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**Borehole Data Package for 1998 Wells
Installed at Single-Shell Tank Waste
Management Area U**

D. G. Horton
F. N. Hodges

March 1999



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

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under Contract DE-AC06-76RLO 1830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Acknowledgment

The analysis of particle size distribution, moisture content, calcium carbonate content, pH, electrical conductivity, cation exchange capacity, and alkalinity were done in the Applied Geology and Geochemistry Group laboratory, Pacific Northwest National Laboratory, Richland, Washington. The work was supervised by Jeff Serne. His laboratory also produced the 1:1 water:sediment extracts for major cation and anion analyses. The cation analyses were done at the Chemical Analysis Laboratory at the University of Georgia in Athens, Georgia. The anion analyses were done in the Pacific Northwest National Laboratory interfacial geochemistry laboratory. Mr. Serne provided interpretations of the physical and chemical data from sediment samples, and those interpretations are incorporated into this report. His contribution is very much appreciated.

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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) U in October 1998 in fulfillment of Tri-Party Agreement (Ecology 1996) milestone M-24-39. The wells are 299-W19-41 and 299-W19-42. Well 299-W19-41 is located east of the southeastern corner of the WMA and replaces downgradient well 299-W19-32. Well 299-W19-42 is located east of the WMA near the northeastern corner and is a new downgradient monitoring well. The locations of all wells in the monitoring network are shown on Figure 1.

The groundwater monitoring plan for WMA U (Caggiano and Goodwin 1991) describes the hydrogeology of the 200 West Area and WMA U. An Interim Change Notice to the groundwater monitoring plan provides justification for the new wells. The new wells were constructed to the specifications and requirements described in Washington Administrative Code (WAC) 173-160 and WAC 173-303.

This document compiles information on the drilling and construction, well development, pump installation, and sediment testing applicable to wells 299-W19-41 and 299-W19-42. Appendix A contains the geologist's log, the Well Construction Summary Report, and Well Summary Sheet (as-built diagram); Appendix B contains results of laboratory measurements of particle size distribution, pH, conductivity, and calcium carbonate and moisture contents; and Appendix C contains geophysical logs. Aquifer tests (slug tests) were performed on both new wells. Results from the aquifer tests will be reported elsewhere. Additional documentation concerning well construction is on file with Bechtel Hanford, Inc., Richland Washington.

English units are used in this report because they are used by drillers to measure and report depths and well construction details. The conversion is made by multiplying feet by 0.3048 to obtain meters; or multiplying inches by 2.54 to obtain centimeters.

2.0 Well 299-W19-41

2.1 Drilling

Well 299-W19-41 was drilled using an air rotary rig. The well was drilled to a total depth of 264.5 ft below ground surface (bgs) during September 1998. Temporary 8 5/8-in.-outside-diameter, carbon steel casing was used from ground surface to total depth. About 300 gal of water were added to the borehole at 264.5 ft bgs to keep fine-grained sediment out of the casing. Static water level was 220.35 ft bgs on September 23, 1998.

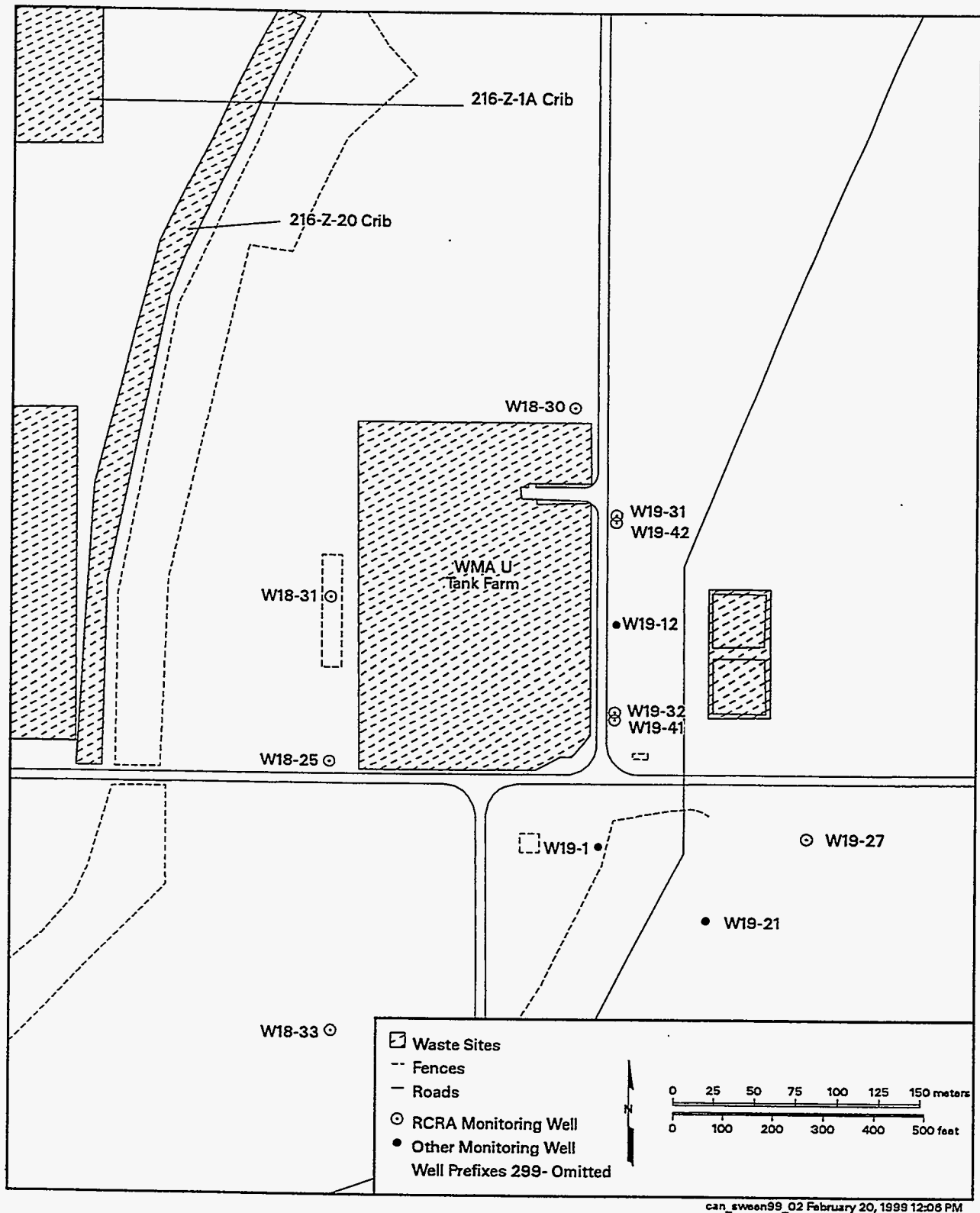


Figure 1. Map of Waste Management Area U and Locations of Wells in the Groundwater Monitoring Network

Sediments encountered during drilling were predominantly sand to sandy gravel from the surface to about 127 ft bgs. Silty sand and silty, sandy gravel were found from 127 ft to total depth. A geologist's log is included in Appendix A.

Grab samples were collected at 29 and 69 ft bgs for measurement of particle size distribution. Test results show that the sample from 29 ft bgs is dominantly gravel with about 10 weight percent sand. The sample from 69 ft bgs is sand. Particle size distribution data are in Appendix B. Additional grab samples were collected at 184 to 186 ft and from 200 to 201 ft bgs for analysis of residual contamination remaining on sediment surfaces from a declining water table. Those analyses have not been completed to date. Sediment samples also were collected for geologic description and archive at approximately 5-ft intervals.

The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. No contamination was noted.

2.2 Well Completion

The permanent casing and screen were installed in well 299-W19-41 in September 1998. A 4-in.-inner-diameter, stainless steel, wire wrap (0.01 in. slot) screen was set from 255.14 to 220.05 ft bgs. The permanent casing is 4-in.-inner-diameter stainless steel from 220.05 ft bgs to 2.0 ft above ground surface. Centralizers were placed at the top and bottom of the screen and every 40 ft from the screen to the surface. The bottom of the screen has a 4-in. end cap.

Silica sand (20-40 mesh) was placed around the screen and casing from 264.5 to 210.4 ft bgs. The annular seal is medium bentonite chips from 210.4 ft to 10.5 ft bgs and Portland cement from 10.5 ft to the surface. A carbon steel protective casing with locking cap covers the well. A 4 ft by 4 ft by 6 in. concrete pad was placed around the well at the surface with four protective steel posts set into the concrete. A brass marker stamped with the well number was placed into the concrete. The Well Construction Summary Report and the Well Summary Sheet (as-built) are included in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in December 1998. The horizontal position of the well was determined by global positioning system observations referenced to horizontal control stations established by the U.S. Army Corps of Engineers. 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. Army Corps of Engineers. Survey data are included in Table 1.

2.3 Well Development and Pump Installation

Well 299-W19-41 was developed on September 30, 1998. A temporary, 2 hp submersible pump was used to remove approximately 1,075 gal of formation water from the well at 7 gal/min. The final turbidity was 2.01 NTU.

Table 1. Survey Data for New Wells At Waste Management Area U

Well Name	Easting (m)	Northing (m)	Elevation (m)	
299-W19-41	566,896.532	135,004.5095		Center of Casing
			206.5308	"X" on Casing
	566,896.553	135,004.796	205.7812	Brass Cap
299-W19-42	566,896.812	135,122.901		Center of Casing
			206.2420	"X" on Casing
	566,896.7955	135,123,220	205.5057	Brass Cap

A dedicated Hydrostar sampling pump was installed in well 299-W19-41 on October 30, 1998. The sampling pump intake is at 241.50 ft depth relative to the brass cap (see Table 1).

3.0 Well 299-W19-42

3.1 Drilling

Well 299-W19-42 was drilled using a cable tool rig with drive barrel from 0 to 140 ft bgs and an air rotary rig from 140 ft to a total depth of 265.2 ft bgs during September 1998. Temporary 9-in.-outside-diameter, carbon steel casing was used from 0 to 135.7 ft bgs and 8 5/8-in.-outside-diameter, carbon steel casing was used from 0 to 265.2 ft bgs. About 300 gal of water were added to the borehole at total depth to keep fine sediment out of the casing. Static water level was 219.56 ft bgs on September 16, 1998.

Sediments encountered during drilling were predominantly sand and sandy gravel from the surface to about 89 ft bgs; silty sands and silt from 89 to 138 ft bgs; caliche from 138 to 141 ft bgs; and silty, sandy gravel, sandy gravel and gravelly sand from 141 to 265 ft bgs. A clastic dike was identified by the geologist at 121 ft bgs based on sediment texture.

Grab samples for particle size distribution were collected at 30 and 70 ft bgs. Test results show that the 30-ft sample is about 80 weight percent gravel and the deeper sample is dominantly sand with considerable silt and clay. Particle size data are included in Appendix B.

Grab samples also were collected at 5-ft intervals from the surface to 140 ft bgs for laboratory measurements of calcium carbonate and moisture contents, pH, conductivity, cation exchange capacity, and extractable ions. Except for the nitrate concentration in the extracts from the 5-ft and 15-ft samples, the results of the analyses indicate that the sediments encountered during well installation are typical for natural Hanford Site sediments. The two anomolous nitrate values may represent a natural heterogeneity

or a past near-surface spill. Two zone in the sediment profile have high carbonate content; 25 to 60 ft bgs and 138.5 to 140 ft bgs. The latter zone coincides with a caliche zone indicated on the geologists log. The results of all laboratory measurements of are in Appendix B.

