

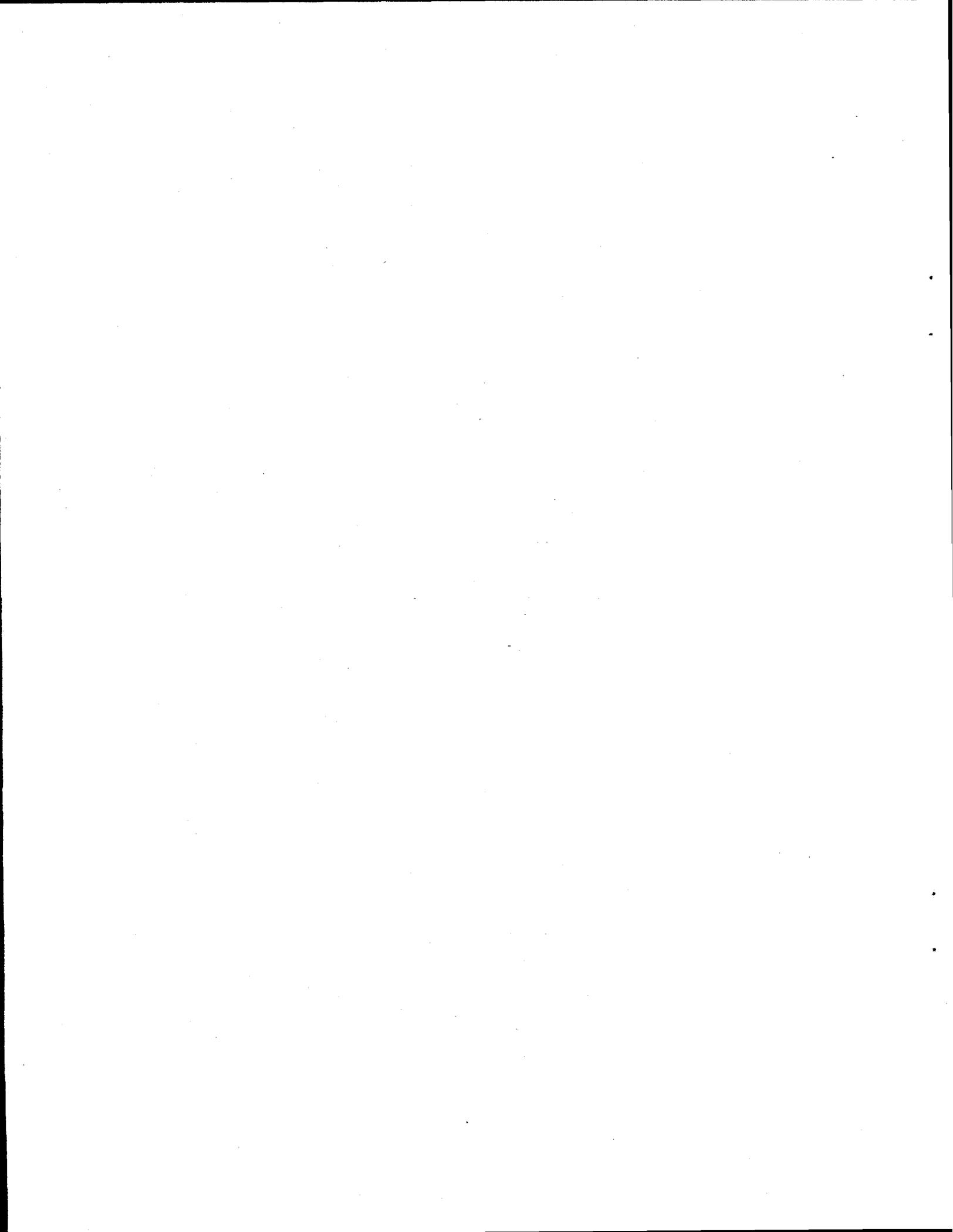
**Borehole Data Package for Wells 299-E33-334
and 299-E33-335 at Single-Shell Tank Waste
Management Area B-BX-BY**

D. G. Horton

May 2000

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

Pacific Northwest National Laboratory
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.

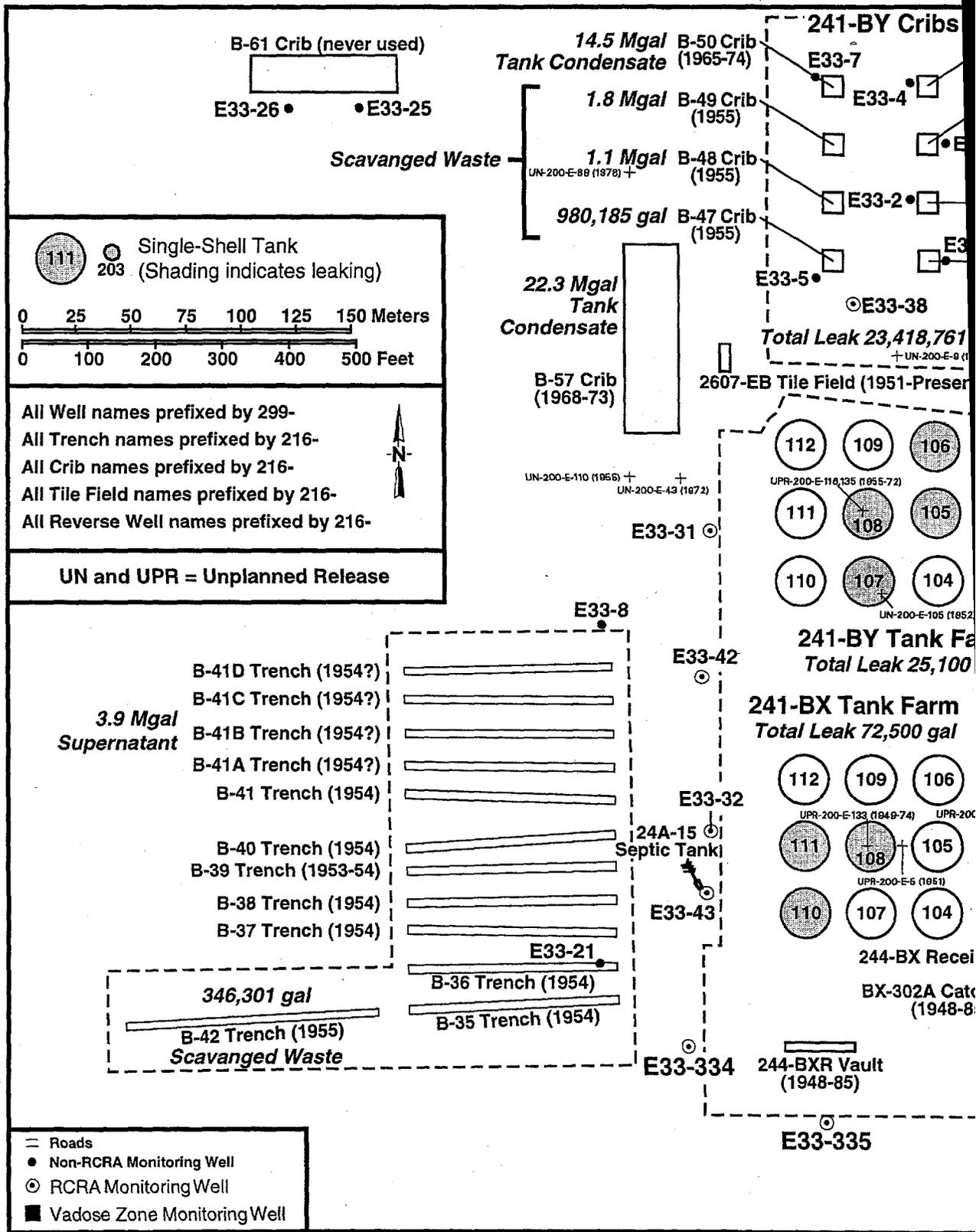


Figure 1. Map of WMA B-BX-BY and Local...

WMA B-BX-BY and Surrounding Facilities

B-46 Crib 1.8 Mgal (1955)

B-45 Crib 1.3 Mgal (1955)

UN-200-E-63 (1981)

B-44 Crib 1.5 Mgal (1954-55)

B-43 Crib 560,106 gal (1954)

Scavaged Waste

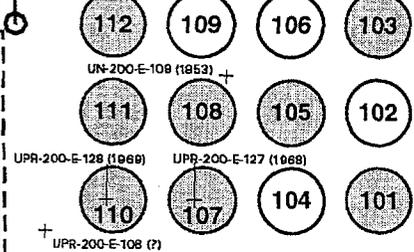
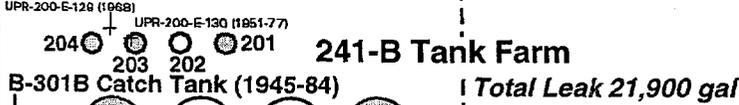
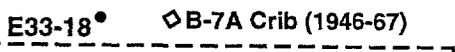
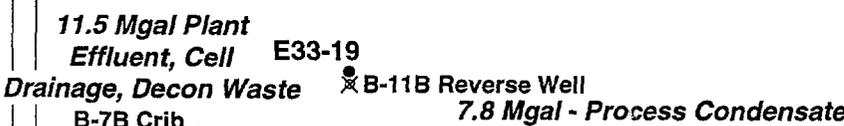
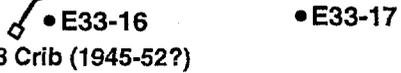


E33-13

UPR-200-E-134 (1973)



B-8TF Tile Field (1945-52?)



E33-33

E33-36



UPR-200-E-6,76,78 (1954,55,68)

UPR-200-E-73 (1951-52)

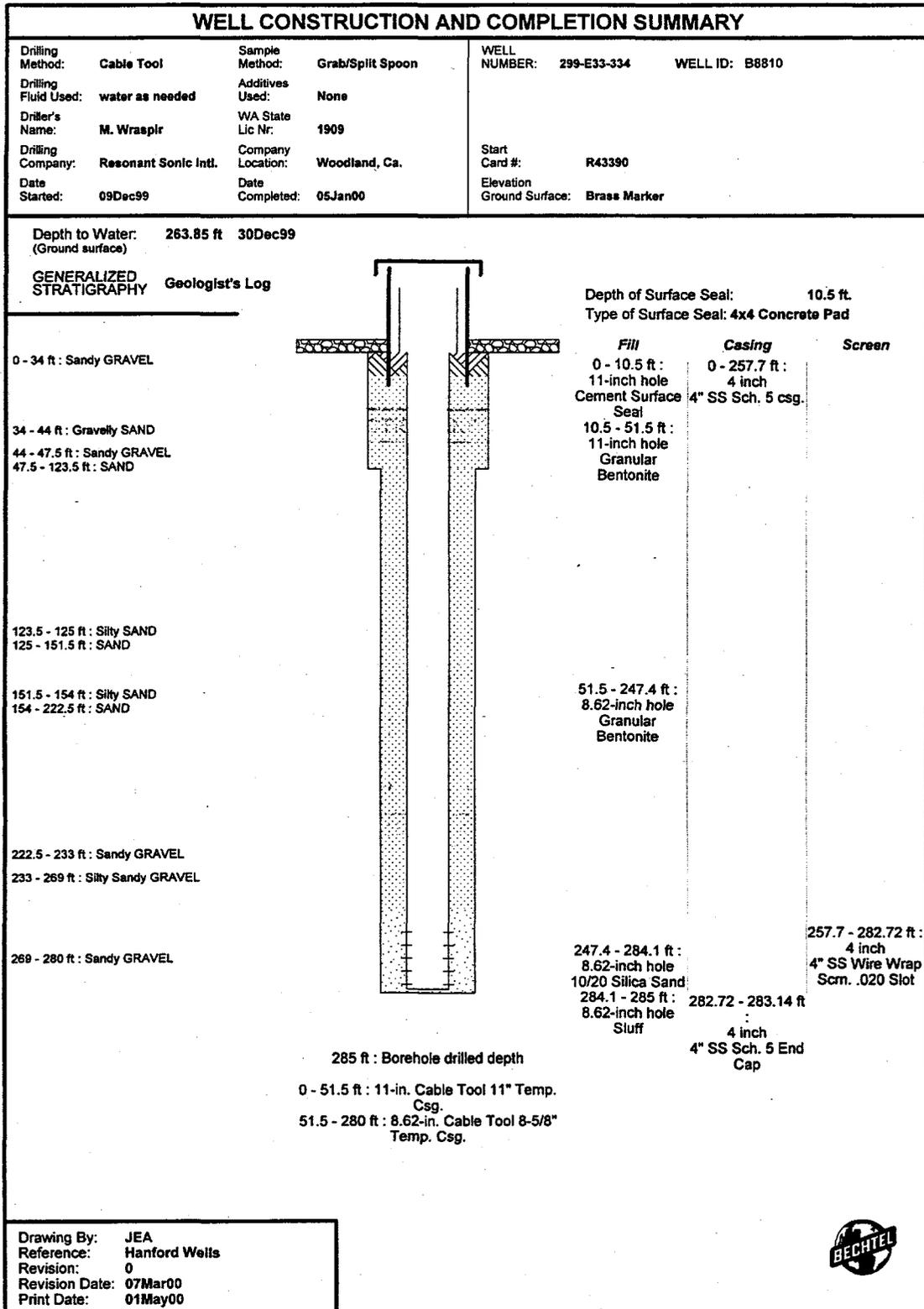
UN-200-E-79 (1053)

UPR-200-E-138 (1970)

