PNNL-13829

Pacific Northwest
National Laboratory
Operated by Battelle for the
U.S. Department of Energy

Borehole Data Package for Calendar Year 2001 RCRA Wells at Single-Shell Tank Waste Management Area S-SX

D. G. Horton

March 2002

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

DISCLAIMER

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This document is a compilation of the information on well drilling and construction, well development, pump installation, and sediment sampling at two new RCRA wells (299-W22-84 and 299-W22-85) constructed at Waste Management Area S-SX in September to November 2001. These wells were constructed to the specifications and requirements described in Washington Administrative Codes 173-160 and 173-303.

Groundwater samples were collected during drilling and borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. The boreholes were geophysically logged with spectral gamma-ray and neutron moisture tools on October 1, 2001. Cesium-137 was found between 0 and 4 ft below ground surface in well 299-W22-85 at a maximum concentration of 0.2 pCi/g.

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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) S-SX in September to November 2001 in partial fulfillment of Tri-Party Agreement (Ecology et al. 1998) milestones M-24-00M. The wells are 299-W22-84 and 299-W22-85. Table 1 correlates the well names with the well numbers. Well 299-W22-84 is located east of the 241-SY tank farm and is a new downgradient well in the monitoring network. Well 299-W22-85 is a new downgradient well located east of the 241-SX tank farm and northwest of the 216-S-8 trench. The locations of all wells in the WMA S-SX monitoring network are shown on Figure 1.

The original assessment monitoring plan for WMA S-SX was issued in 1996 (Caggiano 1996). That plan was updated for the continued assessment at WMA S-SX in 1999 (Johnson and Chou 1999). The updated plan provides justification for the new wells. The new wells were constructed to the specifications and requirements described in Washington Administrative Codes 173-160 and 173-303, the updated assessment plan for WMA S-SX (Johnson and Chou 1999), and the description of work for well drilling and construction.[1]

This document compiles information on the drilling and construction, well development, pump installation, and sediment sampling applicable to the installation of the two new wells. Appendix A contains the Well Summary Sheets (as-built diagrams), the Well Construction Summary Reports, and the geologist's logs; Appendix B contains results of physical and chemical properties testing; and Appendix C contains borehole geophysical logs. Additional documentation concerning well construction is on file with Bechtel Hanford, Inc., Richland, Washington.

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. The information below can be used for conversion to metric units:

- 1 foot (ft) = 0.3048 meter
- 1 inch (in.) = 2.54 centimeters
- 1 gallon (gal) = 3.785 liters

Table 1. Well Names and Well Numbers for Wells Drilled During Calendar Year 2001

Well Name	Well Number
299-W22-84	C3398
299-W22-85	C3399

[1] Letter from J. S. Fruchter (Pacific Northwest National Laboratory) to G. B. Mitchem (Bechtel Hanford, Inc.) *Description of Work for Drilling of CY 2001 RCRA Groundwater Monitoring Wells*, dated April 16, 2001.

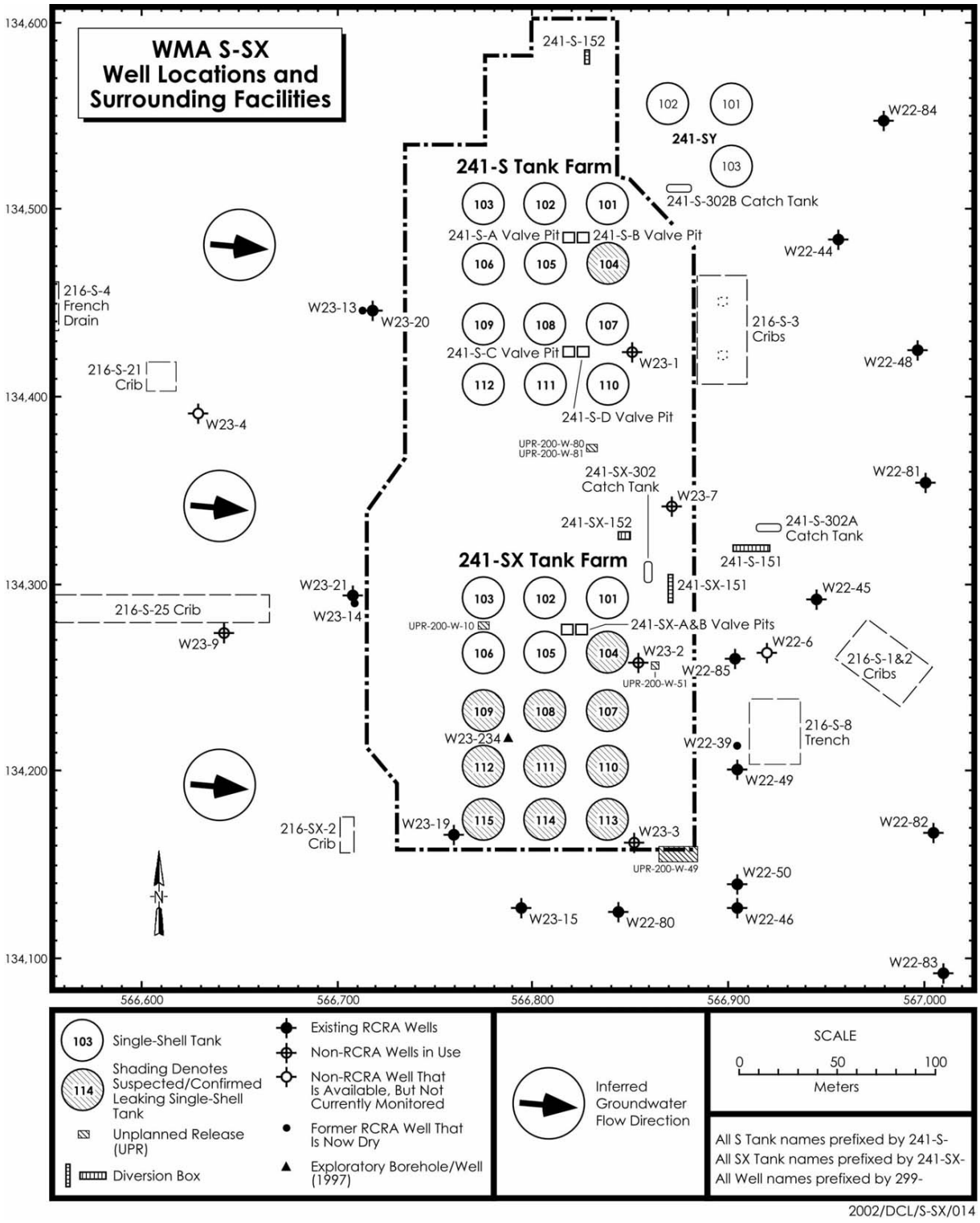

Figure 1. Map of Waste Management Area S-SX and Locations of Wells in the Groundwater Monitoring Network

2.0 Well 299-W22-84

2.1 Drilling and Sampling

Well 299-W22-84 was drilled in October 2001 with a cable tool rig and drive barrel from the surface to 180 ft below ground surface (bgs) and by hard tool from 180 ft bgs to a total depth of 273.5 ft bgs. Temporary 10-¾-in.-outside-diameter, carbon steel casing was used for the entire borehole. Approximately 175 gal of water were added to the borehole during hard tool drilling.

The sediments encountered during drilling were predominantly sand and silty sand and gravelly sand of the Hanford formation from the surface to about 150 ft bgs; undifferenciated Plio-Pliestocene/upper Ringold Formation silt, and silty sand from 150 to about 180 ft bgs; and Ringold Formation member of Wooded Island, unit E silty sandy gravel with minor sandy gravel and sandy silt from a depth of 180 ft to the bottom of the borehole. The geologist's log is included in Appendix A.

Grab samples for geologic description and archive were collected every 5 ft throughout the borehole. Also, two split spoon samples were taken from 225 to 227.5 and from 265 to 267.5 ft bgs for analysis of particle size distribution. Particle size distribution data are in Appendix B.

Two groundwater samples were collected during drilling. The samples were slurries of groundwater and drill cutting obtained during drilling. One sample was from the water table and the other from total depth. The samples were analyzed for anions, metals, specific conductance, and technetium-99. All available results are included in Appendix B.

The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. No contamination was found. The borehole was geophysically logged with spectral gamma and neutron moisture tools. No manmade radionuclides were detected. The logs are included in Appendix C.

2.2 Well Completion

The permanent casing and screen were installed in well 299-W22-84 in October 2001. A 4-in.-inner-diameter, stainless steel, wire wrap, 20 slot screen was set from 267 to 232 ft bgs. The permanent casing is 4-in.-inner-diameter, stainless steel from 232 ft bgs to 2.0 ft above ground surface. A 2-ft-long stainless steel sump is below the screen from a depth of 269.1 to 267 ft.

The filter pack is 10 to 20 mesh silica sand from 222.0 to 273.5 ft bgs. The annular seal is bentonite pellets from 222.0 to 217.4 ft bgs, granular bentonite from 217.4 to 10.3 ft bgs, and Portland cement grout from 10.3 ft 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 protective casing extends 2.35 ft above the surface. The Well Summary Sheet (as-built) and Well Construction Summary Report are included in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in December 2001. 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 and 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 benchmarks established by the U.S. Army Corps of Engineers. Survey data are included in Table 2 and the survey data sheet is included in Appendix A.

Table 2. Survey Data for New Wells at Waste Management Area S-SX

Well Name	Easting (m)	Northing (m)	Elevation (m)	Reference Point
299-W22-84	566978.76	134547.62		Center of Casing
			208.510	"X" on Rim of Casing
	566978.76	134547.84	207.793	Brass Cap
299-W22-85	566902.90	134260.58		Center of Casing
			204.409	Top of Casing
	566902.88	134260.87	203.682	Brass Cap

2.3 Well Development and Pump Installation

Well 299-W22-84 was developed in November 2001. A temporary, 3 hp, submersible pump was used to remove ~5,090 gal of formation water at 10 gal/min with the pump intake at 266 ft bgs. Final drawdown was 17.48 ft and final turbidity was 4.05 NTU.

A dedicated submersible sampling pump was installed in well 299-W22-84 in November 2001. The sampling pump intake is at 245.35 ft below top of casing (the casing extends 2.35 ft above the concrete pad) or about 9.8 ft below the water table. Static water level was 235.55 ft bgs on November 7, 2001.

3.0 Well 299-W22-85

3.1 Drilling and Sampling

Well 299-W22-85 was drilled in September and October 2001 with a cable tool drill rig and drive barrel from the surface to 176 ft bgs and with hard tool from 176 ft to a total depth of 260.1 ft bgs. Temporary 11-¾-in.-outside-diameter, carbon steel casing was used for the entire depth of the borehole. An unknown amount of water was added to the borehole between 140 and 175 ft bgs to keep sediment in the drive barrel and at least 158 gal were added during hard tool drilling.

The sediments encountered during drilling were dominantly sand and silty sand with lesser amounts of sandy gravel and silty sandy gravel of the Hanford formation from the surface to about 125 ft bgs; Plio-Pliestocene silt and sandy silt from 125 to 159 ft bgs with caliche between 150 and 159 ft bgs; and Ringold Formation silty sandy gravel and sandy gravel with minor sand from about 159 ft to total depth (260.1 ft bgs). The geologist's log is included in Appendix A.

Grab samples for geologic description and archive were collected every 5 ft throughout the borehole. Also, two split spoon samples were taken from 220.5 to 222 ft and 255 to 257.5 ft bgs for analysis of particle size distribution. Particle size distribution data are in Appendix B.

Two groundwater samples were collected during drilling. The samples were slurries of drill cuttings and groundwater obtained during drilling. One sample was from the water table and the other from total depth. The samples were analyzed for anions, metals, specific conductance, and technetium-99. All available results are included in Appendix B.

The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. No contamination was found. The borehole was geophysically logged with spectral gamma-ray and neutron moisture tools on October 1, 2001. Cesium-137 was found between 0 and 4 ft bgs with a maximum concentration of 0.2 pCi/g.

3.2 Well Completion

The permanent casing and screen were installed in well 299-W22-85 in October 2001. A 4-in.-inner-diameter, stainless steel, wire wrap, 20 slot screen was set from 252.03 to 217.12 ft bgs. The permanent casing is 4-in.-inner-diameter, stainless steel from 217.12 ft bgs to 2.0 ft above ground surface. A 2-ft-long stainless steel sump is below the screen from a depth of 254.13 to 252.03 ft.

The filter pack is 10 to 20 mesh silica sand from 257.5 to 206.8 ft bgs. The annular seal is bentonite pellets from 206.8 to 202.1 ft bgs, granular bentonite from 202.1 to 10.1 ft bgs, and Portland cement grout from 10.1 ft bgs to the surface. A 4 ft by 4 ft by 6 in. concrete pad was placed around the well at the surface. A 6-in. stainless steel protective casing with locking cap, four protective steel posts, and a brass marker stamped with the well number were set into the concrete. The protective casing extends 2.39 ft above the ground surface. The Well Summary Sheet (as-built) and Well Construction Summary Report are included in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in December 2001. 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 and 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 benchmarks established by the U.S. Army Corps of Engineers. Survey data are included in Table 2 and the survey data sheet is included in Appendix A.

3.3 Well Development and Pump Installation

Well 299-W22-85 was developed in October 2001. A temporary, 3 hp, submersible pump was used to remove approximately 4,710 gallons of formation water. First, about 1590 gal of water were removed from the well at 30 gal/min with a drawdown of about 11.5 ft. The pump intake was at 250.53 ft bgs (about 31.9 ft below the water table). Second, about 3120 gal of water were removed at 30 gal/min with the pump intake at 234.5 ft bgs resulting in 9.34 ft of drawdown. The final turbidity was 3.61 NTU.

A dedicated, Redi Flo-2 submersible sampling pump was installed in well 299-W22-85 in October 2001. The sampling pump intake is at 226.65 ft bgs (or about 8.25 ft below the water table). Static water level was 218.4 ft bgs on October 31, 2001.

4.0 References

Caggiano, J. A. 1996. *Assessment Groundwater Monitoring Plan for Single-Shell Tank Waste Management Area S-SX.* WHC-SD-EN-AP-191, Westinghouse Hanford Company, Richland, Washington.

Ecology - Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. 1998. *Hanford Federal Facility Agreement and Consent Order.* Document No. 89-10, Rev. 5 (The Tri-Party Agreement), Ecology, Olympia, Washington.

Johnson, V. G. and C. J. Chou. 1999. *RCRA Assessment Plan for Single-Shell Waste Management Area S-SX at the Hanford Site.* PNNL-12114, Pacific Northwest National Laboratory, Richland, Washington.

NAVD88. 1988. North American Vertical Datum of 1988.

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 card # R037815

Start Date: 10/01/01
Finish Date: 11/1/01
Page 1 of 1

Specification No.: 0200X-SP-V0004	Rev. No.: 0
ECNs: NA	
Project: CY01 RCRA Drilling	
Drilling Company: Resonant Sonic Inc. (RSI)	
Driller: Gary Howell ("Howie") Lic.# 1930	
Well Name: 299-W22-84	Temp. Well No.: C3398
Approximate Location: East of 241-SY Tank Farm	
Other Companies: CHI, BHI	
Geologist(s): C. Trice, J Hocking, C Martinez, G Thomas	

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
Carbon Steel (FS)	0' - 273.5'	10 5/8" / 9 5/8"
	-	
	-	
	-	
	-	

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

Total Drilled Depth: 273.5' | Hole Dia @ TD: 11"

Well Straightness Test Results: Passed 10/19/01 20.4' long 8.5" OD Tool was used.

DRILLING METHOD/HOLE DIAMETER

Auger:	Diameter From ____ to ____
Cable Tool: X 10 3/4" OD	Diameter From 0' to 273.5'
Air Rotary:	Diameter From ____ to ____
A.R. w/Sonic:	Diameter From ____ to ____
	Diameter From ____ to ____
	Diameter From ____ to ____
	Diameter From ____ to ____

Drilling Fluid: N/A

Total Amt. Of Water Added During Drilling: N/A

Static Water Level: 232.36' bgs Date: 11/2/01

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date
Spectral Gamma	134.0' - 274.0'	10/22/01
Spectral Gamma	0' - 133.0'	10/23/01
Neutron Moisture	0' - 236.75'	10/19/01

Sondes (type)	Interval	Date
	-	
	-	
	-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size
4" ID SS 304/304L Sump	269.1 - 267.0		
4" SS 304/304L SCH 0.55" ID CONT. WIRE WRAP SCREEN	267.0 - 232.0		0.020"
4" ID SS 304/304L Riser	232.0 - +2.00		
6" ID SS Monument	0.00 - +3.00		
	-		

Type	Interval Annual Seal/Filter Pack	*Volume	Mesh Size
Colorado Silica Sand	273.5 - 222.0	57.0 ft³	10-20
1/4" Bentonite Pellets	222.0 - 217.4	3.52 ft³	1/4"
Granular Bentonite Crumbles	217.4 - 10.3	116.7 ft³	
Portland Cement	10.3 - 0	3.82 ft³	N/A
	-		

OTHER ACTIVITIES

Aquifer Test: Drawdown / Recovery	Date: 11/2/01	Well Abandoned:	Yes:	No:	Date:
Description: Well development pumping, drawdown monitored with transducer.		Description:			

WELL SURVEY DATA

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

COMMENTS/REMARKS

* vol. calc. => 0.5454 ft³/ft / (~~0.535 ft³/bag~~ yield) = .ft³ [Ex: 0.5454 ft³/ft / (0.535 ft³/51 bags) = 51.99 ft³]

Reported By: C. TRICE / Jess Hocking		Reviewed By: DC Weekes	
Title: Geologist / Geologist	Date: 10/19/01	Title: Geologist	Date: 11/30/
Signature: C Trice / Jess Hocking		Signature: DC Weekes	

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WELL SUMMARY SHEET

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Date: 10/12/01

Well ID: C3398	Well Name: 299-W22-84
Location: East of 241-SX Tank Farm/200-W	Project: C401 RCRA Drilling
Prepared By: Jess Hocking Date: 11/5/01	Reviewed By: DC Weekes Date: 11/6/01
Signature: Jess Hocking	Signature: DC Weekes

CONSTRUCTION DATA

Description	Diagram
6" ID SS 304 Protective casing 4' above grade	
4" ID SS 304/304L Riser ~~Schedule~~ +2.00' → 232'	
4" ID SS 304/304L 0.020" CONT. Wire wrap Screen ~~Schedule~~ 232' → 267'	
4" ID SS 304/304L Sump ~~Schedule~~ 267' → 269.1'	
Colorado Silica Sand (10-20) 273.5' → 222.0'	
1/4" Bentonite Pellets 222.0' → 217.4'	
Granular Bentonite Crumbles 217.4' → 10.3'	
Portland Cement 10.3' → 0.00'	
All Temp. Casing removed from ground.	
Depths below ground surface	
NOT TO SCALE	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0'-1.0' Fill material
		1.0'-25.3' gravelly SAND (gS)
		25.3'-39.0' SAND (S)
40		39.0'-54.8' gravelly SAND (gS)
		54.8'-60.0' SAND (S)
		60.0'-70.0' slightly silty gravelly SAND
		70.0'-130.0' silty SAND (mS)
80		94.0'-94.5' clay lens
120		130.0'-148.0' SAND (S)
		148.0'-156.0' SILT (m) trace sand
160		156.0'-157.0' gravelly sandy SILT (gsm)
		157.0'-158.0' silty SAND (mS)
		158.0'-161.0' SAND (S)
		161.0'-180.0' silty SAND (mS)
		180.0'-250.0' silty sandy GRAVEL (msG)
200		GW TAGGED @ 232.36' bgs (11/2/01)

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WELL SUMMARY SHEET

Date: 10/17/01

Well ID: C3398	Well Name: 299-W22-84
Location: East of 241-S-A Tank Farm 200 W	Project: C401 RCRA DRILLING
Prepared By: C Martinez Date: 10/18/01	Reviewed By: DC Weekes Date: 11/6/01
Signature: C Martinez	Signature: DC Weekes

CONSTRUCTION DATA

Description	Diagram
Depths below Grand surface.	
All Temp. Casing removed from ground.	
NOT TO SCALE.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
240		
		250'-255.0' sandy SILT (sm)
		255.0'-265.0' silty gravelly SAND (mgs)
		265.0'-273.5' sandy GRAVEL (sG)
		TD@273.5' 10/19/01
280		Static water level at 232.36' (11/2/01)

WELL SURVEY DATA REPORT

ERC Project: 22192	**Prepared By:** Gary B. Wagner, P.L.S. **Company:** Rogers Surveying, Inc.
Date Requested: 11/19/01	**Requestor:**
Date of Survey: 12/05/01	**Surveyor:** Rogers Surveying, Inc.
ERC Point of Contact: Mr. Robert Bone	**Survey Co. Point of Contact:** Gary B. Wagner, P.L.S.
Description of Work: Civil surveying for eleven groundwater wells in 200W & 200E Areas.	**Horizontal Datum:** NAD83(91)
	Vertical Datum: NAVD88
	Units: Metric
	Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
HSWB-037 & GPS 31

Vertical Control Monuments:
HSWB-069 & WELL B8812

Well Name	Well ID	Easting	Northing	Elevation	
299-W22-84	C3398	566978.76	134547.62		**Center of Casing**
				208.510	**"X" on Rim**
		566978.76	134547.84	207.793	**Brass Cap**

Notes:

Surveyor Statement: *I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in December, 2001 under my direct supervision and that the data contained here is true and correct.*	**Certification Seal**

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BOREHOLE LOG

Page 1 of 10
Date: 10/01/01

Well ID: C 3398 | Well Name: 299-W22-84 | Location: East of 241-SY Tank Farm
Project: C-YOI RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
—	Drive Barrel	NA		0.0-1.0' Pad material	Cable tool method,
				1.0-25.3' Gravelly SAND - (gS)	
				gravel 25%, sand 75%, gravel 5% vcse,	
				10% cse, 50% med, 25% fn-vfn pebbles,	
				SAND - 10% silt, 50% vfn, 30% fn 10% med-cse.	4'- small cobble(s)
5 —	Archive			60% basalt, 40% qtz. 10YR5/6 (yishbrn) dry,	
				poorly sorted, SR-SA, weak rxn HCl	Archive @ 5'
				5'0- color change 10YR5/3 (brn), sand	
				blc 40-50% vfn-fn, 10% silt, 20% med, 20-30% cse-vcse.	
10 —	Archive				Archive @ 10'
15 —	Archive			~16.0' gravel pred. med-cse, SR 20%	Archive sx @ 15'
				gravel 15%. sand 85%. sand ~~20%~~ fcse,	
				~~60%~~ 60% med, 20% fn, tr silt.	
20 —	Archive				
					Archive sx @ 20'
25 —	Archive			25.3'-31'SAND(S)	Archive sx @ 25'
				30% vfn, 20% fn, ~~30%~~ 30% med, 10% cse, 10% vcse	
				10YR5/2 (grish brn), sl. moist, SA-SR, 60%-70%	
				basalt, 30-40% qtz, strong rxn with HCl.	