Sediment samples also were collected from well 299-W19-42 for geologic description and archive at approximately 5-ft intervals from the surface to 141 ft bgs and 10-ft intervals from 140 to 265 ft bgs. The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. No contamination was noted.

The well was logged using high resolution, spectral gamma-ray instrumentation from the surface to 139 ft on September 9, 1998, and from 118 to 262 ft on September 13, 1998. The only man-made radionuclide detected was cesium-137 from the surface to 10 ft bgs with a maximum activity of 8.7 pCi/g at 1.25 ft bgs. The geophysical logs are in Appendix C.

3.2 Well Completion

The permanent casing and screen were installed in well 299-W19-42 in September 1998. A 4-in.-inner-diameter, stainless steel, wire wrap (0.01 in. slot) screen was set from 220.28 to 255.37 ft bgs. The permanent casing is 4-in.-inner-diameter stainless steel from 220.28 ft bgs to 2.0 ft above ground surface. Centralizers were placed at the top and bottom of the screen and every 40 ft from the screen to the surface. The bottom of the screen has a 4-in. end cap.

The filter pack is 20-40 mesh, silica sand and was placed from 265.1 to 210.2 ft bgs. The annular seal is medium bentonite chips from 210.2 to 10.2 ft bgs and Portland cement from 10.2 bgs 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. The Well Construction Summary Report and the Well Summary Sheet (as-built) are included in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in December 1998. The horizontal position of the well was determined by global positioning system observations referenced to horizontal control stations established by the U.S. Army Corps of Engineers. 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. Army Corps of Engineers. Survey data are included in Table 1.

3.3 Well Development and Pump Installation

Well 299-W19-42 was developed on September 22, 1998. A temporary, 2 hp submersible pump was used to remove about 1,125 gal of formation water from the well at 6 to 7 gal/min.

A dedicated Hydrostar sampling pump was installed in well 299-W19-42 on October 30, 1998. The sampling pump intake is at 241.50 ft depth relative to the brass cap (see Table 1).

4.0 References

Caggiano, J. A., and S. M. Goodwin. 1991. *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*. WHC-SD-EN-AP-012, Rev. 1. Westinghouse Hanford Company, Richland, Washington.

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. 89-110, Rev. 4 (The Tri-Party Agreement), Ecology, Olympia, 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.

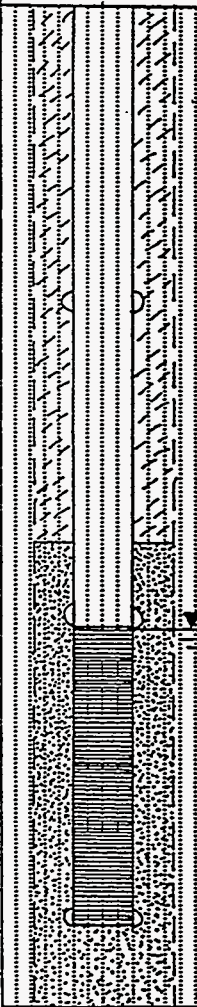
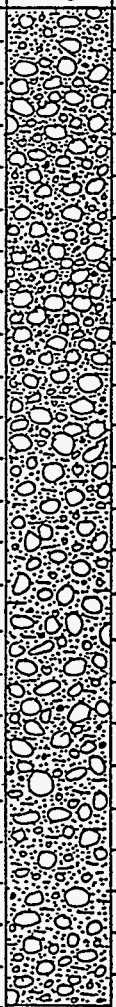
WAC 173-303, Washington Administrative Code. *Dangerous Waste Regulations*. Olympia, Washington.

Appendix A

Well Construction and Completion Documentation

WELL CONSTRUCTION SUMMARY REPORT				Start Date: 9-17-98			
				Finish Date: 9-23-98			
				Page 1 of 1			
Specification No.: 0200X-SP-V0001		Rev. No.: 1		Well Name: 299-W19-41			
ECNs: NA		Approximate Location: intersect of Condon Ave & 16 th St.					
Project: RCRA Drilling 1998		Other Companies: CH2M Hill 200W					
Drilling Company: Layne Christensen		Geologist(s): L.D. Walker					
Driller: W. Franklin							
TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD/HOLE DIAMETER				
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter From _____ to _____			
8 5/8" OD CS (FJ)	0' - 264.5'	8 5/8" / 8"	Cable Tool:	Diameter From _____ to _____			
			Air Rotary: Odex, 9 1/2"	Diameter From 0' to 264.5'			
			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 _____				
			*Note on water added: all at total depth (264.5') to keep fine sediment out of borehole				
			Drilling Fluid: Air				
Total Drilled Depth: 264.5'		Hole Dia @ TD: 9 1/2" 9 1/8"		Total Amt. Of Water Added During Drilling: ~300 gal. *			
Well Straightness Test Results:			Static Water Level: 220.35' Date: 9-23-98				
GEOPHYSICAL LOGGING							
Sondes (type)	Interval	Date	Sondes (type)	Interval	Date		
COMPLETED WELL							
Size/WL/Material	Depth	Thread	Slot Size	Type	Interval Annual Seal/Filter Pack	Volume (Ft³)	Mesh Size
4" ID SS	+2.0 - 220.05'	FJ	NA	Portland Cement	0' - 10.5'	5.14 ft³	NA
4" ID SS with wrap	220.05' - 255.14'	FJ	0.010-in	Bentonite Chips	10.5' - 210.4'	66.24	medium
4" ID SS	255.14' - 264.5'	FJ	NA	Silica Sand	210.4' - 264.5'	29.68	20-40
OTHER ACTIVITIES							
Aquifer Test:		Date:		Well Abandoned:		Yes:	No:
Description:				Description:			
WELL SURVEY DATA							
Date:				Protective Casing Elevation:			
Washington State Plane Coordinates:				Brass Cap Elevation:			
COMMENTS/REMARKS							
CS = carbon steel, SS = stainless steel. Volume calc: cement = 1.285 x 4 = 5.14 ft³, bentonite chips = 0.69 x 96 = 66.24 ft³, 20-40 Silica Sand = 1.12 x 26.5 = 29.68 ft³							
Reported By: L.D. Walker				Reported By: E.C. Rafuse			
Title: Geologist		Date: 9-23-98		Title: FIELD ENGINEER (BAZ)		Date: 09/29/98	
Signature: L.D. Walker				Signature: E.C. Rafuse			

WELL SUMMARY SHEET				Page <u>1</u> of <u>2</u>	
				Date: <u>9-23-98</u>	
Well ID: <u>B8551</u>			Well Name: <u>299-W19-41</u>		
Location: <u>200W; intersect of Camden Ave & 16th St.</u>			Project: <u>RCRA Drilling 1998</u>		
Prepared By: <u>L. D. Walker</u>		Date: <u>9-23-98</u>	Reviewed By: <u>E.C. Ruffe</u>		Date: <u>09/29/98</u>
Signature: <u>L.D. Walker</u>			Signature: <u>E.C. Ruffe</u>		
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
		0		0' - 0.1' : Asphalt	
				0.1' - 14' : Silty Sandy GRAVEL	
Portland Cement: 0' - 10.5'					
				14' - 22' : SAND	
		25		22' - 39' : Sandy GRAVEL	
				39' - 43' : Gravelly SAND	
		50		43' - 47' : Sandy GRAVEL	
Bentonite Chips:				47' - 54' : Gravelly SAND	
10.5' - 210.4'					
				54' - 81' : SAND	
		75		81' - 84' : SAND (Fn)	
				84' - 88' : SAND (csc)	
				88' - 91' : SAND (Fn)	
4 1/2" OD (4" ID) type 304					
stainless steel casing:		100		91' - 127' : SAND	
+2.0' - 220.05'					
		125		127' - 136' : Silty SAND	
				136' - 144' : Sandy SILT	
				- calcareous	

WELL SUMMARY SHEET				Page <u>42</u> of <u>2</u>	
				Date: <u>9-23-98</u>	
Well ID: <u>B8551</u>			Well Name: <u>299-W19-41</u>		
Location: <u>200W; intersect. of Camden Ave & 16th St.</u>			Project: <u>RCRA Drilling 1998</u>		
Prepared By: <u>L.D. Walker</u>		Date: <u>9-23-98</u>	Reviewed By: <u>E.C. Rofuse</u>		Date: <u>09/29/01</u>
Signature: <u>[Signature]</u>			Signature: <u>[Signature]</u>		
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
		150		144'-168': Silty Sandy GRAVEL	
20-40 mesh Silica Sand:		175		168'-188': Sandy GRAVEL	
210.4' - 264.5'					
4 1/2" OD (4" ID) type 304 SS					
continuous wire wrap 0.010-in					
slot screen: 220.05' - 255.14'		200		188'-249': Silty Sandy GRAVEL	
Bottom of 4 1/2" OD (4" ID) type					
304 SS endcap at 255.47'					
		225		Water Level = 220.35' (9-23-98)	
9 1/8" borehole to 264.5'					
8 5/8" OD carbon steel casing					
to 264.5'. All temp.					
casing removed from the		250		249'-253': Silty Sandy GRAVEL - Fe staining	
ground				253'-264.5': Silty Sandy GRAVEL	
Depths are measured		275		TD = 264.5'	
from ground surface					

BOREHOLE LOG

Boring or Well No. 299-W19-41/B8551Sheet 1 of 4Location 200 W; intersect of Camden & 16th St.Project RCRA Drilling 1998

Prepared By

A. Walker / L.D. Walker
(Sign/Print Name)

Date

9-17-98

Reviewed By

E.C. Ruffe / E.C. Ruffe
(Sign/Print Name)

Date

09/29/98

Depth (ft) ()	Sample		Graphic Log	Sample Description Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
	Type and No.	Blows or Recovery			
10	Air Rotary (Olex)	NA		0.1' asphalt, then 0.1' - 14': Silty Sandy GRAVEL (m s G). (40% gravel, 50% sand, 10% silt) 10YR6/3 (pale brown), dry, poorly sorted, max size \approx 20 mm. strong rxn to HCl	8 5/8" OD CS casing 8" Olex bit makes 9 1/2" borehole B, X & detectable
20				14' - 22': Sand (S). (95% sand, 5% silt, tr gravel.) Sand is 80% coarse, tr v. cse, 10% med, 10% fn-v. fn. 10YR5/1 (gray), dry, med sorted, sub. ang; 70% basalt, 20% qtz, 10% other. weak rxn to HCl	drill rate: 10 ft/10 min
30	Grab Sieve Sample #1 29' - 30'			22' - 39': Sandy GRAVEL (s G) (70% gravel, 30% sand, tr silt) tr lg cob, 10% sm cob, 40% v. cse-cse peb, 30% med peb, 20% fn-v. fn peb; sand 20% v. cse, 20% cse, 30% med, 30% fn-v. fn; 10YR5/2 (gray brn), moist at 22', dry by 27', poorly sort, sub ang-sub round; 60% basalt, 40% other.	25': drilling indicates large cobbles drill rate: 10 ft/25 min Sieve sample #1: 29' - 30'
40				39' - 43': Gravelly SAND (g S) (20% gravel, 80% sand), gravel med-v. fn peb sand 30% v. cse, 60% cse, 10% med-v. fn.	End shift 9-17-98
50				43' - 47': Sandy GRAVEL (s G) similar to s G 22' - 39'	
60				47' - 54': Gravelly SAND (g S) (15% gravel, 85% sand, tr silt); gravel 30% med peb, 70% fn-v. fn; sand as below: moist, weak rxn to HCl	
70	Grab Sieve Sample #2 69' - 70'			54' - 81': SAND (S) (5% gravel, 95% sand); gravel med-v. fn peb and sub round; sand 10% v. cse, 30% cse, 40% med, 20% fn-v. fn, short intervals of increased v. fn and tr silt. 10YR6/3 (pale brown), moist; med sorted, sub ang; 20% basalt, 60% qtz, 20% other, max part. size \approx 10 mm. weak rxn to HCl	drill rate 10 ft/11 min. drill rate 10 ft/6 min. Collect sieve sample #2 69' - 70'

BOREHOLE LOG

Boring or Well No. 299-W19-41/B8551

Sheet 2 of 4

Location 200W; intersect of Camden Ave & 16th St.