UPR-200-E-38 (1968)

ns of Wells in the Groundwater Monitoring Network

2000/DCL/B-BX-BY/007



Report Form: WELLS Project File: WELLS.GPJ

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

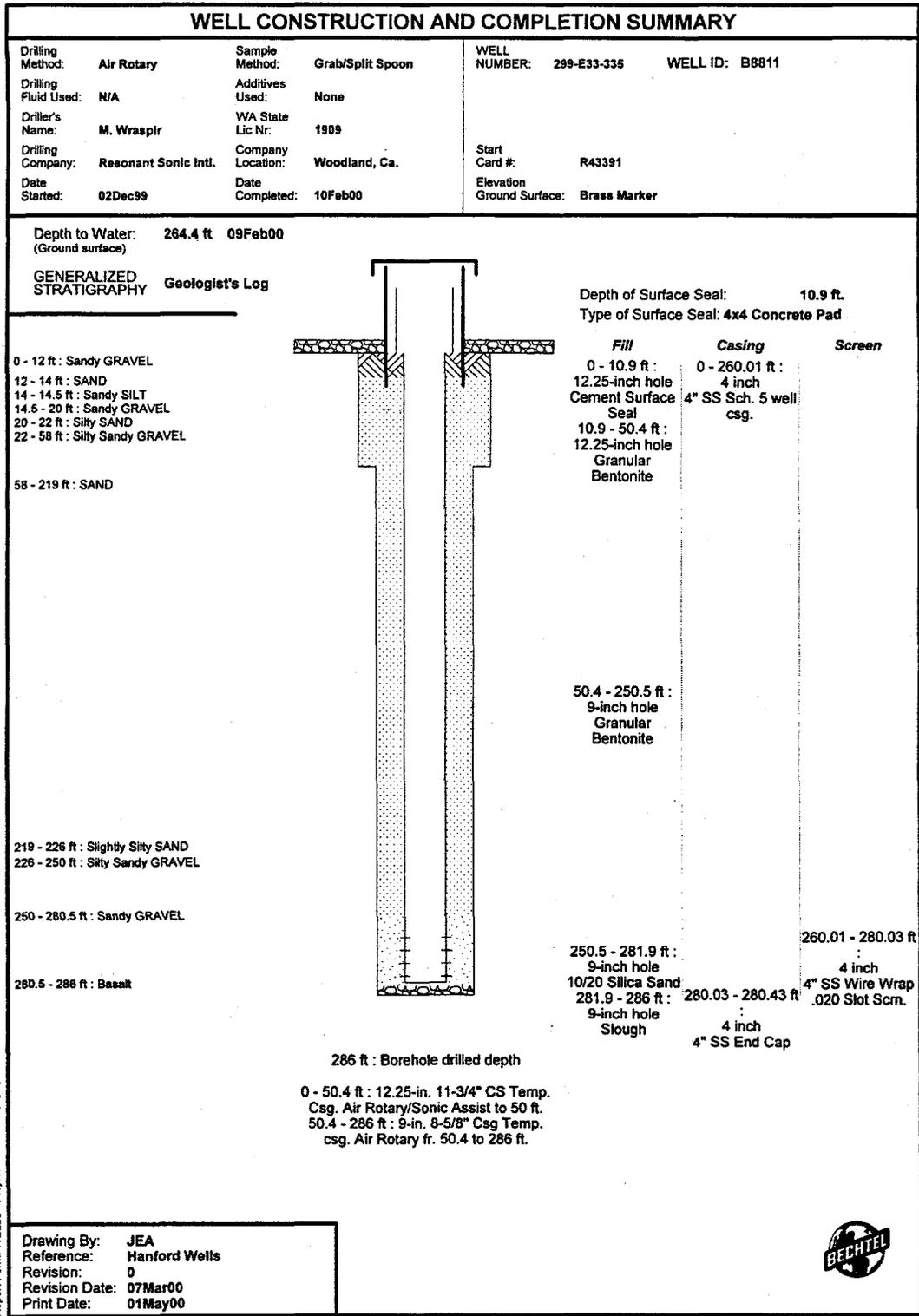


Figure 3. As-Built Diagram for Well 299-E33-335. Elevation reference point is ground surface.

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

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram		Graphic Log	Lithologic Description
Portland Cement Type I, II 0' → 10.5' below ground surface		0		0' → 34': ^{silty} Silty Sandy GRAVEL
Temporary casing 11 3/4" OD 0' → 51.5' bgs		25		34' → 44': Gravelly SAND
Stainless Steel casing, type 304, sched. 5, 4 1/2" OD / 4" ID +2.5' → 257.70' bgs		50		44' → 47.5': Sandy GRAVEL
Granular bentonite 10.5' → 247.4'		75		47.5' → 123.5': SAND
Temporary casing 8 7/8" OD 51.5' → 280'		100		123.5' → 125': Silty SAND
		125		125' → 151.5': SAND

WELL SUMMARY SHEET

Page 2 of 2
Date: 12/27/99

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

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
All depths in feet below ground All temporary casing removed from ground.		150		151.5' → 154': Silty SAND	
				154' → 208': SAND	
		175			
		200			
Silica Sand 10-20 mesh 247.4' → 284.1'				208' → 222.5': SAND	
crushed basalt/sluff 284.1' → 285'		225		222.5' → 229': Silty Sandy GRAVEL	
				229' → 233': Sandy GRAVEL	
			250		233' → 269': Silty Sandy GRAVEL
Stainless Steel screen Cont. wire-wrap 0.020-in slot, type 304 SS 4 1/2" OD / 4" ID 257.70' → 282.72'				WL = 263.85' bgs (12/30/99)	
SS endcap 282.72' → 283.14'		275		269' → 280': Sandy GRAVEL	
				280' → 285': BASALT	
				TD = 285'	

WELL CONSTRUCTION SUMMARY REPORT				Start Date: 12-9-99			
				Finish Date: 1-05-00			
				Page 1 of 1			
Specification No.: 0200X-SP-10002 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					
Driller: M. Waspir		J. Faurote					
TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD/HOLE DIAMETER				
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter From	to		
(FJ) 11" carbon steel	0' - 51.5'	12"/10 3/4"	Cable Tool: ✓	Diameter From	0 to 51.5		
(FJ) 8" carbon steel	0 - 280'	9 1/2"/7 5/8"	Air Rotary:	Diameter From	51.5 to 280		
			A.R. w/Sonic:	Diameter From	to		
				Diameter From	to		
				Diameter From	to		
*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design				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/WL/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	10 1/2 bbl	10-20
4" ID wirewrap screen 304 SS	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	7 1/2 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: 1/16/00	
Signature: <i>L.D. Walker</i>				Signature: <i>J. Davidson</i>			

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		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
0			DB 	0' → 34': ^{new} Silty Sandy GRAVEL (w/ G)	Cable tool drilling 11 3/4" OD CS casing
				50% gravel, 40% sand, 10% silt. Gravel to lg cobble, 10% sm cob, 20% v. cse pb, 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			50% qtz/field/other; max size 15-20 cm, weak rxn HCl.	5': Grab sample for archive, moisture analysis. β, γ < det.
10	Archive, moisture			9': gravel content increase to 60%	10': Grab sample for archive, moisture β, γ < det.
15	Archive, moisture			16': ~0.5' silt rich gravel	15': Grab sample for archive, moisture β, γ < det.
20	Archive, moisture			20' → 21': large cobbles	20': Grab sample for archive, moisture β, γ < det.
25	Archive, moisture			25': HCl rxn weak to moderate	25': Grab sample for archive and moisture β, γ < detectable
					LEL, OVM < det.

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

BOREHOLE LOG					Page 2 of 10
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		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
30	Archive, moisture	DB		Silty Sandy GRAVEL - as on page 1	Cable tool drilling 11 3/4" OD CS casing
	moisture			31': moisture increase	
				34' → 44': Gravelly SAND (GS)	30': Grab sample for archive, moisture
35	Archive, moist			25% gravel, 75% sand, tr silt.	B, X < detect.
				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, med/poor sorted; gravel	31': Grab for moist. 35': Grab sample for archive, moisture
40	Archive, moisture			is R-SR, sand A-SA; Gravel & sand ~50% basalt, 50% qtz, granitic, other	B, X < det.
				salt/pepper appearance, max size ~ 8cm no rxn HCl.	40': Grab sample for archive, moisture
					B, X < 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 f, X < 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 f, X < det.
55	Archive, moisture			11 3/4" OD casing set at 51.5'	
			55': gravel content decrease to trace amounts.	55': Grab sample archive, moisture	
			58': clumps of sand, weakly cemented. mod. rxn to HCl	LEL, OVM & detect.	
Reported By: L.D. Walker			Reviewed By: DC Wecker		
Title: Geologist			Title: Geologist		
Signature: <i>L.D. Walker</i>		Date: 12-14-99	Signature: <i>DC Wecker</i>		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		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
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	65': Grab sample for archive, moisture
				Gray brown (10YR 5/2), sl-moist to dry, mod sorted, SA-A; 30-40% basalt,	
70	Archive, moist			60-70% qtz/feld/other; tr iron staining	70': Grab sample - archive, moisture.
				at 70 feet. Max size ~ 8 mm; weak HCl rxn. Tr fn-v.fn peb. at 70-71'	
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 P, X < detect.	
85	Archive, moisture			85': Grab sample - archive, moisture	

Reported By: <u>L.D. Walker</u>	Reviewed By: <u>DC Weekes</u>
Title: <u>Geologist</u>	Title: <u>Geologist</u>
Signature: <u>L.D. Walker</u>	Date: <u>12/14/99</u>
Signature: <u>DC Weekes</u>	Date: <u>1/10/00</u>

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 (Fl.)	Sample		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
120	Archive Moist	DB		475 → 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 mod moist, poorly sorted, angular to sub-round, ~40% basalt, 60% other. No rxn to HCl	Archive + Moisture
125	Archive Moist			@ 123.5 vf-f sand (70%), silt 30% - Silty Sand	v. tight from 123.5-125' then lost the log
				mod rxn to HCl. Silt to 40% lt-mod CO ₃ cement, 10YR 6/3 (pale brown.)	125' Grab Sample - Archive + moisture.
130	Archive Moist			vf-f sand.	
				130' - SAND (S), gray-brown w/ sporadic vf gravel (<1% @ 1/4" size) and rxn to HCl	Grab Sample - Archive + moisture
135	Archive Moisture			135' - Sand (S) As above, variable silt, local accretions w/ lt to mod rxn to HCl, isolated, sporadic fine gravel grains.	Grab Sample - Archive + Moisture
140	Archive moisture				140' Grab sample - archive, moisture
145	Archive moisture			SAND - as above	145' Grab sample, archive + moisture
					LEL, OVM < detect.

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

BOREHOLE LOG					Page 6 of 10	
Well ID: 88810		Well Name: 299-E 33-334		Location: 200E, outside SW cor. 241-BX ^{Tank Farm}		
Project: FY 2000 RCRA Drilling				Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:	
	Type No.	Blows Recovery				
150	Archive, moist	DB		151.5' → 154': Silty SAND (mS). 5% gravel, 60% sand, 35% silt.	Cable Tool drilling 8 5/8" OD CS casing	
	moisture			Gravel tr sm cob, 40% csc-med peb, 60% fn-v. fn; Sand 40% v. csc-csc, 20% med, 40% fn-v. fn; Brown (10YR 5/3), moist, poorly sorted; gravel R-SR, sand SA; csc sand predom basalt, fn sand predom qtz; max size ≈ 10 cm, mod. rxn HCl	150': Grab sample for archive and moisture analysis. β, γ < detect.	
155	Archive, moist			154' → 208': SAND (S); tr gravel, 100% sand, tr silt. 10% v.csc, 40% csc, 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	152': Moisture samp.	
160	Archive, moist				155': Grab sample - archive, moisture	
165	Archive, moist				160': Grab sample - archive, moisture	
170	Archive, moist				165': Grab sample - archive, moisture	
175	Archive, moist				170': Grab sample - archive, moisture	
					175': tr-5% gravel, v.fn-fn pebs	175': Grab sample - archive, moisture
Reported By: L.D. Walker			Reviewed By: DC Weekes			
Title: Geologist			Title: Geologist			
Signature: <i>L.D. Walker</i>		Date: 12/16/99	Signature: <i>DC Weekes</i>		Date: 1/10/00	

BOREHOLE LOG

Page 7 of 10
Date: 12-16-99

Well ID: <u>B 8810</u>		Well Name: <u>299-E33-334</u>		Location: <u>200E, outside SWD cor. 241-BX Tank Farm</u>	
Project: <u>FY 2000</u>		<u>RCRA Drilling</u>		Reference Measuring Point: <u>Ground Surface</u>	
Depth (FL)	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	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
180	Archive 2 Moist.	DB		Sand with CaCO ₃ cement - strong rxn HCl	8 7/8" OD CS casing
185	Archive 2 Moist.			184' : Sand loose, dry	180' : Grab sample for archive, moisture LEL, OVM < defect A, X < det.
190	Archive 2 Moist.			154' → 208' : SAND (S) At 190' : fr gravel, 100% sand, to silt gravel is fn-v. fn. peb, mainly SA basalt. Sand 20% v. csc, 40% csc, 10% med, 30% fn-v. fn; lt brnish gray (10YR 6/2), dry - sl moist, med sorted, SA-A, 35% basalt, 65% qtz, fild, other; max size ≈ 10 mm, weak rxn HCl	185' : Grab sample - archive, moisture 190' : Grab sample - archive, moisture
195	Archive 2 Moist.			200' : Sand, as above	195' : Grab sample - archive, moisture
200	Archive 2 Moist.			drilling more slowly	200' : Grab sample - archive, moisture
205	Archive 2 Moist.			204' : silt & oil slick, strong rxn HCl then back to sand as above	205' : Grab sample - archive, moisture
210				208' : sand more fine - see next page for description -	End 12/16/99 Beg'n 12/17/99
Reported By: <u>L.D. Walker</u>		Reviewed By: <u>D. Upokes</u>			
Title: <u>Geologist</u>		Title: <u>Geophysist</u>			
Signature: <u>[Signature]</u>		Signature: <u>[Signature]</u>			
Date: <u>12-17-99</u>		Date: <u>12-17-99</u>		Date: <u>1/10/00</u>	

BOREHOLE LOG

Page 8 of 10
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		Graphic Log	Sample Description	Comments:	
	Type No.	Blows Recovery				
210	Archive, moist	DB		208' → 222.5': SAND (S); tr gravel, 100% sand; 5% v.cse, 15% cse, 20% med, 40% 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 < detect.	
215	Archive, moist				215': Grab sample - archive, moisture	
220	Archive, moist				220': Grab sample - archive, moisture	
225	Archive, moisture				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 brownish gray (10YR 6/2), dry (silt layer at 222.5' moist) poorly sorted; gravel SR, sand SA-A, gravel 60% basalt, 40% qtz/granit/other, max size ~4 cm, weak-mod rxn HCl.	225': Grab sample - archive, moisture
230	Archive, moist				229' → 233' : Silty 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, minerals as above, dry.	230': Grab sample - archive, moisture
235	Archive, moist				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' : sl moist increase

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

BOREHOLE LOG					Page <u>9</u> of <u>10</u>
Well ID: <u>B8810</u>		Well Name: <u>299-E33-334</u>		Location: <u>200E, outside SW cor. 241-BK Tank Farm</u>	
Project: <u>FY 2000 RCRA Drilling</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
240	Archive, moisture	DB		233' → 269' : Silty Sandy GRAVEL (us6)	Cable tool drilling 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 -
245	Archive, moisture			30% med peb, 20% fn-v.fn; Sand 10% v.cse-cse, 30% med, 60% fn-v.fn; lt.	archive, moisture
				brnsh gray (10YR 6/2), dry-s/moist, poorly sorted, gravel R-SR, sand SA; 50%	β, γ & detect. LEL, OVM < det.
250	Archive, moist.			basalt, 50% granite/artzite/other; max size ~ 15 cm, weak HCl rxn.	245': Grab sample -
				245': drilling indicates sm cobs/15m boulders	archive, moisture
					250': Grab sample -
					archive, moisture
255	Archive, moist.			254'-255' : sl increase in moisture and silt content	255': Grab sample -
				many of the cse pebbles/cobbles have fresh broken faces due to the drilling	archive, moisture
				β, γ & detect.	
260	Archive, moisture			260': Grab sample -	
				archive, moisture	
			264.5' : sediment becomes wet	265': Grab sample -	
				archive, moisture	
265	Archive, moisture				
	SS #1	80% rec.		265.5' → 268' : split	
	Hyd. Cond. Sieve			spoon sample for	
		DB		hyd. cond. and sieve	
			269' : driller notes heaving sand	analysis.	