Reported By: C TRICE | Reviewed By: L. D. Walker
Title: Geologist-1 | Title: Geologist
Signature: C Trice | Date: 10/01/01 | Signature: L D Walker | Date: 11-8-01

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BOREHOLE LOG

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Date: 10/01/01

Well ID: C3398 | Well Name: 299-W22-84 | Location: E. of 241-SX Tank Farm
Project: CY01 RCRA Drilling | Reference Measuring Point: GS

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30	Drive Barrel	NA		sand - 10% vfn fn - 80% med 10% cse vcse, well sorted.	Black + white sand; 30' archive sx
35	Archive				35' Archive sx
40	Archive			39'-54.8' gravelly SAND (gS) gravel 40%. sand 60%. Gravel gravel 10% vcse, 20% csP, 40% med 20% fn 10 vfn sand: 10% fc, 20% fn 60% med, 10% cse vcse 70-80% basalt, 30-20% qtz. 10YR 6/2 (lt brn gray), moist, poorly sorted, SR-SA, max size: 3"x2"x2" strong rxn HCl.	40' archive sx 43' - large cobble Silt content ↑ to ~10%
45	Archive			45' gravelly SAND (gS) gravel 25%, sand 75%. Gravel 20% fn-vfn, 50% med-csc, 20% vcse, 10% small cobble. Sand: 20% vfn-fn, 40% med, 40% csc-vcse-10YR 6/2 (lt brnish gray), dry, poorly sorted, SA-SR, 60% basalt, 40% qtz. Max particle size: 1x2"x2", very weak rxn to HCl	45' archive sx
50	Archive			49' gravel up to 35%, sand 65%	50' archive sx
55	Archive			54.8'-60.0' SAND (S) 30% fn-vfn, 40% med., 30% csc-vcse 10YR 6/3 (pale brn), dry, 40% basalt, 60% qtz, SA, dry, weak rxn HCl.	55'-archive sx

Reported By: C. Trice | Title: Geologist | Signature: C. Trice | Date: 10/01/01
Reviewed By: L. D. Walker | Title: Geologist | Signature: L. D. Walker | Date: 11-8-01

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BOREHOLE LOG

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Date: 10/02/01

Well ID: C3398	Well Name: 299-W22-84	Location: E. of 241-SX tank farm
Project: C401 RCRA Drilling		Reference Measuring Point: GS

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
60	Cable Tool DIB	NA		60.0'–70' slightly silty gravelly sand (m) (gS) +/- 5% silt gravel 15%, sand 80%. gravel 10% vfn, 10% fn, 30% med, 30% cse 20% vcse. Sand: 30% vfn-fn, 40% med, 30% cse-vcse. Gravel: SR sand SA-SR. 10YR 6/3 (pale brn), 40% basalt, 60% qtz dry, poorly sorted, weak rxn. HCl.	
65	Archive			65' sand predom. med grained, several small cobbles. (basalt, t)	65' archive SX
70	Archive			70'–130' silty SAND (mS) 50% med, 30% fn, 10% vfn, 10% silt, 70% qtz, 30% basalt, 10YR 7/1 (lt gray), mod sorted – well sorted A, SA, weak rxn HCl	70' archive SX
75	Archive			75' moist	75' archive SX
80	Archive				80' archive SX
85	Archive				Grab 85' Archive

Reported By: C. RICE	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist
Signature: C. Rice Date: 10/02/01	Signature: L.D. Walker Date: 11/8/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 4 of 10
Date: 10/03/01

Well ID: C3398 | Well Name: 299-W22-84 | Location: E. of 241-SX tank farm
Project: CY01 RCRA Drilling | Reference Measuring Point: GS

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
90	DIB Archive	n/a		cont. silty SAND - med grained, see previous	Collected 90' archive sx
				94'-95' clay lens	Archive @ 94' sx
95	Archive				Collected 95' sx
100	Archive				Collected 100' sx
105	Archive				Collected 105' sx
110	Archive				Collected 110' sx
					E.O.S. 10/03/01
115	Archive				10/04/01 Collected 115 sx

Reported By: C. TRICE
Title: Geologist
Signature: C Trice Date: 10/03/01

Reviewed By: L. D. Walker
Title: Geologist
Signature: L D Walker Date: 11/8/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 5 of 10
Date: 10/04/01

Well ID: C3398 | Well Name: 299-W22-84 | Location: E of 241-SX Tank farm
Project: CY01 ACRA DRILLING | Reference Measuring Point: GS

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	DIB Archive	N/A		SILTY SAND CONTINUES, MOIST	Collect 120' archive
125	Archive				Collect 125' archive
130	Archive			130'-148' Sand predominately fn grained	Collect 130' archive
135	Archive				Collect 135' archive
140	Archive			~140 Sand - V. fine, well sorted Silt 50%, Sand 50%	Collect 140' archive
145	Archive			148 - 156' Silt: 95% M, 5% S; Silt % very high, v. well compacted, moisture clumping; Sand v. fine, v. well sort, moisture present, sub. rnd. Color: 7.5 YR 5/2 Brown.	Collect 145' archive

Reported By: C. Trice / Jess Hocking | Reviewed By: L.D. Walker
Title: Geologist / Geologist | Title: Geologist
Signature: C Trice / Jess Hocking | Date: 10/04/01 | Signature: D Walker | Date: 11-8-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 6 of 10
Date: 10-5-01

Well ID: C3398 | Well Name: 299-W22-84 | Location: EAST of 241-Sx Tank Farm
Project: RCRA DRILLING FY-02 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
150	DBS ARCHIVE	N/A			Archive / Grab sample taken @ 150'
				@ 153' Trace patches of oxidized iron found in silt clumps.	
155	ARCHIVE				Archive / Grab sample taken @ 155'
				156-157' Gravelly Sandy Silt: 40% S, 40% M, 20% G; Sand v. fine-fine, dry, v. well sort; Silt % decreases; Gravel % increases, irregular basalt chunks, ang. - sub. ang., highly weathered; Color: 7.5 YR 3/3 dark brown.	
160	ARCHIVE				Archive / Grab sample taken @ 160'
				157-158' SAND w/ Silt	E.O.S. 10/05/01
				157-158' Silty Sand: 70% S, 30% M; Sand fine-med., well sort, dry, rnd.; Silt % still decreasing; Gravel not present.	START 10/11/01 @ 1161'
165	ARCHIVE				1000 collect 165ft
				158'-161' Sand: 90% S, 5% M, 5% other: Sand same as above; Silt % very low; Several compacted chunks of caliché; color the same.	Archive/chip tray samples
170	Archive Hard Tool Bit			@ 159' 5% Gravel, 0% other; everything else the same; Gravel max size: sm. pebble, basalt.	Grab 170' Archive
				@ 161' - 180' silty SAND (mS) 85% sand, 15% silt, fa-sse, mod-sorted SR-SA, 60% felsics, 40% basalt, slight to no rxn HCl.	@ 170' change to hard tool bit.
				165 ft SAND w/ SILT, mod sand w/ silty calcarrous lenses mod sorted SR-SA - strong HCl reaction.	α, β, γ @ background OVM/CEL & detect.
175	Archive			170' Predominately sand; silt < 10% (sm) 15%	Grab 175' Archive (slurry)

Reported By: Jess Hocking / C. Martinez | Reviewed By: L.D. Walker
Title: Geologist / Geologist | Title: Geologist
Signature: Jess Hocking / C. Martinez | Date: 10/5/01 (10/11/01) | Signature: L.D. Walker | Date: 11-8-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 2 of 10
Date: 10/11/01

Well ID: C3398 | Well Name: 299-W22-84 | Location: East of 241-SX Tank Farm/200 W
Project: C401 RCRA Drilling | Reference Measuring Point: Ground surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
180	H&T Archive	N/A		180'– 250' silty sandy GRAVEL, 25% silt, 25% sand, 50% gravel. Sand, well-sorted, sb-sA, vf-med, 30% vf-fn, 70% med. Gravel, fragmented, max size unknown, 40% basalt, 60% felsics, 10YR 6/2 (wet) (gray), mod rxn HCl.	Using Hard tool bit. Grab 180' Archive.
185	Archive			10YR 6/3 (dry) Pale Brown	Grab 185' Archive
				185' slurry	α, β, γ @ background. OVM/LEL organics < detect (Am)
190	Archive			190' slurry. Same as 180' description. Based on washed sample. Gravel/Sand/Silt separated & examined.	Grab 190' Archive. Begin drum cuttings @ 191' bgs. (cm)
195	Archive			195' slurry. Same material	Grab 195' Archive. α, β, γ @ background (P.M. ck)
200	Archive			200' same as above	Grab 200' Archive. E.O.S 10/12/01
					Start 10/15/01
205	Archive				Grab 205' Archive. α, β, γ @ background.

Reported By: Charlene Martinez | Reviewed By: L. D. Walker
Title: Geologist | Title: Geologist
Signature: Charlene Martinez | Date: 10/15/01 | Signature: L D Walker | Date: 11-8-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 8 of 10
Date: 10/15/01

Well ID: C3398 | Well Name: 299-W22-84 | Location: East of 241-SX Tank Farm \ 200-W
Project: CY01 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
210	HIT Archive	n/a		210' ~~silty sandy gravel~~, 45% gravel, 30% sand, 25% silt. Sand, mod-sorted, SR-SA vf-cse, 20% vf-fn, 40% med, 40% cse. Fragmented gravel, max size unknown. 35% basalt, 65% felsics. 10YR 6/3 (dry) pale brown. No rxn HCl.	Grab 210' Archive using Hard Tool Bit
215	Archive			215' sample = slurry	Grab 215' Archive
220	Archive				Grab 220' Archive E.O.S. 10/15/01 Start 10/16/01 No A.M. RCT check DUMMEL <detect.
225	Archive	SPLIT spoon 100% rec.		225' (split spoon) silty, sandy Gravel. 70% gravel, 15% sand, 15% silt. Slight cementation. Gravel SR-A, poorly sorted 55% sm pebbles, 20% med, 15% lg, 10% sm cobbles. max size ≤ 65 mm. Sand vf-cse 50% vf-fn, 25% med, 25% cse, mod-sorted. SR-SA. overall color 2.5YR 6/2 light brownish gray. Gravel had white, non-calcereous coating, visible Fe staining. Some limonite colored veining (2.5Y 7/4 pale yellow). Also extensive pale red (10R 6/3) soil in sample other observed colors: 10R 5/3 pale red; 10R 5/3 weak red; 2.5Y 7/3 pale yellow; 2.5Y 8/3 pale yellow; 7.5YR 7/6 Reddish yellow; 7.5YR 8/1 white, 10YR 5/3 brown; 10YR 8/2	Grab 225' Archive Grab 226' G.W. sample. Split spoon 226'-237.5' Grab 230' Archive DUMMEL <detect. No p.m. RCT check End of shift @ 239' bgs 10/16/01
		n/a			
230	Archive				
235	Archive				

Reported By: Charlene Martinez | Reviewed By: L. D. Walker
Title: Geologist | Title: Geologist
Signature: Charlene Martinez | Date: 10/15/01 | Signature: L D Walker | Date: 11-8-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Date: 10/16/01

Well ID: c 3398 | Well Name: 299-W22-44 | Location: East of 241-SX Tank Farm/200 W

Project: C401 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Recovery Log	Graphic Log Blows Recovery	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	HLT Archive		oops! n/A	(ss desc. cont.) very pale brown; 6ley1 8/10Y greenish gray; 6ley1 8/1 white. no rxn HCl. Calcium sulfate ?? Felsic rich. @ 240' silty sandy gravel. Same as previous description (page 8). Slurry.	Start 10/17/01 Grab 240' Archive A.M. IH. OVM/LEL organics < detect. No A.M. RCT.
245	Archive			@ 245' Driller reports harder drilling.	Grab 245' Archive PM OVM/LEL < detect P.M. R, B, α, β background
250	Archive			250' – 255' Sandy SILT (SM). Gravel 5%, sand 40%, silt 55%. Sand vf-cse SR-SA mod-sorted, gravel fragmented. Sand 5% cse, 50% vf-fn, 45% med, no rxn HCl. 10YR6/3 pale brown. 35% basalt, 65% qtz (other)	Grab 250' Archive End of shift 10/17/01 Start 10/18/01
255	Archive			255' – 265' Silty Gravelly SAND (mgS) 15% silt, 30% gravel, 55% sand. 40-50% basalt, 50-60% qtz (other) sand, poorly sorted, SR-SA	Grab 255' Archive
260	Archive				Grab 260' Archive OVM/LEL < detect. R, B, α background
265	Archive		Split spoon 10% rec.	265' – 273.5 Sandy GRAVEL (sG) 10% silt, 35% sand, 55% gravel. Gravel max size = 5m cobbles. R-SA, poorly sorted. Sand, mod-sorted fn-cse. SR-SA. 25% basalt, 75% qtz (other) 2.5YR 6/2 light brownish gray (dry) sample wet. No rxn HCl. smpbk = 20%, med = 10%	Grab 265' Archive "No fingers" were in ss tube. most material fell out. lg = 40%, sm cobb 30%

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 10/17/01

Reviewed By: L. D. Walker | Title: Geologist | Signature: L D Walker | Date: 11/8/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 10 of 10
Date: 10/18/01

Well ID: C3398 | Well Name: 299-W22-84 | Location: East of 241-SX Tank Farm \ 200 W
Project: CY01 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Graphic Log ~~Blows Recovery~~	~~Graphic Log~~ Blows Recovery	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
270	HT Archive		NA	270' Sandy Gravel Same as previous description (page 9)	Grab 270' Archive using hard tool bit
	Archive				273' Grab ~~275'~~ Archive
275		CW 11-8-01		TD = 273.5'	Using hard tool bit collect GW Slurry Sx from 273' bgs.

Reported By: C. TRICE | Title: Geologist | Signature: C Trice | Date: 10/19/01
Reviewed By: L. D. Walker | Title: Geologist | Signature: LD Walker | Date: 11/8/01

BHI-EE-183 (12/97)

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 09/21/01
Finish Date: 10/26/01
Page 1 of 1

Specification No.: 0200X-SP-V0004	Rev. No.: 0	Well Name: 299-E22-85	Temp. Well No.: C3399
ECNs: NA	R037815 Start card	Approximate Location: SE side of S-SX Tank Farm	
Project: C401 RCRA Drilling		Other Companies: BHI, CHI, ASI	
Drilling Company: Resonant (FEI) Sonic Inc.		Geologist(s): C. Martinez, D.S. Watson, J. Wimett, G. Thomas, C. Trice, DC Weekes	
Driller: Kelly Olson / Gary Howell ("Howie") (1930)			

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
Carbon Steel FS 11 3/4"/10 3/4"	0' - 258.9'	12 1/4" / 11"
	-	
	-	
	-	
	-	

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

DRILLING METHOD/HOLE DIAMETER

Auger:	Diameter From ____ to ____
Cable Tool: 11 3/4" OD	Diameter From 0' to 260.1'
Air Rotary:	Diameter From ____ to ____
A.R. w/Sonic:	Diameter From ____ to ____
	Diameter From ____ to ____
	Diameter From ____ to ____
	Diameter From ____ to ____

Bit = drive barrel w/ 9 1/4" OD 0-176' bgs
Hard tool 176' - 260' bgs
Drilling Fluid: N/A

Total Drilled Depth: 260.1' | Hole Dia @ TD: 12"
Total Amt. Of Water Added During Drilling: ——
Well Straightness Test Results: Passed using 20.4'; 8.5" OD
Static Water Level: 218.42' | Date: 10/26/01
Straightness tool: 10/19/01

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	2' - 260'	10/01/01		-	
Neutron Moisture	0' - 222.75'	10/01/01		-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annual Seal/Filter Pack	Volume	Mesh Size
4" ID SS304L sump	252.03' - 259.13'	FJ80	N/A	Colorado Silica Sand (50#)	206.8' - 252.5'	102.5 bags	10-20
4" ID SS304L screen	217.12' - 252.03'	"	0.020"	Bentonite Pellets (50#)	202.1' - 206.8'	5 buckets	1/4"
4" ID SS304L casing	+2.00' - 217.12'	"	N/A	Bentonite Crumbles (50#)	10.1' - 202.1'	195 bags	N/A
	-			Portland Cement (94#)	0' - 10.1'	95 bags	N/A
	-				-		

OTHER ACTIVITIES

Aquifer Test: well development	Date: 10/29/01	Well Abandoned:	Yes:	No:	Date:
Description: Used 3Hp submersible pump w/intake @ 250.53' bgs. withdrew H2O for 57 min. @ 30 gpm & drawdown of 11.58'. 2nd test 68 min. w/drawdown 11.314'. 30 gpm		Description:			
10/30/01 intake @ 234.53' bgs. withdrew H2O for 36 min. @ 30 gpm; drawdown 9.34'					

WELL SURVEY DATA

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

COMMENTS/REMARKS

Vol. calcs: silica sand, 102.5 bags * 0.535 ft³/bag = 54.84 ft³; bent. pellets, 5 buckets * 0.62 ft³/bucket = 3.1 ft³; bent. crumbles, 195 bags * 0.71 ft³/bag = 138.45 ft³; portland cement = 9.5 bags * 1.385 ft³/bag = 13.21 ft³

Reported By: Charlene Martinez		Reviewed By: Jess Hocking	
Title: Geologist	Date: 10/26/01	Title: Geologist	Date: 11/5/01
Signature: Charlene Martinez		Signature: Jess Hocking	

BHI-EE-181 (12/97)

WELL SUMMARY SHEET

Page 1 of 2

Date: 09/27/01

Well ID: C 3899	Well Name: 299-W22-85
Location: SE side of S-SX Tank Farm/200 W	Project: C401 RCRA Drilling
Prepared By: C. Martinez	Date: 09/27/01
Reviewed By: Jess Hocking	Date: 11/5/01
Signature: C. Martinez 10/22/01	Signature: Jess Hocking

CONSTRUCTION DATA

Description	Diagram
6" ID (6" dia. protective casing set 1.00' above stainless casing	
4" ID SS304L casing: +2.00' → 217.12'	
Portland Cement grout: 0' → 10.1'	
Bentonite crumbles: 10.1' → 202.1'	
1/4" Bentonite pellets: 202.1' → 206.8'	
4" ID SS304L 0.030-in. slot cont. wire-wrap wellscreen: 217.12' → 252.03'	
10-20 mesh silica sand: 206.8' → 257.5'	
4" ID SS304L tailpipe: 252.03' → 254.13'	
muddy backfill: 257.5' → 260.1	
All temporary casing removed:	
All depths are in feet below ground surface.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0'-5' Backfill material
		5'-17' Sand (s) (silt lens @ 16')
		17'-26' sandy SILT (sM)
		26'-32' SAND (s)
		32'-45' silty SAND (mS) (silt lens @ 35')
40		45'-47' sandy GRAVEL (sG)
		47'-54' silty sandy GRAVEL (msG)
		54'-57' SAND (s)
		57'-65' silty (SAND) (s) (silt lens @ 60')
		65'-70' SAND (s) (silt lens @ 66')
80		70'-85' (100') silty SAND (s) silt lens @ 86' sand lens @ 95'
		100'-104' SAND (s)
		104'-130' silty SAND (mS)
120		130'-140' SILT (m)
		140'-143' sandy SILT (sM)
		143'-149' SILT (m)
		149'-151' sandy SILT (sM)
160		151'-153' SILT (m)
		153'-155' CALICHE
		155'-162' silty sandy GRAVEL (msG)
		162'-168' silty gravelly SAND (mgS)
		168'-174' SAND (s)
200		174'-180' sandy GRAVEL (sG)
		180'-235' silty sandy GRAVEL (msG)

BHI-EE-189 (12/97)

WELL SUMMARY SHEET

Page 2 of 2

Date: 10/08/01

Well ID: C3399	Well Name: 299-W22-85
Location: SE Side of S-SX Tank Farm \ 200 W	Project: CY01 RCRA Drilling
Prepared By: C. Martinez Date: 10/08/01	Reviewed By: Jess Hocking Date: 11/5/01
Signature: C. Martinez	Signature: Jess Hocking

CONSTRUCTION DATA

Description	Diagram
All temporary casing removed.	
All depths are in feet below ground surface.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
240		235'-255' gravelly silty SAND(gmS)
		255'-260.1' silty sandy GRAVEL(msG)
280		TD = 260.1' bgs
		static water level = 218.42' bgs (10/26/01)
320		

BHI-EE-189 (12/97)

WELL SURVEY DATA REPORT

ERC Project: 22192	**Prepared By:** Gary B. Wagner, P.L.S. **Company:** Rogers Surveying, Inc.
Date Requested: 11/19/01	**Requestor:**
Date of Survey: 12/05/01	**Surveyor:** Rogers Surveying, Inc.
ERC Point of Contact: Mr. Robert Bone	**Survey Co. Point of Contact:** Gary B. Wagner, P.L.S.
Description of Work: Civil surveying for eleven groundwater wells in 200W & 200E Areas.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Metric **Hanford Area Designation:** 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
HSWB-037 & GPS 31

Vertical Control Monuments:
HSWB-069 & WELL B8813

Well Name	Well ID	Easting	Northing	Elevation	
299-W22-85	C3399	566902.90	134260.58		**Center of Casing**
				204.409	**"X" on Rim**
		566902.88	134260.87	203.682	**Brass Cap**

Notes:

Surveyor Statement: *I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in December, 2001 under my direct supervision and that the data contained here is true and correct.*	**Certification Seal**

BHI-EE-202 (09/98)

BOREHOLE LOG

Page 1 of 9
Date:

Well ID: C3399 | Well Name: 299-W22-85 | Location: SE corner of S-SX Tank Farm/200 W
Project: CTUIR ERRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0	Cable Tool Drive Barrel	N/A		0'-5' Backfill material. silty Sandy Gravel	Cable tool drive barrel 9 1/4" | 8 5/8" bit
5	Archive			5'-17' Sand (s) 95% sand, 5% gravel fn-vcse sand, SR, mod sorted, 70% bas, 30% felsics. Gravel, max size = 5cm med pebbles SR. 10YR 4/1 (dark gray) no rxn HCl. Sand 20% cse, 30% med, 50% fine.	Grab 5' Archive
10	Archive			@ 10' sand vf-m, well sorted, SR, Basalt 30%, felsics 70%. strong rxn HCl. 10YR5/2 (grayish brown)	Grab 10' Archive. 10'-14.5' sporadic silt lenses. laminer bedding 10YR6/3 (pale brown) strong rxn HCl
15	Archive			@ 12' silt ~ 5% @ 15' sand 60% v cse-cse, 30% med, 10% fine. 80% bas. 20% felsics. No rxn HCl. @ 16' silt lenses	Grab 15' Archive
20	Archive			17'-26' sandy SILT (sM) 55% silt, 45% sand. Bas 35%, Felsics 65%. Sand vf-f, very well sorted. SR, micaceous, no rxn Hcl. Silt - strong rxn HCl. 10YR5/2 light grayish brown	Grab 20' Archive.
25	Archive			25'-32.0' Sand (s) 95% sand, 5% silt 60% basalt, 40% felsics, 45% vcse - cse, 40% med, 15% fine., SA, poorly sorted 7.5 YR 5/1 gray. no to slight rxn HCl.	Grab 25' Archive. 0 VM/LEL < detect. All samples Am α, β, γ @ background

Reported By: Charlene Martinez		Reviewed By: Jess Hocking	
Title: Geologist		Title: Geologist	
Signature: Charlene Martinez	Date: 09/21/01	Signature: Jess Hocking	Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 2 of 9
Date: 09/21/01

Well ID: c3399 | Well Name: 299-W22-85 | Location: S.E. corner of S-SX Tank Farm Zone W
Project: C101 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30	D/B Archive	N/A		@ 30' sand mod sorted, sse-vcse 25% coarse, med 35%, f-vf 40% basalt 65% felsics 35% 7.5 YR 5/1 gray. No rxn HCl. Silt content increasing	Grab 30' Archive. All samples in Pm α, β, γ @ background
35	Archive			35'-45' Silty Sand (mS) 15% silt, 85% sand. 75% vf-fn, 25% med, well sorted, SR-R, 60% felsics, 40% basalt 10 YR 6/2 light brownish gray	Grab 35' Archive. Silt lens @ 35. E.O.S. 09/21/01. Start 09/24/01
40	Archive			@ 35' silt lens. 10 YR 6/2, strong rxn HCl	Grab 40' Archive
				@ 40' clastic dyke. Fragmented quartzite. calcareous coating. Basalt rich sand, 75% bas, 25% felsics, poorly sorted, SR-SA	Rock > 6"
45	Archive			Sand no rxn HCl.	Grab 45' Archive. OVM/LEL < detect (Ambient)
				45'-47' Sandy GRAVEL (sG) 45% sand, 55% gravel. Sand, SA, poorly sorted, 5% fine, 55% vcse-cse, 45% med. Gravel, SR-SA,	@ 48' → hard drilling, no returns.
50	Archive			mod sorted, 75% small pebbles, 15% med, 10% lg pebbles. Trace cobbles. max size < 90 mm 7.5 YR 5/1 gray no rxn HCl 35% basalt, 65% qtz (other)	Grab 50' Archive 35'-50' α, β, γ @ background. Downgraded to low risk
				@ 48' silty sand, vf-fn sand, felsic rich strong rxn HCl very well sorted, F, 10 YR 6/3 pale brown	
55	Archive			47'-54' Silty Sandy GRAVEL (msG) 15% silt, 35% sand, 45% gravel. Sand, vf-vcse, SA, poorly sorted, 25% vf-fn, 40% med, 35% vcse,	Grab Archive @ 55' OVM/LEL < detect. 56' Rock > 8" x 5" (basalt)

