endcap 282.72' → 283.14'	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
150		
		151.5' → 154': Silty SAND
		154' → 208': SAND
175		
200		
		208' → 222.5': SAND
225		222.5' → 229': ~~Silty~~ Sandy GRAVEL
		229' → 233': Sandy GRAVEL
		233' → 269': Silty Sandy GRAVEL
250		
		WL = 263.85' bgs (12/30/99)
275		269' → 280': Sandy GRAVEL
		280' → 285': BASALT
		TD = 285'

BHI-EE-189 (12/97)

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 12-9-99
Finish Date: 1-05-00
Page 1 of 1

Specification No.: 0200X-SP-V0002	Rev. No.: 0	Well Name: 299-E33-334	Temp. Well No.: B8810
ECNs: NA		Approximate Location: SW. cor. 241-BX Tank Farm/200E	
Project: RCRA Drilling FY 2000		Other Companies: CHI	
Drilling Company: Resonant Sonic International		Geologist(s): L. Walker D. Weekes J. Faurote	
Driller: M. Wraspir			

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
(FJ) 11" Carbon Steel	0' - 51.5'	12"/10 3/4"
(FJ) 8" Carbon Steel	0 - 280'	9"/7 5/8"
	-	
	-	
	-	

*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design

DRILLING METHOD/HOLE DIAMETER

Auger:	Diameter From ___ to ___
Cable Tool: ✓	Diameter From 0 to 51.5
Air Rotary:	Diameter From 51.5 to 280
A.R. w/Sonic:	Diameter From ___ to ___
	Diameter From ___ to ___
	Diameter From ___ to ___
	Diameter From ___ to ___

Drilling Fluid: water

Total Drilled Depth: 285' Hole Dia @ TD: 7"

Total Amt. Of Water Added During Drilling: ~800 gallons

Well Straightness Test Results:

Static Water Level: 263.85' Date: 12-30-99

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Neutron Moisture	48' - 264'	12-27-99		-	
Spectral Gamma	0' - 285'	12-27-99		-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annual Seal/Filter Pack	Volume	Mesh Size
4" ID endcap, 304 SS	283.14' - 282.72'			Colorado Silica Sand	284.1 - 247.4	10½ bag	10-20
4" ID wirewrap 304 SS screen	282.72 - 257.70		0.020 in	Granular Bentonite	247.4 - 10.5	137 bag	8-mesh
4" ID casing, 304 SS	257.70 - +2.5			Portland Cement w/bent.	10.5 - 0	7½ sack	NA
↳ sched. 5	-				-		
	-				-		

OTHER ACTIVITIES

Aquifer Test: Pump test / Development	Date: 1-5-00	Well Abandoned:	Yes:	No:	Date:
Description: Drawdown & recovery monitored with pressure & transducer during final well development.		Description:			

WELL SURVEY DATA

Date:	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Cap Elevation:

COMMENTS/REMARKS

Volume calcs: Portland Cement - 7.5 x (1.285 ft^3) = 9.64 ft^3 ; Granular bentonite: 137 x 0.71 ft^3 = 97.27 ft^3 ; Silica Sand: 10.5 x 11.76 ft^3

Reported By: L.D. Walker		Reviewed By: J Davidson	
Title: Geologist	Date: 1-11-00	Title: Sr. Eng	Date: 1/18/00
Signature: L.D. Walker		Signature: J Davidson	

BHI-EE-181 (12/97)

BOREHOLE LOG

Page 1 of 10
Date: 12-9-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200 E, outside SW corner 241-BX Tank Farm
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0		DB			Cable tool drilling
				0'→34': ~~Silty~~ Sandy, GRAVEL (~~mSG~~ mSG)	11¾" OD CS casing
				50% gravel, 40% sand, 10% silt. Gravel tr lg cobble, 10% sm cob, 20% v. cse peb, 30% cse, 30% med, 10% fn-v. fn; Sand 20% v.cse to cse, 30% med, 50% fn-v. fn; brown (10YR 4/3)	10"-dia. drive barrel
					β,γ < detectable
5	Archive, moisture				5': Grab sample For archive, moisture analysis. β,γ < det.
				moist, very poorly sorted; gravel R-SR, sand SA-A; gravel predom basalt-also qtzite, granitic, other; sand 50% basalt, 50% qtz/Felds/other; max size 15-20 cm,	
10	Archive, moisture			weak rxn HCl.	10': Grab sample for
				9': gravel content increase to 60%	archive, moisture
					β,γ < det.
15	Archive, moist			16': ~0.5' silt rich gravel	15': Grab sample For archive, moisture β,γ < det.
					20': Grab sample For
20	Archive, moisture			20'→21': large cobbles	archive, moisture
					β,γ < det.
					25': Grab sample For
25	Archive, moisture			25': HCl rxn weak to moderate	archive and moisture
					β,γ < detectable
					LEL, OVM < det.

Reported By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 12-10-99

Reviewed By: DC Weekes | Title: Geologist | Signature: DC Weekes | Date: 1/10/00

BOREHOLE LOG

Date: 12-10-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW corner 241-BX Tank Farm

Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30	Archive, moisture	DB		~~Silty~~ Sandy GRAVEL - as on page 1	Cable tool drilling 11 3/4" OD CS casing
	Moisture			31': moisture increase	
					30': Grab sample for archive, moisture β,γ < detect.
35	Archive, moist.			34' → 44': Gravelly SAND(gS) 25% gravel, 75% sand, tr silt. Gravel tr sm cob, 20% v.cse-cse peb, 40% med peb, 30% fn-v.fn peb; sand 60% v.cse, 20% cse, 20% med-v.fn. Grayish brn (10YR 5/2), moist, mod/poor sorted; gravel is R-SR, sand A-SA; Gravel & sand ~50% basalt, 50% qtz, granitic, other salt/pepper appearance, max size ~ 8cm no rxn HCl.	31': Grab for moist. 35': Grab sample For archive, moisture β,γ < det.
40	Archive, moisture				40': Grab sample for archive, moisture β,γ < det. LEL, OVM < det.
45	Archive moist.			44' → 47.5': Sandy GRAVEL (sG); similar to above, but gravel 40%, sand 60%	45.5': Grab sample Archive/ moisture β,γ < det.
50	Archive, moisture			47.5' → 123.5': SAND (S); 5% gravel, 95% sand. Gravel med-Fn peb, SR-R; sand similar to above - predom. v.cse to cse.	50.5': Grab sample archive and moisture β,γ < det.
55	Archive, moisture			55': gravel content decrease to trace amounts.	11 3/4" OD casing set at 51.5' 55': Grab sample archive, moisture
				58': clumps of sand, weakly cemented. mod. rxn to HCl	LEL, OVM < detect.

Reported By: L.D. Walker | Title: Geologist | Signature: [signature] | Date: 12-14-99

Reviewed By: DC Weekes | Title: Geologist | Signature: DC Weekes | Date: 1/10/00

BOREHOLE LOG

Page 3 of 10
Date: 12-14-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW corner 241-BX Tank Farm
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
60	Archive, moisture	DB			Cable tool drilling
				61.5': Thin layer (~0.2') sandy silt, then back to sand.	8 5/8" OD CS casing
					60': Grab sample for archive and moisture
65	Archive, moist			47.5'→123.5': SAND (S) tr gravel, 100% sand, tr silt. Sand is 10% V. cse, 30% cse, 40% med, 20% fn-v. fn Gray brown (10YR 5/2), sl-moist to dry, mod sorted, SA-A; 30-40% basalt, 60-70% qtz/feld/other; tr iron staining at 70 feet. Max size ~ 8 mm; weak HCl rxn. Tr fn-v. fn peb. at 70'-71'	65': Grab sample for archive, moisture
70	Archive, moist.				70': Grab sample - archive, moisture.
75	Archive, moisture			75': moisture increase - dry to moist.	75': Grab sample - archive, moisture.
80	Archive, moisture			80': Sand predom. cse; otherwise as above.	80': Grab sample - archive, moisture β, γ < detect.
85	Archive, moisture				85': Grab sample - archive, moisture

Reported By: L.D. Walker | Title: Geologist | Signature: L D Walker | Date: 12/14/99

Reviewed By: D C Weekes | Title: Geologist | Signature: D C Weekes | Date: 1/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 4 of 10
Date: 12-14-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW corner 241-BX Tank Farm
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
90	Archive; moisture	DB		47.5'→123.5': SAND (S)	Cable tool drilling
				At 90': 100% sand, tr silt.	8 3/8" OD CS casing
				20% v.cse, 40% cse, 20% med, 20% Fn-v.Fn	
				grysh brn (10YR 5/2), dry-sl. moist,	90': Grab sample for
				mod sorted- ~~well sort~~ w, A-SA, 40%	archive and moisture
95	Archive, moisture			basalt, 60% qtz, Feld, other; weak rxn	
				HCl - occas. weakly cemented fragment	95': Grab sample-
				with a strong rxn to HCl	archive, moisture
					100': Grab sample-
100	Archive) moist.				archive, moisture.
				101'→101.5': silty sand. Sand predom.	
				v. fn-fn. 40% silt, 60% sand.	
				1065': return to predom. cse sand.	
					105': Grab sample-
105	Archive moist.				archive, moisture
					End 12-14-99
	Waste Charact. 3				
	BOX5J8 BOX5K3			Sand continues, no rxn to HCl, same	110' Grab Sample-
				description as @ top of page.	Archive and moisture
110	Archive moist				
					107.5': Waste Charact.*
					Sample - BOX5J8, 5K3
				114-115.5 sl. sty sand, silt is thin,	115' Grab sample -
115	Archive moist			discontinuous, sporadic @ 6-10%	Archive & Moisture

Reported By: L.D. Walker | Reviewed By: D.C. Weekes
Title: Geologist | Title: Geologist
Signature: L.D. Walker | Date: 12/15/99 | Signature: D.C. Weekes | Date: 1/10/00

BOREHOLE LOG

Page 5 of 10
Date: 12-15-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW cor 241-Bx Tank Farm
Project: FY2000 RCRA drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	Archive moist	DB		47.5 → 123.5': SAND (S)	120' Grab sample
				At 120': Sand (S) with trace to locally 10% silt. 20% vcr, 40% cr, 20% med and 20% f-vf grayish-brown (10YR 5/2). The unit is ~~mt~~ moist, poorly sorted, angular to	Archive + Moisture
125	Archive & moist			sub-round, ~40% basalt, 60% other. No rxn to HCl	V. tight from 123.5-125- then Lost the load.
				@ 123.5 vf-f sand (70%), silt 30% - Silty Sand	125: Grab Sample - Archive & moisture.
				mod rxn to HCl. Silt to 40%, lt-mod	
				$CO_3^=$ cement, 10YR6/3 (Pale brown.)	
130	Archive moist			vf-f sand.	
				130' - SAND (S), gray-brown w/ sporadic vf gravel (< 1% @ 1/4" size)	Grab Sample - Archive & moisture
				NO RXN to HCl	
135	Archive moisture			135' - Sand (S) As above, variable	Grab Sample -
				silt, local accretions w/ lt to mod	Archive & Moisture
				rxn to HCl, Isolated, sporadic fine	
				gravel grains.	Begin 12/16/99
140	Archive, moisture				140': Grab sample -
					archive, moisture
145	Archive, moist.			SAND - as above	145': Grab sample,
					archive & moisture.
					LEL, OVM < detect.

Reported By: JM Faurote / L.D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: JM Faurote / L.D. Walker | Date: 12/15/99 | Signature: DC Weekes | Date: 1/10/00

BOREHOLE LOG

Page 6 of 10
Date: 12-16-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW cor. 241-BX Tank Farm
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
150	Archive, moist.	DB			Cable Tool drilling
				151.5'→154': Silty SAND (mS). 5% gravel, 60% sand, 35% silt. Gravel tr sm cob, 40% cse-med peb, 60% fn-v. fn; Sand 40% v. cse-cse, 20% med, 40% fn-v. fn; Brown (10YR 5/3), moist, poorly sorted; gravel R-SR, sand SA; cse sand predom basalt, fn sand predom qtz; max size ≈ 10 cm, mod. rxn HCl	8 5/8" OD CS casing
	moisture				150': Grab sample for archive and moisture analysis. β, γ < detect.
155	Archive, moist.				152': Moisture samp.
				154'→208': SAND (S); tr gravel, 100% sand, tr silt. 10% v.cse, 40% cse, 20% med, 30% fn-v.fn; lt brnish gray (10YR 6/2), dry-sl moist, mod. sorted, SA, ~40% basalt, 60% qtz, Felds, other; max size ~5 mm; predom. no rxn HCl, occ. weak-mod rxn → tr cemented.	155': Grab sample - archive, moisture
160	Archive, moist.				160': Grab sample - archive, moisture.
165	Archive, moist.				165': Grab sample - archive, moisture
170	Archive, moist.			Sand similar to above; predom med.	170': Grab sample - archive, moisture
175	Archive, moist.			175': tr-5% gravel, v.Fn-Fn pebs	175': Grab sample - archive, moisture

Reported By: L. D. Walker | Title: Geologist | Signature: L D Walker | Date: 12/16/99
Reviewed By: DC Weekes | Title: Geologist | Signature: DC Weekes | Date: 1/10/00

BOREHOLE LOG

Date: 12-16-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW cor. 241-BX Tank Farm

Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
180	Archive, moisture	DB			Cable Tool drilling
				sand with $CaCO_3$ cement - strong rxn HCl	8⅝" OD CS casing
				184': sand loose, dry	180': Grab sample for archive, moisture
185	Archive, moist.				LEL, OVM < detect.
					β, γ < det.
				154' → 208': SAND (S)	
				At 190': tr gravel, 100% sand, tr silt.	185': Grab sample - archive, moisture.
	Archive, moist.			gravel is Fn - v. Fn peb, mainly SA basalt.	
190				sand 20% v. csc, 40% csc, 10% med, 30%	
				Fn - v. Fn; lt brnish gray (10YR6/2), dry	190': Grab sample - archive, moisture
				- sl moist, mod. sorted, SA-A, 35%	
				basalt, 65% qtz, Feld, other; max	
				size ≈ 10 mm, weak rxn HCl	
195 ~~200~~	Archive, moist.				195': Grab sample - archive, moisture
200 ~~205~~	Archive, moist.			200': Sand, as above	200': Grab sample - archive, moisture
				drilling more slowly	
				204': silt ~ 0.1' thick, strong rxn HCl	
205 ~~210~~	Archive, moist.			then back to sand as above	205': Grab sample - archive, moisture
					End 12/16/99
				208': Sand more fine	Begin 12/17/99
				- see next page for description -	

Reported By: L.D. Walker | Reviewed By: DC Weekes

Title: Geologist | Title: Geologist

Signature: L.D. Walker | Date: 12-17-99 | Signature: DC Weekes | Date: 1/10/00

BOREHOLE LOG

Date: 12-17-99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW cor. 241-BX Tank Farm

Project: FY2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
210	Archive, moist.	DB		208'→222.5': SAND (S); tr gravel, 100% sand; 5% v. cse, ~~15%~~ 5% cse, 20% med, ~~40%~~ 50% fn, 20% v. Fn; grayish brn (10YR 5/2), dry, well sorted; SA-A, 25% basalt, 75% qtz/feld/other - tr mica, weak rxn HCl.	Cable Tool drilling 8 5/8" OD CS casing 210': Grab sample - archive, moisture -8,8 < detect.
215	Archive, moist				215': Grab sample - archive, moisture.
220	Archive, moist.			222.5': sharp contact; ~0.2' silt, then: ~~Silty~~ Sandy GRAVEL (msG) 40% gravel, 50% sand, 10% silt. Gravel tr v. cse peb, 20% cse peb, 40% med peb, 30% fn, 10% v. fn; sand 20% v. cse-cse 20% med, 60% fn - v. fn. Lt brnish gray (10YR 6/2), dry (silt layer at 222.5' moist) poorly sorted; gravel SR, sand SA-A, gravel 60% basalt, 40% qtz/granitic/other, max size ~4 cm, weak-mod rxn HCl.	220': Grab sample - archive, moisture LEL, OVM < det.
225	Archive, moisture				225': Grab sample - archive, moisture
230	Archive, moist.			-material gradually becomes coarser- 229'→233': Sandy GRAVEL (sG) 60% gravel, 35% sand, <5% silt. Gravel tr sm cobble, 50% v-cse - cse peb, 40% med - fn, 10% fn peb. Color, sand,	230': Grab sample - archive, moisture begin 12/20/99
235	Archive moist.			minerals as above, dry. 233'→269': Silty Sandy Gravel (msG) 60% gravel, 25% sand, 15% silt. as above, with silt content increase	235': Grab sample - archive, moisture 238.5': s/ moist increase

Reported By: L.D. Walker | Reviewed By: DC Weekes

Title: Geologist | Title: Geologist dcw

Signature: LD Walker | Date: 12/20/99 | Signature: DC Weekes | Date: 1/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Date: 12/20/99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E, outside SW cor. 241-BX Tank Farm

Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	Archive, moisture	DB			Cable tool drilling
				233'→269': Silty Sandy GRAVEL (ms6)	8 5/8" OD CS casing
				60% gravel, 25% sand, 15% silt. Gravel	
				tr lg cob, 10% sm cob, 40% v.cse-cse peb,	240': Grab sample -
				30% med peb, 20% fn-v.fn; Sand 10%	archive, moisture
245	Archive, moisture			v.cse-cse, 30% med, 60% fn-v.fn; lt.	β,γ < detect.
				brnish gray (10YR 6/2), dry-sl moist,	LEL, OVM < det.
				poorly sorted, gravel R-SR, sand SA; 50%	
				basalt, 50% granite/qtzite/other; max	245': Grab sample -
				size ~ 15 cm, weak HCl rxn.	archive, moisture.
250	Archive, moist.			245': drilling indicates ~~sm~~ lg cobs/~~lg~~ sm boulders	
					250': Grab sample -
					archive, moisture
				254'-255': sl increase in moisture	255': Grab sample -
255	Archive, moist.			and silt content	archive, moisture
					β,γ < detect.
				many of the cse pebbles/cobbles have	
				fresh broken faces due to the drilling	
260	Archive, moisture				260': Grab sample
					archive, moisture
				264.5': sediment becomes wet	265': Grab sample -
	Archive, moisture				archive, moisture
265					
	SS #1 Hyd. Cond, Sieve	80% rec.			265.5'→268': split
					spoon sample for
					hyd. cond. and sieve
		DB		269': driller notes heaving sand	analysis.