Reported By: <u>L.D. Walker</u>	Reviewed By: <u>DC Weekes</u>
Title: <u>Geologist</u>	Title: <u>Geologist</u>
Signature: <u>[Signature]</u>	Signature: <u>[Signature]</u>
Date: <u>12-20-99</u>	Date: <u>1/10/00</u>

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		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
270	Archive Waste Character	PB ↓ HT		269' → 280': Sandy GRAVEL (sG) 70% gravel, 25-30% sand, 4-30% c/w 45% silt. Gravel fr cob, 30% v.cse-cse peb, 20% med peb, 50% Fh-v.fh peb; sand 30% v.cse, 20% cse, 30% med, 20% Fh-v.fh;	Cable tool drilling 8 5/8" OD CS casing 12/21/99 a.m. W.L. = 259.5'
275	SS #2 hyd. cond./ sieve/ archive	100% rec. HT		v. dk grayish brn (10YR3/2), wet, poorly sorted; gravel R-SR, sand SA; 40% basalt, 40% granitic, 20% quartzite/other; max size ≈ 10 cm; no HCl run - loose, no cementing.	270': Grab sample - archive and *Waste characterization (BOX5J9, BOX5K4)
280	Archive Samples	↓		275': silt increasing, ~5% 280': Hit basalt. Sample is probably unregas. very crushed gravels, slight run to HCl	275': Split spoon sample hyd. cond./sieve/ archive
285		↓		280' → 285': BASALT, fine pulverized basalt w/some sand from above, 10YR4/1 dark gray (wet)	280': hard tool sample with coarse sand
290				Starting at 280' drilling is very slow TD = 285 ft 12/22/99 Bottom of 8 5/8" casing @ 280 ft bgs.	
295					

Reported By: L.D. Walker / DC Weekes

Reviewed By: J D Williams

Title: Geologist

Title: Sr. Engineer

Signature: L.D. Walker / DC Weekes Date: 12/22/99

Signature: J D Williams Date: 12/22/99

WELL SUMMARY SHEET

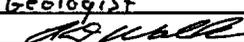
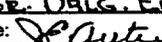
Page 1 of 2

Date: 2-9-00

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

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram		Graphic Log	Lithologic Description
Portland Cement 0 → 10.9' below ground surface		0		0' → 7': Sandy GRAVEL 7' → 12': Sandy GRAVEL 12' → 14': SAND 14' → 14.5': Sandy SILT 14.5' → 20': Sandy GRAVEL 20' → 22': Silty SAND 22' → 45': Silty Sandy GRAVEL 45' → 50': Silty Sandy GRAVEL 50' → 58': Silty Sandy GRAVEL 58' → 219': SAND
Temporary casing 11 3/4" OD 0 → 50.4'		25		
Stainless steel casing type 304, sched. 5 4 1/2" OD / 4" ID + 2.2' → 260.01'		50		
Granular bentonite 10.9' → 250.5'		75		
Temp casing 8 5/8" OD 50.4' → 280.8'		100		
		125		

WELL SUMMARY SHEET			Page 2 of 2			
			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: <i>L.D. Walker</i>		Signature: <i>DC Weekes</i>				
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
		150				
		175				
		200				
Silica Sand 10-20 mesh 250.5' → 281.9'						
Sluff: 281.9' → 286'				225	219' → 226': Slightly Silty SAND	
Stainless Steel Wellscreen Cont. wire wrap 0.020-in slot, type 304-SS, 4 1/2" x 4" 260.01' → 280.03'				250	226' → 250': Silty Sandy GRAVEL	
Stainless Steel endcap, type 304 4 1/2" x 4" 280.03' → 280.43'				275	250' → 280.5': Sandy GRAVEL	
					2-9-00 W.L. = 264.40'	
					280.5' → 286': BASALT	
					TD = 286'	
All depths in feet below ground All temporary casing removed from the ground						

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			
ECNs: NA		Approximate Location: S. side BX-BY Tank Farm/200E		Temp. Well No.: 88811			
Project: RCRA drilling FY 2000		Other Companies: BHE, CHI, THI					
Drilling Company: Resonant Sonic Intn.		Geologist(s): P. Moore					
Driller: W. Worth		L. Walker					
TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD/HOLE DIAMETER				
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter From _____ to _____			
(FJ) 1 3/4" OD Carbon Steel	0 - 50.4	12 1/4" / 10 3/4"	Cable Tool:	Diameter From _____ to _____			
(FJ) 2 5/8" OD Carbon Steel	0 - 280.8	9" / 7 5/8"	Air Rotary:	Diameter From 50' to 286'			
			A.R. w/Sonic:	Diameter From 0 to 50.4			
				Diameter From _____ to _____			
				Diameter From _____ to _____			
*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design				Diameter From _____ to _____			
			Drilling Fluid: raw water ²⁻¹⁰⁻⁹⁹ 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 w/ screen	280.03 - 260.01		0.020"	Granular Bentonite	250.5 - 10.9	88.40	#8
4" ID 304SS casing (sched. 5) ²	260.01 - 12.2		NA	Portland Cement w/ 5% bent.	10.9 - 0	11.57	NA
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 23 gpm. 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 = 23.54 ft ³ ; #8 mesh gran. bent: 124.5 (50-lbs bag) x 0.71 Ft ³ /bag = 88.40 ft ³ ; Portland cement: 9 (94-lbs/bag) x 1.285 = 11.57 ft ³							
Reported By: L. D. Walker		Date: 2-10-00		Reviewed By: J. E. AUSTEN			
Title: Geologist		Date: 2-10-00		Title: SR. DRUG. ENGR.		Date: 2/28/00	
Signature: 				Signature: 			

BOREHOLE LOG

Page 1 of 10

Date: 12/2/99

Well ID: 299-E33-325 Well Name: B8811 Location: Southside 3x8¹/₂ Tank Farm
 Project: 1999 RCRA Protection wells Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
0					Some, 1 3/4" casing.
0-7'				0-7' sandy GRAVEL, 35% gravel, 65% sand, gravels 60% basalt, 40% other, numerous cobbles, A-SR, moist, max cobble = 160mm poorly sorted, sand 10% s/s (moist) yellow brown	
5	Archive 1			SA, 40% basalt, 60% other, v. poorly sorted, rxn to HCl = strong	Soil + background @ 300-350dpm
7-12				7-12 sandy GRAVEL, 65% gravel, 35% sand, 10% s/s, 10% r 3/2 very dk gray brown, gravel 70% basalt, 30% other, A-SR, gravel max part = 65mm, sand 80% basalt, 20% other, SA, no rxn to HCl, mod. sorted (mod + less grained), several cobbles (broken) to 110mm	: < action level
10	Archive 2			12-14 SAND, as above,	
14-14.5	Archive 3			14-14.5 silt lens (sandy), 70% silt, 30% sand, 10% r s/s, (moist), brown, moist, mod. strong rxn HCl, sand 50-60% basalt, trace mica, mod less grained, mod. sorted	
14.5-20				14.5-20' sandy gravel 40% gravel, (A-SR, 40% basalt, mod sorted), sand 10% s/s (moist) dk yellow brown, moist, v. poorly sorted, mod rxn HCl.	
20	Archive 4			20-22 silty SAND, 45% silt, 55% sand, 2.5% s/s 1/4 it. dk brown, moist,	
20	Archive 5			22-25 silty sandy GRAVEL, 10% silt, 55% gravel, 35% sand, v. poorly sorted gravel SR, max part = 70mm, sand: 2.5% s/s 1/4 it. dk brown, moist, v. poorly sorted, 40% basalt, no rxn to HCl, cobbles to 200mm.	
25	Archive 5				
30	Archive 6				

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

BHI-EE-183 (12/97)

BOREHOLE LOG					Page <u>2</u> of <u>10</u>	
Well ID: <u>299-E33-335</u>		Well Name: <u>B8811</u>		Date: <u>12/2/99</u>		
Project: <u>1999 RCRA Protection well</u>				Reference Measuring Point: <u>Ground surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:	
	Type No.	Blows Recovery				
30					Soil 11 3/4" casing	
35	Archive 7				All soil to 50' < 50dpm over background Background	
40	Archive 8				Varies (300-350dpm)	
45	Archive 9	NA			45 - 50' silty sandy gravel, increasing silt content and clumps of sandy silt, 20% silt, 45% sand, 35% gravel, Gravel poorly sorted, SA-SL, 60% basalt, 40% other, max particle = 60mm, Sand 40% basalt, 60% other, 10% 4 1/2 (max) dk. grey brown, moist, mild rxn to HCl.	End 12/2/99 Beg. 12/3/99
50	Archive 10				50' → 58': Silty Sandy GRAVEL (us G) similar to described above. Air rotary drilling breaks up gravel over 1-2 cm weak rxn to HCl	End 12/3/99 1-31-00
55	Grab-Archive				58' gravel decreases to SAND - see page 3 description	Begin Air rotary drilling; 8 3/8" / 7 1/8" carbon steel casing
						55': Grab sample for archive.
Reported By: <u>Pat Moore</u>			Reviewed By: <u>DC Weekes</u>			
Title: <u>Geology-st</u>			Title: <u>Geologist</u>			
Signature: <u>Pat Moore</u>		Date: <u>12/2/99</u>	Signature: <u>DC Weekes</u>		Date: <u>2/10/00</u>	

BHI-EE-183 (12/97)

BOREHOLE LOG					Page <u>3</u> of <u>10</u>
Well ID: <u>B8811</u>		Well Name: <u>299-E33-335</u>		Location: <u>Southside BX-BY Tank Farm</u>	
Project: <u>2000 FY RCRA Drilling</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		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
	Type No.	Blows Recovery			
60	Grab-Archive	Air Rotary		58' → 219': SAND (S); tr-5% gravel, 90-100% sand, tr-5% silt. Gravel fr 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; med-well sorted; sub-angular to sub-round; 20-30% basalt, 50% qtz, 20-30% feldsp w 1-3% 70-80% qtz/feld/other. Max part. size ≈ 10 mm, weak rxn HCl.	Air rotary 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-Archive			70': Grab sample for archive B ₃₈ < detectable OVM, LFL < detect.	
75	Grab-Archive			75': grain ^w grain size decrease. Sand is predom med otherwise similar to above tr mica	75': Grab sample for archive
80	Grab-Archive				80': Grab sample for archive
85	Grab-Archive				85': Grab sample for archive

Reported By: <u>L.D. Walker</u>	Reviewed By: <u>DC Weekes</u>
Title: <u>Geologist</u>	Title: <u>Geologist</u>
Signature: <u>[Signature]</u>	Date: <u>1-31-00</u>
Signature: <u>[Signature]</u>	Date: <u>2/10/00</u>

BHI-EE-183 (12/97)

BOREHOLE LOG					Page <u>4</u> of <u>10</u>	
Well ID: <u>B8811</u>		Well Name: <u>299-E33-335</u>		Location: <u>South side BX-BY Tank Farm/200 E</u>		
Project: <u>FY 2000 RCRA Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:	
	Type No.	Blows Recovery				
90	Grab-Archive Air Rotary	NA		SAND (S) as described on page 3. at 90': grain size increase. Sand is predom cse	Air rotary, 7/4" tricone bit; 8 5/8" OD CS casing 90': Grab sample for archive	
95	Grab-Archive				95': Grab sample for archive	
100	Grab-Archive				100': tr v. fn pnb	100': Grab sample for archive
105	Grab-Archive					105': Grab sample for archive
110	Grab-Archive				SAND (S) - similar to above tr gravel, 100% sand, tr silt Gravel is v. fn pnb; Sand 10% v. cse; 30% cse, 40% med, 20% Fn-v. fn; 10YR 4/2 (dk gr. brn), sl moist; med sorted, A-SA; 30% basalt, 70% qtz/	110': Grab sample for archive
115	Grab-Archive				other, tr mica; Max size ≈ 4 mm, weak rxn HCl.	115': Grab sample for archive

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>DC Weefes</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>L.D. Walker</u>	Date: <u>1-31-00</u>	Signature: <u>DC Weefes</u>	Date: <u>2/10/00</u>

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

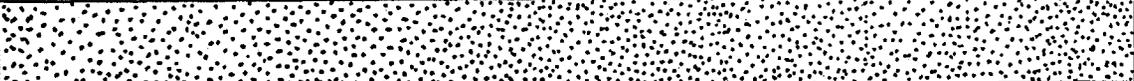
Project: FY 2000 RCRA Drilling Reference Measuring Point:

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
120	Grab-Archive Air Rotary	NA			Air rotary; 7/8" tricone bit 8 5/8" OD casing
125	Grab-Archive			124' → 125': sl increase in silt. 95% sand, 5% silt	120': Grab sample for archive
				silt content decrease, sand becomes coarser	125': Grab sample for archive
130	Grab-Archive				130': Grab sample for archive
				SAND (S); tr gravel, 100% sand, tr silt. Gravel fn-v. fn peb;	
135	Grab-Archive			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
140	Grab-Archive				140': Grab sample for archive; end 1-31-00 Begin 2-1-00
145	Grab-Archive			145': sand becoming finer - predom. medium	145': Grab sample for archive.