Reported By: Charlene Martinez | Reviewed By: Jess Hocking
Title: Geologist | Title: Geologist
Signature: Charlene Martinez | Date: 09/21/01 | Signature: Jess Hocking | Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 3 of 9

Date: 09/24/01

Well ID: C3399 | Well Name: 299-W22-85 | Location: SE side of S-SX tank farm/200W

Project: CY 01 RCRA Drilling | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
60	D/B Archive	N/A		@ 47' (cont.) gravel, SR-A, poorly sorted, max size = 75 mm; 60% sm pebbles; 20% med, 15% lg; 5% sm. cobbles. 40% bas/60% fels. 10YR 5/2 grayish brown. Strong rxn HCl. @ 51' silt decreasing to 10%, gravel 45%, sand 25%.	Grab 60' Archive silt lens @ 60'
65	Archive				Grab Archive @ 65' 10YR 4/3 (Pale Brown) silt lens @ 66'
			No returns	@ 54' — 57' Sand (S) SR-SA, mod sorted, 10% fn, 35% med, 55% cse-vcse micaceous 40% bas, 60% felsics, no rxn HCl. 5Y 7/1 light gray @ 52' gravel 5%, silt nodules, sand 95%	trace caliche Strong rxn HCl
70	Archive			57' - 65' silty SAND (mS) 20% silt, 80% sand, 35% basalt, 65% felsics, SA poorly sorted 15% fn, 35% med, 50% cse. 10YR 6/2 light brownish gray. Strong rxn HCl @ 62-65' silt 5% decreases to 8-10%. @ 60' silt lens 10YR 6/2 strong rxn HCl	Grab 70' Archive
75	Archive				Grab 75' Archive a, B, BG background OVM/HEL 2 detect. (P.M. cks)
80	Archive			65'-70' Sand (S) 5% silt 95% sand SA poorly sorted 15% cse-vcse, 60% med, 25% fn. 5Y 6/2 gray. 75% felsics, 25% basalt. no rxn HCl.	Grab 80' Archive
85	Archive			70' - 85' silty SAND (mS) 40% silt, 60% sand (SR) vf-fn, well sorted @ 70', gradual gradation to cse-vcse, poorly sorted, SA between 73'-75', sequence repeated from 75'-85'. Light brownish gray. Strong rxn HCl. 85'-86' Sand (S). same desc as 54'-57'	Grab 85' Archive @ 86' silt lens. Apparent laminar bedding 10YR6/ E.O.S. 09/25/01

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 09/25/01

Reviewed By: Jess Hocking | Title: Geologist | Signature: Jess Hocking | Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

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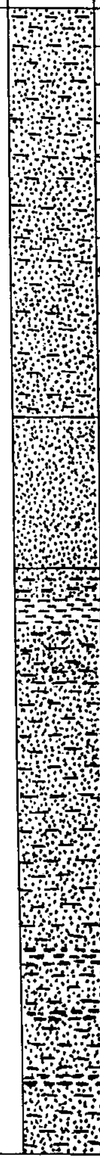
Date: 09/26/01

Well ID: C3399	Well Name: 299-W22-85	Location: S.E. side of S-SX Tank Farm/200 W
Project: CY 01 RCRA Drilling		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample: Type No.	Sample: Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
90	DIB Archive	n/a		86'-86.5' silt lens 95% silt, 5% sand	Grab 90' Archive
				silt. laminar bedding. sand, vf-fn, well	
				sorted, non-basaltic. 10YR 6/3 (Pale Brown)	
				Strong rxn HCl.	
95	Archive			86.5'-100' Silty SAND (mS) Same description	Grab 95' Archive
				as 70'-85' sequence.	
				@ 94' silt lens, well laminated, non	
				basaltic 10YR 6/3, pale brown. Strong rxn HCl.	
100	Archive			100'-104' SAND (S) vf-m, well sorted	Grab 100' Archive
				SR, 60% vf-fn, 40% med, 70% Felsics	A.m. α, β, γ @ background
				30% basalt. No rxn HCl. 2.5Y 6/2 light	LEL/ovm/organics <
				brownish gray.	detect.
105	Archive			104'-130' silty sand (mS) 45% silt, 55%	
				sand, SR, well sorted vf-fn, <10% med	Grab 105' Archive
				(micaceous) grains, felsic rich 20% basalt, light	silt lens @ 105'
				brownish gray 10YR 6/2. Strong rxn HCl.	P.M. α, β, γ @ background
				@ 105' silt lens. Apparent laminar	
110	Archive			bedding. Felsic rich 10YR 6/3, pale brown	Grab 110' Archive
				Strong rxn HCl.	
				silt lens appearing sporadically	
				from 114'-118'. Some fine grained	
				sand interbbed in the laminated layers.	
115	Archive			Visible Fe staining. Strong rxn HCl,	Grab 115' Archive
				non-basaltic, 10YR 6/3 pale brown.	

Reported By: Charlene Martinez		Reviewed By: Jess Hocking	
Title: Geologist		Title: Geologist	
Signature: Charlene Martinez	Date: 09/26/01	Signature: Jess Hocking	Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 5 of 9
Date: 09/26/01

Well ID: C3399 | Well Name: 299-W22-85 | Location: S.E. Side of S-SX Tank Farm/200 W

Project: CY01 RCRA Drilling | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample: Type No.	Sample: Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	D/B Archive	n/A		120' Silty sand continuing from 104' (page 4)	Grab 120' Archive
125	Archive				Grab 125' Archive E.O.S. 09/26/01
					Start 09/27/01
130	Archive			130'-140' silt (m) 100%, non-plastic, very dense unit with some consolidation. Visible Fe staining and there is laminated bedding. nonbasaltic, 10YR 6/3, pale brown. Strong rxn HCl	Grab 130' Archive Am α, β, γ @ background OVM/LEL/organ < detect.
135	Archive			@135' 95% silt, 5% sand, few gray shale fragments. Strong rxn HCl.	Grab 135' Archive (shale fragments in silt) very hard drilling
140	Archive			140'-143' sandy SILT (sM) 10% sand, 90% silt. vf-fn, SR-R, well-sorted 10YR 6/3 pale brown, strong rxn HCl.	Grab 140' Archive Am α, β, γ @ background OVM/LEL < detect
				143'-149' SILT (m) 95% silt, <5% sand, dense unit, Fe staining, felsic rich, 10YR 6/3 pale brown, strong rxn HCl.	Grab 145' Archive
145	Archive				

Reported By: Charlene Martinez | Reviewed By: Jess Hocking

Title: Geologist | Title: Geologist

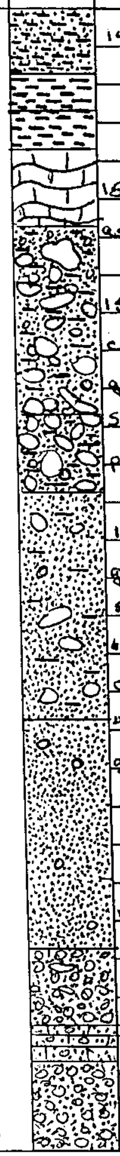
Signature: Charlene Martinez | Date: 09/27/01 | Signature: Jess Hocking | Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 6 of 9
Date: 09/27/01

Well ID: C3399
Well Name: 299-W22-85
Location: S.E side of S-SX Tank Farm\200 W
Project: CY01 RCRA Drilling
Reference Measuring Point: Ground Surface



Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments: (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
150	D/B Archive	n/A	149'-151' sandy SILT (sM) similar to	Grab Archive@150'
			140' interval, except sand 25%,	E.O.S. 09/27/01
			silt 75%.	
				Start 09/28/01
			161'-153' SILT (m). Same description	α, β, γ @ background (A.M.)
155	Archive		as page 5 (143'-149' interval)	Grab 155' Archive
				Top of Ringold@155'
			153'-155' Caliche. very fine grained unit;	Cobble 8"x6"x4"
			calcareous; coating on poorly sorted SR-SA	
			gravel interbedded with a very densely compacted silt.	
160	Archive		Some consolidation. Iron staining. 7.5YR 8/2	Grab 160' Archive
			pinkish white. Strong rxn HCl.	
			155'-162' silty sandy GRAVEL (msG) 55%	
			gravel, 30% sand, 15% silt. Sand, mod sorted	
165	Archive		SR-SA, 70% fn, 15% med, 15% cse, gravel,	Grab 165 Archive
			45% sm pebbles, 5% med, 10% lg, 20%	α, β, γ @ background
			cobbles. Poorly sorted, SR-SA, 60% basalt,	
			40% felsics. Strong rxn HCl. 10YR 5/2	
			grayish brown.	
170	Archive			Grab 170' Archive
	End of Drive Barrel		162'-168' silty gravelly SAND (mgS) 8%	Em. OVM/LEL/organics
			silt, 82% (Em) sand, 10% gravel. Sand SA-A,	< detect.
			mod sorted, gravel, poorly sorted. Cobbles	
			≤4" Felsic Rich, micaceous, 10YR 5/3	
175	Archive		Brown. No rxn HCl.	Grab 175' Archive
	H T			E.O.S. 09/28/01
	Hard Tool Bit		168'-174' Sand (S) vf-m, well sorted	
			SR, 25% basalt, 25% felsics, 10YR 6/2	Start 10/01/01
			light brownish gray. No rxn HCl. trace gravel	micaceous

Reported By: Charlene Martinez
Title: Geologist
Signature: Charlene Martinez
Date: 09/28/01

Reviewed By: Jess Hocking
Title: Geologist
Signature: Jess Hocking
Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

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Date: 09128101

Well ID: C3399 | Well Name: 299-W22-85 | Location: SE Side of S-SX Tank Farm/200W
Project: C401 RCRA Drilling | Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
180	HT Archive	n/a		174'-180' sandy GRAVEL (sG) 55% gravel, 40% sand, 5% silt. Sand SR-SA, mod-sorted, gravel SR-A, poorly sorted, 55% to sm pebbles, 20% med, 15% lg pebbles, 10% cobbles. Max size = cobble 6.5"x6"x3". 40% basalt, 60% felsics. 10YR6/2 light brownish gray, no rxn HCl. @175' (end) sG is cemented.	175'- drilling is extremely hard using drive barrel. Getting no returns @176' A.M. of B.Z. @ background OVM/LEL < detect. 180'-GRAB SAMPLE
185	Archive				
190	Archive			180'→235' SILTY SANDY GRAVEL (msG) 5% gravel, 40% SAND, 10% SILT. SAND: SR-SA, MOD. SORTED, 45% BASALT, NO RXN HCL; GRAVEL: SR-A, POORLY SORTED, HIGHLY FRAGMENTED DUE TO HARD TOOL USE, 40% BASALT; 10YR 6/2 LT. BROWNISH GRAY.	CABLE TOOL/HARD TOOL BIT Grnd, B.Z- BKGRND. OVM/LEL < DETECT HT @ 176' Grab 185 Archive A.M. of B.Z @ background Grab 190' Archive Grab 195' Archive E.O.S. 10/02/01
195	Archive				
200	Archive			200' silty sandy GRAVEL (msG). G-35%, S-40%, M-25%. Gravel 40%-M, 50%f, 5%vf pebbles. Max size 20mm subrounded. All other gravels broken and subAngular. Gravel content 20% basalt 65% Metamorphic (Quartzite) (coarse, red, clear, white) and 15% Granite. Sand - 15% vc, 25% c, 45% m, 15% f-vf. Sand = 75% Quartzite, 15% Basalt, 10% Granite. Sand is subangular. Color 2.5Y 4/2 Dark grayish brown. 205' decreasing Gravel & increasing Sand.	200'-Grab Sample 201'-Rad & IH Survey background/undetect
205	Archive				205'-Grab Sample 205'-Rad & IH Survey background/undetect

Reported By: Charlene Martinez/Greg Thomas | Reviewed By: Jess Hocking
Title: Geologist | Title: Geologist
Signature: Charlene Martinez Greg Thomas | Date: 10/01/01 | Signature: Jess Hocking | Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 8 of 9
Date: 10/04/01

Well ID: C3399 | Well Name: 299-W22-85 | Location: SE side of S-SX Tank Farm/200W
Project: CY01 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
210	HT Archive	N/A		210' Silty Sandy GRAVEL (msG) G-45%, S-40% M-15%. Gravel 1%C, 40%M, 57%f, 2Vf pebbles.	210' - Grab Sample
				All gravels broken and subangular. Gravel content Approx 20% basalt. Sand same as 200' description.	IH & Rad survey - Nondetect / Background
				Color 10YR 2/2 Dark grayish brown.	
215	Archive			215' Silty Sandy GRAVEL (msG). G-45% S-33%, M-22%.	
					Tagged H_2O @ 218.42' (10/26/01) bgs
					220' GW Sample
220				220.5'-222' Silty Sandy GRAVEL (msG). G-50%,	220.5'-222 Split Spoon
	Split Spoon	60% rec.		S-30%, M-20%. Gravel 35% small cobbles and V. cs pebbles,	
		N/A		25% cP, 18% mP, 22% f & vfp. Max size 9" diameter.	
				60% Quartzite, 30% Basalt & 10% other. Sand 25% vc,	
225				25% c, 35% m & 15% f-vf. Sand is 70% Quartzite,	
				25% Basalt & 5% other. Sand is angular to subrounded.	
	Archive			Color varies overall 10YR 5/2 (grayish brown) however	
				10YR 8/6 & 8/1 for Quartzite sands surrounding cobbles or VCP.	227' - Grab Sample
				Also 10R 3/6 next to some cobbles & VCP in silty sand matrix.	
				Also 10YR 2/1 and chart 1 for Gley 1 5/2 (pale green).	
230	Archive			Sediments - Moist however no free water present.	IH & RCT Survey Nondetect / background
				227' Silty Sandy Gravel - G-35% S-45% M 20%	
				230' Silty Sandy Gravel - G-35%, S-40%, M-25%	230' - Grab Sample
235	Archive			235'-255' Gravelly Silty Sand (gmS). S-55%	235'-Grab sample
				M-25%, G-20%. Gravel is angular and	
				broken with size from med - vf.	

Reported By: Greg Thomas | Title: Geologist | Signature: Greg Thomas | Date: 10/04/01

Reviewed By: Jess Hocking | Title: Geologist | Signature: Jess Hocking | Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 9 of 9	Date: 10/08/01

Well ID: C3399	Well Name: 299-W22-85	Location: S.E. side of S-SX Tank Farm / 200 W
Project: C401 RCRA Drilling		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample: Type No.	Sample: Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	H/T	n/A			
240	Archive	↓		Gravelly silty sand (gmS) sand 45%, silt	Grab 240' Archive
	↓			25%, gravel 30%. Sand, mod-sorted	
				vf-cse, SR-SA, Gravel, fragmented; Angular	
				10YR 5/2 grayish brown (dry sample)	
				no rxn HCl.	
245	Archive				Grab 245' Archive
	↓				
					α, β, γ @ background
					ovm/LEL/organics <
					detect.
250	Archive				Grab 250' Archive
	↓				
					E.O.S. 10/08/01
				255' - 260.1' silty sandy GRAVEL (msG)	
255	Archive	↓		@ 255' sand 40%, gravel 40%, silt 20%.	Grab 255' Archive
	2nd split spoon	90% rec.		sand 40% basalt, 60% felsics, fn-cse, SR-	split spoon 255-257.5'
				SA, poorly sorted. Gravel, max size = 25mm	90% rec.
		n/A		sm cobble, poorly sorted SR-A, some frag-	α, β, γ @ background
				mentation. No rxn HCl. Extensive Fe	ovm/LEL/organics
260	Archive	↓		staining @ 257'-257.5' (end of split spoon	< detectable.
				interval) overall color 10YR 6/3 Pale Brown	Grab 260' Archive
				other observed colors: 5Y 7/4 pale yellow	
				2.5 YR 8/2 Pinkish white; Gley1 8/N	
				white. @ 257' color changed to 2.5YR 3/2	TD = 260.1' bgs
265				dusky red. Remained that color to end of	
				split spoon.	

Reported By: Charlene Martinez		Reviewed By: Jess Hocking
Title: Geologist		Title: Geologist
Signature: Charlene Martinez	Date: 10/08/01	Signature: Jess Hocking / Date: 11/5/01

BHI-EE-183 (12/97)

Appendix B

Physical and Chemical Properties Data

Appendix B

Physical and Chemical Properties Data

This appendix includes the results of testing for particle size distribution on split spoon samples from the wells 299-W22-84 and 299-W22-85. The analyses were done by CH2M HILL Hanford, Inc. using standard sieve techniques.

This appendix also contains the results of testing for technetium-99, uranium-238, and metals. Technetium and uranium were measured by inductively coupled plasma – mass spectrometry and metals by inductively coupled plasma – atomic emission spectrometry. All samples were acidified with 2% HNO_3 and analyzed according to standard operating procedures in laboratories at Pacific Northwest National Laboratory.

Table B.1. Electrical Conductivity and pH in Wells 299-W22-84 and 299-W22-85

Well Name and Depth (ft)	pH	EC (mS/cm)
299-W22-84		
226	7.76	0.327
273	7.68	0.306
299-W22-85		
220	7.69	0.341
260	7.71	0.244

Table B.2. Metals in Samples from Wells 299-W22-84 and 299-W22-85

Well Name and Depth (ft)	Al 394.4[(a)] <125[(b)]	As 193.7 <125	B 249.7 <125	Ba 455.4 <25	Ca Rad 393.7 <50	Cd 228.8 <25	Co 228.6 <25	Cr 267.7 <30	Cu 324.8 <50	Fe 274.0 <50
299-W22-84										
226	<125	<125	(44)	46	17873	<25	(2)	(10)	(1)	320
273	<125	(30)	(50)	34	15112	<25	(3)	(1)	(2)	(21)
299-W22-85										
220	(1)	(37)	(41)	36	16234	<25	(1)	<30	(1)	<50
260	<125	(32)	(43)	39	15707	<25	(3)	<30	<50	<50

Well Name and Depth (ft)	K Rad 766 <12500	Mg Rad 279.6 <50	Mn 294.9 <113	Mo 204.6 <25	Ni 231.6 <50	Sr Rad 407.8 <50	Zn 213.9 <25	Na Rad 589.6 <2500	S 182.6 <2500	Ti 334.9 <2500	Zr 343.8 <125
299-W22-84											
226	5787	5786	(51)	101	(2)	91	(5)	33547	15606	<125	<125
273	4878	5159	(82)	85	(1)	65	(6)	36257	13098	<125	<125
299-W22-85											
220	5774	5020	(53)	45	(1)	76	27	38811	17580	<125	<125
260	4063	5162	(89)	99	<50	64	(6)	22390	7904	<125	<125

All concentrations are reported in µg/L (ppb).
(a) Wavelength.
(b) Lower limit of quantification.

Table B.3. Technetium-99 and Uranium-238 in Samples from Wells 299-W22-84 and 299-W22-85

Well Name and Depth (ft)	Tc-99[(a)] <0.05[(b)] µg/L	U-238 <0.025 µg/L
299-W22-84		
226	(0.004)	1.13
273	(0.004)	0.331
299-W22-85		
220	(0.005)	1.33
260	(0.005)	0.456

(a) Isotope of choice.
(b) Lower limit of quantification.

Table B.4. Anions in Samples from Wells 299-W22-84 and 299-W22-85

Well Name and Depth (ft)	Fluoride	Chloride	Nitrite	Bromide	Nitrate	Sulfate	Phosphate	Carbonate
299-W22-84								
226	1.34	11.67	<1.00	<1.00	1.43	47.36	<1.50	77.24
273	3.24	15.32	<1.00	<1.00	<1.00	40.42	<1.50	74.67
299-W22-85								
220	1.50	17.14	<1.00	<1.00	1.62	57.18	<1.50	73.88
260	1.17	5.62	<1.00	<1.00	<1.00	24.08	<1.50	83.45

Note: All concentrations reported in parts per million (ppm).

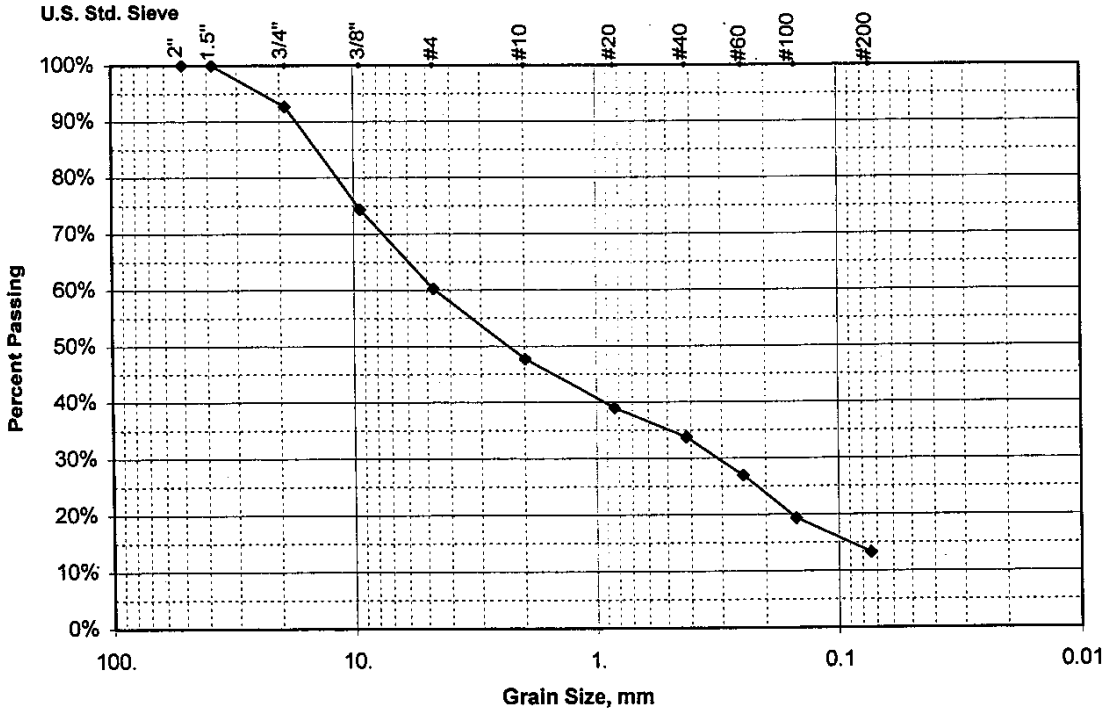
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W14-18	DEPTH	222.0'-224.0'	SAMPLE#	W14-18-222.0	WELL ID#	C3396
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	11/02/2001

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
985.80	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	71.9	7.3	92.7	19.05	
	3/8"	252.5	25.6	74.4	9.42	
	#4	392.3	39.8	60.2	4.70	
	#10	516.0	52.3	47.7	1.98	
	#20	601.6	61.0	39.0	0.83	
	#40	652.7	66.2	33.8	0.42	
	#60	720.8	73.1	26.9	0.25	
	#100	795.2	80.7	19.3	0.150	
	#200	854.6	86.7	13.3	0.074	

Sieve Analysis Data for Sample W14-18-222.0



Comments: Silty Sandy Gravel

All data are accurately and completely recorded.