Project RCRA Drilling 1998

Prepared By L.D. Walker Date 9-18-98
(Sign/Print Name)Reviewed By E.C. Rame Date 09/29/98
(Sign/Print Name)

Depth (80)	Sample		Graphic Log	Sample Description Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
	Type and No.	Blows or Recovery			
	Air Rotary (Odex)	NA		81'-84': SAND (S) similar to above but finer. 80% Fn - v. Fn, 5% silt (5% med)	8 5/8" OD CS casing 8" Odex bit makes 9 1/2" bore
90				84'-88': med-cse SAND 88'-91': Fn-v.Fn SAND, tr silt	B, X < detect OVM, LEL < detect
100				91'-127': SAND (S) 100% sand, tr silt; tr v. cse, 10% cse, 70% med, 20% Fn-v. Fn; 10YR 5/3 (brown), moist, mod-well sorted, sub ang; 10% basalt, 80% qtz, 10% other, max size ≈ 5mm weak rxn to HCl	drill rate 10 ft./11 min.
110				108': sand as above but mainly Fn-v. Fn, tr silt	
120					
130				127'-136': Silty SAND (mS) (60% sand, 40% silt); sand tr med, 20% Fn, 80% v. Fn; 10YR 6/3 (pale brn), moist, mod sorted, sub ang; 10% basalt, tr mica strong rxn HCl	127': drilling indicates consolidated sediment
140				136'-144': Sandy SILT (sM) (45% sand, 55% silt); sand 10% Fn, 90% v. Fn; 10YR 6/3 (pale brn), moist, low plasticity, strong rxn HCl - Calcareous	Calcareous, possible caliche
150				142': tr gravel in silt 144'-168': Silty Sandy GRAVEL (msG) (60% gravel, 30% sand, 10% silt); gravel tr sm. cob, 20% v. cse-cse peb, 30% med, 50% Fn-v. Fn peb; sand 30% v. cse, 20% cse, 20% med, 30% Fn-v. Fn; 10YR 5/2 (gray. brn) dry; poorly sorted; gravel sub round, 60% basalt, 20% qtz, 20% granitic and other	drill rate 10 ft./20 min.

BOREHOLE LOG

Boring or Well No. 299-W19-41/B8551

Sheet 3 of 4

Location 200W; intersect. of Camden Ave & 16th St.

Project RCRA Drilling 1998

Prepared By L.D. Walker Date 9-18-98
(Sign/Print Name)Reviewed By EC Rofe/EC Rofe Date 09/29/98
(Sign/Print Name)

Depth (160)	Sample		Graphic Log	Sample Description Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
	Type and No.	Blows or Recovery			
	Air Rotary (Odex)	NA			8 7/8" OD. CS. casing 8" Odex bit makes 9 1/2" borehole
170				168' - 188': Sandy GRAVEL (sG) (60% gravel, 35% sand, 5% silt) gravel 10% sm. cob, 20% v. cse. peb, 40% med. peb, 30% fn - v. fn. peb; sand 50% v. cse - cse, 30% med, 20% fn - v. fn; 10YR5/1 (gray), dry, poorly sorted, gravel sub round, sand sub ang., 60% basalt, 20% qtz, 20%	End shift 9/18/98
	Grab			181' - 183': poor air circulation - possible open framework gravel/cobbles	181' - 183': Poor air circulation
190	184' - 186' "Bathtub Ring"			188' - 249': Silty Sandy GRAVEL (m s G) (60% gravel, 30% sand, 10% silt) gravel tr cob, 20% v. cse. peb, 20% cse. peb, 40% med. peb, 20% fn - v. fn; sand 10% v. cse - cse, 30% med, 50% fn, 10% v. fn. 10YR6/2 (lt brn. gray) dry; poorly sorted, gravel sub round, sand sub rnd - sub ang, sand is 75% qtz 10% basalt, 15% other; weak rxn to HCl. tr mica	Collect First "Bathtub Ring" Sample from 184' - 186'
200	Grab 200' - 201' "Bathtub Ring"				Collect second "Bathtub Ring" Sample from 200' - 201'
210					Drill rate: 10 ft/20 min. OVM, LEL < detect
220					231': sediment moist
230				Silty Sandy GRAVEL - as above	

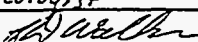
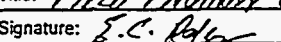
Boring or Well No. 299-W19-41 / B8551

Sheet 4 of 4

Project RCRA Drilling 1998

Reviewed By EC Rame/EC Refuse Date 09/29/98
(Sign/Print Name)

A-6000-382 (01:93)

WELL CONSTRUCTION SUMMARY REPORT				Start Date: 8/31/98			
				Finish Date: 9-16-98			
				Page 1 of 1			
Specification No.: 0200X-SP-V0001		Rev. No.: 1		Well Name: 299-W19-42			
ECNs: NA				Approximate Location: 55' East of 241-U Tank Farm, 2006			
Project: RCRA Drilling 1998				Other Companies: CH2M Hill			
Drilling Company: Layne Christensen				Geologist(s): DC Weekes			
Driller: M. Wraspir / W. Franklin				LD 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 _____			
9" OD carbon steel (FS)	0' - 135.7'	0.8' / 0.7'	Cable Tool: Drive barrel	Diameter From 0' to 140'			
8 5/8" OD CS (FJ)	0' - 265.2'	8 5/8" / 8"	Air Rotary: Odex; 9 1/2"	Diameter From 0' to 265.2'			
			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 _____			
			Note on water added: all at total depth to keep fine sediment out of casing				
			Drilling Fluid: Air				
Total Drilled Depth: 265.2'		Hole Dia @ TD: 9 1/2"		Total Amt. Of Water Added During Drilling: ~300 gal.			
Well Straightness Test Results: NA		Static Water Level: 219.56' bgs		Date: 9-16-98			
GEOPHYSICAL LOGGING							
Sondes (type)	Interval	Date	Sondes (type)	Interval	Date		
Spectral Gamma (KUT + Cs-137)	0' - 139'	9-9-98	Spectral Gamma KUT	118' - 262'	9-13-98		
Neutron	0' - 136'	9-9-98	Neutron	120' - 219'	9-13-98		
COMPLETED WELL							
Size/WL/Material	Depth	Thread	Slot Size	Type	Interval Annual Seal/Filter Pack	Volume (Ft³)	Mesh Size
4" ID SS	220.28' - 220.28'	FJ	NA	Portland Cement	0' - 10.2'	30.84	NA
4" ID SS wire wrap	220.28' - 255.37'	FJ	0.010-in	Bentonite chips	10.2' - 210.2'	75.21	medium
4" ID SS	255.37' - 255.70'	FJ	NA	Silica Sand	210.2' - 265.1'	29.68	20-40
OTHER ACTIVITIES							
Aquifer Test:		Date:		Well Abandoned:		Yes:	No:
Description:				Description:			
WELL SURVEY DATA							
Date:				Protective Casing Elevation:			
Washington State Plane Coordinates:				Brass Cap Elevation:			
COMMENTS/REMARKS							
CS = carbon steel; SS = stainless steel; Volume calc: cement = 1.285 x 24 = 30.84 Ft³, Bentonite chips = 0.69 x 109 = 75.21 Ft³, 20-40 silica sand = 1.12 x 26.5 = 29.68 Ft³							
Reported By: L. D. Walker				Reported By: E. C. Rafuse			
Title: Geologist		Date: 9-17-98		Title: FIELD ENGINEER (BNI)		Date: 09/20/98	
Signature: 				Signature: 			

WELL SUMMARY SHEET				Page <u>1</u> of <u>2</u>	
				Date: <u>9-17-98</u>	
Well ID: <u>88553</u>			Well Name: <u>299-W19-42</u>		
Location: <u>55' East of 241-U Tank Farm, 200W</u>			Project: <u>RCRA Drilling 1998</u>		
Prepared By: <u>L.D. Walker</u>		Date: <u>9-12-98</u>	Reviewed By: <u>Edward C. Refuse</u>		Date: <u>09/23/98</u>
Signature: <u>L.D. Walker</u>			Signature: <u>Edward C. Refuse</u>		
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
		0		<u>0'-0.7' : Backfill (gm S)</u>	
				<u>0.7'-7' : Sand</u>	
<u>Portland Cement : 0'-10.2'</u>				<u>7'-15' : Sandy Gravel</u>	
				<u>15'-16' : Sand</u>	
		25		<u>16'-32.5' : Sandy Gravel</u>	
				<u>32.5'-39' : Sandy Gravel</u>	
				<u>39'-43.5' : Sandy Gravel</u>	
<u>Bentonite Chips:</u>		50		<u>43.5'-52' : Slightly Silty Gravelly Sand</u>	
<u>10.2' - 210.2'</u>				<u>52'-53' : Sandy Gravel</u>	
				<u>53'-71' : Sand</u>	
		75		<u>71'-79' : Sand</u>	
<u>4 1/2" OD (4" ID) type 304</u>				<u>79'-84' : Slightly Silty Sand</u>	
<u>stainless steel casing:</u>				<u>84'-89' : Sand</u>	
<u>+2.0' - 220.28'</u>				<u>89'-105' : Slightly Silty Sand</u>	
		100		<u>105'-119.5' : Silty Sand</u>	
				<u>119.5'-138.5' : Silt</u>	
		125		<u>138.5'-141' : Caliche</u>	
				<u>(Sandy Gravel)</u>	

Page 4² of 2
Date: 9-17-98

BHI-EE-189 (12/97)

BOREHOLE LOG

Boring or Well No. 299-W19-42/88553

Sheet 1 of 4

Location 55' East of 241-U Tank Farm, 200W

Project RCRA Drilling 1998

Prepared By DCWeekes DCWeekes Date 9/3/98
(Sign/Print Name)Reviewed By Edward Rabe/Edward Rabe Date 9/23/98
(Sign/Print Name)