Reported By: <u>L.D. Walker</u>	Reviewed By: <u>DC Weekes</u>
Title: <u>Geologist</u>	Title: <u>Geologist</u>
Signature: <u>[Signature]</u>	Date: <u>2-1-00</u>
Signature: <u>[Signature]</u>	Date: <u>2/10/00</u>

BOREHOLE LOG

Page 6 of 10
Date: 2-1-00

Well ID: <u>B8811</u>		Well Name: <u>299-E33-335</u>		Location: <u>South side BX-BY Tank Farm</u>	
Project: <u>FY2000</u>		<u>RCRA Drilling</u>		Reference Measuring Point: <u>Ground Surface</u>	
Depth (ft)	Sample Type No.	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	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
150	SS #1	100% rec. & archive		<p><u>SAND (S), tr gravel, 100% sand,</u> <u>tr silt. Gravel Fr-v-Fn; Sand 15%</u> <u>v. cse, 30% cse, 40% med, 15% Fr-v-Fn. 10YR 4/2 (dk gr brn)</u> <u>s/ moist, med sorted, A-SA,</u> <u>30-35% basalt, 6.5-70% qtz/other, max size ~ 5 mm, weak HCl rxn.</u></p> <p style="text-align: right;">Air rotary, 7 1/4" tricone bit, 8 3/8" OD CS casing</p>	
	Grab - Archive			149' - 151.5': split Spoon for paleo-mag analysis. Also, 150' air rotary grab sample for archive.	
160	Grab - Archive			155': Grab sample for archive	
165	Grab - Archive			160': Grab sample for archive. Sand size decreases - predom med-Fn mineralogy as above	
170	Grab - Archive			165': Grab sample for archive	
175	Grab - Archive			170': Grab sample for archive	
				175': Grab sample for archive. Sand becoming coarser med-cse	
Reported By: <u>LD Walker</u>			Reviewed By: <u>DA Weekes</u>		
Title: <u>Geologist</u>			Title: <u>Geologist</u>		
Signature: <u>[Signature]</u>			Signature: <u>[Signature]</u>		
Date: <u>2-1-00</u>			Date: <u>2/10/00</u>		

BH1-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 (Fl.)	Sample		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
180	SS #2 Palco-mag	90% rec.		SAND (S), tr-5% gravel, 95-100% sand, tr silt. Gravel med-v. fn pb,	Air rotary, 7/4" torque bit, 8 5/8" OD casing
	Air Rotary			Sand 20% v.cse, 20% cse, 40% med,	179-180': Grab sample for archive.
185	Grab-Archive			20% fn-v. fn; 10 YR 5/2 (gn brown), sl-moist to dry; mod sorted, A-SR,	180' → 182.4': Split spoon for palco-mag analysis
				40% basalt, 60% gtz/feld/other; max size ≈ 10 mm; rxn to HCl weak-none.	186' → 187': driller notes binding in drill bit indicating gravels
190	Grab-Archive				185': Grab sample for archive
					190': Grab sample for archive
195	Grab-Archive				195': sand becoming finer - predom med-fn
					200': Grab Sample for archive
200	Grab-Archive				200': tr gravel; fn-med
					205': Grab Sample for archive
205	Grab-Archive			sand is med-well sorted, predom med size; 25% basalt, 75% gtz/other	

Reported By: <u>L.D. Walker</u>	Reviewed By: <u>DC Weekes</u>
Title: <u>Geologist</u>	Title: <u>Geologist</u>
Signature: <u>[Signature]</u>	Signature: <u>[Signature]</u>
Date: <u>2-2-00</u>	Date: <u>2/10/00</u>

BOREHOLE LOG					Page <u>8</u> of <u>10</u>
Well ID: <u>B8811</u>		Well Name: <u>299-E33-335</u>		Location: <u>South side BX-BY Tank Farm/200E</u>	
Project: <u>FY 2000 RCRA Drilling</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
210	Grab - Archive 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, med- well sorted; SA; 20% basalt, 80% qtz/feld/other, tr iron stain; max size ~ 2 mm; no rxn HCl.	Air rotary; 8% op casing 209'→210': grab sample for archive LEL, OYM & detect
215	Grab - Archive Waste Charact.			219'→226': Slightly Silty SAND (mS) 85%-90% sand, 10-15% silt	209.8'→212.2': split Spore for paleo-mag analysis.
220	Grab - Archive			Sand 80% v. Fn, 20% Fn - med/cse increase ~ 225'. 10YR 6/3 (pale brown)	215': Grab sample For archive
225	Grab - Archive			sl moist; well sorted, SA-SR, 10-15% basalt, 85-90% qtz/felds; weak to mod rxn to HCl	217': Grab sample Waste characterization HEIS # 80X5K1, 80X5K6 B, X < detect.
230	Grab - 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.	220': Grab sample For archive
235	Grab - Archive			Sand predom. med-Fn. 10YR 5/2 (grayish brown), dry; sand A-SA; grave 60% basalt, 40% qtz/granitic/other Sand 30% basalt, 70% qtz/other weak rxn HCl.	225': Grab sample For archive 230': Grab sample For archive. 235': Grab sample For archive

Reported By: <u>L.D. Walker</u>	Reviewed By: <u>DC Weekes</u>
Title: <u>Geologist</u>	Title: <u>Geologist</u>
Signature: <u>L.D. Walker</u>	Signature: <u>DC Weekes</u>
Date: <u>2-2-00</u>	Date: <u>2/10/00</u>

BOREHOLE LOG					Page 9 of 10	
Well ID: B8811		Well Name: 299-E33-335		Location: South side B&BY Tank Farm / 200E		
Project: FY 2000 RCRA Drilling.			Reference Measuring Point: Ground Surface			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:	
	Type No.	Blows Recovery				
240	Grab-Archive	NA			Air rotary; 8 5/8" 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)	250': grab sample for archive
					50% gravel, 40-45% sand, 5-10% silt	
					Drilling indicates occ. cobbles	drill rate slows to 5 ft/15 min
					Sand 10% v.cse-cse, 40% med, 40% F _n , 10% v.F _n ; color and minerals	
255	Grab-Archive				similar to MSG described above;	255': Grab sample for archive.
					dry, weak rxn HCl.	
260	Grab-Archive				260': Grab sample for archive	
				~262': cuttings begin to appear moist		
265	Grab-Archive			265' → 266'	265': Grab Sample for archive	
				Drilling indicates smaller gravel v.F _n -F _n , round pebbles in cuttings		

Reported By: L.D. Walker	Reviewed By: DC Weekes
Title: Geologist	Title: Geologist
Signature: <i>L.D. Walker</i>	Signature: <i>DC Weekes</i>
Date: 2-2-00	Date: 2/10/00

BOREHOLE LOG					Page <u>10</u> of <u>10</u>
Well ID: <u>B8811</u>		Well Name: <u>299-E33-335</u>		Location: <u>S. side BX-BY Tank Farm / 200E</u>	
Project: <u>FY 2000 RCRA Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type No.	Blows Recovery			
270	Grab - Archive	NA		Sandy GRAVEL (SG) as described pg. 9	Air rotary; 8 5/8" OD casing
	Grab - Waste Charact.			gravel content slowly increase to ≈ 70%.	270': Grab sample for archive
275	Grab - Archive				272': Grab sample for waste charact.
					HEIS #80X5K2, 80X5K7
					275': Grab sample for archive
280	Grab - Archive			280.5' → 286': BASALT	280': Grab sample for archive
				vesicular upper ~1 ft, then solid fresh fragments. Black, wet.	
285	Grab - Archive			285': Grab sample for archive	
290				8 5/8" OD casing set at 280.8'	
				TD = 286 ft. bgs	
				Water level 264.40' (2-9-00)	
295					
Reported By: <u>L.D. Walker</u>			Reviewed By: <u>DC Weekes</u>		
Title: <u>Geologist</u>			Title: <u>Geologist</u>		
Signature: <u>L.D. Walker</u>		Date: <u>2-2-00</u>	Signature: <u>DC Weekes</u>		Date: <u>2/10/00</u>

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 105° 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 # <u>B8810</u>	Water Depth <u>263.8</u> ft	Total Depth <u>285</u> ft
Elevation Reference <u>n/a</u>	Elevation <u>n/a</u> ft	
Depth Reference <u>Surface</u>	Casing Stickup <u>2.1</u> ft	
Casing Diameter <u>11.75</u> in	Depth Interval <u>0 to 51.75</u> ft	Thickness <u>0.5</u> in
Casing Diameter <u>7.625</u> in	Depth Interval <u>0 to 280</u> ft	Thickness <u>0.5</u> in

Logging Information

Log Type:	NaI Spectral Gamma Ray	
Company	Waste Management Technical Services	
Date/Archive File Name	December 27, 1999	H2E33334
Logging Engineers	<u>S.E.Kos</u>	
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

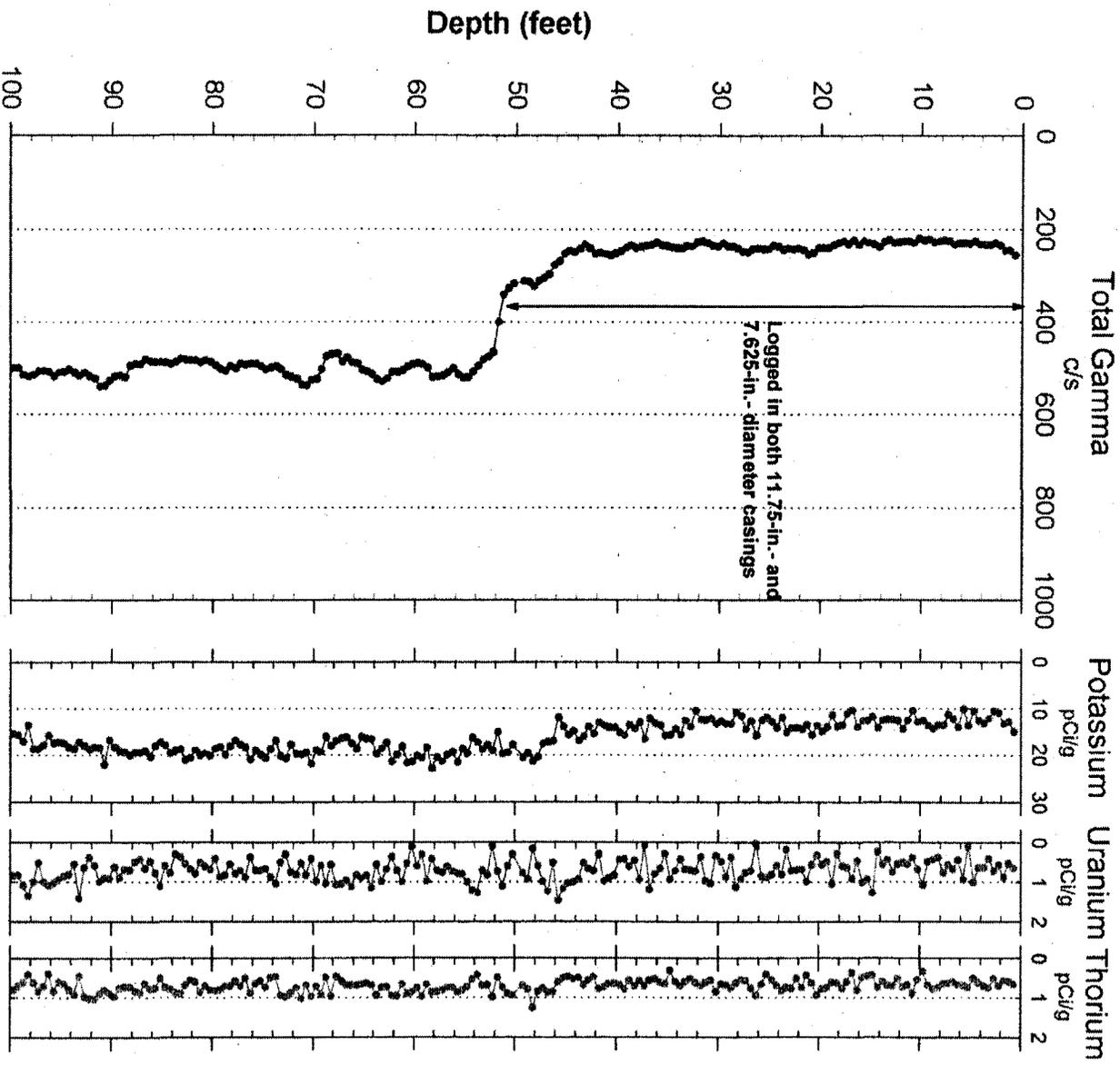
Company	Three Rivers Scientific
Analyst	Russ Randall
Date	February 15, 2000
Depth Reference	Ground Surface