Checked By: JMWeekes JCWeekes Date: 11/2/01

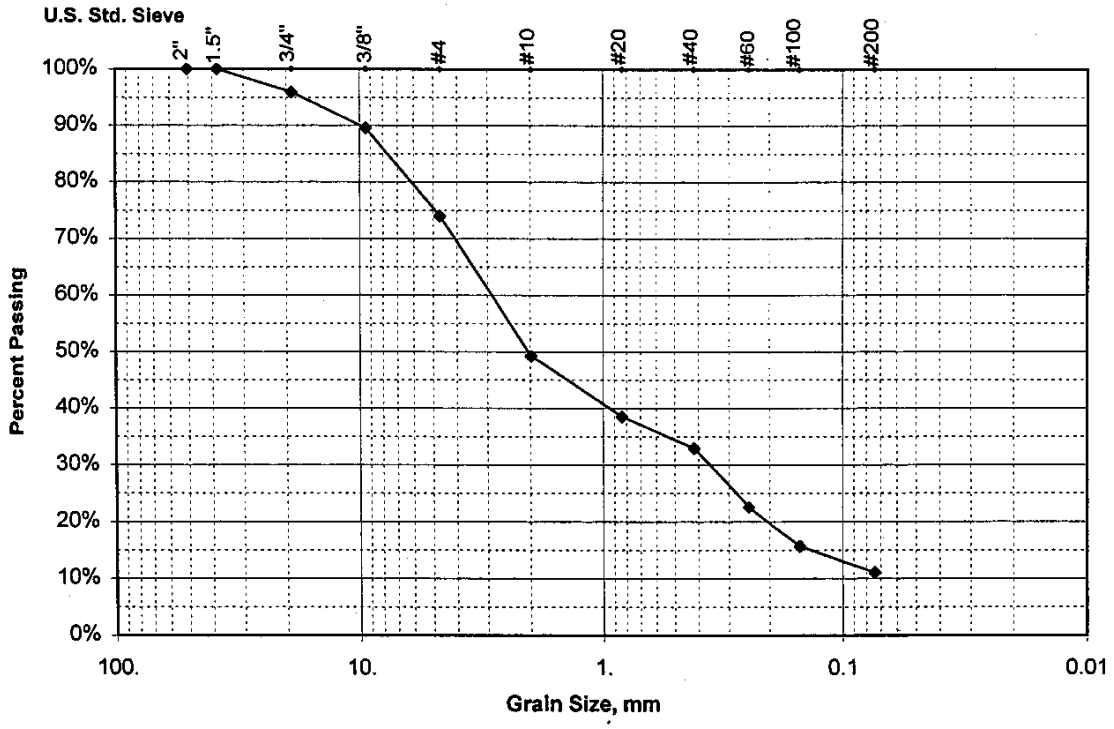
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W14-18	DEPTH	255.0'-257.0'	SAMPLE#	W14-18-255.0	WELL ID#	C3396
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	11/02/2001

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
974.70	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	39.7	4.1	95.9	19.05	
	3/8"	102.1	10.5	89.5	9.42	
	#4	253.6	26.0	74.0	4.70	
	#10	494.5	50.7	49.3	1.98	
	#20	599.2	61.5	38.5	0.83	
	#40	653.1	67.0	33.0	0.42	
	#60	754.9	77.4	22.6	0.25	
	#100	821.6	84.3	15.7	0.150	
	#200	867.2	89.0	11.0	0.074	

Sieve Analysis Data for Sample W14-18-255.0



Comments: Silty Sandy Gravel

All data are accurately and completely recorded.

Checked By: JMWimett DCWeekes Date: 11/2/01

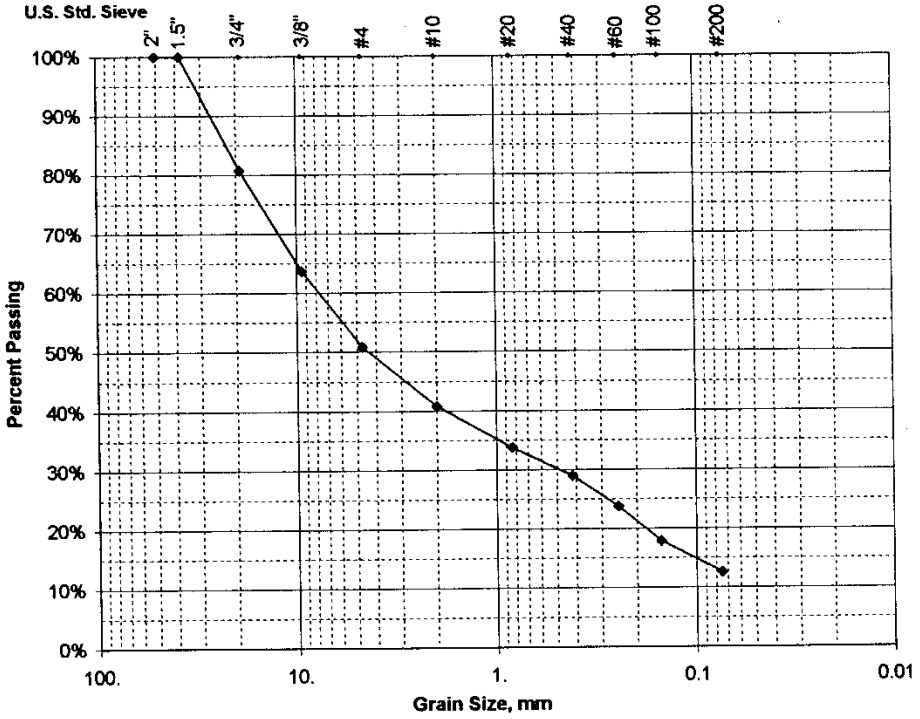
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W22-84	DEPTH	225.0'-227.5'	SAMPLE#	W22-84-225.0	WELL ID#	C3398
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	#########

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
973.60	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	188.0	19.3	80.7	19.05	
	3/8"	353.3	36.3	63.7	9.42	
	#4	478.3	49.1	50.9	4.70	
	#10	577.0	59.3	40.7	1.98	
	#20	646.0	66.4	33.6	0.83	
	#40	692.6	71.1	28.9	0.42	
	#60	743.3	76.3	23.7	0.25	
	#100	799.8	82.1	17.9	0.150	
	#200	851.9	87.5	12.5	0.074	

Sieve Analysis Data for Sample W22-84-225.0



Comments: Silty Sandy Gravel

All data are accurately and completely recorded.

Checked By: Date:

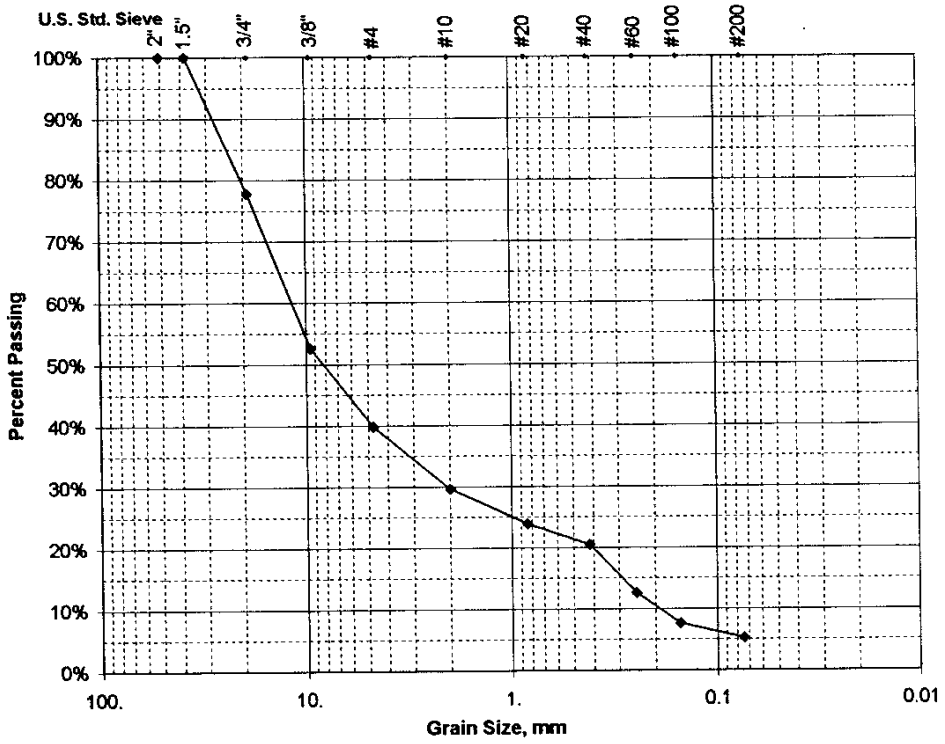
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W22-84	DEPTH	265.0'-267.5'	SAMPLE#	W22-84-265.0	WELL ID#	C3398
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	##########

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
851.90	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	189.5	22.2	77.8	19.05	
	3/8"	404.2	47.4	52.6	9.42	
	#4	512.8	60.2	39.8	4.70	
	#10	599.7	70.4	29.6	1.98	
	#20	648.5	76.1	23.9	0.83	
	#40	677.3	79.5	20.5	0.42	
	#60	744.6	87.4	12.6	0.25	
	#100	787.4	92.4	7.6	0.150	
	#200	807.0	94.7	5.3	0.074	

Sieve Analysis Data for Sample W22-84-265.0



Comments: Sandy Gravel

All data are accurately and completely recorded.

Checked By: Date:

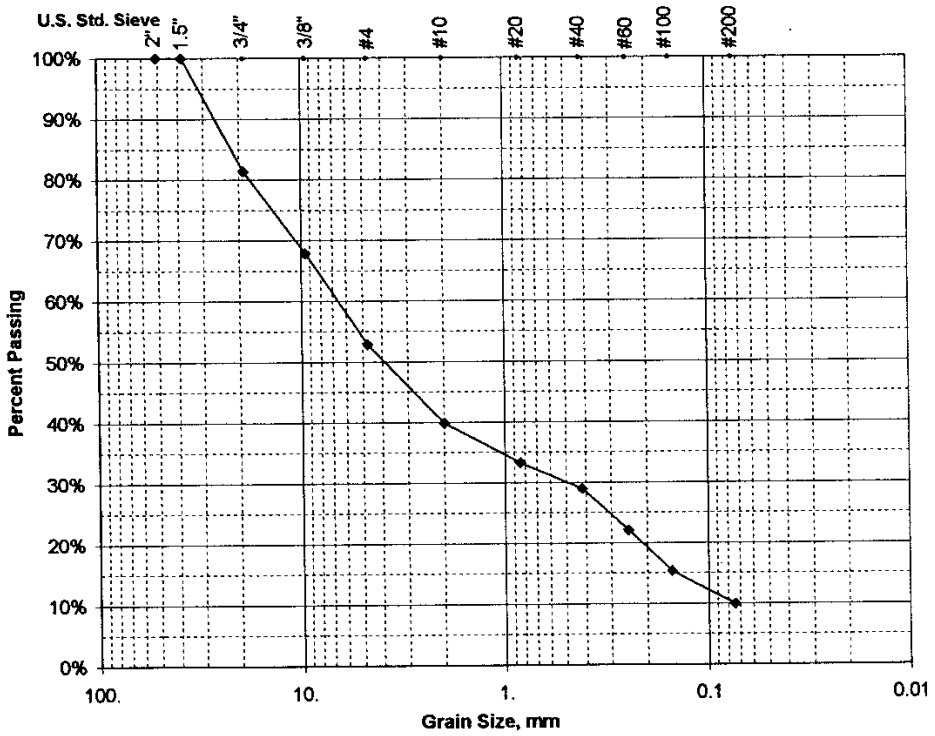
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W22-85	DEPTH	220.5'-222.0'	SAMPLE#	W22-85-220.5	WELL ID#	C3399
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	#########

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
619.80	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	115.7	18.7	81.3	19.05	
	3/8"	199.5	32.2	67.8	9.42	
	#4	292.5	47.2	52.8	4.70	
	#10	373.1	60.2	39.8	1.98	
	#20	414.1	66.8	33.2	0.83	
	#40	440.6	71.1	28.9	0.42	
	#60	482.7	77.9	22.1	0.25	
	#100	524.8	84.7	15.3	0.150	
	#200	558.5	90.1	9.9	0.074	

Sieve Analysis Data for Sample W22-85-220.5



Comments: Sandy Gravel

All data are accurately and completely recorded.

Checked By: Date:

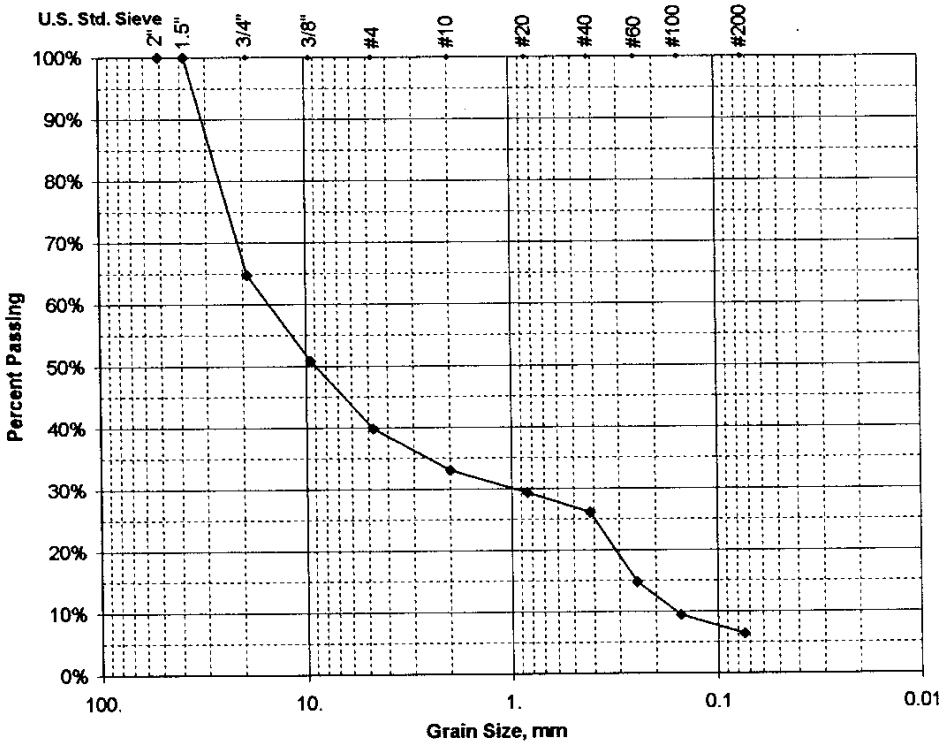
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W22-85	DEPTH	255.0'-257.5'	SAMPLE#	W22-85-255.0	WELL ID#	C3399
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	#########

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
972.40	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	343.5	35.3	64.7	19.05	
	3/8"	478.3	49.2	50.8	9.42	
	#4	585.6	60.2	39.8	4.70	
	#10	651.7	67.0	33.0	1.98	
	#20	687.1	70.7	29.3	0.83	
	#40	719.1	74.0	26.0	0.42	
	#60	829.4	85.3	14.7	0.25	
	#100	881.0	90.6	9.4	0.150	
	#200	910.0	93.6	6.4	0.074	

Sieve Analysis Data for Sample W22-85-255.0



Comments: Sandy Gravel

All data are accurately and completely recorded.

Checked By: Date:

Appendix C

Borehole Geophysical Logs

Appendix C

Borehole Geophysical Logs

This appendix contains the borehole geophysical logs obtained from boreholes 299-W22-81, 299-W22-84, and 299-W22-85. The logs were run and analyzed by MACTEC-ERS. Header information and log analyses are included with the logs.

299-W22-84 (C3398)

Log Data Report

Borehole Information:

Borehole:	299-W22-84 (C3398)		Site: East of SY Tank Farm		
Coordinates (Plant)		GWL (ft)[1]: 233.2		GWL Date: 10/19/01	
North	East	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
not available	not available	Oct. 2001	Unknown	273.5	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel threaded	2.6	10.75	9.375	11/16	2.6	273.3

Borehole Notes:

Prior to drilling activities around this borehole, a 1.5- to 2-ft-thick gravel pad was spread over a ground surface that was previously posted as a "soil contamination area." The logging engineer measured the pipe stickup at the borehole using a steel tape. Calipers were used to measure only casing outside diameter and thickness. The casing inside diameter was calculated.

Logging Equipment Information:

Logging System:	RLS-1		Type: HPGe (70%)
Calibration Date:		Calibration Reference:	
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	RLS-1		Type: Moisture
Calibration Date:	07/01	Calibration Reference:	RLSM00.0 (Randall 2001)
		Logging Procedure:	MAC-HGLP 1.6.5

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4
Date	10/22/01	10/23/01	10/23/01	
Logging Engineer	Spatz	Spatz	Spatz	
Start Depth (ft)	274.0	0	134.0	
Finish Depth (ft)	134.0	133.0	162.0	
Count Time (sec)	N/A[3]	N/A	N/A	
Live/Real	R	R	R	
Shield (Y/N)	N/A	N/A	N/A	
MSA Interval (ft)	1.0	1.0	1.0	
ft/min	N/A	N/A	N/A	
Pre-Verification	B0591CAB	B0601CAB	B0601CAB	
Start File	B0591000	B0601000	B0601134	
Finish File	B0591140	B0601133	B0601162	
Post-Verification	B0591CAA	B0601CAA	B0601CAA	

Log Run	1	2	3	4
Depth Return Error (ft)	-0.1	N/A	0	
Comments	See fine-gain adjustment statements below.	See fine-gain adjustment statements below.	Repeat section. No fine-gain adjustments made.	

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2	3	4
Date	10/19/01	10/19/01	10/19/01	
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	Ground surface	100.0	237.0	
Finish Depth (ft)	100.0	236.75	213.0	
Count Time (sec)	N/A	N/A	N/A	
Live/Real	L	L	L	
Shield (Y/N)	N/A	N/A	N/A	
MSA Interval (ft)	0.25	0.25	0.25	
ft/min	1.0 ft/min	1.0 ft/min	1.0 ft/min	
Pre-Verification	C0242CAB	C02421CAB	C0242CAB	
Start File	C0242000	CR242401	CR242000	
Finish File	C0242400	CR242948	CR242097	
Post-Verification	C0242CAA	C0242CAA	CR242CAA	
Depth Return Error (ft)	N/A	N/A	0	
Comments	Ended log run to reset file subdirectory.	Groundwater detected below 236.75 ft.	Repeat section.	

Logging Operation Notes:

Zero reference is the top of ground surface, and log depths are relative to ground level. The sonde is centralized in the borehole for both the SGLS and NMLS.

The borehole was logged in the drill pipe before completion as a groundwater monitoring well. In order to obtain reliable spectra while minimizing overall logging time, the depth interval was increased from 0.5 ft to 1.0 ft.

Logging data were collected with the MCA's gain stabilization feature engaged. Fine-gain adjustments were made after file C0591052 (222 ft) during SGLS logging run 1. Fine-gain adjustment was made after files B0601028 (28 ft), B0601029 (29 ft), B0601050 (50 ft), B0601054 (54 ft), B0601066 (66 ft), and B0601069 (69 ft) during SGLS logging run 2. Fine gain adjustments were not necessary during logging run 3.

Analysis Notes:

Analyst:	Sobczyk	Date:	11/06/01	Reference:	MAC-VZCP 1.7.9 Rev. 2

Pre-run and post-run verification spectra for the SGLS were evaluated. The acceptance criteria for field verification of the RLS-1 logging system are in the process of being established. Examinations of spectra indicate that the detector appears to have functioned normally during the log run, and the log data are provisionally accepted, subject to further review and analysis.

Individual SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL. Corrections for casing thickness, water in the borehole, and dead time have yet to be specifically determined for the RLS

system. Therefore, corrections for these environmental factors were applied based upon the calibration of the Gamma 2B system. The resulting log values appear reasonable. A correction for a casing thickness of 11/16 in. was applied for the entire length of the borehole. A correction for water in the borehole was applied below 236.0 ft, and this depth was determined from the neutron log. A dead time correction of 1.02 was applied at one point (0 ft). Typically, dead time varied between 5 and 8 % with the maximum amount of dead time (16 %) occurring at the ground surface.

Pre-run and post-run verification spectra for the neutron tool were evaluated. The pre-survey verification spectrum (file C0242CAB) recorded 750 gross cps, and the post-survey verification spectrum (file CR242CAA) recorded 713 gross cps.

Moisture calibration models at Hanford for 10-in. holes with 11/16-in. casing have not been established. Thus, the neutron data were not processed to estimate volumetric moisture content because the relatively large borehole diameter and casing thickness are beyond the range of conditions for which the moisture gauge was calibrated. Moisture gauge data are presented as gross counts. In general, an increase in neutron count is indicative of an increase in moisture content, but a quantitative calculation of volumetric moisture cannot be made at this time. The rerun of the neutron-moisture tool showed good repeatability.

Log Plot Notes:

Separate log plots are provided for gross gamma, naturally occurring radionuclides (^{40}K, ^{232}Th, ^{238}U, and associated decay progeny), and man-made radionuclides. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statis tics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing and water corrections. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. A gross neutron log of neutron counts is also shown on the combination plot.

Results and Interpretations:

The changes in gross gamma counts depend primarily upon changes in ^{40}K activities and the presence of radon in the borehole. Man-made radionuclides were not detected during any of the SGLS logging runs. The apparent gradual increase in counts at the 609-keV photopeak from 25 to 134 ft is interpreted as a buildup of radon in the borehole. The amount of counts at the 1764-keV photopeak increases over this interval, as well, but not as much as at the 609-keV photopeak. The increase in gross gamma counts from about 175 cps to about 220 cps at a log depth of 66 ft corresponds with an increase in apparent ^{40}K activity from about 12 to 14 pCi/g to 17 to 19 pCi/g. This increase ^{40}K is interpreted as the Hanford H2. On the basis of low ^{40}K activities, the carbonate-rich paleosols of the Pliocene-Pleistocene are interpreted as being between 209 and 219 ft. The caliche layer with characteristically high uranium content (greater than 2.0 pCi/g) is absent. The top of the Ringold is picked at 210 ft.

The rerun of the RLS -1 showed good repeatability of the estimates of ^{40}K and ^{232}Th and supports the interpretation that radon (^{222}Rn) was presence during logging. The total gamma was about 20 cps higher during the rerun than during the original log run. Because apparent ^{40}K and ^{232}Th activities remained unchanged while estimates for apparent ^{238}U activities increased during the rerun, the apparent increase in ^{238}U activities can be explained by the presence of ^{222}Rn. During the original log run, the ^{238}U activity based on 609-keV photopeak was about 2.0 pCi/g while the estimated activity is about 3.0 pCi/g during the rerun. Similarly, the estimated ^{238}U activity based on the 1764-keV photopeak is also greater during the rerun. The apparent concentration based on the 609-keV peak appears to increase more than that based on the 1764 peak because the casing correction factor decreases with increasing energy level. If the source of the gamma photons is within the casing, then there is less attenuation than would be expected, and the effect of the casing correction is an apparent increase in the calculated concentration. This log is unusual in that the repeat log shows elevated ^{214}Bi relative to the original run. In general, ^{222}Rn shows up in the original run

and dissipates before the repeat run. Increased radon in the repeat log of a recently drilled hole strongly suggests that the hole is venting radon.

The highest neutron counts occurred in the groundwater as expected. The comparison of the neutron data with the SGLS data is complicated by the relatively large diameter of this borehole and differing vertical resolution of the two data sets. The sample interval for the moisture gauge tool is ¼ ft versus 1 ft for the SGLS. Thus, the neutron log has a finer vertical resolution than the SGLS logs.