Depth (ft)	Sample		Graphic Log	Sample Description Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
	Type and No.	Blows or Recovery			
0		DB		0'-0.8' Backfill (Gravelly Silty SAND) dry	Started drilling 8/31/98
	2 lith, 1 CaCO ₃ 1 moisture			0.8'-7' SAND (S): tr vc, tr vcp, 5% c, 30% m, 40% f, 25% vf, tr silt, 10% A/S	Sample @ 5'
				brown (moist), 10YR 6/2 light brownish gray (dry), moist, well sorted, SA-SR, 30% bas, 70% qtz, talc	End of shift 8/31/98
10	2 lith, 1 CaCO ₃ 1 moist.			max 4mm, strong rxn to HCl	
				7'-15' Sandy GRAVEL (SG): 60% gravel, 35% sand, 5% silt; Gravel 80% bas, 20% other, SA-R, some CaCO ₃ coatings, mostly 2cm, max 10";	15'-16' Sand interbed
20	2 lith, 1 CaCO ₃ 1 moist.	19 HT		sand 20% vc, 20% c, 20% m, 20% f, 20% vf, A-SA, 80% bas, 20% other; 2.5Y 5/3 light olive brown (moist), 2.5Y 6/3 light yellowish brown (dry), moist, v poorly sorted, strong rxn to HCl	Large basalt boulder from 19'-20' ft, HT 19'-21' 1/2'
		DB		15'-16' SAND (S): tr vfp, 10% vc, 10% c, 30% m, 40% f, 25% vf, 10% silt; 15% bas, 85% qtz and other, max 3mm, 10YR 4/3 dark brown (moist), 10YR 6/2 light brownish gray (dry), A-SA, strong rxn to HCl, moist	End of shift 9/1/98
30	2 lith, 1 CaCO ₃ 1 moist.			16'-32 1/2' Sandy GRAVEL (SG): as above	Typical @ 30' (last)
				Sandy gravel, ~10% silt, moist	
40	2 lith, 1 CaCO ₃ 1 moist.			32 1/2'-39' Sandy GRAVEL (SG): overall gravel size much smaller than above, 60% gravel, 35% sand, 5% silt; gravel is mostly vfp to mp, 95% bas, 5% qtz and other, A-SR; sand is evenly distributed (vf-vc), A-SA, 70% bas, 30% other, same color as above (moist + dry), moist, v poorly sorted, strong rxn to HCl	
50	2 lith, 1 CaCO ₃ 1 moist.			39'-43 1/2' Sandy GRAVEL (SG): same as 16'-32 1/2' interval, moist	
60	2 lith, 1 CaCO ₃ 1 moist.			43 1/2'-52' Slightly Silty Gravelly SAND (m) S: 25% gravel, 60% sand, 15% silt; gravel is tr vp, 20% mp, 40% fp, 40% vfp, 80% bas, 20% other, A-R; sand is 50% bas, 50% other, A-SA, 15% silt, evenly distributed; 2.5Y 5/3 light olive brown (moist), 2.5Y 6/3 light yellowish brown (dry), moist, v poorly sorted, strong rxn to HCl	End of shift 9/2/98
70	2 lith, 1 CaCO ₃ 1 moist.			52'-53' Sandy GRAVEL: same as 16'-32 1/2', moist	
				53'-71' SAND (S): see next page	

A-6000-382 (01/93)

BOREHOLE LOG

Boring or Well No. 299-W19-42/B8553Sheet 2 of 4Location SS East of 24-U Tank farm, 200 WProject RCRA Drilling 1998Prepared By DC WeekesDate 9/4/98Reviewed By Edward Refuse / Kenneth RefuseDate 9/23/98

(Sign/Print Name)

(Sign/Print Name)

Depth (ft)	Sample		Graphic Log	Sample Description Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
	Type and No.	Blows or Recovery			
60		DB		53'-71' SAND(S): 8% gravel (mostly f-vf), 82% sand [30% vc, 30% c, 20% m, 10% f, 10% vf], 10% silt; 2.5Y5/3 light olive brown (moist), 2.5Y6/3 light yellow brown (dry), moist, moderately sorted; gravel is 80% bas, 20% other, A-SR, sand is 40% bas, 60% other, A-SA, strong rxn to HCl @ 69'-70' sand is finer overall	Sample @ 73'
70	1 moist 2.1H, 1CaCO ₃ 1 mt, 1 mt, 2.1H			71'-80' SAND(S): tr-gravel, 5% vc, 10% c, 30% m, 30% f, 15% vf, 10% silt, same color as above (moist & dry), moist, moderately sorted, sand is 40% bas, 60% other, A-SA, strong rxn to HCl	Sample @ 75'
80	2.1H, 1CaCO ₃ 1 mt, 1 mt			79'-84' slightly silty SAND(m)S: tr-vc, 5% c, 10% m, 35% f, 30% vf, 20% silt, 2.5Y6/3 light yellowish brown (dry), moist, moist color as above, moderately sorted, strong rxn to HCl	Sample @ 80'
90	2.1H, 1CaCO ₃ 1 moist			starting @ ~81' material is finer, tr-c, 5% m, 20% f, 55% vf, 20% silt, well sorted, strong rxn to HCl, moist	Sample @ 85'
100	2.1H, 1CaCO ₃ 1 moist			85'-89' SAND(S): same as 71'-79', moist, strong rxn to HCl	Sample @ 90' Hard drilling
110	2.1H, 1CaCO ₃ 1 mt			@ 88' thin vf sand lens, moist, strong rxn to HCl 89'-105' slightly silty SAND(m)S: tr-vc, 10% c, 10% m, 30% f, 35% vf, 15% silt, same color (moist & dry), moist, strong rxn to HCl	Sample @ 95'
120	2.1H, 1CaCO ₃ 1 mt			@ 104'-105' lens of vc-vf sand with 15% silt & 5% vf pebbles	End of shift 9/3/98
130	2.1H, 1CaCO ₃ 1 mt			105'-117.5' silty SAND(ms): 5% >ms, 70% vf-f, 25% silt, same color (moist & dry) as above, moist, well sorted, 90% qtz, 10% other inc. mica, strong rxn to HCl, crude bedding	Sample @ 100'
140	4 liners			117.5'-138.5' SILT(M): up to 10% vf-f, sand, low plasticity, hard to form a thread, 2.5Y5/3 light olive brown (moist), 2.5Y6/3 light yellowish brown (dry), moist, strong rxn continues as slightly moist sandy silt to silt - the %ages fall about the line.	Sample @ 105'
150	2.1H, 1CaCO ₃ 1 mt			138.5'-141' CALICHE: subrounded to rounded gravel in sand & CaCO ₃ matrix, moderately consolidated, gravel is 80% bas	Sample @ 110'
160	2.1H, 1CaCO ₃ 1 mt				Sample @ 115'
170					Sample @ 120' End of shift
180					Clastic dike ~122.5'-123.5' within silt 124'-125' is sandy, silt - may contain 'last' dikes - will split spoon 124.5' to 127.5'
190					slightly drier 126'-130'
200					Sand lens ~122.5'-123.5' (cmly)
210					
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A-6000-382 (01/93)

BOREHOLE LOG				Boring or Well No. <u>299-W19-42/88553</u>	
				Sheet <u>3</u> of <u>4</u>	
Location <u>SS' East of 241- U Tank Farm, 200 W</u>			Project <u>RCRA Drilling 1998</u>		
Prepared By <u>DC Weekes</u> <small>(Sign/Print Name)</small> <u>LD Walker</u>			Date <u>9-12-98</u> Reviewed By <u>E.C. Refuse</u> <small>(Sign/Print Name)</small> Date <u>9/23/01</u>		

Depth	Sample		Graphic Log	Sample Description	Comments
	Type and No.	Blows or Recovery			
(140)	Air Rotary (Odex)	NA			
150				141' - 170': Silty Sandy Gravel (SG) (60% gravel, 30% sand, 10% silt) gravel tr boulder, 10% cobble, 30% v. cse peb, 40% cse-med peb, 30% fn-v. fn peb; sand 20% v. cse, 50% cse, 30% med-v. fn; 10 YR 6/2 (lt. brn gray) dry; poorly sorted; gravel sub-round-round, sand sub-ang; gravel and sand 60% basalt, 20% qtz, 20% other; strong rxn to HCL 140-150 ft, no HCL rxn by 160 ft.	8 5/8" OD CS casing 8" Odex bit; 9 1/2" borehole -drilling indicates 4"-6" cobbles End of shift 9/11/98
160				170' - 189': Sandy Gravel (SG) (70% gravel, 25% sand, 5% silt) gravel 10% cobble, 20% v. cse peb, 20% cse peb, 30% med peb, 20% fn-v. fn peb; sand 30% v. cse-cse, 30% med, 40% fn-v. fn; 10 YR 5/1 (gray) dry; poorly sorted; gravel sub-round, sand ang-sub ang; gravel 60% basalt, 30% granitic, 10% other, sand 75% qtz, 10% basalt, 5% other tr mica; max size ~250 mm; no rxn HCL.	157' drilling indicates small boulders
170				189' - 196': Gravelly Sand (GS) (15% gravel, 85% sand, tr silt) gravel med-fn peb; sand 10% cse, 80% med, 10% fn; dry, well sorted, sub-ang; sand 80% qtz, 10% basalt, 10% other	smooth drilling 189'-196'
180				196' - 222': Sandy Gravel (SG) (50% gravel, 45% sand, 5% silt) gravel tr cob, 30% v. cse-cse peb, 50% med, 20% fn-v. fn; sand 20% cse, 60% med, 20% fn-v. fn, 10 YR 7/2 (lt. gray) dry, poorly sorted, gravel round-sub round; gravel 40% basalt, sand 75% qtz, 10% basalt	OVM 4 ppm momentary, then < detect. LEL < detect pH < detect no rxn HCL
190					
200					
210					

BOREHOLE LOG

Boring or Well No. 299-W19-42 / B8553Sheet 4 of 4Location 55' East of 241-U Tank, Farm, 200WProject RCRA Drilling 1998Prepared By L.D. Walker / [Signature] Date 9-12-98Reviewed By E.C. Rouse / [Signature] Date 9/23/98

Depth (220)	Sample		Graphic Log	Sample Description Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
	Type and No.	Blows or Recovery			
	Air Rotary (Odex)	NA			8 5/8" OD CS casing
					8" Odex bit; 9 1/2" borehole
230				222'-265.2': Silty Sandy Gravel (msG) (60% gravel, 30% sand, 10% silt) gravel fr boulder, 10% cobble, 20% v. cse peb, 20% cse peb, 30% med, 20% Fn - v. Fn peb; Sand fr v. cse, 10% cse, 30% med, 50% Fn, 10% v. Fn, 10% R5/2 (grayish brn), moist; poorly sorted, gravel round - sub round, sand sub-ang; gravel 40% basalt, 40% granitics, 20% other; sand 60% qtz, 15% basalt, 25% other, tamica; no rxn HCl.	
240					
250					B, X < detect
260					
270					TD = 265.2 Ft. bgs 9-12-98 Water level = 220.35 Ft.
280					
290					

Appendix B

Physical and Chemical Properties Data

Appendix B

Physical and Chemical Properties Data

This Appendix includes the results of laboratory testing for particle size distribution, moisture content, calcium carbonate content, pH, electrical conductivity, cation exchange capacity, and water extractable ions.

Moisture content was measured as weight loss after drying an aliquot of the bulk sample at 105°C for 24 h or until weight was constant for two consecutive measurements.

Calcium carbonate content was determined as the gravimetric equivalent of measured total carbon from an air-dried aliquot of the <2 mm fraction. The sample was combusted in a total carbon analyzer at 975°C and the weight of evolved carbon dioxide was determined and converted to calcium carbonate equivalent. Reagent grade calcium carbonate was used as a standard. Instrument precision was ± 3 wt% based on replicate measurements of reagent grade calcium carbonate.

Exchangeable cations were determined by inductively coupled plasma analysis (ICP) after exchange with an ammonium acetate solution. Twenty grams of air dried sediment was mixed with 50 mL of 1M ammonium acetate for 16 h. Electrical conductivity, pH, and major cations and anions were determined from a 1:1 water:sediment extract. The concentrations of major cations were measured with ICP, anions were determined by ion chromatography, and alkalinity was measured by titration. Electrical conductivity and pH were determined from unfiltered aliquots and cations and anions from aliquots of solution filtered through 0.45 μ m membranes.

Particle size analysis was done using standard sieve techniques. Samples were oven dried at 105°C for 24 h (or until weight was constant for two consecutive measurements) prior to analysis.