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

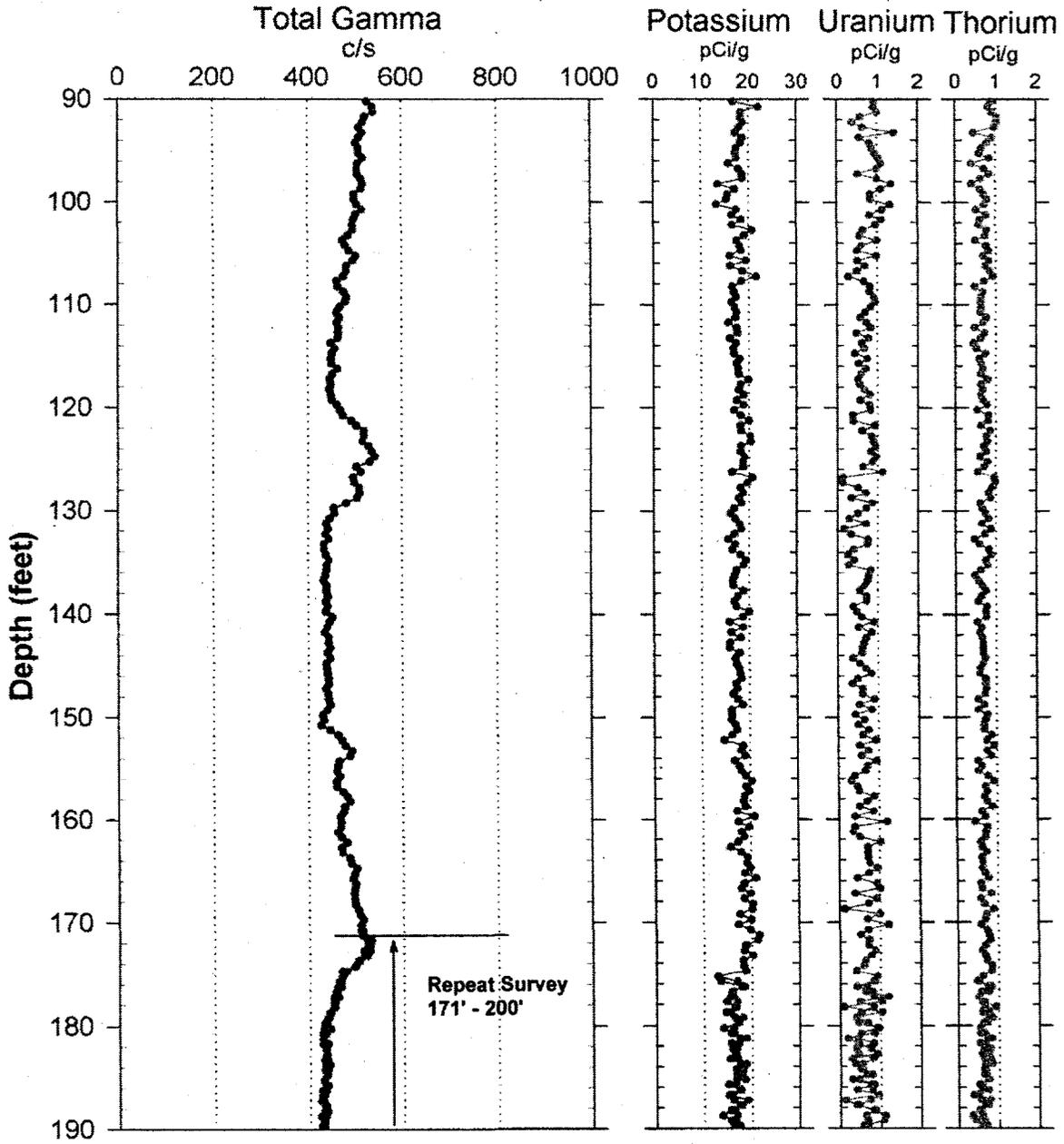
Waste Management Technical Services

Project: RCRA Drilling 2000

Log Date: Dec. 27, 1999

Well: 299-E33-334

Depth Datum: Ground Level



RLS Spectral Scintillator Borehole Survey

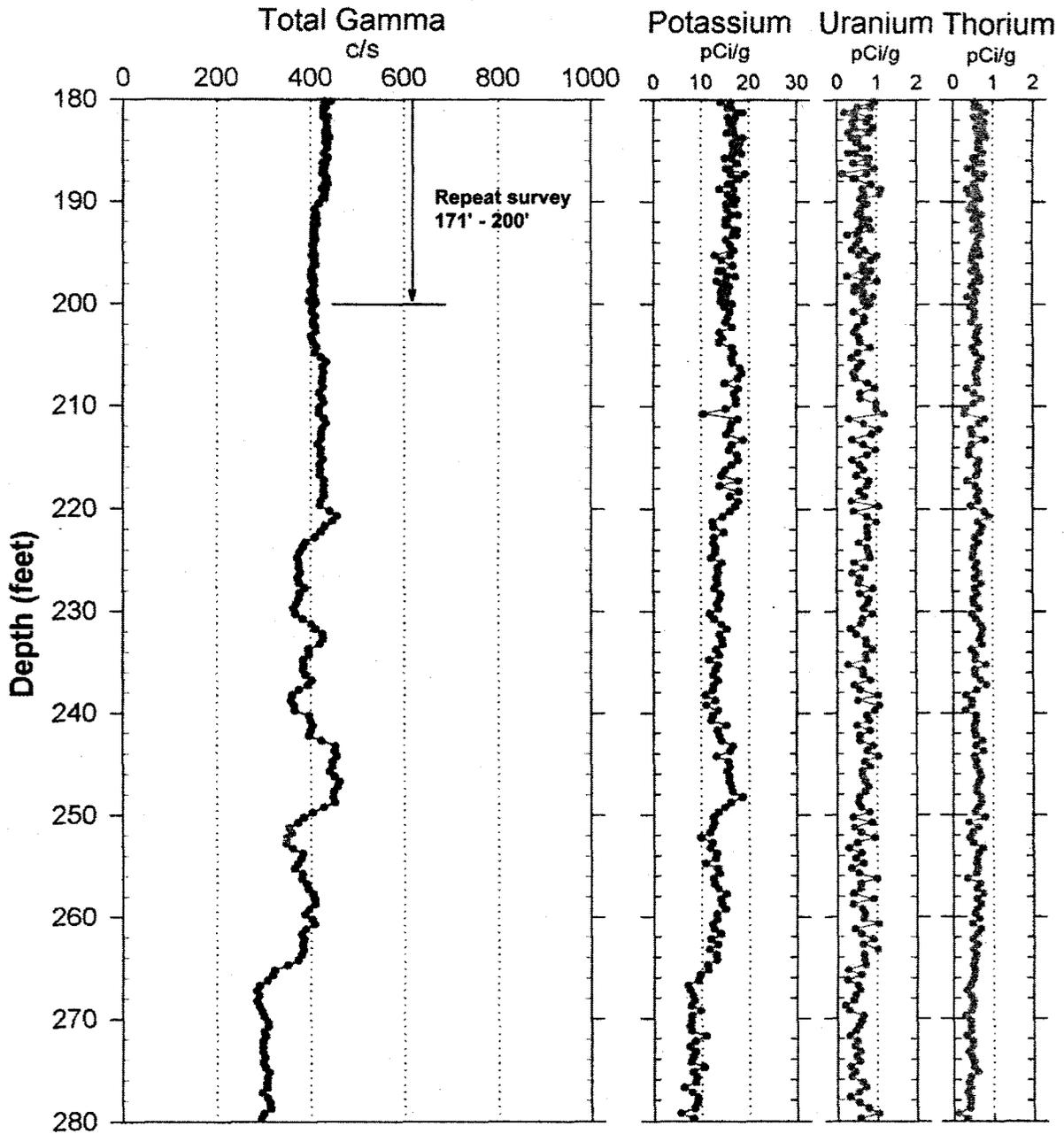
Waste Management Technical Services

Project: RCRA Drilling 2000

Log Date: Dec. 27, 1999

Well: 299-E33-334

Depth Datum: Ground Level



RLS Spectral Scintillator Borehole Survey

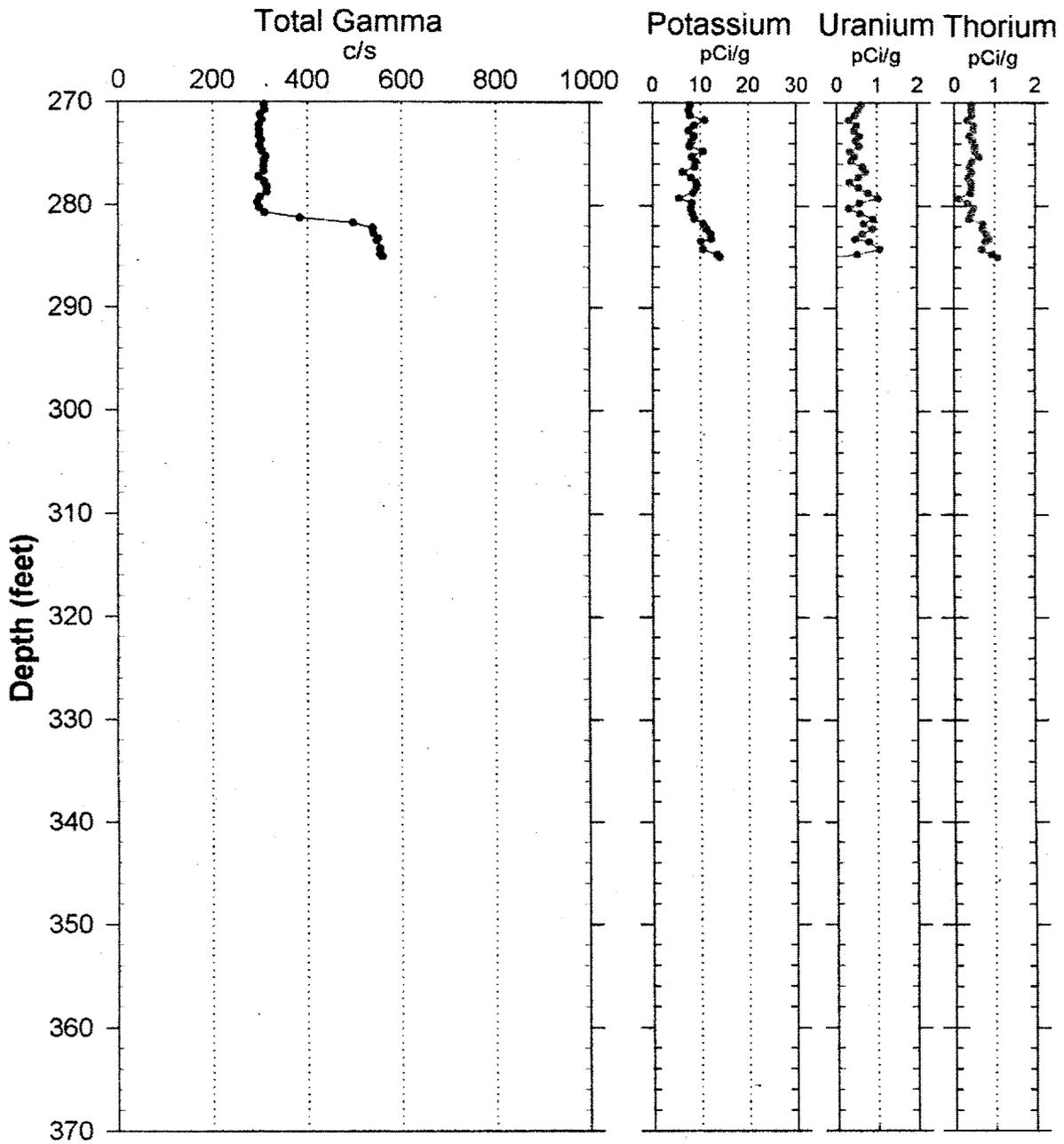
Waste Management Technical Services

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
Log Type: NaI Spectral Gamma Ray

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

Logging Information

Log Type:	Neutron-Neutron Moisture	
Company	Waste Management Technical Services	
Logging Engineers	<u>S. E. Kos</u>	
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