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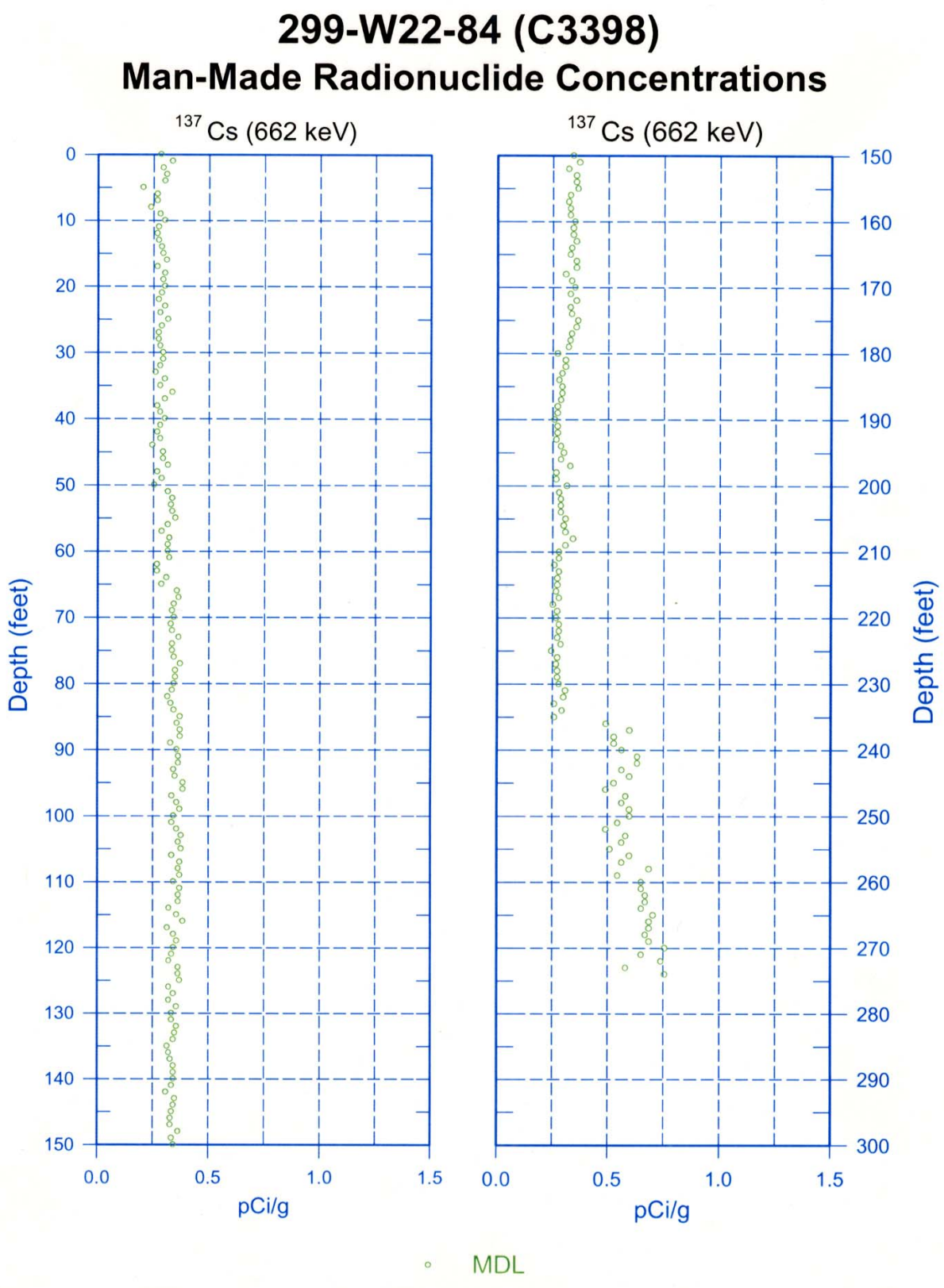
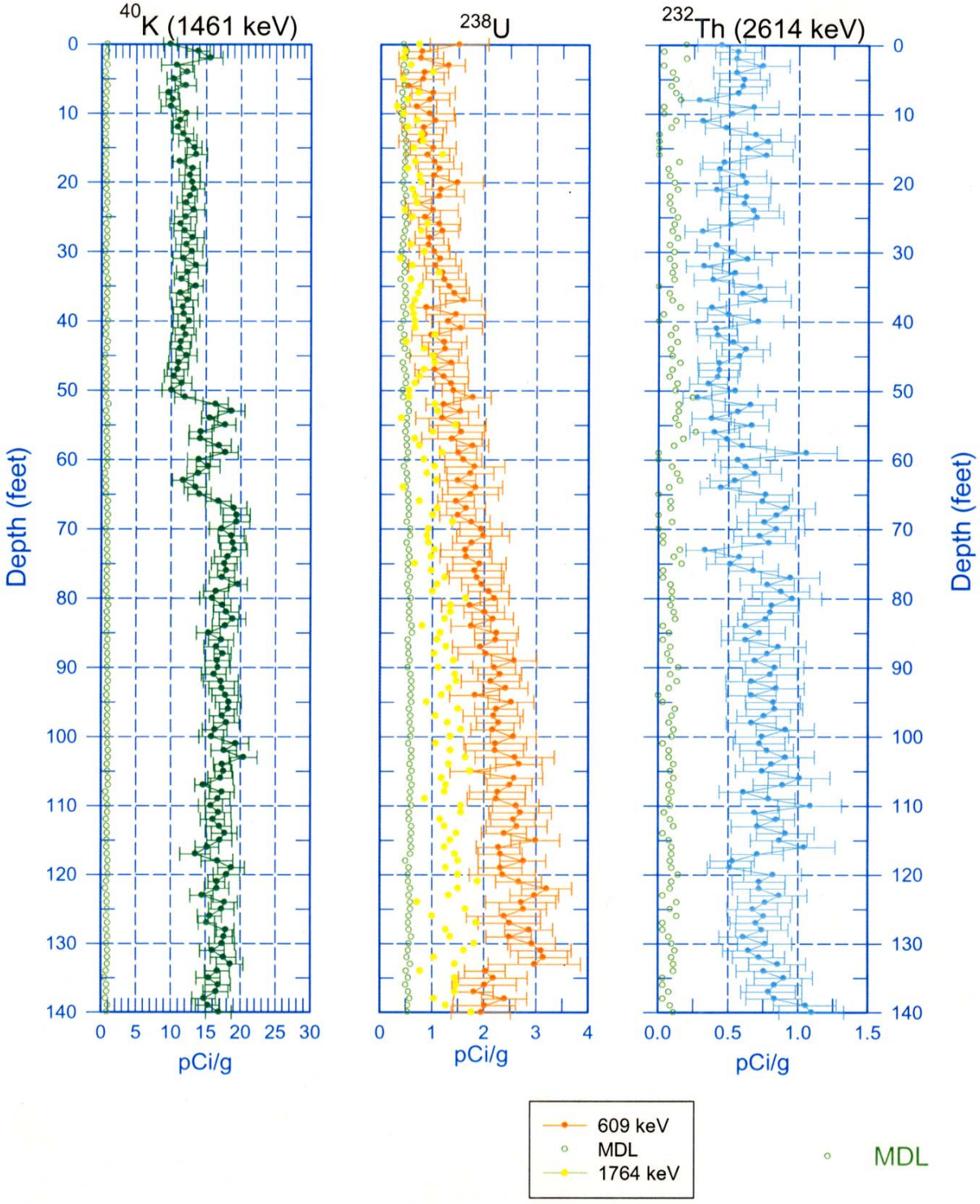
[1] GWL – groundwater level
[2] TOC – top of casing
[3] Not applicable – N/A

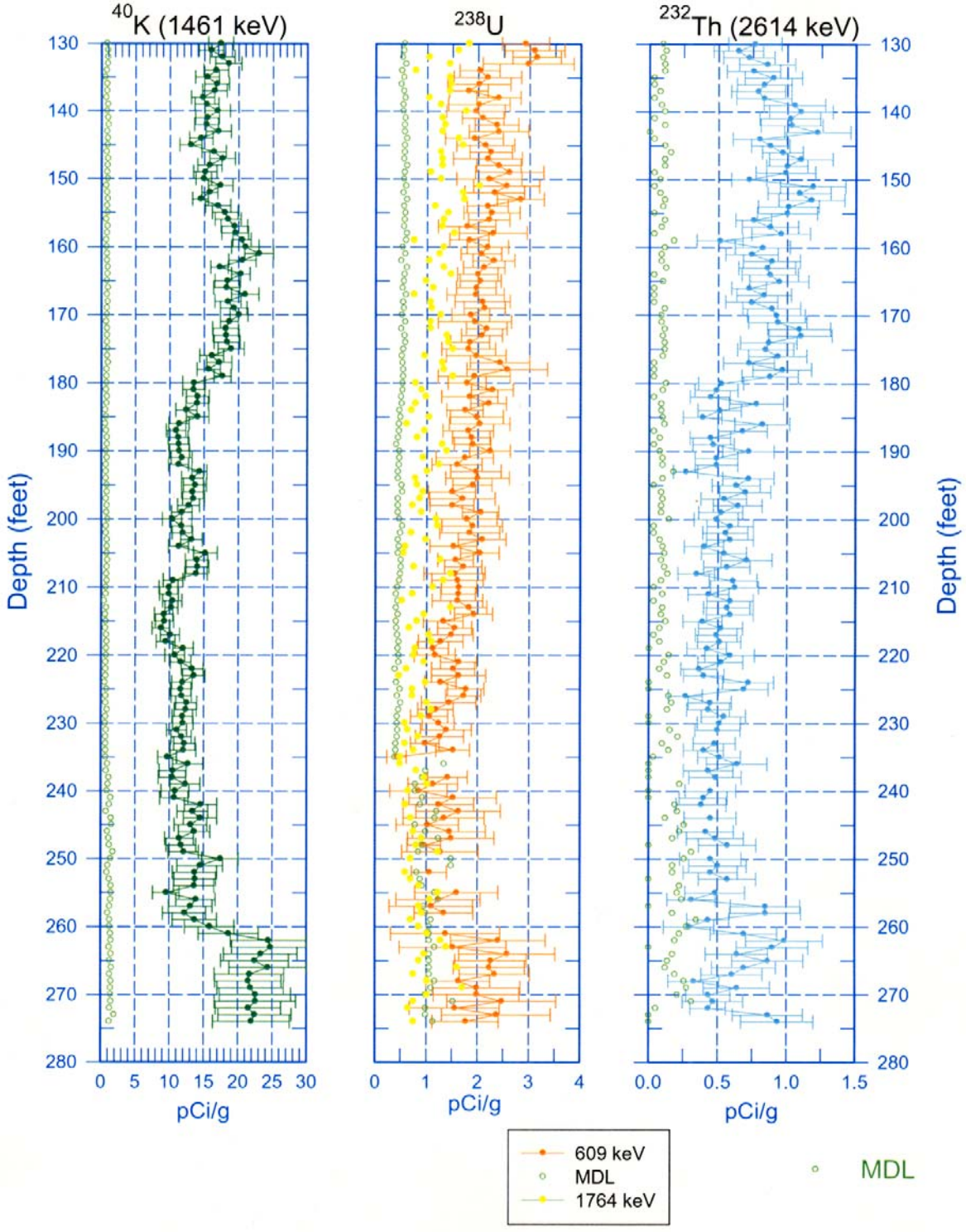
Reference: Randall, R., 2001. *Certificate of Calibration RLSM00.0*, July 11, 2001, Three Rivers Scientific, Richland, WA.

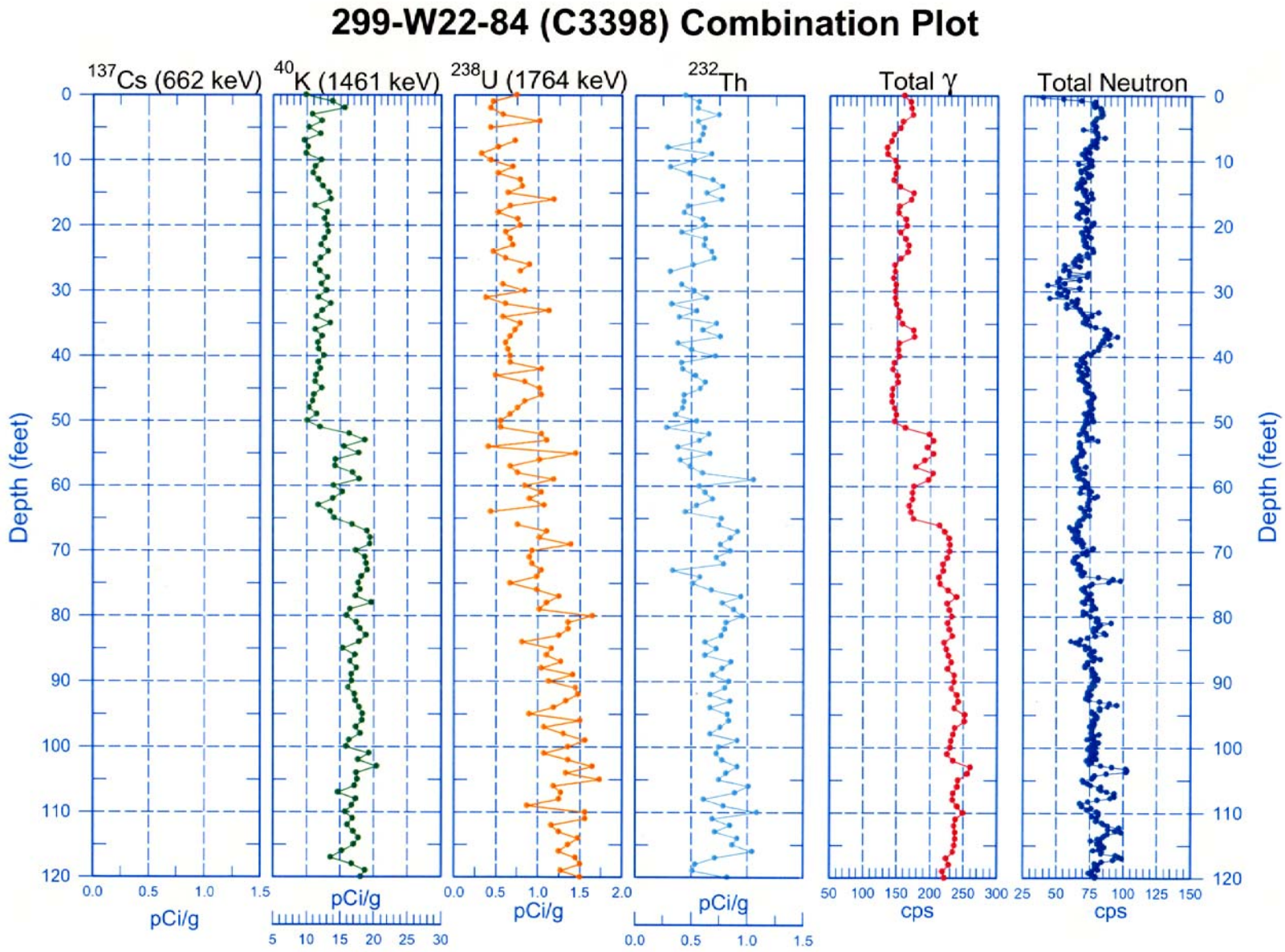

299-W22-84 (C3398)
Man-Made Radionuclide Concentrations
137 Cs (662 keV)
137 Cs (662 keV)
Depth (feet)
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
0.0
0.5
1.0
1.5
pCi/g
MDL