Reported By: L.D. Walker | Reviewed By: DC Weekes

Title: Geologist | Title: Geologist

Signature: [signature] | Date: 12-20-99 | Signature: [signature] | Date: 1/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 10 of 10
Date: 12/20/99

Well ID: B8810 | Well Name: 299-E33-334 | Location: 200E/outside SW cor. 241-BX Tank Farm
Project: FY 2000 RCRA Drilling. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
270	Archive & Waste Charact.	PB		269' → 280': Sandy GRAVEL (sG)	Cable tool drilling
				70% gravel, 25-30% sand, ←30% cw	8 5/8" OD CS casing
		HT		<5% silt. Gravel tr cob, 30% v.cse-cse	12/21/99 a.m.
				peb, 20% med peb, 50% Fn-v.Fn peb; sand	W.L. = 259.5'
				30% v.cse, 20% cse, 30% med, 20% fn-v.fn;	270': Grab sample -
275	SS #2 hyd. cond/ sieve/ archive	100% rec.		v. dk grayish brn (10YR3/2), wet, poorly	archive and
				sorted; gravel R-SR, sand SA; 40%	*Waste characterization
		HT		basalt, 40% granitic, 20% qtzite/other;	(B0X5J9, B0X5K4)
				max size ≈ 10 cm; no HCl rxn - loose,	272': switch to hard tool
	Archive Samples			no cementing.	
280	Archive Samples			275': silt increasing, ~5%	275': Split spoon sample
				280': Hit basalt. Sample is probably unrepres. (279'-280')	hyd. cond./sieve/
				very crushed gravels, slight rxn to HCl	archive
				280' → 285': BASALT, fine pulverized	280': hard tool sample
				basalt w/some sand from above, 10YR4/1	with coarse sand
285				dark gray (wet)	Starting at 280' drilling
					is very slow
					TD = 285 ft
					12/22/99
					Bottom of 8 5/8" casing
290					@ 280 ft bgs.
295					

Reported By: L.D. Walker / DC Weekes | Reviewed By: J Owidsen
Title: Geologist | Title: S. Engineer
Signature: LD Walker / DC Weekes | Date: 12/22/99 | Signature: JA Owidsen | Date: 1/6/00

BHI-EE-183 (12/97)

WELL SUMMARY SHEET

Page 1 of 2

Date: 2-9-00

Well ID: B8811		Well Name: 299-E33-335	
Location: South side BX-BY Tank Farm / 200 E		Project: FY 2000 RCRA Drilling	
Prepared By: L.D. Walker	Date: 2-9-00	Reviewed By: DC Weekes	Date: 2/10/00
Signature: LD Walker		Signature: DC Weekes	

CONSTRUCTION DATA

Description	Diagram
Portland Cement 0 → 10.9' below ground surface	
Temporary casing 11 3/4" OD 0 → 50.4'	
Stainless steel casing type 304, sched. 5 4 1/2" OD / 4" ID +2.2' → 260.01'	
Granular bentonite 10.9' → 250.5'	
Temp casing 8 5/8" OD 50.4' → 280.8'	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		
		0' → 7': Sandy GRAVEL
		7' → 12': Sandy GRAVEL
		12' → 14': SAND
		14' → 14.5': Sandy SILT
25		14.5' → 20': Sandy GRAVEL
		20' → 22': Silty SAND
		22' → 45': Silty Sandy GRAVEL
50		45' → 50': Silty Sandy GRAVEL
		50' → 58': Silty Sandy GRAVEL
75		58' → 219': SAND
100		
125		

BHI-EE-189 (12/97)

WELL SUMMARY SHEET

Date: 2-9-00

Well ID: B 8811		Well Name: 299-E 33-335	
Location: South side BX-BY Tank Farm / 200E		Project: FY 2000 RCRA Drilling	
Prepared By: L. D. Walker	Date: 2-9-00	Reviewed By: DC Weekes	Date: 2/10/00
Signature: LD Walker		Signature: DC Weekes	

CONSTRUCTION DATA

Description	Diagram
Silica Sand 10-20 mesh 250.5' → 281.9'	
Sluff: 281.9' → 286'	
Stainless Steel Wellscreen Cont. wire wrap 0.020-in slot, type 304-SS, 4½"/4" 260.01' → 280.03'	
Stainless Steel endcap, type 304 4½"/4" 280.03' → 280.43'	
All depths in feet below ground. All temporary casing removed from the ground.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
150		
175		
200		
225		219' → 226': Slightly Silty SAND
		226' → 250': Silty Sandy GRAVEL
250		250' → 280.5': Sandy GRAVEL
		2-9-00 W.L. = 264.40'
275		280.5' → 286': BASALT
		TD = 286'

BHI-EE-189 (12/97)

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 12-2-99
Finish Date: 2-10-00
Page 1 of 1

Specification No.: 0200X-SP-V0002	Rev. No.: 0	Well Name: 299-E33-335	Temp. Well No.: B8811
ECNs: NA		Approximate Location: S. side BX-BY Tank Farm/200E	
Project: RCRA drilling FY 2000		Other Companies: BHI, CHI, THI	
Drilling Company: Resonant Sonic Intn.		Geologist(s): P. Moore, L. Walker	
Driller: W. Worth			

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
(FJ) 11 3/4" OD Carbon Steel	0 - 50.4	12 1/4" / 10 3/4"
(FJ) 8 5/8" OD Carbon Steel	0 - 280.8'	9" / 7 5/8"
	-	
	-	
	-	

*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design

DRILLING METHOD/HOLE DIAMETER

Auger:	Diameter From ____ to ____
Cable Tool:	Diameter From ____ to ____
Air Rotary:	Diameter From 50' to 286'
A.R. w/Sonic:	Diameter From 0 to 50.4
	Diameter From ____ to ____
	Diameter From ____ to ____
	Diameter From ____ to ____

Drilling Fluid: ~~new water~~ 2-10-00 LW Air

Total Drilled Depth: 286' | Hole Dia @ TD: 7 1/4"

Total Amt. Of Water Added During Drilling: ~800 gallons

Well Straightness Test Results:

Static Water Level: 264.40' Date: 2-9-00

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
RLS Neutron Moisture	46' - 265'	2-3-00		-	
RLS Spectral gamma (Sodium iodide)	0 - 282.5	2-2-00		-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annual Seal/Filter Pack	Volume (Cu. Ft.)	Mesh Size
4" ID 304SS endcap	280.43' - 280.03		NA	Silica Sand	281.9' - 250.5	23.54	10-20
4" ID 304SS ww screen	280.03 - 260.01		0.020-in	Granular Bentonite	250.5 - 10.9	88.40	#8
4" ID 304SS casing (sched. 5)	260.01 - +2.2		NA	Portland Cement	10.9 - 0	11.57	NA
	-			w/ 5% bent.	-		
	-				-		

OTHER ACTIVITIES

Aquifer Test: Pumping well development	Date: 2-10-00	Well Abandoned:	Yes:	No:	Date:
Description: Drawdown less than 0.1 ft at sustained pump rate of 23gpm. Final turbidity = 0.74 NTU.		Description:			

WELL SURVEY DATA

Date:	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Cap Elevation:

COMMENTS/REMARKS

10-20 Silica Sand: 22 (100-lbs bag) x 1.07 ft^3/bag = 23.54ft^3; #8 mesh gran. bent: 124.5 (50-lbs bag) x 0.71 ft^3/bag = 88.40ft^3; Portland cement: 9 (94-lbs/bag) x 1.285 = 11.57ft^3

Reported By: L.D. Walker LW 2-10-00 2-10-00		Reviewed By: J.E. Auten	
Title: Geologist	Date: ~~2-10-00~~	Title: Sr. Drlg. Engr.	Date: 2/28/00
Signature:		Signature:	

BHI-EE-181 (12/97)

BOREHOLE LOG

Page 1 of 10
Date: 12/2/99

Well ID: 299-E33-335 | Well Name: B8811 | Location: Southside 3x8' Park Farm
Project: 1999 RCRA Protection wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0					Sonic, 11 3/4"
				0-7' sandy GRAVEL, 35% Gravel,	casing.
				65% SAND, Gravels 60% basalt, 40% other,	
				numerous cobbles, A-SR, moist, max cobble = 160mm	
	Archive 1			poorly sorted, Sand 10YR 5/6 (moist) yellow brown	
5				SA, 40% basalt, 60% other, v. poorly sorted, rxn to HCl = strong	
					50:1 + background
				7-12 sandy GRAVEL, 65% Gravel,	@ 300-350 dpm
				35% sand, ~~10YR 5/6 yellow~~, 10YR 3/2 very	∴ Action level
	Archive 2			dk gray brown, gravel 70% basalt, 30% other, A-SR,	
10		PA		Gravel max part = 65mm, Sand 80% basalt,	
				20% other, SA, no rxn to HCl, mod. sorted (med +	
				Less grained), several cobbles (broken) to 110mm)	
				12-14 SAND, as above,	
	Archive 3			14-14.5' silt loose (sandy), 70% silt,	
15				30% sand, 10YR 5/3, (moist), brown, moist, mod-strong rxn HCl,	
				sand 50-60% basalt, trace mica, med-Less grained,	
				mod. sorted	
				14.5-20' sandy Gravel 40% gravel,	
	Archive 4			(A-SR, 40% basalt, mod sorted), sand 10YR 4/4	
20				(moist) dk yellow brown, moist, V. poorly sorted, mod rxn HCl.	
				20-~~22~~ 22.5' Silty SAND, 45% silt, 55%	
	Archive 5			sand, 2.5Y 5/4 lt. olive brown, moist,	
				~~22~~ 22.5-45 Silty Sandy GRAVEL, 10% silt,	
				55% gravel, 35% sand, V. poorly sorted gravel	
	Archive 5			SR, max particle = 70mm, sand: 2.5Y 5/3 lt. olive brown,	
25				moist, v. poorly sorted, 40% basalt,	
				no RXN to HCl, cobbles to 200mm.	
	Archive 6				
30					

Reported By: Pat Moore | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: Pat Moore | Date: 12/2/99 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 2 of 10
Date: 12/2/99

Well ID: 299-E33-335 | Well Name: B8811 | Location: South side BxBY Tank Farm
Project: 1999 RCRA Protection wells | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30					Sonic 11 3/4" casing
	Archive 7				
35					All soil to 50' < 50 dpm over background
	Archive 9				Background varies (300-350 dpm)
40		NA			
	Archive 9			45 - 50' Silty sandy gravel, increasing silt content and clumps of sandy silt, 20% silt, 45% sand, 35% gravel, Gravels poorly sorted, SA-SR, 60% basalt, 40% other, max particle = 60 mm, Sand 40% basalt, 60% other, 10YR 4/2 (moist) dk. grayish brown, moist, mild rxn to HCl.	End 12/2/99 Beg. 12/3/99
45					End 12/3/99
	Archive 10				1-31-00
50				50' → 58': Silty Sandy GRAVEL (ms G) similar to described above. Air rotary drilling breaks up gravel over 1-2 cm weak rxn to HCl	Begin Air rotary drilling; 8 5/8"/7 5/8" carbon steel casing
	Grab-Archive				55': Grab sample for archive.
55				58': gravel decreases to SAND - see page 3 description	

Reported By: Pat Moore | Title: Geolog-ist | Signature: Pat Moore | Date: 12/2/99
Reviewed By: DC Weekes | Title: Geologist | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 3 of 10
Date: 1-31-00

Well ID: B8811 | Well Name: 299-E33-335 | Location: Southside BX-BY Tank Farm
Project: 2000 FY RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
60	Grab-Archive	Air Rotary			Air rotary
				58' → 219': SAND (S); tr-5% gravel, 90-100% sand, tr-5% silt. Gravel tr med-fn peb, predom v-fn peb. Sand is 25% v. cse, 20% cse, 25% med, 30% fn-v. fn; dk grayish brn (10YR 4/2), sl moist; mod-well sorted; sub-angular to sub-round; 20-30% basalt, ~~50% qtz, 20-30% Feldsp~~ LW 1-31-00 70-80% qtz/Feld/other. Max part. size ≈ 10 mm, weak rxn HCl.	Casing 8 5/8" OD
					7 1/4" tricone bit
					60': Grab sample for archive
65	Grab-Archive				
					65': Grab sample for archive
					70': Grab sample for archive
70	Grab-Archive				B, S < detectable OVM, LEL < detect.
				75': ~~grain~~ grain size decrease. Sand is predom med otherwise similar to above tr mica	
75	Grab-Archive				75': Grab sample for archive
					80': Grab sample for archive
80	Grab-Archive				
					85': Grab sample for archive.
85	Grab-Archive				

Reported By: L.D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LD Walker | Date: 1-31-00 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 4 of 10
Date: 1-31-00

Well ID: B8811 | Well Name: 299-E33-335 | Location: South side BX-BY Tank Farm/200 E
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
90	Grab-Archive	NA		SAND (S) as described on page 3.	Air rotary, 7¼" tricone bit; 8⅝" OD cs casing
	Air Rotary			at 90': grain size increase. Sand is predom cse	
					90': Grab sample for archive
95	Grab-Archive				
					95': Grab sample for archive
100	Grab-Archive			100': tr v. fn peb	100': Grab sample for archive
					105': Grab sample for archive
105	Grab-Archive				
					110': Grab sample for archive
				SAND (S) - similar to above tr gravel, 100% sand, tr silt Gravel is v. fn peb; Sand 10% v. cse, 30% cse, 40% med, 20% Fn-v. fn; 10YR4/2 (dk gr. brn), s/ moist; mod sorted, A-SA; 30% basalt, 70% qtz/ other, tr mica; Max size ≈ 4 mm, weak rxn HCl.	
110	Grab-Archive				
					115': Grab sample for archive
115	Grab-Archive				

Reported By: L.D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LDWalker | Date: 1-31-00 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 5 of 10
Date: 1-31-00

Well ID: B8811 | Well Name: 299-E33-335 | Location: South side BX-BY Tank Farm/200
Project: FY 2000 RCRA Drilling | Reference Measuring Point:

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	Grab-Archive	NA			Air rotary; 7¼" tricone bit
	Air Rotary				8⅝" OD casing
				124'→125': sl increase in silt. 95% sand, 5% silt	120': Grab sample for archive
125	Grab-archive				
					125': Grab sample for archive
				silt content decrease, sand becomes coarser	
130	Grab-Archive				130': Grab sample for archive
				SAND (S); tr gravel, 100% sand, tr silt. Gravel Fn-v. Fn peb; Sand 20% v. cse, 30% cse, 30% med, 20% Fn-v. Fn; 10YR4/2 (dk gr brn) sl moist; mod sorted; SA-SR; 30% basalt, 70% qtz/Felds/other, tr mica; Max size 5-6 mm; weak rxn HCl.	135': Grab sample for archive
135	Grab-Archive				
					140': Grab sample for archive; end 1-31-00
140	Grab-Archive				Begin 2-1-00
				145': sand becoming finer - predom. medium	145': Grab sample for archive.
145	Grab-Archive				

Reported By: L.D. Walker | Title: Geologist | Signature: LD Walker | Date: 2-1-00
Reviewed By: DC Weekes | Title: Geologist | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 6 of 10
Date: 2-1-00

Well ID: B8811 | Well Name: 299-E33-335 | Location: South side BX-BY Tank Farm
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
150	SS #1 paleo-mag.	100% rec. & archive			Air rotary, 7 1/4" tricone bit, 8 5/8" OD CS casing
				SAND (S), tr gravel, 100% sand, tr silt. Gravel Fn-v. Fn; Sand 15% v. cse, 30% cse, 40% med, 15% Fn-v. Fn. 10YR 4/2 (dk gr brn) sl moist, mod sorted, A-SA, 30-35% basalt, 65-70% qtz/other, max size ~ 5 mm, weak HCl rxn.	149'→151.5': split spoon for paleo-mag analysis. Also, 150' air rotary grab sample for archive.
155	Grab-Archive				155': Grab sample For archive
160	Grab-Archive				160': Grab sample For archive.
165	Grab-Archive			Sand size decreases - predom med-Fn mineralogy as above	165': Grab sample For archive
170	Grab-archive				170' Grab sample For archive
175	Grab-Archive				175': Grab sample For archive.
				Sand becoming coarser med-cse	

Reported By: LD Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LD Walker | Date: 2-1-00 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 7 of 10
Date: 2-1-00

Well ID: B8811 | Well Name: 299-E33-335 | Location: South side BX-BY Tank Farm/200E
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
180	Grab-Archive				Air rotary, 7¼" tricone bit, 8⅝" OD casing
	SS #2 Paleo-mag	90% rec.		SAND (S), tr-5% gravel, 95-100% sand, tr silt. Gravel med-v. fn peb, sand 20% v. cse, 20% cse, 40% med, 20% fn-v. fn; 10YR 5/2 (gr brown), sl-moist to dry; mod sorted, A-SR, 40% basalt, 60% qtz/feld/other; max size ≈ 10 mm; rxn to HCl weak-none.	179-180': Grab sample for archive.
	Air Rotary ↓ Grab-archive				180'→182.4': split spoon for paleo-mag. analysis
185				186'→187': driller notes binding in drill bit indicating gravels	
	Grab-Archive				185': Grab sample for archive
190					190': Grab sample for archive
	Grab-Archive			195': sand becoming finer - predom med-fn	
195					200': Grab sample for archive
					Begin 2-2-00
	Grab-Archive			200': tr gravel; fn-med	205': Grab sample for archive
200					
	Grab-Archive			sand is mod-well sorted, predom med size; 25% basalt, 75% qtz/other	
205					

Reported By: L.D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LD Walker | Date: 2-2-00 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 8 of 10
Date: 2-2-00

Well ID: B 8811 | Well Name: 299-E33-335 | Location: South side BX-BY Tank Farm/200E
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
210	Grab-Archive				Air rotary; 8⅝" OD casing
	SS #3 Paleo-mag	90% rec.		SAND (S) 100% sand, tr silt. 20% v. cse-cse, 60% med, 20% fn-v. fn. 10YR 5/2 (grayish brn), sl moist, mod-well sorted; SA; 20% basalt, 80% qtz/feld/other, tr iron stain; max size ~ 2 mm; no rxn HCl.	209'→210': grab sample for archive <EL, OVM < detect
215	Grab-Archive				209.8'→212.2': split spoon for paleo-mag analysis.
	Grab-Waste Charact.			219'→226': Slightly Silty SAND (ms) S) 85%-90% sand, 10-15% silt Sand 80% v. fn, 20% fn-med/cse increase ~225'. 10YR 6/3 (pale brown) sl moist; well sorted, SA-SR, 10-15% basalt, 85-90% qtz/felds; weak to mod rxn to HCl	215': Grab sample for archive
220	Grab-Archive				217': Grab sample Waste characterization. HEIS # B0X5K1, B0X5K6 β, γ < detect.
225	Grab-Archive				220': Grab sample for archive
				226'→250': Silty Sandy GRAVEL (msG) 40% gravel, 45% sand, 15% silt. Due to drilling method, impossible to accurately give gravel size distribution. Rounded fn-med pebbles common, drilling indicated occas. cobble sizes. Sand predom. med-fn. 10YR 5/2 (grayish brown), dry; sand A-SA; gravel 60% basalt, 40% qtz/granitic/other Sand 30% basalt, 70% qtz/other weak rxn HCl.	225': Grab sample for archive
230	Grab-Archive				230': Grab sample for archive.
235	Grab-Archive				235': Grab sample for archive

Reported By: L.D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LD Walker | Date: 2-2-00 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 9 of 10
Date: 2-2-00

Well ID: B8811 | Well Name: 299-E33-335 | Location: South side BXBY Tank Farm / 200E
Project: FY 2000 RCRA Drilling. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	Grab-Archive	NA			Air rotary; 8⅝" OD casing 240': grab sample For archive
245	Grab-Archive			Silt content decreasing	245': grab sample For archive
250	Grab-Archive			250'→280.5': Sandy GRAVEL (sG) 50% gravel, 40-45% sand, 5-10% silt. Drilling indicates occ. cobbles. Sand 10% v.cse-cse, 40% med, 40% Fn, 10% v. fn; color and minerals similar to msG described above; dry, weak rxn HCl.	250': grab sample For archive drill rate slows to 5 Ft/15 min
255	Grab-Archive				255': Grab sample For archive.
260	Grab-Archive			~262': cuttings begin to appear moist	260': Grab sample For archive.
265	Grab-Archive			265'→266' Drilling indicates smaller gravel v. Fn - Fn, round pebbles in cuttings	265': Grab Sample For archive

Reported By: L.D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LD Walker | Date: 2-2-00 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 10 of 10
Date: 2-2-00

Well ID: B8811 | Well Name: 299-E33-335 | Location: S. side BX-BY Tank Farm / 200 E
Project: FY 2000 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
270	Grab-Archive	NA			Air rotary; 8 5/8" OD Casing
	Grab-Waste Charact.			Sandy GRAVEL (sG) as described pg. 9	270': Grab sample For archive
				gravel content slowly increase to ≈ 70%	272': Grab sample For waste charact. HEIS #B0X5K2, B0X5K7
275	Grab-Archive				275': Grab sample For archive
280	Grab-Archive			280.5' → 286': BASALT vesicular upper ~1 Ft, then solid Fresh fragments. Black, wet.	280': Grab sample For archive
285	Grab-Archive				285': Grab sample For archive
					8 5/8" OD casing set at 280.8' TD = 286 Ft. bgs
290					Water level 264.40' (2-9-00)
295					

Reported By: L.D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LD Walker | Date: 2-2-00 | Signature: DC Weekes | Date: 2/10/00

BHI-EE-183 (12/97)

Appendix B

Moisture Content for Samples from Well 299-E33-334

Appendix B

Moisture Content for Samples from Well 299-E33-334

This appendix includes the results of laboratory testing for moisture content of samples collected from well 299-E33-334. Moisture content was measured as weight loss after drying an aliquot of the bulk sample at 105º C for 24 hours or until weight was constant for two consecutive measurements. The measurements were done in the Applied Geology and Geochemistry Group laboratory under the supervision of Mr. Jeff Serne.

Table B.1. Moisture Content of Sediment Samples from Borehole 299-E33-334

299-E33-334					
Depth (ft bgs)	**Moisture Content (wt %)**	**Depth (ft bgs)**	**Moisture Content (wt %)**	**Depth (ft bgs)**	**Moisture Content (wt %)**
5	4.14	95	3.12	185	2.59
10	4.24	100	3.03	190	2.79
15	3.91	105	3.25	195	3.23
20	5.86	110	3.74	200	3.15
25	6.90	115	3.43	205	2.92
30	6.14	120	3.44	210	3.63
31	11.19	125	6.69	215	3.48
35	3.38	130	2.16	220	3.21
40	3.58	135	2.25	225	2.79
45.5	3.11	140	2.39	230	2.63
50.5	2.17	145	2.40	235	2.65
55	2.24	150	2.42	240	2.99
60	3.06	152	8.00	245	2.93
65	2.05	155	2.68	250	3.16
70	2.19	160	2.74	255	3.66
75	2.39	165	2.68	260	2.88
80	2.45	170	2.84	265	5.24
85	2.99	175	2.63		
90	2.71	180	2.70		

Appendix C

Borehole Geophysical Logs

Appendix C

Borehole Geophysical Logs

This appendix contains the NaI spectral gamma-ray and neutron-neutron moisture logs for wells 299-E33-334 and 299-E33-335. The logs were run and analyzed by Waste Management Federal Services Northwest, Inc. Log Header sheets and Log Analysis Summary Reports are included with the logs.

RLS Scintillator Gamma Ray Borehole Survey

Waste Management Technical Services

Log Header

Project: PNNL RCRA Well: **299-E33-334**

Log Type: NaI Spectral Gamma Ray

Borehole Information

Well #	B8810	Water Depth	263.8 ft	Total Depth	285 ft
Elevation Reference	n/a	Elevation	n/a ft		
Depth Reference	Surface	Casing Stickup	2.1 ft		
Casing Diameter	11.75 in	Depth Interval	0 to 51.75 ft	Thickness	0.5 in
Casing Diameter	7.625 in	Depth Interval	0 to 280 ft	Thickness	0.5 in

Logging Information

Log Type:	NaI Spectral Gamma Ray	
Company	Waste Management Technical Services	
Date/Archive File Name	December 27, 1999	H2E33334
Logging Engineers	S.E.Kos	
Instrument Series	RLSNAI00L00.0	
Logging Unit	RLS-1	
Depth Interval	1 to 200 ft	Prefix A688
	170 to 285 ft	Prefix A689
Instrument Calibration Date	Dec 13, 1999	
Calibration Report	WHC-SD-EN-TI-293	

Analysis Information

Company	Three Rivers Scientific
Analyst	Russ Randall
Date	February 15, 2000
Depth Reference	Ground Surface

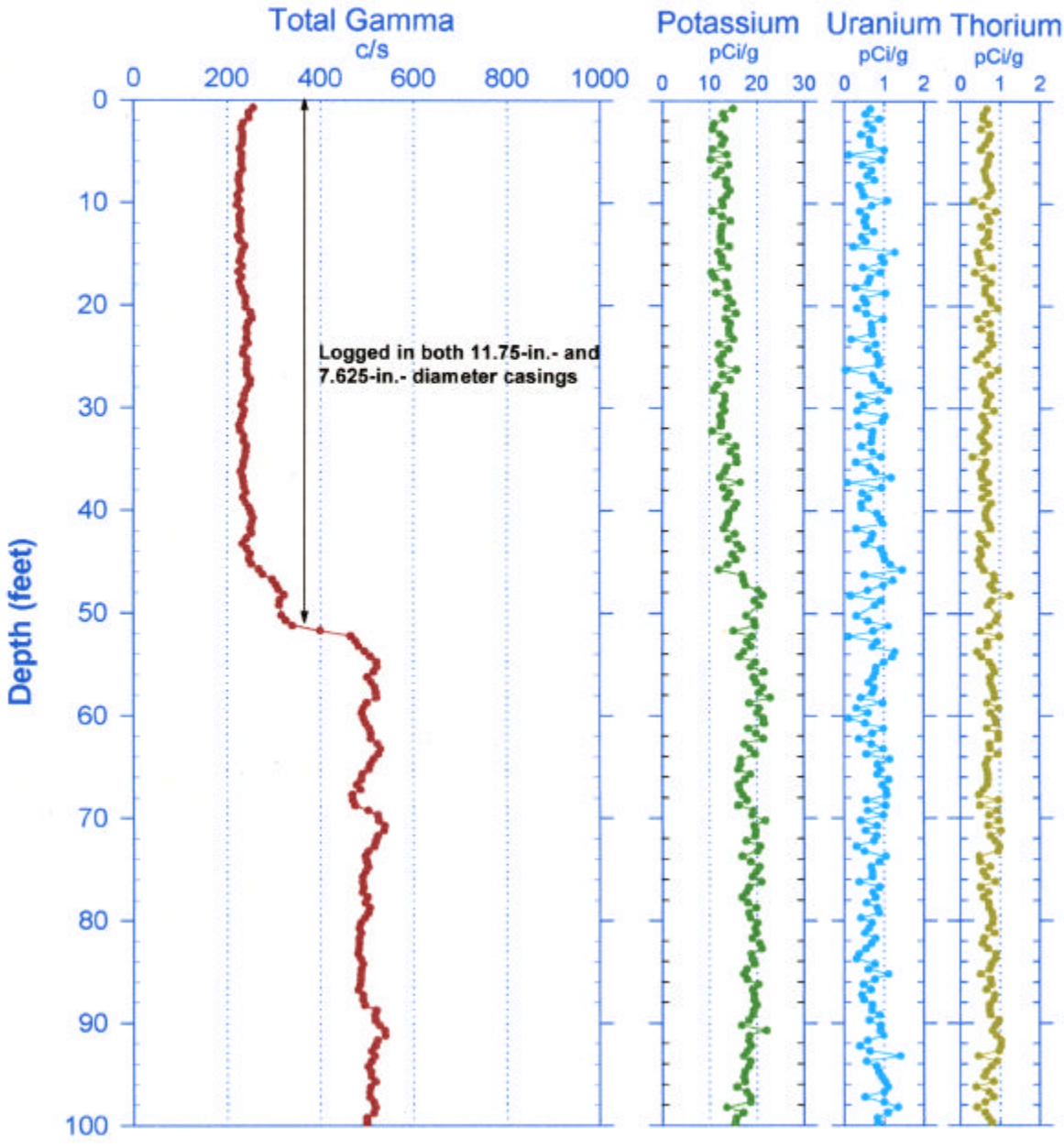
Notes Some individual spectra over 170 to 200 feet exhibited gain to high to measure the thorium photo peak. These spectra were deleted from the analysis. Since the deleted spectra were all contained in the repeated interval, no depth intervals were lost.