Table B.1. Particle Size Data for Samples from Wells 299-W19-41 and 299-W19-42

Particle Size (mm)	Sieve	Weight of Dry Sample (g)	Weight Percent
299-W19-41—Depth 29 to 30 ft			
2	10	561	82.1
0.88	20	67.9	9.9
0.425	40	23.41	3.4
0.25	60	5.61	0.8
0.106	140	5.16	0.8
0.075	200	2.1	0.3
<0.075	Pan	18.11	2.7
Total		683.29	100.0
299-W19-41—Depth 69 to 70 ft			
2	10	1.8	0.9
0.88	20	27.54	14.4
0.425	40	77.59	40.5
0.25	60	55.9	29.2
0.106	140	20.39	10.6
0.075	200	2.69	1.4
<0.075	Pan	5.55	2.9
Total		191.46	100.0

Particle Size (mm)	Sieve	Weight of Dry Sample (g)	Weight Percent
299-W19-42—Depth 30 ft			
2	10	783	80.0
0.88	20	57.55	5.9
0.425	40	51.97	5.3
0.25	60	31.12	3.2
0.106	140	29.07	3.0
0.075	200	6.95	0.7
<0.075	Pan	19.09	2.0
Total		978.75	100.0
299-W19-42—Depth 70 ft			
2	10	2.4	1.2
0.88	20	20.72	10.7
0.425	40	66.77	34.5
0.25	60	44.4	23.0
0.106	140	29.05	15.0
0.075	200	7.88	4.1
<0.075	Pan	22.18	11.5
Total		193.4	100.0

Table B.2. Moisture Content, pH, and Electrical Conductivity for Samples from Well 299-W19-42

Sample Depth (ft)	Moisture Content (wt%)	pH	Electrical Conductivity ($\mu\text{S}/\text{cm}$)	Temperature ($^{\circ}\text{C}$)
5	8.2	8.42	141	16.3
10	8.8	8.86	114	16.2
15	12.2	8.72	198	16.4
25	5.9	8.83	143	16.2
30	4.0	8.82	110	15.9
35	3.6	8.62	129	15.1
40	3.8	8.89	117	16.3
45	4.0	8.55	125	15.6
50	9.3	8.52	115	15.6
55	3.9	8.62	117	16.0
60	6.7	8.5	148	15.2
65	3.0	8.51	147	15.9
70	3.4	8.58	154	15.4
73	7.2	8.58	138	15.8
75	2.9	8.56	140	16.2
80	6.0	8.48	175	16.2
85	3.3	8.58	136	15.7
90	6.4	8.3	154	14.0
95	6.0	8.29	136	16.2
100	5.6	8.45	143	15.7
105	7.3	8.45	132	15.5
110	6.6	8.47	131	15.6
115	4.4	8.46	131	15.6
120	14.5	8.32	158	15.6
130	12.7	NA	NA	NA
135	15.2	8.32	147	15.6
138.5	22.0	7.83	201	17.2
140	20.4	7.88	203	17.2

NA = not analyzed.

Table B.3. Major Cations, Major Anions, and Alkalinity for Samples from Well 299-W19-42

Depth (ft)	Cations (mg/L)						Total Cations (meq/L)	Monovalent Cations (%)	Divalent Cations (%)
	Ba	Ca	K	Mg	Na	Sr			
5	0.00	32.76	6.94	3.14	5.66	0.07	2.32	18.28	81.72
10	0.05	12.45	10.40	5.65	10.83	0.07	1.82	40.39	59.61
15	0.00	10.14	9.37	1.84	44.88	0.04	2.85	76.90	23.10
25	0.01	8.91	10.58	1.38	16.14	0.05	1.53	63.46	36.54
30	0.09	10.22	7.23	1.92	17.82	0.06	1.63	58.87	41.13
35	0.20	11.27	7.57	3.05	12.68	0.07	1.56	47.67	52.33
40	0.11	9.80	8.49	2.37	10.83	0.06	1.38	50.02	49.98
45	0.11	10.83	4.16	3.24	11.94	0.08	1.44	43.57	56.43
50	0.17	10.59	3.42	3.61	7.58	0.07	1.25	33.49	66.51
55	0.09	9.59	10.19	2.84	11.30	0.07	1.47	51.26	48.74
60	0.18	11.48	6.67	3.67	9.57	0.09	1.47	40.01	59.99
65	0.13	12.58	2.22	4.07	6.18	0.09	1.29	25.18	74.82
70	0.14	12.82	4.16	4.08	10.14	0.09	1.53	35.85	64.15
73	0.10	10.63	1.75	3.22	13.38	0.08	1.43	43.95	56.05
75	0.16	9.59	4.14	3.08	11.85	0.08	1.36	45.77	54.23
80	0.34	13.39	0.00	4.05	13.85	0.10	1.61	37.38	62.62
85	0.16	10.58	4.39	3.50	10.85	0.08	1.40	41.62	58.38
90	0.24	11.85	6.00	2.83	11.34	0.07	1.48	43.82	56.18
95	0.11	11.46	4.94	2.54	7.98	0.08	1.26	37.66	62.34
100	0.24	11.62	1.82	2.49	12.37	0.07	1.37	42.53	57.47
105	0.13	10.01	0.00	2.12	8.40	0.05	1.04	35.03	64.97
110	0.10	11.76	0.00	2.50	10.54	0.07	1.25	36.55	63.45
115	0.02	11.83	0.00	2.76	13.75	0.06	1.42	42.21	57.79
120	0.03	13.00	0.00	2.88	16.82	0.06	1.62	45.18	54.82
130	0.08	11.98	0.00	3.05	13.95	0.05	1.46	41.63	58.37
135	0.17	11.82	0.00	3.75	16.59	0.06	1.62	44.43	55.57
138.5	0.17	14.88	0.00	6.27	16.35	0.10	1.97	36.02	63.98
140	0.26	15.31	0.00	6.13	8.69	0.10	1.65	22.88	77.12

Table B.3. (contd)

Depth (ft)	Anions (mg/L)					Total Anions (meq/L)	Electrical Balance (%)
	Alkalinity as CaCO ₃	F	Cl	NO ₃	SO ₄		
5	108.60	0.54	3.07	6.69	2.69	2.45	-5.56
10	55.55	0.54	0.89	<0.06	2.88	1.22	39.40
15	89.32	1.80	2.84	4.65	10.32	2.25	23.49
25	60.00	0.68	2.07	1.39	8.90	1.50	2.02
30	52.83	0.66	2.06	<0.06	9.77	1.35	18.64
35	55.03	0.52	2.52	0.98	9.37	1.41	10.29
40	45.91	0.52	2.14	<0.06	10.35	1.22	11.87
45	50.20	0.49	1.90	1.99	10.37	1.33	7.65
50	51.36	0.40	2.63	2.20	8.21	1.33	-6.40
55	51.04	0.43	1.92	1.13	7.63	1.27	14.06
60	53.04	0.60	2.72	0.94	20.41	1.61	-9.25
65	46.64	0.31	1.68	1.06	20.69	1.44	-11.17
70	52.41	0.54	2.44	<0.06	16.17	1.48	2.95
73	36.36	0.49	2.22	<0.06	9.90	1.02	33.01
75	50.60	0.43	1.38	<0.06	7.12	1.22	10.47
80	53.04	0.59	1.65	<0.06	28.81	1.74	-7.60
85	55.03	0.42	1.37	<0.06	7.33	1.31	6.63
90	67.51	0.58	1.44	<0.06	9.96	1.63	-9.83
95	52.83	0.49	0.79	<0.06	7.40	1.26	-0.11
100	54.10	0.52	1.33	<0.06	8.63	1.33	3.58
105	37.09	0.39	0.76	<0.06	5.81	0.90	14.14
110	51.36	0.45	0.69	<0.06	10.42	1.29	-2.58
115	54.51	0.50	0.80	0.16	11.88	1.39	2.04
120	55.93	0.84	1.43	<0.06	14.18	1.50	7.73
130	70.23	0.63	0.70	<0.06	9.69	1.66	-12.92
135	67.96	0.54	1.12	<0.06	10.15	1.63	-0.39
138.5	69.64	0.92	0.61	0.32	14.57	1.77	11.06
140	72.32	0.90	0.63	0.13	11.99	1.76	-6.46

Table B.4. Cation Exchange Capacity and CaCO₃ Content for
Samples from Well 299-W19-42

Depth (ft)	CEC (meq/100g)	Divalent Cations (%)	CaCO ₃ (wt%)
5	7.38	98.26	3.48
10	8.21	95.94	3.43
15			
25	8.04	94.43	26.06
30			
35			
40	6.11	94.90	15.84
45			
50			
55	4.50	96.87	12.42
60	4.92	94.51	8.25
65			
70			
73			
75			
80	5.90	93.77	1.84
85	5.38	94.26	2.91
90			
95	5.72	95.03	2.04
100			
105			
110			
115			
120	8.81	92.90	3.18
130	7.63	95.19	2.97
135			
138.5	8.02	93.60	57.58
140	7.99	93.71	36.99

Appendix C

Geophysical Logs

Appendix C

Geophysical Logs

This appendix contains the high purity, germanium spectral gamma-ray log. The log was run by Waste Management Federal Services, Inc., Northwest and log data analysis completed by Three Rivers Scientific Company. Included with the log is a Log Header sheet, Acceptance QA Processing data, and a Log Analysis Summary Report.

RLS Spectral Gamma Ray Borehole Survey

Waste Management Federal Services NW

Log Header

Project: RCRA Drilling – FY1998

Well: 299 - W19 - 42

Log Type: HPGe Spectral Gamma Ray

Borehole Information

Well ID	<u>B8553</u>	Water Depth	<u>220.3</u> ft	Total Depth	<u>265.7</u> ft
Elevation Reference	<u>Ground</u>	Elevation	<u>n/a</u> ft		
Depth Reference	<u>Ground Surface</u>	Casing Stickup	<u>0.86</u> ft 1 st Log <u>0.6</u> ft 2 nd Log		
Casing Diameter	<u>8</u> in 1 st Log	Depth Interval	<u>0 to 136.9</u> ft	Thickness	<u>0.5</u> in
Casing Diameter	<u>8</u> in 2 nd Log	Depth Interval	<u>0 to 265.7</u> ft	Thickness	<u>0.312</u> in

Logging Information

Log Type:	HPGe Spectral Gamma Ray		
Company	Waste Management Federal Services NW		
Date/Archive File Name	Sep 13, 1998	H2W19042	
Logging Engineers	<u>J.Meisner</u>		
Instrument Series	RLSG3.1		
Logging Unit	RLS2		
Depth Interval	0 to 139.5 ft	Prefix B215	1 st Log
	115 to 264.5 ft	Prefix B216	2 nd Log
Instrument Calibration Date	Sep 11, 1998		
Calibration Report	WHC-SD-EN-TI-292, Rev. 0		

Analysis Information

Company	Three Rivers Scientific
Analyst	Russ Randall
Date	January 2, 1999

Notes The only man made radionuclide detected is Cs-13 from surface to 10 feet. The maximum observed reading is 8.7 pCi/g at 1.25 feet. The 1st Log was run at the end of the drilling with the 0.5 inch wall casing, and the 2nd log was run at total depth with the 0.312 inch wall casing.