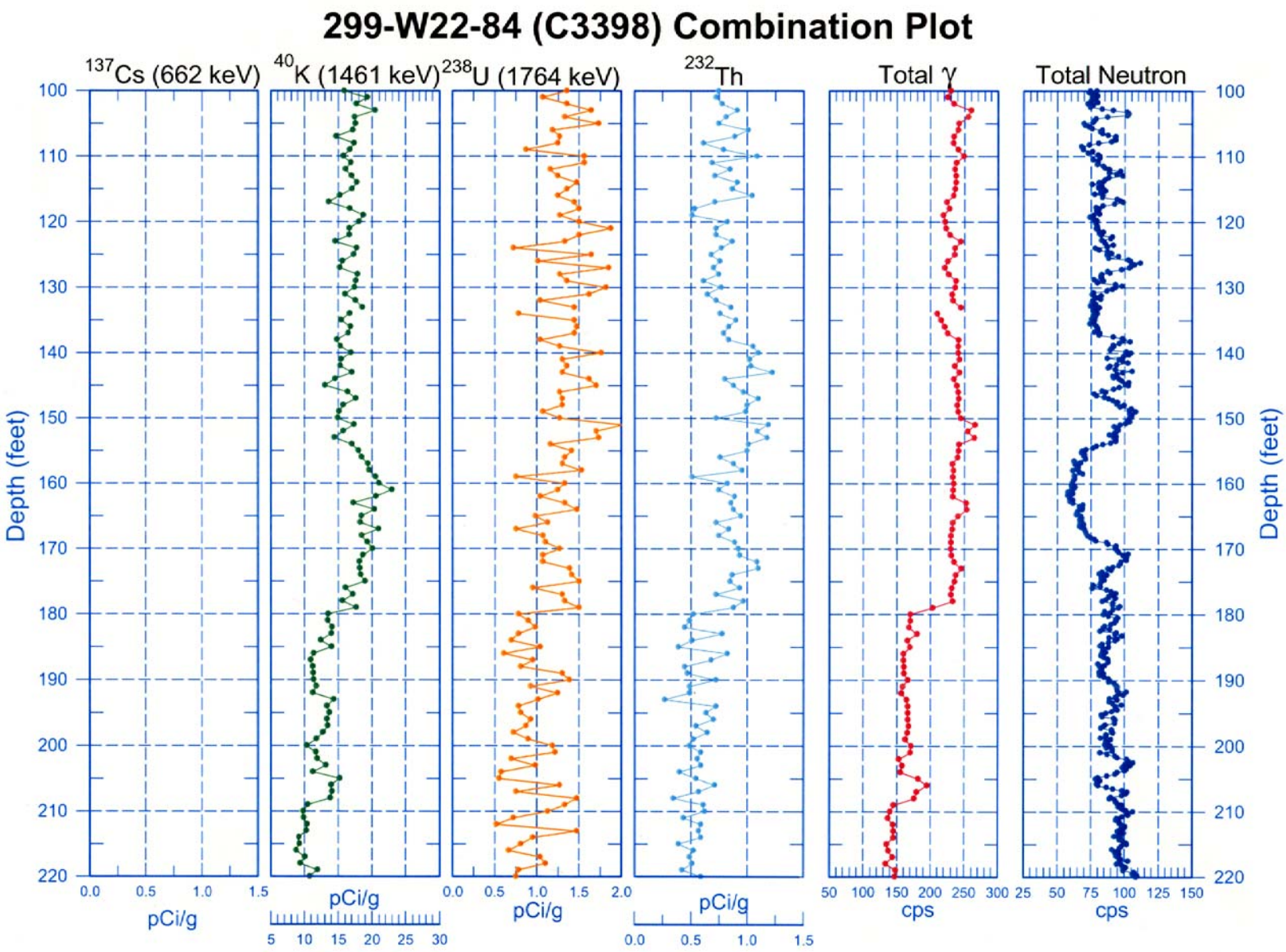
299-W22-84 (C3398)
Natural Gamma Logs

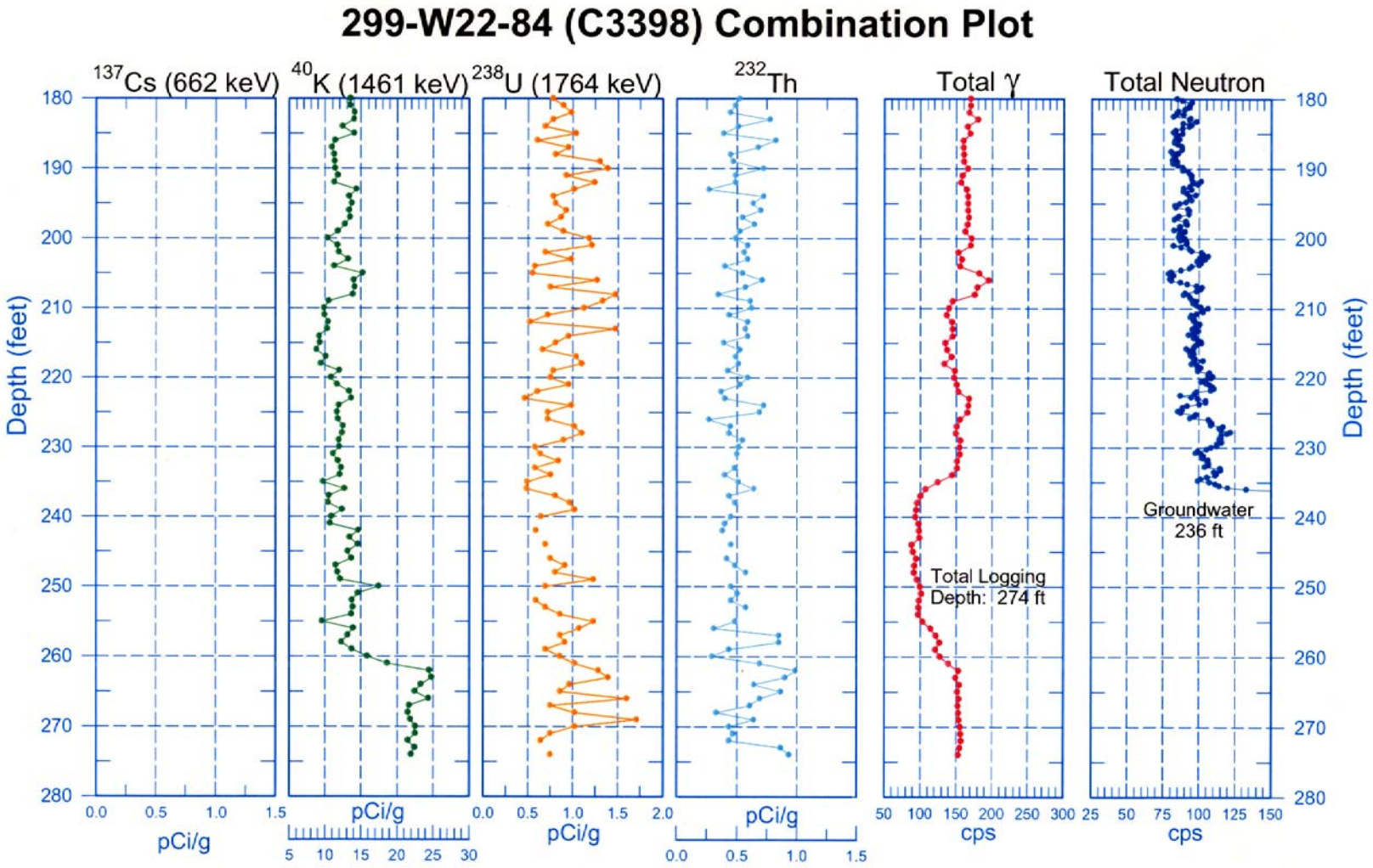


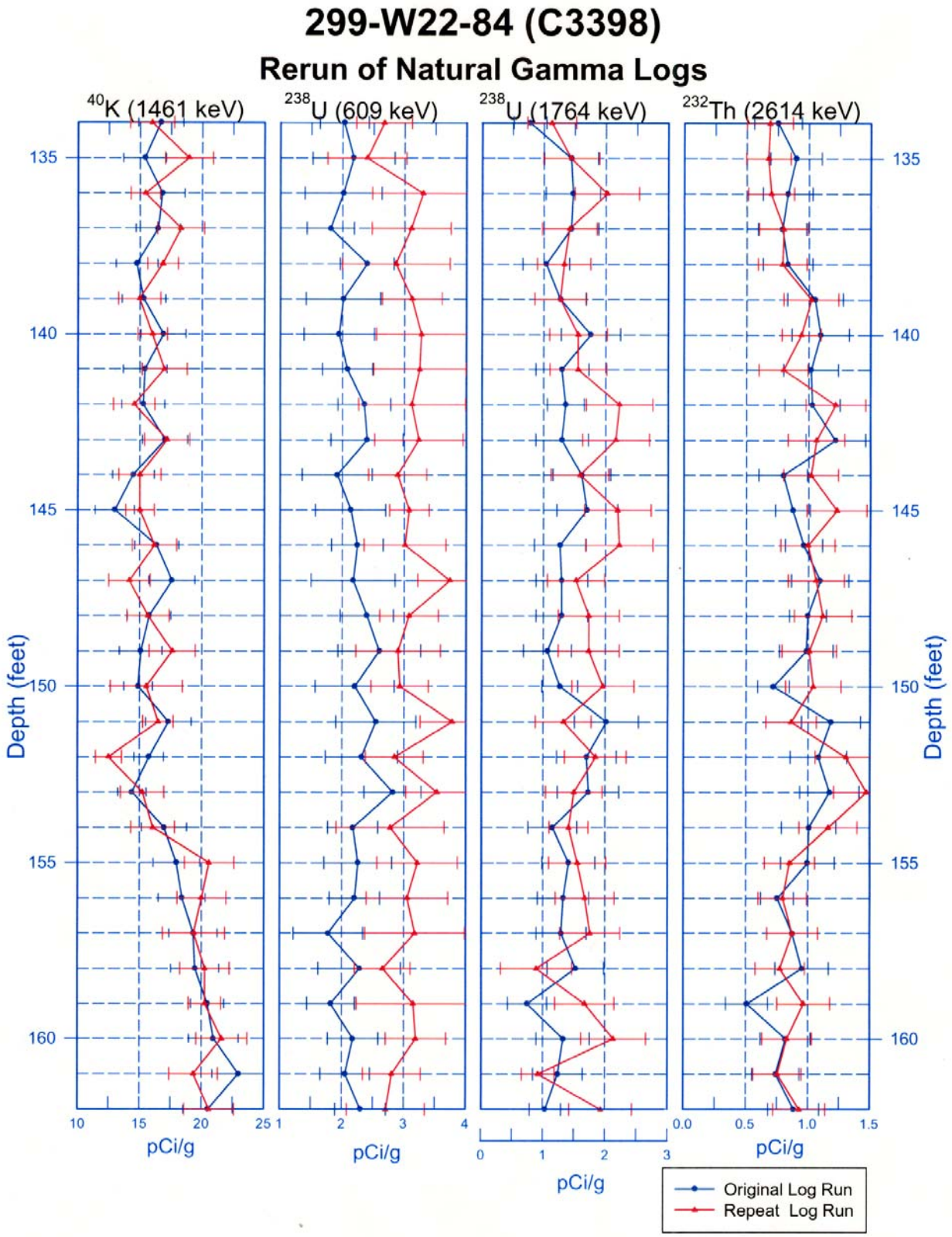
299-W22-84 (C3398)
Natural Gamma Logs

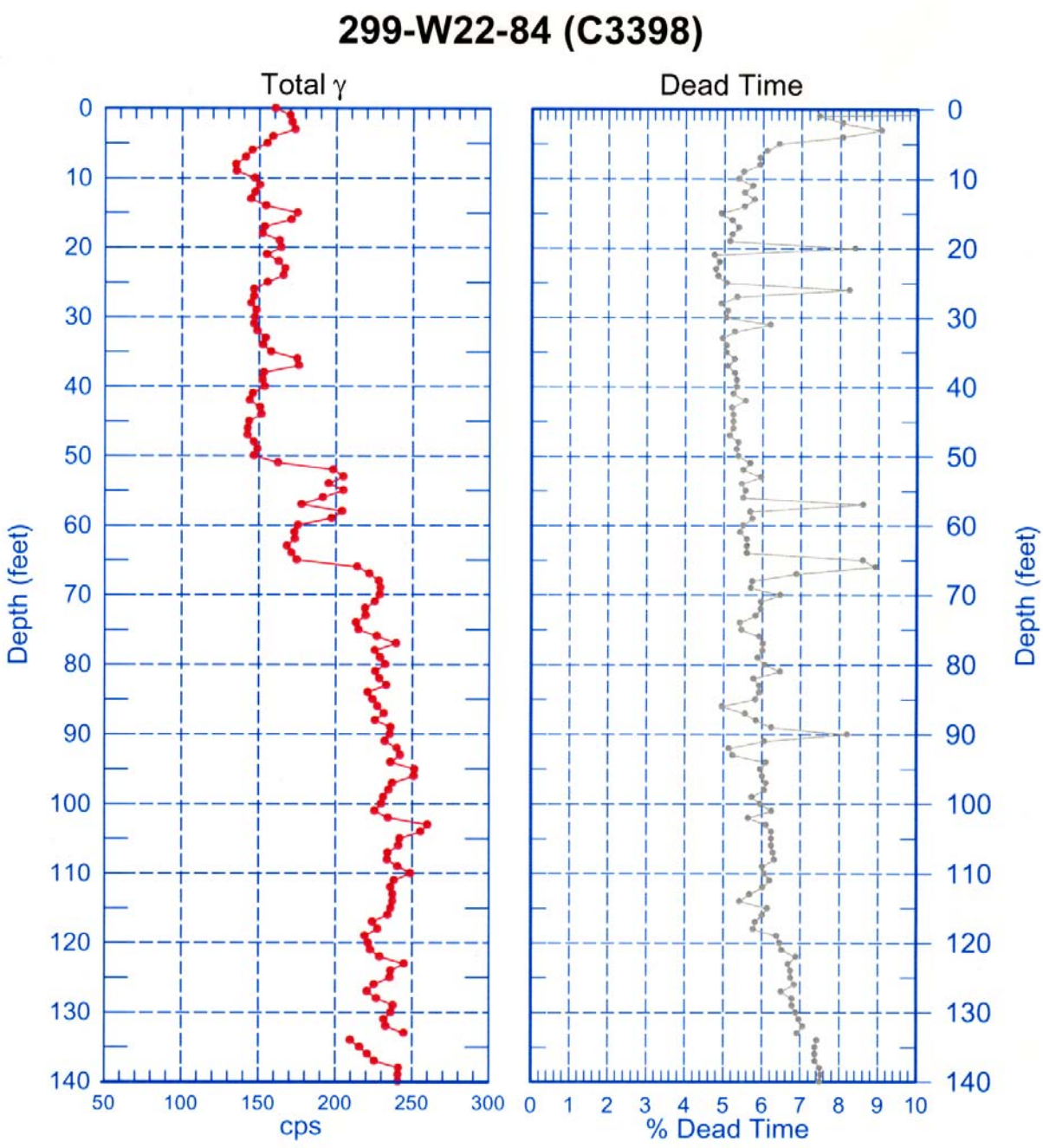


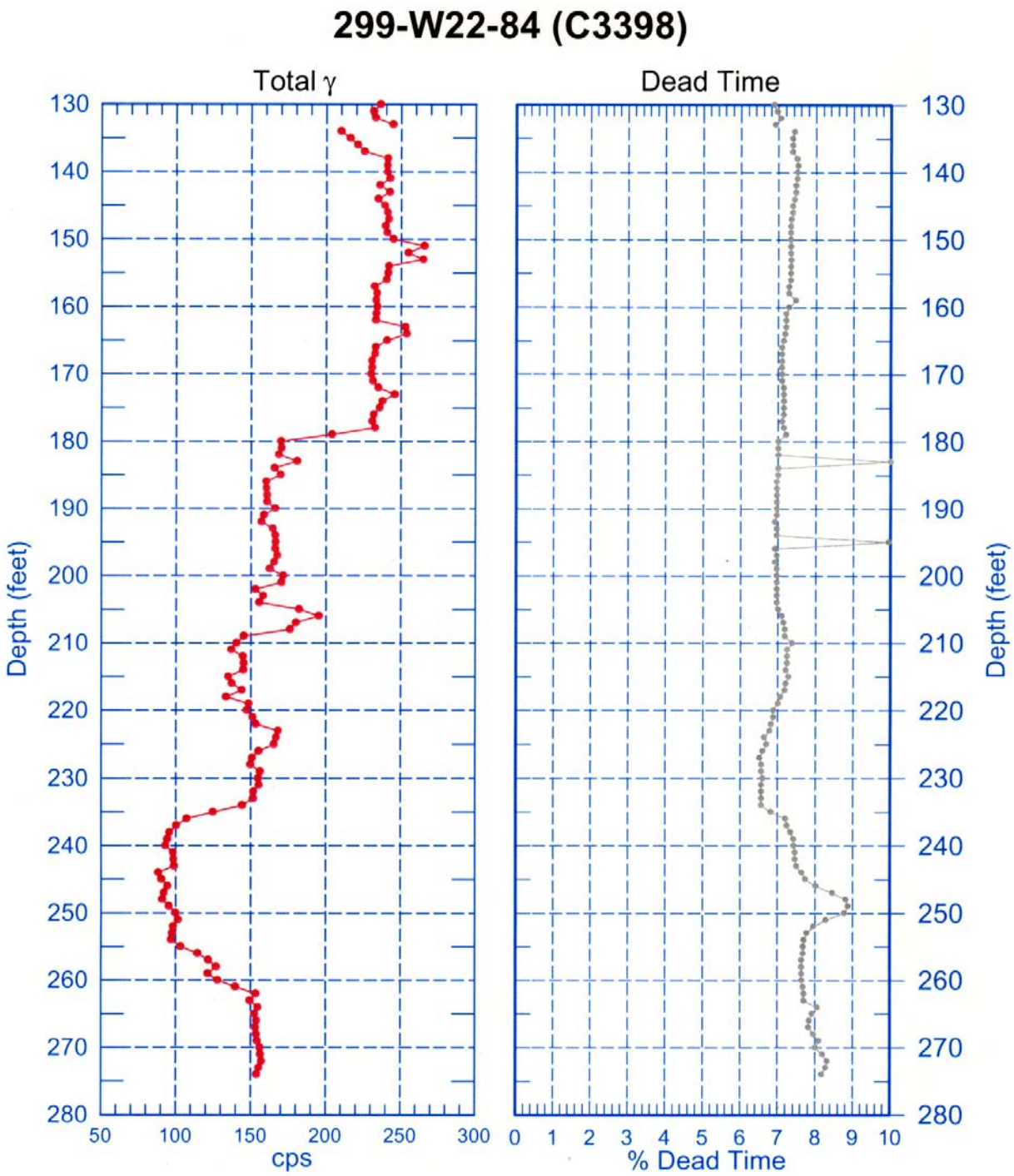

299-W22-84 (C3398) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (1764 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps

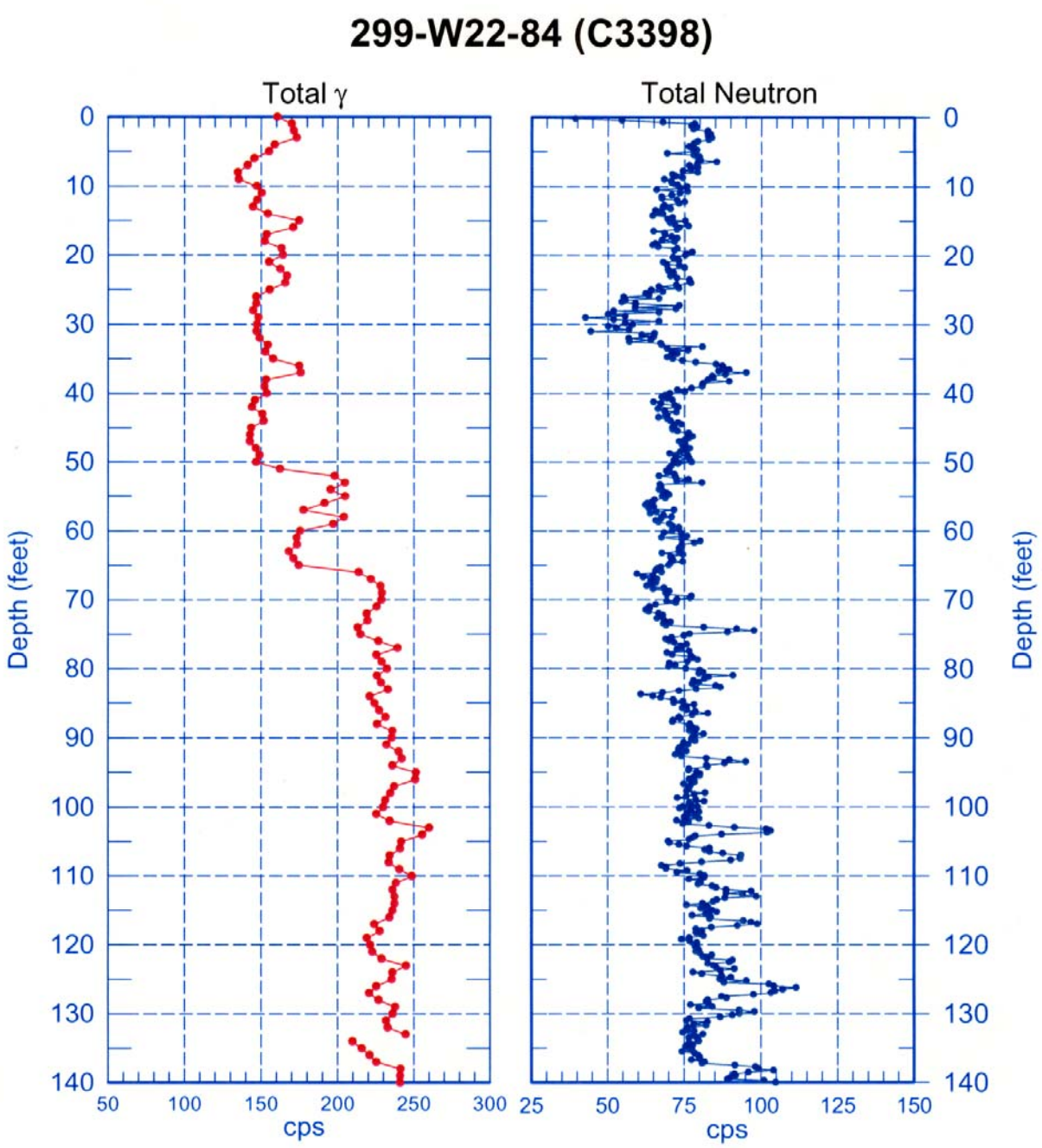

299-W22-84 (C3398) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (1764 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps

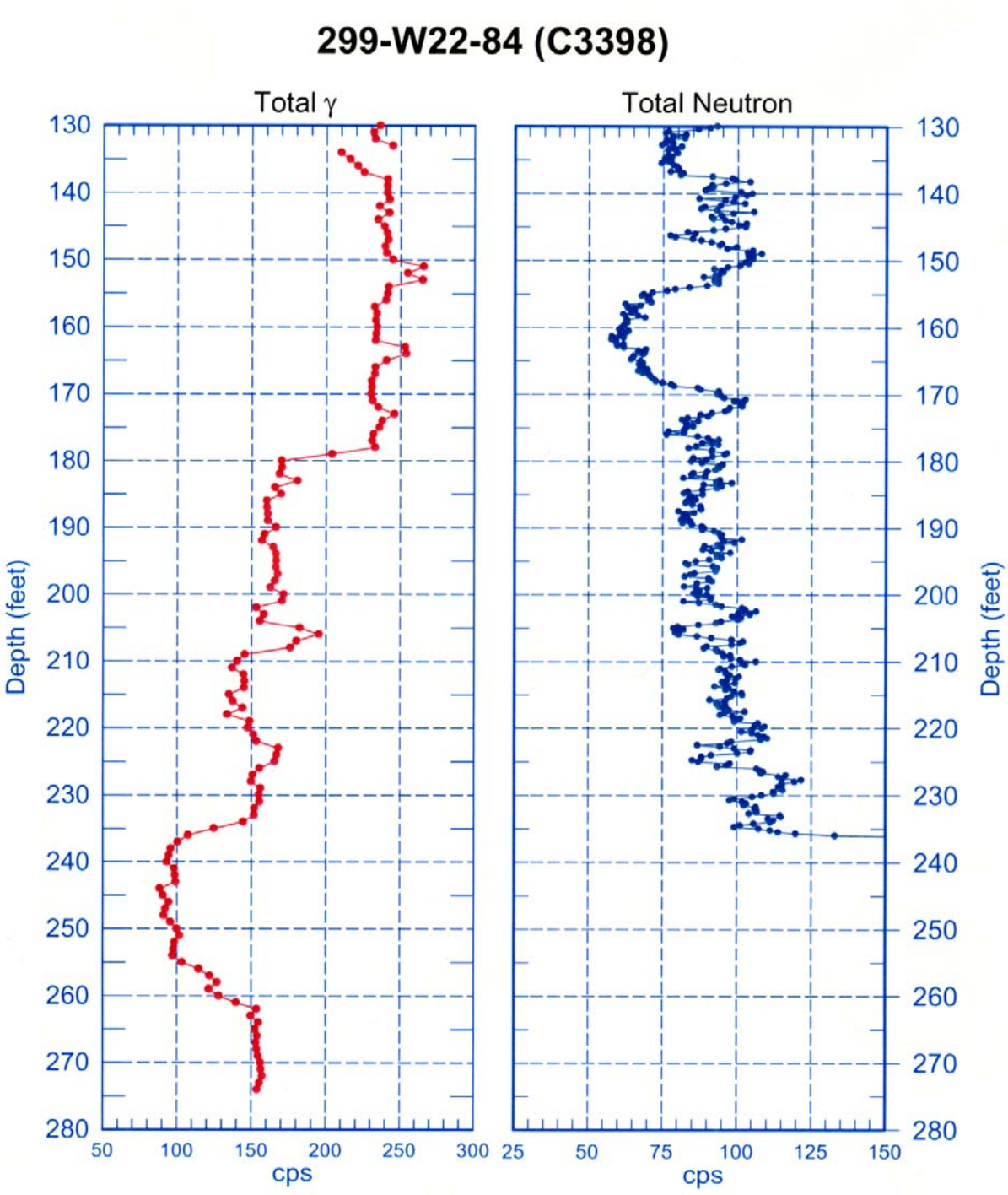

299-W22-84 (C3398) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (1764 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps
Groundwater
236 ft
Total Logging
Depth: 274 ft

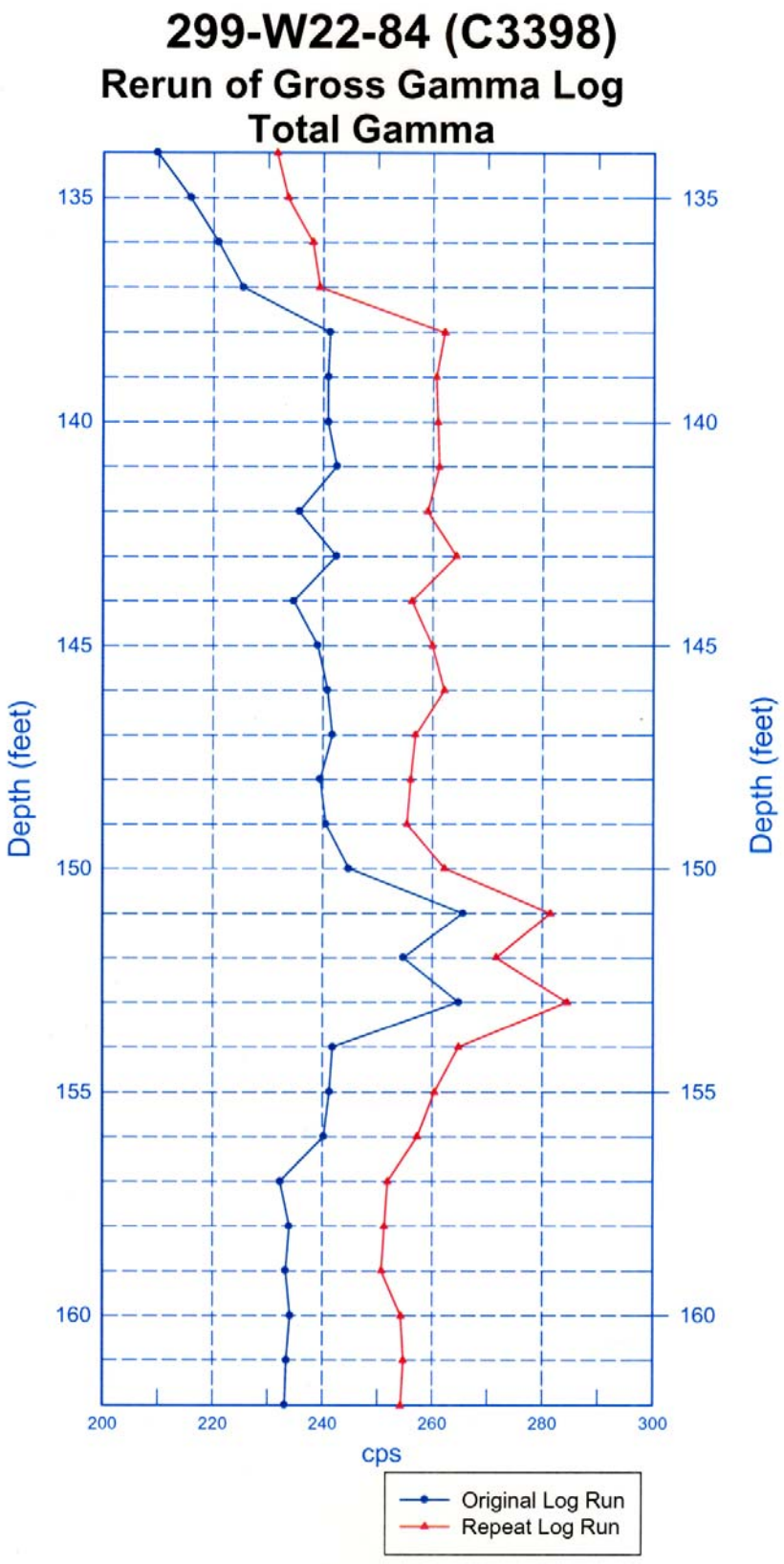

299-W22-84 (C3398)
Rerun of Natural Gamma Logs
40K (1461 keV)
238U (609 keV)
238U (1764 keV)
232Th (2614 keV)
Depth (feet)
135
140
145
150
155
160
10
15
20
25
1
2
3
4
0
1
2
3
0.0
0.5
1.0
1.5
pCi/g
Original Log Run
Repeat Log Run

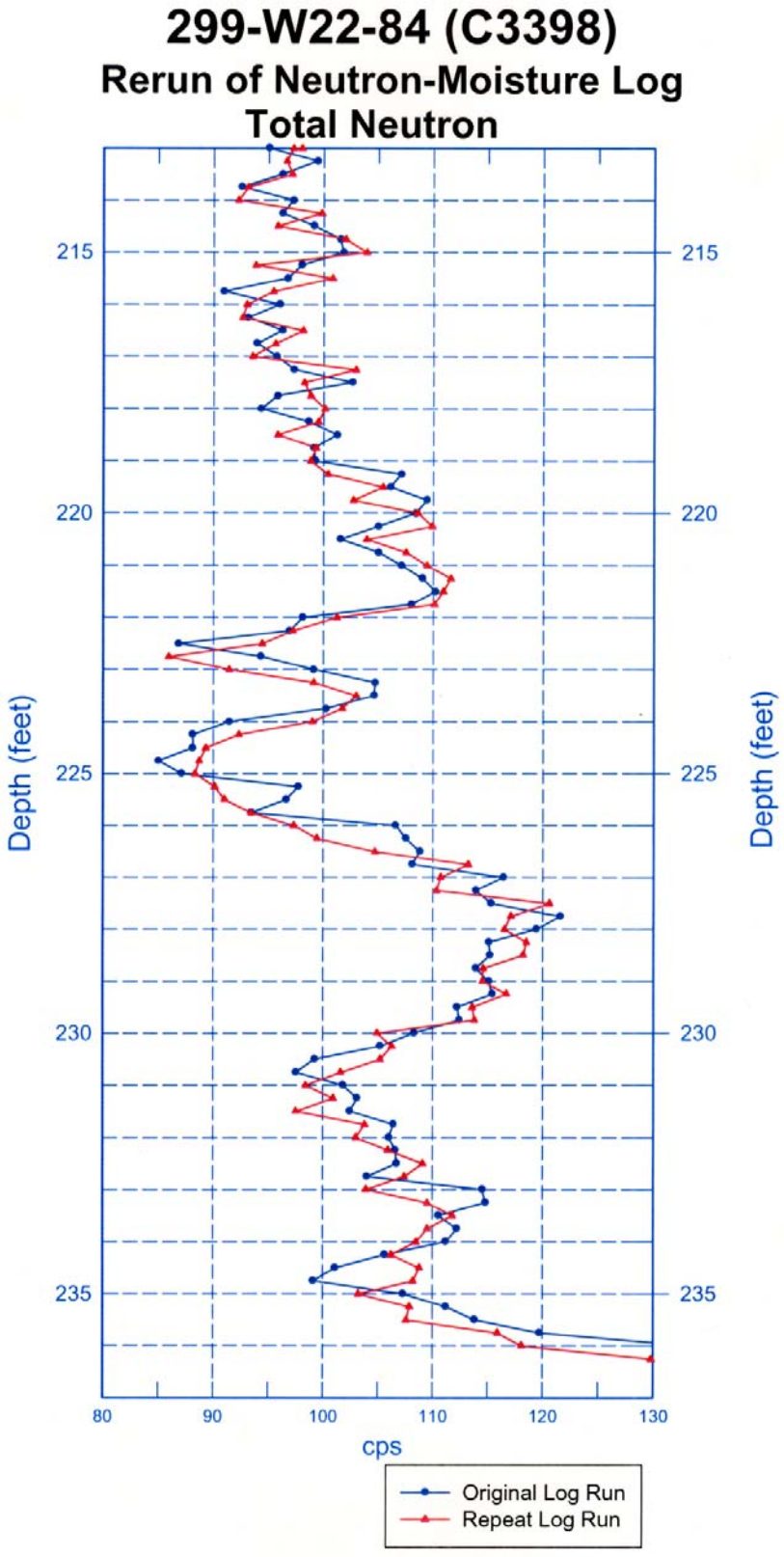

299-W22-84 (C3398)
Total γ
Dead Time
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
50
100
150
200
250
300
cps
0
1
2
3
4
5
6
7
8
9
10
% Dead Time


299-W22-84 (C3398)
Total γ
Dead Time
Depth (feet)
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
50
100
150
200
250
300
cps
0
1
2
3
4
5
6
7
8
9
10
% Dead Time


299-W22-84 (C3398)
Total γ
Total Neutron
Depth (feet)
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
50
100
150
200
250
300
cps
25
50
75
100
125
150
cps


299-W22-84 (C3398)
Total γ
Total Neutron
Depth (feet)
Depth (feet)
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
50
100
150
200
250
300
25
50
75
100
125
150
cps
cps


299-W22-84 (C3398)
Rerun of Gross Gamma Log
Total Gamma
135
140
145
150
155
160
Depth (feet)
200
220
240
260
280
300
cps
Original Log Run
Repeat Log Run


299-W22-84 (C3398)
Rerun of Neutron-Moisture Log
Total Neutron
215
220
225
230
235
Depth (feet)
80
90
100
110
120
130
cps
Original Log Run
Repeat Log Run

299-W22-85 (C3399)

Log Data Report

Borehole Information:

Borehole:	299-W22-85 (C3399)		Site: East of SX Tank Farm	
Coordinates (Plant)		GWL (ft)[1]: 222.5		GWL Date: 10/09/01
North	East	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
		Oct. 2001	Unknown	260	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel threaded	2.0	11 3/4	10 3/4	0.5	2.0	260

Borehole Notes:

The logging engineer measured the pipe stickup at the borehole using a steel tape.