RLS Spectral Scintillator Borehole Survey

Waste Management Technical Services

Project: RCRA Drilling 2000 Log Date: Dec. 27, 1999

Well: 299-E33-334 Depth Datum: Ground Level

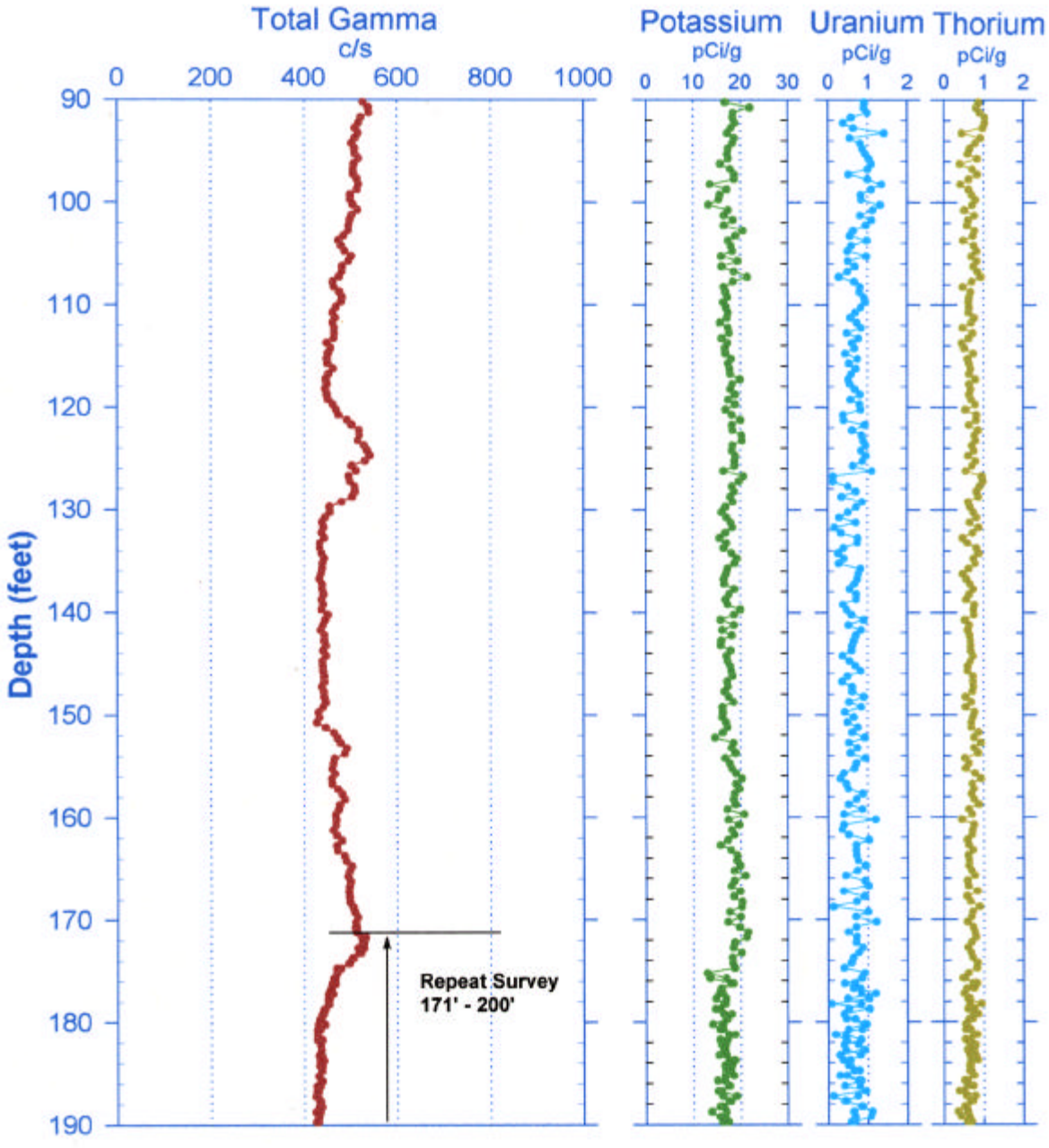


RLS Spectral Scintillator Borehole Survey

Waste Management Technical Services

Project: RCRA Drilling 2000 Log Date: Dec. 27, 1999

Well: 299-E33-334 Depth Datum: Ground Level

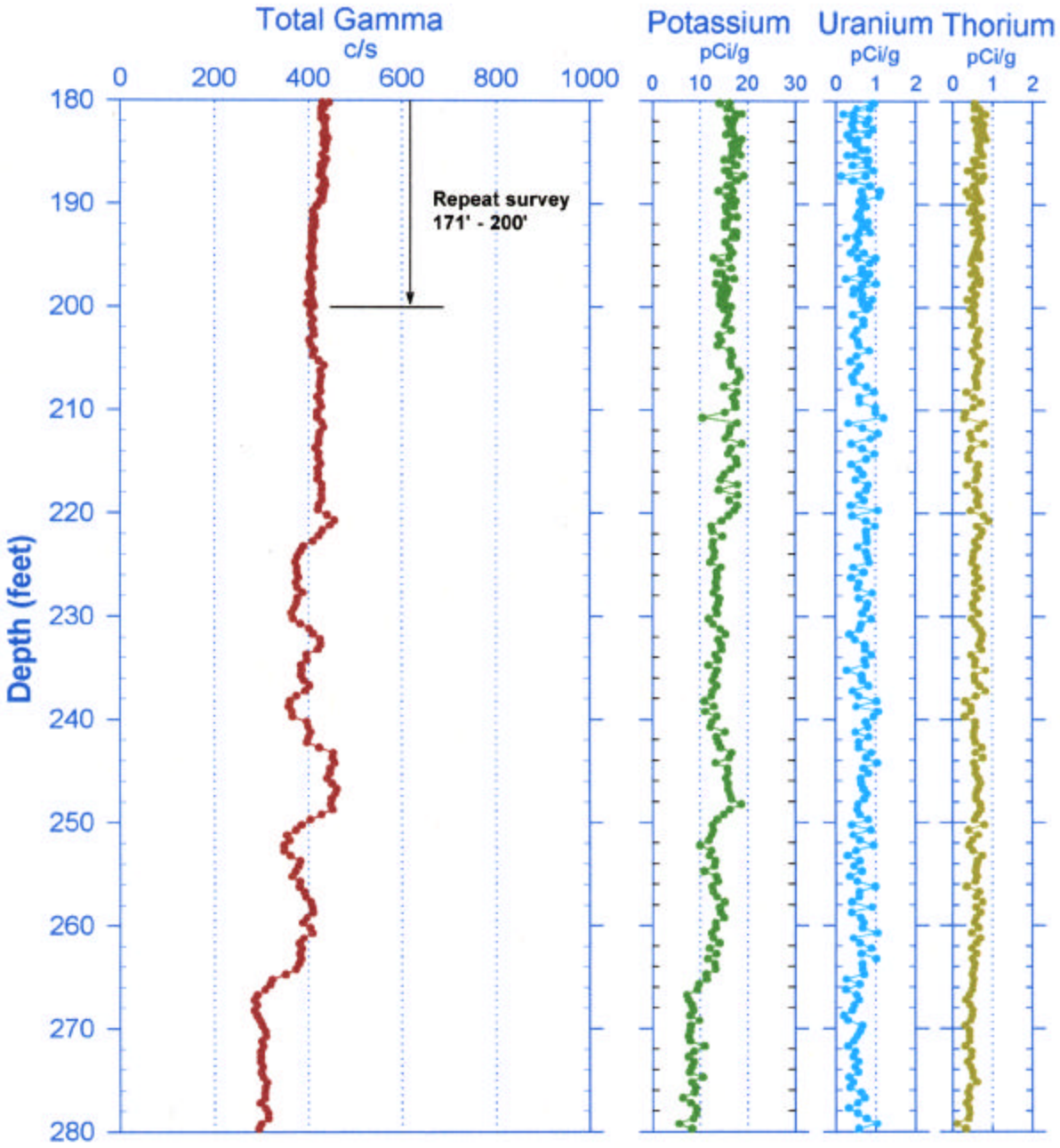


RLS Spectral Scintillator Borehole Survey

Waste Management Technical Services

Project: RCRA Drilling 2000 Log Date: Dec. 27, 1999

Well: 299-E33-334 Depth Datum: Ground Level



RLS Spectral Scintillator Borehole Survey

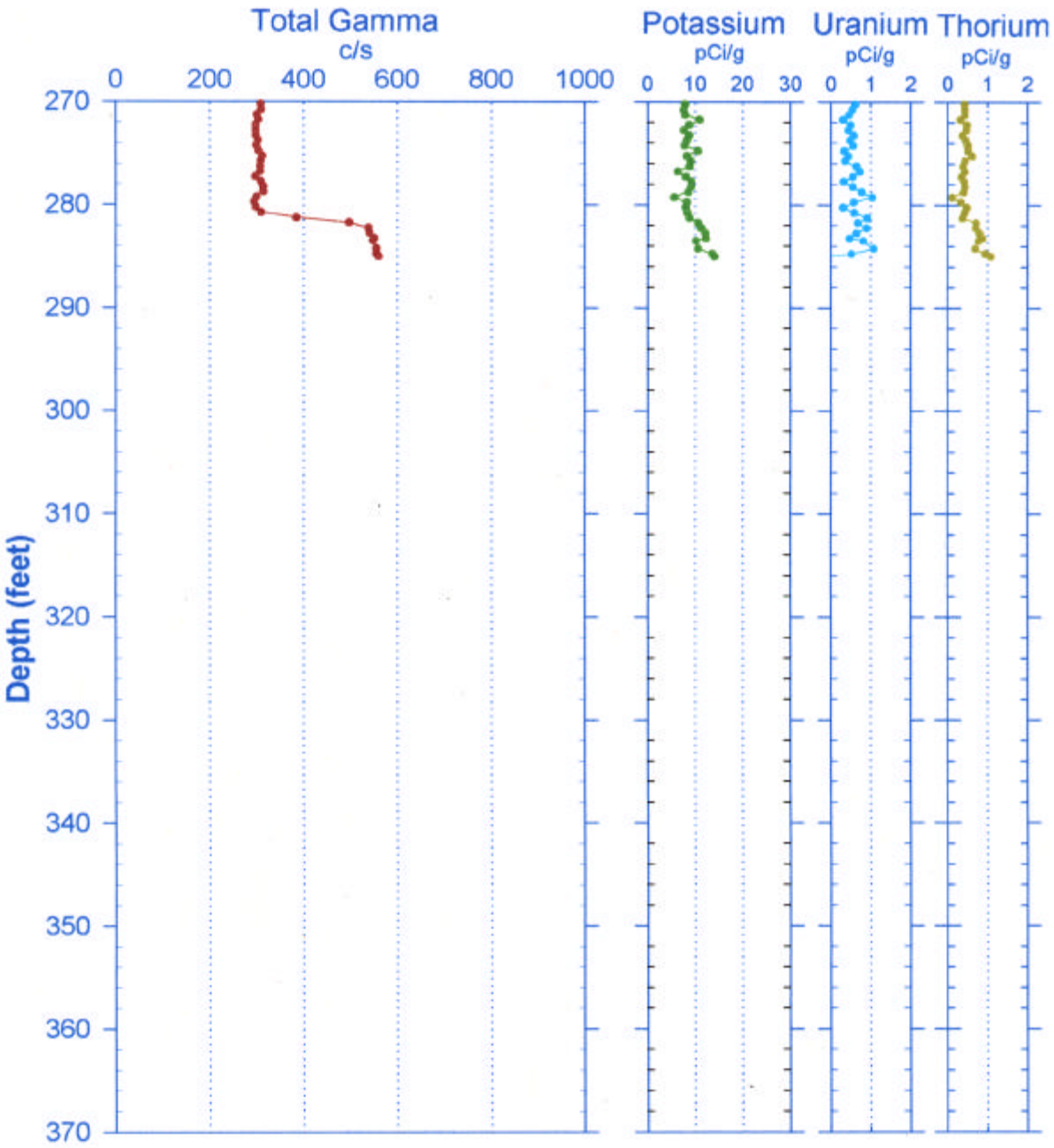
Waste Management Technical Services

Project: RCRA Drilling 2000

Log Date: Dec. 27, 1999

Well: 299-E33-334

Depth Datum: Ground Level



RLS Scintillator Gamma Ray Borehole Survey

Waste Management Technical Services

Log Analysis Summary Report

Project: PNNL RCRA
Well: 299-E33-334
Log Type: NaI Spectral Gamma Ray
Log Date: December 27, 1999

General Notes:

Total gamma is a response to geologic concentrations of natural radionuclides.

Log data collected with a depth reference of ground surface.

Log data over the depths from 170.75 to 1175.25, 193.73 to 194.25, and 195.75 to 196.25 were lost due to excessive energy gain. Since these data points were covered in the repeat interval, all depths have at least one reading.

The energy to channel gain-settings changed throughout the logged intervals. The changes were outside of acceptable standards for the KUT computations. Thus a processing of the spectra to re-gain the energy using the potassium photo peak was performed. The results were successful except for the intervals listed above.

System Performance Verify: The pre- and post-log verification passed performance standards.

Repeat Interval: Based on the repeat interval, the logging system performed as per specifications.

Environmental Corrections: All radionuclide concentrations have been corrected for casing attenuation (entire well). Water correction was applied to depths deeper than 263.8 feet. No casing correction was applied to the total gamma due to Compton downscatter interference.

Radionuclides:

The potassium signal increases at 48 feet. The casing thickness changes from a total of 1.0 inch to 0.5 inch at 51.75 feet. Thus the increase in potassium at 48 feet is due to lithology and not an error in the casing thickness correction.

RLS Neutron-Neutron Moisture Survey

Waste Management Technical Services

LOG HEADER

Project: RCRA drilling 1999 **Well:** 299-E33-334

Borehole Information

Well # 299-E33-334	Water Depth 268.3 ft	Total Depth 284 ft
Elevation Reference n/a	Elevation n/a ft	
Depth Reference Ground Surface	Casing Stickup 11.75 in. – 0', 8.625 in. – 2.1'	
Casing Diameter 11.75 in.	Depth Interval 0 to 51.7 ft	Thickness 0.5 in.
Casing Diameter 8.625 in.	Depth Interval 0 to 280 ft	Thickness 0.5 in.

Logging Information

Log Type:	Neutron-Neutron Moisture	
Company	Waste Management Technical Services	
Logging Engineers	S. E. Kos	
Instrument Series	RLSM00.0	
Logging Date	December 27, 1999	
Logging Unit	RLS-1	
Depth Interval	48.0' to 168.0'	Prefix A690
	148.0' to 264.0'	A691
Instrument Calibration Date	May 13, 1999	
Calibration Report	WHC-SD-EN-TI-306, Rev. 0	

Analysis Information

Company	Waste Management Technical Services
Analyst	Steven Kos
Date	December 27, 1999
Depth Reference	Ground Surface

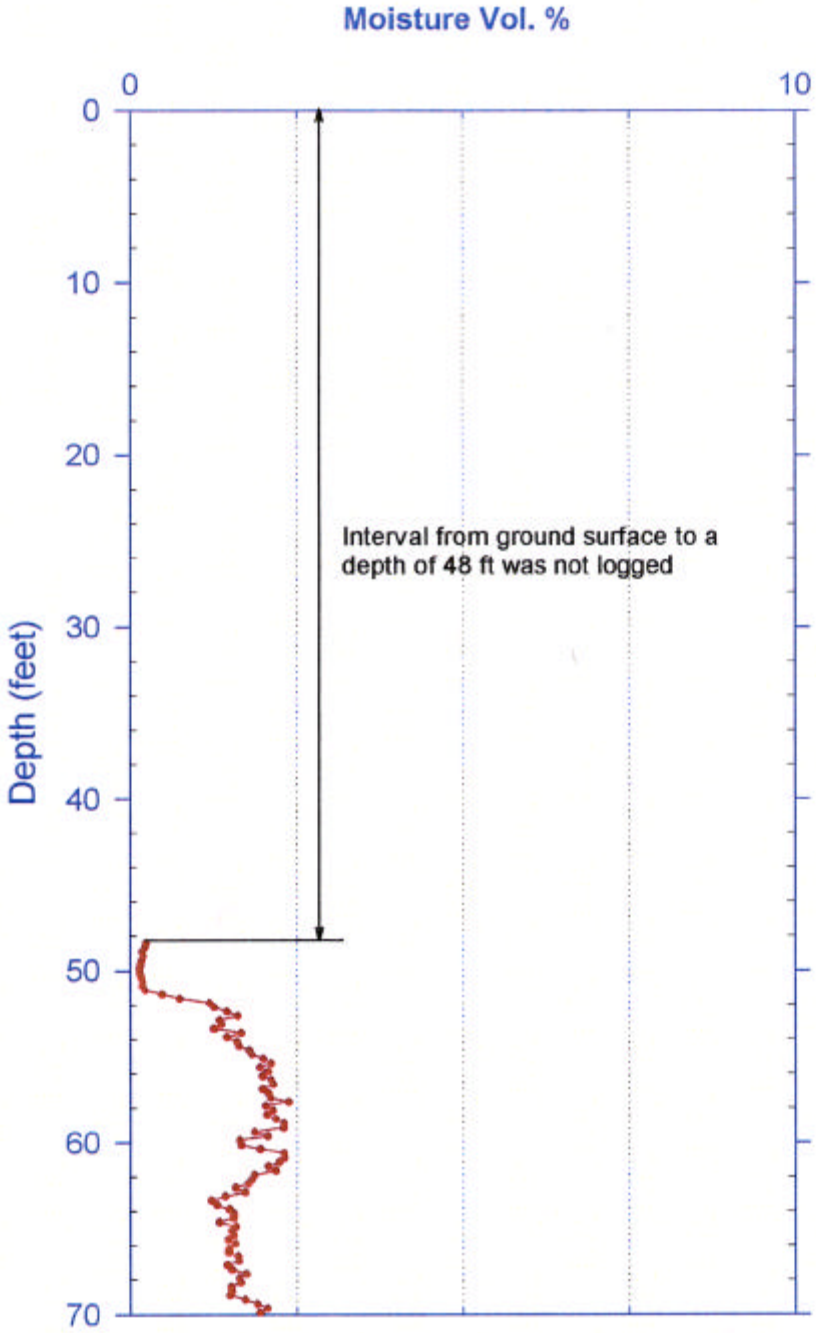
Notes The moisture measurements were acquired at 0.250-ft depth intervals at a logging speed of 1.0 ft per minute. A repeat survey was conducted between depths of 148 and 168 ft.

Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-334

Log Date : December 27, 1999
Depth Datum: Ground Level

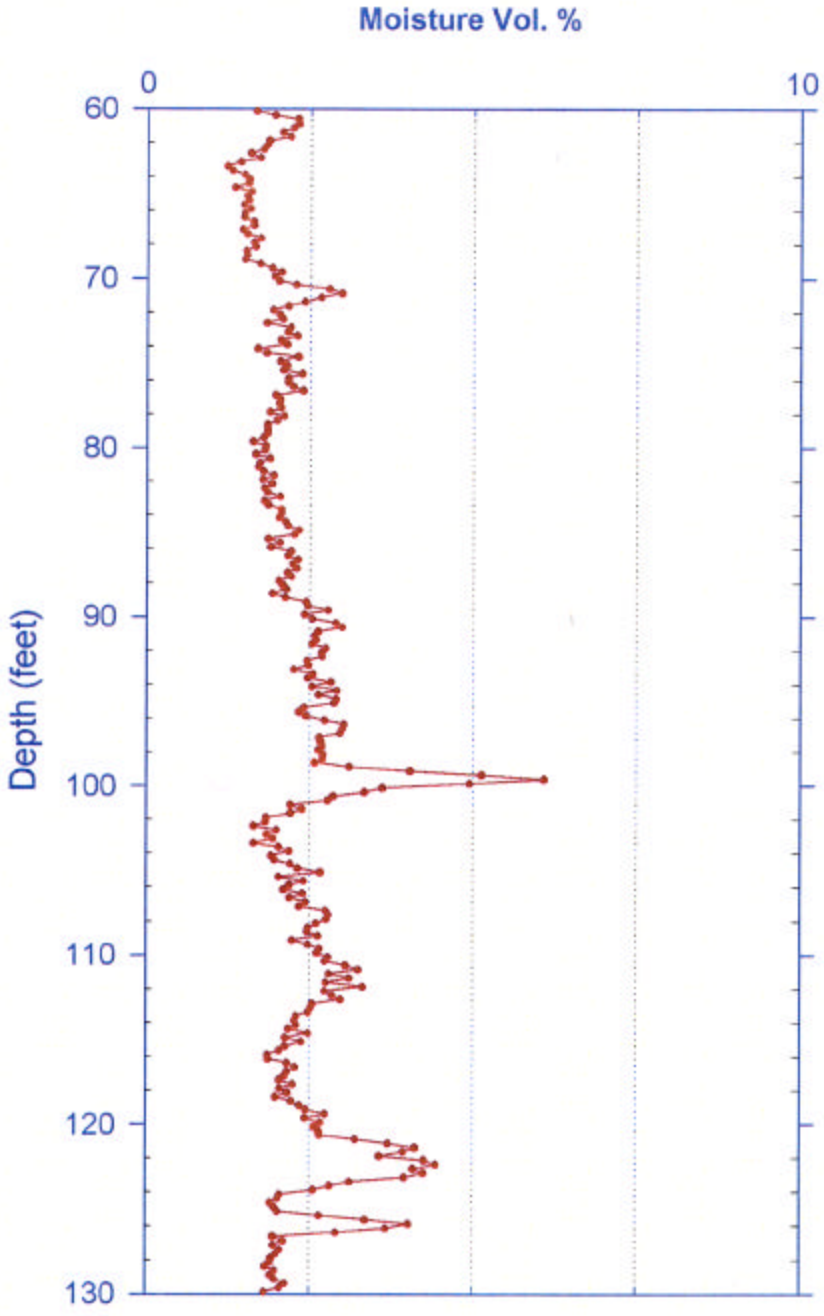


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-334

Log Date : December 27, 1999
Depth Datum: Ground Level

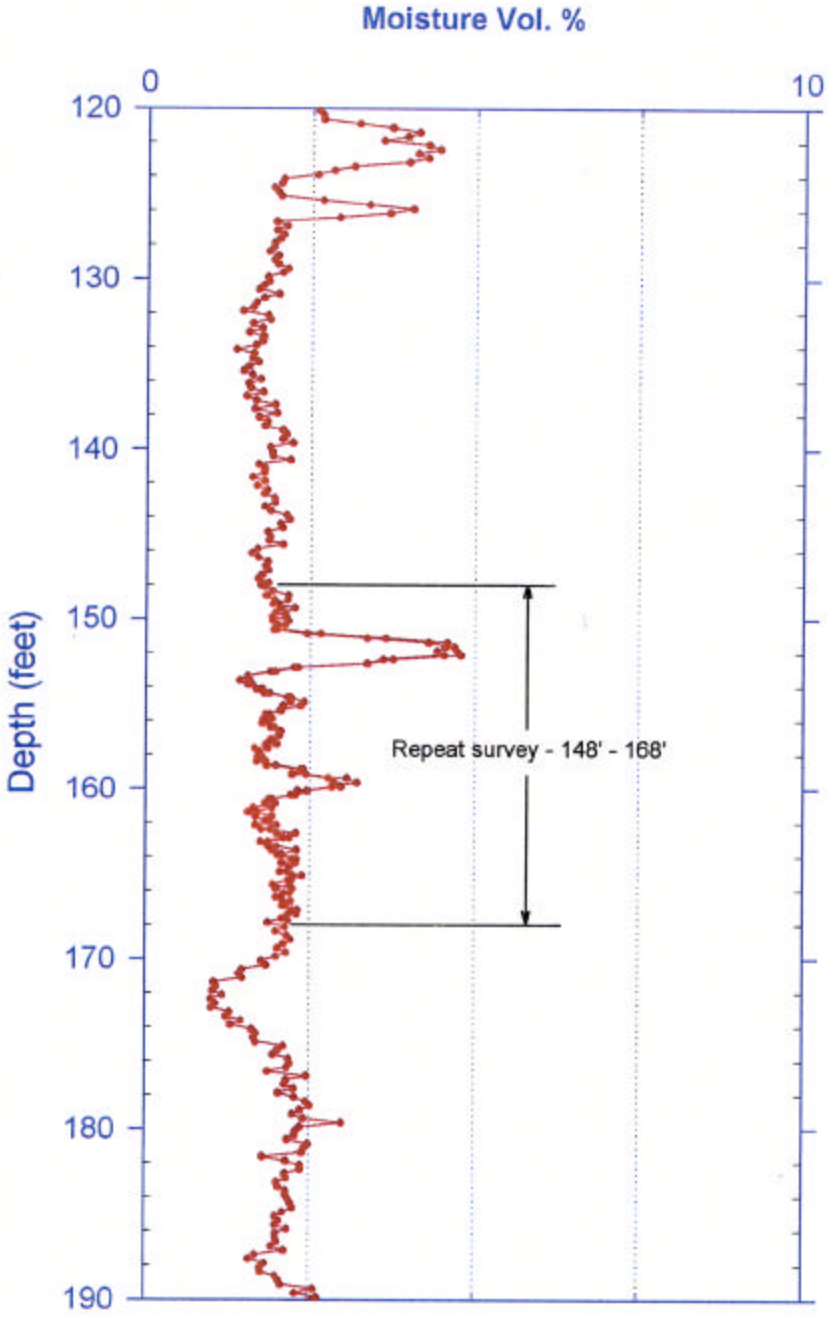


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-334

Log Date : December 27, 1999
Depth Datum: Ground Level

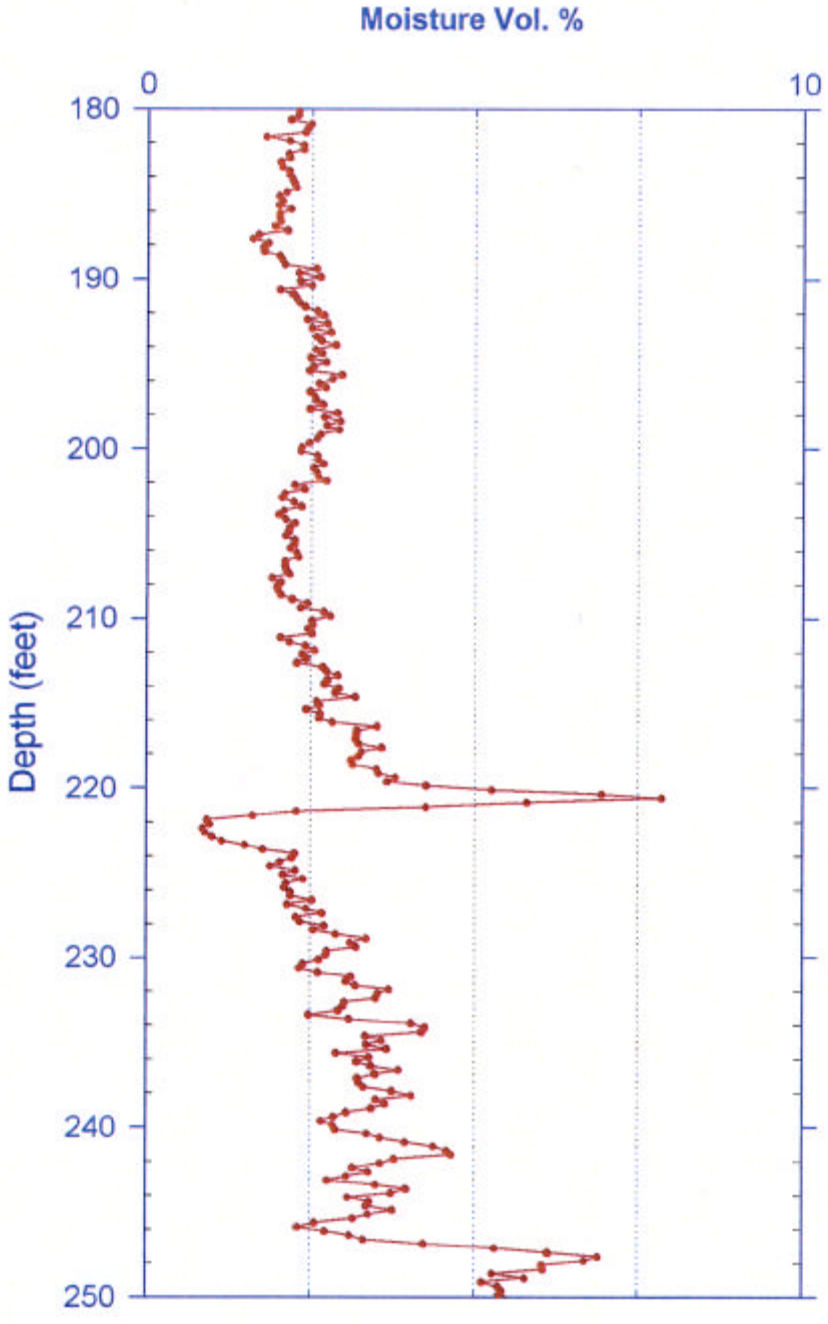


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-334

Log Date : December 27, 1999
Depth Datum: Ground Level

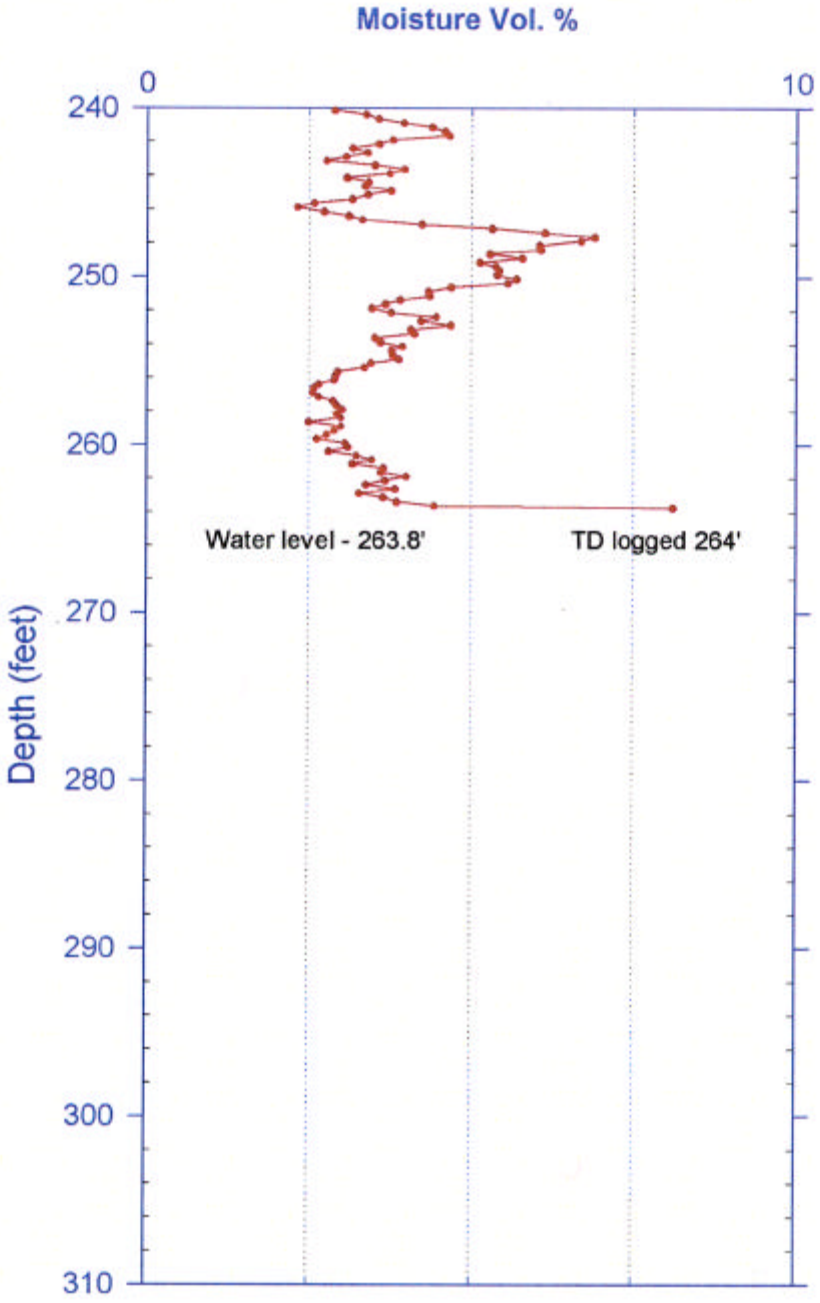


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-334

Log Date : December 27, 1999
Depth Datum: Ground Level



RLS Neutron-Neutron Moisture Survey

Waste Management Technical Services

Summary Report

Project: RCRA Drilling 1999 **Well:** 299-E33-334

General Notes

All log data were collected with reference to ground surface. The moisture survey was not conducted in the 11.75-in.-diameter casing (from ground surface to a depth of 48 ft) since the logging tool is not calibrated for this size casing. The survey was terminated at a depth of 264 ft where groundwater was encountered.

System Performance Verification: The pre- and post-survey verification passed performance standards, -3.4% in the shield verifier.

Repeat Interval: A repeat survey was conducted between depths of 148 and 168 ft. The results show good repeatability of the moisture profiles from the original and repeat surveys.

Environmental Corrections: The moisture measurements have been corrected for casing attenuation throughout the entire well. A casing correction for 8-in.-diameter casing was applied to the data.

Observations

The moisture values are about 2 percent volumetric moisture content from a depth of about 50 ft, to a depth of 210 ft. At a depth of 210 ft, the moisture content fluctuates between slightly below 2 percent to slightly above 8 percent at a depth of 220 ft. The lowest moisture content values (other than within the short interval logged in the 11-in.- and 8-in.-diameter casings between depths of 48 and 51 ft) were measured at a depth of 222ft. Several peaks of elevated moisture content (above the 2 percent background) occur at depths of 100 ft, 122 ft, 126 ft, 152 ft, and 248 ft. The intervals of elevated moisture content most likely correlate to occurrence of fine- grained sediments that retain moisture.