RLS Spectral Gamma Ray Borehole Survey

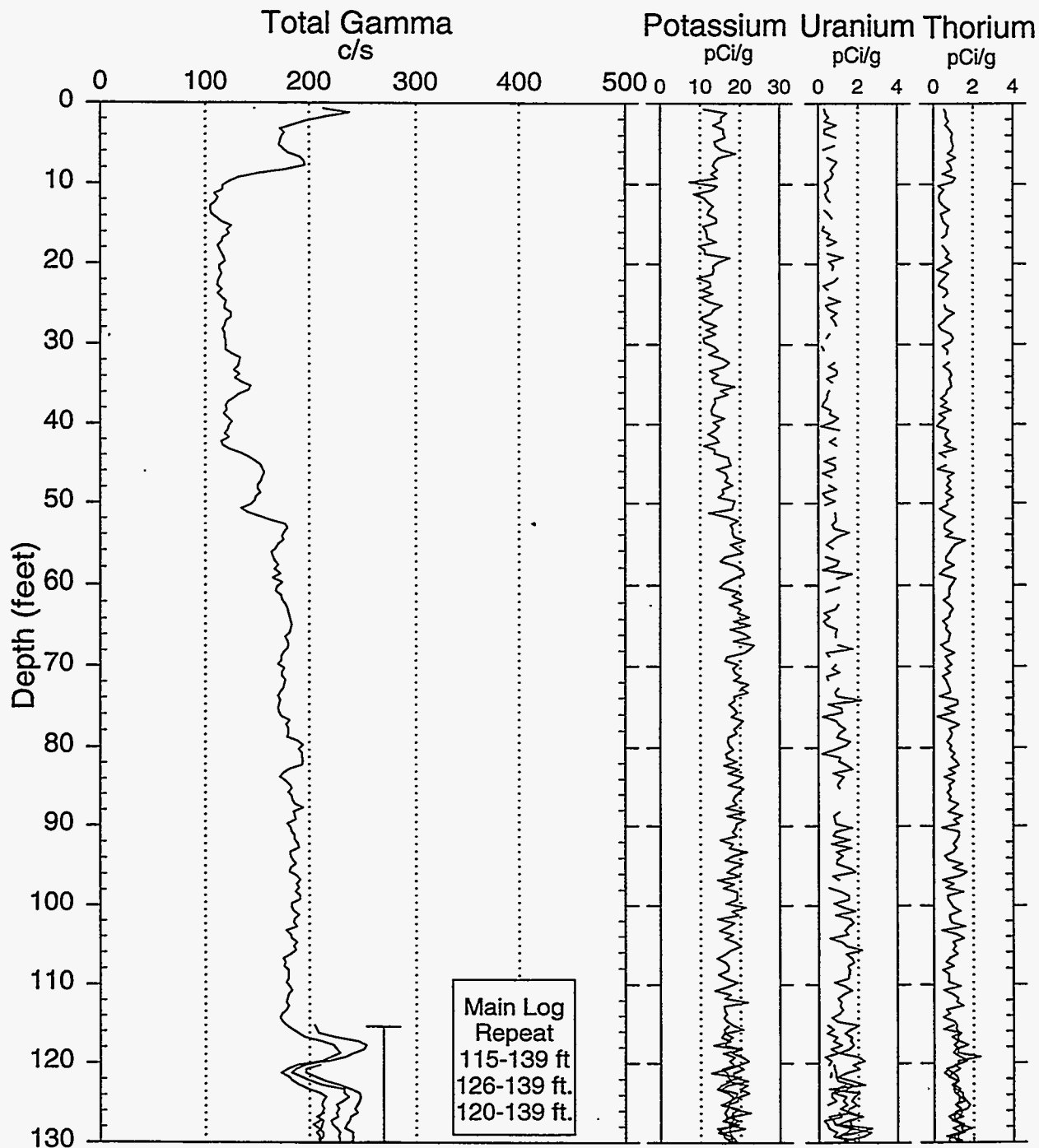
Waste Management Federal Services NW

Project: RCRA Drilling - FY1998

Log Date: Sept. 9 & 13, 1998

Borehole: 299-W19-42 (B8553)

Naturally Occurring Radionuclides



Analysis by: Three Rivers Scientific

RLS Spectral Gamma Ray Borehole Survey

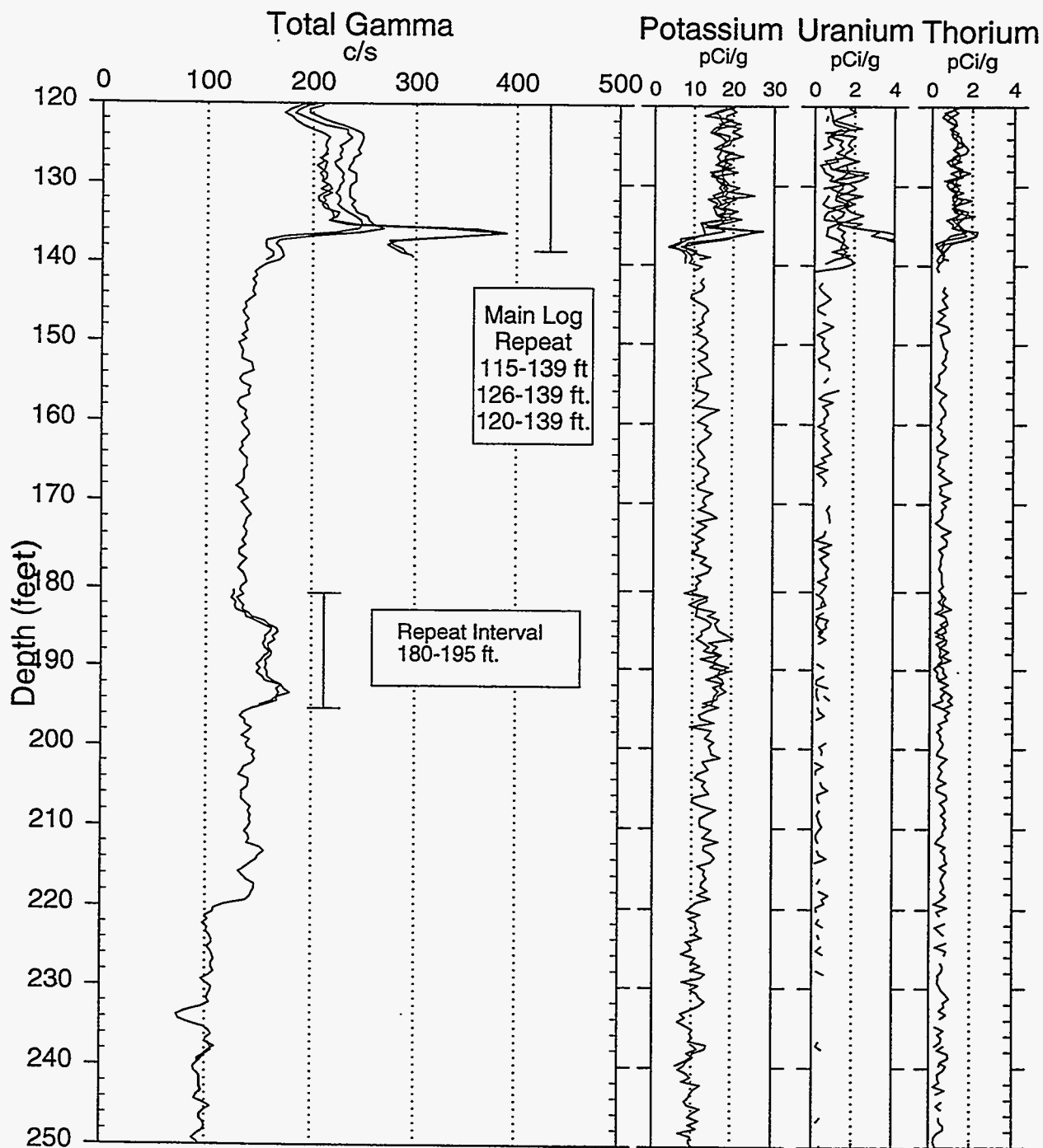
Waste Management Federal Services NW

Project: RCRA Drilling - FY1998

Log Date: Sept. 9 & 13, 1998

Borehole: 299-W19-42 (B8553)

Naturally Occurring Radionuclides



Analysis by: Three Rivers Scientific

RLS Spectral Gamma Ray Borehole Survey

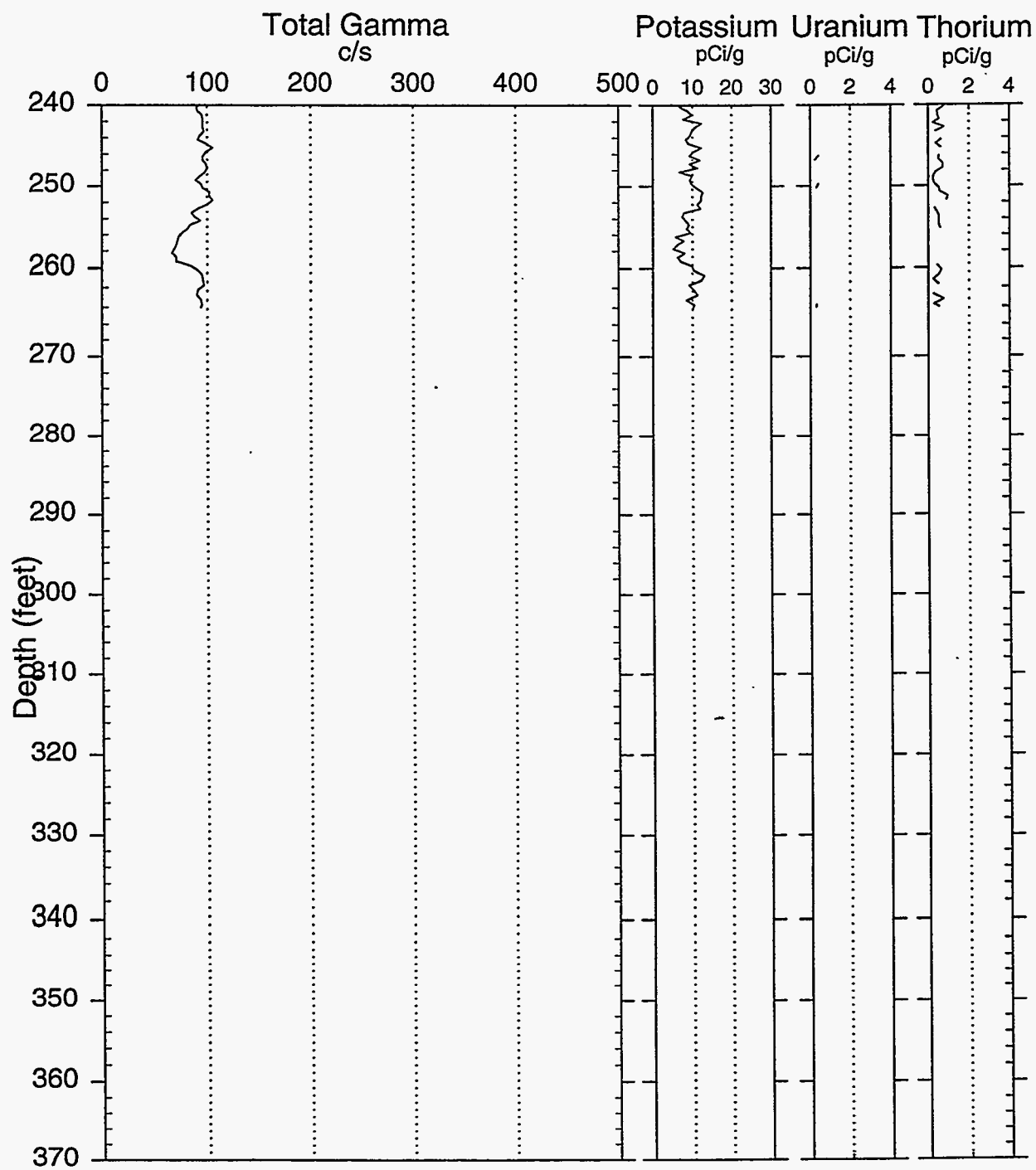
Waste Management Federal Services NW

Project: RCRA Drilling - FY1998

Log Date: Sept. 9 & 13, 1998

Borehole: 299-W19-42 (B8553)