Logging Equipment Information:

Logging System:	RLS-1		Type: HPGe (70%)
Calibration Date:		Calibration Reference:	
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	RLS-1		Type: Moisture
Calibration Date:	07/01	Calibration Reference:	RLSM00.0 (Randall 2001)
		Logging Procedure:	MAC-HGLP 1.6.5

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4
Date	10/10/01	10/10/01	10/10/01	
Logging Engineer	Spatz	Spatz	Spatz	
Start Depth (ft)	260.0	97.0	70.0	
Finish Depth (ft)	71.0	71.0	2.0	
Count Time (sec)	100	100	100	
Live/Real	R	R	R	
Shield (Y/N)	N/A[3]	N/A	N/A	
MSA Interval (ft)	1.0	1.0	1.0	
ft/min	N/A	N/A	N/A	
Pre-Verification	B0581CAB	B0581CAB	B0581CAB	
Start File	B0581000	B0581190	B0581217	
Finish File	B0581189	B0581216	B0581285	
Post-Verification	B0581CAA	B0581CAA	B0581CAA	
Depth Return Error (ft)	0	N/A	0	
Comments	Fine-gain adjustments	Repeat section	Fine-gain adjustments	

Neutron Moisture Logging System (NMLS) Run Information:

Log Run	1	2	3	4
Date	10/09/01	10/09/01		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	0	222.75		
Finish Depth (ft)	222.5	199.0		
Count Time (sec)	N/A	N/A		
Live/Real	R	R		
Shield (Y/N)	N/A	N/A		
MSA Interval (ft)	0.25	0.25		
ft/min	1.0/min	1.0/min		
Pre-Verification	C0232CAB	C0232CAB		
Start File	C0232000	CR232000		
Finish File	C0232890	CR232095		
Post-Verification	CR232CAA	CR232CAA		
Depth Return Error (ft)	N/A	0		
Comments	None	Repeat section		

Logging Operation Notes:

Zero reference is the top of ground surface, and log depths are relative to ground level. The sonde is centralized in the borehole for both the SGLS and NMLS.

A longer count time (200 sec) was required with the SGLS because of the relatively thick casing. The borehole was logged in the drill pipe before completion as a groundwater monitoring well. In order to obtain reliable spectra while minimizing overall logging time, the depth interval was increased from 0.5 to 1.0 ft.

The MCA's fine-gain stabilization feature is not enabled on the RLS-1 logging system. Fine-gain adjustments were made after files B0581003 (257 ft), B0581013 (247 ft), B0581019 (241 ft), B0581021 (239 ft), B0581050 (210 ft), and B0581160 (100 ft) during SGLS logging run 1. Log run 1 was terminated to refill the sonde with liquid nitrogen. Fine-gain adjustment was made after file B0581228 (59 ft) during SGLS logging run 3. Fine gain adjustments were not necessary during SGLS logging run 2. Pre- and post-survey verification spectra were collected using the 082 Amersham verifier.

Analysis Notes:

Analyst:	Sobczyk	Date:	10/18/01	Reference:	MAC-VZCP 1.7.9 Rev. 2

Pre-run and post-run verification spectra for the SGLS were evaluated. The acceptance criteria for field verification of the RLS-1 logging system are in the process of being established. Examinations of spectra indicate that the detector appears to have functioned normally during the log run, and the log data are provisionally accepted, subject to further review and analysis.

Individual SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL. Corrections were applied for a casing thickness of 0.5 in. from the ground surface to 260 ft. A correction for water in the borehole was applied below 222.5 ft; this depth was determined from the neutron log. Dead time corrections were not applied. Typically, dead time varied between 5 and 8 percent with the maximum amount of dead time (11 percent) occurring at 256 ft. The rerun of the RLS-1 showed good repeatability.

Pre-run and post-run verification spectra for the neutron tool were evaluated. The pre-survey verification spectrum (file C0232CAB) recorded 725 gross cps while the post-survey verification spectrum (file CR232CAA) recorded 741 gross cps.

Moisture calibration models at Hanford for 11-in. holes with 1/2-in. casing have not been established. Thus, the neutron log was not processed to estimate volumetric moisture content because the relatively large borehole diameter and casing thickness are beyond the range of conditions for which the tool was calibrated. Neutron data are presented as gross counts. In general, an increase in neutron count is indicative of an increase in moisture content, but a quantitative calculation of volumetric moisture cannot be made at this time. The rerun of the neutron-moisture tool showed good repeatability with the exception that the two runs appear to be off-depth. This apparent discrepancy is due to acquiring data in continuous mode in different directions. During the original log, data were acquired while going deeper into the hole, and the data are shifted upward about 1.5 in. During the repeat logging, data were acquired while coming out of the hole, and the data are shifted downward about 1.5 in. Regardless of the logging direction, the depth error is small (1.5 in.).

Log Plot Notes:

Separate log plots are provided for gross gamma, naturally occurring radionuclides (^{40}K, ^{232}Th, ^{238}U, and associated decay progeny), and man-made radionuclides. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing and water corrections. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. A gross neutron log of neutron counts is also shown on the combination plot.

Results and Interpretations:

^{137}Cs was the only man-made radionuclide detected. ^{137}Cs activity was detected near the ground surface at a log depth of 4 ft. The measured ^{137}Cs activity was about 0.2 pCi/g.

The changes in gross gamma counts depend primarily upon changes in ^{40}K activities. The increase in gross gamma counts from about 180 cps to about 230 cps at a log depth of 53 ft corresponds with an increase in apparent ^{40}K activity from about 12 to 17 pCi/g. This increase in total gamma is interpreted as the Hanford H2. The increase in ^{232}Th activity from about 0.8 to 1.0 pCi/g and the increase in gross gamma counts from 250 to 280 cps near 120 ft are tentatively picked to represent the top of the Early Palouse Soil. The transition between the Hanford and Early Palouse Soil is gradational as opposed to abrupt. On the basis of low K-40 activities, the carbonate-rich paleosols of the Pliocene-Pleistocene are interpreted as being between 150 and 159 ft. The caliche layer with characteristically high uranium content (greater than 2.0 pCi/g) is absent. The top of the Ringold is picked at 159 ft.

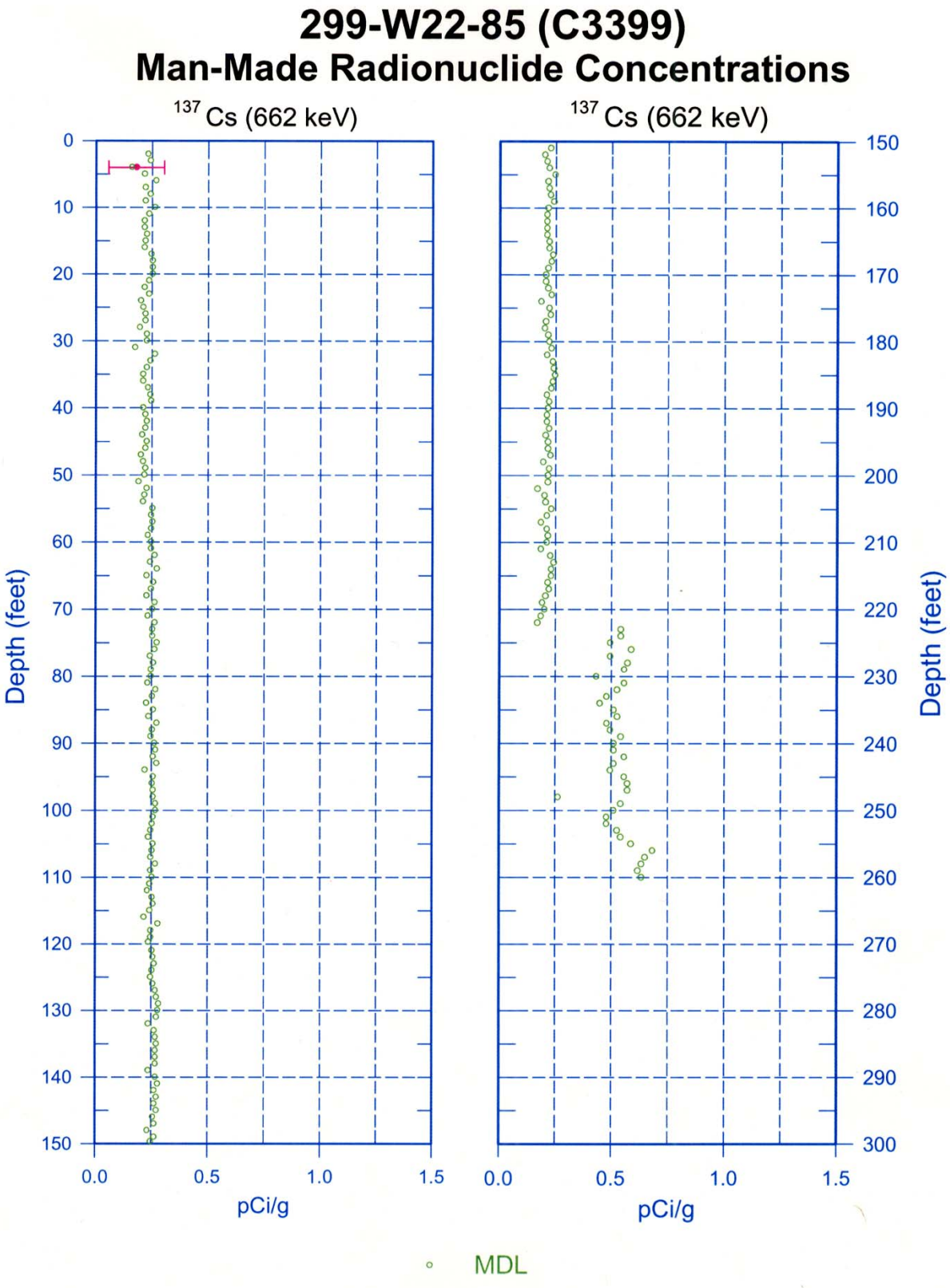
Below 222 ft, the apparent increase in ^{238}U activity based on 609-keV spectral line of about 1.0 pCi/g is greater than the apparent increase in ^{238}U activity based on 1764-keV line of about 1/4 pCi/g. This apparent increase in ^{238}U at groundwater may be the result of dissolved radon (^{222}Rn) in the water, an incorrect water correction factor, or a combination of both. The apparent concentration based on the 609-keV peak appears to increase more than that based on the 1764-keV peak because the water correction factor decreases with increasing energy level. If the source of the gamma photons is within the water, then there is less attenuation than would be expected, and the effect of the water correction is an apparent increase in the calculated concentration. Alternatively, the water correction factor may be too high, resulting in the apparent increase. At this time, the apparent increase in ^{238}U at groundwater is under review, and the water correction will be changed if necessary.

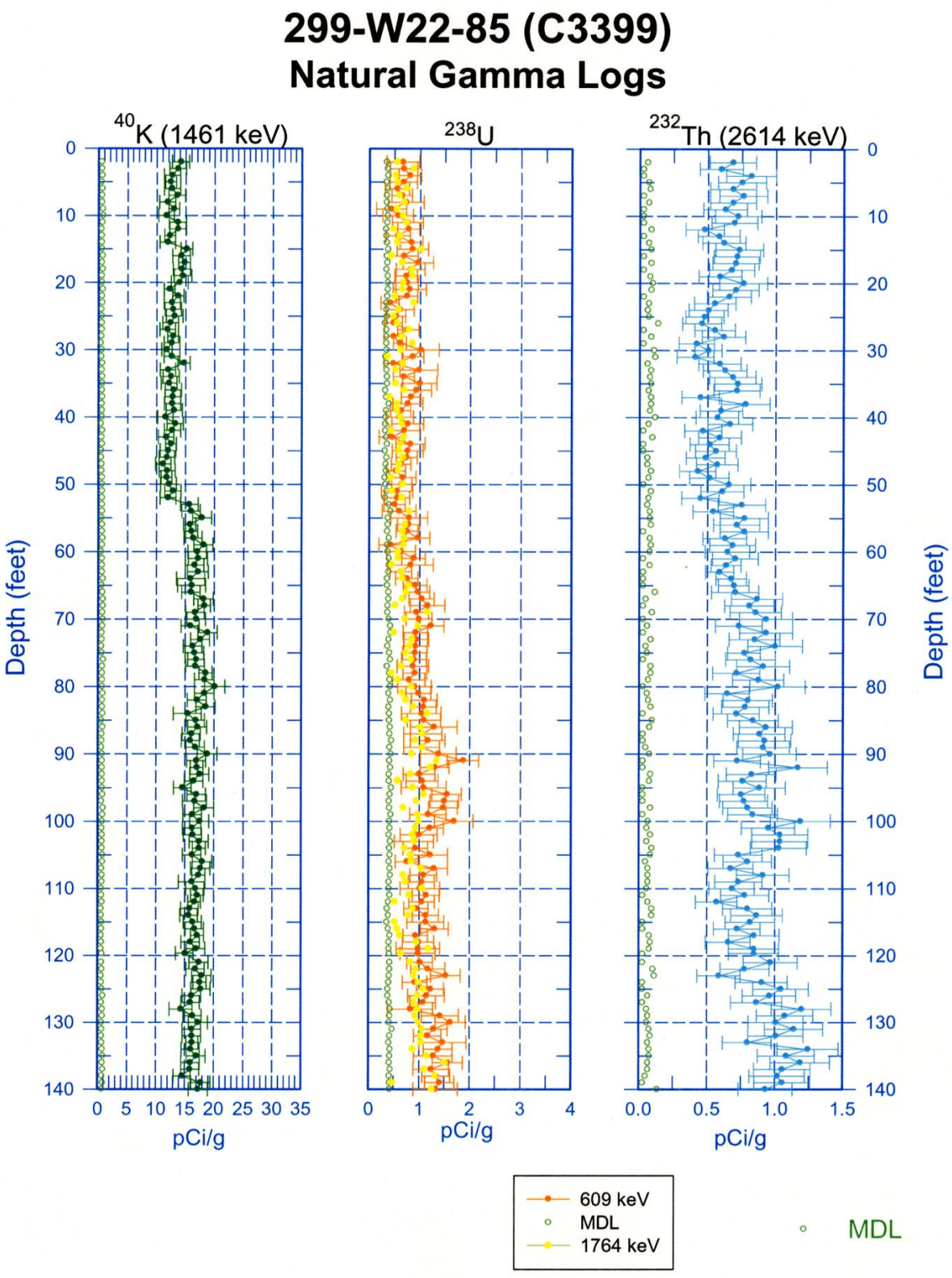
The highest neutron counts occurred in the groundwater as expected. The comparison of the neutron data with the SGLS data is complicated by the differing vertical resolution of the two data sets. The sample

interval of the neutron-moisture log is 1/4 ft versus 1 ft for the SGLS. Thus, the neutron log has a finer vertical resolution than the SGLS logs.

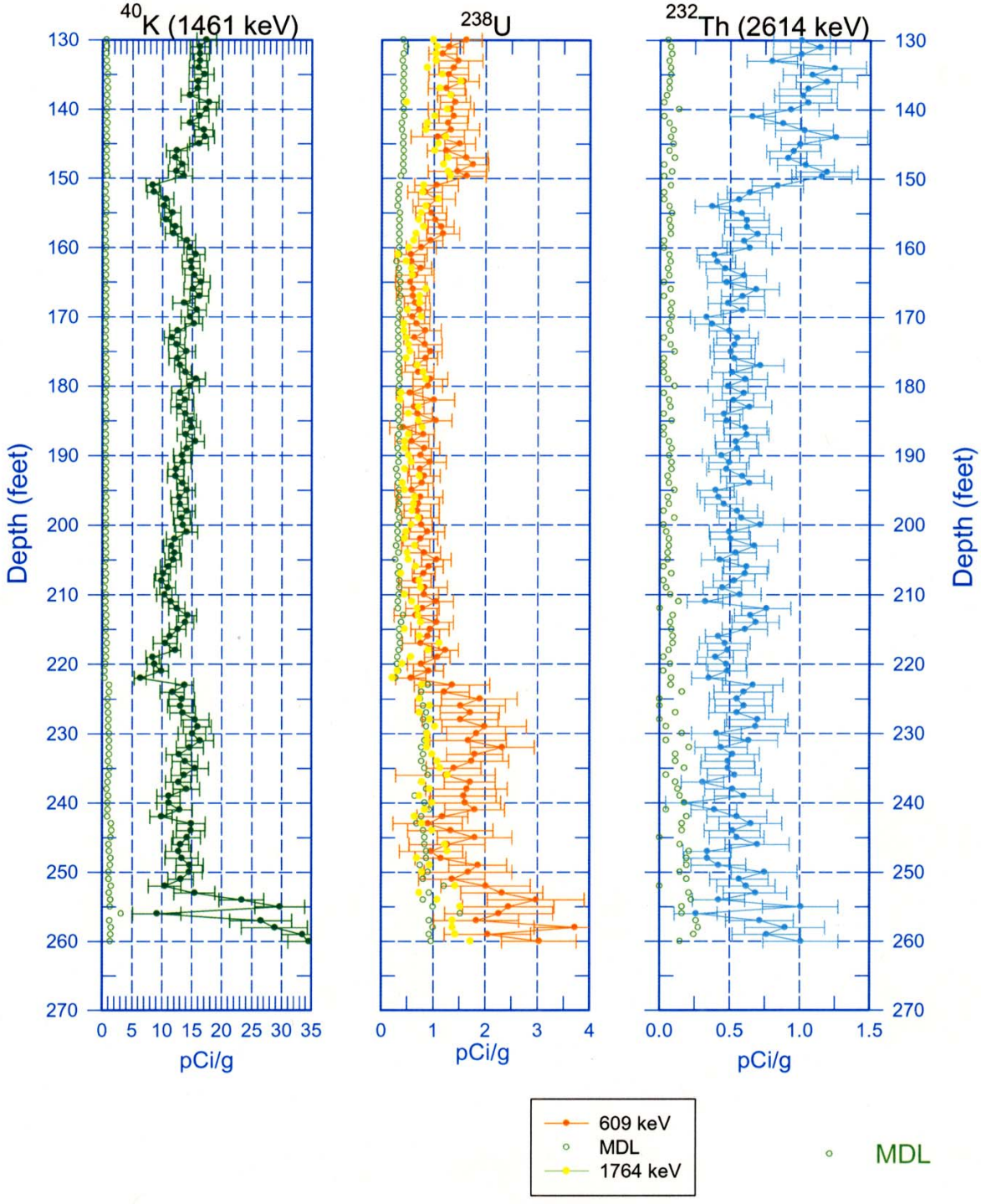
Reference: Randall, R., 2001. *Certificate of Calibration RLSM00.0*, July 11, 2001, Three Rivers Scientific, Richland, Washington.

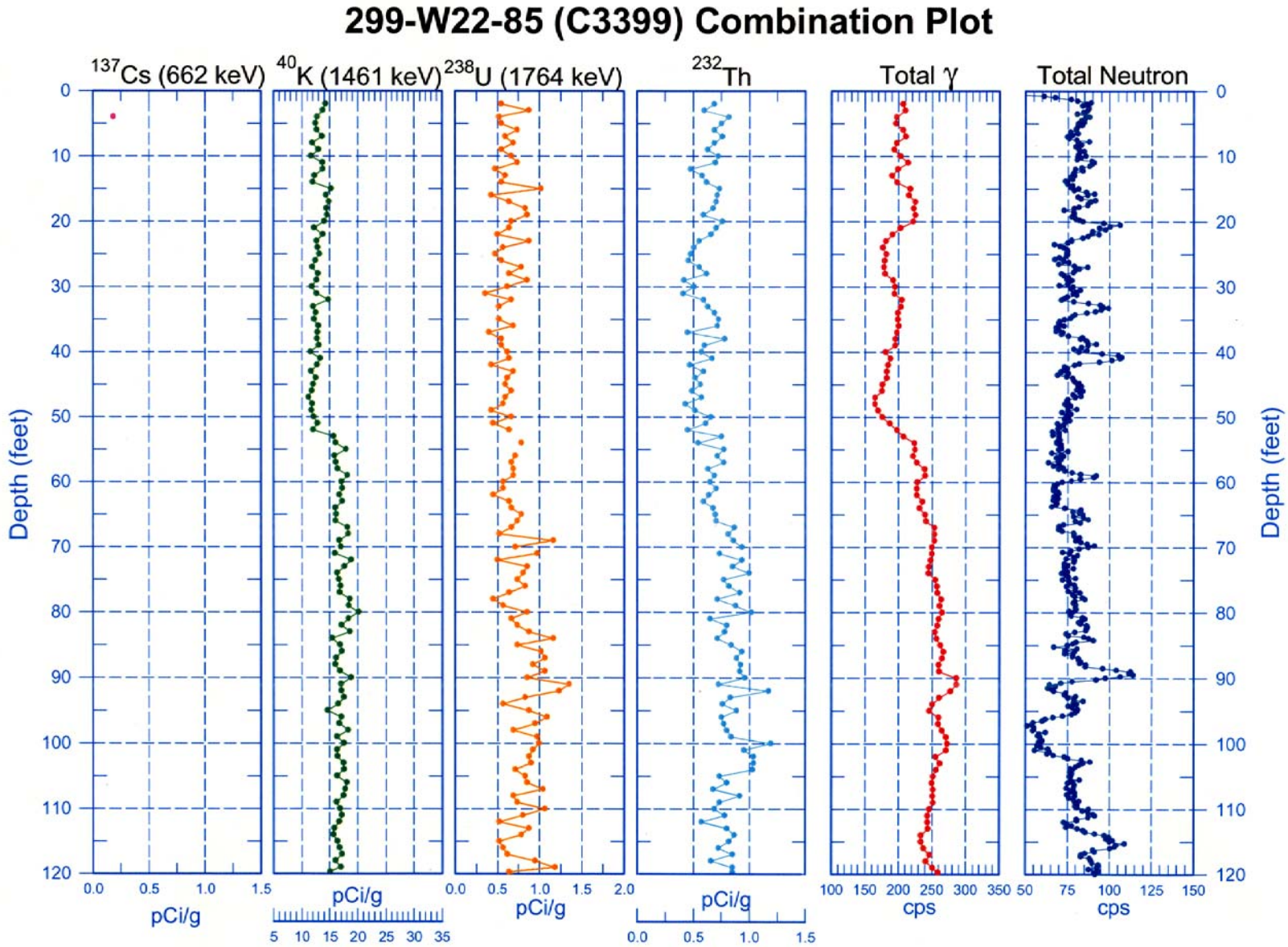
[1] GWL – groundwater level
[2] TOC – top of casing
[3] N/A – not applicable