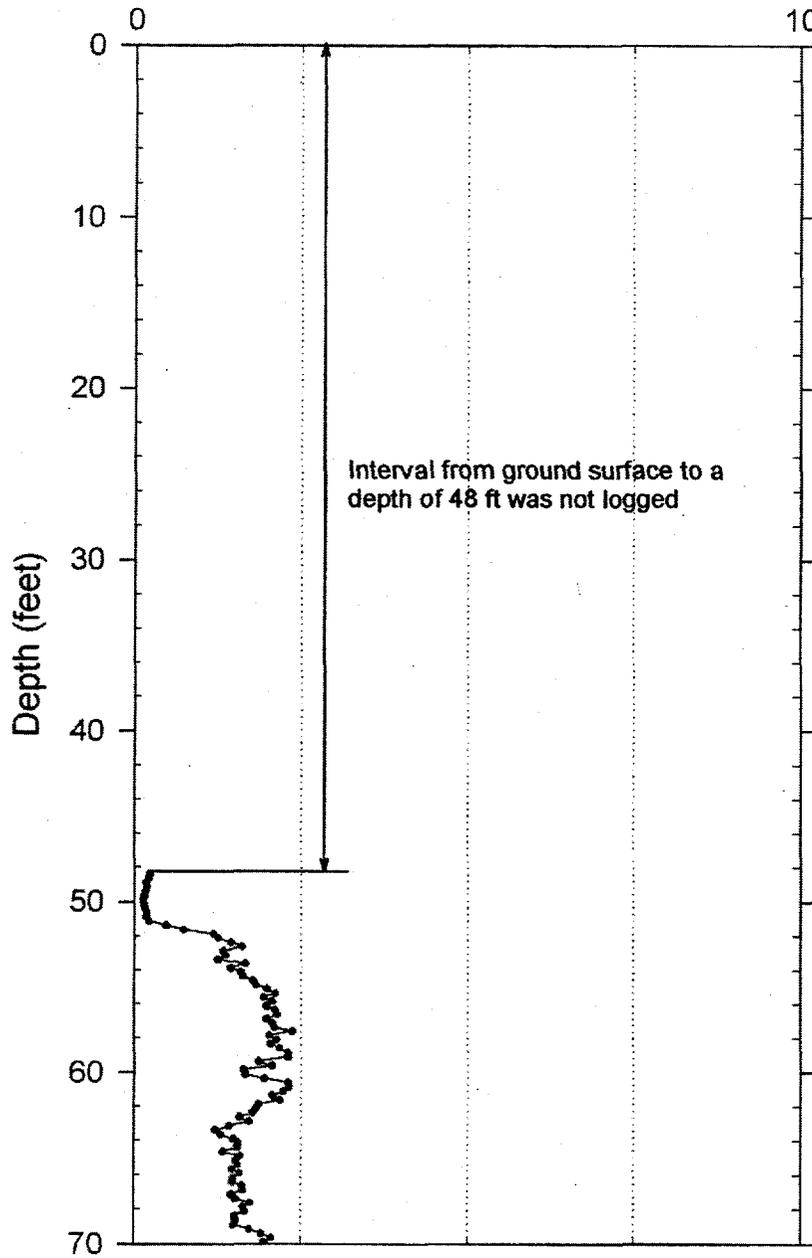
Project: 1999 RCRA Drilling

Log Date : December 27, 1999

Borehole: 299-E33-334

Depth Datum: Ground Level

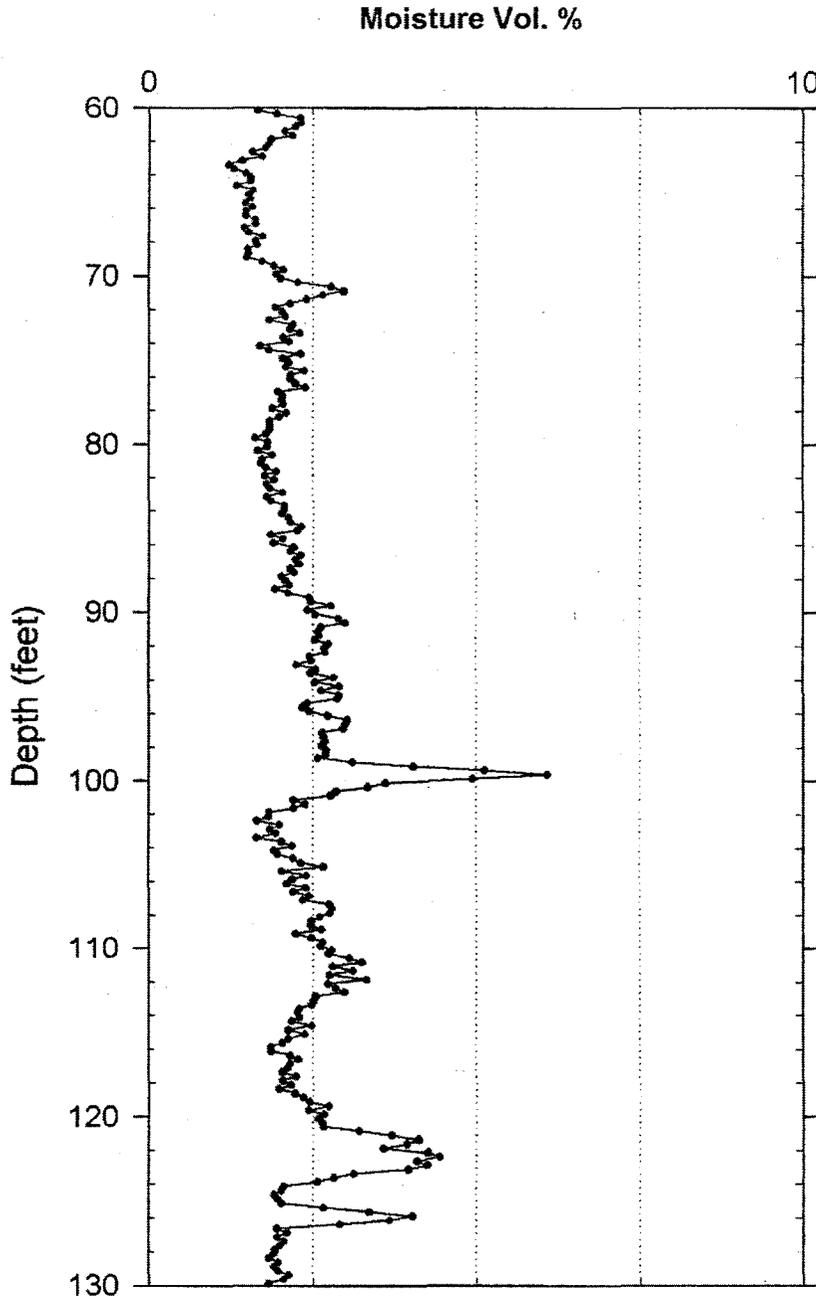
Moisture Vol. %



Neutron-Neutron Moisture Survey
Waste Management Technical Services

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

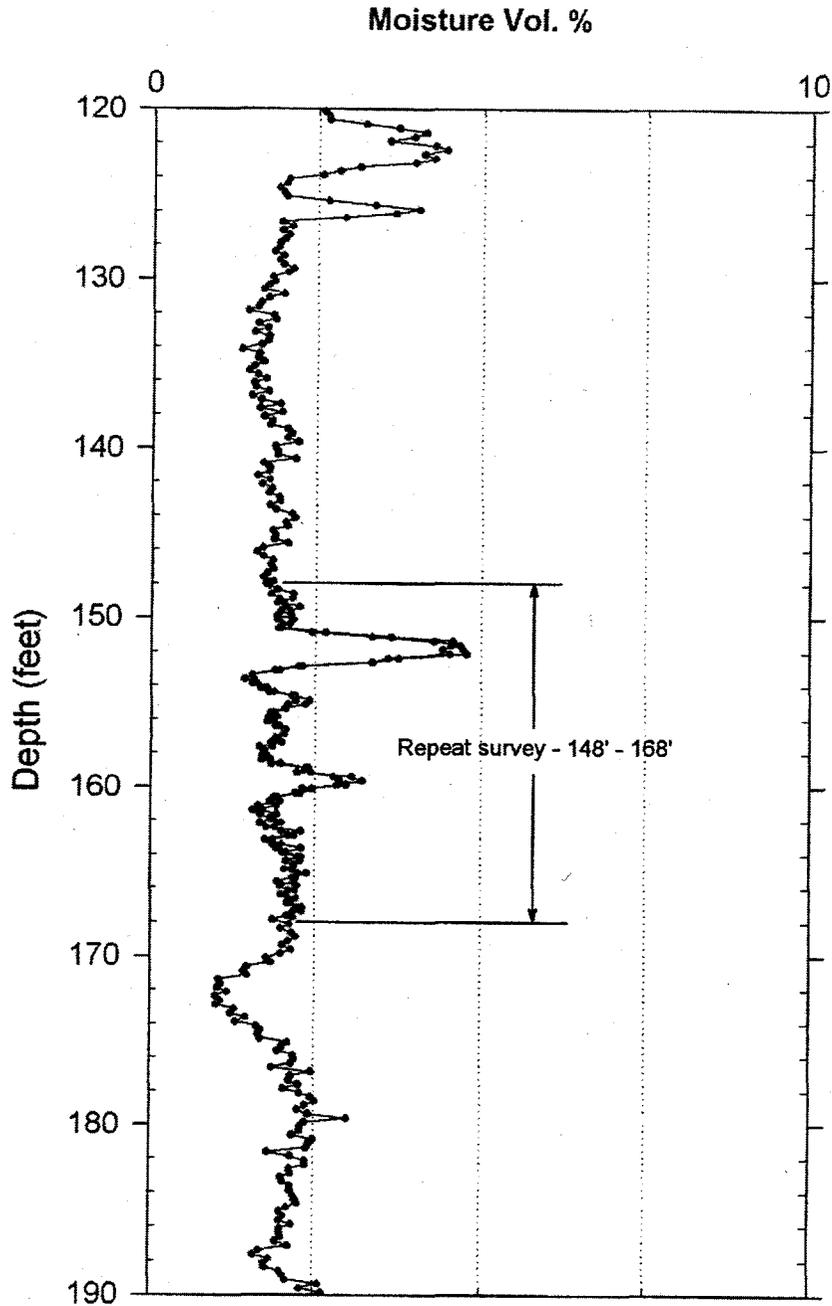
Log Date : December 27, 1999
Depth Datum: Ground Level



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

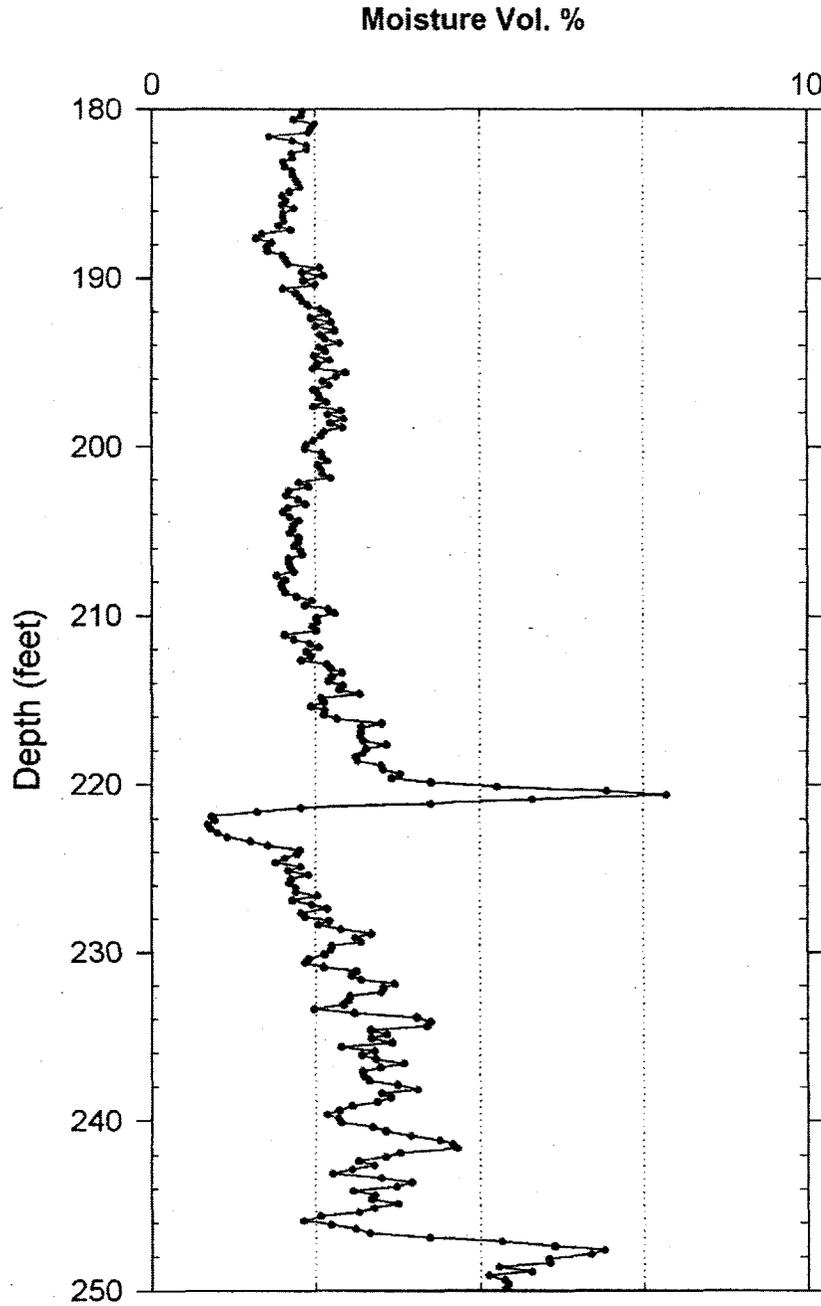


Neutron-Neutron Moisture Survey

Waste Management Technical Services

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

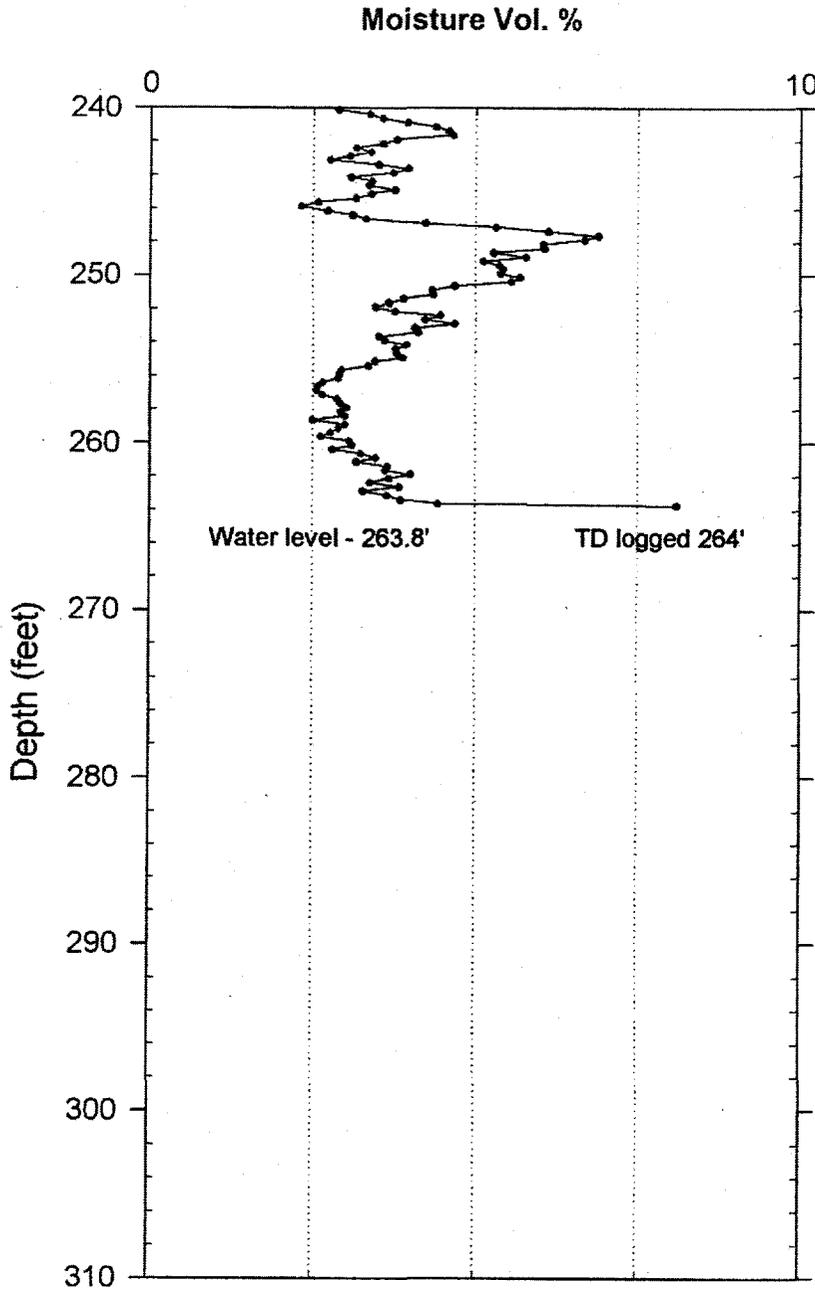
Log Date : December 27, 1999
Depth Datum: Ground Level



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

Logging Information

Log Type:	NaI Spectral Gamma Ray	
Company	Waste Management Technical Services	
Date/Archive File Name	February 2, 2000	H2E33335
Logging Engineers	<u>J.E.Meisner</u>	
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	<u>None.</u>	