The measurements acquired in double casings between depths of 48 and 51 ft and are not valid measurements. These measurements can be utilized to determine the bottom of the double casing string, which is located at a depth of 51 ft.

The moisture content increases (to an off-scale value) at a depth of about 264 ft where groundwater is encountered.

RLS Scintillator Gamma Ray Borehole Survey

Waste Management Technical Services

Log Header

Project: PNNL RCRA Well: **299-E33-335**

Log Type: NaI Spectral Gamma Ray

Borehole Information

Well # B8811	Water Depth	278 ft	Total Depth	284 ft	
Elevation Reference n/a	Elevation	n/a ft			
Depth Reference Surface	Casing Stickup	.25 ft			
Casing Diameter 11.75 in	Depth Interval	0 to 50 ft	Thickness	0.5 in	
Casing Diameter 7.625 in	Depth Interval	0 to 280 ft	Thickness	0.5 in	

Logging Information

Log Type:	NaI Spectral Gamma Ray	
Company	Waste Management Technical Services	
Date/Archive File Name	February 2, 2000	H2E33335
Logging Engineers	J.E.Meisner	
Instrument Series	RLSN2.0	
Logging Unit	RLS-1	
Depth Interval	0 to 175 ft	Prefix A697
	170 to 282 ft	Prefix A698
Instrument Calibration Date	Feb 18, 1999	
Calibration Report	WHC-SD-EN-TI-293	

Analysis Information

Company	Three Rivers Scientific
Analyst	Russ Randall
Date	February 15, 2000
Depth Reference	Ground Surface

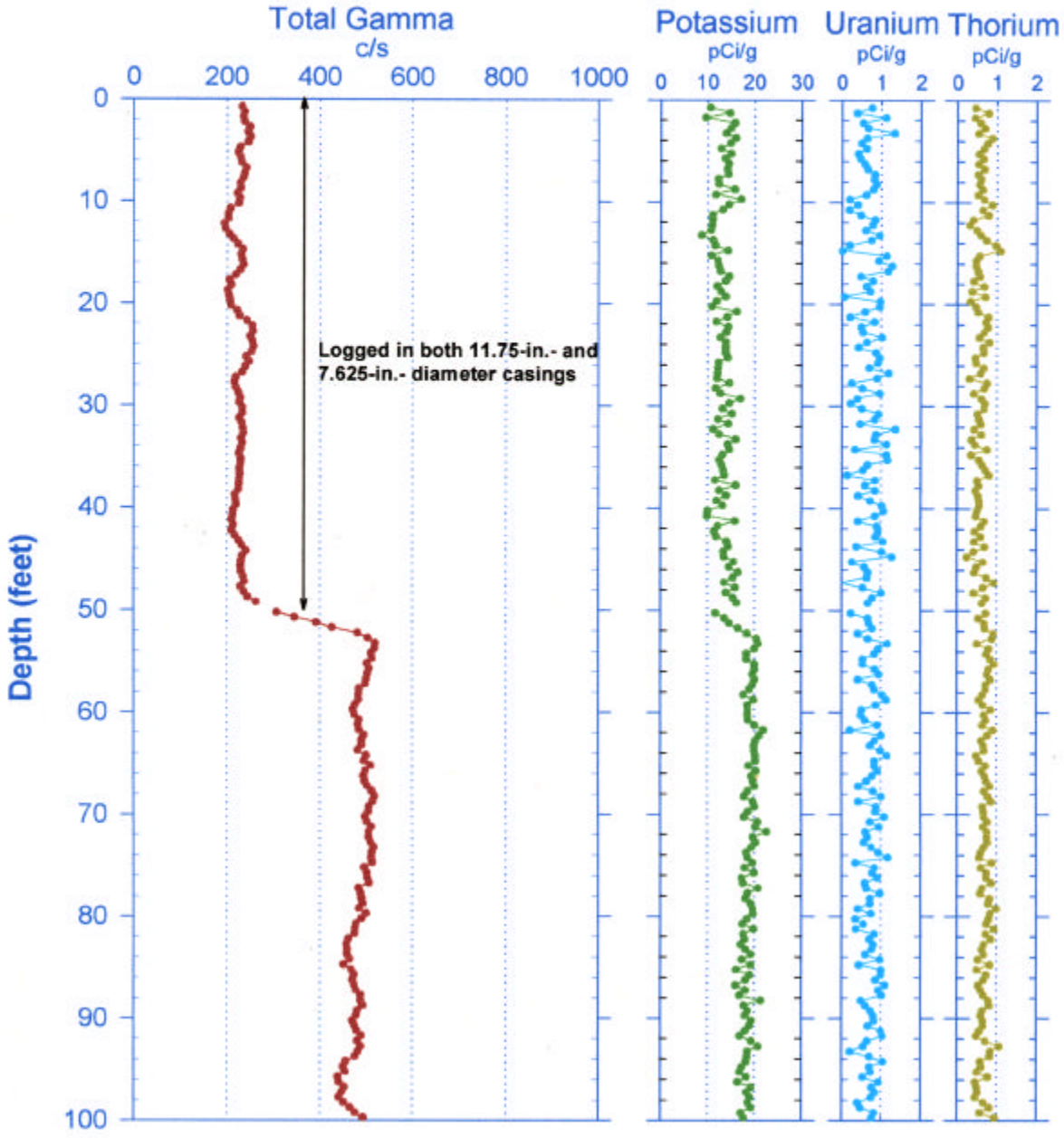
Notes None.

RLS Spectral Scintillator Borehole Survey

Waste Management Technical Services

Project: RCRA Drilling 2000 Log Date: Feb. 2, 2000

Well: 299-E33-335 Depth Datum: Ground Level

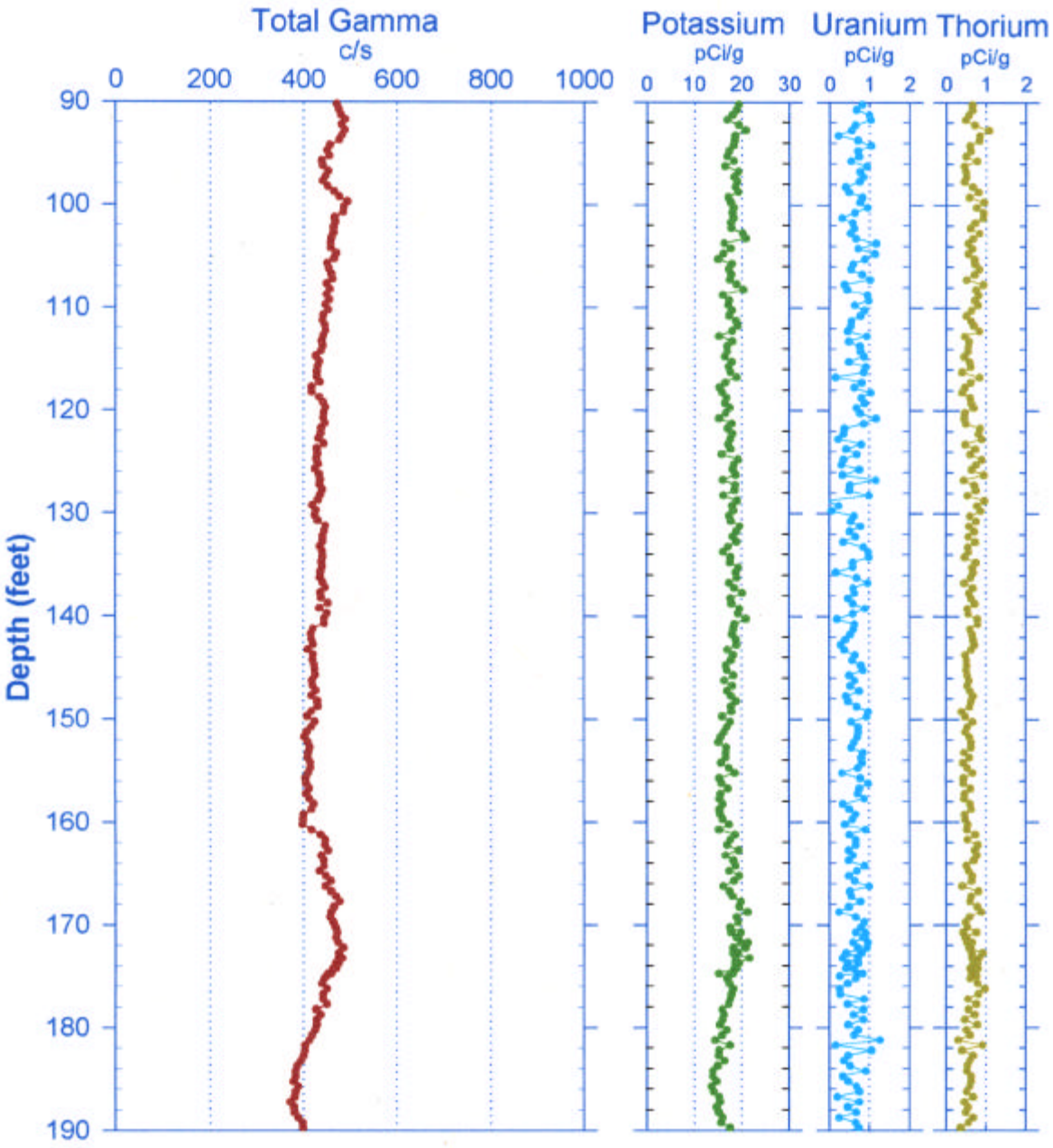


RLS Spectral Scintillator Borehole Survey

Waste Management Technical Services

Project: RCRA Drilling 2000 Log Date: Feb. 2, 2000

Well: 299-E33-335 Depth Datum: Ground Level

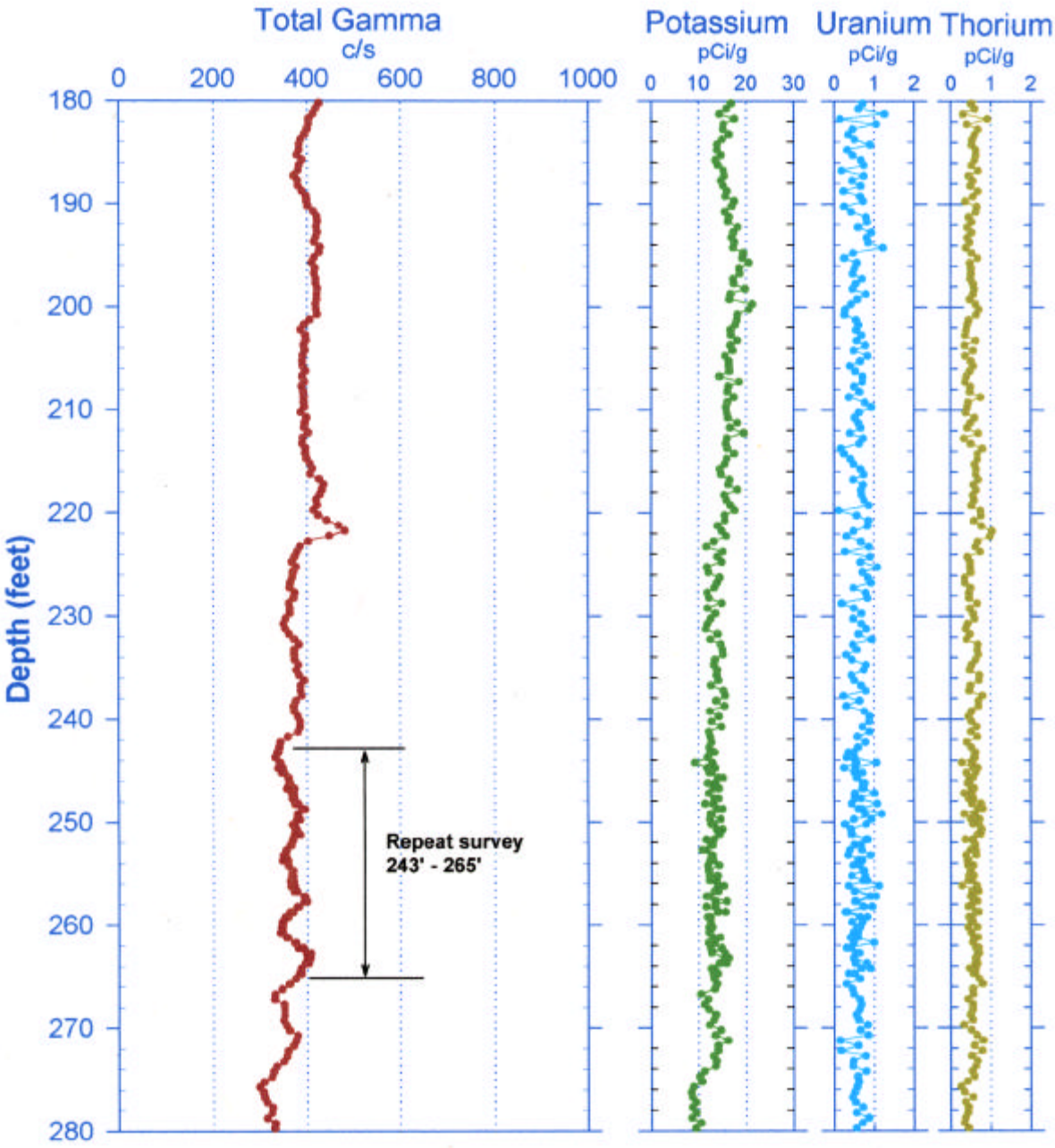


RLS Spectral Scintillator Borehole Survey

Waste Management Technical Services

Project: RCRA Drilling 2000 Log Date: Feb. 2, 2000

Well: 299-E33-335 Depth Datum: Ground Level



RLS Spectral Scintillator Borehole Survey

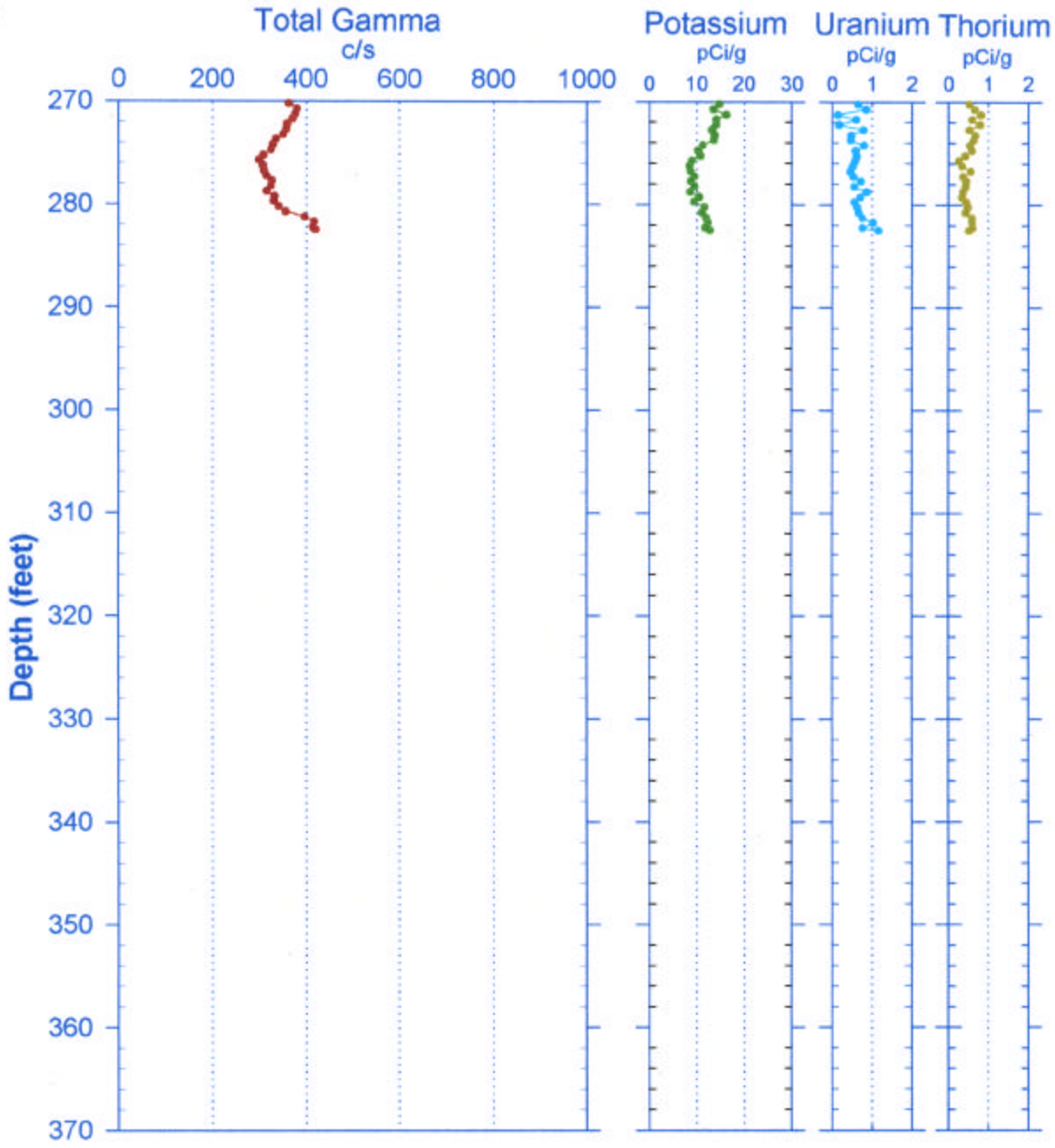
Waste Management Technical Services

Project: RCRA Drilling 2000

Log Date: Feb. 2, 2000

Well: 299-E33-335

Depth Datum: Ground Level



RLS Scintillator Gamma Ray Borehole Survey

Waste Management Technical Services

Log Analysis Summary Report

Project:	PNNL RCRA	Well:	299-E33-335
Log Type:	NaI Spectral Gamma Ray	Log Date:	February 2, 2000

General Notes:

Total gamma is a response to geologic concentrations of natural radionuclides.