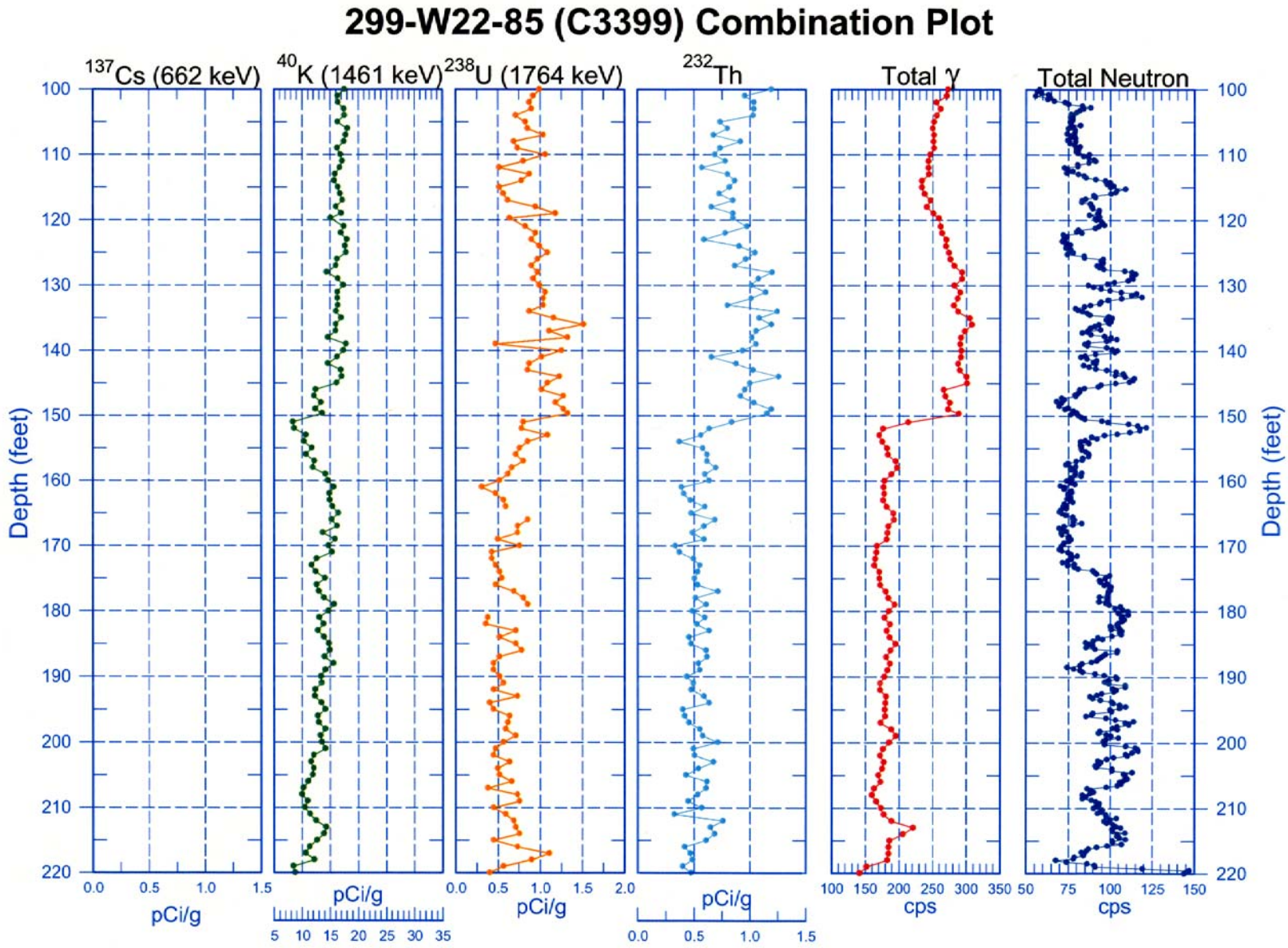

299-W22-85 (C3399)
Man-Made Radionuclide Concentrations
137 Cs (662 keV)
137 Cs (662 keV)
Depth (feet)
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
0.0
0.5
1.0
1.5
pCi/g
pCi/g
MDL

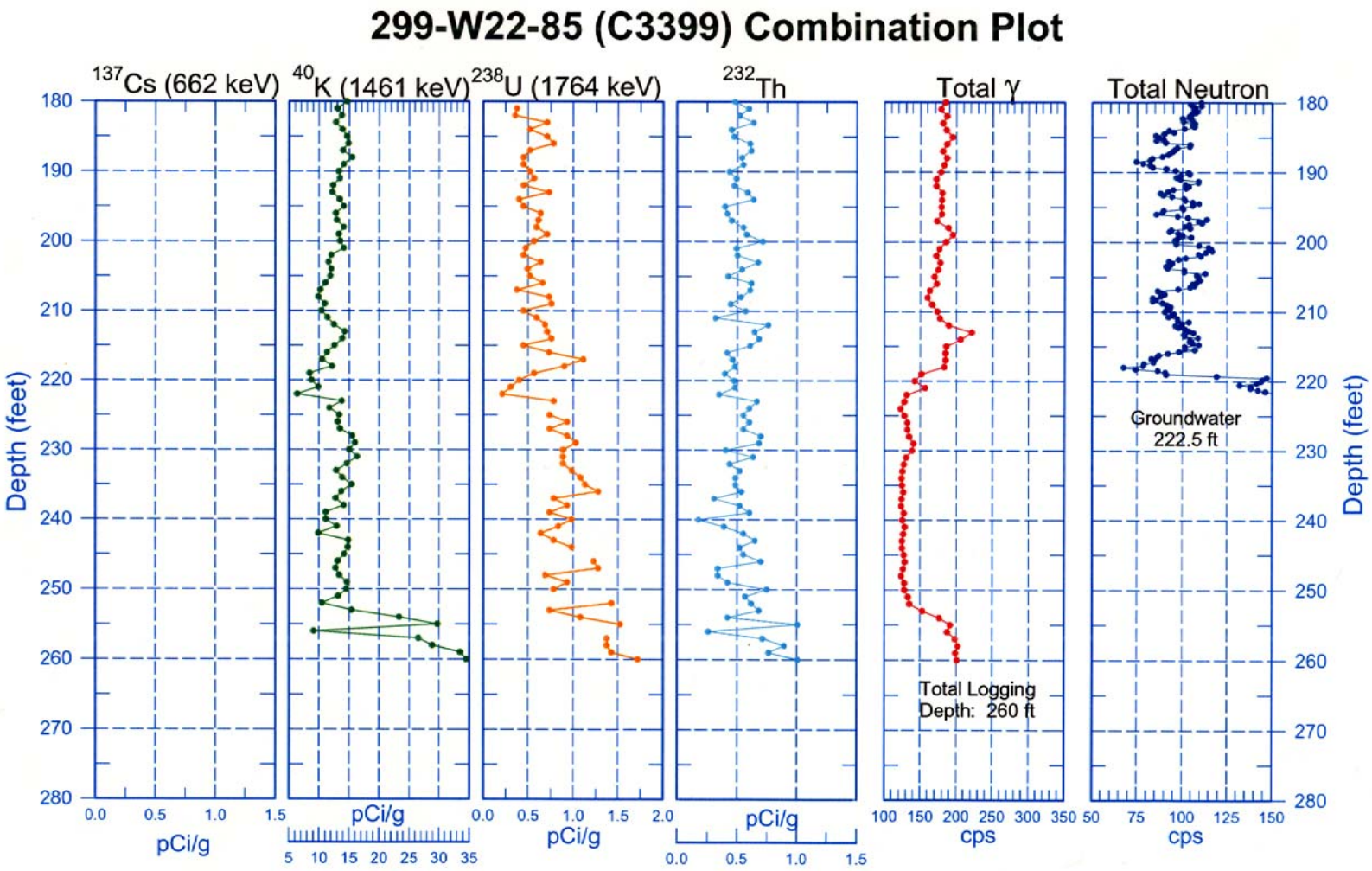

299-W22-85 (C3399)
Natural Gamma Logs
40K (1461 keV)
238U
232Th (2614 keV)
Depth (feet)
0 5 10 15 20 25 30 35
pCi/g
0 1 2 3 4
pCi/g
0.0 0.5 1.0 1.5
pCi/g
609 keV
MDL
1764 keV
MDL

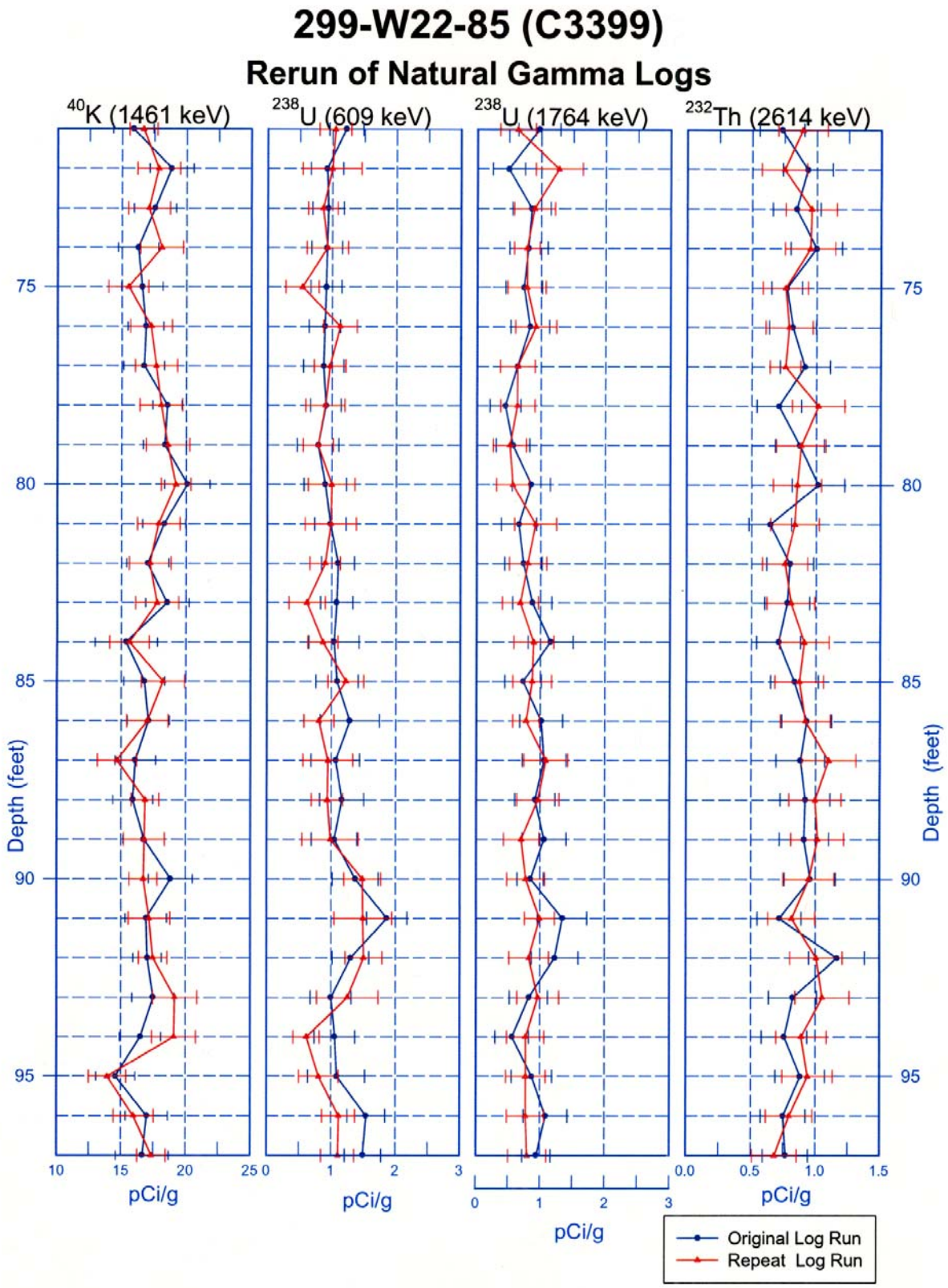
299-W22-85 (C3399)
Natural Gamma Logs

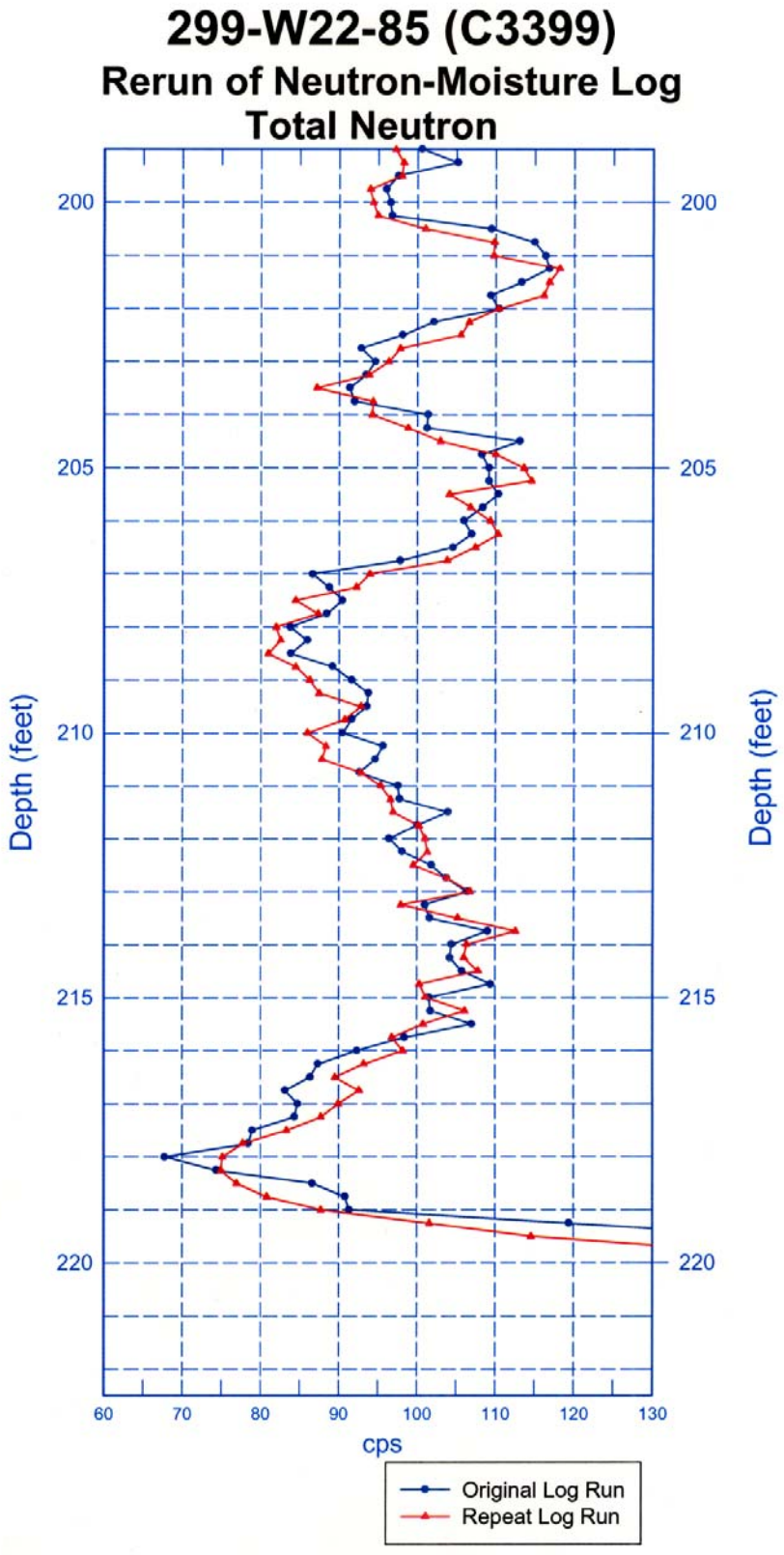


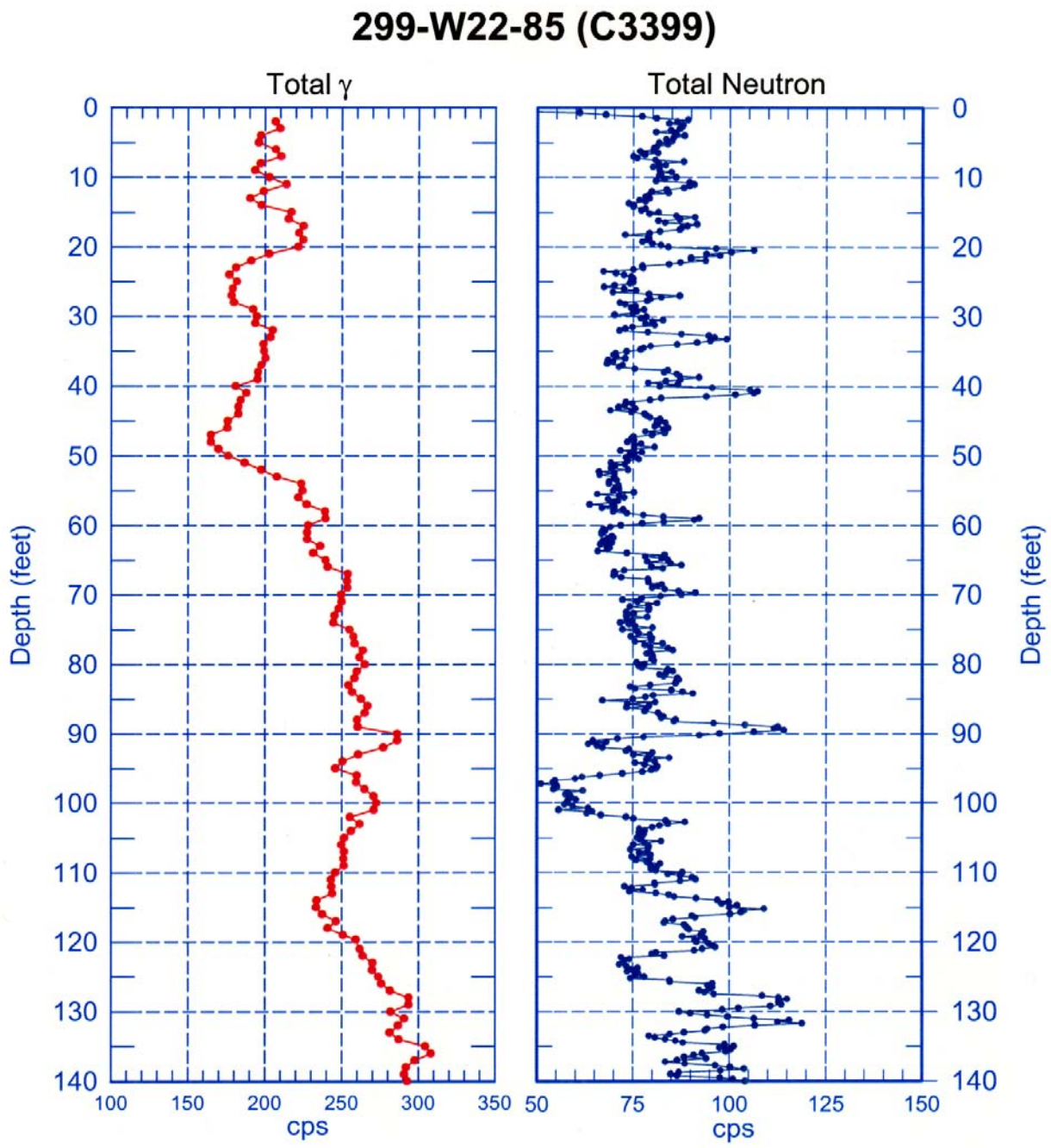

299-W22-85 (C3399) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (1764 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps

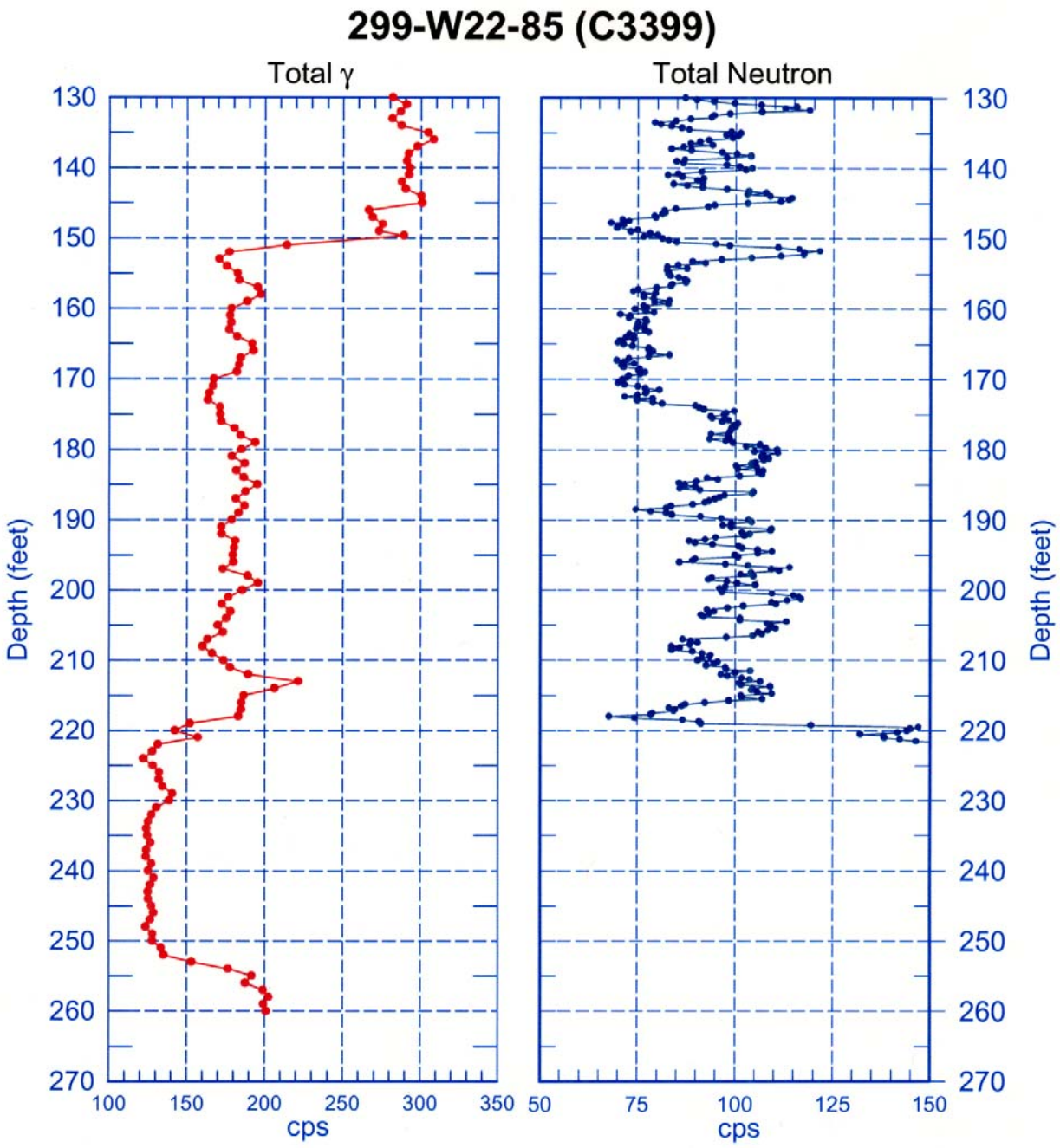

299-W22-85 (C3399) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (1764 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps


299-W22-85 (C3399) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (1764 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps
Groundwater
222.5 ft
Total Logging
Depth: 260 ft


299-W22-85 (C3399)
Rerun of Natural Gamma Logs
40K (1461 keV)
238U (609 keV)
238U (1764 keV)
232Th (2614 keV)
Depth (feet)
75
80
85
90
95
10 15 20 25
0 1 2 3
0 1 2 3
0.0 0.5 1.0 1.5
pCi/g
Original Log Run
Repeat Log Run


299-W22-85 (C3399)
Rerun of Neutron-Moisture Log
Total Neutron
200
205
210
215
220
Depth (feet)
60
70
80
90
100
110
120
130
cps
Original Log Run
Repeat Log Run


299-W22-85 (C3399)
Total γ
Total Neutron
Depth (feet)
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
100
150
200
250
300
350
50
75
100
125
150
cps
cps


299-W22-85 (C3399)
Total γ
Total Neutron
Depth (feet)
Depth (feet)
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
100
150
200
250
300
350
50
75
100
125
150
cps
cps

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