RLS Spectral Scintillator Borehole Survey

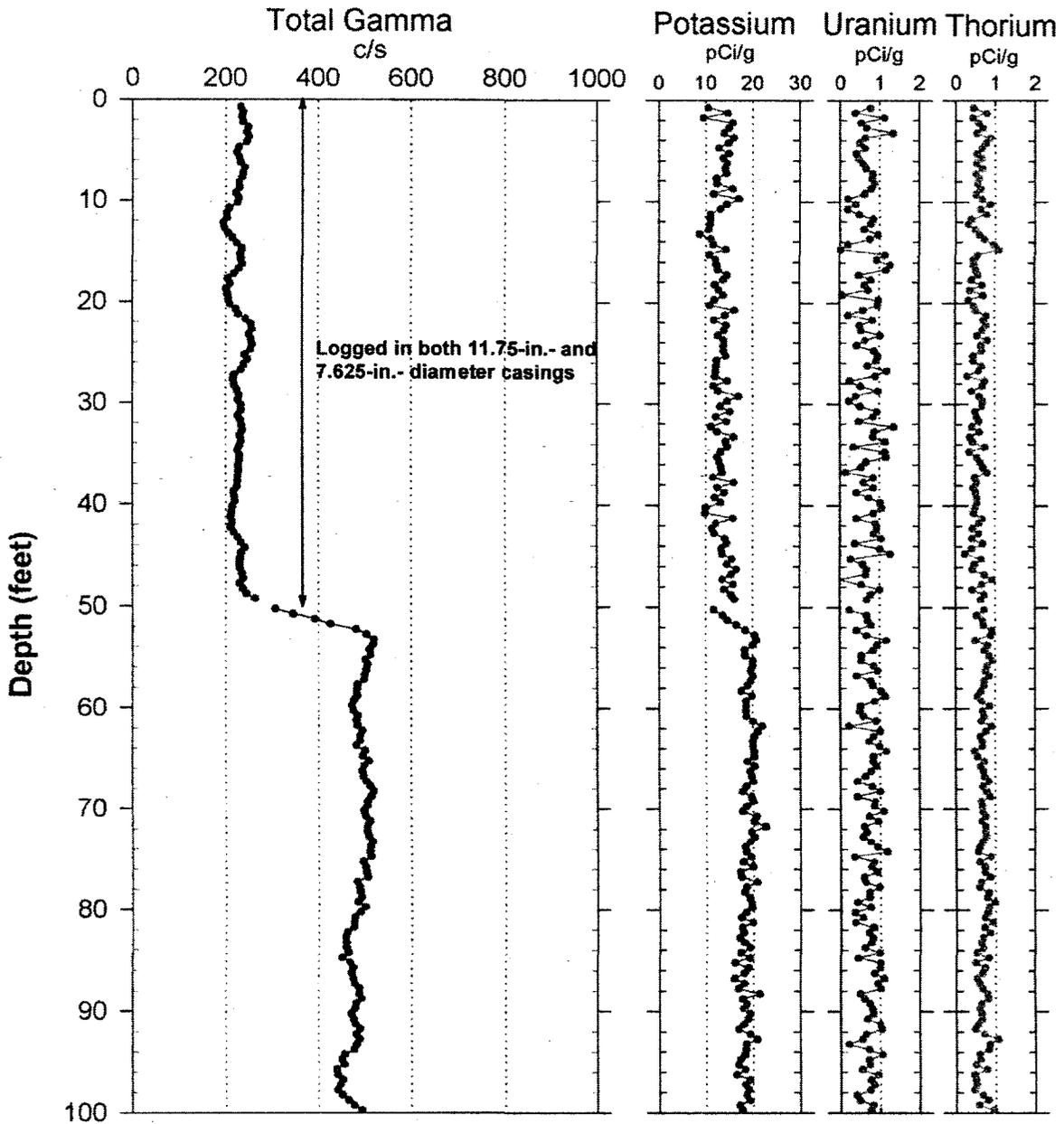
Waste Management Technical Services

Project: RCRA Drilling 2000

Log Date: Feb. 2, 2000

Well: 299-E33-335

Depth Datum: Ground Level



RLS Spectral Scintillator Borehole Survey

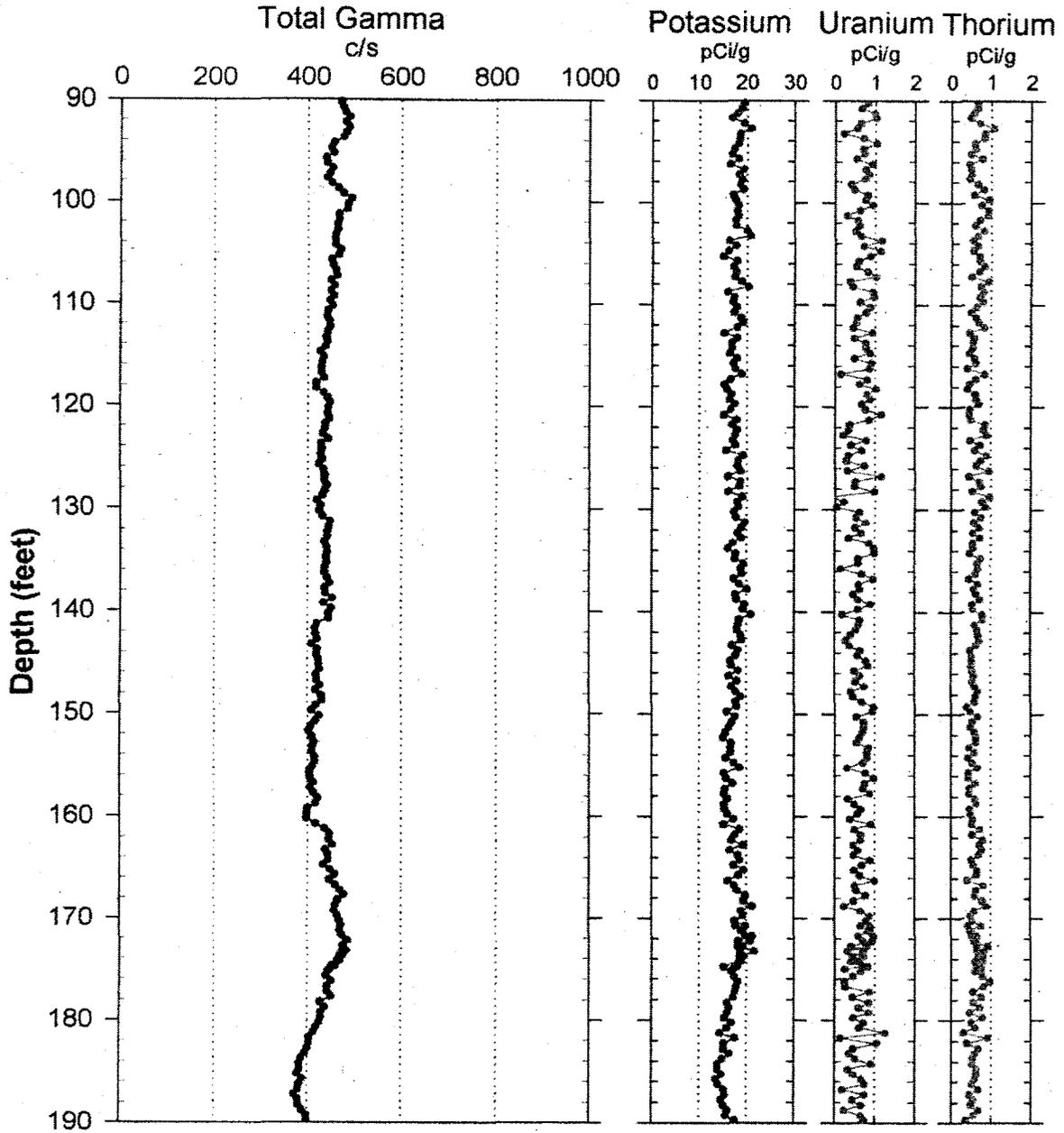
Waste Management Technical Services

Project: RCRA Drilling 2000

Log Date: Feb. 2, 2000

Well: 299-E33-335

Depth Datum: Ground Level



RLS Spectral Scintillator Borehole Survey

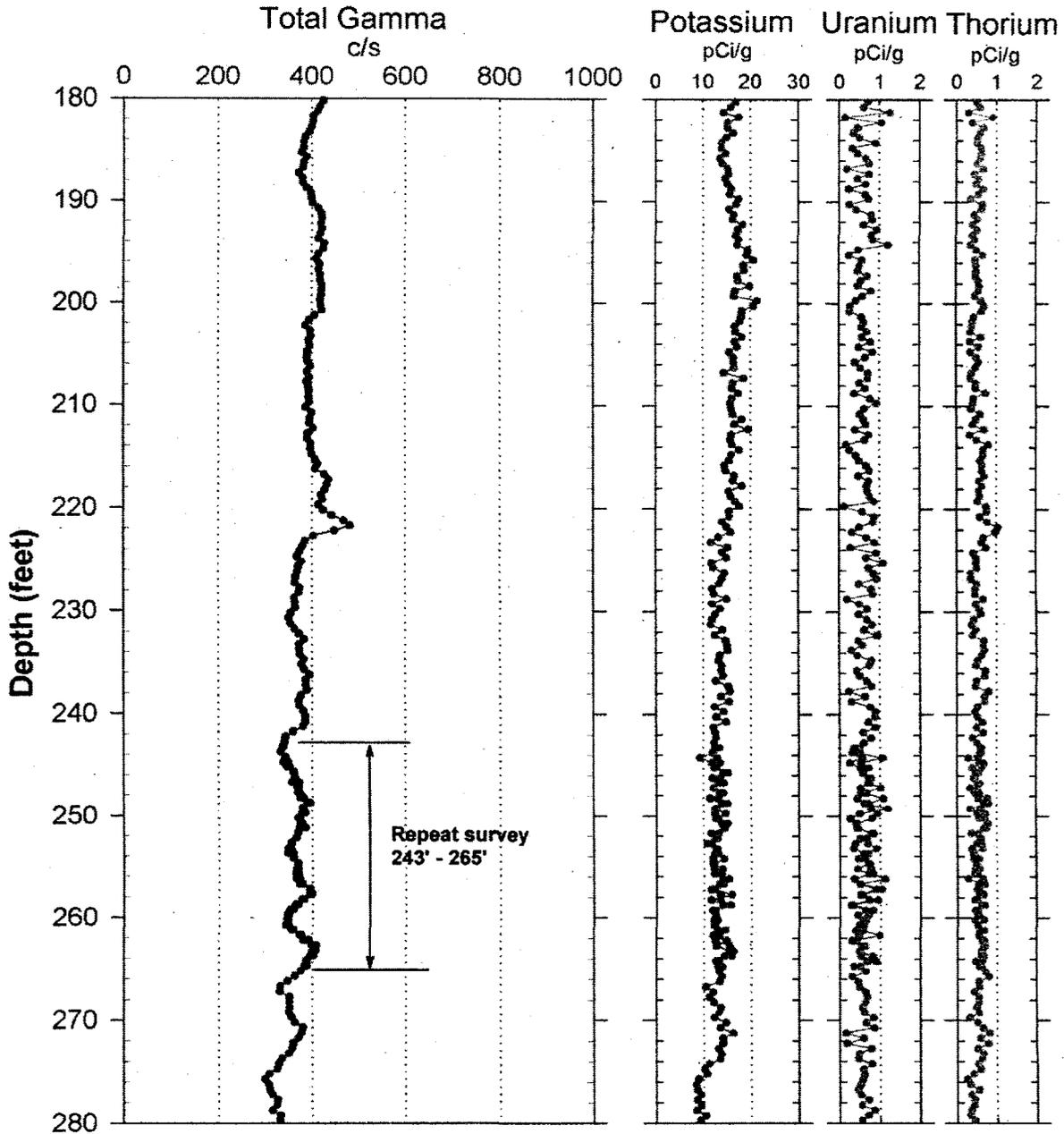
Waste Management Technical Services

Project: RCRA Drilling 2000

Log Date: Feb. 2, 2000

Well: 299-E33-335

Depth Datum: Ground Level



RLS Spectral Scintillator Borehole Survey

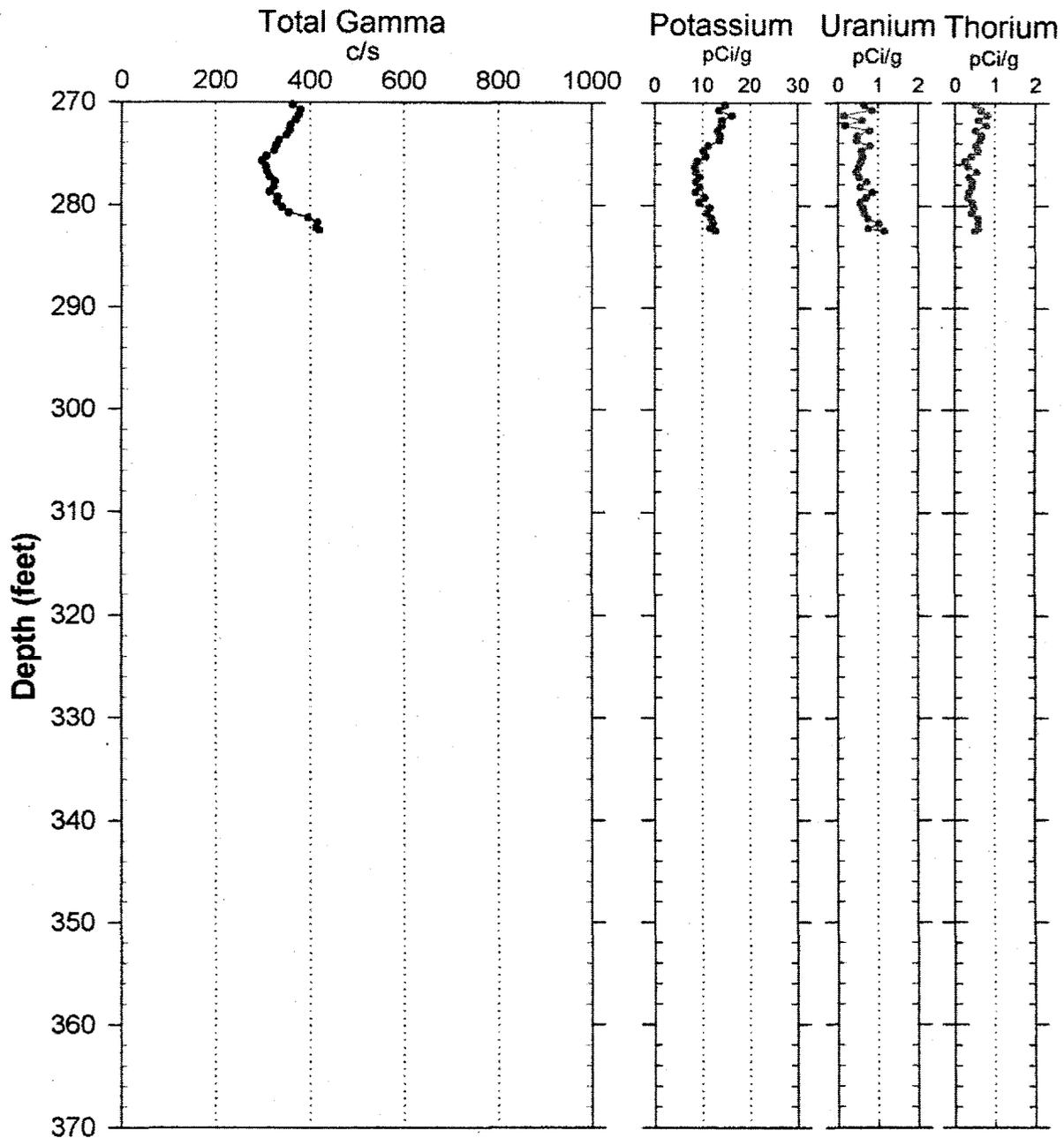
Waste Management Technical Services

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
Log Type: NaI Spectral Gamma Ray

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

Logging Information

Log Type:	Neutron-Neutron Moisture	
Company	Waste Management Technical Services	
Logging Engineers	<u>J.E. Meisner</u>	
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

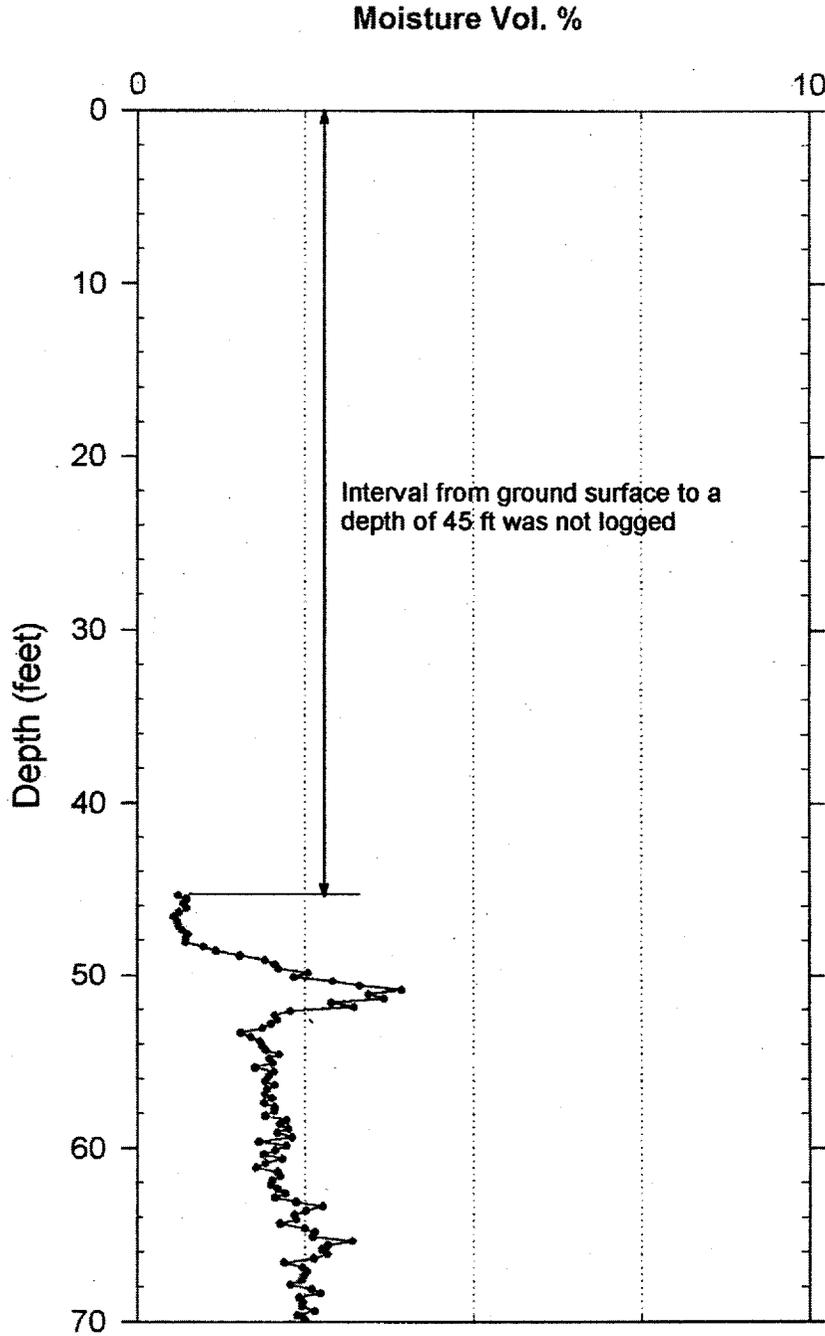
Company	Waste Management Technical Services	
Analyst	Steven Kos	
Date	March 13, 2000	
Depth Reference	Ground Surface	