Naturally Occurring Radionuclides



Analysis by: Three Rivers Scientific

RLS Spectral Gamma-Ray Borehole Survey

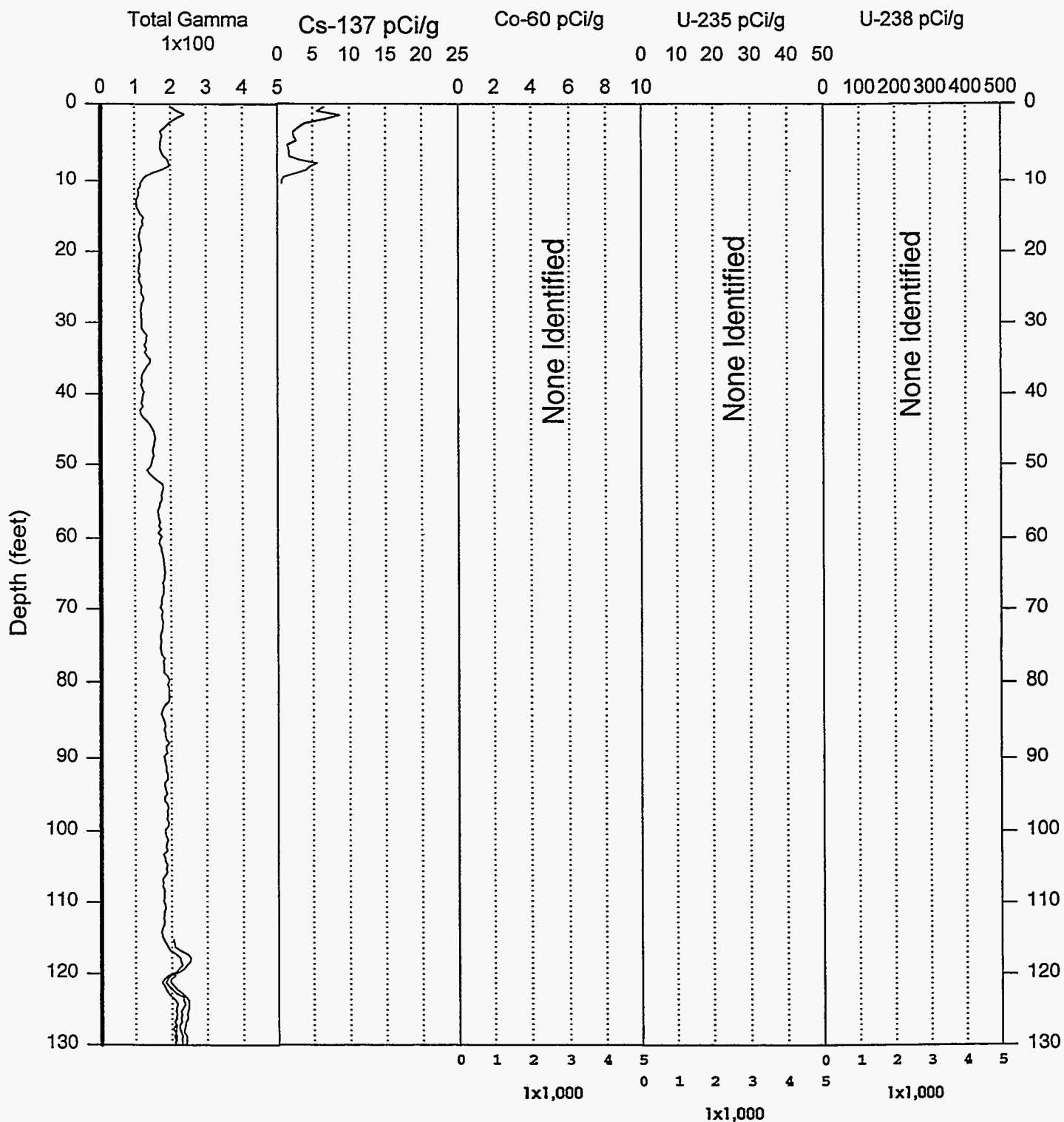
Waste Management Federal Services Inc., Northwest Operations

Project: RCRA Drilling - 98

Log Date : September 9, 1998

Borehole : 299-W19-42

Depth Datum: Ground Level



Analysis by: Three Rivers Scientific

RLS Spectral Gamma-Ray Borehole Survey

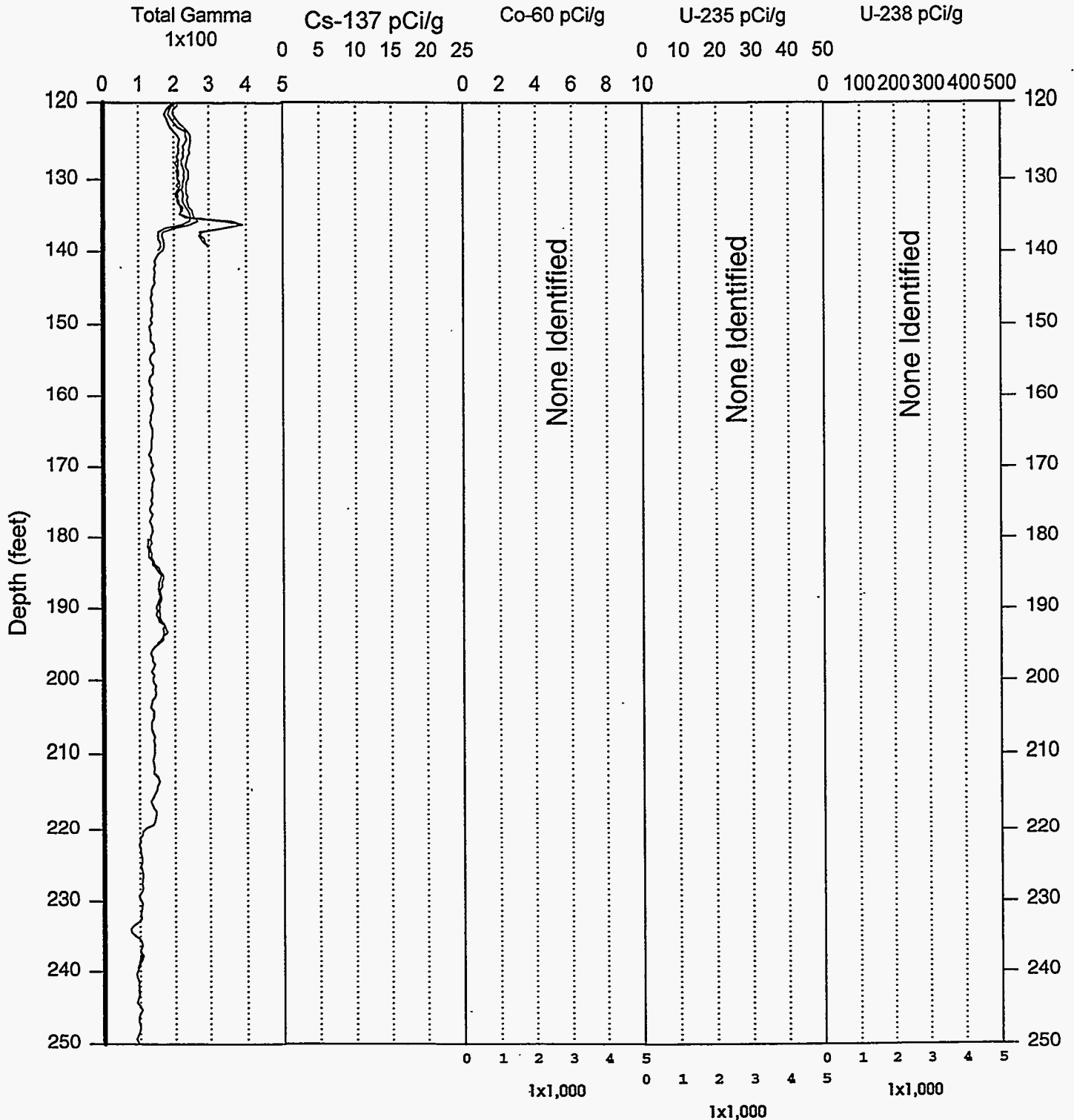
Waste Management Federal Services Inc., Northwest Operations

Project: RCRA Drilling - 98

Log Date : September 9, 1998

Borehole : 299-W19-42

Depth Datum: Ground Level



Analysis by: Three Rivers Scientific

RLS Spectral Gamma-Ray Borehole Survey

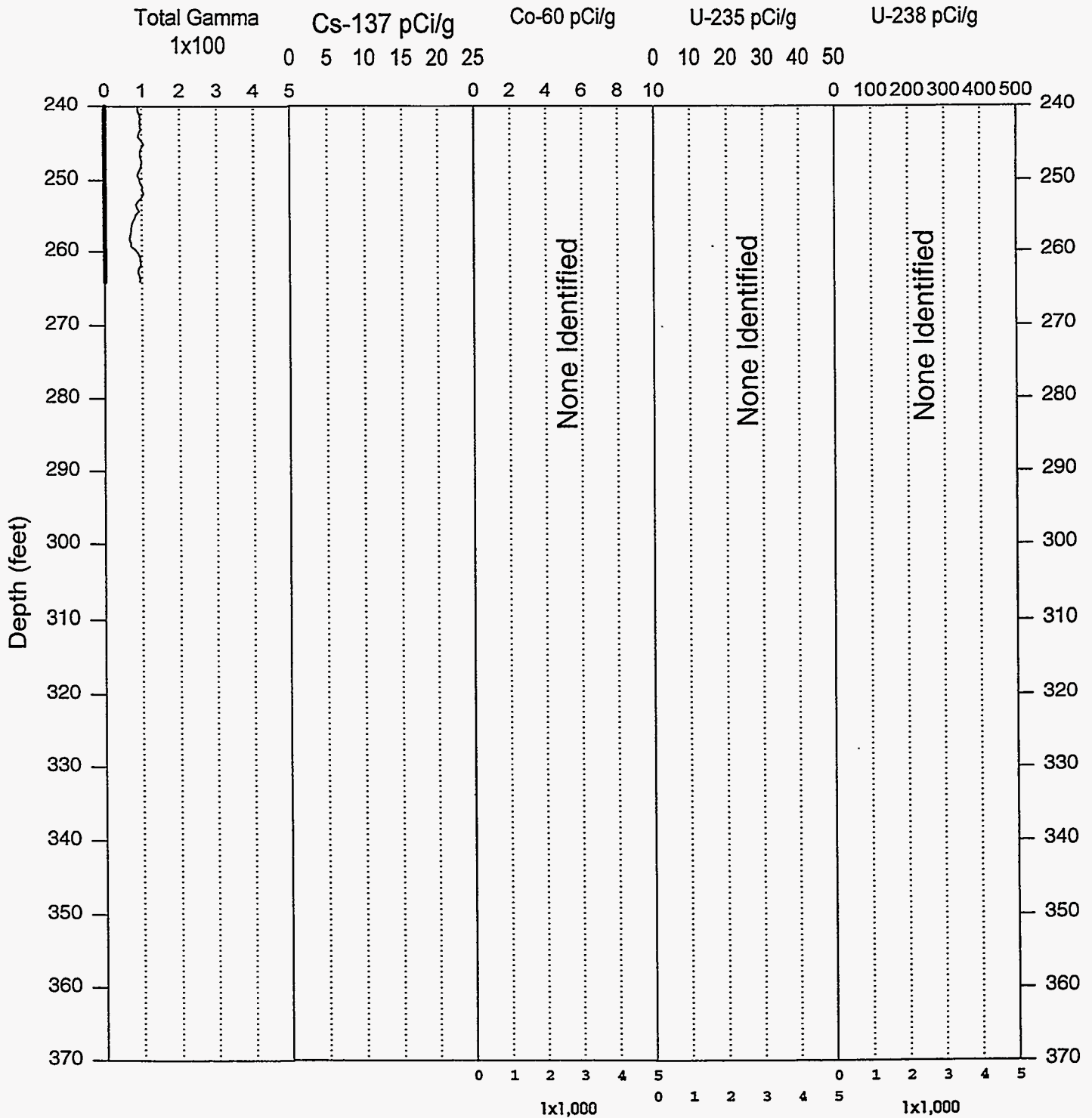
Waste Management Federal Services Inc., Northwest Operations