Log data collected with a depth reference of ground surface.

The energy to channel gain-settings changed very little throughout the logged intervals. A processing of the spectra to re-gain the energy using the potassium photo peak was performed. The results were successful.

System Performance Verify: The pre- and post-log verification passed performance standards.

Repeat Interval: Based on the repeat interval, the logging system performed as per specifications.

Environmental Corrections: All radionuclide concentrations have been corrected for casing attenuation (entire well). Water correction was applied to depths deeper than 278 feet. No casing correction was applied to the total gamma due to Compton downscatter interference.

Radionuclides:

The potassium signal increases at 50 feet. The casing thickness changes from a total of 1.0 inch to 0.5 inch at 50 feet. However, the increase in potassium at 50 feet is due to lithology and not an error in the casing thickness correction.

RLS Neutron-Neutron Moisture Survey

Waste Management Technical Services

LOG HEADER

Project: RCRA drilling 1999 **Well:** 299-E33-335

Borehole Information

Well # 299-E33-335	Water Depth 278 ft	Total Depth 284 ft
Elevation Reference n/a	Elevation n/a ft	
Depth Reference Ground Surface	Casing Stickup 11.75 in. – 0', 8.625 in. – 0.25'	
Casing Diameter 11.75 in.	Depth Interval 0 to 51 ft	Thickness 0.5 in.
Casing Diameter 8.625 in.	Depth Interval 0 to 238 ft	Thickness 0.5 in.

Logging Information

Log Type:	Neutron-Neutron Moisture	
Company	Waste Management Technical Services	
Logging Engineers	J.E. Meisner	
Instrument Series	RLSM00.0	
Logging Date	February 3, 2000	
Logging Unit	RLS-1	
Depth Interval	45.0' to 165.0'	Prefix MA54
	162.0' to 215.0'	MA55
	80.0' to 95.0'	MA56
Instrument Calibration Date	May 13, 1999	
Calibration Report	WHC-SD-EN-TI-306, Rev. 0	

Analysis Information

Company	Waste Management Technical Services
Analyst	Steven Kos
Date	March 13, 2000
Depth Reference	Ground Surface

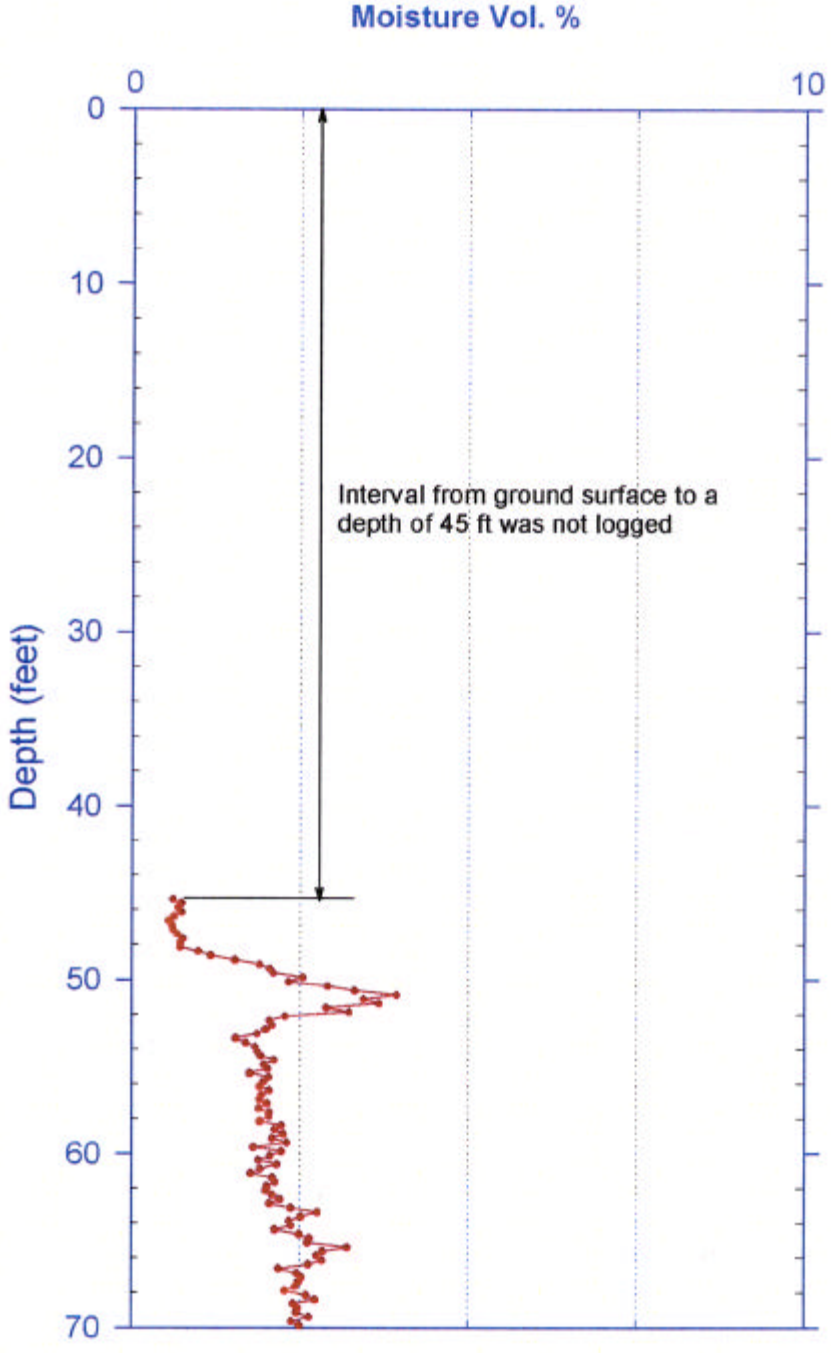
Notes The moisture measurements were acquired at 0.250-ft depth intervals at a logging speed of 1.0 ft per minute. Repeat surveys were conducted between depths of 80 and 95 ft, between depths of 147 and 150 ft, between depths of 162 and 165 ft, and between depths of 215 and 225 ft.

Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-335

Log Date : February 3, 2000
Depth Datum: Ground Level

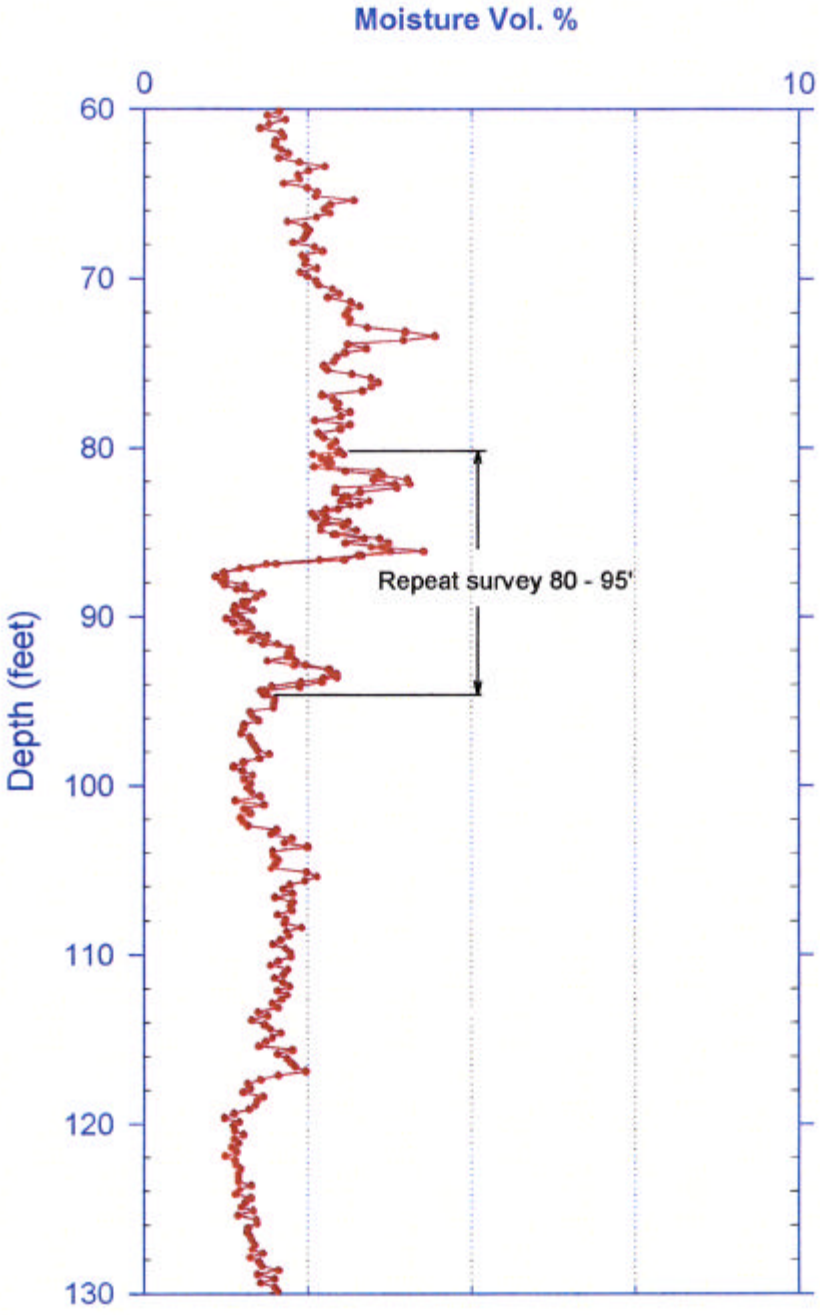


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-335

Log Date : February 3, 2000
Depth Datum: Ground Level

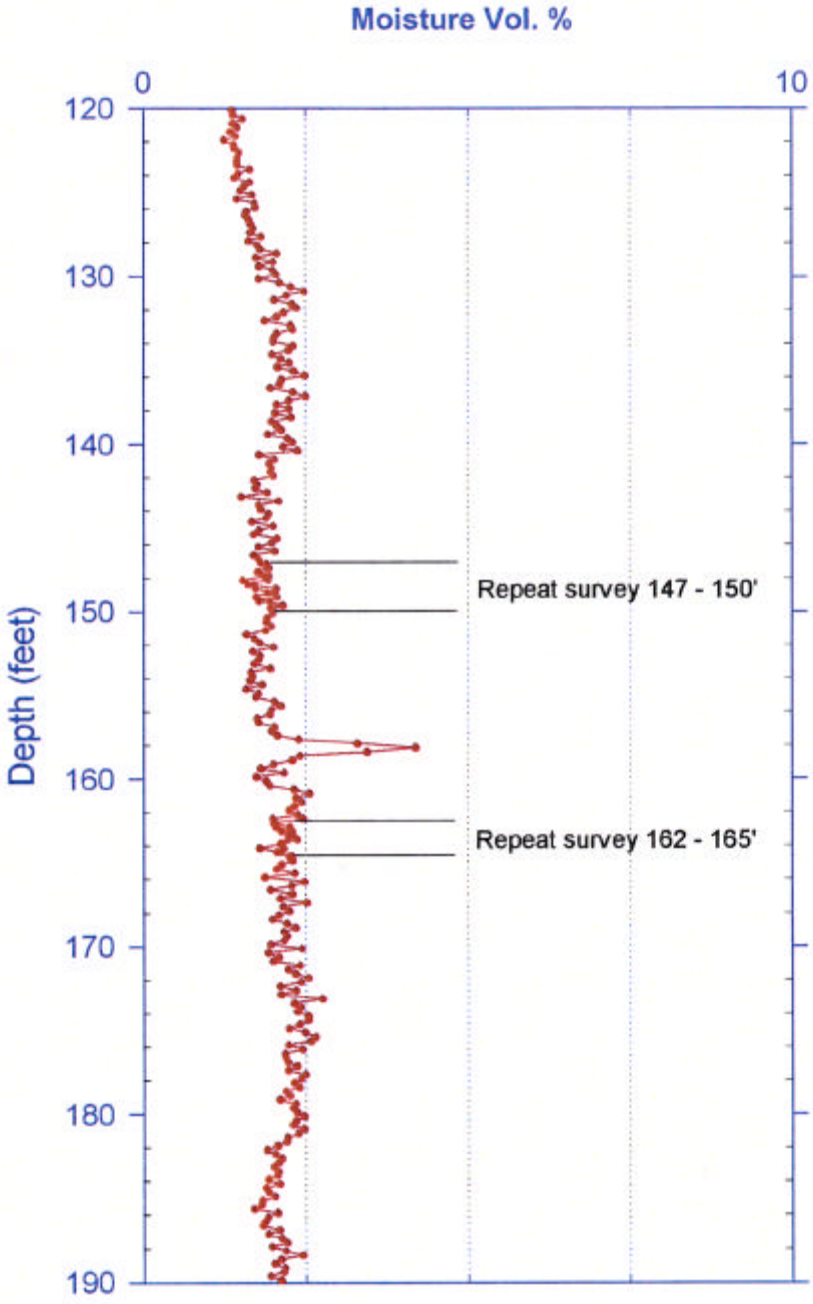


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-335

Log Date : February 3, 2000
Depth Datum: Ground Level

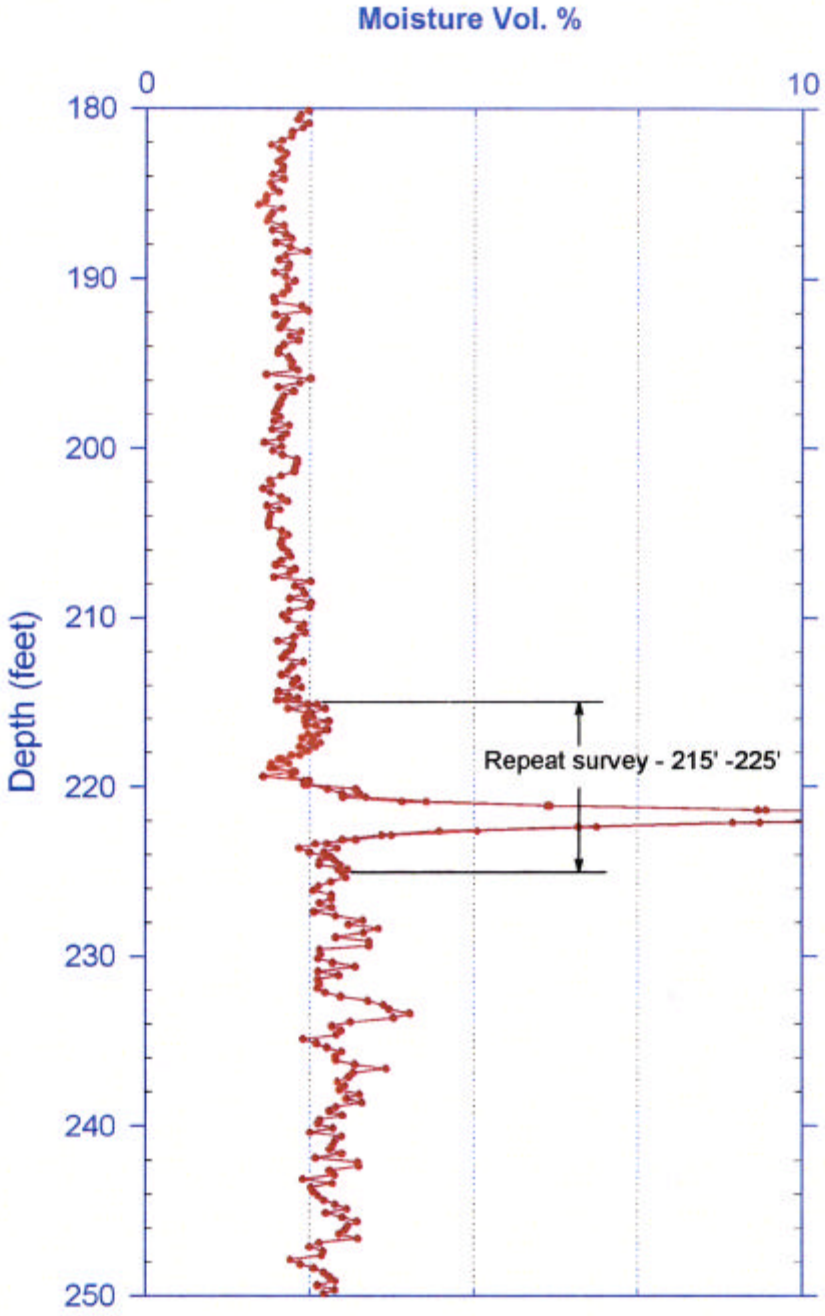


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-335

Log Date : February 3, 2000
Depth Datum: Ground Level

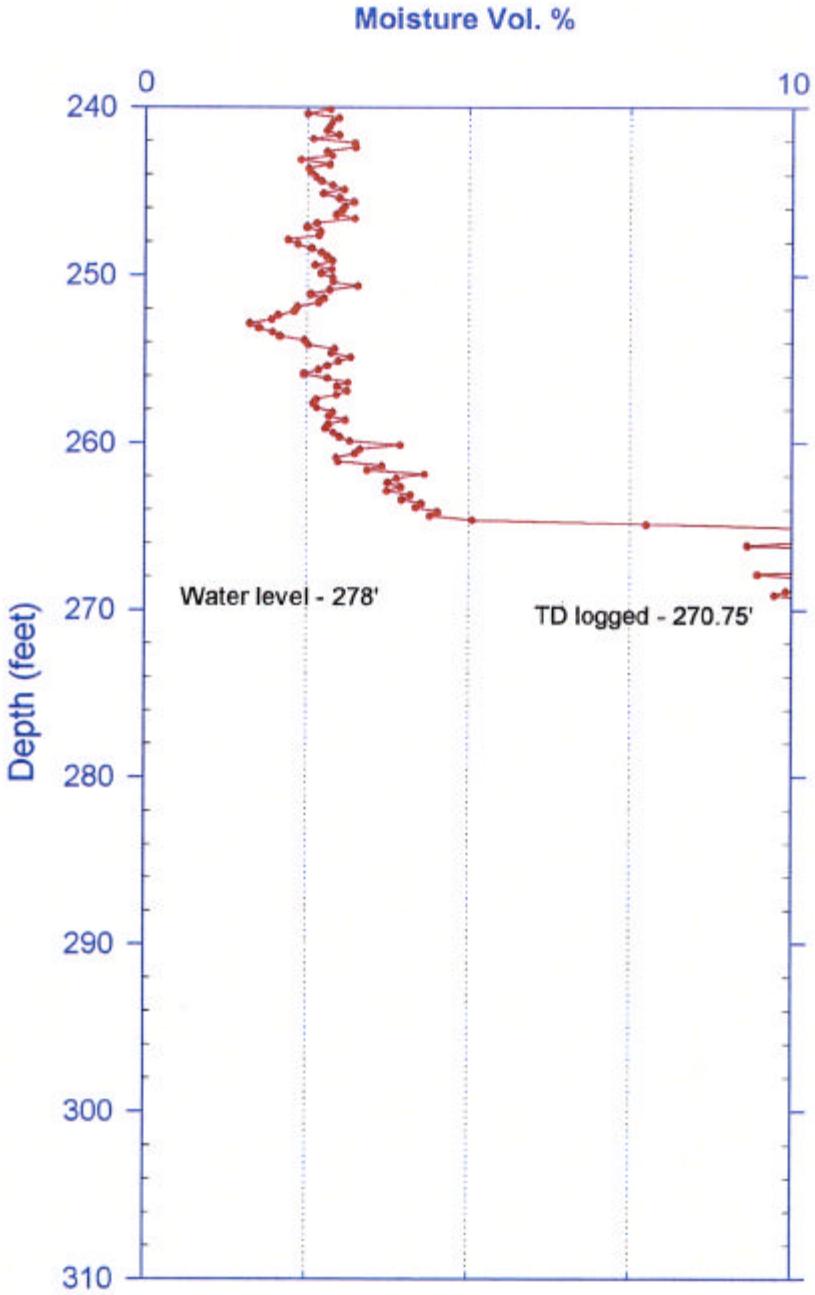


Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling
Borehole: 299-E33-335

Log Date : February 3, 2000
Depth Datum: Ground Level



RLS Neutron-Neutron Moisture Survey

Waste Management Technical Services

Summary Report

Project: RCRA Drilling 1999 **Well:** 299-E33-335

General Notes

All log data were collected with reference to ground surface. The moisture survey was not conducted in the 11.75-in.-diameter casing (from ground surface to a depth of 45 ft) since the logging tool is not calibrated for this size casing. The survey was terminated at a depth of 270.75 ft where groundwater was encountered.

System Performance Verification: The pre- and post-survey verification passed performance standards, -3.4% in the shield verifier.

Repeat Interval: Repeat surveys were conducted between depths of 80 and 95 ft, between depths of 147 and 150 ft, between depths of 162 and 165 ft, and between depths of 215 and 225 ft. The results show good repeatability of the moisture profiles from the original and repeat surveys.

Environmental Corrections: The moisture measurements have been corrected for casing attenuation throughout the entire well. A casing correction for 8-in.-diameter casing was applied to the data.

Observations

The moisture values are slightly less than 2 percent volumetric moisture content throughout most of the log. The values increase slightly in the interval between depths of about 70 and 87 ft. Within this interval the maximum value detected in this boreholes of about 4 percent moisture content was measured (at a depth of 86 ft). Over the short interval between depths of 50 and 52 ft, the moisture content values reach a high of about 4 percent.

Over the interval between 45 and about 48 ft, the moisture measurements are not valid because they were acquired in two casings. The do indicate that the bottom of the double casing string is located at a depth of about 48 ft.

The moisture content increases (to an off-scale value) at a depth of about 215 ft where groundwater is encountered.

Appendix D

Groundwater Chemistry Data

Appendix D

Groundwater Chemistry Data

This appendix contains analytical results from groundwater samples collected at 279 ft below ground surface (bgs) from well 299-E33-334 and at 272 ft bgs from well 299-E33-335 after well development. Columns 6 and 7 in this appendix contain qualifiers that should be considered when using the analytical values. The definitions of the qualifiers are given below.

Qualifier	Definition
U	Undetected at the detection limit.
C	For inorganics - blank contamination is above the practical quantitation limit.
B	For organics - compound was found in the blank (blank contamination). For inorganics - result is less than the practical quantitation limit.
D	Adjusted dilution factor.

Table D.1. Composition of Groundwater from Wells 299-E33-334 and 299-E33-335

Constituent	Sample Date	Filter	Value	Analytical Units	Lab Qualifier	Counting Error	Total Analysis Error
Well 299-E33-334 279 ft bgs							
Aluminum	1/5/00	Y	19.7	µg/L	U		
Iron	1/5/00	Y	49.2	µg/L	B		
Magnesium	1/5/00	Y	10300	µg/L			
Potassium	1/5/00	Y	5550	µg/L			
Nickel	1/5/00	Y	12.8	µg/L	U		
Manganese	1/5/00	Y	11.3	µg/L	B		
Silver	1/5/00	Y	5.5	µg/L	U		
Strontium (elemental)	1/5/00	Y	169	µg/L			
Barium	1/5/00	Y	61.1	µg/L	B		
Antimony	1/5/00	Y	40.9	µg/L	U		
Calcium	1/5/00	Y	34200	µg/L			
Zinc	1/5/00	Y	183	µg/L			
Vanadium	1/5/00	Y	22.3	µg/L	B		
Copper	1/5/00	Y	6.4	µg/L	U		
Cobalt	1/5/00	Y	2.8	µg/L	U		
Chromium	1/5/00	Y	3	µg/L	U		
Cadmium	1/5/00	Y	3.3	µg/L	U		
Beryllium	1/5/00	Y	0.5	µg/L	U		
Sodium	1/5/00	Y	21300	µg/L			
Sulfate	1/5/00	N	41.5	mg/L	D		
Chloride	1/5/00	N	14.7	mg/L	D		
Cyanide	1/5/00	N	1.6	µg/L	U		
Fluoride	1/5/00	N	0.36	mg/L			
Nitrogen in Nitrite	1/5/00	N	0.0074	mg/L	U		
pH Measurement	1/5/00	N	8	pH			
Temperature	1/5/00	N	16	Deg C			
Turbidity	1/5/00	N	0.7	NTU			
pH Measurement	1/5/00	N	8.1	pH			
Nitrogen in Nitrate	1/5/00	N	3.4	mg/L	D		
Dissolved Oxygen	1/5/00	N	6.51	mg/L			
Specific Conductance	1/5/00	N	369	µS/cm			
Tritium	1/5/00	N	7140	pCi/L		330	600
Cesium-137	1/5/00	N	-1.21	pCi/L	U	4.3	4.3
Cobalt-60	1/5/00	N	1.27	pCi/L	U	3.9	3.9

Table D.1. (contd)

Constituent	Sample Date	Filter	Value	Analytical Units	Lab Qualifier	Counting Error	Total Analysis Error
Strontium-90	1/5/00	N	-0.00897	pCi/L	U	0.23	0.23
Gross beta	1/5/00	N	15	pCi/L		2.3	3
Beryllium-7	1/5/00	N	9.16	pCi/L	U	63	63
Cesium-134	1/5/00	N	-3.12	pCi/L	U	4.6	4.6
Antimony-125	1/5/00	N	-1.47	pCi/L	U	12	12
Europium-152	1/5/00	N	-4.94	pCi/L	U	10	10
Europium-155	1/5/00	N	-3.41	pCi/L	U	11	11
Uranium	1/5/00	N	2.75	µg/L			0.44
Europium-154	1/5/00	N	-6.45	pCi/L	U	14	14
Technetium-99	1/5/00	N	58.9	pCi/L		2.4	15
Ruthenium-106	1/5/00	N	3.22	pCi/L	U	37	37
Potassium-40	1/5/00	N	-3.12	pCi/L	U	68	68
Gross alpha	1/5/00	N	0.922	pCi/L	U	1.1	1.1
Well 299-E33-335 272 ft bgs							
Specific Conductance	2/10/00	N	370	µS/cm			
pH Measurement	2/10/00	N	8.18	pH			
Turbidity	2/10/00	N	0.92	NTU			
Temperature	2/10/00	N	16.1	Deg C			
Tritium	2/10/00	N	6880	pCi/L		340	620
Cesium-137	2/10/00	N	0.261	pCi/L	U	3.2	3.2
Strontium-90	2/10/00	N	-0.0384	pCi/L	U	0.27	0.27
Gross alpha	2/10/00	N	1.81	pCi/L	U	1.4	1.5
Beryllium-7	2/10/00	N	-15.2	pCi/L	U	41	41
Cesium-134	2/10/00	N	-1.56	pCi/L	U	3.7	3.7
Antimony-125	2/10/00	N	2.25	pCi/L	U	8.8	8.8
Europium-152	2/10/00	N	0.463	pCi/L	U	9.5	9.5
Uranium	2/10/00	N	2.74	µg/L			0.65
Europium-154	2/10/00	N	4.27	pCi/L	U	9.2	9.2
Europium-155	2/10/00	N	-4.62	pCi/L	U	6.9	6.9
Technetium-99	2/10/00	N	59.2	pCi/L		2.4	15
Potassium-40	2/10/00	N	8.97	pCi/L	U	53	53
Gross beta	2/10/00	N	18.3	pCi/L		2.4	3.4
Cobalt-60	2/10/00	N	0.546	pCi/L	U	3.4	3.4
Ruthenium-106	2/10/00	N	-13.7	pCi/L	U	32	32
Specific Conductance	3/2/00	N	368	µS/cm	C		
Total organic halides	3/2/00	N	4.3	µg/L	U		

Table D.1. (contd)

Constituent	Sample Date	Filter	Value	Analytical Units	Lab Qualifier	Counting Error	Total Analysis Error
Specific Conductance	3/2/00	N	382	µS/cm			
Temperature	3/2/00	N	17.5	Deg C			
pH Measurement	3/2/00	N	8.03	pH			
Total organic carbon	3/2/00	N	0.6	mg/L	B		
Total organic halides	3/2/00	N	4.3	µg/L	U		
Specific Conductance	3/2/00	N	382	µS/cm			
Temperature	3/2/00	N	17.5	Deg C			
Total organic carbon	3/2/00	N	0.69	mg/L	B		
pH Measurement	3/2/00	N	8.03	pH			
Total organic halides	3/2/00	N	4.3	µg/L	U		
Specific Conductance	3/2/00	N	382	µS/cm			
pH Measurement	3/2/00	N	8.03	pH			
Total organic carbon	3/2/00	N	0.59	mg/L	B		
Temperature	3/2/00	N	17.5	Deg C			
Total organic halides	3/2/00	N	4.3	µg/L	U		
Specific Conductance	3/2/00	N	382	µS/cm			
Temperature	3/2/00	N	17.5	Deg C			
pH Measurement	3/2/00	N	8.02	pH			
Turbidity	3/2/00	N	2.8	NTU			
Total organic carbon	3/2/00	N	0.74	mg/L	B		
Aluminum	3/2/00	Y	19.7	µg/L	U		
Iron	3/2/00	Y	65.8	µg/L	B		
Magnesium	3/2/00	Y	11100	µg/L			
Manganese	3/2/00	Y	17.3	µg/L			
Sodium	3/2/00	Y	19600	µg/L			
Antimony	3/2/00	Y	40.9	µg/L	U		
Beryllium	3/2/00	Y	0.5	µg/L	U		
Chromium	3/2/00	Y	5.2	µg/L	B		
Copper	3/2/00	Y	6.4	µg/L	U		
Cobalt	3/2/00	Y	2.8	µg/L	U		
Calcium	3/2/00	Y	37200	µg/L			
Zinc	3/2/00	Y	13.8	µg/L	B		
Vanadium	3/2/00	Y	15.8	µg/L	B		
Cadmium	3/2/00	Y	3.3	µg/L	U		
Barium	3/2/00	Y	47.2	µg/L	B		

Table D.1. (contd)

Constituent	Sample Date	Filter	Value	Analytical Units	Lab Qualifier	Counting Error	Total Analysis Error
Strontium (elemental)	3/2/00	Y	197	µg/L			
Silver	3/2/00	Y	5.5	µg/L	U		
Potassium	3/2/00	Y	5310	µg/L			
Nickel	3/2/00	Y	12.8	µg/L	U		
Sulfate	3/2/00	N	43.5	mg/L	D		
Chloride	3/2/00	N	16.3	mg/L	D		
Fluoride	3/2/00	N	0.37	mg/L			
Alkalinity	3/2/00	N	122	mg/L			
Total dissolved solids	3/2/00	N	241	mg/L			
Nitrogen in Nitrate	3/2/00	N	3.4	mg/L	D		
Nitrogen in Nitrite	3/2/00	N	0.0074	mg/L	U		
Cyanide	3/2/00	N	1.6	µg/L	U		

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