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 Log Date : February 3, 2000
Borehole: 299-E33-335 Depth Datum: Ground Level



Neutron-Neutron Moisture Survey

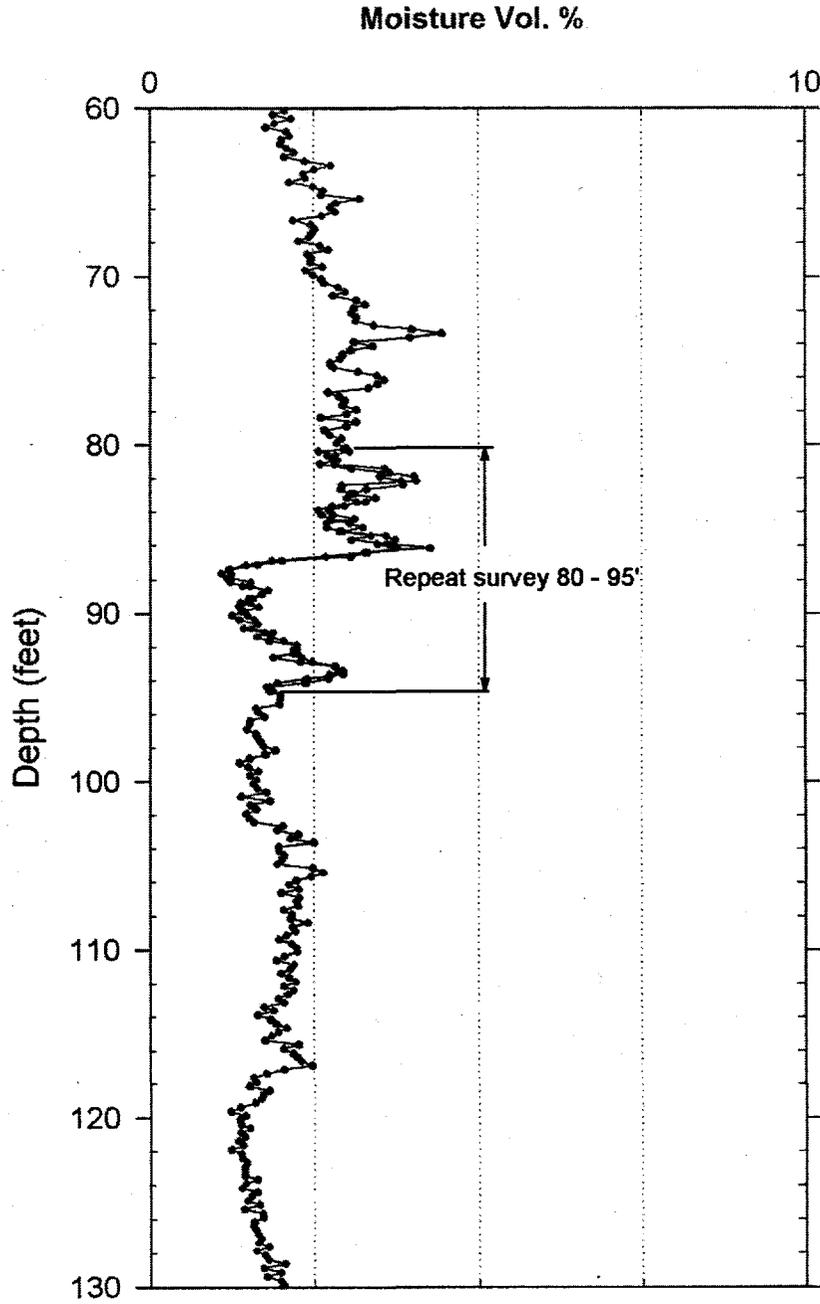
Waste Management Technical Services

Project: 1999 RCRA Drilling

Log Date : February 3, 2000

Borehole: 299-E33-335

Depth Datum: Ground Level

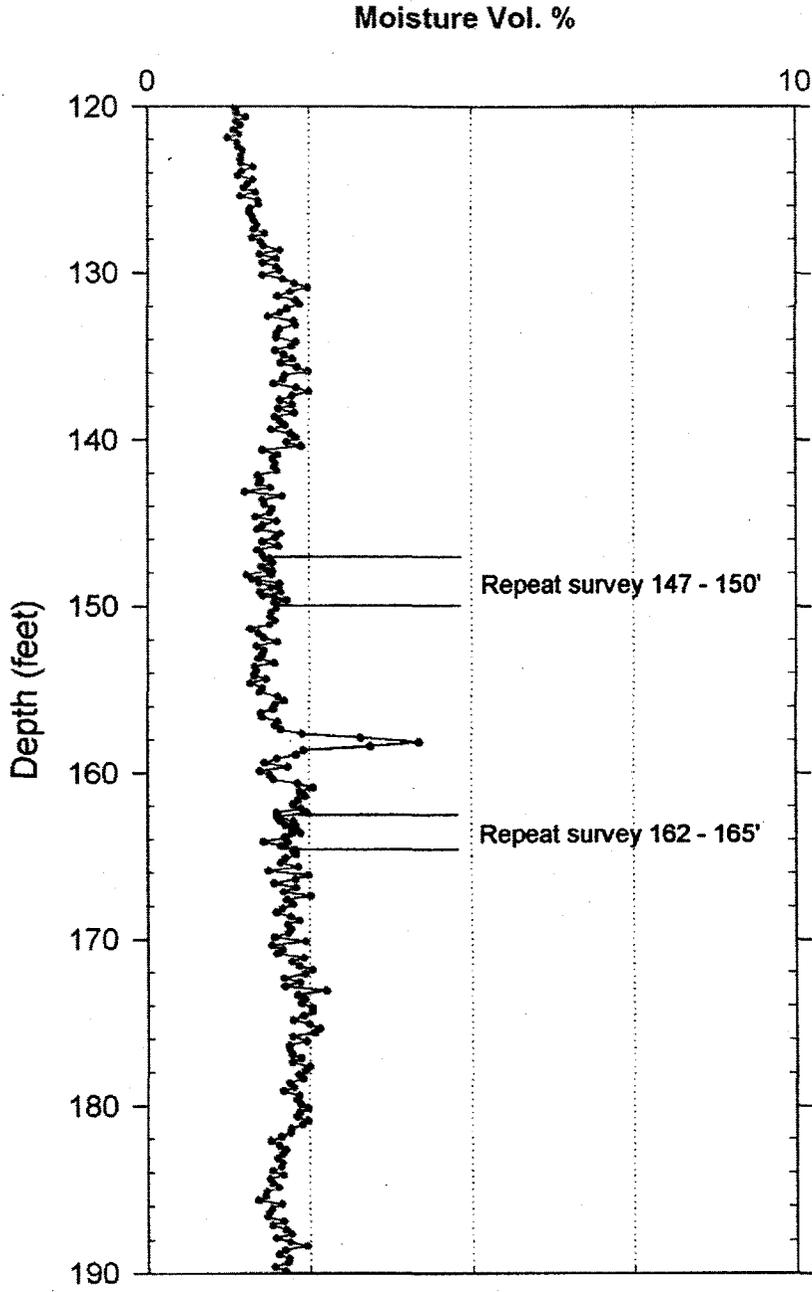


Neutron-Neutron Moisture Survey

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

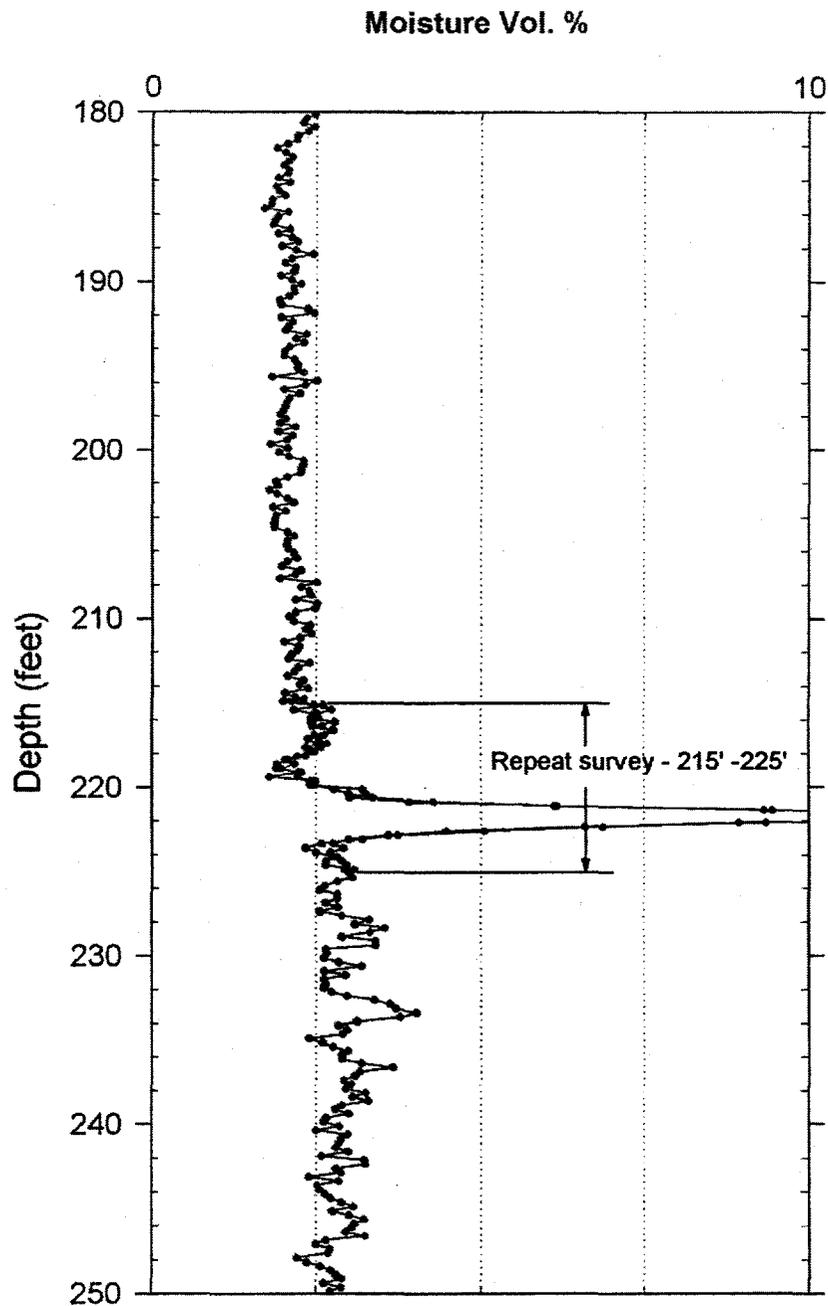
Waste Management Technical Services

Project: 1999 RCRA Drilling

Log Date : February 3, 2000

Borehole: 299-E33-335

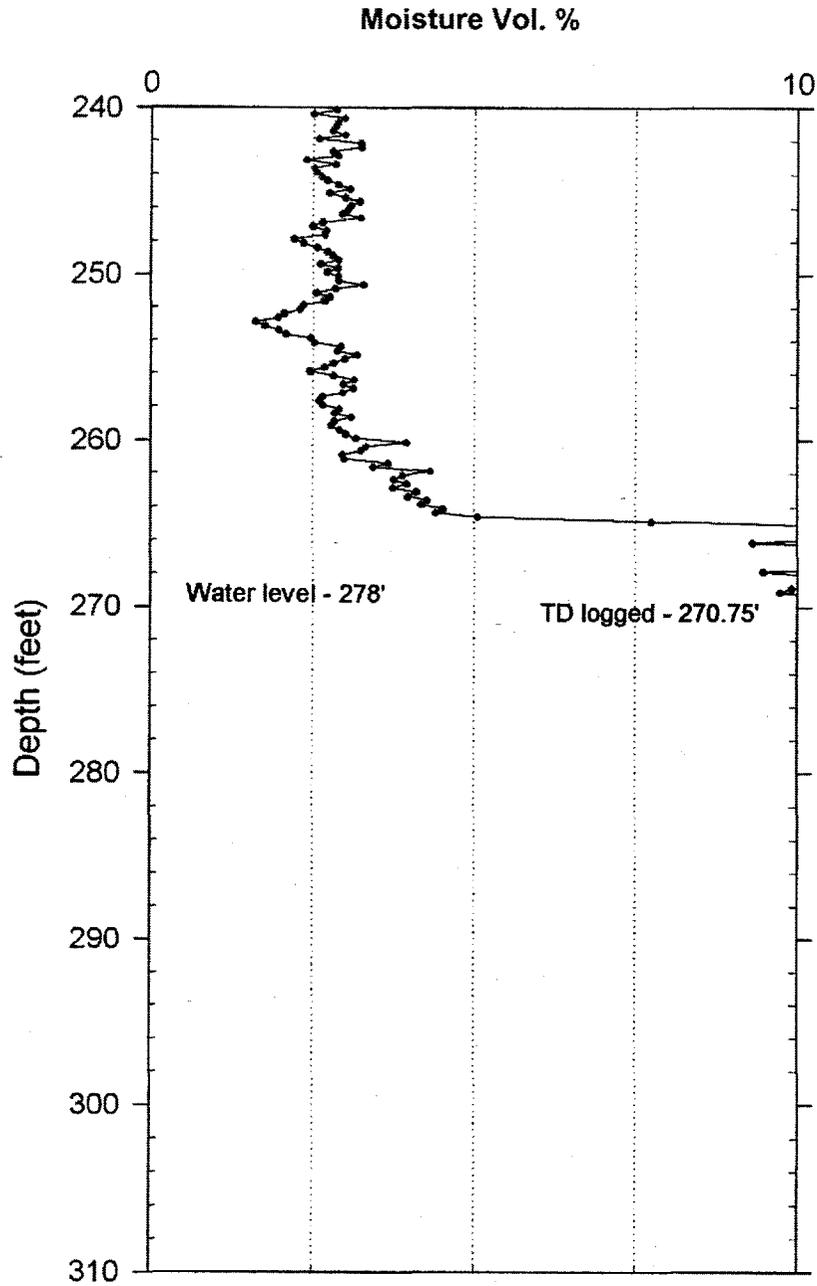
Depth Datum: Ground Level



Neutron-Neutron Moisture Survey

Waste Management Technical Services

Project: 1999 RCRA Drilling Log Date : February 3, 2000
Borehole: 299-E33-335 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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