Project: RCRA Drilling - 98

Log Date : September 9, 1998

Borehole : 299-W19-42

Depth Datum: Ground Level



Analysis by: Three Rivers Scientific

RLS Spectral Gamma Ray Borehole Survey

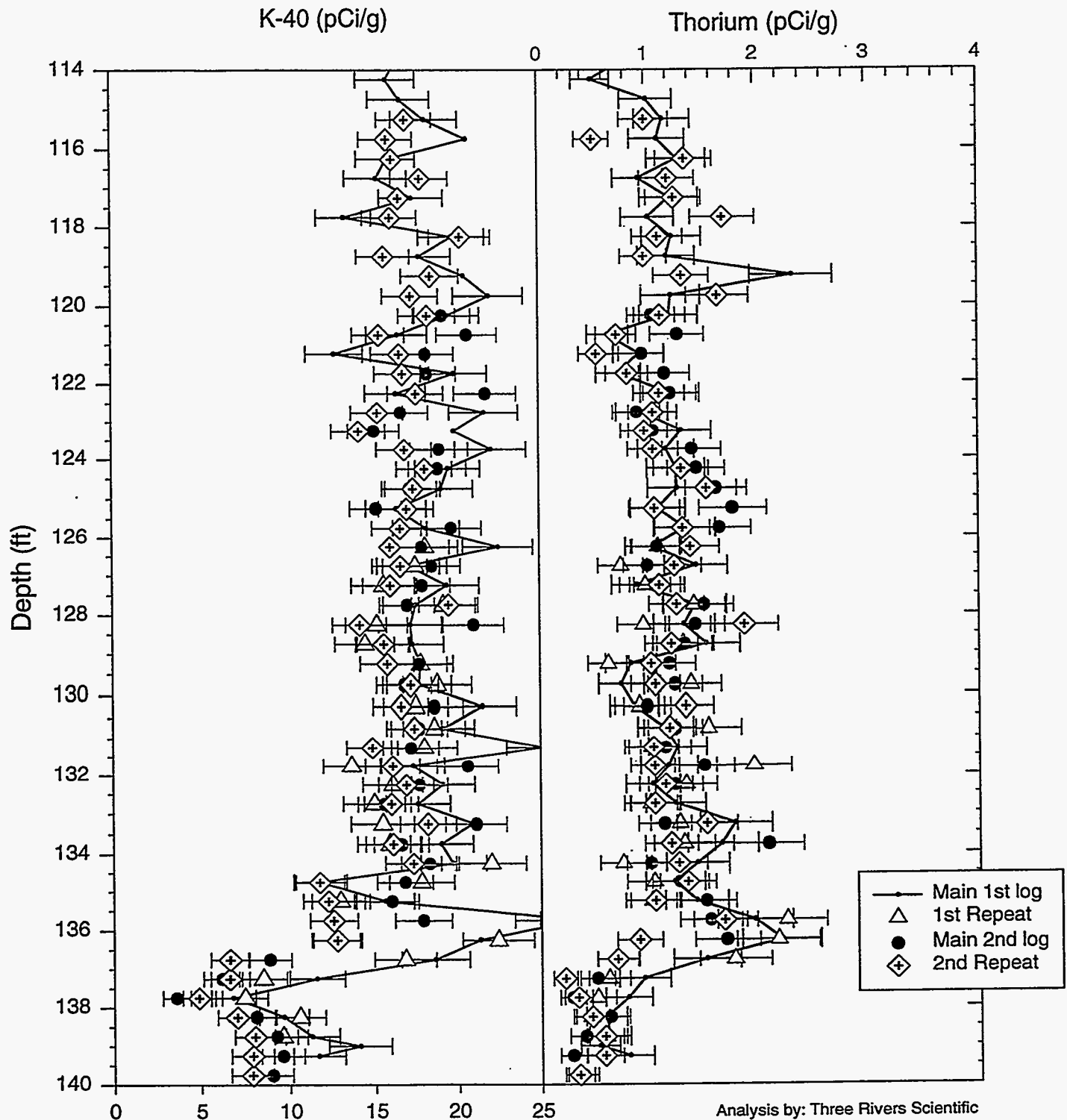
Acceptance QA Processing

Project: RCRA Drilling - FY1998

Borehole: 299-W19-42 (B8553)

Log Date: Sep 9 & 13, 1998

Compare Main Log & Repeats

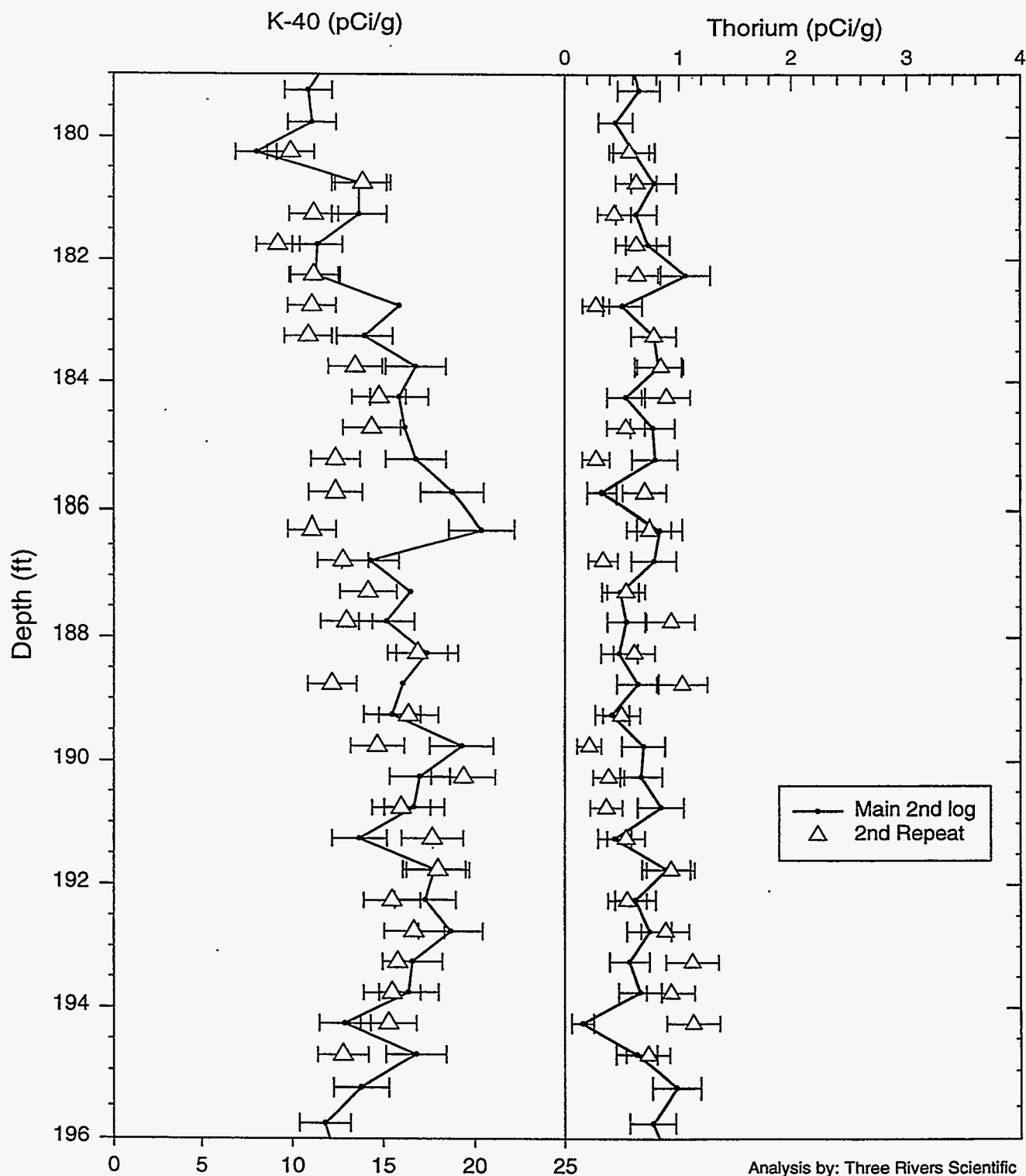


RLS Spectral Gamma Ray Borehole Survey

Acceptance QA Processing

Project: RCRA Drilling - FY1998
Borehole: 299-W19-42 (B8553)

Log Date: Sep 9 & 13, 1998
Compare 2nd Log & Repeat



RLS Spectral Gamma Ray Borehole Survey

Waste Management Federal Services NW

Log Analysis Summary Report

Project: RCRA Drilling - FY1998
Log Type: HPGe Spectral Gamma Ray

Well ID: 299-W19-42
Log Dates: Sep 9 & 13, 1998

General Notes:

Total gamma is a response to formation lithology for the entire depth logged below 10 feet, since a small level of Cs-137 exists from 0 to 10 feet..

The system dead-time limit was not exceeded (less than 5%) for the borehole survey.

System Performance Verify: The pre- and post-log verifications were performed using coleman #2 mantle, and passed the equipment performance check. The maximum FWHM for the 583 keV gamma ray photo peak both the survey dates was 2.45 keV. The maximum acceptable FWHM resolution is 3.10 keV for probe RLSG3.1 on these log dates.

Repeat Interval: The drilling of this well was changed from 0.5 inch wall casing to 0.312 inch wall casing after Sep 9, 1998. The depth interval reached with the 0.5 inch wall casing was 136.9 feet. Therefore, the repeat has two classes. First, the 1st log run on Sep 9, 1998 covered entire depth at this time (0 to 139.5 feet), and repeated over the lower interval from 126 to 139 feet. The 2nd log covered different casing, thus a relog & repeat interval was chosen from 115 to 140 feet, as well as a repeat interval for the 2nd log of 180 to 195 feet.

Both intervals of repeat and the combination of repeat & re-log demonstrate acceptable variances within statistical precision of the data, as can be seen in the Acceptance QA processing plots. Note that the potassium and uranium concentrations have been casing corrected for the different casing thickness used for the overlap intervals.

There are several observations concerning the character of the repeat nature for these logging passes. Radon pumping is observed between survey dates as well as the start and end of the second logging run on this well. The changes in uranium and gross are not accompanied by changes in the potassium or thorium. Also, on the 1st log, the depth interval logged exceeded the casing depth and the instrument was observed to begin to drop out of casing. This caused an apparent rinse in the gross for this logging pass.

Environmental Corrections: The KUT concentrations have been corrected for casing attenuation (entire well) and water inside the casing (below 220.3 feet) for a centralized detector configuration. No casing correction was applied to the total gamma due to Compton downscatter interference.

Radionuclides:

The only man-made radionuclide detected is Cs-137 from 0 to 10 feet. The maximum observed reading is 8.7 pCi/g at 1.25 feet. No other man-made radionuclides were detected, even using a factor 4 summing technique.

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